

348

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Government of India
Ministry of Water Resources

WATERSHED ATLAS OF INDIA



Central Water Commission
Ministry of Water Resources
Sewa Bhawan, R.K. Puram
New Delhi – 110 066



National Remote Sensing Centre
ISRO, Department of Space
Govt. of India, Balanagar
Hyderabad – 500 037



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इंडिया-वारिस India-WRIS

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देश में जल संसाधन आँकड़ों का जनन व वेब सामर्थ्य सूचना प्रणाली का क्रियान्वयन
Generation of Database and Implementation of Web Enabled Water Resources
Information System (India-WRIS) in the country

Preface

India is endowed with a rich and vast diversity of natural resources in general and water in particular. The National Water Policy of India (2002) recognizes that development and management of water resources need to be governed by national perspectives in order to develop and conserve the scarce water resources in an integrated and environmentally sound basis. The policy emphasizes the need for effective management of water resources by intensifying research efforts in use of remote sensing technology and developing an information system. In this reference a Memorandum of Understanding (MoU) was signed on December 3, 2008 between the Central Water Commission (CWC) and National Remote Sensing Centre (NRSC), Indian Space Research Organisation (ISRO) to execute the project “Generation of Database and Implementation of Web enabled Water resources Information System in the Country” short named as India-WRIS WebGIS.

India-WRIS WebGIS has been developed and is in public domain since December 2010 (www.india-wris.nrsc.gov.in). It provides a ‘Single Window solution’ for all water resources data and information in a standardized national GIS framework and allow users to search, access, visualize, understand and analyze comprehensive and contextual water resources data and information for planning, development and Integrated Water Resources Management (IWRM).

Watersheds play a critical role in the natural functioning of the earth thus considered as one of the primary planning units in the field of natural resource management. It is not only the hydrological unit but also socio-political-ecological entity, determining food, social, and economical security and provides life support services to people. Watershed management is a way of looking at relationships among people, land and water.

The ‘Watershed Atlas of India’ is one of the outcomes under India-WRIS project and has been prepared using large scale drainage network, Digital Elevation Model (DEM) and other ancillary data. It depicts distribution of watersheds in basins and sub-basins of the country along with its major water resource assets, hydrological observatories, terrain characteristics, rainfall variability and land use / land cover.

This atlas will be an important digital database for planning and monitoring of development programmes being implemented in the country on watershed basis. It will serve as a uniform baseline for developing hydrologic unit based data bank to be used for water resources management.

Acknowledgement

The 'Watershed Atlas of India', is an outcome of the project "Generation of Database and Implementation of Web enabled Water resources Information System in the Country" short named as India-WRIS WebGIS jointly executed by the Central Water Commission (CWC) and National Remote Sensing Centre (NRSC), Indian Space Research Organization (ISRO).

This Atlas is published based on the work of systematic and scientific delineation of hydrological units of the country in hierarchical manner along with analysis of various GIS layers created under this project by the project team.

We, on behalf of the authors and India-WRIS project team, acknowledge; Shri Alok Rawat, Secretary, Ministry of Water Resources; Mrs. Sudha Midha, Additional Secretary, Ministry of Water Resources; Er. A. B. Pandya, Chairman, Central Water Commission; Dr. K. Radhakrishnan, Chairman, Indian Space Research Organization and Secretary, Department of Space; Shri Sudarsanam Srinivasan, Secretary to GOI and Member-Finance, Department of Space; Shri A. Vijay Anand, Additional Secretary, Department of Space; Dr. V. Koteswara Rao, Scientific Secretary, ISRO; Dr. V. Jayaraman, Ex-Director, NRSC for constant encouragement and guidance, technical discussions and for evincing keen interest in India-WRIS project and this atlas.

Our foremost acknowledgement is towards India-WRIS project team who created and organized large number of data sets and information in GIS format as seamless layers and attribute data for the entire country which served as base for this atlas. Thanks are also due to all CWC and NRSC / ISRO officials who carried out the quality assurance and shown their enthusiastic involvement. Finally, our sincere thanks are to all divisions and officials of NRSC and CWC for their valuable support during the preparation of this atlas.

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Contents

Preface	iii
Acknowledgement	iv
Section 1: Introduction	1
1.1 Water Resource Scenario in the Country	2
1.2 Concept of Watershed	3
1.3 Hydrological Units Delineation in the Country-Earlier Attempts	3
1.4 Present Initiative of Hydrological Units Delineation	4
Section 2: Methodology for Delineation and Codification of Hydrological Units	5
2.1 Data/ Software Used	6
2.2 Stages of Hydrological Units Delineation	7
2.3 Detailed Procedure for Delineation and Codification of Hydrological Units	7
2.3.1 Creation of Depression less DEM	7
2.3.2 Generation of Flow Direction	8
2.3.3 Computation of Flow Accumulation	8
2.3.4 Visualization of High Flow Pathway/Stream Network by Applying Threshold	9
2.3.5 Identifying the Pour Points and Hydrological Unit Delineation	9
2.3.6 Validation & Editing of Delineated Hydrological Unit Boundary	10
2.3.7 Codification of Hydrological Units	10
2.4 Scope for Further Delineation	12
Section 3: Rainfall and Elevation Zones of India	13
3.1 Average Annual Rainfall (1971-2005)	14
3.2 Average Monthly Rainfall (1971-2005)	15
3.3 Elevation Zone	16
Section 4: Hydrology of India	17
4.1 Hydrology of India - Divisions	18
4.2 Hydrology of India - Regions	19
4.3 Basins in India & Adjoining Countries	20
4.4 CWC Basins	21
4.5 India-WRIS Basins	22
4.6 CWC Basins & India-WRIS Basins (A Comparison)	23
4.7 India-WRIS Sub Basins	24
4.8 Watersheds of India	28

Contents

Section 5: Basin wise Watersheds	29
5.1 Indus	30
5.2 Ganga	47
5.3 Brahmaputra	71
5.4 Barak and Others	77
5.5 Godavari	83
5.6 Krishna	94
5.7 Cauvery	104
5.8 Subernarekha	110
5.9 Brahmani and Baitarni	114
5.10 Mahanadi	119
5.11 Pennar	125
5.12 Mahi	130
5.13 Sabarmati	135
5.14 Narmada	140
5.15 Tapi	146
5.16 West Flowing Rivers South of Tapi	152
5.17 East Flowing Rivers between Mahanadi and Godavari	160
5.18 East Flowing Rivers between Godavari and Krishna	165
5.19 East Flowing Rivers between Krishna and Pennar	169
5.20 East Flowing Rivers between Pennar and Cauvery	173
5.21 East Flowing Rivers South of Cauvery	178
5.22 West Flowing Rivers of Kutch and Saurashtra including Luni	183
5.23 Minor Rivers Draining into Bangladesh	192
5.24 Minor Rivers Draining into Myanmar	197
5.25 Area of North Ladakh not Draining into Indus	202
5.26 Drainage Area of Andaman & Nicobar Islands	202
5.27 Drainage Area of Lakshadweep Islands	202
Authors	203
India-WRIS Project Team	204
References	205

List of Figures

Figure 1: Creation of Depression less DEM	8
Figure 2: Generation of Flow Direction	8
Figure 3: Computation of Flow Accumulation	9
Figure 4: Flow Chart for Hydrological Units Delineation	10
Figure 5: Hierarchy and Codification of Hydrological Units	11
Figure 6: Watershed Codification	12

List of Table

Table 1 : Hierarchy and Codification of Hydrological Units	10
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List of Abbreviations

%	Percent
AISLUS	All India Soil and Land Use Survey
Avg.	Average
B/W/A	Barrage/Weir/Anicut
BCM	Billion Cubic Meter
CGWB	Central Ground Water Board
CM	Centimeter
CWC	Central Water Commission
CWPC	Central Water and Power Corporation
DEM	Digital Elevation Model
EFR	East Flowing Rivers
FF	Flood Forecasting stations
G	Gauge stations
GD	Gauge and Discharge stations
GDQ	Gauge, Discharge and Water Quality stations
GDS	Gauge, Discharge and Sediment stations
GDSQ	Gauge, Discharge, Sediment and Water Quality stations
HO	Hydro-Meteorological Observations
India-WRIS	India-Water Resource Information System
IRS	Indian Remote Sensing Satellites
ISRO	Indian Space Research Organization
LISS	Linear Imaging Self Scanning Sensor
LSC	Live Storage Capacity
Max.	Maximum
MCM	Million Cubic Meter
Min.	Minimum
NCIWRDP	National Commission for Integrated Water Resource Development Plan
SLUSI	Soil & Land Use Survey of India
SOI	Survey of India
Sq. km	Square Kilometer
SRTM	Shuttle Radar Topography Mission

Section-1

Introduction

Introduction

Water is the essential resource to sustain life in this universe. Life is not possible without water. The existence of the plant and animal kingdoms depends on water. Water is essential for irrigation, generation of hydro-electricity, navigation and industries. India has a rich heritage of water conservation.

1.1 Water Resource Scenario in the Country

On an average, every year India gets 4,000 billion cubic meters (BCM, 1 BCM = 1 cu km) of water by way of mostly rainfall and some snowfall. However, there are considerable spatial and temporal variations in the distribution of rainfall and hence in availability of water in time and space in the country. It is estimated that out of the 4000 BCM water, 1869 BCM is available water resource. Out of this the quantity that can be put to use (Utilizable) is only 1123 BCM (690 BCM from surface water resources and 433 BCM from ground water resources). The water demand in the year 2000 was 634 BCM and it is going to be 1093 BCM by the year 2025. Efforts, therefore, need to be made to increase the utilizable quantity by conservation, improving efficiencies and increasing supply sources.

The annual average rainfall of our country is about 118.28 cm. Mean (1901-2003) rainfall of July is 286.5 mm, which is the highest and contributes 24.2 % of annual average rainfall. The August rainfall is slightly lower and it contributes 21.2% of annual average rainfall. June and September rainfall are almost similar and they contribute 13.8 % and 14.2 % of annual average rainfall respectively. The mean south-west monsoon rainfall (87.72 cm) contributes 74.2 % of annual average rainfall. Contribution of pre-monsoon rainfall and post-monsoon rainfall in annual average rainfall is mostly the same (11%). Coefficient of variation is higher during the months of November, December, January and February (Guhathakurta and Rajeevan, 2006). Majority of this precipitation runs off to sea resulting water scarcity in summer seasons especially in dryland areas where there is no source of irrigation facility. In such cases many resorts to ground water over utilization to meet demands. It has led to declining of groundwater level in many parts of the country.

Also, it does not rain equally all over the country. The west coast, east coast, West Bengal, Bihar and north-eastern States have adequate rainfall whereas insufficient rainfall occurs in north-western region, south Indian plateau and mid-Gangetic plains. Floods may occur in the heavy rainfall areas whereas drought breaks out in the low rainfall areas.

Sometimes the summer south-west monsoons break late and close earlier, and in some years break earlier and close earlier too. Again at times it doesn't rain in the growing period of crops in the months of July and August. Sometimes late monsoons also damage crops; therefore, this monsoon rainfall is very uncertain. As a result of such irregular, unequal and uncertain monsoon rainfall, natural calamities like flood and drought have their devastating effects in our country. About one third of the country's area is drought prone. The south and western parts comprising the states of Rajasthan, Gujarat, Andhra Pradesh, Madhya Pradesh, Maharashtra, Tamil Nadu and Karnataka are the drought prone states. On the other hand, north and north eastern regions including states of Uttar Pradesh, Bihar, West Bengal and Assam are subjected to periodic flooding. This occurrence of flood and drought has adverse impact on food production and also causes substantial loss of fertile top soil and country's wealth. Therefore, integrated development and management of water resources of the country with scientific data base is a pre-requisite for achieving sustainable development.

Water resource development needs to be at both macro and micro levels. Construction of large dams and reservoirs for irrigation and power generation are covered under macro level whereas development programmes at watershed level primarily for conservation of soil and water resources are covered under micro level.

1.2 Concept of Watershed

Watersheds play a critical role in the natural functioning of the Earth thus considered as one of the primary planning units in the field of natural resource management. Watershed approach is more rational because land and water resources have optimum interaction and synergetic effect when developed on watershed basis. The hydrologic unit boundary is important for determining what areas are involved in contributing runoff, sediment, and pollutants. The Watershed or hydrological unit is considered as scientific and appropriate base for necessary surveys and investigations for assessment of natural resources and subsequent planning and implementation of various development approaches. Drainage basin or hydrologic-unit maps are necessary tools for many water-resource studies such as flood assessments, water-quality sampling, water-use reporting, watershed protection, conservation planning, and resource management.

Watershed boundaries define the aerial extent of land surface from which the runoff flows to a defined drain, channel, stream or river at any particular point. It's a general phenomenon governed by the topography of the terrain. The boundary between two adjacent watersheds is called the drainage divide line. Pour point is the point at which the water flows out of the area. This is the lowest point in elevation along the boundary or the drainage lines. Depending on the size and topography, watersheds can contain numerous tributaries, such as streams and ditches, and ponding areas such as detention structures, natural ponds and wetlands.

Boundary of any watershed plays an important role because hydrologic processes can be described, and to some degree controlled or managed within a watershed. As watershed boundaries are scalable, in that one can define a watershed large enough to exhibit or accommodate the ecological processes of interest. Multiple sizes of watersheds can be delineated, and they can be nested for hierarchical analysis.

1.3 Hydrological Units Delineation in the Country-Earlier Attempts

The systematic delineation of river basins was first attempted in 1949 by Central Water and Power Corporation (CWPC) under the able leadership of Dr. A. N. Khosla, in which entire country has been distinctly, delineated into 6 water resources regions. These regions have been further divided into 66 major river catchments. It has been extensively used in the planning and development of surface water resources of the country. In this context, codification of river systems of India was done by Mansinghal Consultants in 1970. The firm adopted the methodology based on the area concept. The suggested hydrological units are: water resource region, river basins, river sub-basin, watershed, sub-watershed, mini-watershed and micro-watershed. The recommended size of the watershed is in the range of 250 -750 Sq. km (CGWB, 2006).

One of the major landmark works in this direction was done by the All India Soil and Land Use Survey (AISLUS) presently known as SLUSI (Soil & Land Use Survey of India), Dept. of Agriculture and Cooperation. A National level Watershed Atlas on 1: 1 million scale was published in 1990 using the base map generated from Irrigation Atlas of India (AIS&LUS, 1990). This atlas is being extensively used in the country for various purposes. These maps are available in hard copy and require digitization for integration in GIS platform. Latter based on demand for digital spatial data for effective implementation of all land based development programmes, they updated, revised and published second edition of the Watershed Atlas of India (SLUSI, 2012). It contains hydrological units of the country categorised in five stages viz. region, basin, catchment, sub-catchment and watershed. The river systems of the country have been divided into 6 water resources region viz., Indus drainage, Ganges drainage, Brahmaputra drainage, all drainage flowing into Bay of Bengal except the Ganges and Brahmaputra, all drainage flowing into Arabian Sea except the Indus and the ephemeral drainage in Rajasthan. These have been further divided into 37 basins and 117 catchments, 588 sub-catchments and 3851 watersheds.

The effort was also made by Central Ground Water board (CGWB) in this direction under Hydrology Project phase I where Watershed Atlas on 1:250,000 scale has been prepared (CGWB, 2006). The drainage maps of Survey of India (SOI) on 1:250,000 scales have been used as base map for the delineation of basin, sub-basin and watershed. Major drainages along with their names were derived from SOI topsheets on 1:250,000 scale. In this atlas, the entire river systems of the country have been divided into 34 basins, 94 Sub-basins and 3448 watersheds.

Delineation of river basins of the country was also attempted by Central Water Commission (CWC) and National Commission for Integrated Water Resource Development Plan (NCIWRDP) where entire country has been divided into 22 and 24 river basins, respectively.

1.4 Present Initiative of Hydrological Units Delineation

There exist large variation in criteria, methodology and purposes in delineation of hydrological units in the country among various organisations. The attempts made so far for delineation of hydrological boundaries up to watershed level have some limitations. This work on watershed delineation is quite old. Due to lack of detail drainage on smaller scale base map (1:1 million & 1:250,000), precise delineation of watershed was not possible especially in flat terrain areas. However, for effective implementation of water resources development scheme at grass root level there is growing requirement of a larger scale map.

Preparation of a National level watershed atlas on 1:50,000 scale is considered appropriate at present because the standard 1:50,000 scale map series of the country are available, and now a days majority of thematic maps are also being produced on same or larger scale. In this context, hydrological units have been delineated precisely using larger scale drainage network (1:50,000), Digital Elevation Model (DEM) and other ancillary data under joint project between Indian Space Research Organization (ISRO) and Central Water Commission (CWC), entitled "Generation of Database and Implementation of Web Enabled Water Resources Information System (India-WRIS) in the Country."

'Watershed Atlas of India' on 1:50,000 scale will be an important digital database for planning and monitoring of development programmes being implemented in the country on watershed basis. This is the outcome of a systematic and scientific delineation along with its hierarchical alpha-numeric codification. It will serve as a uniform baseline for developing hydrologic unit based data bank to be used for water resources management. Runoff, sedimentation, water balance, evapotranspiration and several other catchment characterization related studies should be taken up on watershed basis. These hydrological unit boundaries should be used by various organisations involved in development activities related to integrated water resources and management on watershed basis. The hydrological unit boundaries up to sub basin level can be downloaded from the India-WRIS WebGIS portal (www.india-wris.nrsc.gov.in).

Section-2

Methodology for Delineation and Codification of Hydrological Units

Methodology for Delineation and Codification of Hydrological Units

Delineating hydrological units has been a strenuous task due to varying geography of India and the base data availability. Size of hydrologic unit is of practical importance in implementation of any land and water resources development programme. A workable size of the hydrological unit is defined by the aim and objective of the particular development programme.

Traditionally, hydrological unit boundaries have been delineated using a visual interpretation of topographic maps. This method, referred to as “manual delineation”, is tedious and time consuming, but historically was considered to be the most effective and accurate method. However, the quality and accuracy of manual delineations are dependent on the scale of the topographic map used, and the delineator’s interpretation of the map (Stanton, 2001). Demarcation of watershed boundary can also be done using field survey. It is not only time consuming but also laborious task. Semi-automated watershed delineation represents an attractive alternative that is potentially more objective, repeatable, cost-effective, and consistent with other digital data sets than manual delineation. The automated extraction of topographic parameters from DEM is recognized as a viable alternative to traditional surveys and manual evaluation of topographic maps, particularly as the quality and coverage of DEM data increases (Qamer et al., 2010).

Semi-automated approach has been adopted under this project for delineation of hydrological unit boundaries using ArcGIS Hydrology Tool and datasets like DEM, larger scale drainage network (1:50,000) and other ancillary data. For delineation of different levels of hydrological units, viz., water resource division, water resource region, basin, sub-basin and watershed, similar methodology has been followed except the criteria for identification of pour point.

2.1 Data/Software Used

- SRTM 90 m DEM: A digital elevation model (DEM) is the three dimensional representation of continuous variation of relief over space. The Shuttle Radar Topography Mission is based on the principal of interferometric SAR. The spatial resolution is 30 m for USA and 90 m for rest of the world. Its horizontal and vertical accuracies are 20 meters and 16 meter, respectively. However, the vertical accuracy of + 10 meters can be achieved (Jarvis et al., 2008).
- SOI topographic maps on 1:50000 scale.
- Drainage network mapped from IRS P6 LISS IV & CARTOSAT merged data of 2011-12 on 1:50000 scale.
- Surface water bodies (location and extend) mapped from IRS P6 LISS IV & CARTOSAT merged data of 2011-12 on 1:50000 scale.
- Location of hydro observation stations: These are maintained by CWC, where hydrological observation parameters such as gauge (river water level), discharge (amount of water released from a cross section in the river in a given time period) and sediments are measured.
- Location of dams.
- ArcGIS version 10.0.

2.2 Stages of Hydrological Units Delineation

Stage I: Water Resource Division

Entire country has been divided into 3 water resource divisions namely, all drainage flowing into Arabian sea, all drainage flowing into Bay of Bengal and Minor rivers draining into other basins/countries (Myanmar, China, and Bangladesh). It highlights the broad drainage pattern of India.

Stage II: Water Resource Region

Water resource divisions have been further subdivided into 6 water resources regions namely, Indus drainage, Rivers draining into Arabian sea, Rivers draining into Bay of Bengal, Brahmaputra drainage, Minor rivers draining into other basins/countries (Myanmar, China, and Bangladesh) and Island drainage.

Stage III: Basin

Each water resource region has been divided into basins which constitute individual big river or a combination of smaller ones which are contiguous to each other. Entire country is covered by 27 basins.

Stage IV: Sub-Basin

Each basin has been divided further into a number of sub-basins which are mostly pertaining to main tributaries or a group of contiguous small tributaries or individual streams. In some of the cases, where the drainage systems are too large, basin is divided into upper, middle and lower sub-basins. 101 sub-basins have been delineated from the above basins.

Stage V: Watershed

Each sub-basin has been divided into a number of watersheds which are the smaller sized hydrologic units in the lower level category based on pour points. Topography and hydrological features as well as area criteria have been considered for placing appropriate pour point. Watersheds are delineated from upstream to downstream. Total 4566 watersheds have been delineated from above sub-basins.

2.3 Detailed Procedure for Delineation and Codification of Hydrological Units

The detailed step by step procedure for delineation using DEM and other ancillary data and codification of hydrological units is as follows:

2.3.1 Creation of Depression less DEM

A DEM that has been processed to remove all sinks and peaks is called a depression less DEM and its profile view is shown in figure 1. To create an accurate representation of flow direction and, therefore, accumulated flow, it is best to use a dataset that is free of sinks or peaks. Sink is an area surrounded by higher elevation values and is also referred to as a depression or pit. This is an area of internal drainage. Some of these may be natural, particularly in glacial or karst areas (Mark 1988), although many sinks are imperfections in the DEM. Likewise, a spike, or peak, is an area surrounded by cells of lower value. These are more commonly natural features and are less detrimental to the calculation of flow direction. Sinks and peaks are often errors due to the resolution of the data or rounding of elevations to the nearest integer value. Sinks should be filled to ensure proper delineation of basins and streams. If the sinks are not filled, a derived drainage network may be discontinuous. It was prepared using "Fill" function of ArcGIS Spatial Analysis hydrology tool.

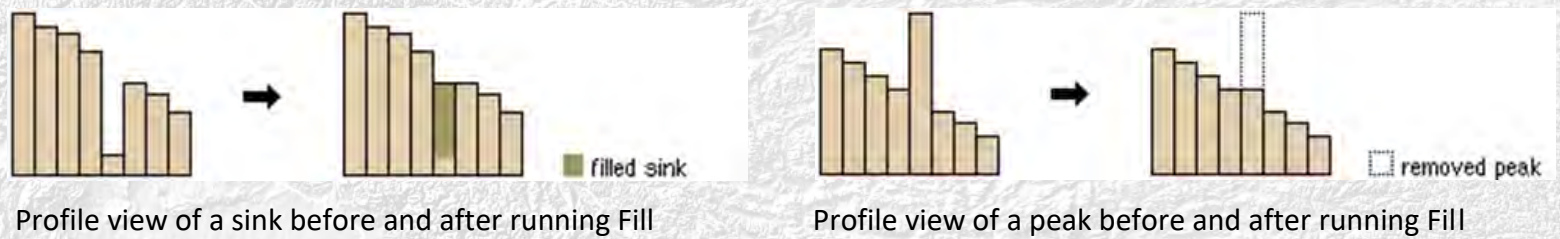


Figure 1: Creation of Depression less DEM

2.3.2 Generation of Flow Direction

It creates raster of flow direction from each cell to its steepest downslope neighbour. Flow direction indicates the direction of flow from every cell in the raster representing the landscape. It is important to know in hydrologic modelling the direction in which a landscape drains and it is shown in figure 2. It was prepared using “Flow Direction” function of ArcGIS Spatial Analysis hydrology tool.

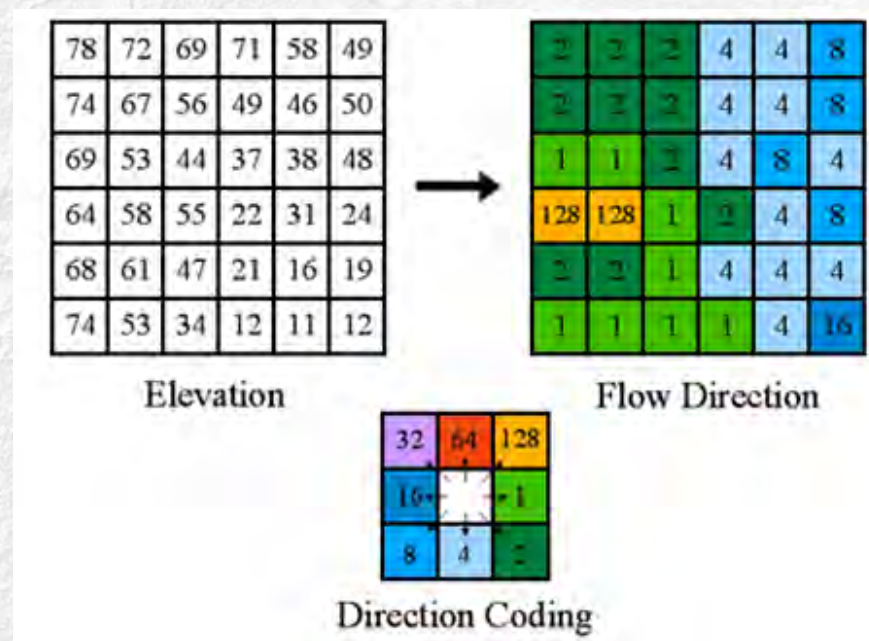


Figure 2: Generation of Flow Direction

2.3.3 Computation of Flow Accumulation

It creates a raster of accumulated flow into each cell. It computes accumulated flow as the accumulated weight of all cells flowing into each downslope cell in the output raster. If no weight raster is provided, a weight of one is applied to each cell, and the value of cells in the output raster will be the number of cells that flow into each cell. The flow accumulation raster has a value for each cell. The value represents the number of cells upstream from that cell. Cells with higher values will tend to be located in drainage channels rather than on hillsides or ridges. Flow accumulations are important because they allow us to locate cells with high cumulative flow and it is shown in figure 3. It was prepared using “Flow Accumulation” function of ArcGIS Spatial Analysis hydrology tool.

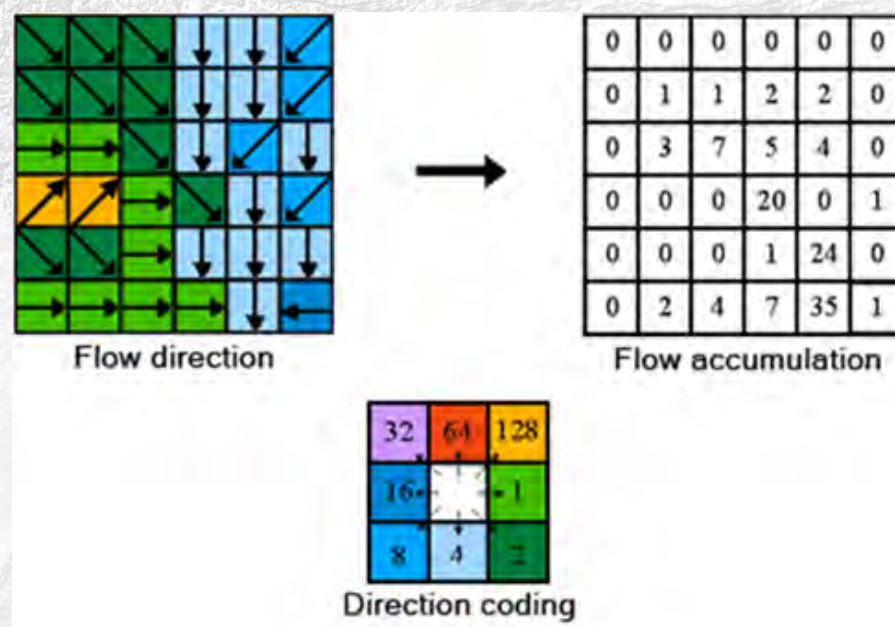


Figure 3: Computation of Flow Accumulation

2.3.4 Visualization of High Flow Pathway/Stream Network by Applying Threshold

By selecting cells with the greatest accumulated flow, a network of high-flow cells can be created. This is nothing but raster representation of stream network. This is required in order to identify and place appropriate outlet for hydrological unit. It was done by classifying flow accumulation raster using symbology tool in ArcGIS. The threshold value is different for different stages of hydrological units and selected on the basis of terrain conditions using trial and error method.

2.3.5 Identifying the Pour Points and Hydrological Unit Delineation

For delineation of hydrological units, pour points (locations for which you want to know the contributing area) need to be identified. It is the point at which water flows out of an area. This is usually the lowest point along the boundary of the hydrological unit. Usually these locations are mouths of streams or other hydrologic points of interest, such as a gauging station or dam. Pour points for larger hydrological units such as water resource division, water resource region, basin and sub-basin are identified based on the criteria given above in stages I to IV.

For smaller hydrological unit like watershed, pour points should be located in cells of high cumulative flow; otherwise the resultant watersheds will be very small and insignificant. Stream network gives an idea about watershed boundary that is contributing flow to that particular pour point; in the meantime the flow accumulation pixel value and resolution of DEM (90 m) gives the idea about the area of that watershed. It is considered that area of watershed will be ranging from 200-1800 sq. km. So topography and hydrological features as well as area criteria are considered for placing appropriate pour point. Ancillary data like topo maps on 1:50000 scale, drainage network and surface water bodies (location and extend) mapped from IRS P6 LISS IV & CARTOSAT merged data, location of hydro observation stations and location of dams are considered for identification of pour points. Pour points are selected based on hydrologic principal only. However, sometimes its location may vary to adjust size and shape of watershed. Hydrological unit boundaries for different levels are delineated based on identified pour points using “Watershed” function of ArcGIS Spatial Analysis hydrology tool.

2.3.6 Validation & Editing of Delineated Hydrological Unit Boundary

Delineated hydrological unit boundary has been validated & edited with reference to ancillary data like topo maps on 1:50000 scale, drainage network and surface water bodies (location and extend) mapped from IRS P6 LISS IV & CAR-TOSAT merged data. Hydrological unit boundary has to match with ridge line on topo maps. It should not cross the drainage line at any location except at outlet. In case of major shifting of derived hydrological unit boundary from ridge line or any conflict between hydrological unit boundary, drainage line and topo contour lines, adjustments have been done manually. The detailed flow diagram for hydrological unit delineation and validation is shown in figure 4.

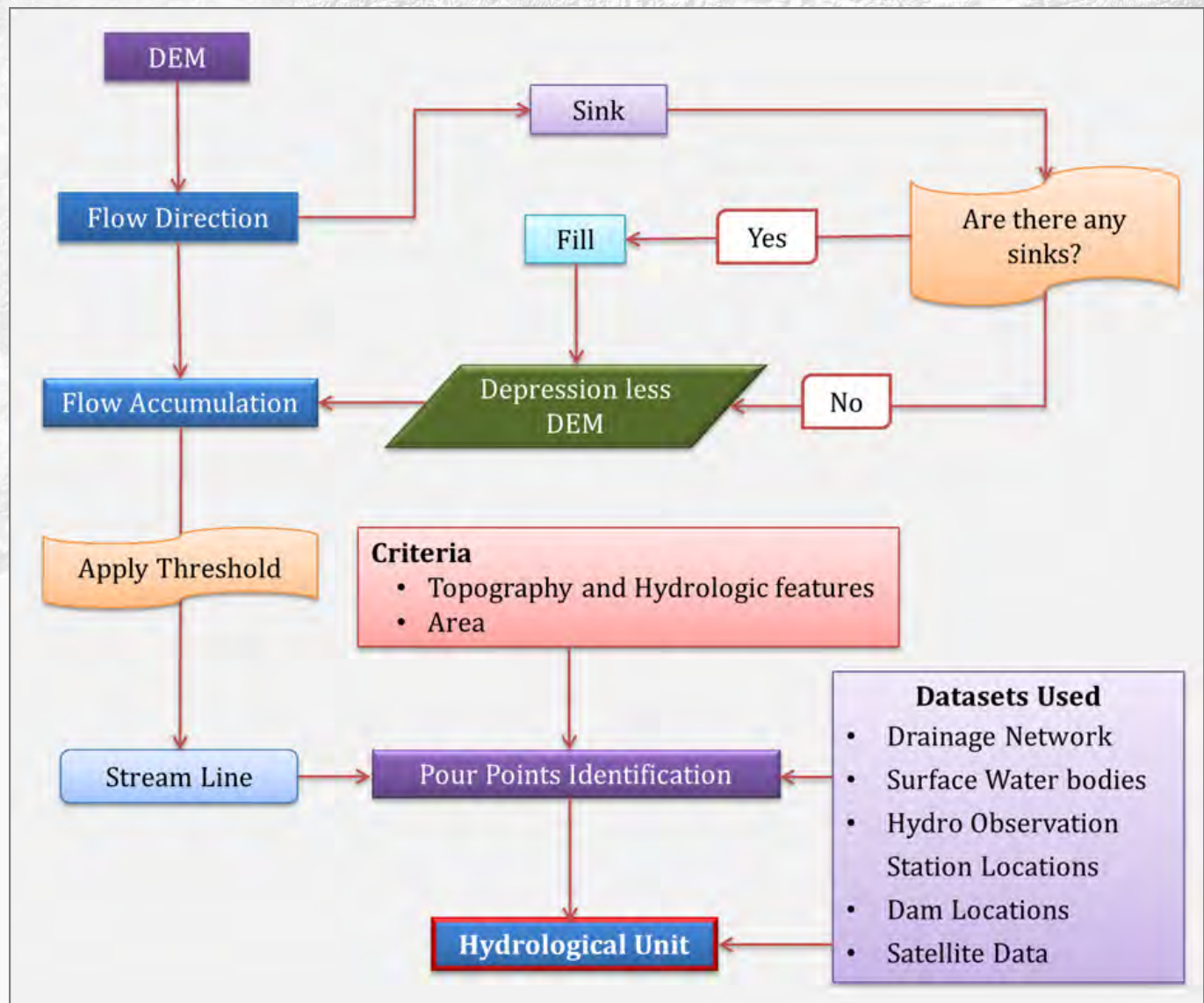


Figure 4: Flow Chart for Hydrological Units Delineation

2.3.7 Codification of Hydrological Units

The codification schema assigns unique code for each category of hydrological unit. Different stages of delineation have been codified in a systematic way using alphanumeric codification system. Following hydrological units and codification schema have been adopted in India-WRIs project (Table 1 & Figure 5).

Table 1: Hierarchy and Codification of Hydrological Units

Sl. No.	Hydrological Unit Boundary	Size Range (Sq. km)	Average Size (Sq. km.)	Width/ Digits	Code
1	Region	8,247 - 20,85,387	6,27,953	1	A - E
2	Basin	669 - 8,08,337	1,17,788	02	1-27
3	Sub basin	669 - 1,24,867	31,485	03	XYZ
4	Watersheds	200 - 1,800	696	02	1-99

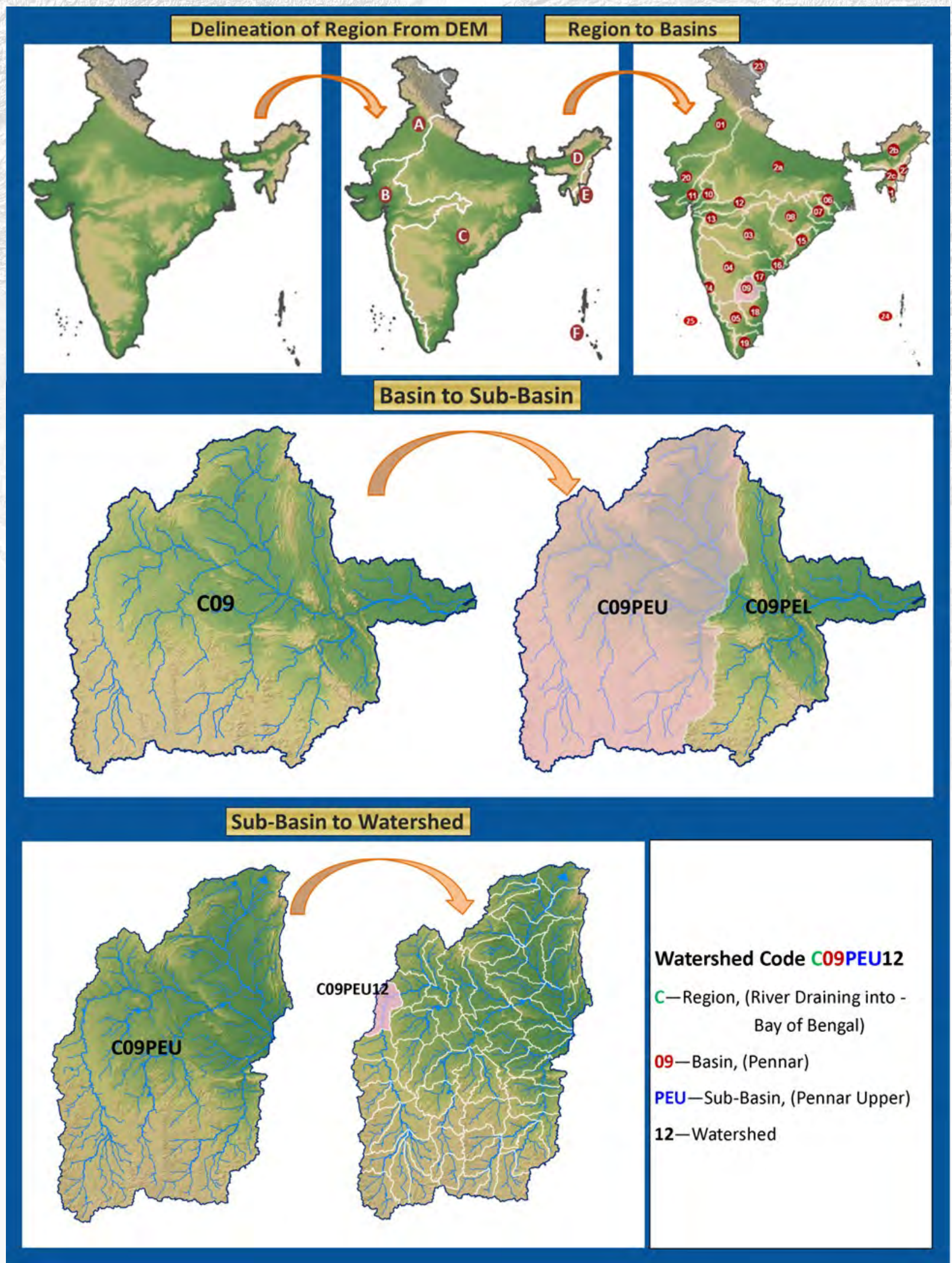


Figure 5: Hierarchy and Codification of Hydrological Units

Codes for watersheds have been assigned from the upstream to downstream direction, sequentially based on the location of the outlet, starting with the uppermost stream outlet. Watershed codification for Cauvery upper sub-basin is shown in figure 6. The downstream code is always a higher number than the upstream code. The main-stem hydrologic unit carries the higher code when outlets are adjacent or break at the same place as shown in figure 13 (watersheds 03 and 05). All numbers from the lowest to the highest have been used and no numbers are skipped. For example, codification has been started at the upstream end of the drainage and code for the first watershed given as 01; code for the next watershed downstream as 02, and so forth. (USGS, 2012).

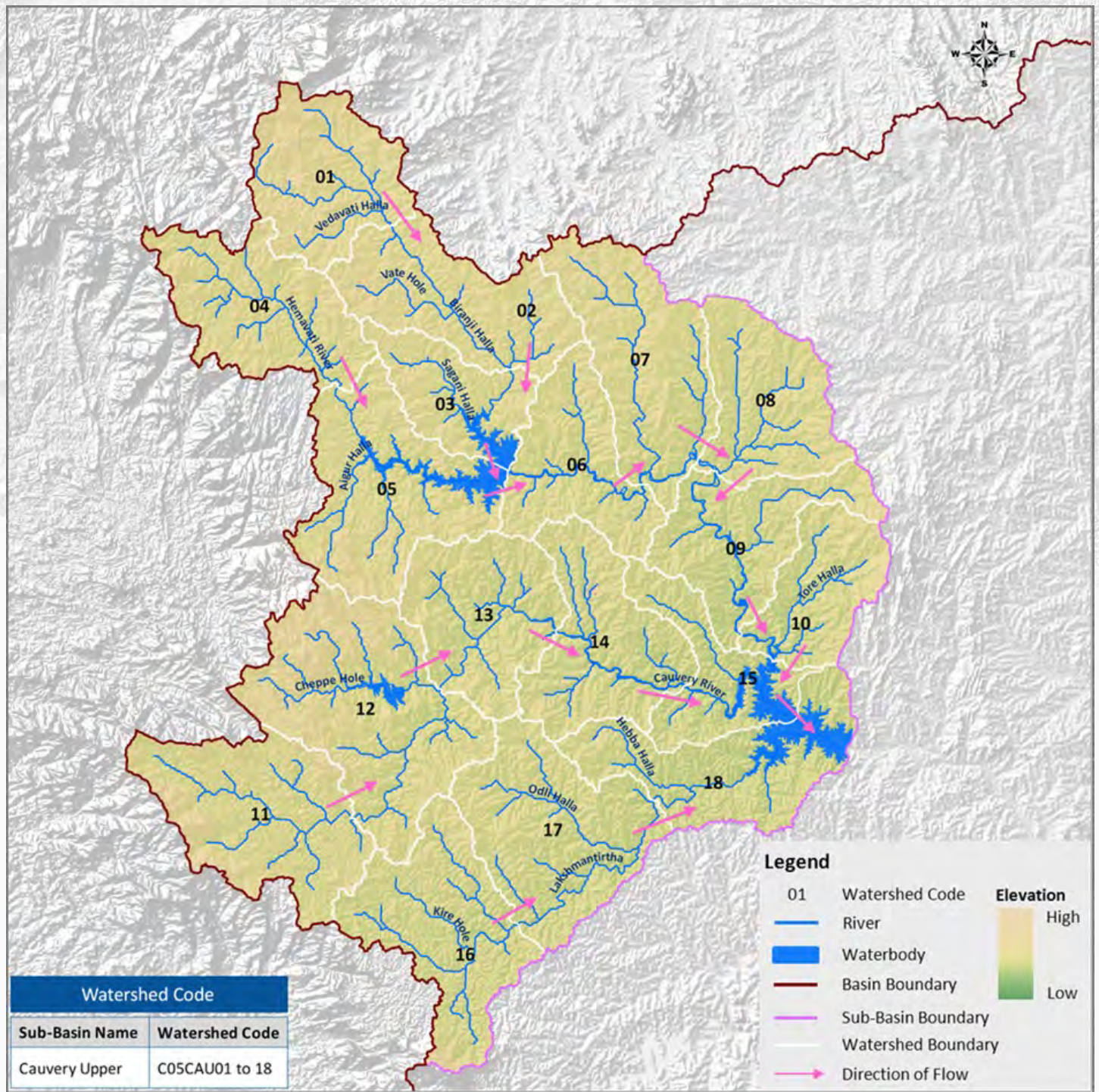


Figure 6: Watershed Codification

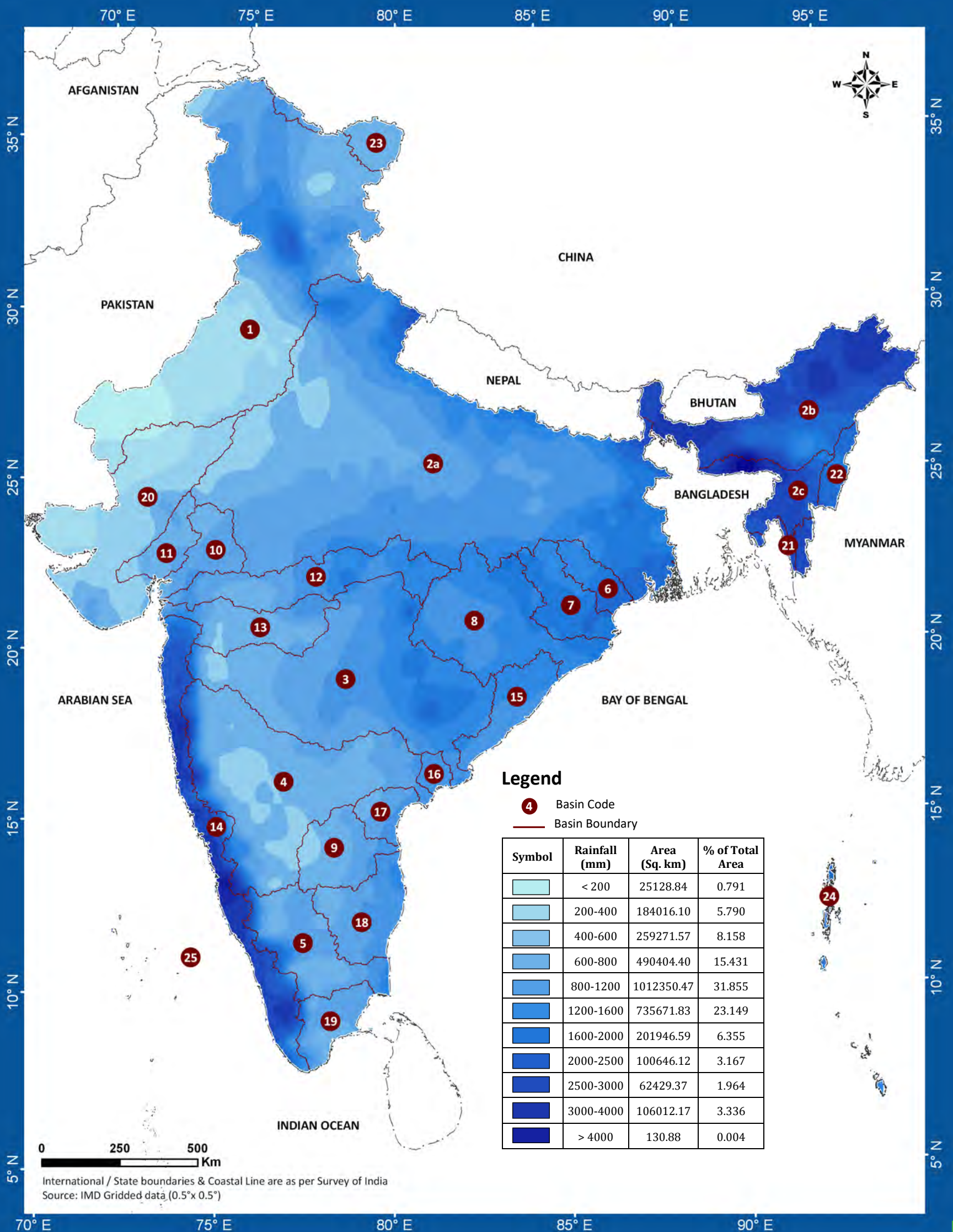
2.4 Scope for Further Delineation

Scale of hydrological unit delineation can be improved further (i.e. larger than 1:50,000 scale) using latest high resolution DEM and satellite data. Implementation of development programs at field level requires precise boundary at much larger scale like 1:4,000. However, these watersheds can be further divided in to number of sub-watersheds and micro-watersheds. Sub-watersheds will be mostly pertaining to small tributaries or a group of contiguous small tributaries. Micro-watersheds will be mostly pertaining to small local tributaries and nallas or a group of contiguous small local nallas.

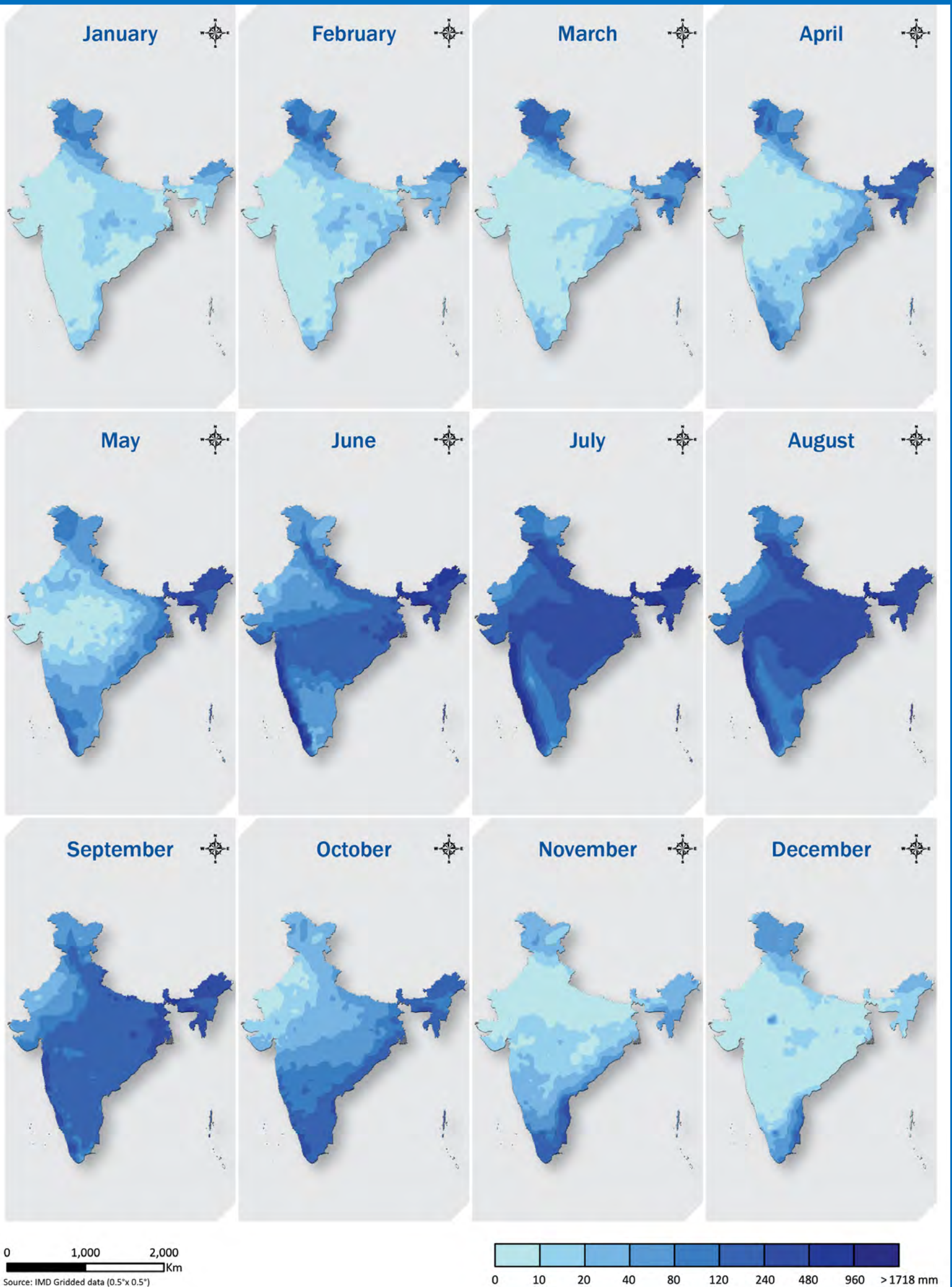
Section-3

Rainfall and Elevation Zones of India

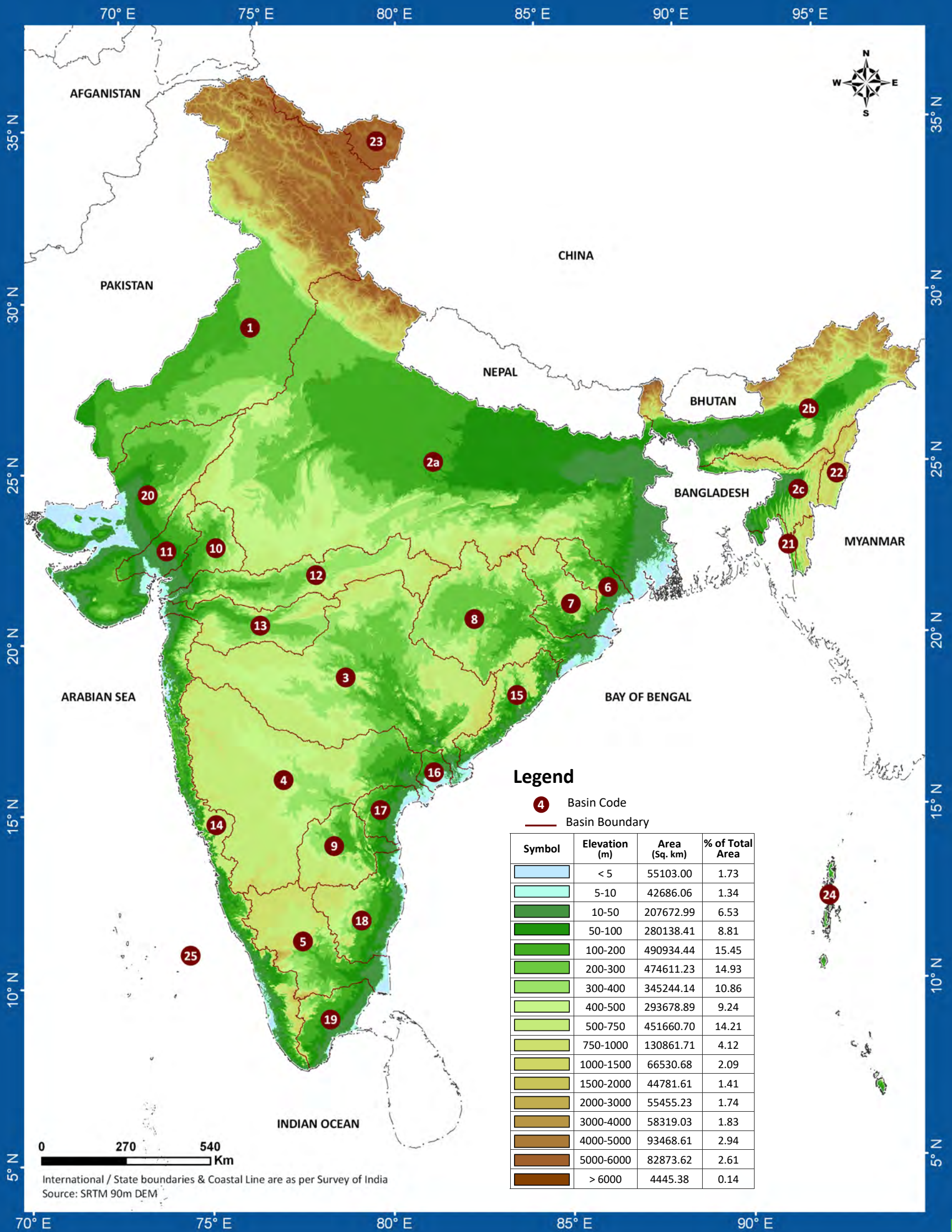
3.1 AVERAGE ANNUAL RAINFALL (1971 - 2005)



3.2 Average Monthly Rainfall (1971-2005)



3.3 ELEVATION ZONE



Section-4

Hydrology of India

4.1 HYDROLOGY OF INDIA - DIVISIONS



4.2 HYDROLOGY OF INDIA - REGIONS



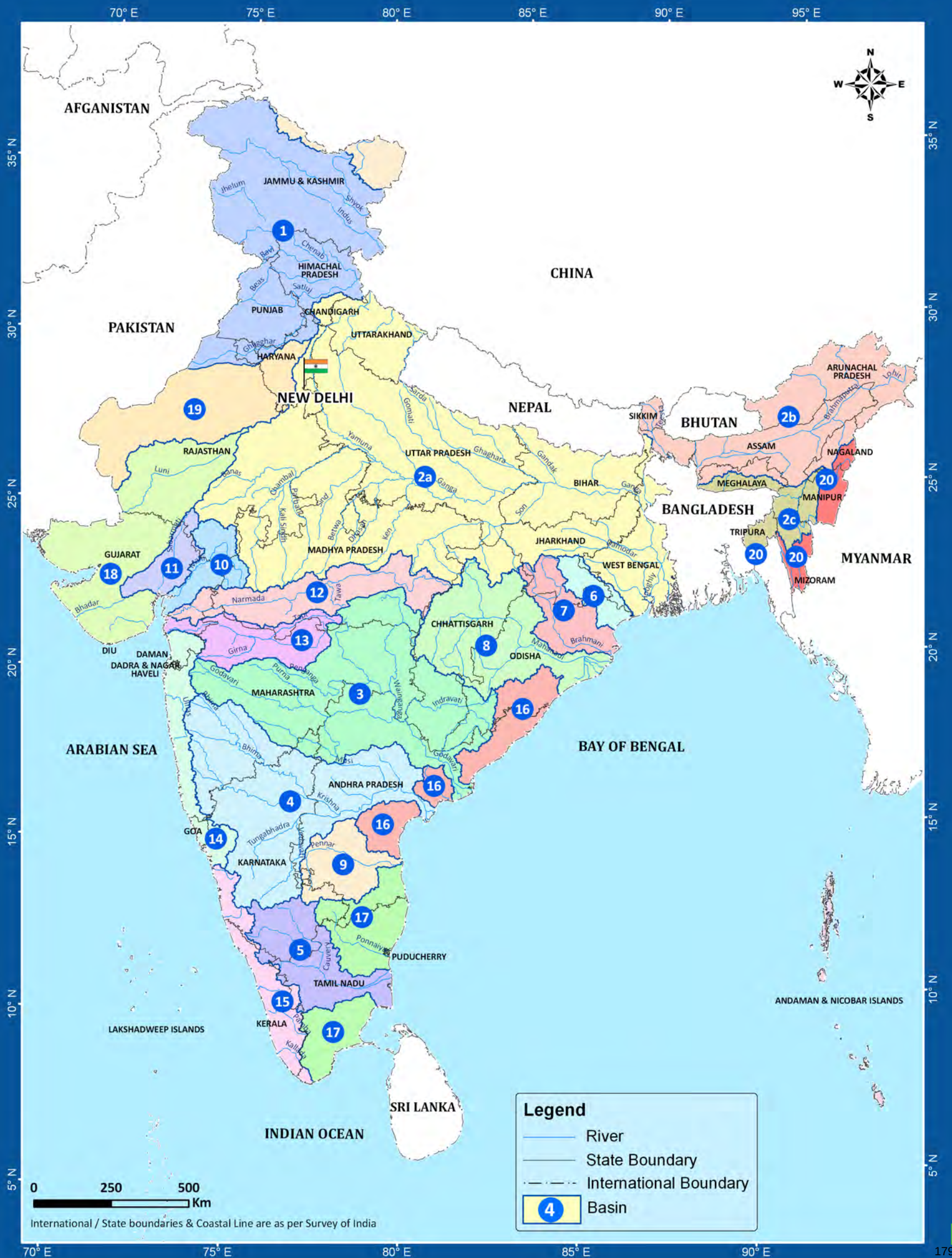
4.3 BASINS IN INDIA & ADJOINING COUNTRIES



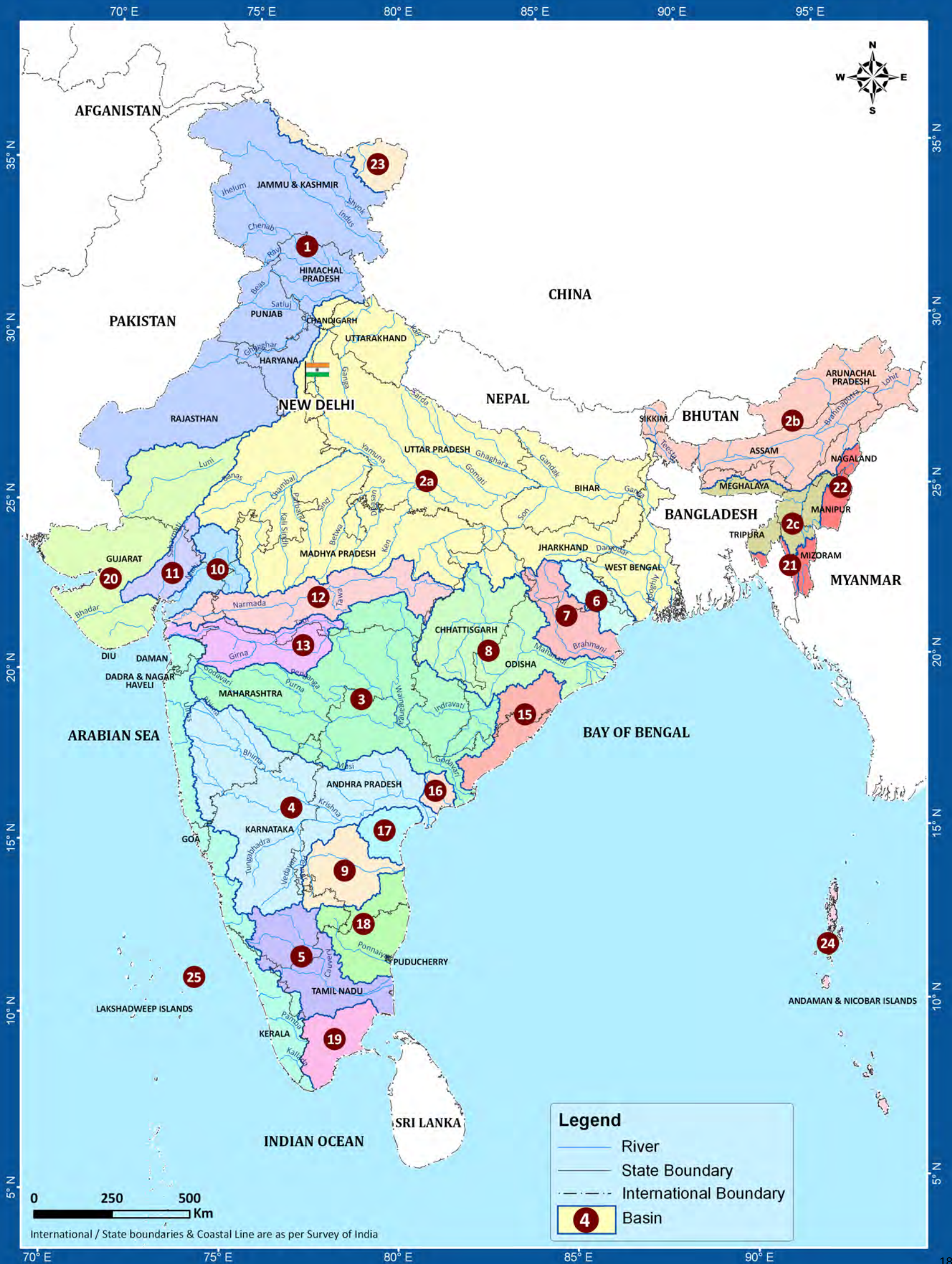
Trans-boundary Basins of India

Basin Name	Trans-boundary Basins		
	India	Drainage coming from other countries	Drainage flowing to other countries
Ganga			
Indus			
Brahmaputra			
Barak and others Basin			
WFR of Kutch and Saurashtra including Luni			

4.4 Cwc Basins



4.5 INDIA - WRIS BASINS



4.6 CWC BASINS & INDIA - WRIS BASINS



A COMPARISON

CWC Basins			India-WRIS Basins		
Sl. No.	Basin Code (CWC)	Basin Name (CWC)	Sl. No.	Basin Code (India-WRIS)	Basin Name (India-WRIS)
1	1	Indus (Up to border)	1	1	Indus (Up to border)
2	2 a	Ganga	2	2 a	Ganga
3	2 b	Brahmaputra	3	2 b	Brahmaputra
4	2 c	Barak and others	4	2 c	Barak and others
5	3	Godavari	5	3	Godavari
6	4	Krishna	6	4	Krishna
7	5	Cauvery	7	5	Cauvery
8	6	Subernarekha	8	6	Subernarekha
9	7	Brahmani and Baitarni	9	7	Brahmani and Baitarni
10	8	Mahanadi	10	8	Mahanadi
11	9	Pennar	11	9	Pennar
12	10	Mahi	12	10	Mahi
13	11	Sabarmati	13	11	Sabarmati
14	12	Narmada	14	12	Narmada
15	13	Tapi	15	13	Tapi
16	14	West flowing rivers from Tapi to Tadri	16	14	West flowing rivers South of Tapi
17	15	West flowing rivers from Tadri to Kanyakumari			
18	16	East flowing rivers between Mahanadi and Pennar	17	15	East flowing rivers between Mahanadi and Godavari
			18	16	East flowing rivers between Godavari and Krishna
			19	17	East flowing rivers between Krishna and Pennar
19	17	East flowing rivers between Pennar and Kanyakumari	20	18	East flowing rivers between Pennar and Cauvery
			21	19	East flowing rivers South of Cauvery
20	18	West flowing rivers of Kutch and Saurashtra including Luni	22	20	West flowing rivers of Kutch and Saurashtra including Luni
21	19	Area of inland drainage in Rajasthan			
22	20	Minor rivers draining into Myanmar (Burma and Bangladesh)	23	21	Minor rivers draining into Bangladesh
			24	22	Minor rivers draining into Myanmar
			25	23	Area of North Ladakh not draining into Indus Basin
			26	24	Drainage area of Andaman and Nicobar Islands
			27	25	Drainage area of Lakshadweep Islands

While delineating the basins under India-WRIS, the Area of inland drainage in Rajasthan is merged with the Indus Basin (upto border). This basin is recognized as a separate basin by CWC wherein the river dries out in desert part before draining its water. West flowing rivers from Tapi to Tadri and Tadri to Kanyakumari which are counted as separate basins by CWC, has been combined as West flowing rivers South of Tapi under India-WRIS. The East flowing rivers between Mahanadi & Godavari, Godavari & Krishna, and Krishna & Pennar are recognized as one basin by CWC. As all three of them are separated by Godavari and Krishna Basin and drains independently into Bay of Bengal, these basins are considered separate as per India-WRIS categorization. Similarly, the East flowing rivers between Pennar and Cauvery basin and East flowing rivers south of Cauvery basin are kept as distinct basins under India-WRIS as they are physically interrupted by Pennar basin. Likewise, the outfall of rivers draining into Myanmar and Bangladesh is different, hence the two are considered as different basins. Apart from already existing basin as per CWC, three new basins for rivers not out falling into any of the existing basins have been introduced as: Area of north Ladakh not draining into Indus basin, Drainage area of Lakshadweep Islands and Drainage area of Andaman & Nicobar Islands.

Legend

- 4 Basin Code
- 4 Sub Basin Code
- Major River
- Basin Boundary
- - - International Boundary

0 250 500 Km

International / State Boundaries & Coastal line are as per Survey of India



Basin Code	Sub-Basin No.	Basin and Sub-Basin	Sub-Basin Code	No. of Watershed	Area in Sq.km
01		Indus (Up to border)		669	
	1	1. Barmer	BAM	38	21658.94
	2	2. Beas	BEA	30	19002.47
	3	3. Chautang and others	CHA	39	27704.24
	4	4. Chenab	CHE	48	29981.38
	5	5. Churu	CHR	95	66832.75
	6	6. Ghaghar and others	GHO	75	49978.93
	7	7. Gilgit	GIL	37	27088.7
	8	8. Jhelum	JHE	44	29200.52
	9	9. Indus Lower	INL	31	23894.1
	10	10. Ravi	RAV	20	13710.2
	11	11. Shyok	SHY	53	38545.05
	12	12. Satluj Lower	SUL	58	38442.79
	13	13. Satluj Upper	SUU	31	21439.43
	14	14. Indus Upper	INU	70	46450.13
2A		Ganga		980	
	15	1. Above Ramganga Confluence	ARA	51	39104.61
	16	2. Banas	BAN	64	51651.51
	17	3. Bhagirathi and others	BHG	75	64038.97
	18	4. Chambal Lower	CHL	14	10941.26
	19	5. Chambal Upper	CHU	30	25546.57
	20	6. Damodar	DAM	60	41965.49
	21	7. Gandak and others	GAN	76	57105.90
	22	8. Ghaghara	GHA	76	58634.18
	23	9. Ghaghara Confluence to Gomti Confluence	GHG	36	26254.06
	24	10. Gomti	GOM	41	29865.21
	25	11. Kali Sindh and others up to Confluence with Parbati	KAS	64	48492.61
	26	12. Kosi	KOS	19	17568.11
	27	13. Ramganga	RAM	40	30839.69
	28	14. Sone	SON	83	65110.05
	29	15. Tons	TON	23	16905.74
	30	16. Upstream of Gomti Confluence to Muzaffarnagar	UGO	40	29061.37
	31	17. Yamuna Lower	YAL	98	124867.19
	32	18. Yamuna Middle	YAM	43	34586.39
	33	19. Yamuna Upper	YAU	47	35798.19
2B		Brahmaputra		180	
	34	1. Brahmaputra Lower	BRL	83	87392.22
	35	2. Brahmaputra Upper	BRU	97	98972.87
2C		Barak and others		77	
	36	1. Barak	BAR	47	27658.98
	37	2. Kynchiang and other South Flowing Rivers	KYN	17	10267.39
	38	3. Naoch chara and others	NAO	13	7695.81

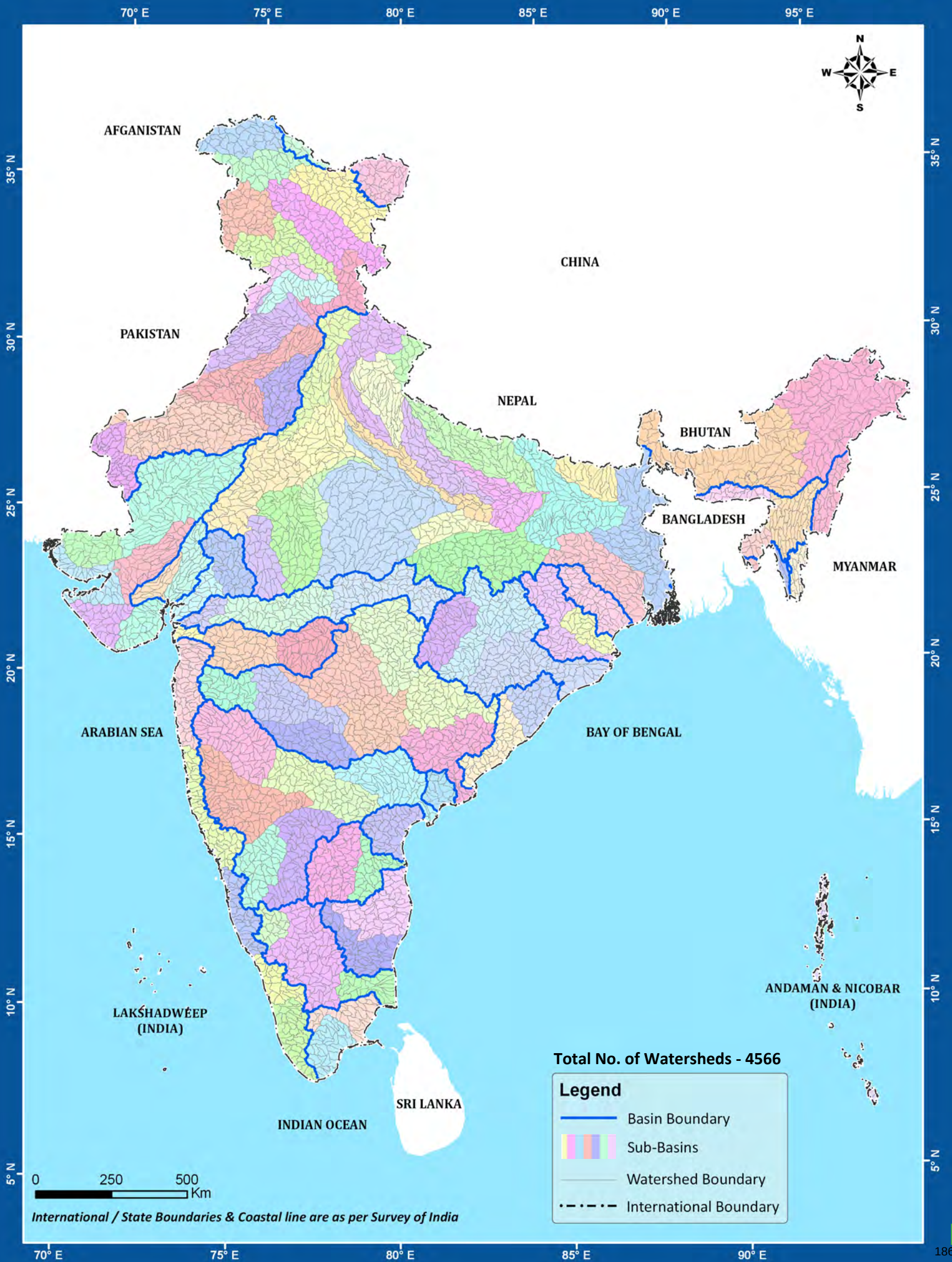


Basin Code	Sub-Basin No.	Basin and Sub-Basin	Sub-Basin Code	No. of Watershed	Area in Sq.km
03		Godavari		466	
	39	1. Godavari Lower	GDL	67	43771.54
	40	2. Godavari Middle	GDM	56	36290.47
	41	3. Godavari Upper	GDU	33	21443.23
	42	4. Indravati	IND	60	39027.49
	43	5. Manjra	MAJ	44	29472.88
	44	6. Pranhita and others	PRA	57	36119.60
	45	7. Wardha	WAR	69	46242.09
	46	8. Weinganga	WEI	80	49695.40
04		Krishna		391	
	47	1. Bhima Lower	BHL	36	23652.70
	48	2. Bhima Upper	BHU	71	44793.32
	49	3. Krishna Lower	KRL	59	39494.33
	50	4. Krishna Middle	KRM	36	22229.12
	51	5. Krishna Upper	KRU	85	54504.77
	52	6. Tungabhadra Lower	TUL	59	41556.48
	53	7. Tungabhadra Upper	TUU	45	28519.41
05		Cauvery		132	
	54	1. Cauvery Lower (CAL)	CAL	28	17386.45
	55	2. Cauvery Middle (CAM)	CAM	86	57280.98
	56	3. Cauvery Upper (CAU)	CAU	18	10958.80
06		Subarnarekha		45	
	57	1. Subarnarekha (SUB)	SUB	45	25792.16
07		Brahmani and Baitarni		79	
	58	1. Baitarni	BAI	21	14351.23
	59	2. Brahmani	BRA	58	37545.83
08		Mahanadi		227	
	60	1. Mahanadi Lower	MAL	91	57958.88
	61	2. Mahanadi Middle	MAM	88	51895.91
	62	3. Mahanadi Upper	MAU	48	29796.64
09		Pennar		90	
	63	1. Pennar Lower	PEL	29	17979.85
	64	2. Pennar Upper	PEU	61	36263.58
10		Mahi		63	
	65	1. Mahi Lower	MHL	22	13377.00
	66	2. Mahi Upper	MHU	41	24959.80
11		Sabarmati		51	
	67	1. Sabarmati Lower	SAL	17	10865.32
	68	2. Sabarmati Upper	SAU	34	19813.27
12		Narmada		150	
	69	1. Narmada Lower	NAL	16	8904.02
	70	2. Narmada Middle	NAM	63	40575.72
	71	3. Narmada Upper	NAU	71	43192.68



Basin Code	Sub-Basin No.	Basin and Sub-Basin	Sub-Basin Code	No. of Watershed	Area in Sq.km
13		Tapi		100	
	72	1. Tapi Lower	TAL	07	4108.90
	73	2. Tapi Middle	TAM	47	31766.67
	74	3. Tapi Upper	TAU	46	28047.34
14		West Flowing Rivers South of Tapi		188	
	75	1. Bhatsol and others	BHT	49	29348.90
	76	2. Netravati and others	NET	32	18762.09
	77	3. Periyar and others	PAR	37	21895.21
	78	4. Varrar and others	VAR	23	14164.70
	79	5. Vasishti and others	VAS	47	27473.95
15		East Flowing Rivers between Mahanadi and Godavari		75	
	80	1. Nagvati and other	NAG	41	24372.24
	81	2. Vamsadhara and other	VAM	34	21870.63
16		East Flowing Rivers between Godavari and Krishna		16	
	82	1. East Flowing Rivers between Godavari and Krishna	GTK	16	10342.29
17		East Flowing Rivers between Krishna and Pennar		41	
	83	1. East Flowing Rivers between Krishna and Pennar	KTP	41	23334.63
18		East Flowing Rivers between Pennar and Cauvery		102	
	84	1. Palar and other	PAL	56	35392.34
	85	2. Ponnaiyar and other	PON	46	28249.49
19		East Flowing Rivers South of Cauvery		63	
	86	1. Pamba and others	PAM	30	18289.41
	87	2. Vaippar and others	VAI	33	20356.69
20		West Flowing Rivers of Kutch and Saurashtra including Luni		268	
	88	1. Bhadar and other West Flowing Rivers	BHA	30	18489.70
	89	2. Luni Lower	LUL	42	29180.12
	90	3. Luni Upper	LUU	81	70202.58
	91	4. Drainage of Rann	RAN	40	21229.90
	92	5. Saraswati	SAR	43	27260.84
	93	6. Shetrunji and other East Flowing Rivers	SHE	32	18221.67
21		Minor Rivers Draining into Bangladesh		09	
	94	1. Karnaphuli and others	KPO	06	3776.84
	95	2. Muhury and others	MHO	03	1676.39
22		Minor Rivers Draining into Myanmar		45	
	96	1. Imphal and others	IMP	29	16754.90
	97	2. Mangpui Lui and others	MAN	16	7976.18
23		Area of North Ladakh not Draining into Indus		42	
	98	1. Shaksgam	SHK	09	6523.50
	99	2. Sulmar	SUM	33	22715.73
24		Drainage Area of Andaman and Nicobar Islands		16	
	100	1. Drainage Area of Andaman and Nicobar Islands	DAN	16	7577.85
25		Drainage Area of Lakshadweep Islands		01	
	101	1. Drainage Area of Lakshadweep Islands	DAL	01	669.81

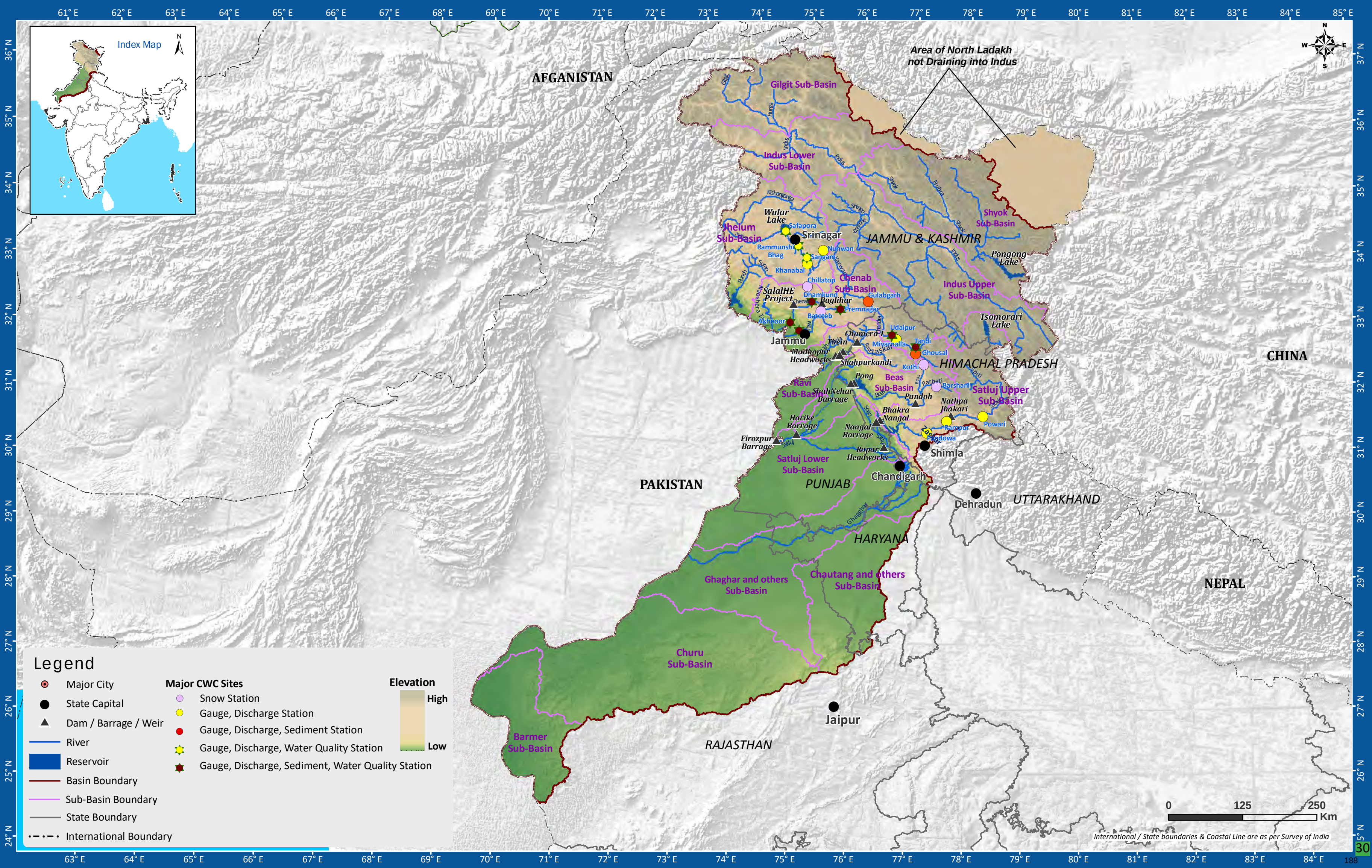
4.8 WATERSHEDS OF INDIA



Section - 5

Basin wise Watersheds

5.1 INDUS BASIN



The Indus basin extends over China (Tibet), India, Afghanistan and Pakistan draining an area of 11,48,860 Sq.km. In India, the basin spreads over states of Jammu & Kashmir, Himachal Pradesh, Punjab, Rajasthan, Haryana and Union Territory of Chandigarh having an area of 4,53,929.63 Sq.km which is nearly 13.8% of the total geographical area of the country. The geographical extent of the basin is between 69°29'3" to 79°37'37" east longitudes and 25°17'23" to 37°4'41" north latitudes with a maximum length and width of around 1285 km and 560 km respectively. The basin is bounded by the Himalayas on the east, by the Karakoram and Haramosh ranges on the north, by the Sulaiman and Kirthar ranges on the west, and by the Arabian Sea on the south.

The Indus River rises from the lofty mountains of Himalayas around Mansarovar Lake in Tibet at an elevation of 5,182 m. The total length of Indus from origin to its outfall in Arabian Sea is 2,880 km, out of which 1,114 km flows through India. Its principal tributaries in India are the Jhelum, the Chenab, the Ravi, the Beas and the Satluj, all joining from left. The major part of basin is covered with agricultural land accounting to 44.40% of the total area and 1.41% of the basin is covered by water bodies.

The water resource development in the Indus basin is governed by the various provision of the Indus water treaty, 1960. According to this treaty the water of the Ravi, the Beas and the Satluj shall be available for the unrestricted use by India. India has also been permitted to make domestic use, non-consumptive use, uses for runoff the river Hydroelectric plants and specified agricultural use from the Indus, the Jhelum and the Chenab.

Salient Features of Indus Basin

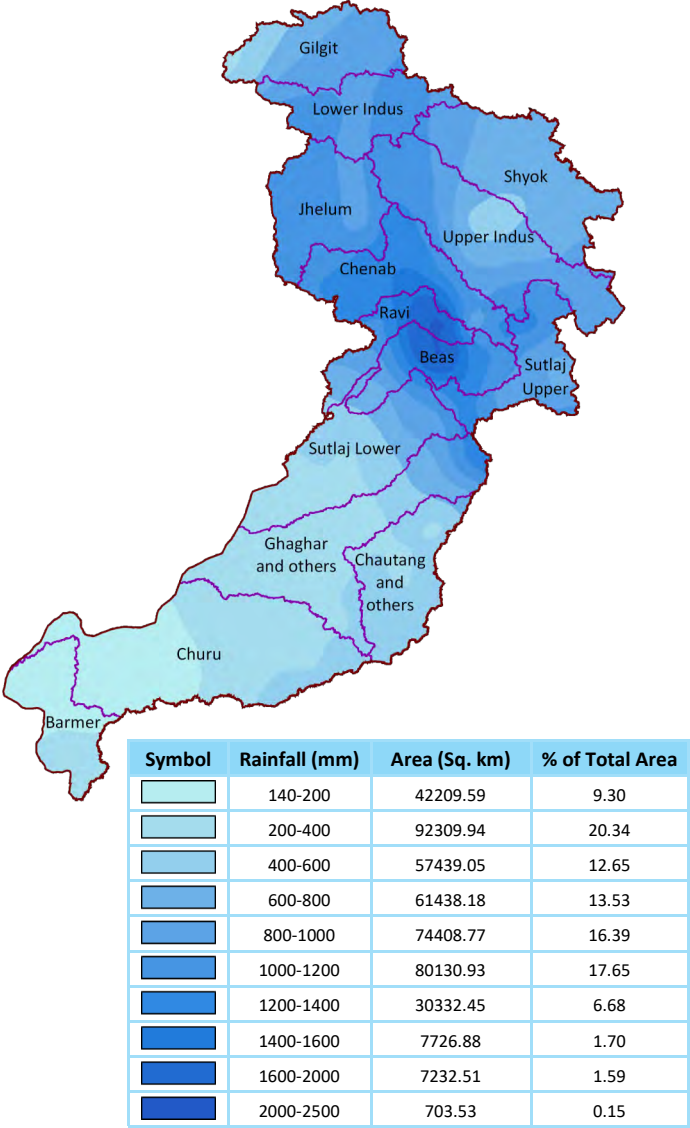
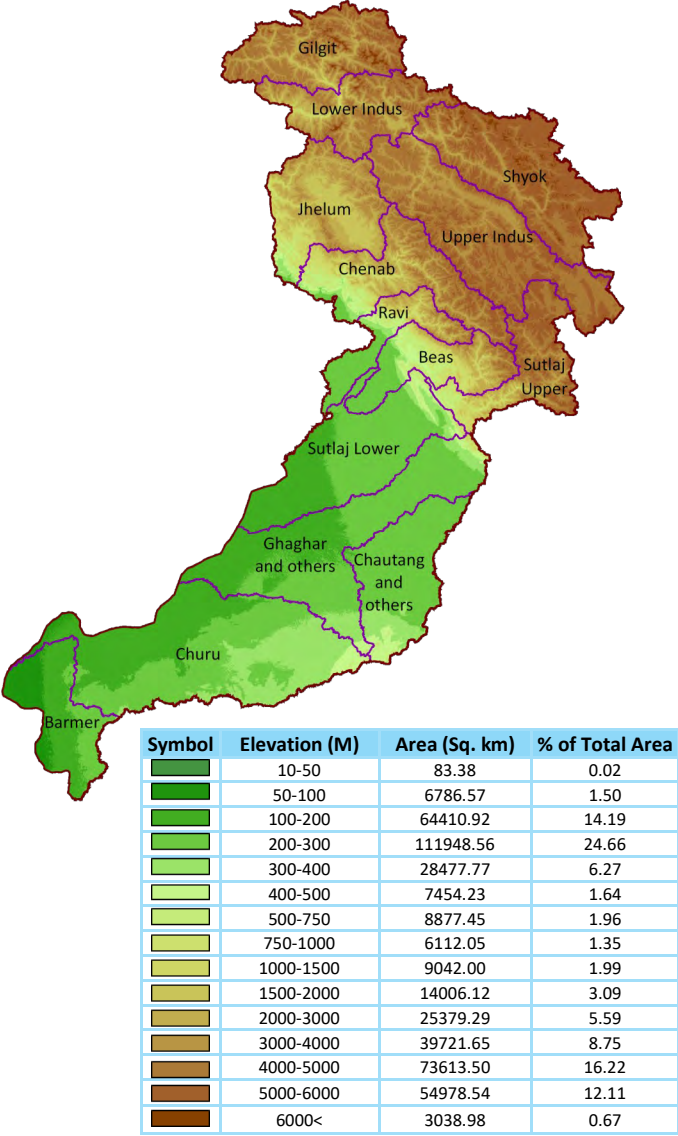
Basin Extent	Longitude	69°29'3" to 79°37'37" E
	Latitude	25°17'23" to 37°4'41" N
Length of Indus River (Km)		1114 (in India)
Catchment Area (Sq.km.)		453929
Average Water Resource Potential (MCM)		73310
Utilizable Surface Water Resource (MCM)		46000
Live Storage Capacity of Completed Projects (MCM)		16285.9
Live Storage Capacity of Projects Under Construction (MCM)		282.53
Total Live Storage Capacity of Projects (MCM)		16568.43
No. of Hydrological Observation Stations		26

Major Water Resource Assets

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Barmer	21658.94	0	0	0	169	0
2	Beas	19002.47	11	7	10	425	2
3	Chautang and others	27704.24	1	0	1	4171	0
4	Chenab	29981.38	4	2	1	201	13
5	Churu	66832.75	0	0	2	4562	0
6	Ghaghar and others	49978.93	2	0	4	4578	0
7	Gilgit	27088.70	0	0	0	0	0
8	Jhelum	29200.52	3	6	2	352	5
9	Indus Lower	23894.10	0	0	0	0	0
10	Ravi	13710.20	7	4	8	590	1
11	Shyok	38545.05	0	0	0	82	0
12	Sutlaj Lower	38442.79	7	4	14	4269	0
13	Sutlaj Upper	21439.43	4	3	6	37	5
14	Indus Upper	46450.13	1	5	0	151	0

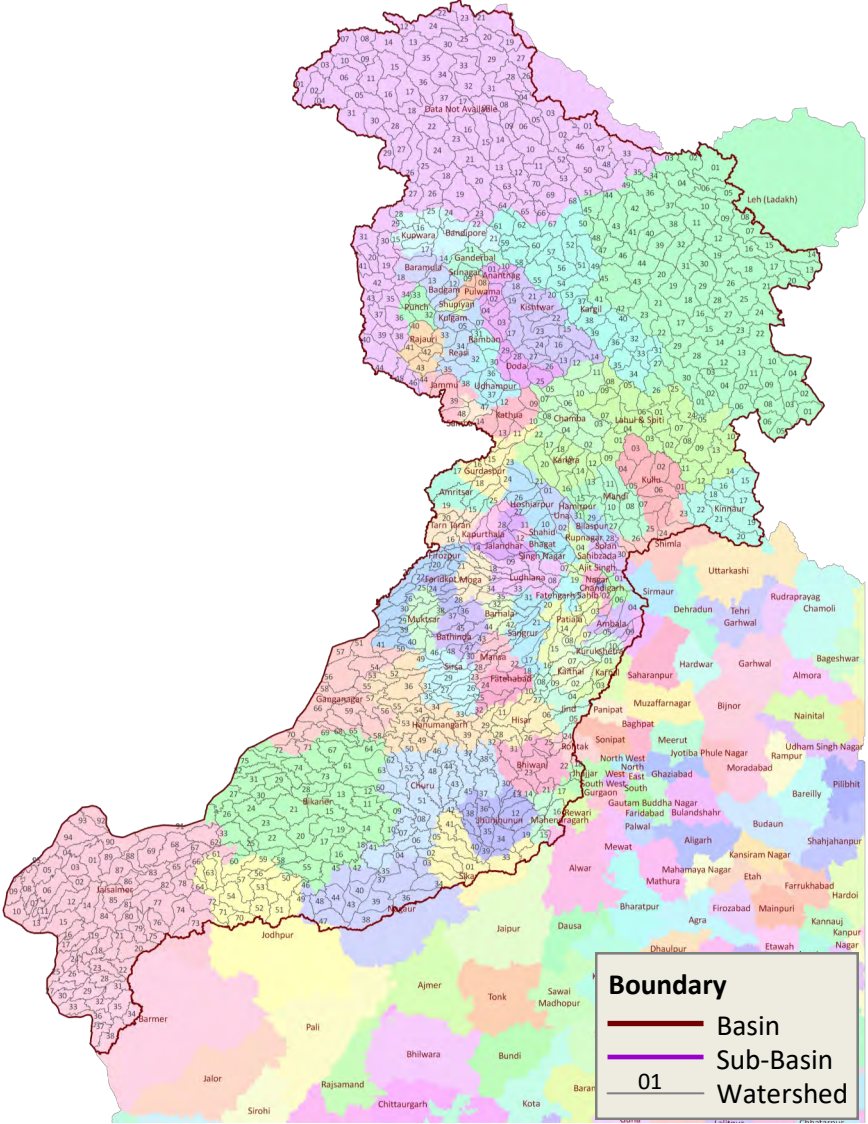
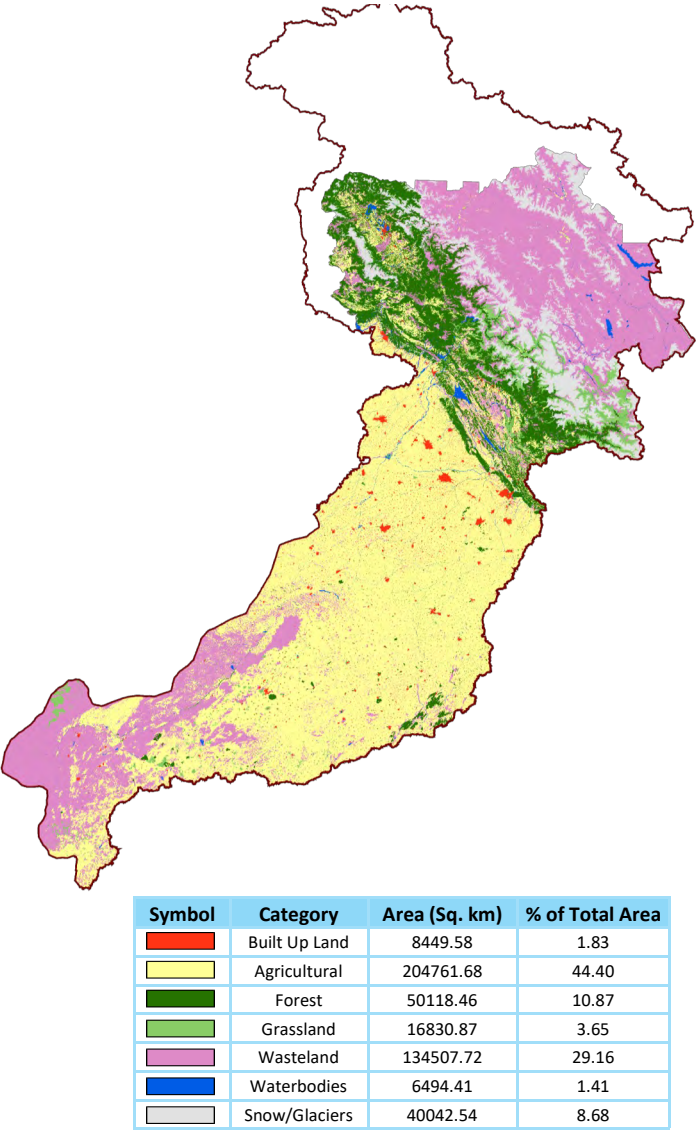
Watershed Statistics

Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Barmer	38	358.42	886.47	569.97
2	Beas	30	388.75	999.14	633.42
3	Chautang and others	39	326.27	1405.48	710.37
4	Chenab	48	323.39	1126.77	624.61
5	Churu	95	416.41	1235.16	703.50
6	Ghaghar and others	75	317.44	1494.82	666.39
7	Gilgit	37	339.63	1011.51	732.13
8	Jhelum	44	320.24	1322.17	663.65
9	Indus Lower	31	319.30	1270.43	770.78
10	Ravi	20	390.23	1302.52	685.51
11	Shyok	53	430.05	1373.86	727.27
12	Sutlaj Lower	58	329.08	1296.31	662.81
13	Sutlaj Upper	31	383.54	952.20	691.59
14	Indus Upper	70	383.02	973.92	663.57

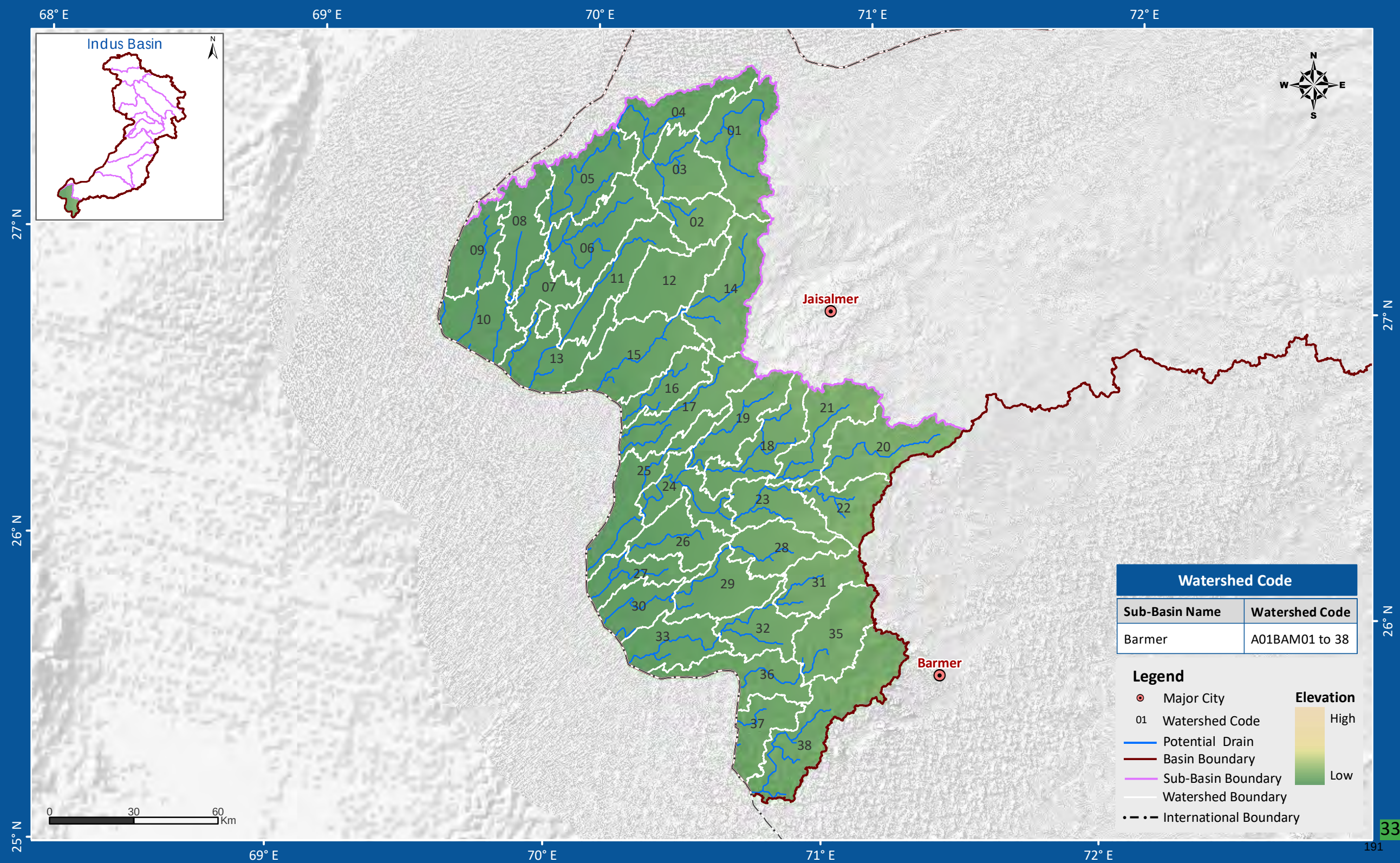


Land Use / Land Cover (2005-06)

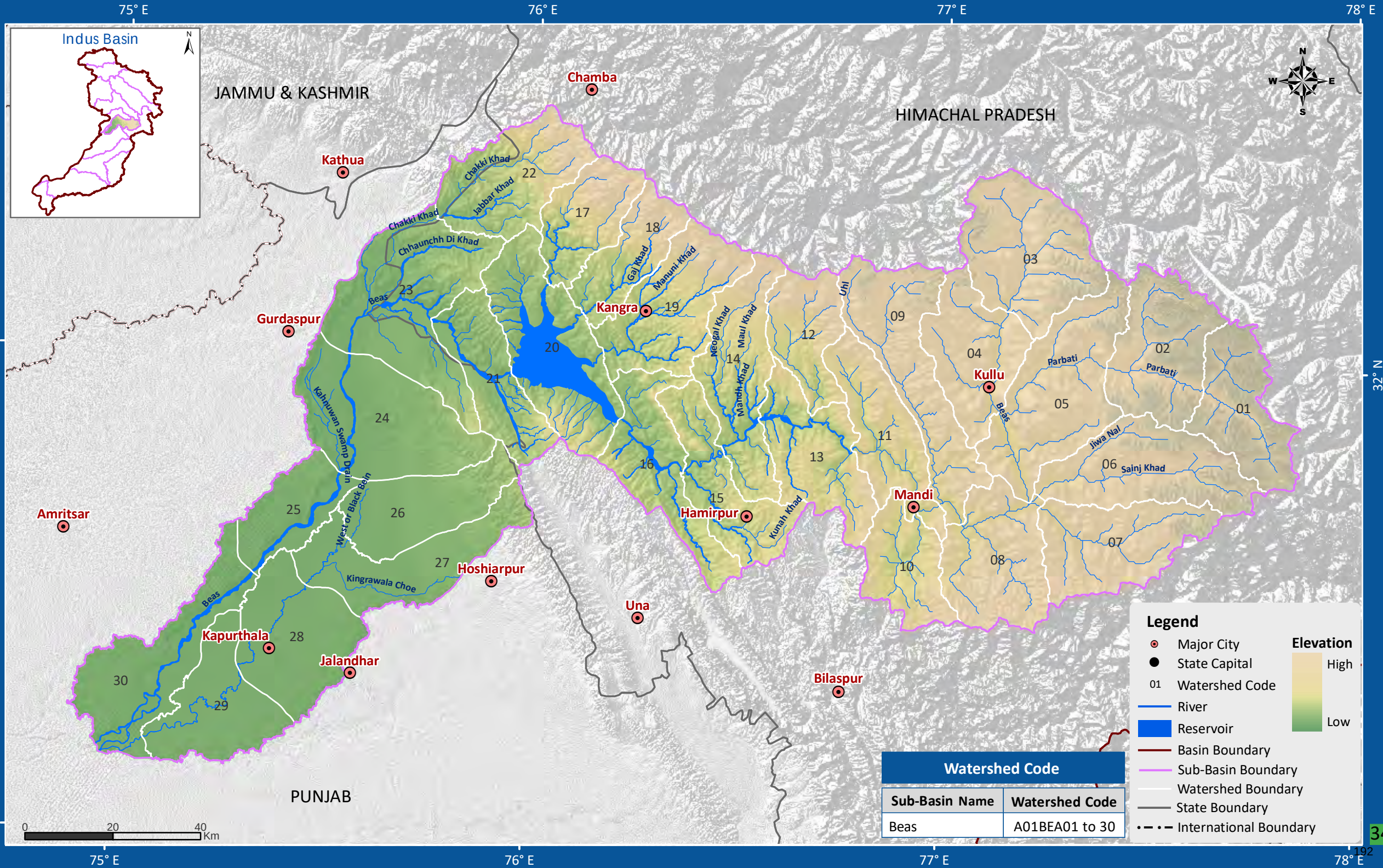
Districts



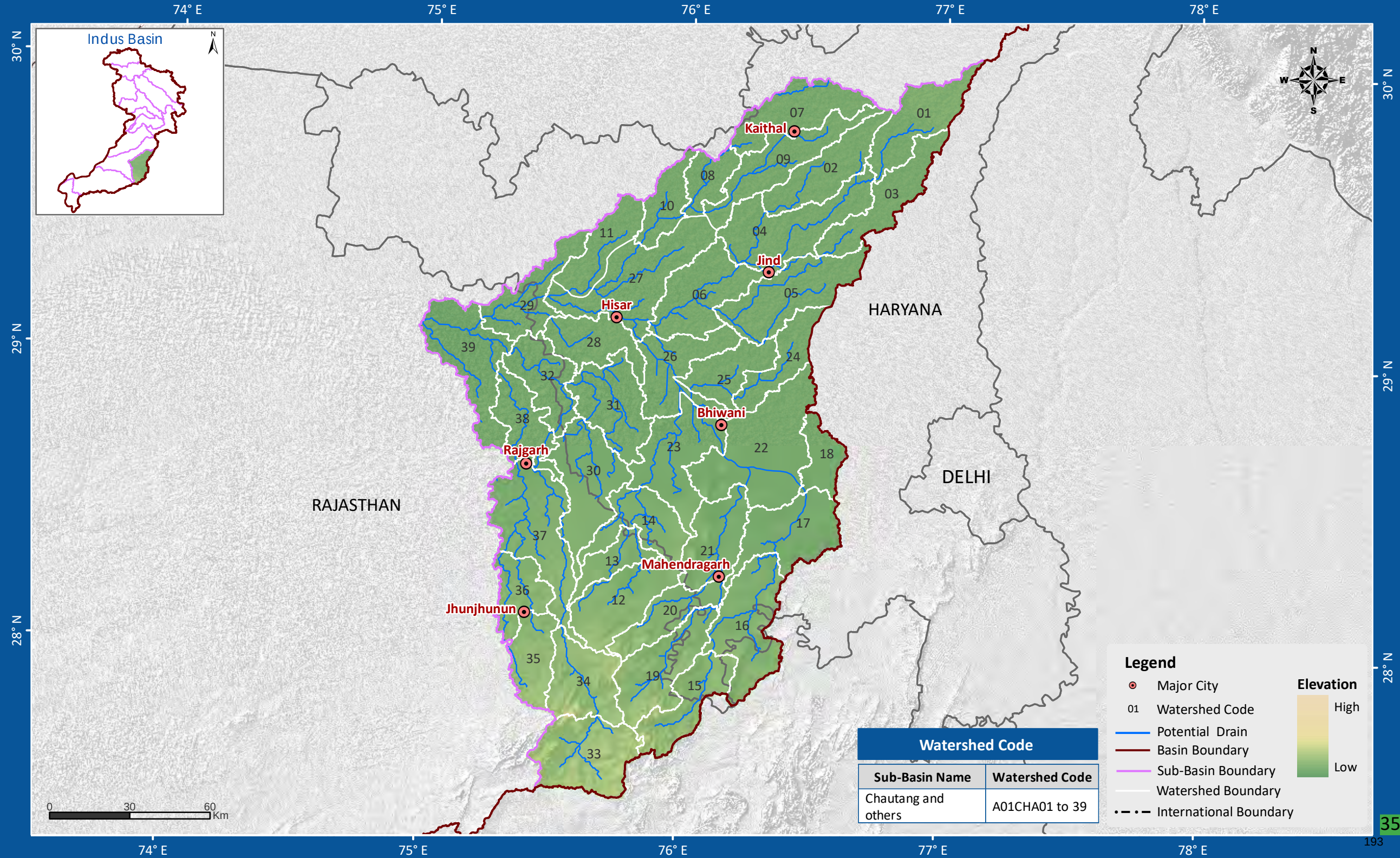
1. Barmer Sub-Basin



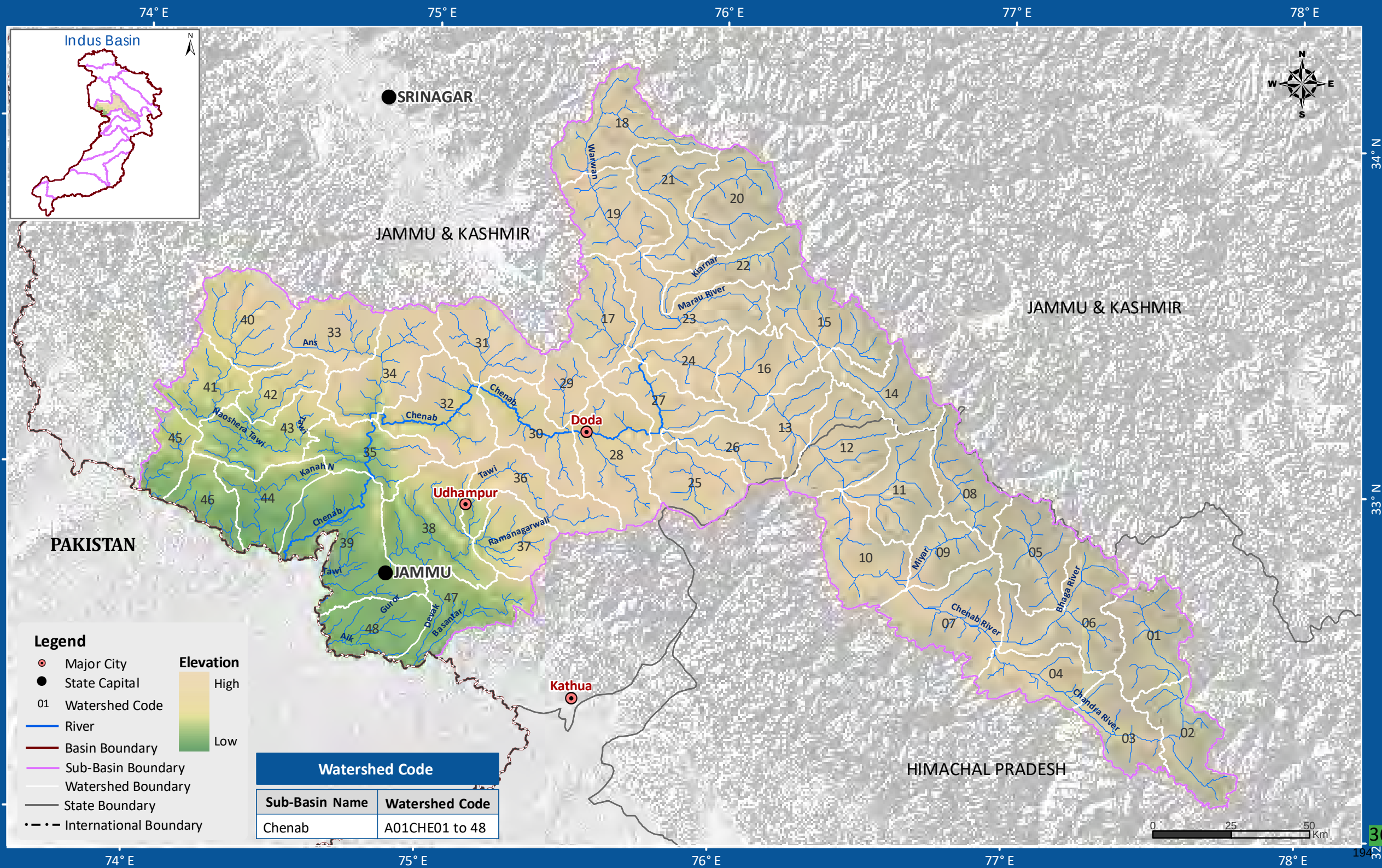
2. Beas 389 Sub-Basin



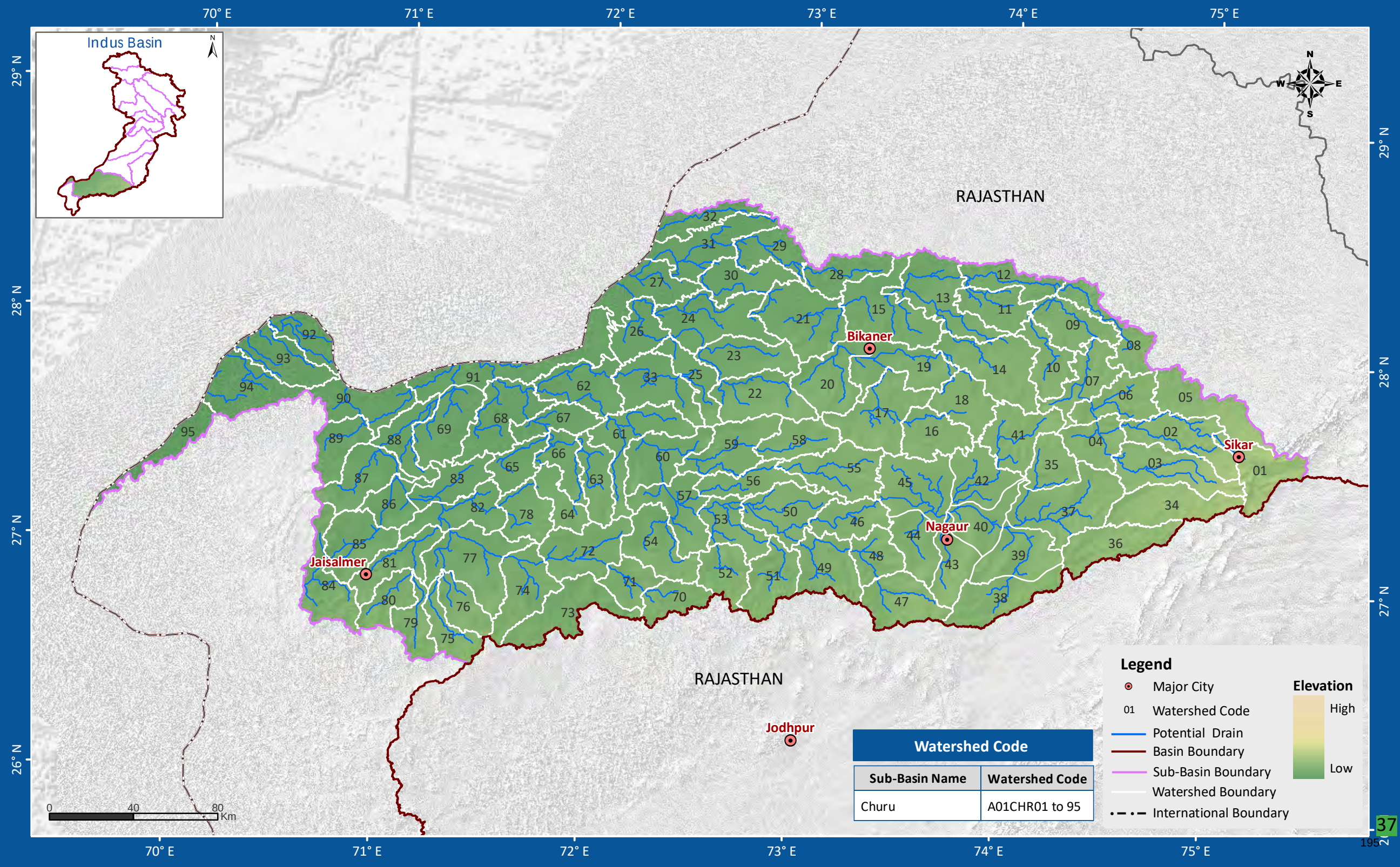
3. Chautang and others Sub-Basin



4. Chenab Sub-Basin



392 5. Churu Sub-Basin



Legend

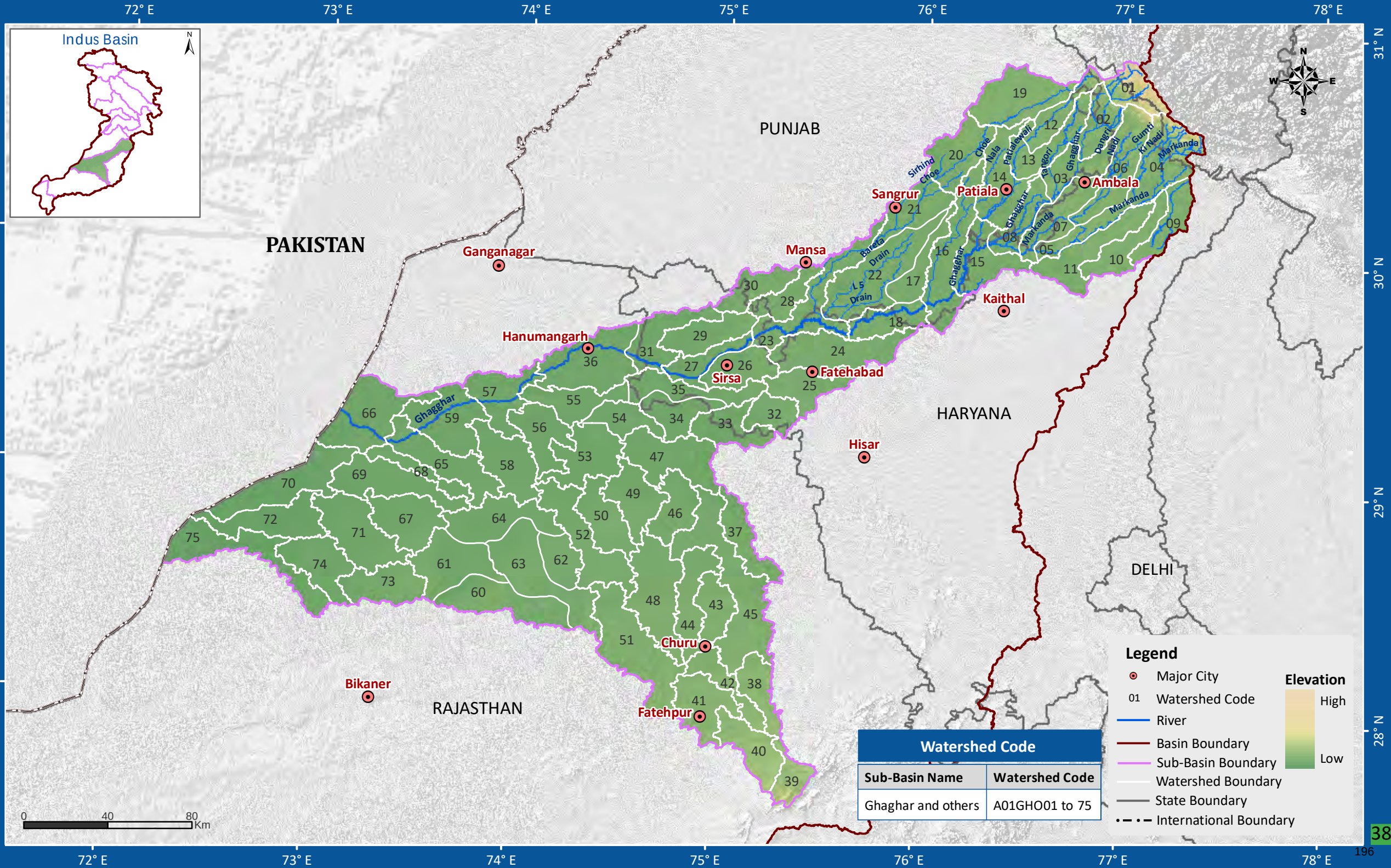
- Major City
- 01 Watershed Code
- Potential Drain
- Basin Boundary
- Sub-Basin Boundary
- Watershed Boundary
- International Boundary

Elevation

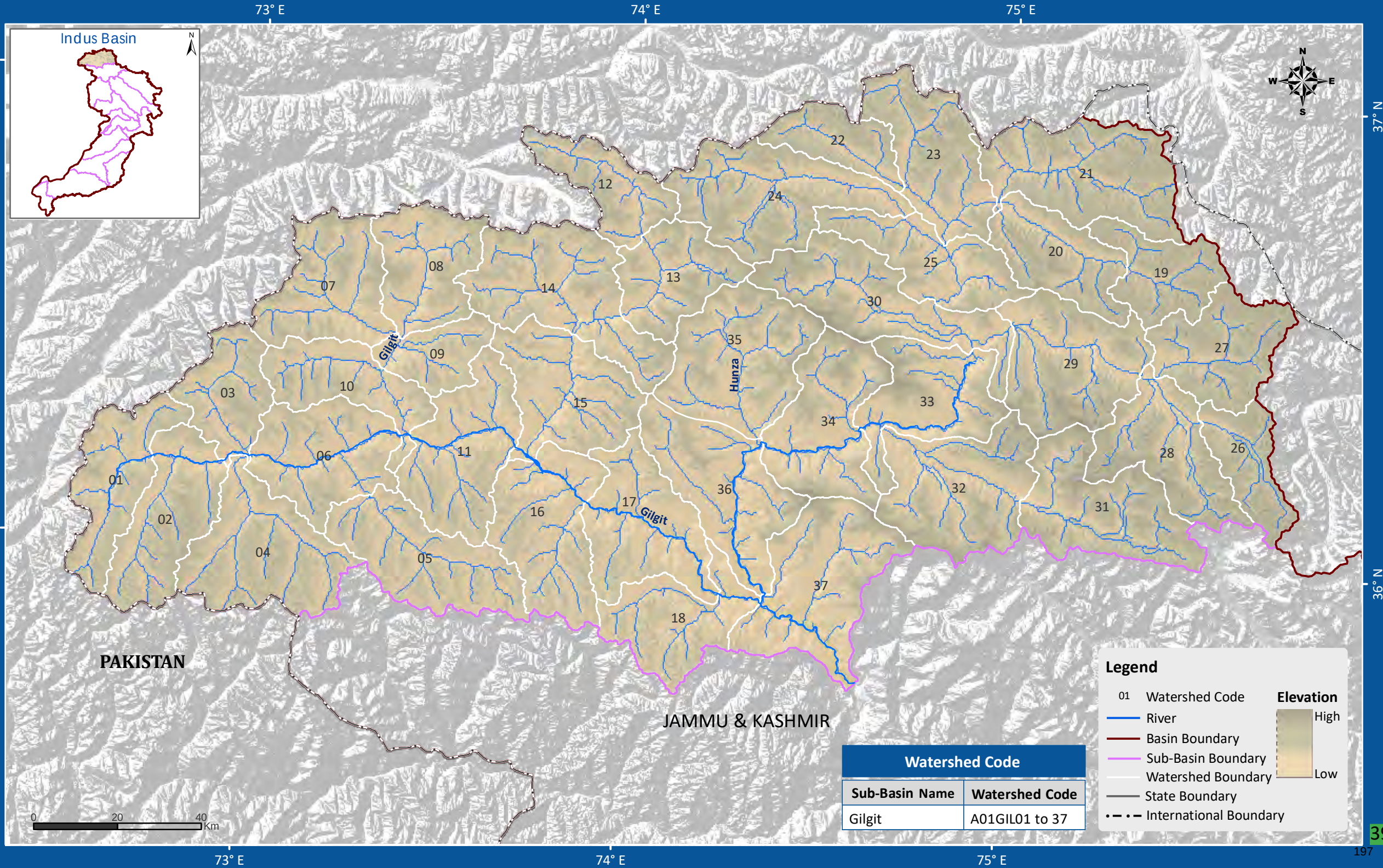
- High
- Low

Watershed Code	
Sub-Basin Name	Watershed Code
Churu	A01CHR01 to 95

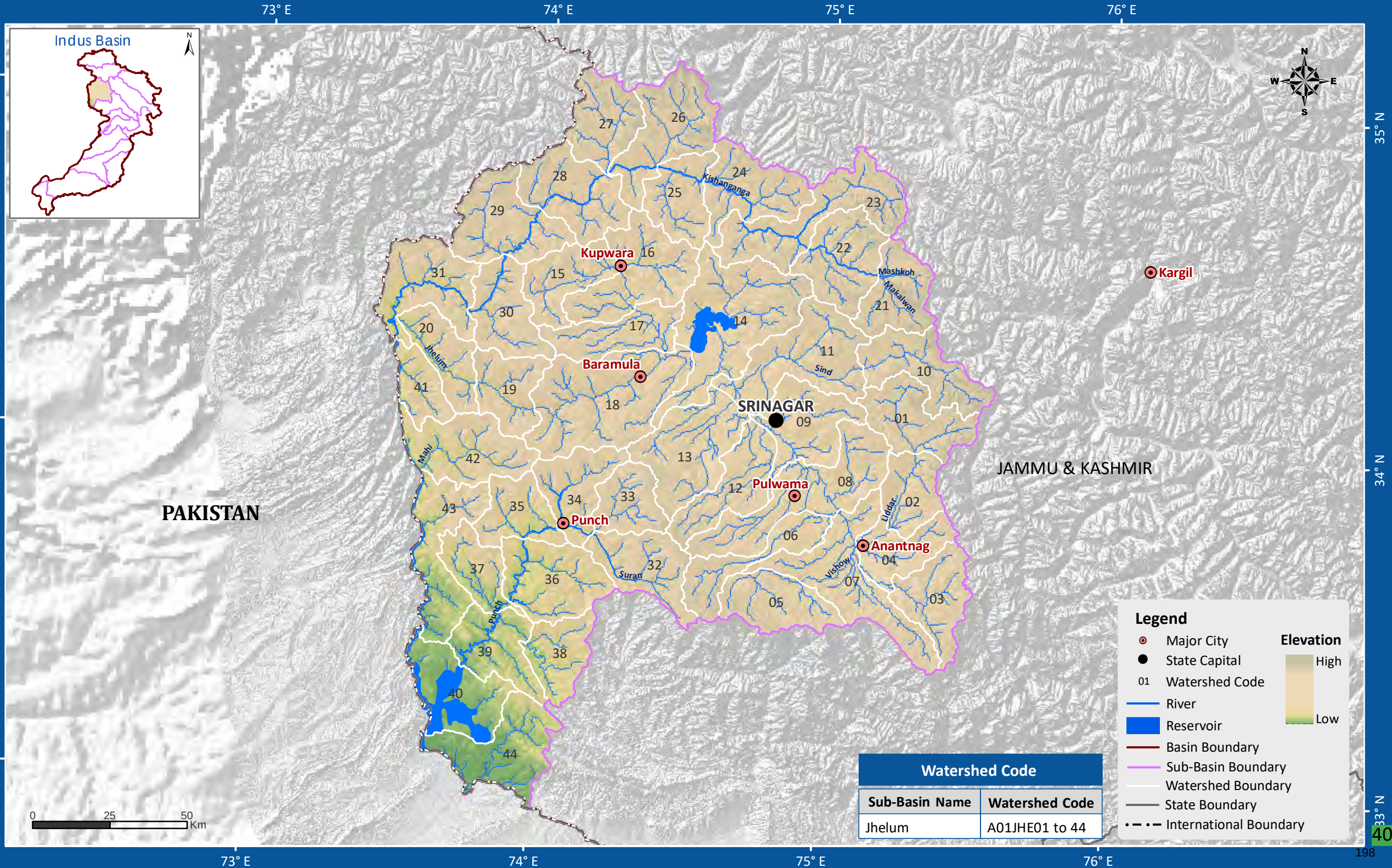
6. Ghaghar and Others Sub-Basin



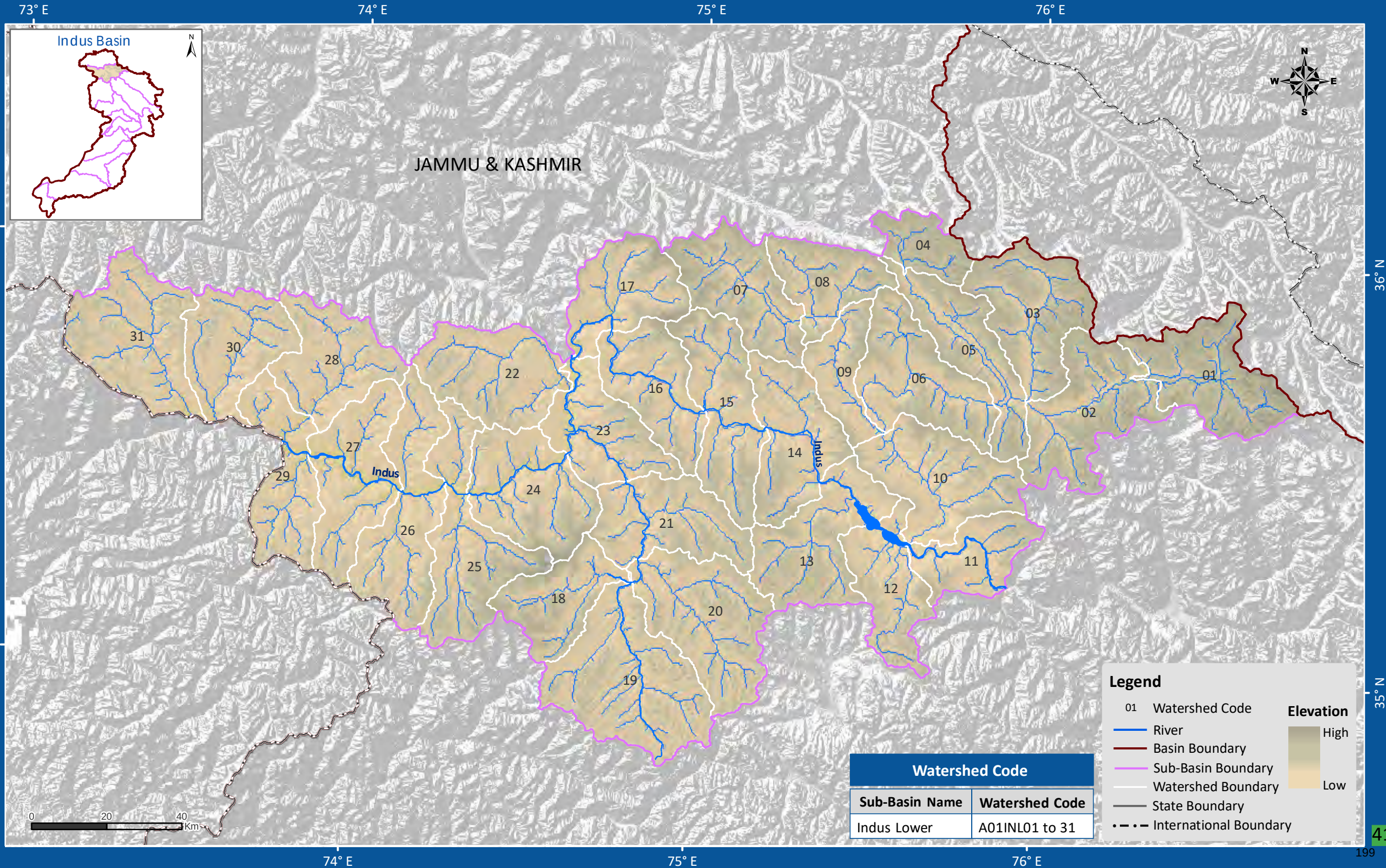
7. Gilgit Sub-Basin



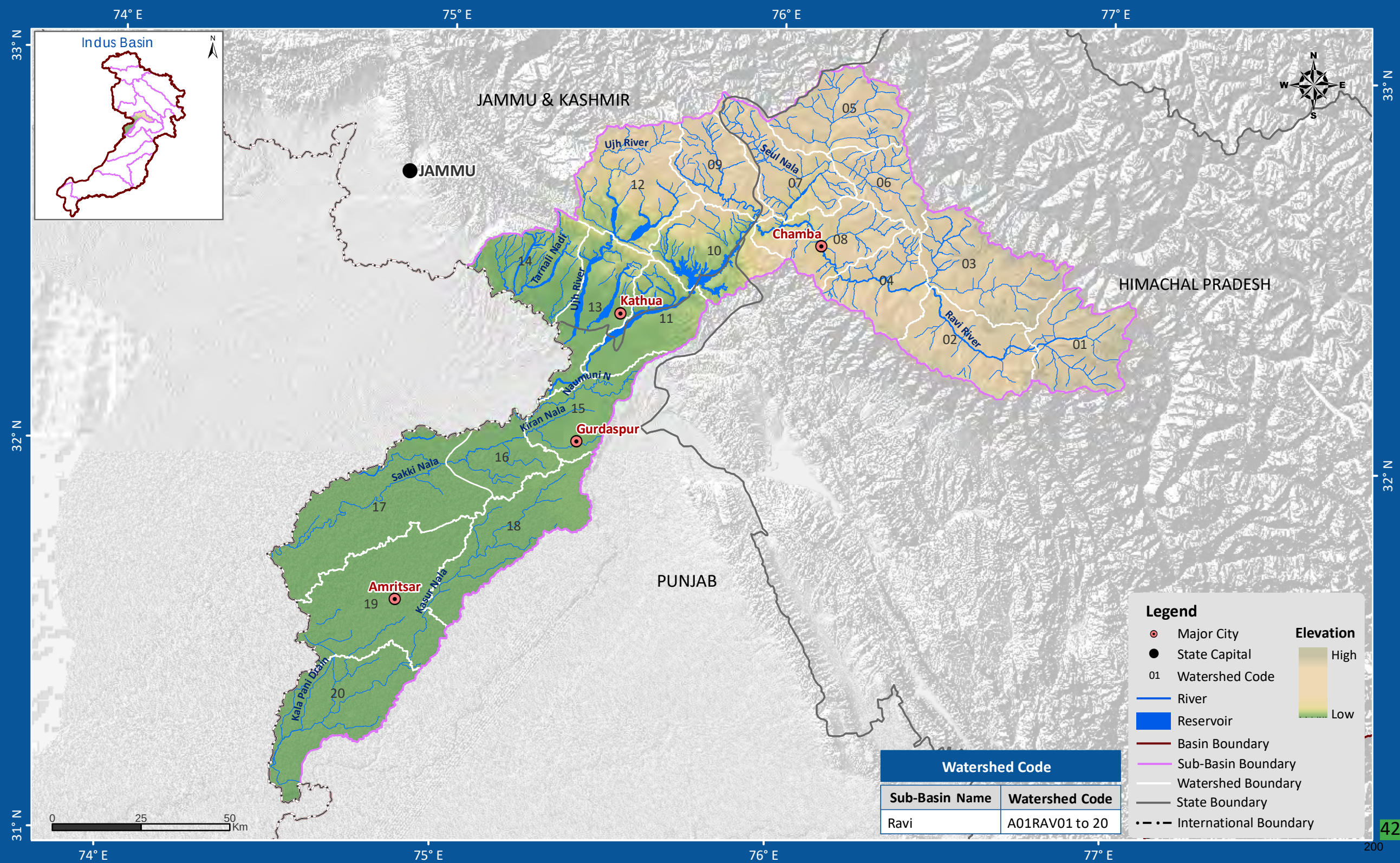
8. Jhelum Sub-Basin



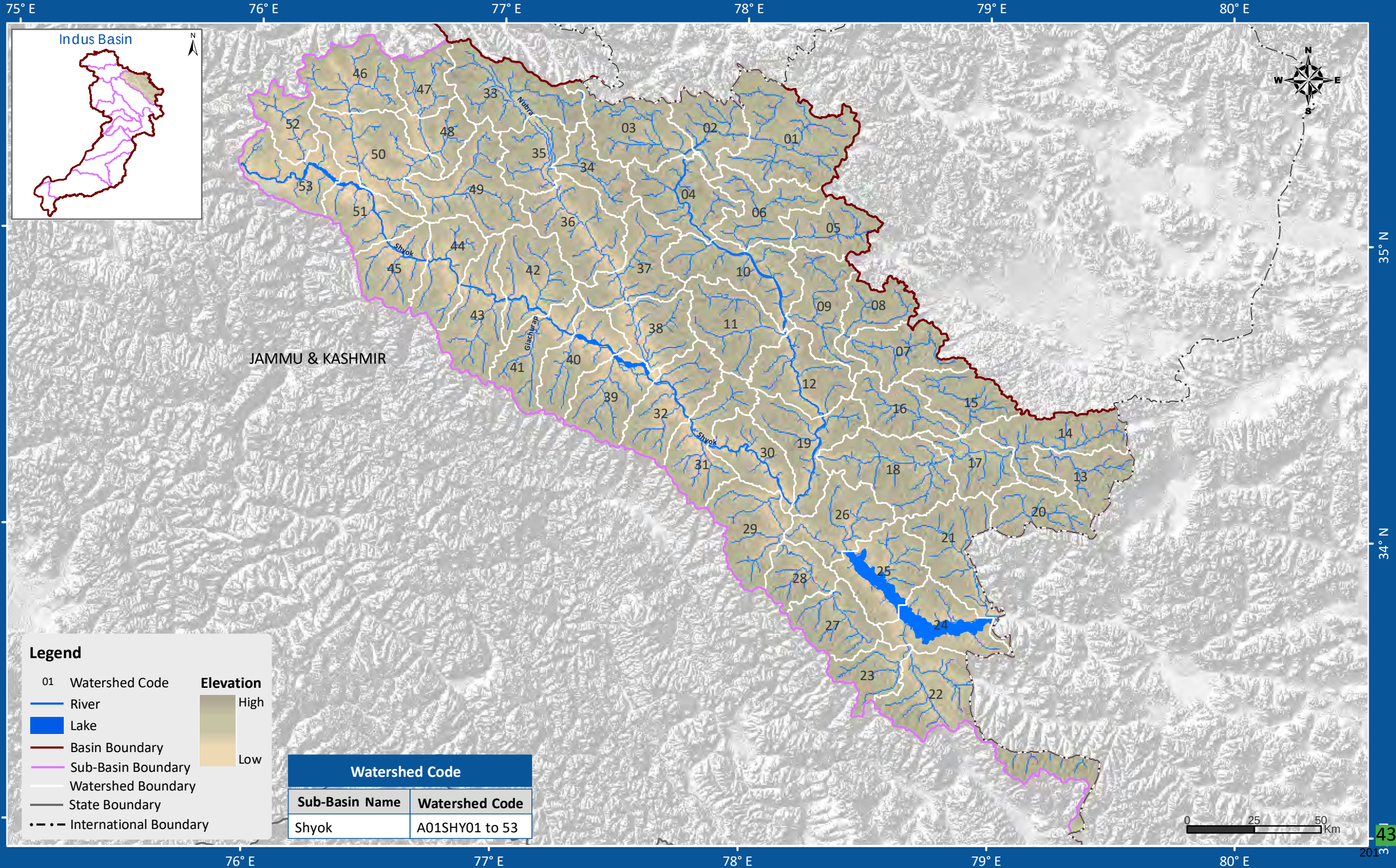
396 9. Indus Lower Sub-Basin



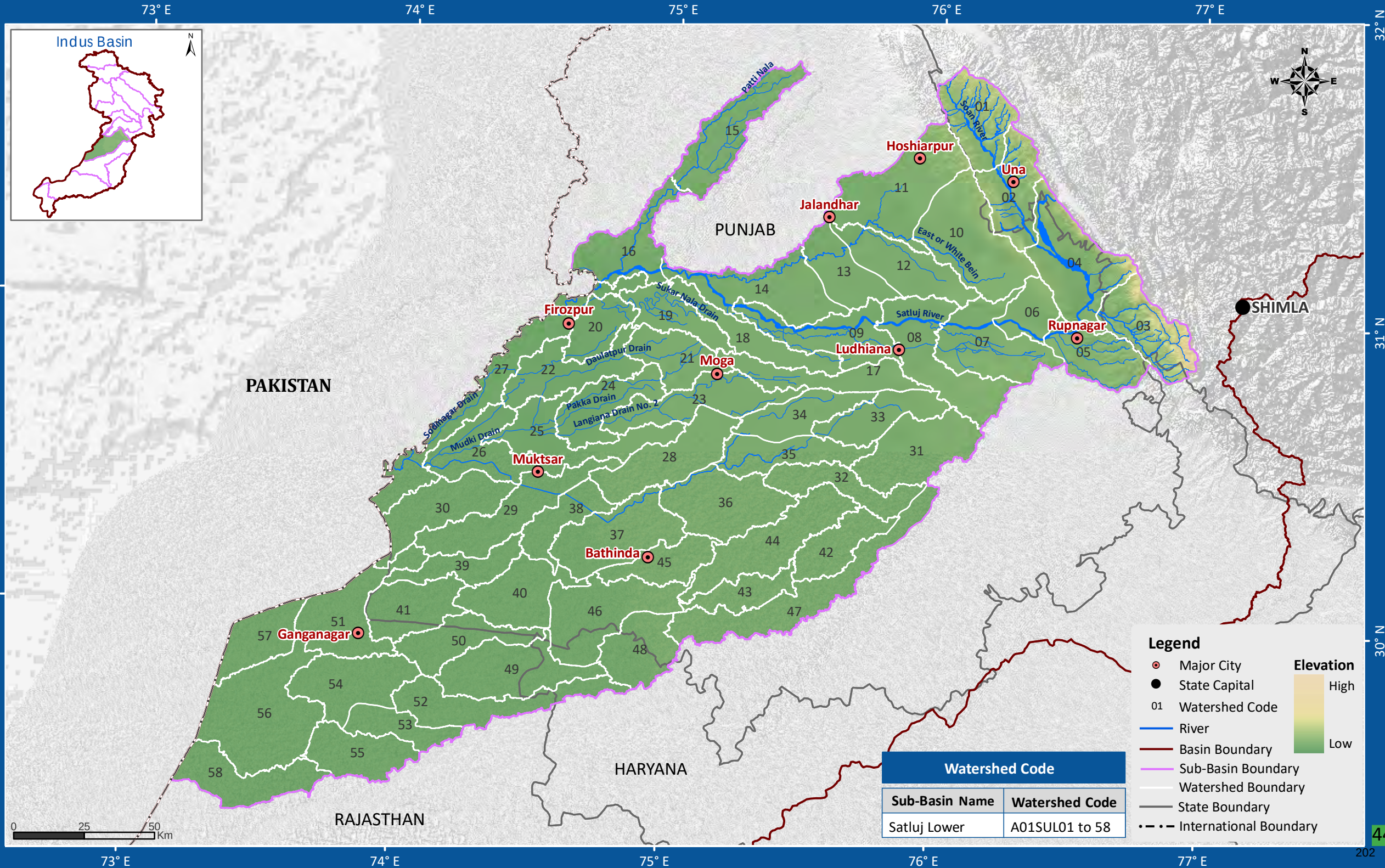
10. Ravi Sub-Basin



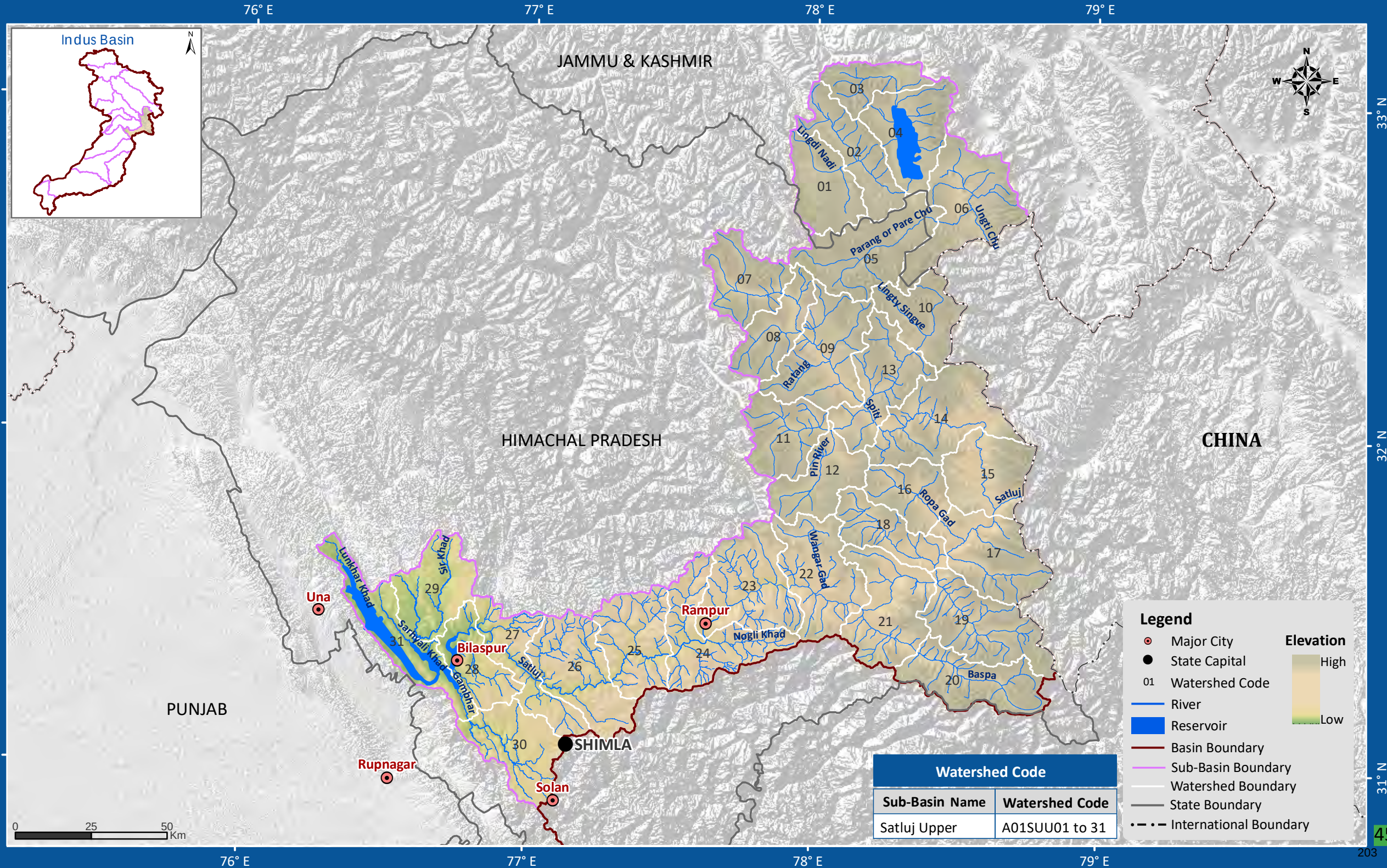
11. Shyok³⁹⁸ Sub-Basin



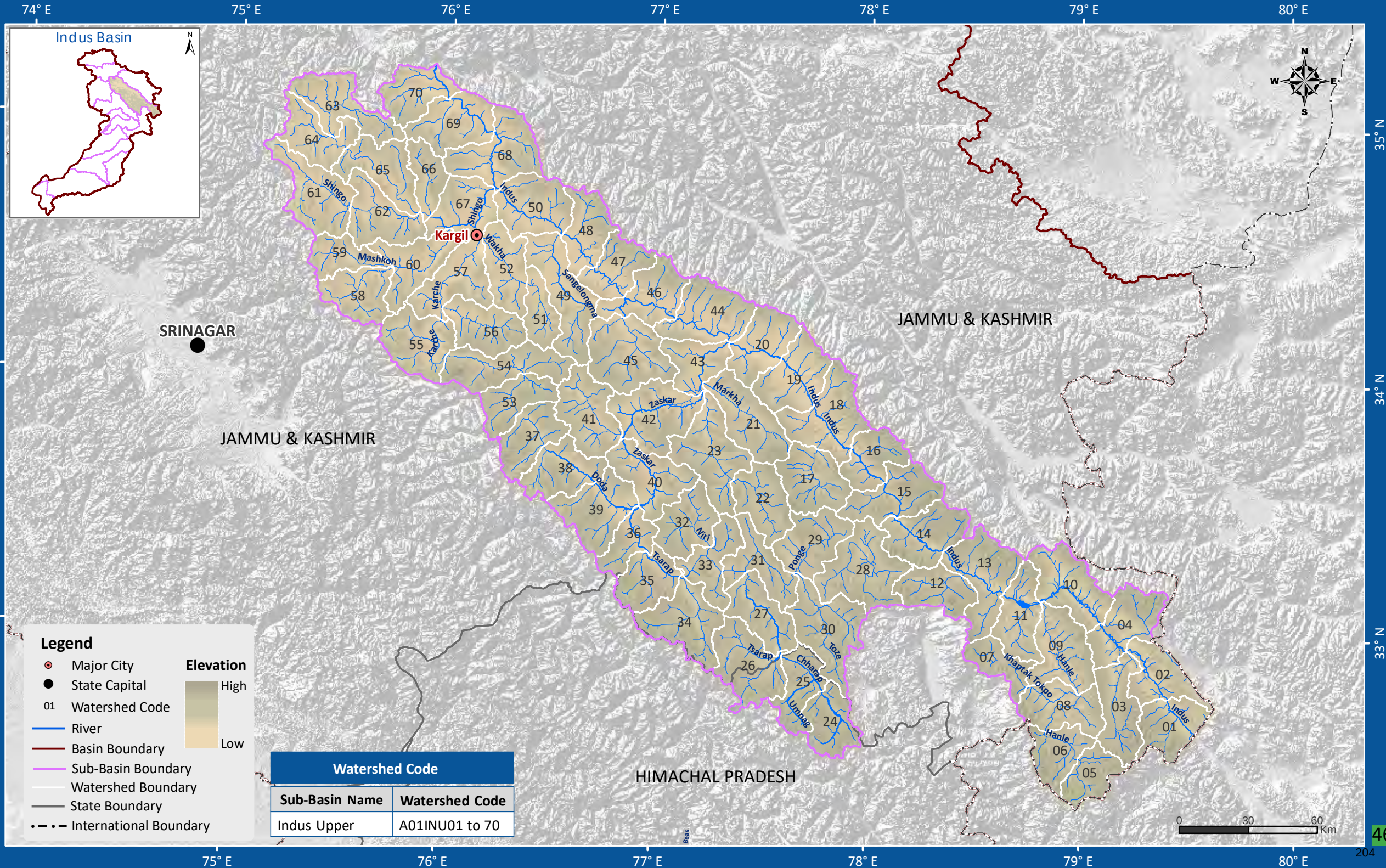
12. Satluj Lower Sub-Basin

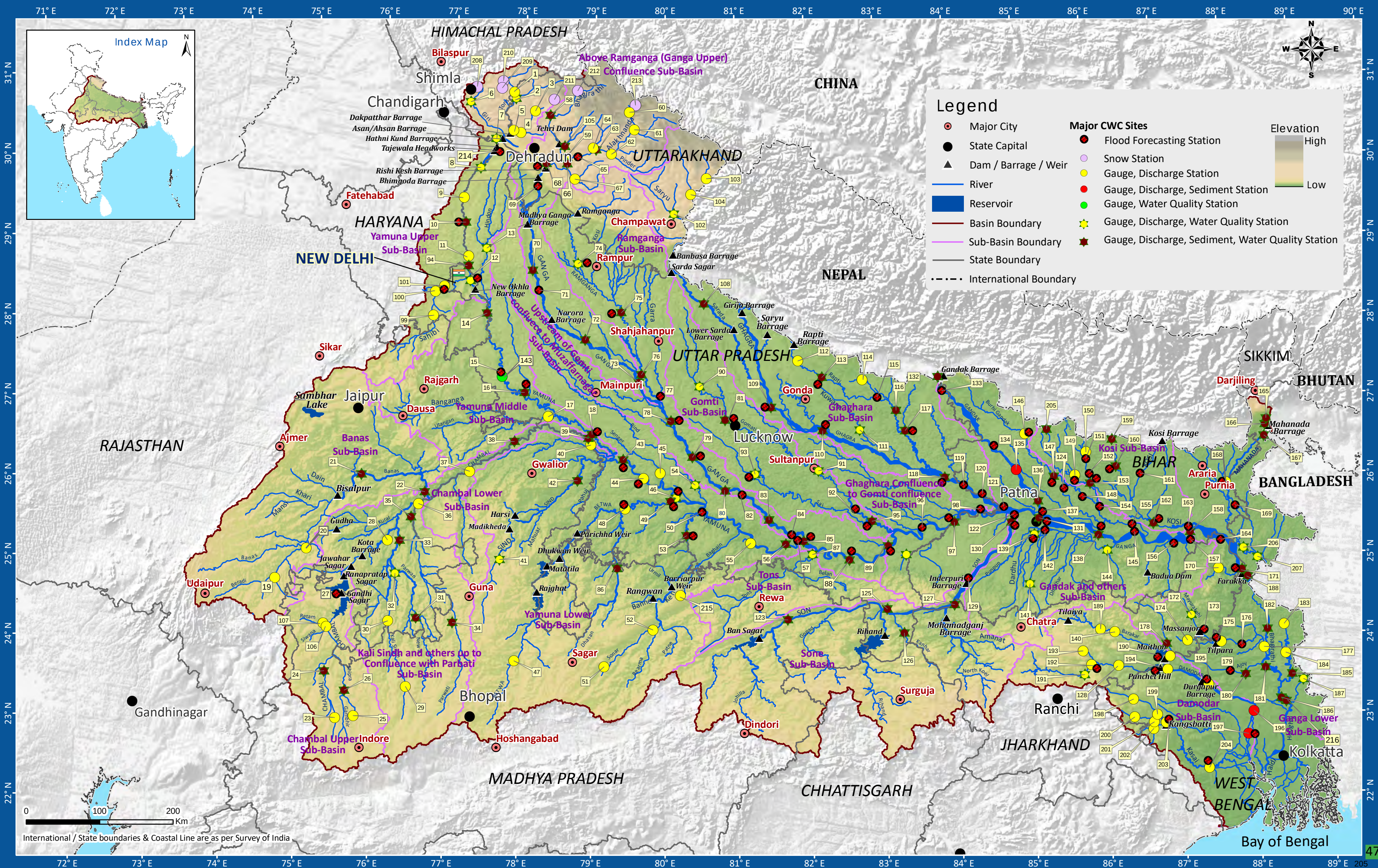


13. Satluj Upper Sub-Basin



14. Indus Upper Sub-Basin





Ganga Basin Hydrological Observation Sites

S. No.	Site Name	S. No.	Site Name	S. No.	Site Name
1	Tuini (P)(GD)	73	Fatehgarh (GDSQ)	145	Munger (FF)
2	Tuini(T) (GDQ)	74	Moradabad (GDQ & FF)	146	Lalbegia ghat (GD & FF)
3	Naugaon (GD)	75	Bareilly (GDSQ & FF)	147	Sikanderpur (GDSQ & FF)
4	Bausan (GD)	76	Dabri (GDSQ)	148	Samastipur (FF)
5	Haripur (GD)	77	Kannauj (FF)	149	Benibad (GD & FF)
6	Yashwant Nagar (GDQ)	78	Ankinghat (GDSQ & FF)	150	Saulighat (GD)
7	Paonta (GDQ)	79	Kanpur (GDSQ & FF)	151	Kamtaul (FF)
8	Kalanaur (GDQ)	80	Bhithaura (GDSQ)	152	Ekmighat (GDSQ & FF)
9	Karnal (GD)	81	Lucknow (GDSQ & FF)	153	Hayaghat (GDSQ & FF)
10	Mawi (GDSQ & FF)	82	Dalmau (FF)	154	Rosera (FF)
11	Baghpat (GD)	83	Shahjadpur (GDSQ)	155	Khagaria (FF)
12	Delhi Rly Bridge (GDSQ & FF)	84	Phaphamau (FF)	156	Bhagalpur (FF)
13	Galeta (GDQ)	85	Chhatnag (GDSQ & FF)	157	Colgong/ Kahalgaon (FF)
14	Mohana (GDSQ)	86	Garrauli (GDSQ)	158	Azmabad (GDSQ)
15	Mathura (FF)	87	Mejja Road (GDQ)	159	Jainagar (GDSQ)
16	Agra (GDSQ & FF)	88	Mirzapur (GDSQ & FF)	160	Jhanjharpur (GDSQ & FF)
17	Arnota (GD)	89	Varanasi (GDSQ & FF)	161	Basua (FF)
18	Etawah (GDSQ & FF)	90	Neemsar (GDQ)	162	Baltara (GDSQ & FF)
19	Chittorgarh (GD)	91	Sultanpur (GDQ)	163	Kursela (FF)
20	Bigod (GD)	92	Jaunpur (G & FF)	164	Sahibganj (FF)
21	Tonk (GDSQ)	93	Raibareli (GDQ & FF)	165	Siliguri (GDSQ)
22	Baranwada (GDSQ)	94	Palla (GDQ)	166	Matigara (GDSQ)
23	Dhareri (GD)	95	Maighat (GDSQ)	167	Sonapur (GDSQ)
24	Tal (GDSQ)	96	Ghazipur (FF)	168	Dhengra ghat (GD & FF)
25	Ujjain (GD)	97	Buxar (GDSQ & FF)	169	Jhawa (FF)
26	Mahidpur (GDSQ)	98	Ballia (FF)	170	Barhait (GD)
27	Gandhi Sagar (FF)	99	Masani (GD)	171	Farakka (GDSQ & IF)
28	Mandawara (GD)	100	Dadri (GD)	172	Maharo (GDQ)
29	Sarangpur (GD)	101	Dhansa (GD & FF)	173	Massanjore Dam (GD & IF)
30	Salavad (GD)	102	Ghat (GDQ)	174	Tantloi (GD)
31	Aklara (GDSQ)	103	Tawaghat (GD)	175	Tilpara Barrage (GD & IF)
32	Sangod (GDQ)	104	Jauljibi (GD)	176	Narayanpur (FF)
33	Barod (GDSQ)	105	Zero Point (GDSQ)	177	Bazarsaw(GD)
34	A.B. Road X-ing (GDSQ)	106	Nahargarh (GD)	178	Jamtara (GDSQ)
35	Khatoli (GDSQ)	107	Tumri (GD)	179	Gheropara (FF)
36	Pali (GD)	108	Paliakalan (GDSQ)	180	Nutanhat (GDSQ)
37	Manderial (GD)	109	Elginbridge (GDSQ & FF)	181	Katwa (Purbast hali) (GDSQ)
38	Dholpur (GDSQ)	110	Ayodhya (GDSQ & FF)	182	Berhampore (GDSQ)
39	Udi (GDSQ)	111	Basti (GDQ)	183	Islampur (GD)
40	Bhind (GD)	112	Bhinga (GD)	184	Palashi para (GD)
41	Pachauli (GDQ)	113	Balrampur (GDSQ & FF)	185	Chapra (GDSQ)
42	Seondha (GDSQ)	114	Kakarahi(GD)	186	Kalna (Ebb) (GDSQ)
43	Auraiya (GDSQ & FF)	115	Bansi (G & FF)	187	Hanskhali (GDQ)
44	Kalpi (GD & FF)	116	Regauli (GDSQ)	188	H/R Farraka (GDSQ)
45	Lalpur (GD)	117	Birdghat (GDSQ & FF)	189	Barkisuriya (GD)
46	Hamirpur (GDQ & FF)	118	Turtipar (GDSQ & FF)	190	Maithon Dam (GD & IF)
47	Basoda (GD)	119	Darauli (FF)	191	Ramgarh (GDQ)
48	Mohana (GD & FF)	120	Gangpur Siswan (FF)	192	Tenughat Dam (GD & IF)
49	Shahijina (GDSQ & FF)	121	Chhapra (FF)	193	Konar Dam (GD)
50	Chillaghat (FF)	122	Maner (FF)	194	Panchet Dam (GD & IF)
51	Garhakota (GD)	123	Kuldah Bridge (GDSQ)	195	Durgapur Barrage (GD & IF)
52	Gaisabad (GD)	124	Rewaghat (FF)	196	Jamalpur (GDS)
53	Banda (GDSQ & FF)	125	Chopan (GDSQ)	197	Harinkhola (GDS & FF)
54	Kora (GDQ)	126	Duddhi (GDSQ)	198	Simulia (GD)
55	Rajapur (GD)	127	Japla (GDSQ)	199	Tusuma (GD)
56	Pratappur (GDSQ)	128	Pupunki (GD)	200	Rangagora (GD)
57	Naini (FF)	129	Inderpuri (FF)	201	Kharidwar (GD)
58	Uttarkashi (GDSQ)	130	Koelwar (GDSQ & FF)	202	Phulberia (GD)
59	Deoprayag (GD)	131	Gandhi ghat (GDSQ)	203	Kangsabati Dam (GD & IF)
60	Badrinath (GD)	132	Tribeni (GDSQ)	204	Mohanpur (GD & FF)
61	Joshimath (GD)	133	Khadda (FF)	205	Dheng Bridge (GDSQ)
62	Karanprayag (GD)	134	Chatia (FF)	206	Labha (GDQ)
63	Rudraprayag (GDSQ)	135	Dumariaghat(GDS)	207	English Bazar (GDQ)
64	Rudraprayag (GD)	136	Lalganj (GDSQ)	208	Kufri SHO
65	Srinagar (FF)	137	Hazipur (FF)	209	Jubbal SHO-II
66	Deoprayag (GDSQ)	138	Hathidah (GDSQ & FF)	210	Jubbal SHO-I
67	Marora (D/S) (GD)	139	Sripalpur (GDQ & FF)	211	Hanuman Chetty SHO
68	Rishikesh (GDSQ & FF)	140	Nandadih (GD)	212	Harsil SHO
69	Haridwar (FF)	141	Gaya (GDQ)	213	Auli SHO
70	Garhamukteshwar (GDSQ)	142	Patna (Dighaghat) (FF)	214	Tajewala Weir (Hathnikund) (FF)
71	Narora Barrage (U/S)(FF)	143	Gokul Barrage (GQ)	215	Madla (GD)
72	Kachlabridge (GDSQ)	144	Lakhisarai (GDQ)	216	Kalna (Flow) (GDSQ)

The Ganga basin outspreads in India, Tibet (China), Nepal and Bangladesh over an area of 10,86,000 Sq.km. In India, it covers states of Uttar Pradesh, Madhya Pradesh, Rajasthan, Bihar, WestBengal, Uttarakhand, Jharkhand, Haryana, Chhattisgarh, Himachal Pradesh and Union Territory of Delhi draining an area of 8,61,452 Sq.km which is nearly 26% of the total geographical area of the country. The basin lies between east longitudes 73°2' to 89°5' and north latitudes 21°6' to 31°21' having maximum length and width of approx. 1,543 km and 1024 km. The basin is bounded by the Himalayas on the north, by the Aravalli on the west, by the Vindhya and Chhotanagpur plateau on the south and by the Brahmaputra Ridge on the east. The Ganga rises in the Gangotri glacier in the Himalayas at an elevation of about 7,010 m in the Uttarkashi district of Uttarakhand. At its source, the river is called as the Bhagirathi. It descends down the valley upto Devprayag where after joining another hill stream Alaknanda, it is called Ganga. The total length of river Ganga (measured along the Bhagirathi and the Hooghly) up to its outfall into Bay of Bengal is 2,525 km. The principal tributaries joining the river from right are the Yamuna and the Son. The Ramganga, the Ghaghra, the Gandak, the Kosi and the Mahananda join the river from left. The Chambal and the Betwa are the two other important sub-tributaries. The major part of basin in Indian territory is covered with agricultural land accounting to 65.57% of the total area and 3.47% of the basin is covered by water bodies.

Salient Features of Ganga Basin

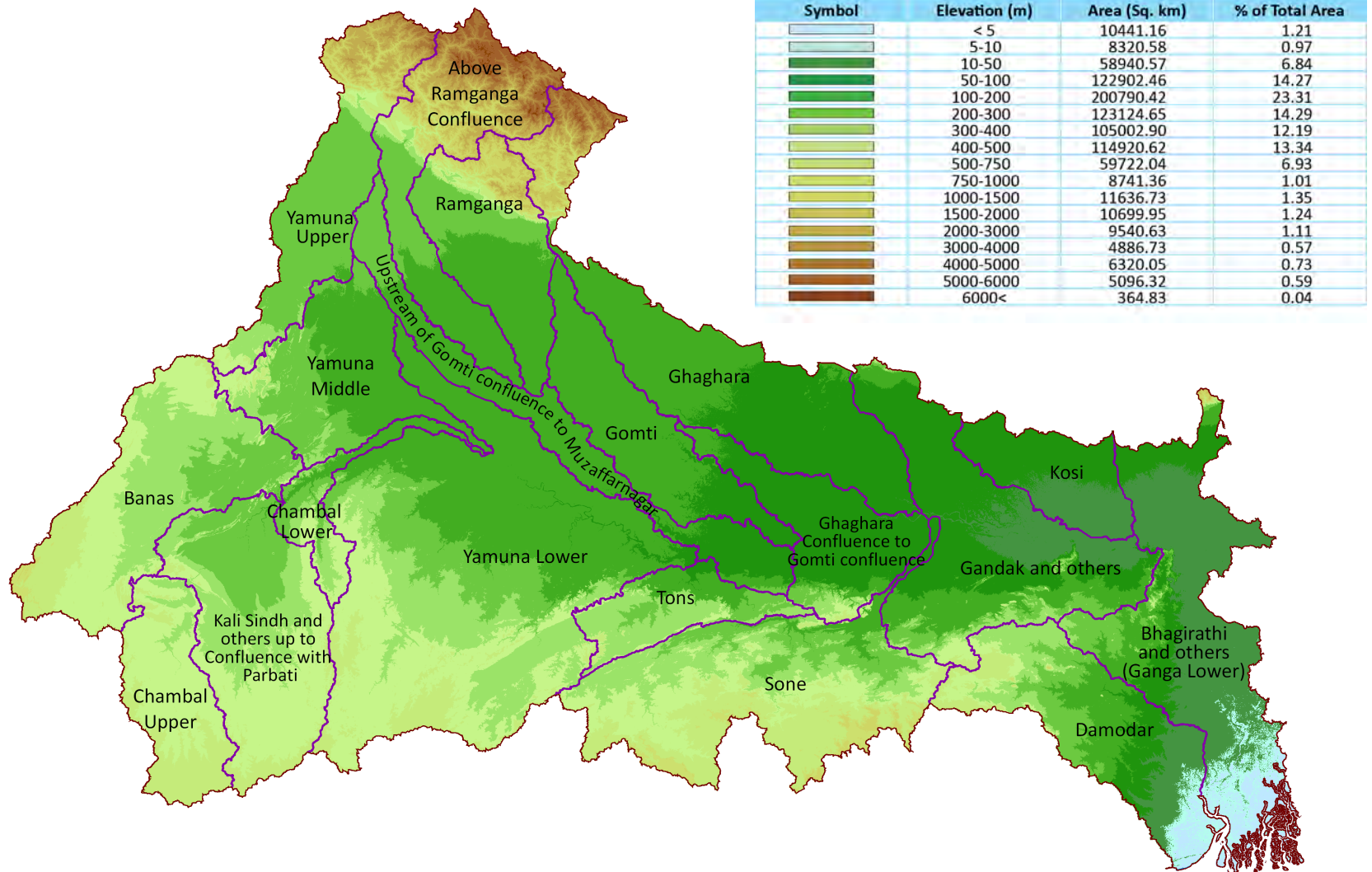
Basin Extent	Longitude	73° 2' to 89° 5' E
	Latitude	21° 6' to 31° 21' N
Length of Ganga River (Km)		2525
Catchment Area (Sq.km.)		861452
Average Water Resource Potential (MCM)		525020
Utilizable Surface Water Resource (MCM)		250000
Live Storage Capacity of Completed Projects (MCM)		42060.2
Live Storage Capacity of Projects Under Construction (MCM)		18600.18
Total Live Storage Capacity of Projects (MCM)		60660.38
No. of Hydrological Observation Stations		318
No. of Flood Forecasting Stations		83

Major Water Resource Assets

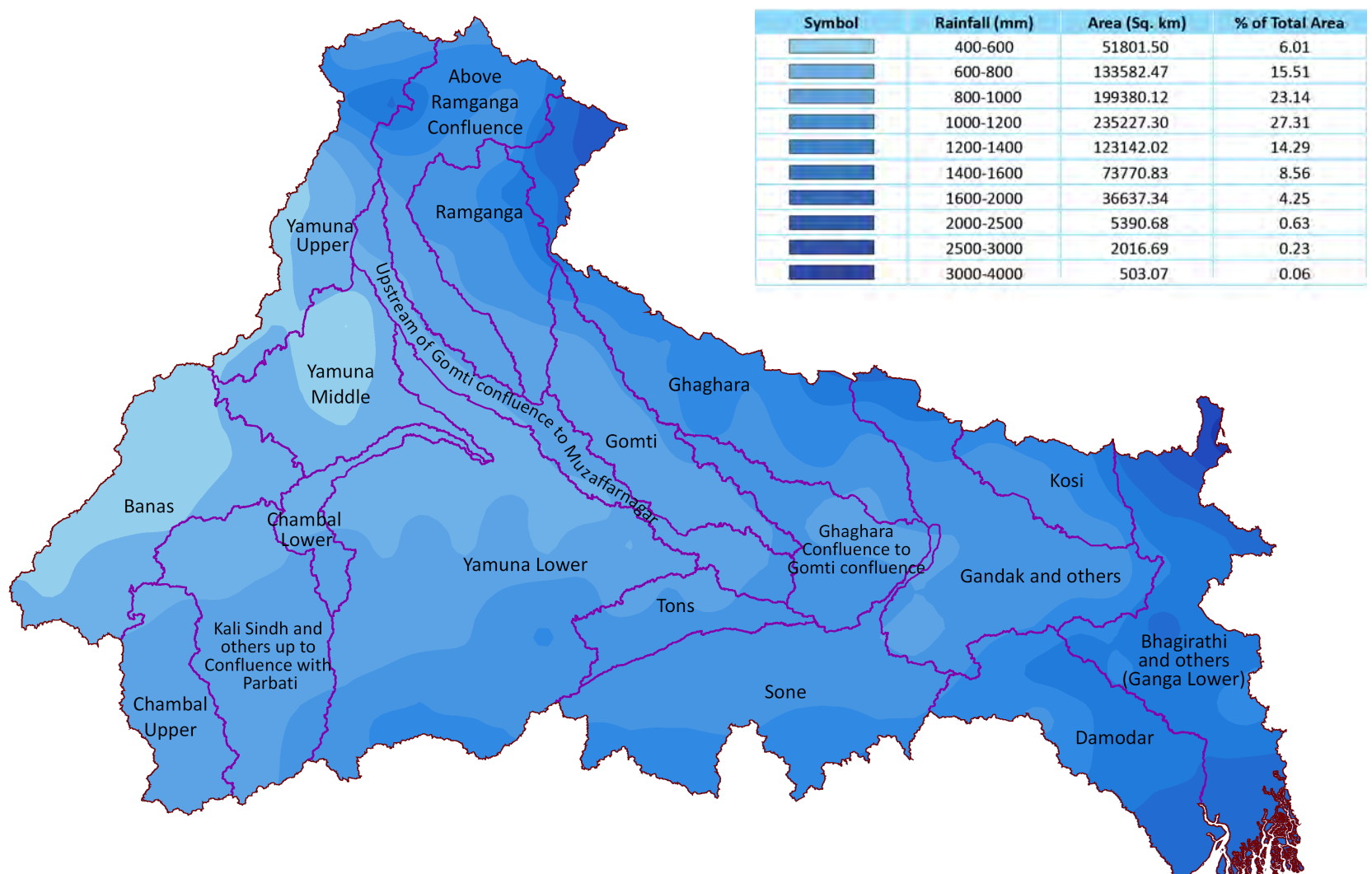
Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Above Ramganga Confluence	39104.61	3	9	7	945	24
2	Banas	51651.51	76	0	172	16624	7
3	Bhagirathi and others (Ganga Lower)	64038.97	12	13	12	77873	38
4	Chambal Lower	10941.26	3	0	10	1198	3
5	Chambal Upper	25546.57	31	1	31	4878	7
6	Damodar	41965.49	39	9	29	51641	26
7	Gandak and others	56260.43	30	41	21	24116	30
8	Ghaghara	58634.18	11	8	15	5622	48
9	Ghaghara Confluence to Gomti Confluence	26254.06	12	7	19	5903	7
10	Gomti	29865.21	0	1	0	2006	10
11	Kali Sindh and others up to Confluence with Parbati	48492.61	125	3	106	6468	9
12	Kosi	18413.58	0	3	0	20696	14
13	Ramganga	30839.69	11	10	12	1786	11
14	Sone	65110.05	159	21	149	27469	14
15	Tons	16905.74	32	4	29	5214	3
16	Upstream of Gomti Confluence to Muzaffarnagar	29061.37	14	1	13	2057	14
17	Yamuna Lower	124867.19	201	17	199	16022	23
18	Yamuna Middle	34586.39	19	1	22	3576	7
19	Yamuna Upper	35798.19	6	12	14	2842	23

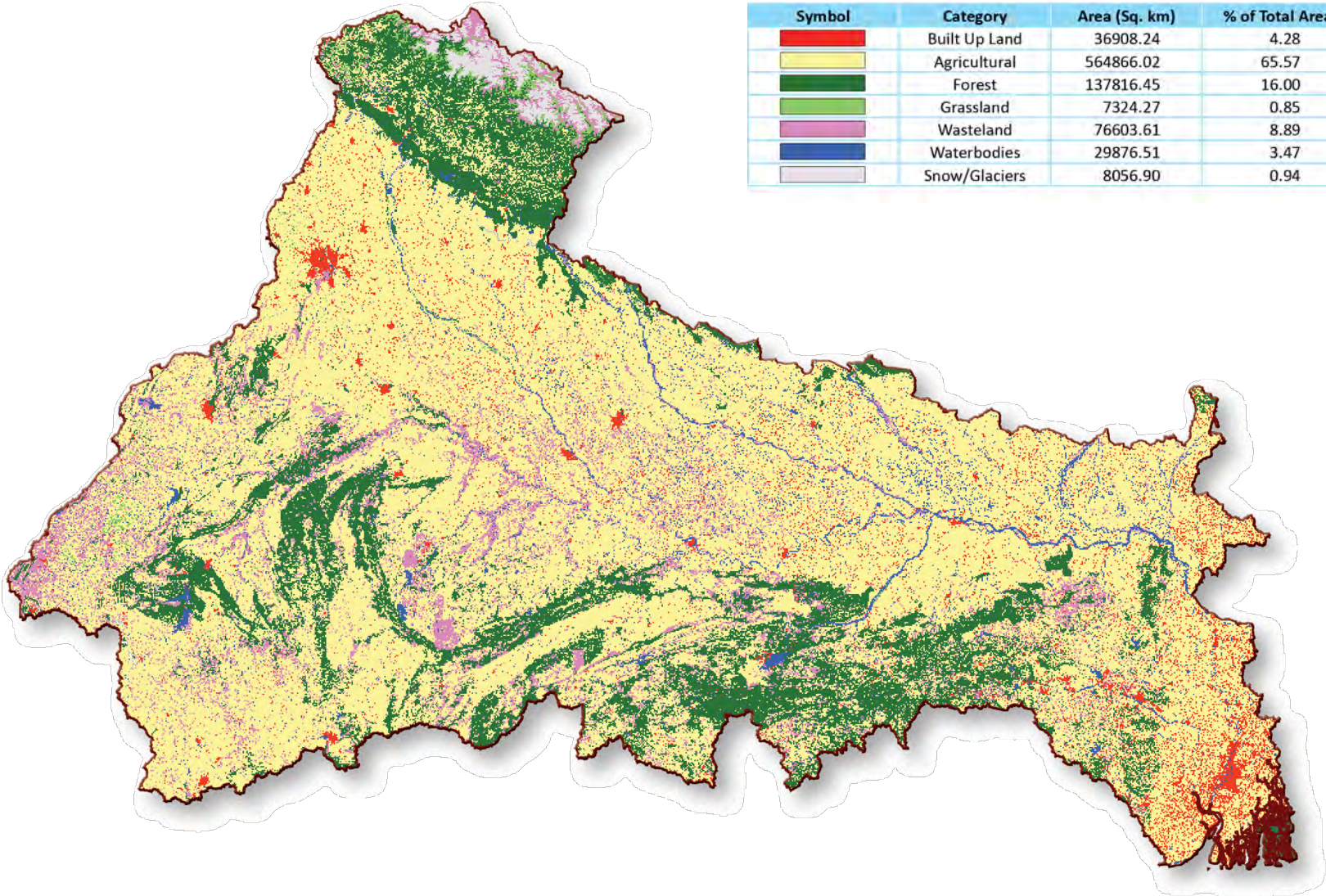
Watershed Statistics

Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Above Ramganga Confluence	51	430.18	1301.20	766.76
2	Banas	64	330.66	1432.97	807.05
3	Bhagirathi and others (Ganga Lower)	75	308.24	1754.95	853.85
4	Chambal Lower	14	405.59	1135.93	781.52
5	Chambal Upper	30	405.14	1403.97	851.55
6	Damodar	60	326.16	1301.09	699.42
7	Gandak and others	76	334.87	1308.88	740.27
8	Ghaghara	76	374.93	1300.49	771.50
9	Ghaghara Confluence to Gomti Confluence	36	372.40	1761.77	729.28
10	Gomti	41	333.29	1330.50	728.42
11	Kali Sindh and others up to Confluence with Parbati	64	429.86	1275.01	757.70
12	Kosi	19	303.77	1694.96	969.14
13	Ramganga	40	350.05	1442.76	770.99
14	Sone	83	380.66	1389.01	784.46
15	Tons	23	442.40	1173.36	735.03
16	Upstream of Gomti Confluence to Muzaffarnagar	40	364.16	1281.12	726.53
17	Yamuna Lower	98	735.54	1781.43	1274.15
18	Yamuna Middle	43	410.43	1232.25	804.33
19	Yamuna Upper	47	321.77	1241.11	761.66

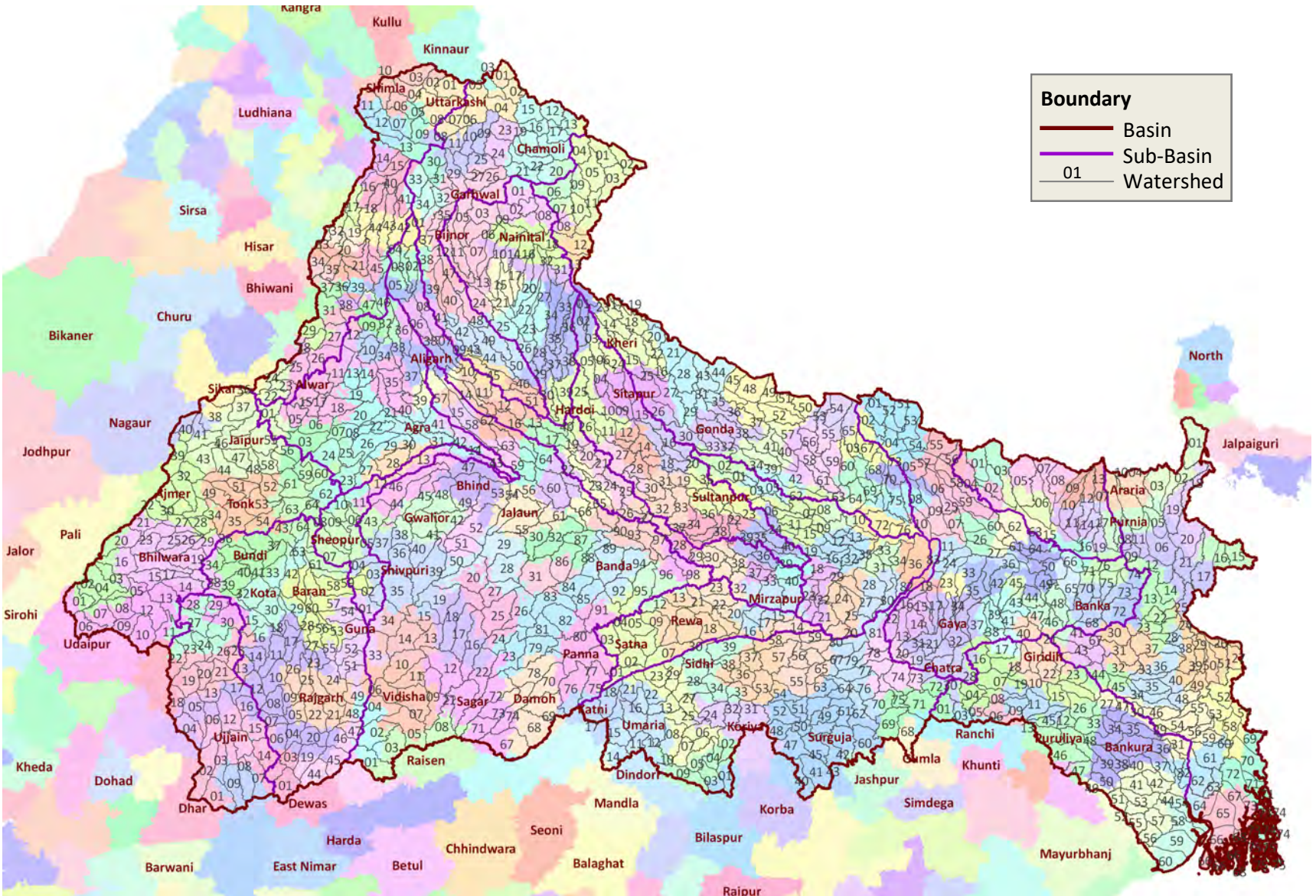


Average Annual Rainfall (1971-2005)

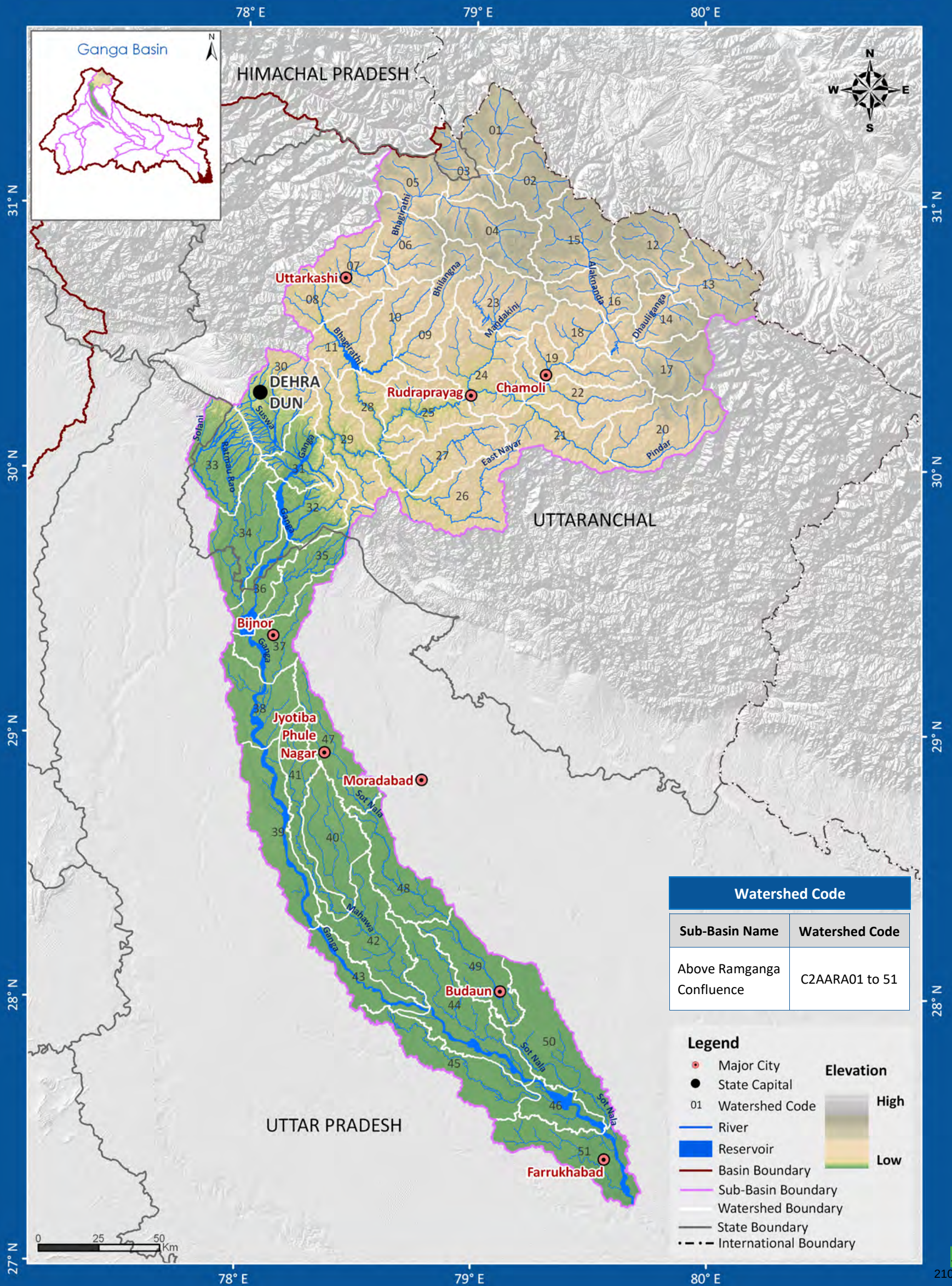




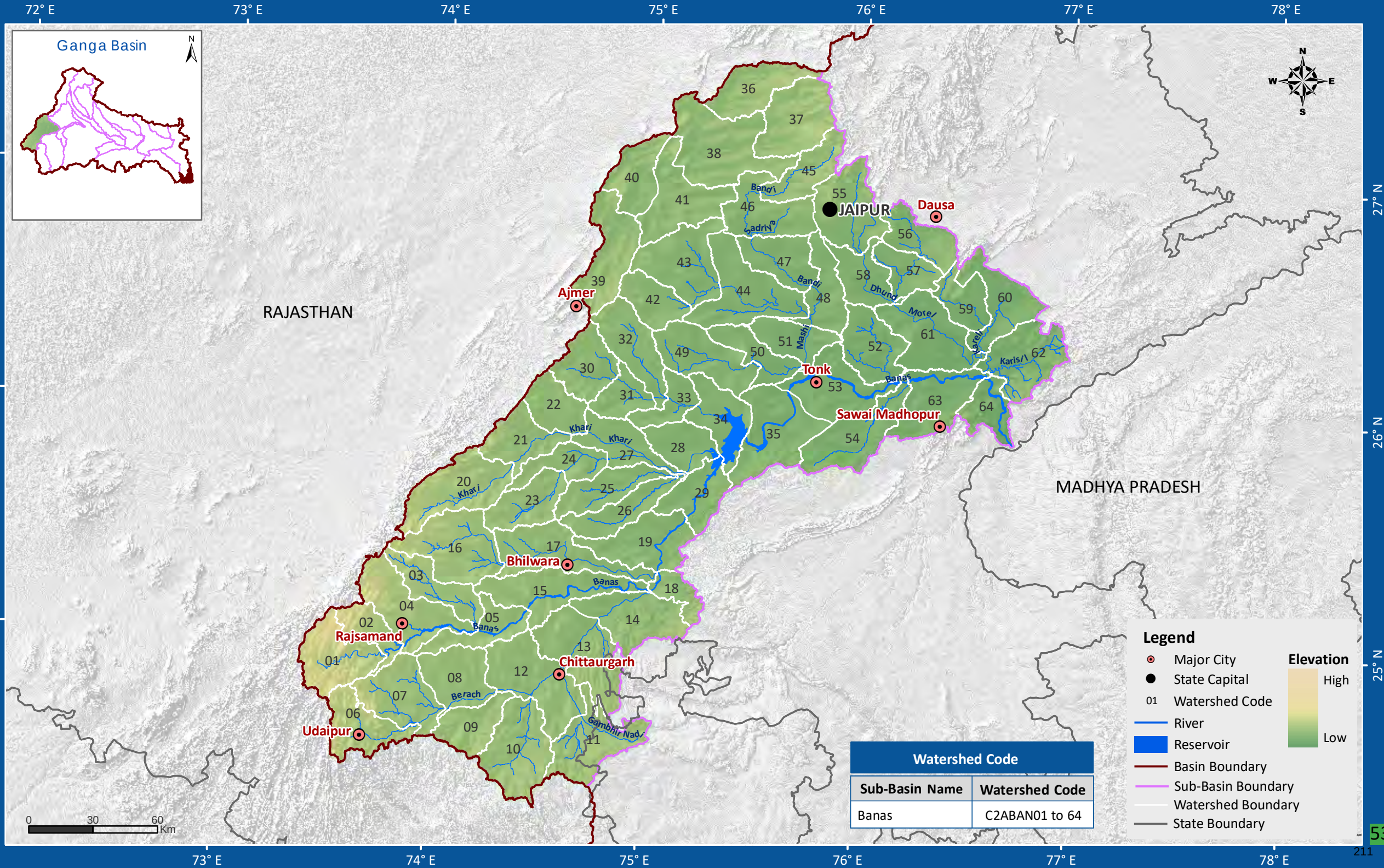
Districts



1. Above Ramganga Confluence 407 Sub-Basin



2. Banas Sub-Basin⁴⁰⁸

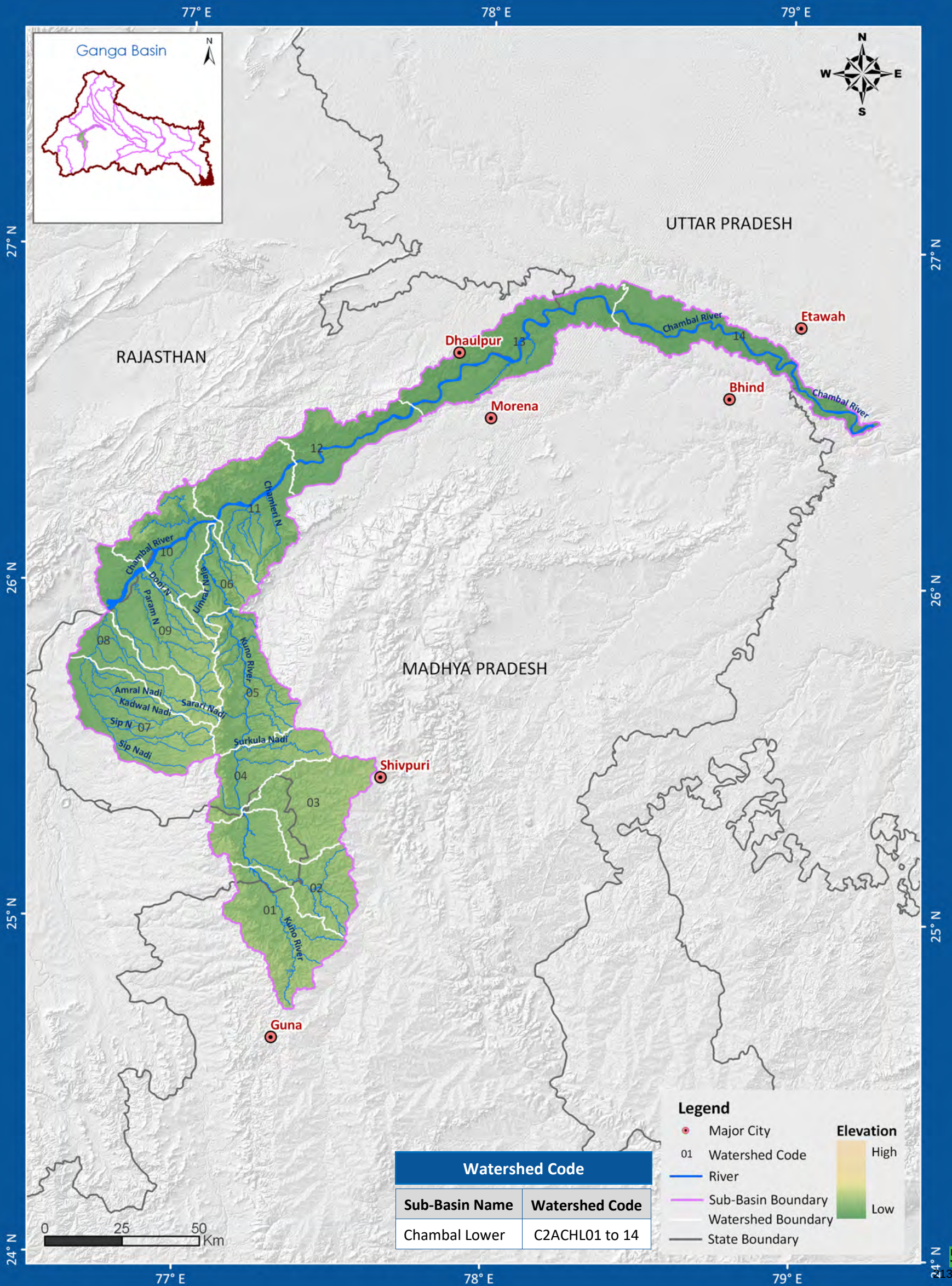


3. Bhagirathi and others Sub-Basin

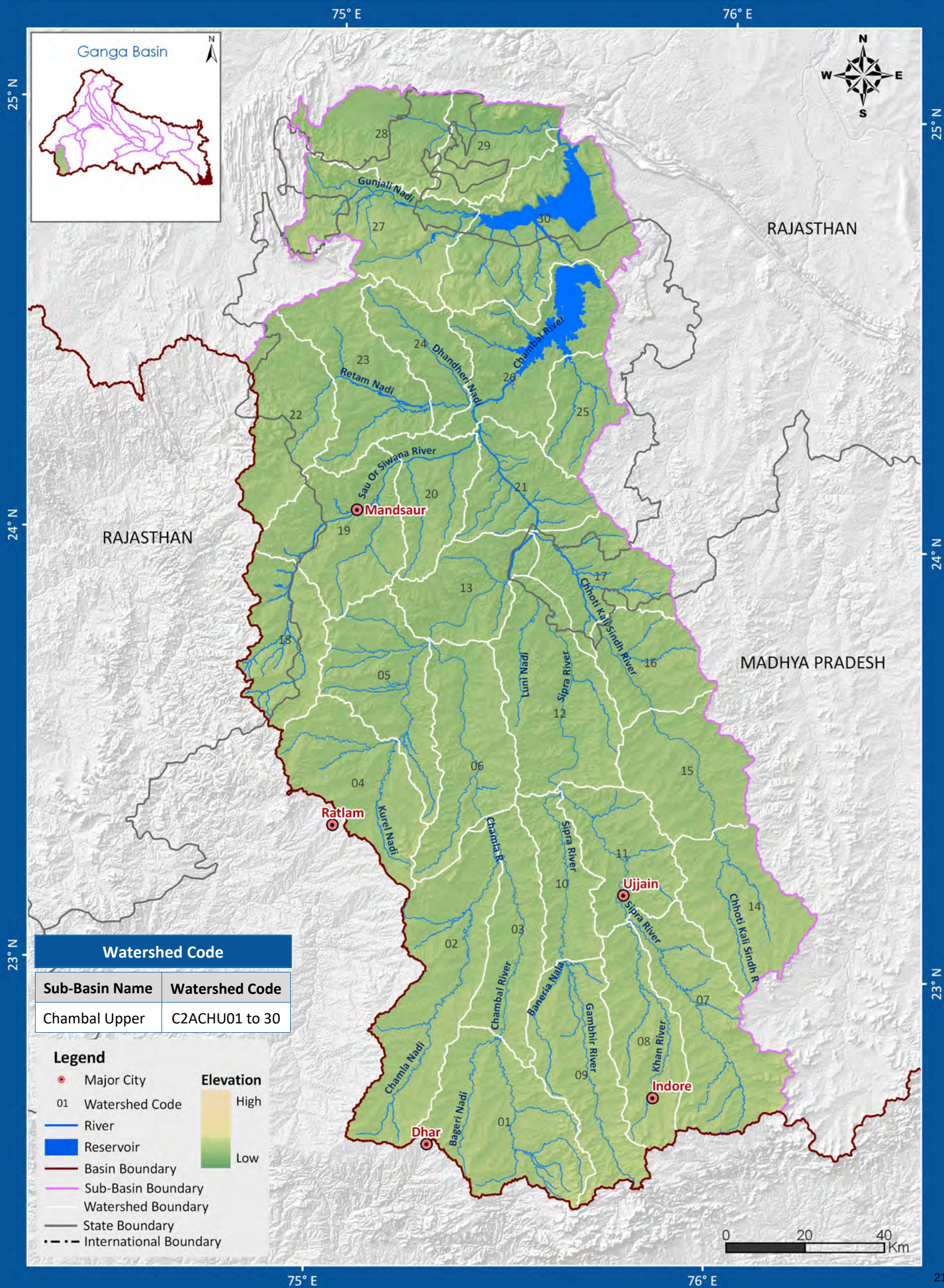
409



410 4. Chambal Lower Sub-Basin



411 5. Chambal Upper Sub-Basin

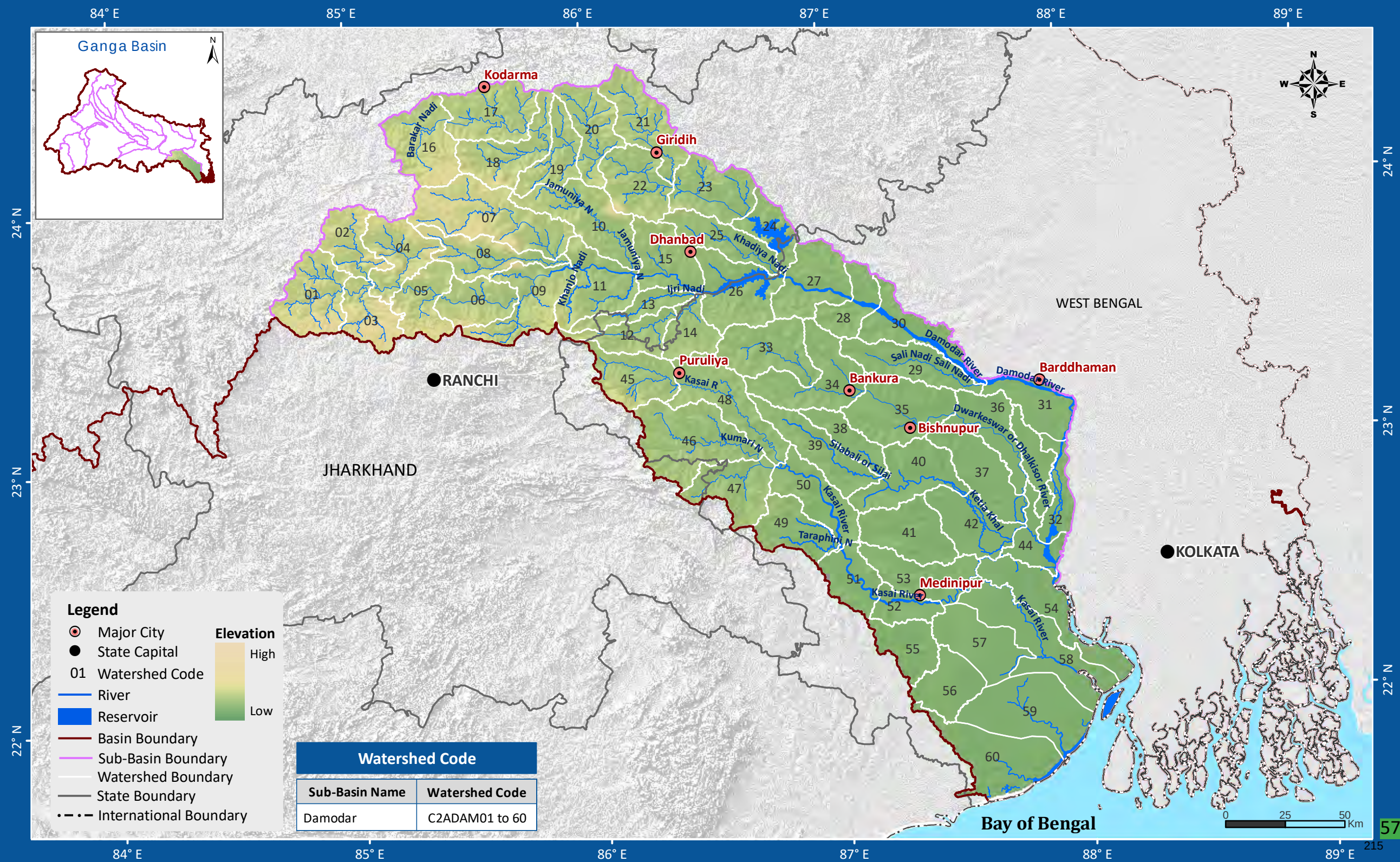


Watershed Code

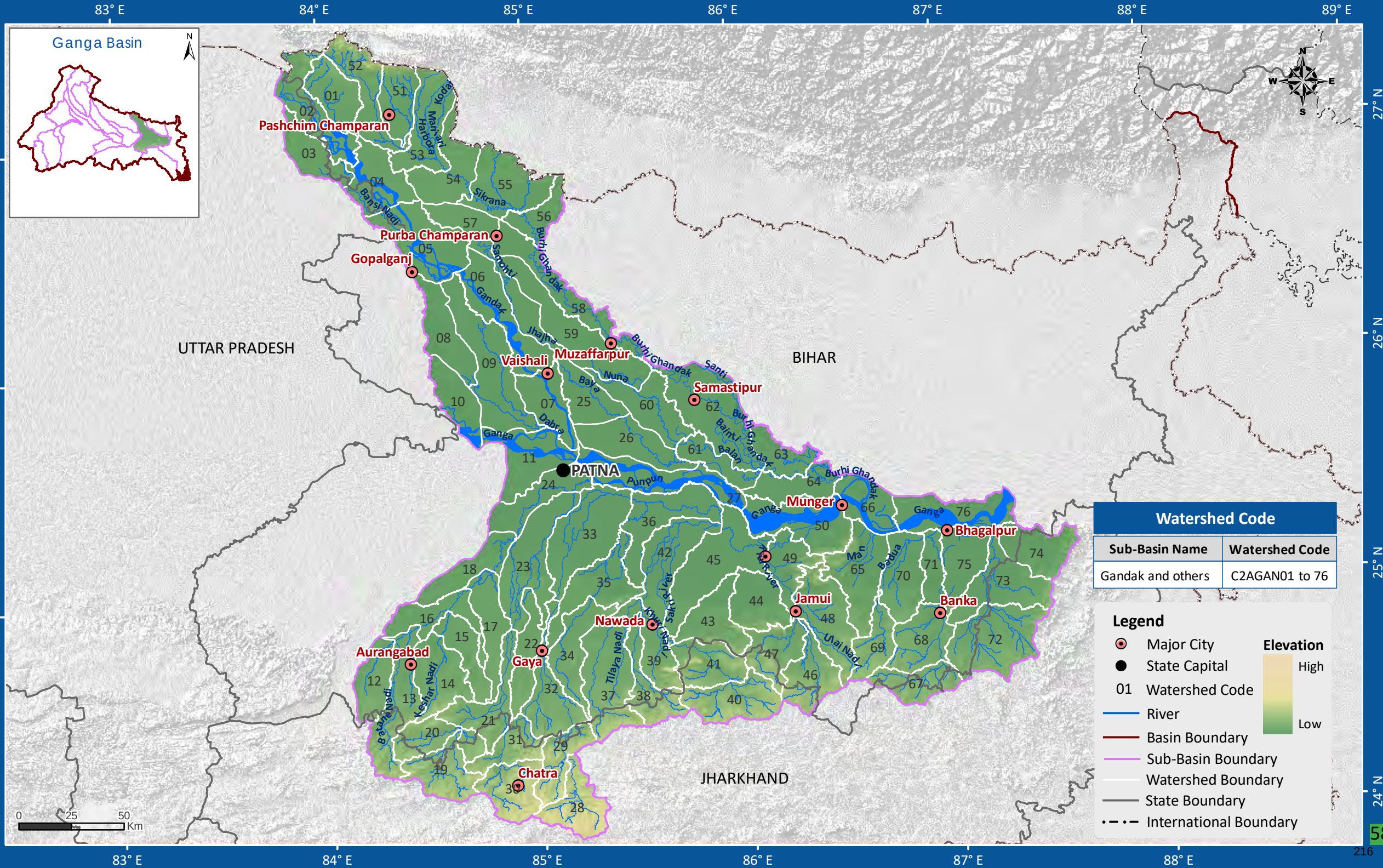
Sub-Basin Name	Watershed Code
Chambal Upper	C2ACHU01 to 30

Legend

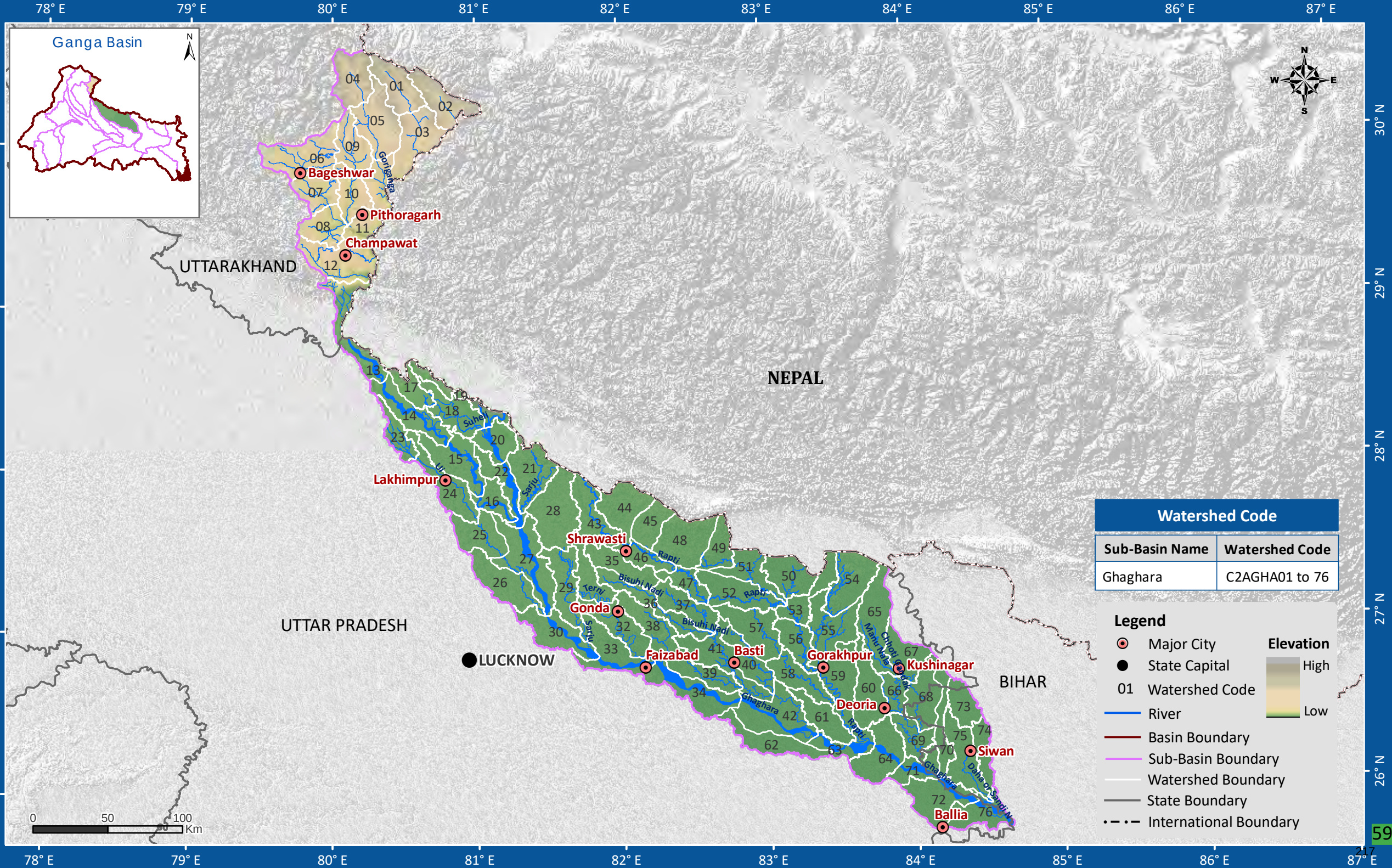
- Major City
 - 01 Watershed Code
 - River
 - Reservoir
 - Basin Boundary
 - Sub-Basin Boundary
 - Watershed Boundary
 - State Boundary
 - International Boundary
- Elevation**
- High
- Low



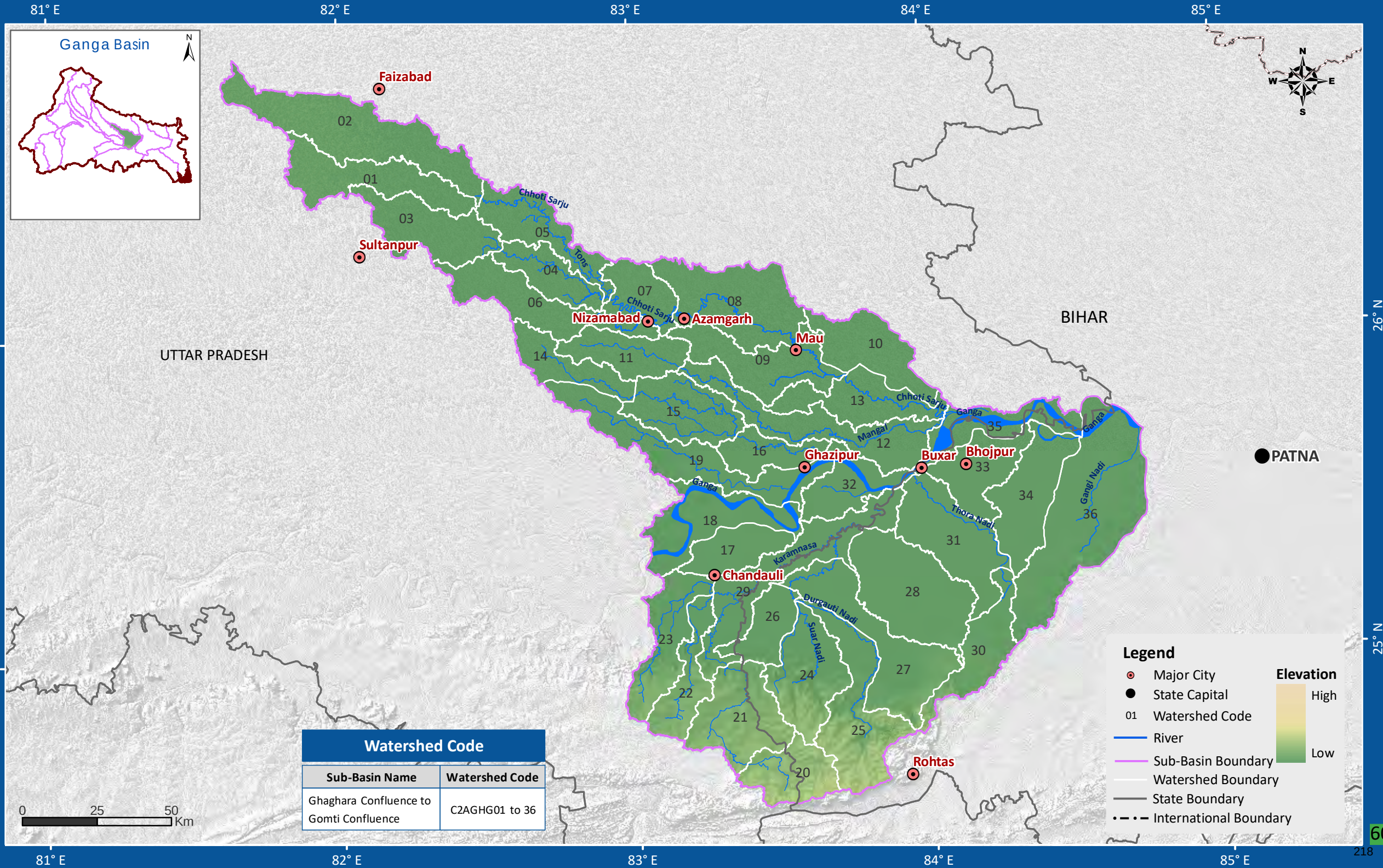
7. Gandak and others Sub-Basin



8. Ghaghara⁴¹⁴ Sub-Basin



9. Ghaghara Confluence to Gomti Confluence Sub-Basin

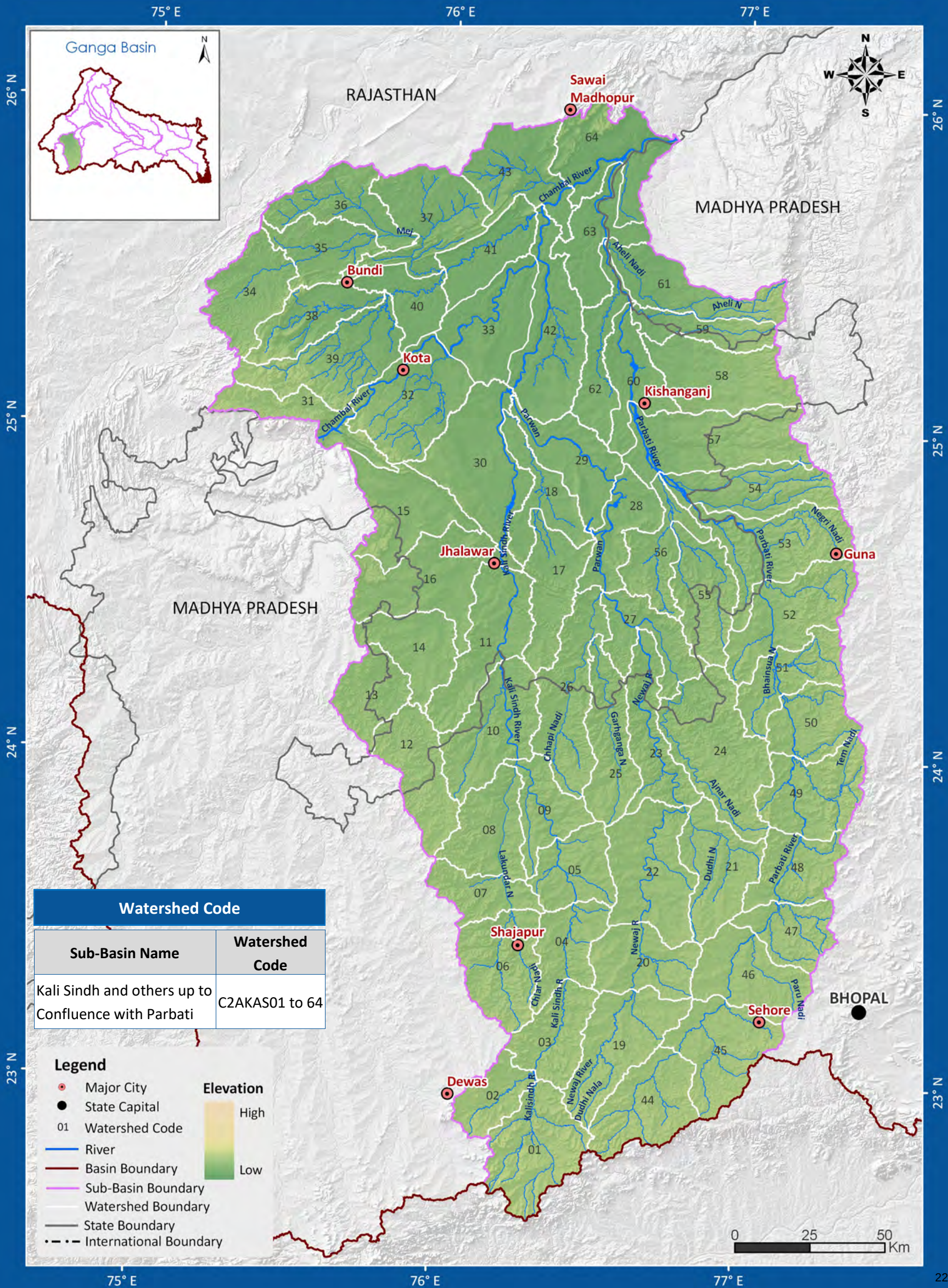


10. Gomti Sub-Basin

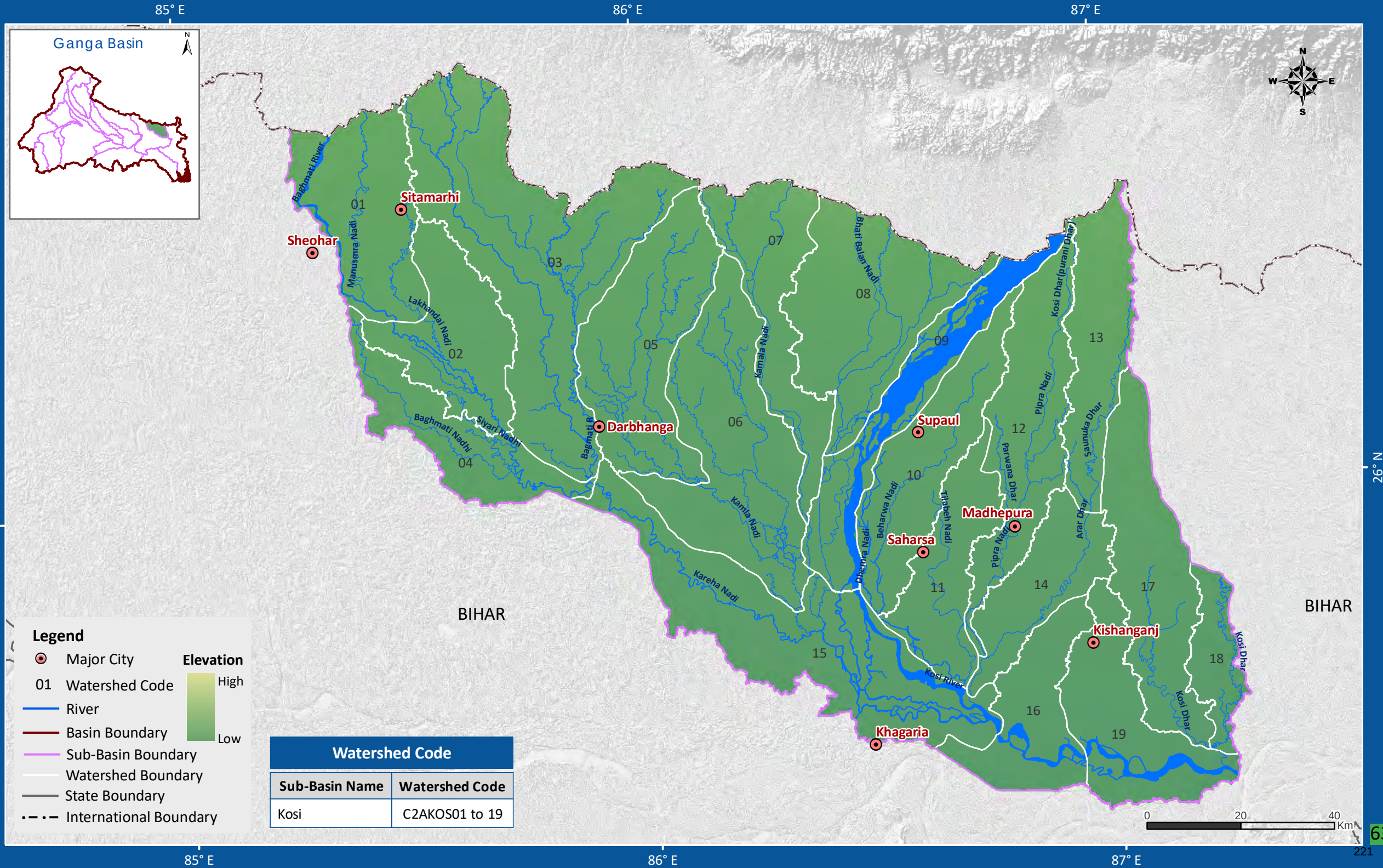
416



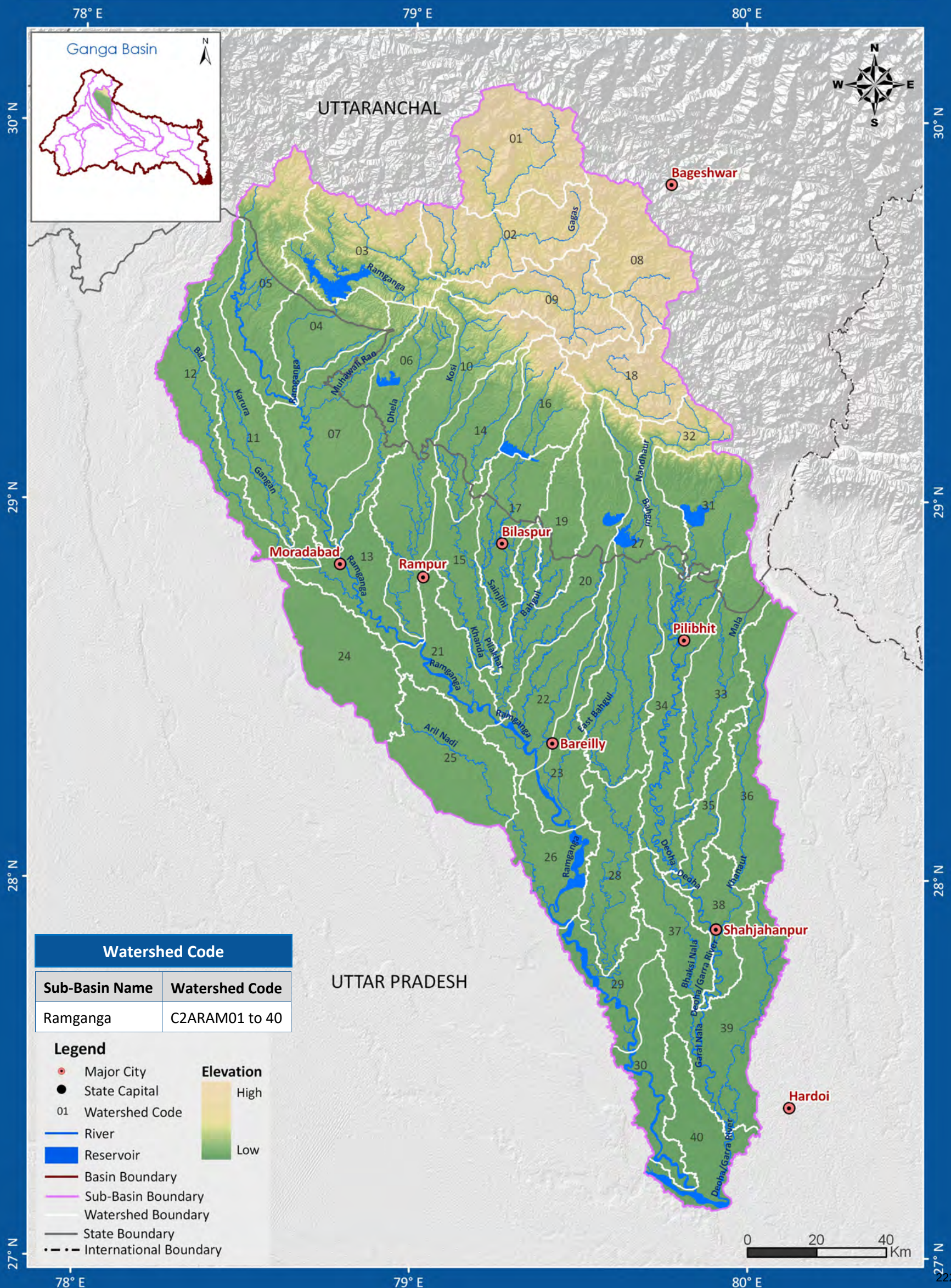
11. Kali Sindh and others up to Confluence with Parbati Sub-Basin



12. Kosi Sub-Basin⁴¹⁸



419 13. Ramganga Sub-Basin



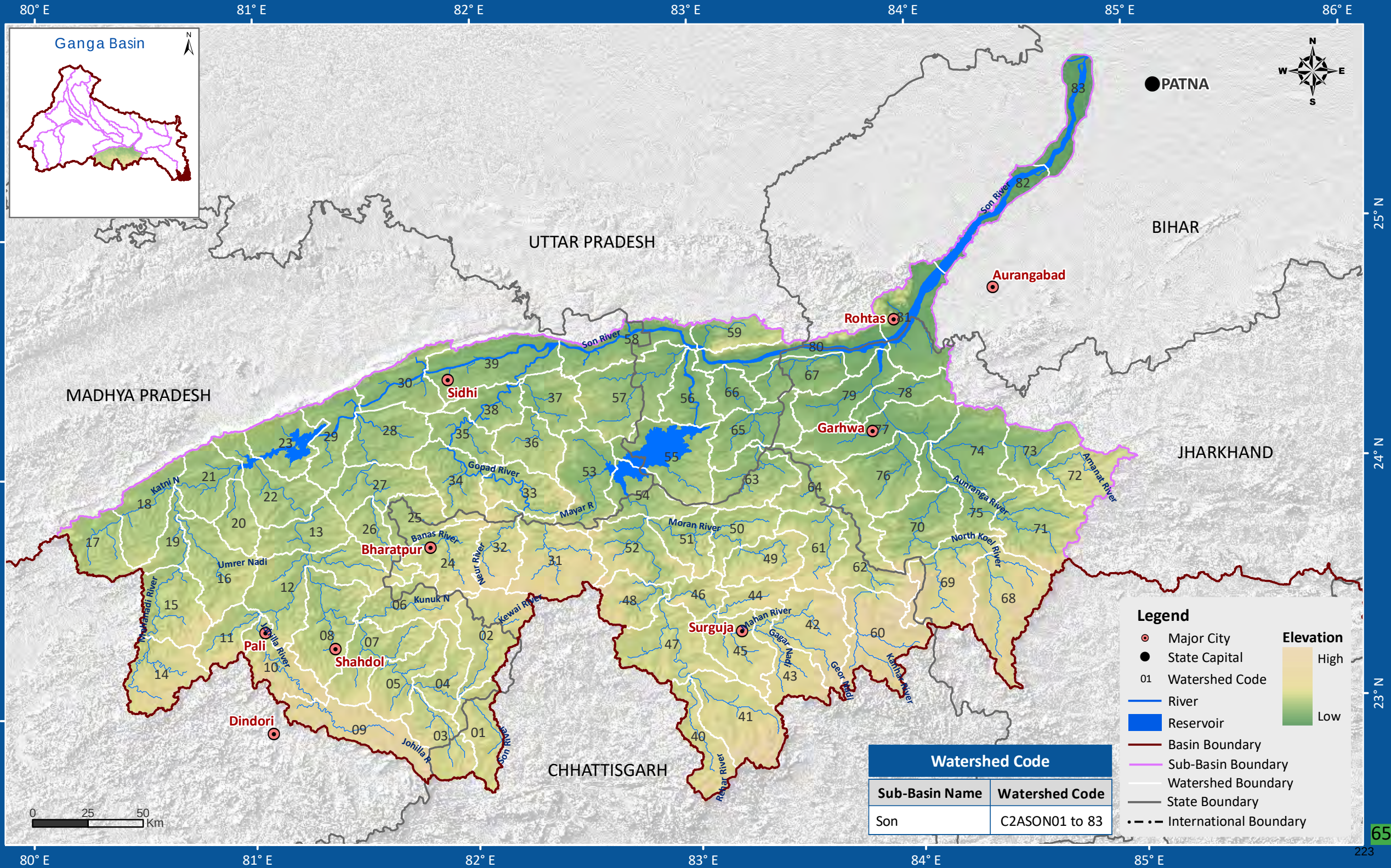
Watershed Code

Sub-Basin Name	Watershed Code
Ramganga	C2ARAM01 to 40

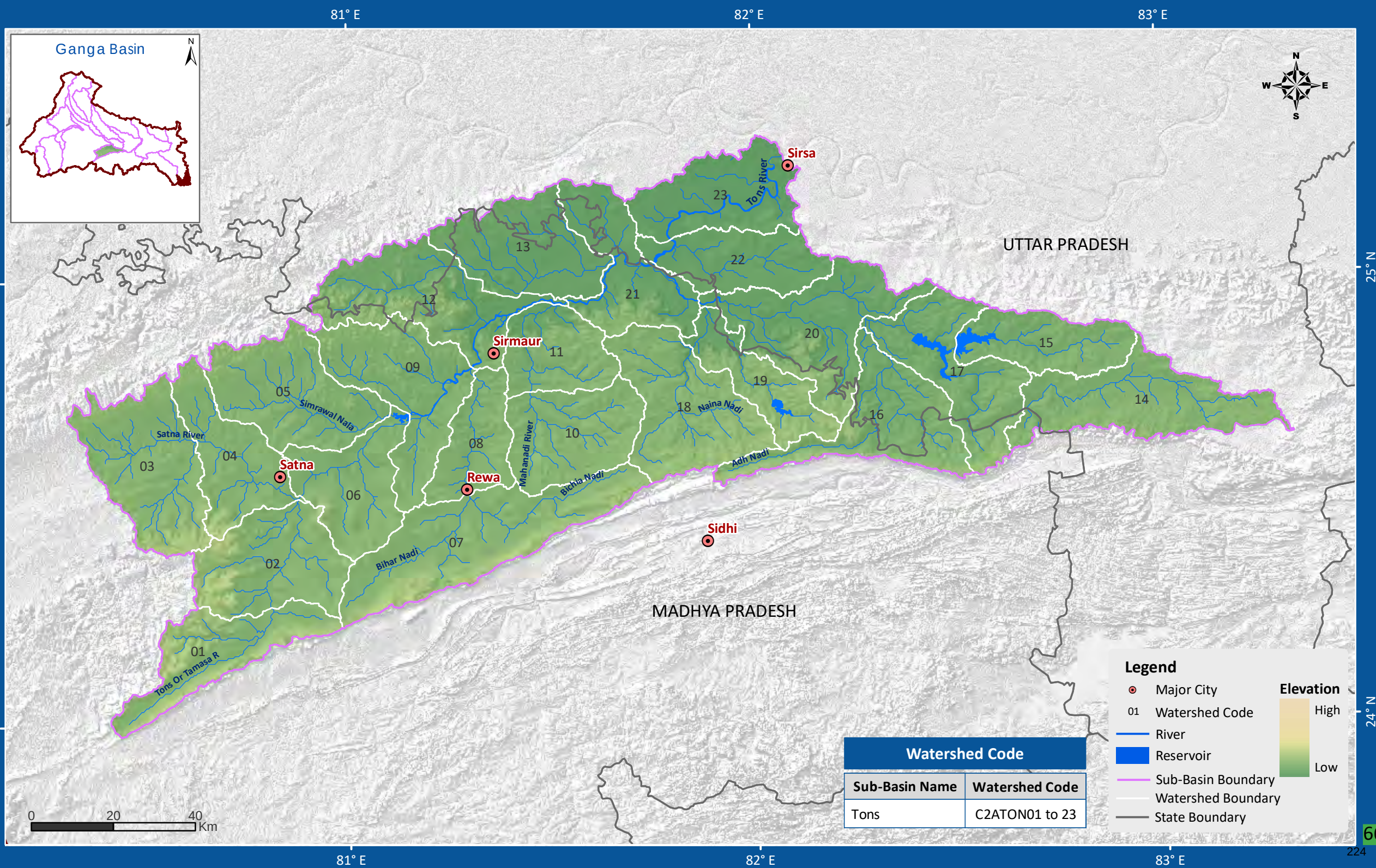
Legend

- Major City
 - State Capital
 - 01 Watershed Code
 - River
 - Reservoir
 - Basin Boundary
 - Sub-Basin Boundary
 - Watershed Boundary
 - State Boundary
 - International Boundary
- Elevation**
- High
- Low

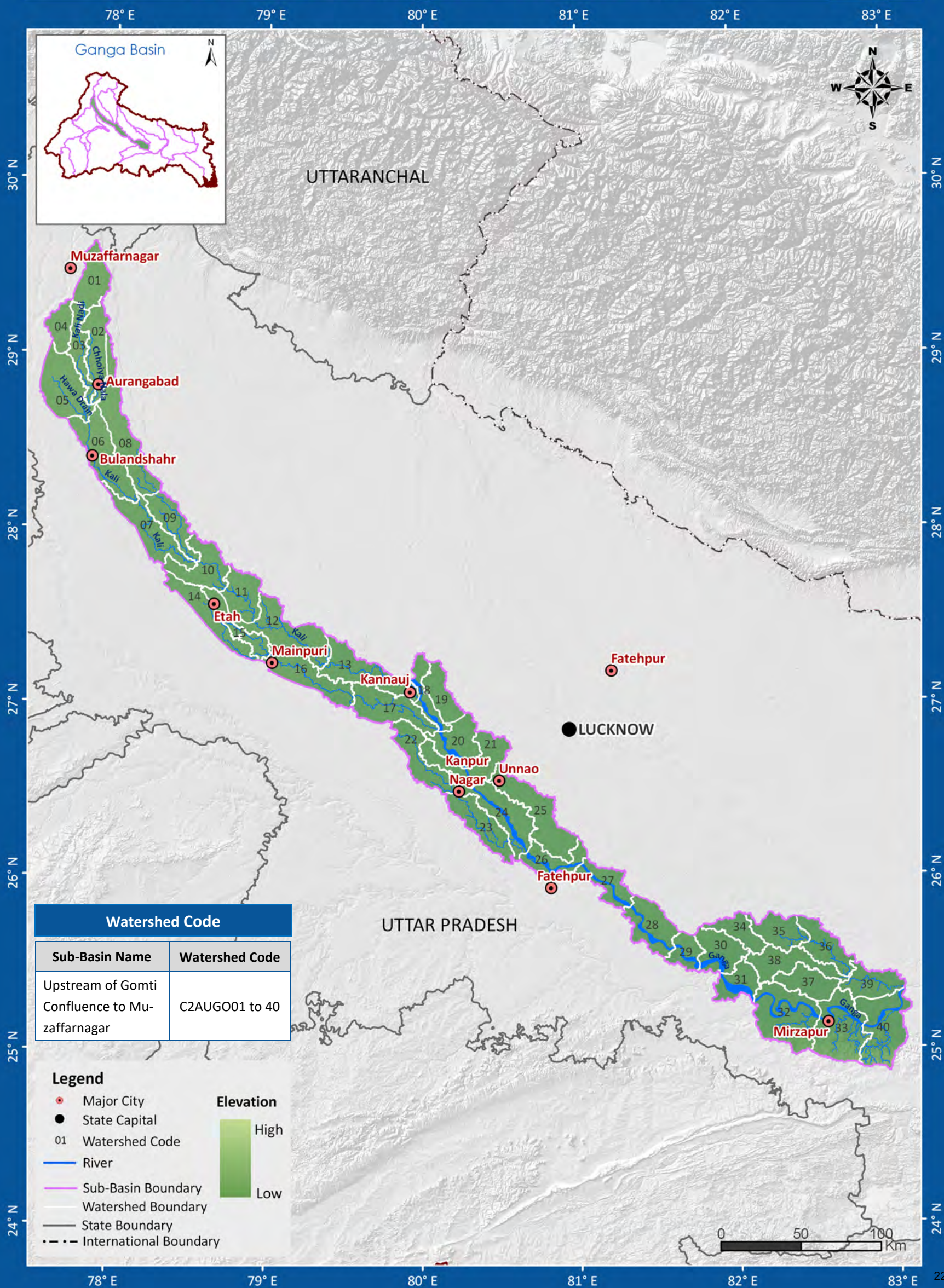
14. Son Sub-Basin



15. Tons Sub-Basin



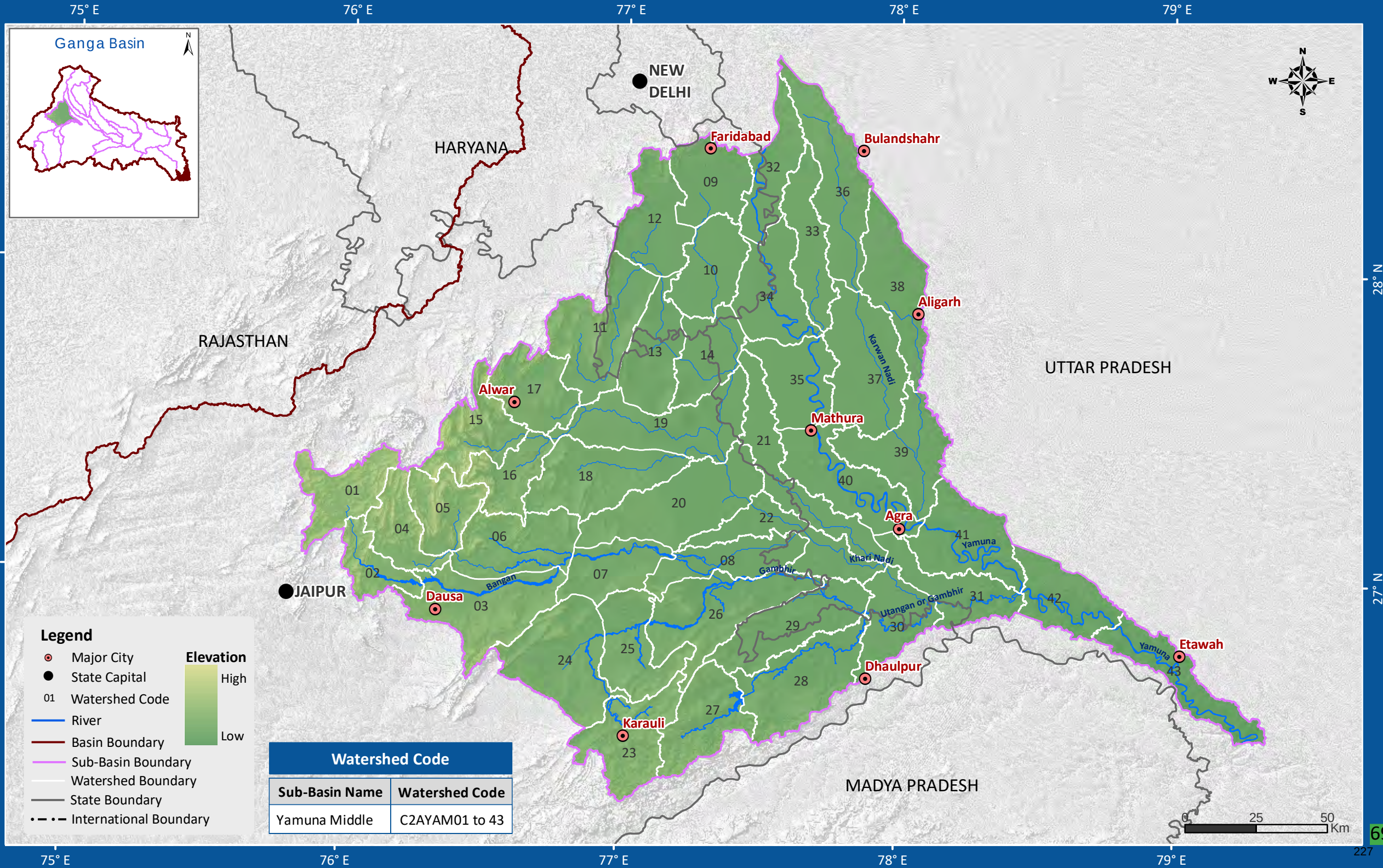
16. Upstream of Gomti Confluence to Muzaffarnagar Sub-Basin



423 17. Yamuna Lower Sub-Basin



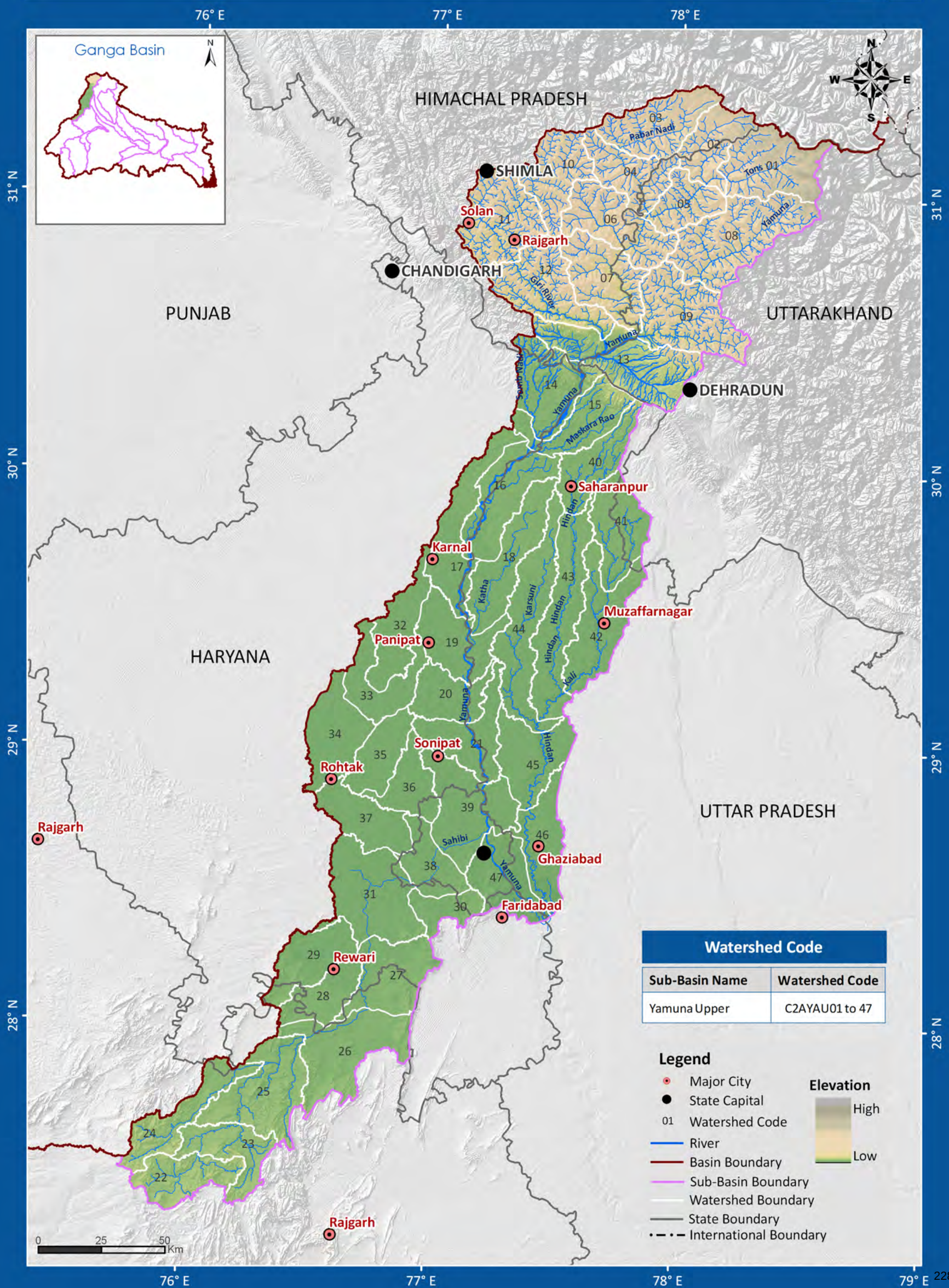
18. Yamuna Middle Sub-Basin

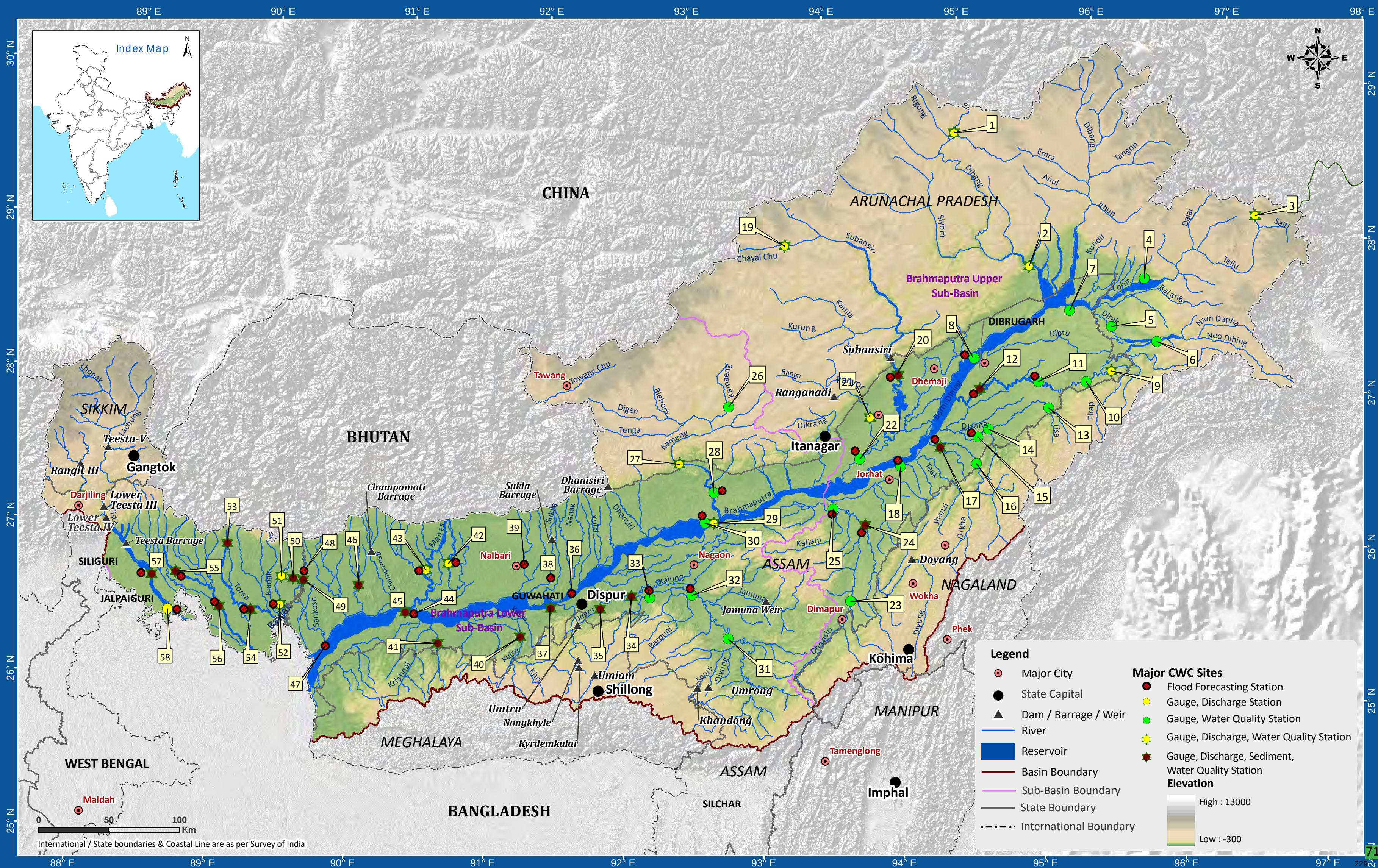


19. Yamuna Upper Sub-Basin



425





The Brahmaputra basin spreads over countries of Tibet (China), Bhutan, India and Bangladesh having a total area of 5,80,000 Sq.km. In India, it spreads over states of Arunachal Pradesh, Assam, West Bengal, Meghalaya, Nagaland and Sikkim and lies between 88°11' to 96°57' east longitudes and 24° 44' to 30°3' north latitudes and extends over an area of 1,94,413 Sq.km which is nearly 5.9 % of the total geographical area of the country. It is bounded by the Himalayas on the north, by the Patkari range of hills on the east running along the India-Myanmar border, by the Assam range of hills on the south and by the Himalayas and the ridge separating it from Ganga basin on the west. The Brahmaputra River originates in the north from Kailash ranges of Himalayas at an elevation of 5,150 m just south of the lake called Konggyu Tsho and flows for about a total length of 2,900 km. In India, it flows for 916 km. The principal tributaries of the river joining from right are the Lohit, the Dibang, the Subansiri, the Jiabharali, the Dhansiri, the Manas, the Torsa, the Sankosh and the Teesta whereas the Burhidihing, the Desang, the Dikhow, the Dhansiri and the Kopili joins it from left. The major part of basin is covered with forest accounting to 55.48% of the total area and 5.79% of the basin is covered by water bodies.

Salient Features of Brahmaputra Basin

Basin Extent	Longitude Latitude	88°11' to 96° 57' E 24°44' to 30° 3' N
Length of Brahmaputra River (Km)		916 (in India)
Catchment Area (Sq.km.)		194413
Average Water Resource Potential (MCM)		537240
Utilizable Surface Water Resource (MCM)		24000
Live Storage Capacity of Completed Projects (MCM)		2326.92*
Live Storage Capacity of Projects Under Construction (MCM)		9353.64*
Total Live Storage Capacity of Projects (MCM)		11680.56*
No. of Hydrological Observation Stations		114
No. of Flood Forecasting Stations		27

*Combined with Barak & others

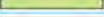
S. No.	Site Name	S. No.	Site Name
1	Tuting (GDQ)	30	Tezpur (GQ & FF)
2	Passighat (GDQ)	31	Kheronighat (GQ)
3	Kibithu (GDQ)	32	Kampur (GQ & FF)
4	Tezu (GQ)	33	Dharamtul (GQ & FF)
5	Namsai (GQ)	34	Jagibhakatgaon (GDSQ)
6	Miao (GQ)	35	Sonapur (GDSQ)
7	Dholabazar (GQ)	36	Guwahati (G & FF)
8	Dibrugarh (GQ & FF)	37	Pandu (GDSQ)
9	Udaipur (GDQ)	38	Puthimari (NHX) (G & FF)
10	Margherita (GQ)	39	Pagladia (NTX) (G & FF)
11	Naharkatia (GQ & FF)	40	Kulsi (GDSQ)
12	Chenimari (Khowang) (GDSQ)	41	Dudhnai (GDSQ)
13	Dillighat (GQ)	42	Beki Road bridge (GDQ & FF)
14	Desangpani (GQ)	43	Manas NH Crossing (GDQ & FF)
15	Nanglamoraghat (GQ & FF)	44	Goalpara (G & FF)
16	Bihubar (GQ)	45	Pancharatna (GDSQ)
17	Sivasagar (GDSQ & FF)	46	Kokrajhar (GDSQ)
18	Neamatighat (GQ & FF)	47	Dhubri (G & FF)
19	Lemeking (GDQ)	48	Golakganj (G & FF)
20	Chouldhowaghat (GDSQ)	49	Sankosh (GDSQ)
21	Ranganadi NT-Road Crossing (GDQ)	50	Barabisha (GDSQ)
22	Badatighat (GQ & FF)	51	Chepan (GDQ)
23	Bokajan (GQ)	52	Tufanganj (GDQ & FF)
24	Golaghat (GDSQ & FF)	53	Hasimara (GDSQ)
25	Numaligarh (GQ & FF)	54	Ghughumari (GDSQ & FF)
26	Seppa (GQ)	55	NH-31 (GDSQ & FF)
27	Bhalukpong (GDQ)	56	Mathabhanga (GDSQ & FF)
28	Jiabharali NT Road X-ing (GQ & FF)	57	Domohani (GDSQ & FF)
29	Bhomoraguri (GDQ)	58	Mekhliganj (GD & FF)

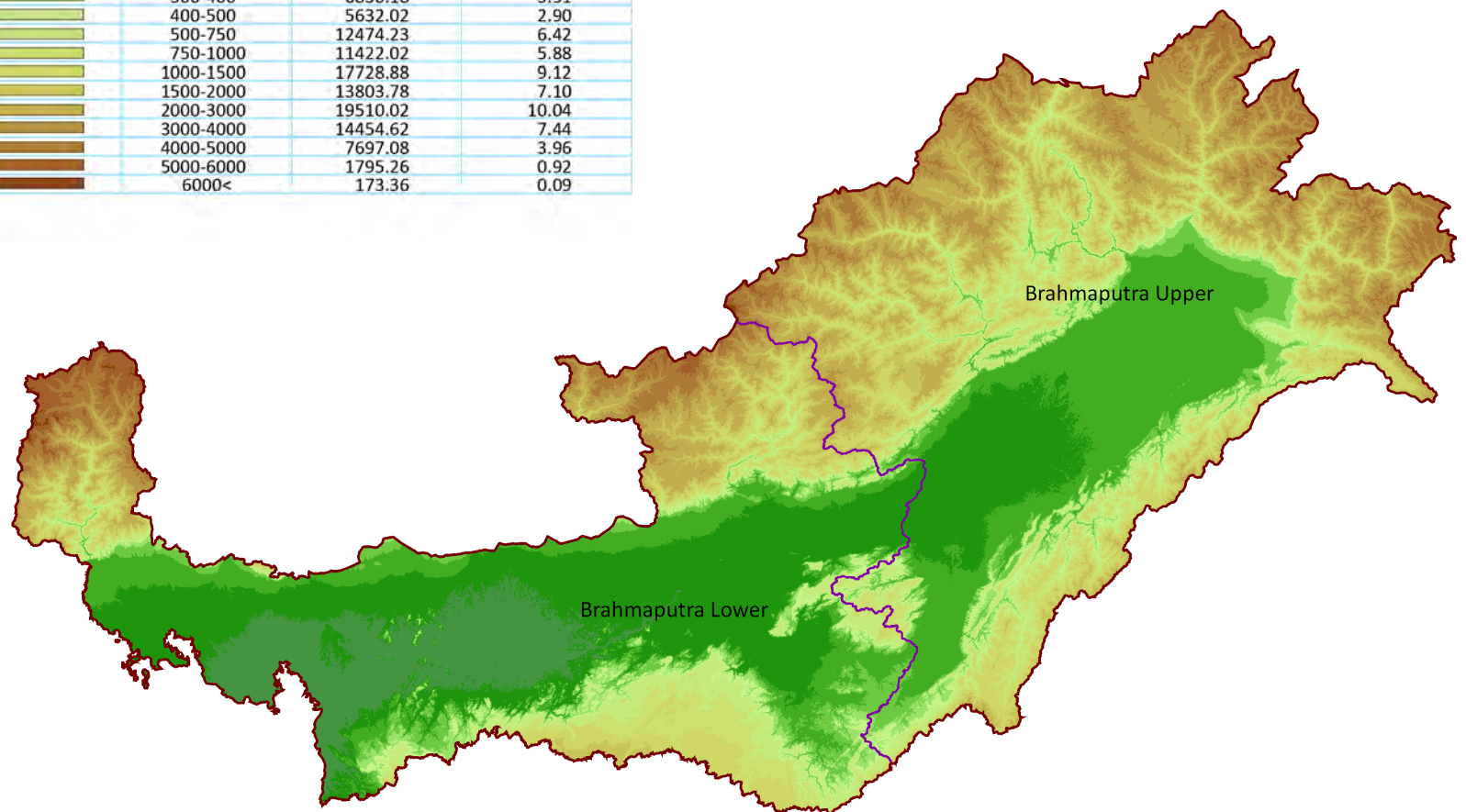
Major Water Resource Assets

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Brahmaputra Lower	87392.22	13	21	4	11313	76
2	Brahmaputra Upper	98972.87	3	1	3	4719	38

Watershed Statistics

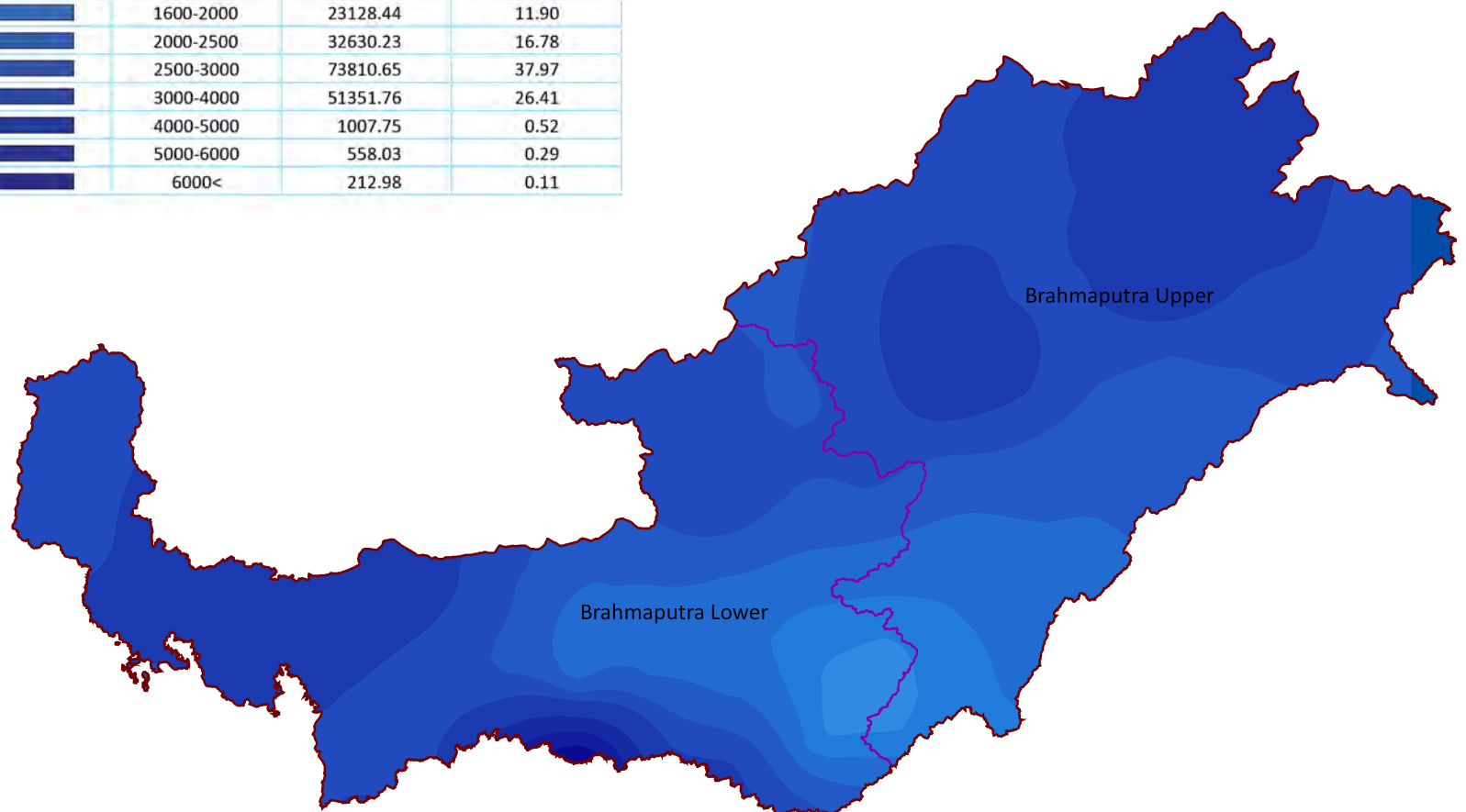
Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Brahmaputra Lower	83	429.01	1490.01	1052.92
2	Brahmaputra Upper	97	488.58	1473.03	1022.33

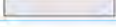
Symbol	Elevation (m)	Area (Sq. km)	% of Total Area
	10-50	12652.14	6.51
	50-100	33336.92	17.15
	100-200	27506.95	14.15
	200-300	9395.54	4.83
	300-400	6830.18	3.51
	400-500	5632.02	2.90
	500-750	12474.23	6.42
	750-1000	11422.02	5.88
	1000-1500	17728.88	9.12
	1500-2000	13803.78	7.10
	2000-3000	19510.02	10.04
	3000-4000	14454.62	7.44
	4000-5000	7697.08	3.96
	5000-6000	1795.26	0.92
	6000<	173.36	0.09

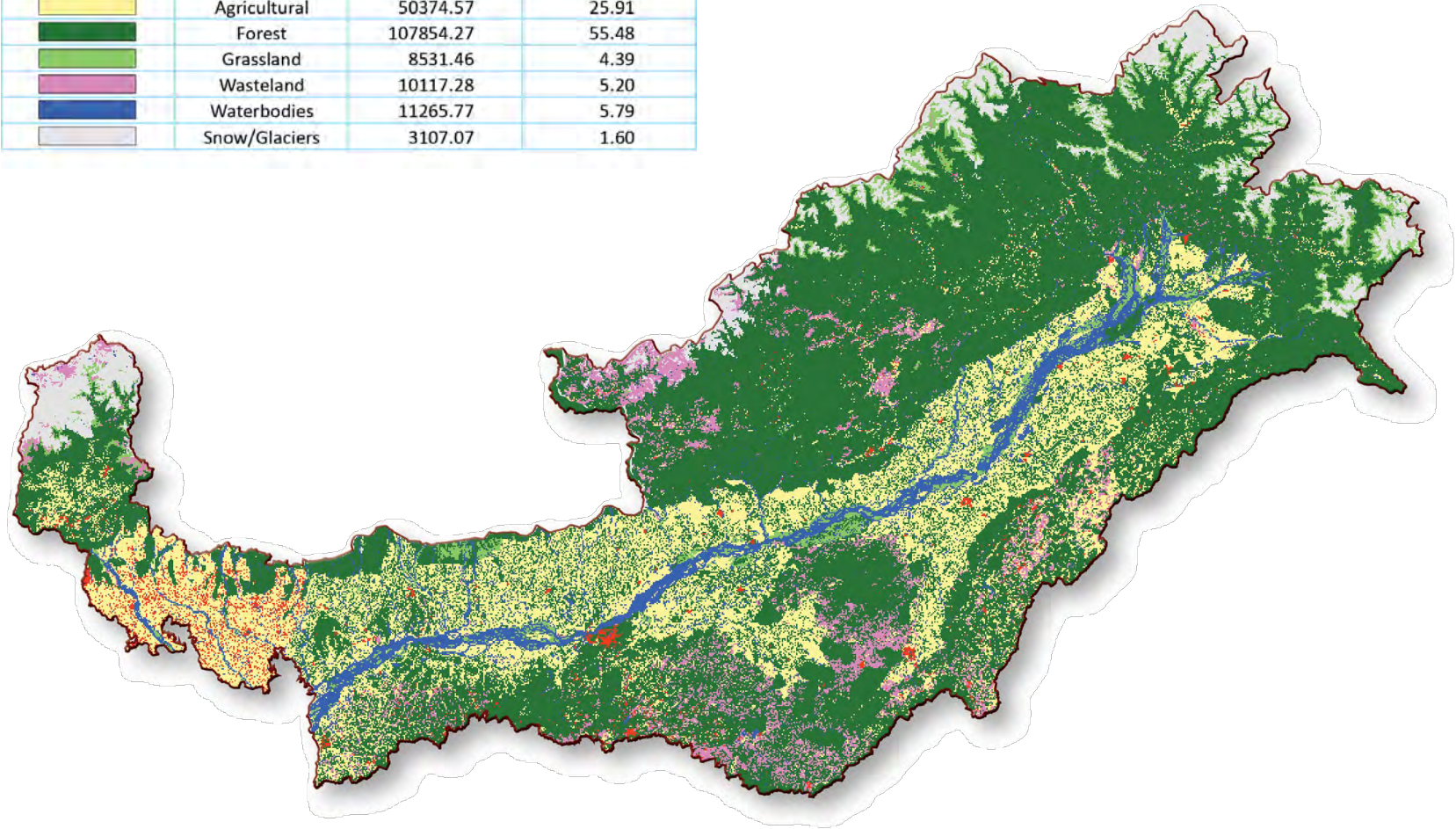


Average Annual Rainfall (1971-2005)

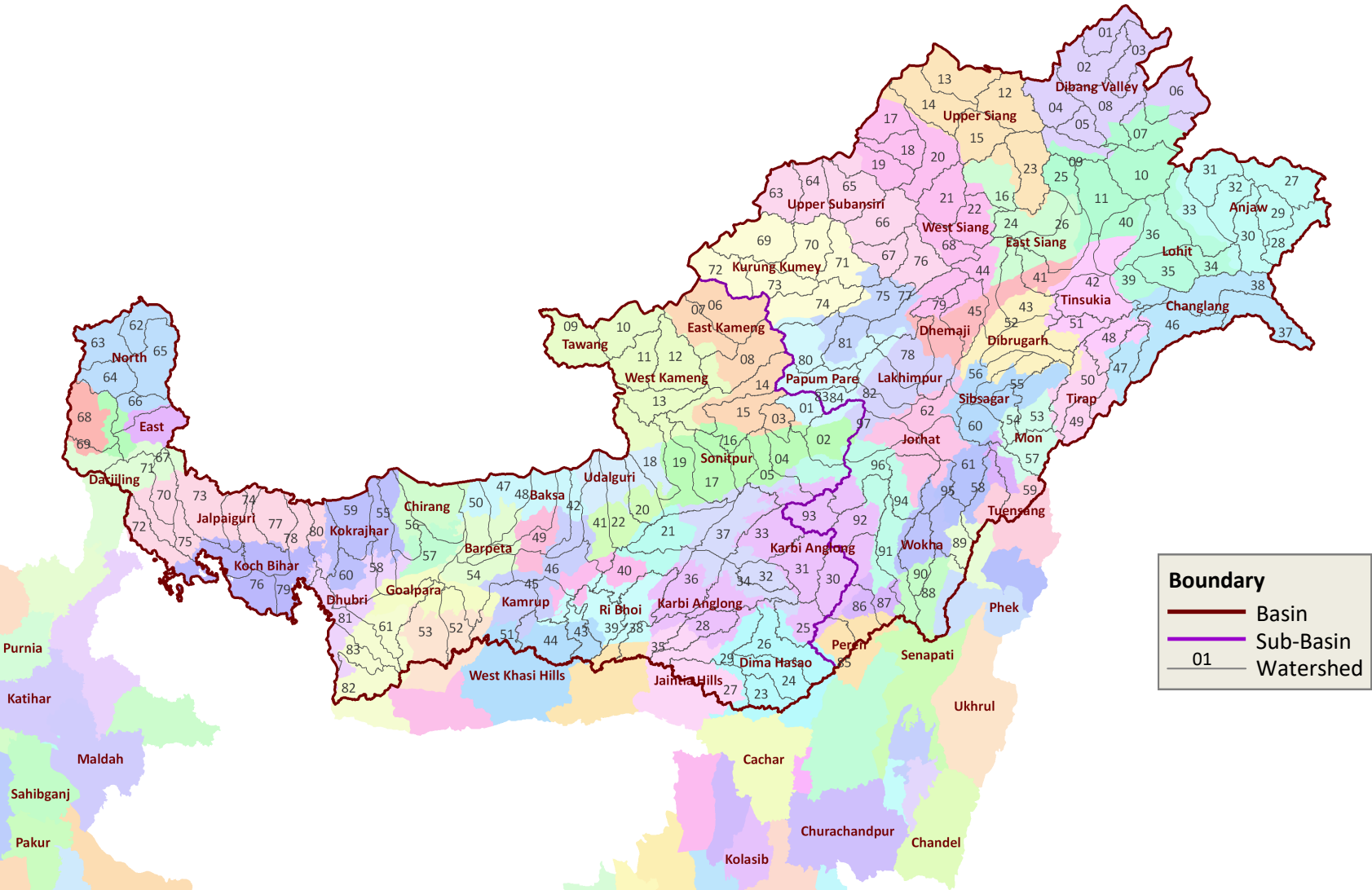
Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	1200-1400	3124.43	1.61
	1400-1600	8588.73	4.42
	1600-2000	23128.44	11.90
	2000-2500	32630.23	16.78
	2500-3000	73810.65	37.97
	3000-4000	51351.76	26.41
	4000-5000	1007.75	0.52
	5000-6000	558.03	0.29
	6000<	212.98	0.11



Symbol	Category	Area (Sq. km)	% of Total Area
	Built Up Land	3162.58	1.63
	Agricultural	50374.57	25.91
	Forest	107854.27	55.48
	Grassland	8531.46	4.39
	Wasteland	10117.28	5.20
	Waterbodies	11265.77	5.79
	Snow/Glaciers	3107.07	1.60



Districts



Boundary

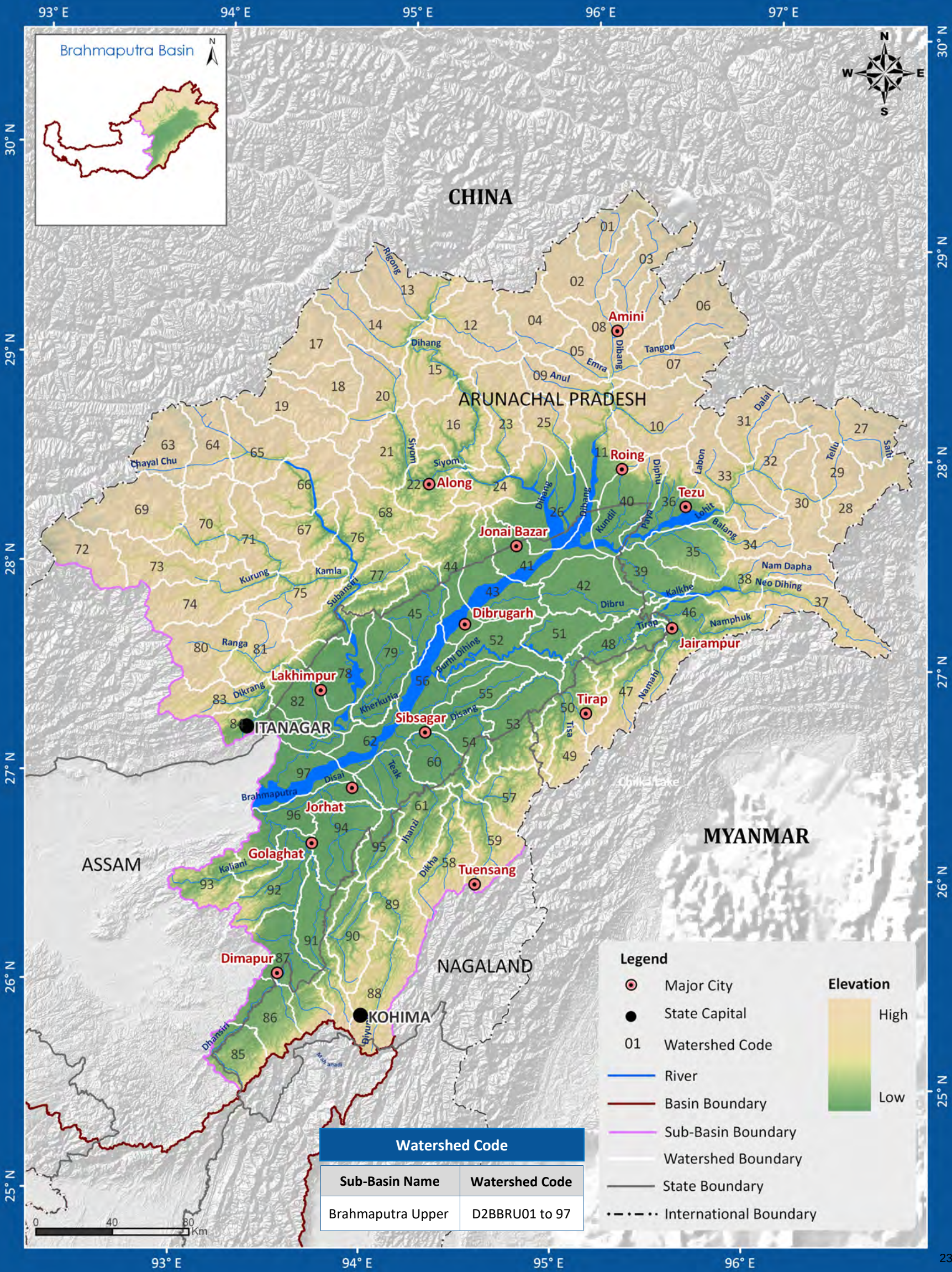
-  Basin
-  Sub-Basin
-  Watershed

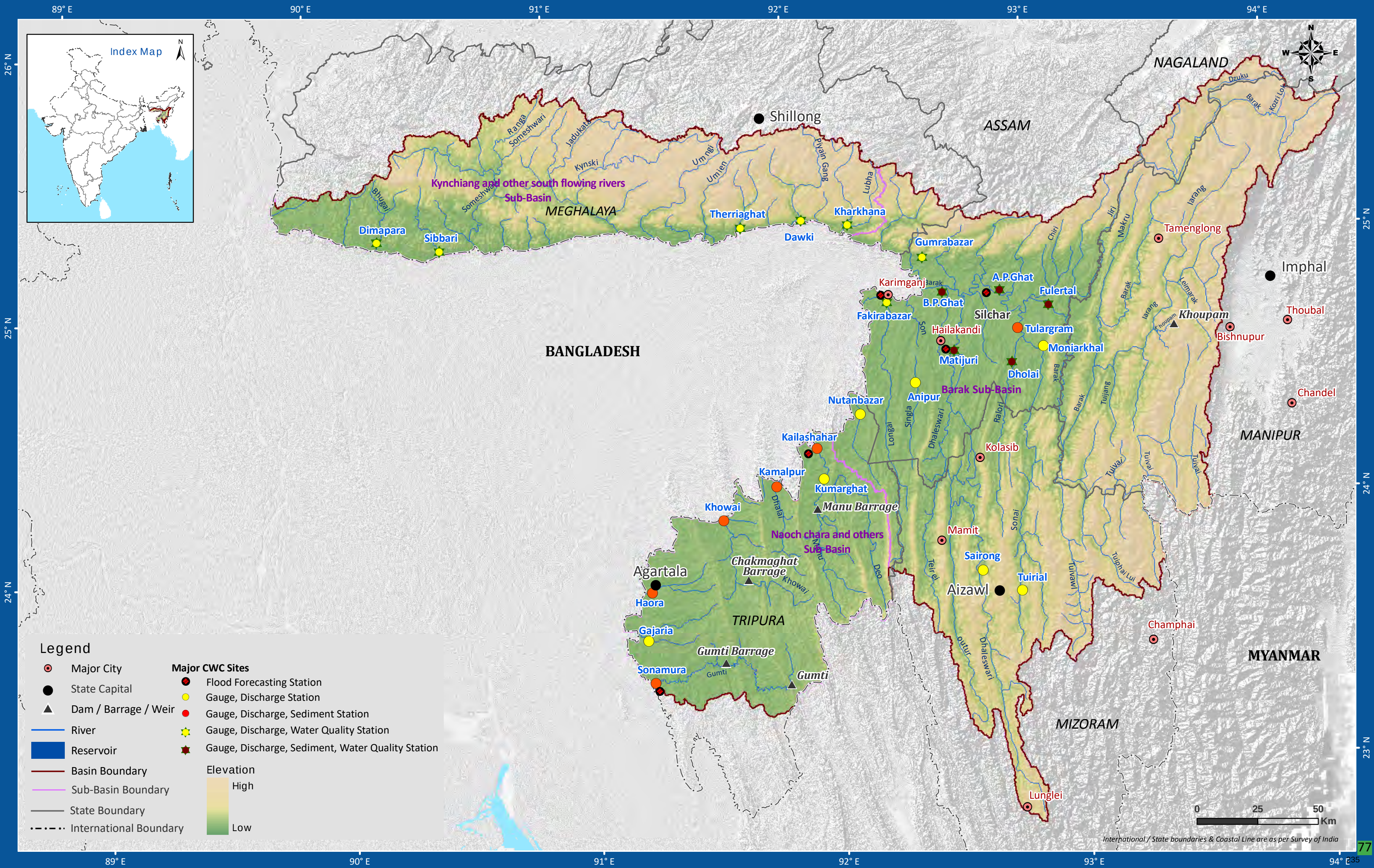
1. Brahmaputra⁴³⁰ Lower Sub-Basin



431

2. Brahmaputra Upper Sub-Basin





The basin covers parts of India, Bangladesh and Myanmar. In India it spreads over states of Meghalaya, Manipur, Mizoram, Assam, Tripura and Nagaland having an area of 41,723 Sq.km which is nearly 1.38% of the total geographical area of the country. The basin extends between 89°50' to 94°0' east longitudes and 22°44' to 25°58' north latitudes with maximum length and width of 460 km and 350 km. It is bounded by the Barail range separating it from the Brahmaputra basin on the north, by the Naga and Lushai hills on the east and by Mizo hills and territory of Bangladesh on the south and west.

The Barak River rises from the Manipur hills, south of Mao in Senapati district of Manipur at an elevation of 2,331 m. It flows then along Nagaland-Manipur border through hilly terrains and enters Assam. It further enters Bangladesh where it is known by the name of the Surma and the Kushiya and later called the Meghna before receiving the combined flow of the Ganga and the Brahmaputra. The length of the Barak River from its origin upto the border of Assam along the Kushiya is 564 km. The principal tributaries of Barak joining from north bank are the Jiri, the Chiri, the Modhura, the Jatinga, the Harang, the Kalain and the Gumra whereas the Dhaleswari, the Singla, the Longai, the Sonai and the Katakhal joins from south bank. The major part of basin is covered with forest accounting to 72.58% of the total area and only 1.92% of the basin is covered by water bodies.

Salient Features of Barak and Others Basin

Basin Extent	Longitude	89°50' to 94° 0' E
	Latitude	22°44' to 25° 58' N
Length of Barak River (Km)		564 (in India)
Catchment Area (Sq.km.)		41723
Average Water Resource Potential (MCM)		48360
Utilizable Surface Water Resource (MCM)		-
Live Storage Capacity of Completed Projects (MCM)		2326.92*
Live Storage Capacity of Projects Under Construction (MCM)		9353.64*
Total Live Storage Capacity of Projects (MCM)		11680.56*
No. of Hydrological Observation Stations		52
No. of Flood Forecasting Stations		5

*Combined with Brahmaputra Basin

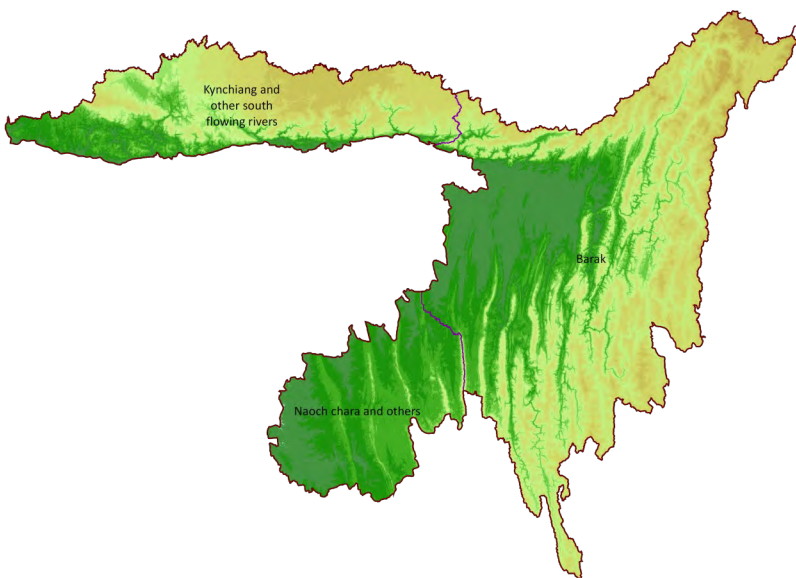
Major Water Resource Assets

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Barak	27658.98	1	0	2	2410	31
2	Kynchiang and other South Flowing Rivers	10267.39	2	0	1	4	10
3	Naoch Chara and others	7695.81	1	3	1	68	11

Watershed Statistics

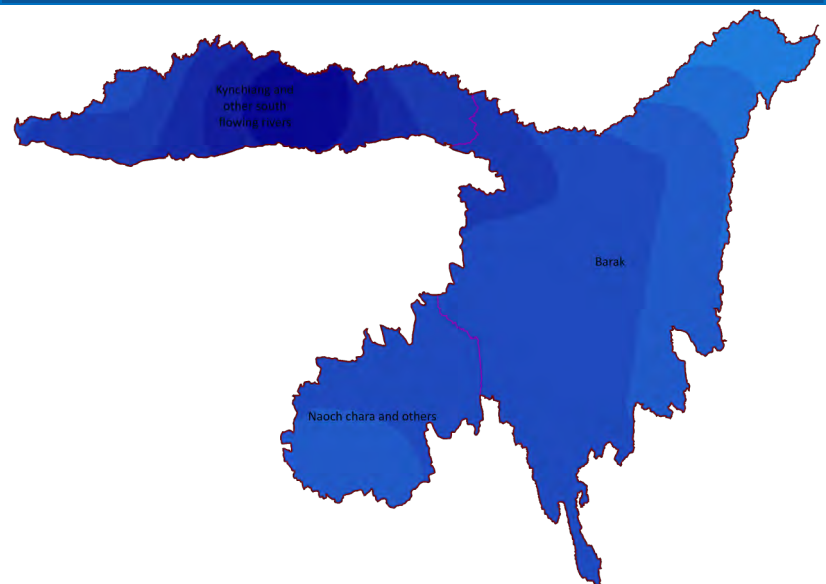
Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Barak	47	365.66	844.23	588.49
2	Kynchiang and other South Flowing Rivers	17	308.78	790.32	603.96
3	Naoch Chara and others	13	383.79	856.71	591.99

Elevation Zone



Symbol	Elevation (m)	Area (Sq. km)	% of Total Area
	5-10	8.78	0.02
	10-50	6039.97	14.48
	50-100	5490.55	13.16
	100-200	5162.21	12.37
	200-300	2511.08	6.02
	300-400	2398.68	5.75
	400-500	2374.52	5.69
	500-750	5363.78	12.86
	750-1000	4430.72	10.62
	1000-1500	5401.00	12.94
	1500-2000	2193.94	5.26
	2000-3000	347.77	0.83

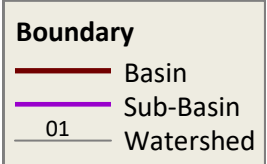
Average Annual Rainfall (1971-2005)



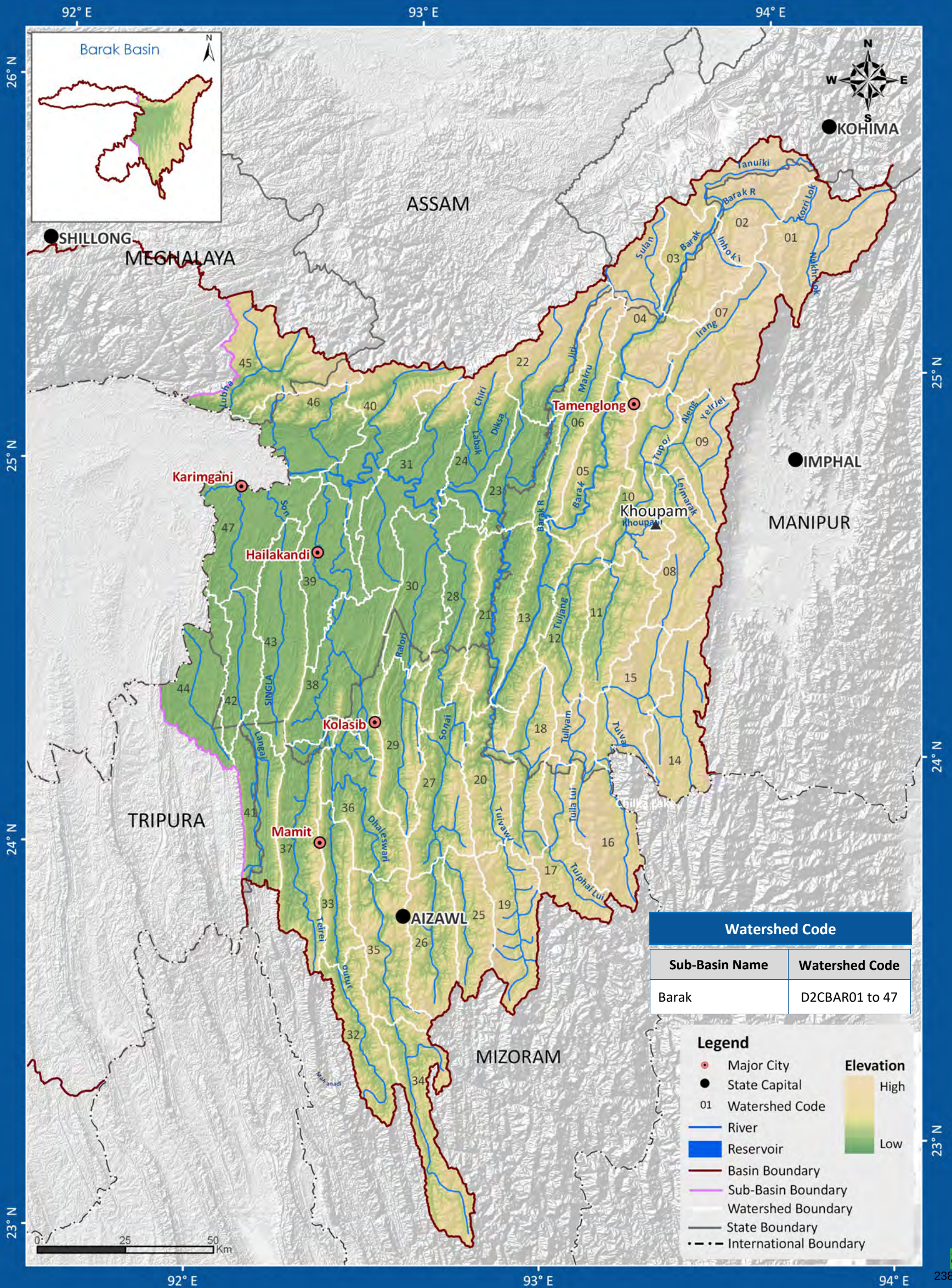
Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	1400-1600	1507.38	3.61
	1600-2000	1514.84	3.63
	2000-2500	9659.74	23.15
	2500-3000	18499.26	44.36
	3000-4000	5171.50	12.39
	4000-5000	1741.14	4.17
	5000-6000	1633.36	3.91
	6000<	1995.78	4.78



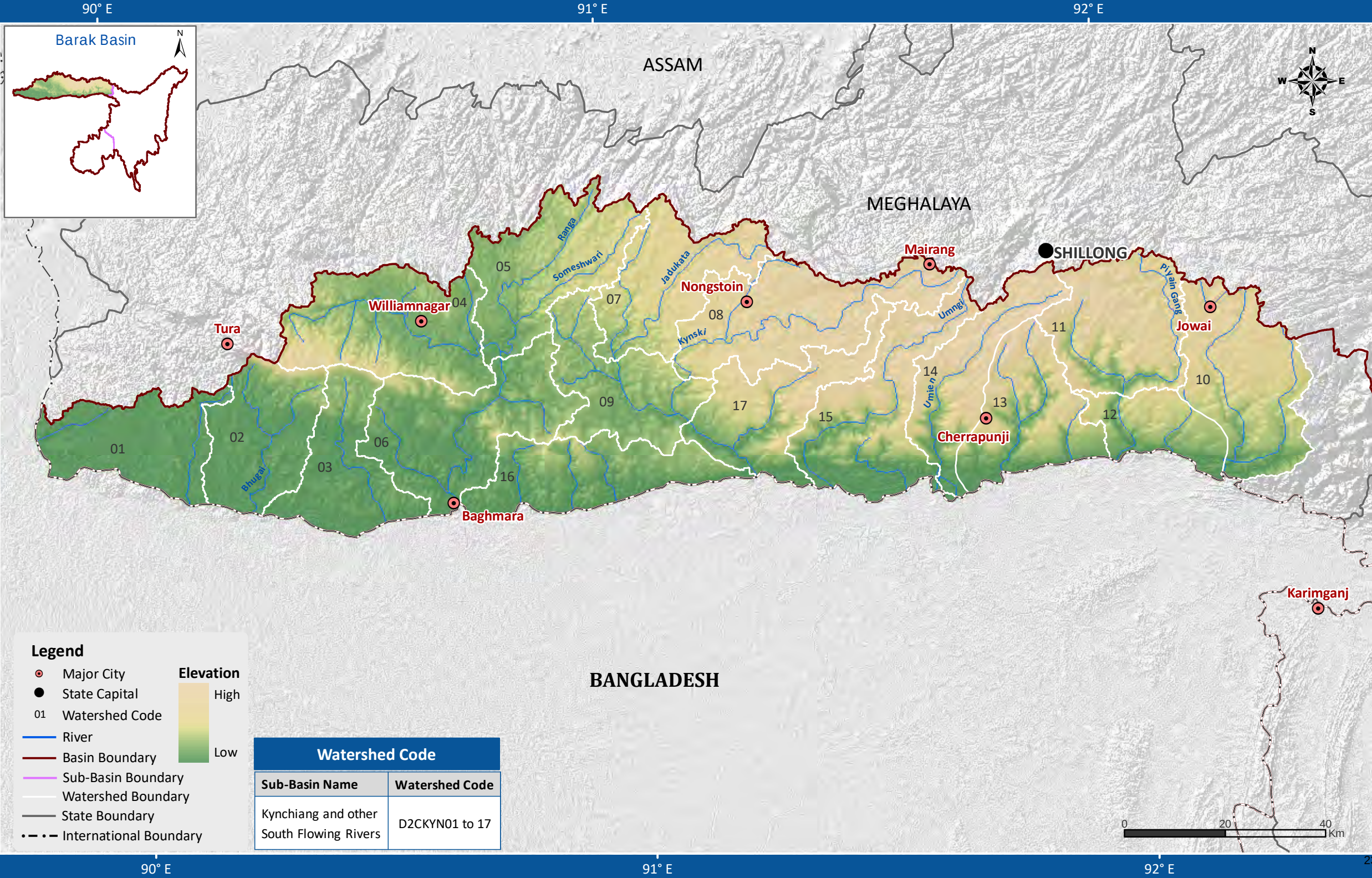
Districts



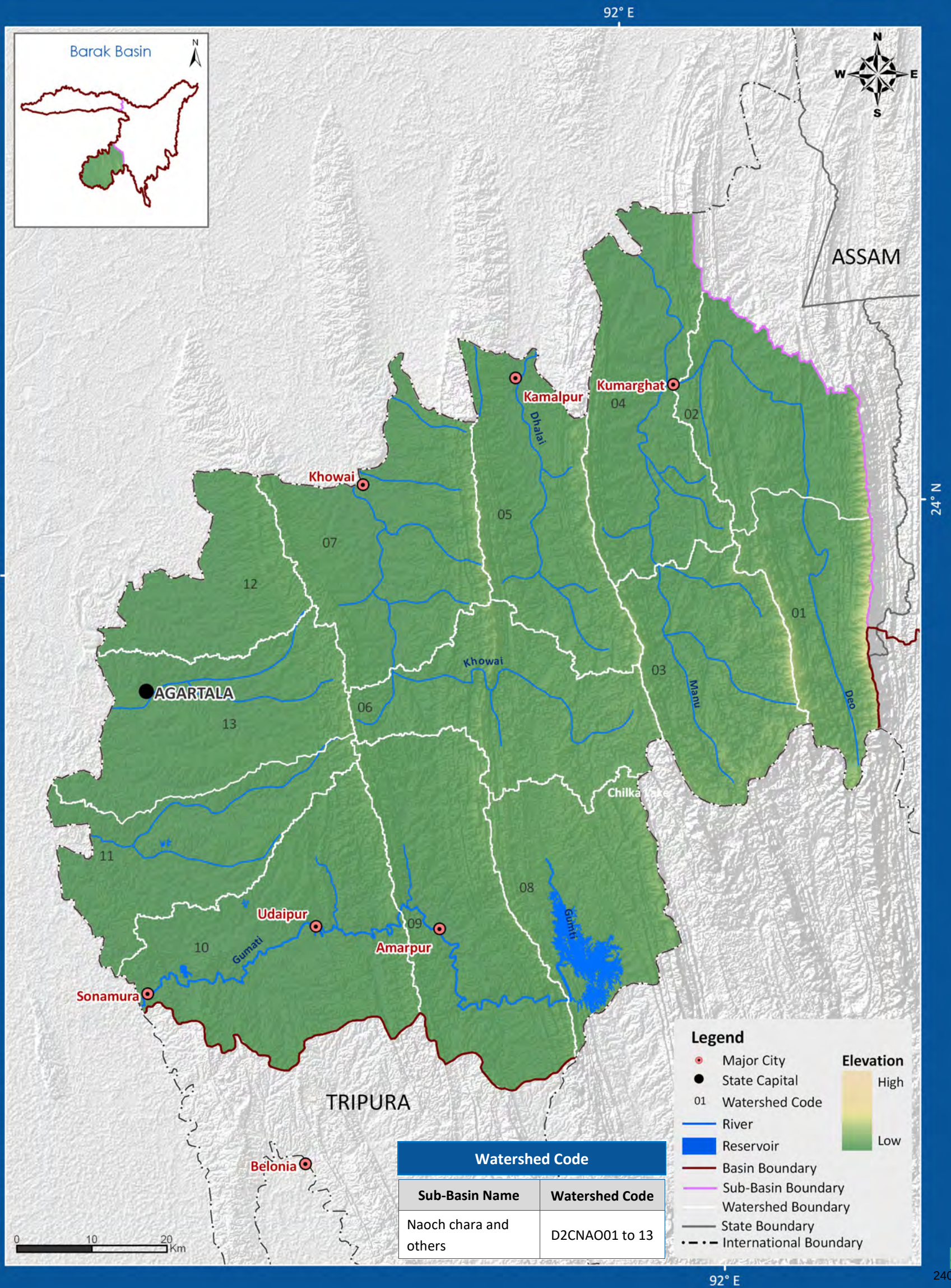
1. Barak Sub-Basin



2. Kynchiang and other South Flowing Rivers Sub-Basin



3. Naoch Chara and others Sub-Basin



5.5 GODAVARI BASIN



The Godavari basin extends over states of Maharashtra, Andhra Pradesh, Chhattisgarh and Odisha in addition to smaller parts in Madhya Pradesh, Karnataka and Union territory of Puducherry having a total area of 3,12,812 Sq.km with a maximum length and width of about 995 km and 583 km. It lies between 73°24' to 83°4' east longitudes and 16°19' to 22°34' north latitudes and accounts for nearly 9.5% of the total geographical area of the country. The basin is bounded by Satmala hills, the Ajanta range and the Mahadeo hills on the north, by the Eastern Ghats on the south and the east and by the Western Ghats on the west.

The Godavari River rises from Trimbakeshwar in the Nashik district of Maharashtra about 80 km from the Arabian Sea at an elevation of 1,067 m. The total length of Godavari from its origin to outfall into the Bay of Bengal is 1,465 km. Its principal tributaries joining from right are the Pravara and the Manjra whereas the Purna, the Penganga, the Wardha, the Wainganga, the Indravati and the Kolab joins from left. The major part of basin is covered with agricultural land accounting to 59.57% of the total area and 3.6% of the basin is covered by water bodies.

Salient Features of Godavari Basin

Basin Extent	Longitude	73° 24' to 83° 4' E
	Latitude	16° 19' to 22° 34' N
Length of Godavari River (Km)		1465
Catchment Area (Sq.km.)		312812
Average Water Resource Potential (MCM)		110540
Utilizable Surface Water Resource (MCM)		76300
Live Storage Capacity of Completed Projects (MCM)		25124.6
Live Storage Capacity of Projects Under Construction (MCM)		6205.79
Total Live Storage Capacity of Projects (MCM)		31330.39
No. of Hydrological Observation Stations		88
No. of Flood Forecasting Stations		18

Major Water Resource Assets

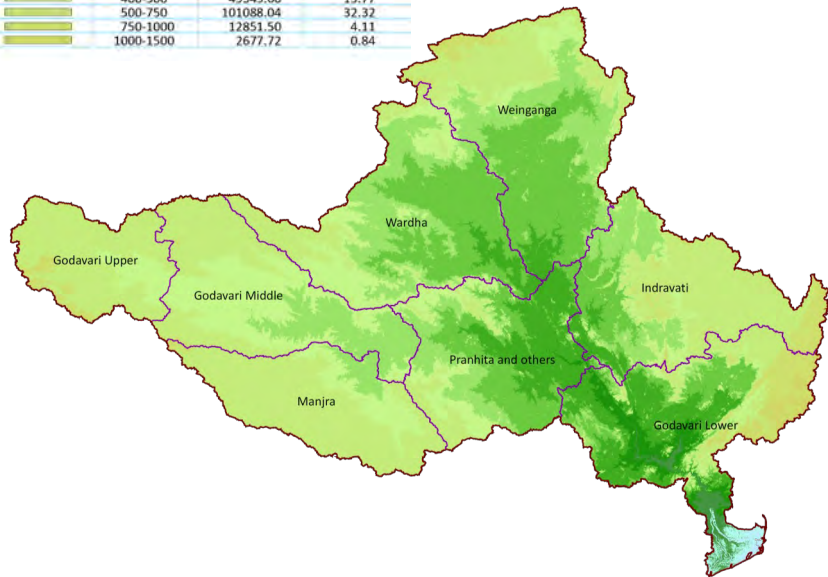
Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Godavari Lower	44492.9	28	9	30	7523	19
2	Godavari Middle	36290.5	186	16	178	4634	13
3	Godavari Upper	21443.2	114	5	108	2909	8
4	Indravati	38306.1	21	0	15	15728	11
5	Manjra	29472.9	128	2	118	4088	6
6	Pranhita and others	36119.6	59	3	55	5081	7
7	Wardha	46242.1	236	7	220	4099	11
8	Weinganga	49695.4	149	5	145	17816	13

Watershed Statistics

Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Water-shed (sq. km)	Max. size of Water-shed (sq. km)	Avg. size of Water-shed (sq. km)
1	Godavari Lower	67	304.77	989.28	653.30
2	Godavari Middle	56	325.87	954.32	648.04
3	Godavari Upper	33	331.11	987.06	649.79
4	Indravati	60	343.14	992.92	648.95
5	Manjra	44	421.07	980.21	669.84
6	Pranhita and others	57	326.11	981.77	633.67
7	Wardha	69	361.22	945.71	670.18
8	Weinganga	80	305.64	971.62	621.19

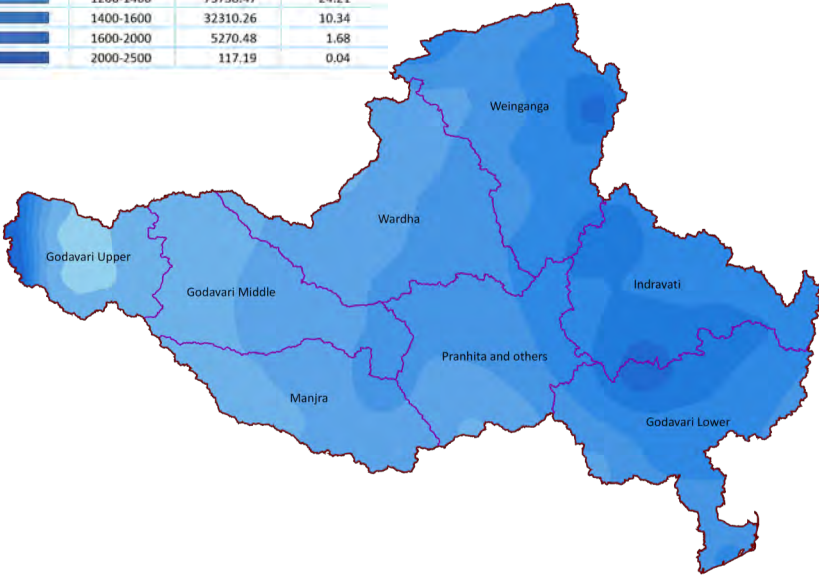
Elevation Zone

Symbol	Elevation (m)	Area (Sq. km)	% of Total Area
	< 5	810.25	0.26
	5-10	1374.58	0.44
	10-50	2778.22	0.89
	50-100	4711.13	1.51
	100-200	27105.94	8.67
	200-300	55928.81	17.86
	300-400	54140.26	17.31
	400-500	49345.60	15.77
	500-750	101088.04	32.32
	750-1000	12851.50	4.11
	1000-1500	2677.72	0.84

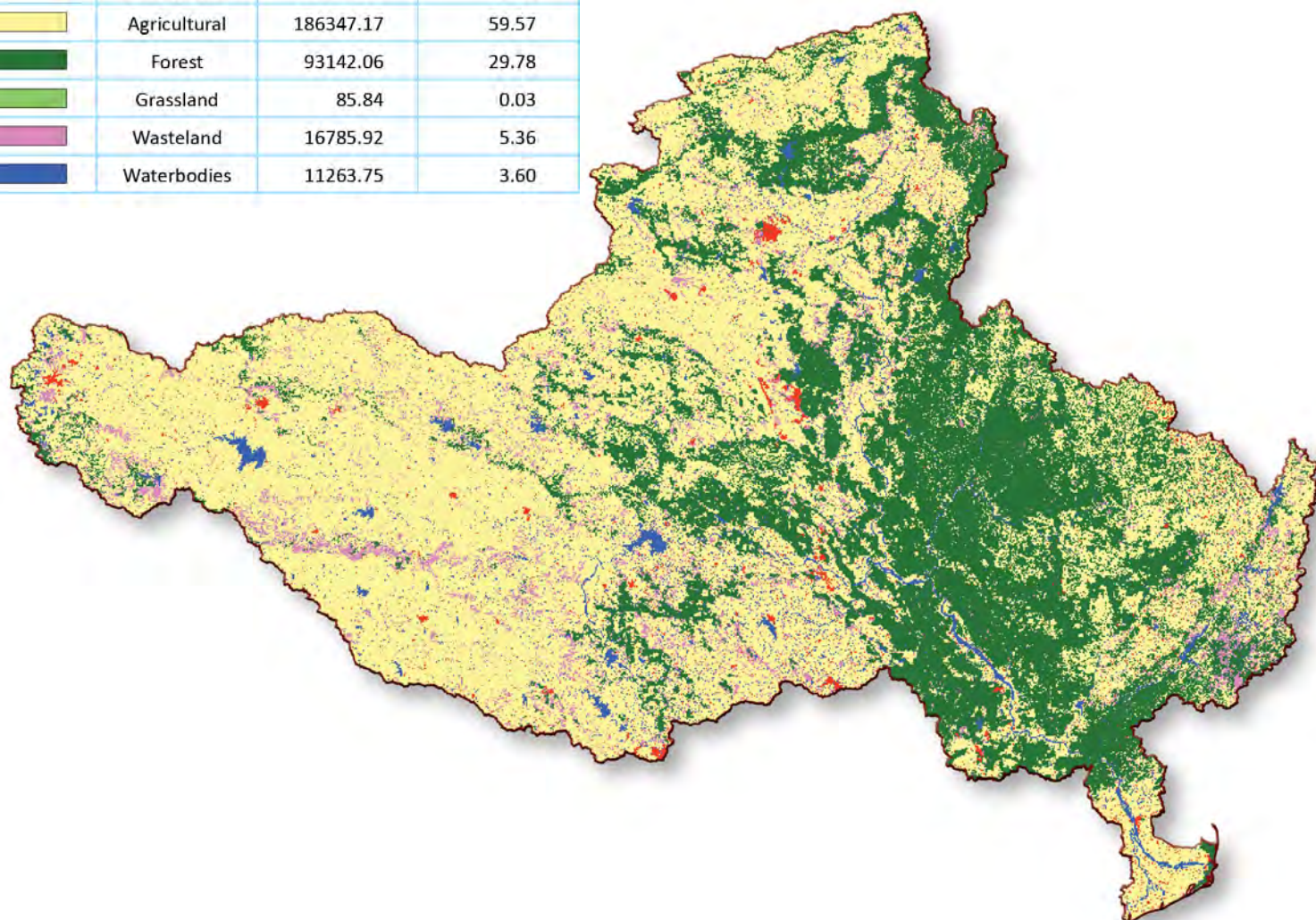


Average Annual Rainfall (1971-2005)

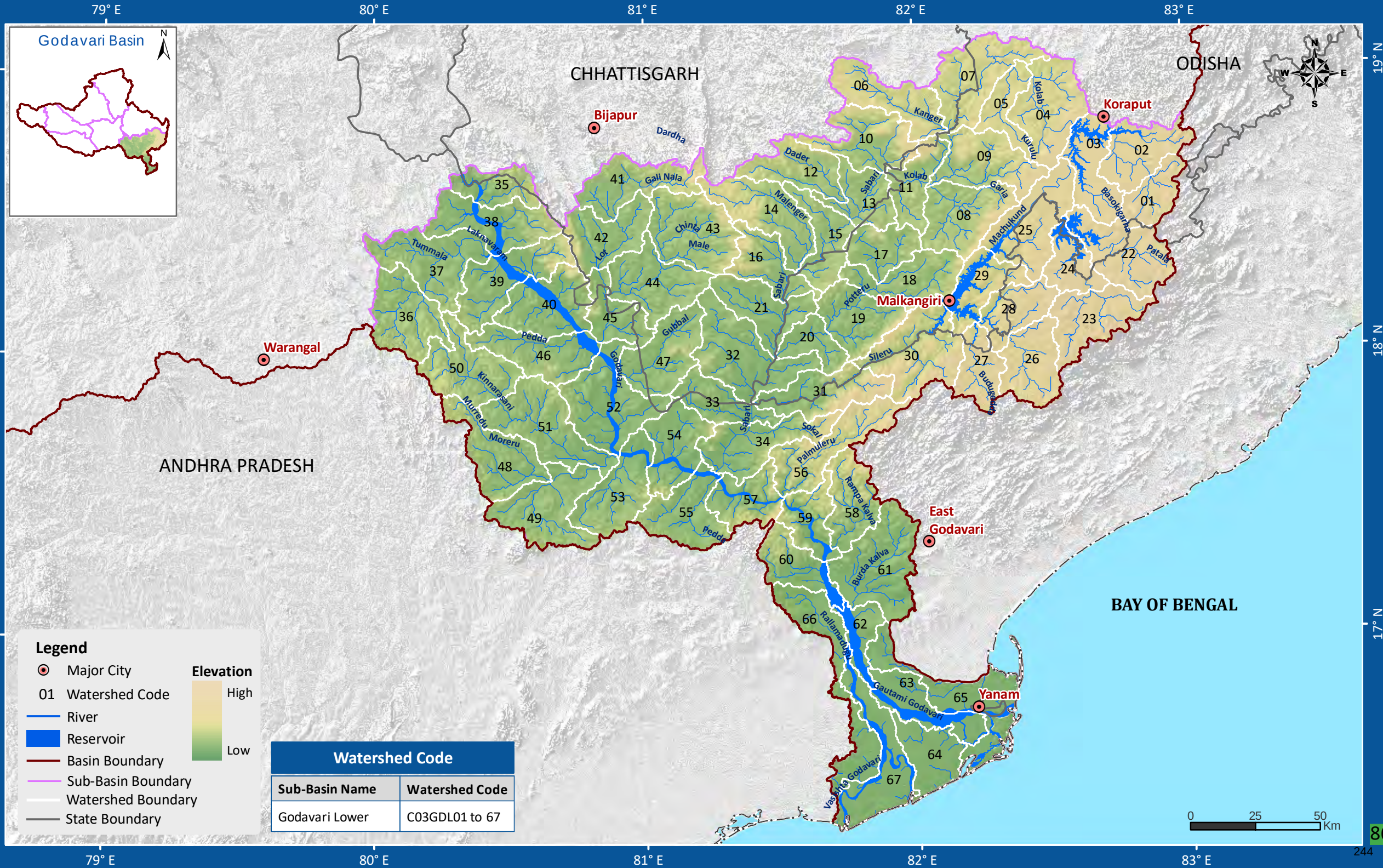
Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	400-600	5702.88	1.82
	600-800	42435.92	13.57
	800-1000	73644.91	23.54
	1000-1200	77591.89	24.80
	1200-1400	75738.47	24.21
	1400-1600	32310.26	10.34
	1600-2000	5270.48	1.68
	2000-2500	117.19	0.04



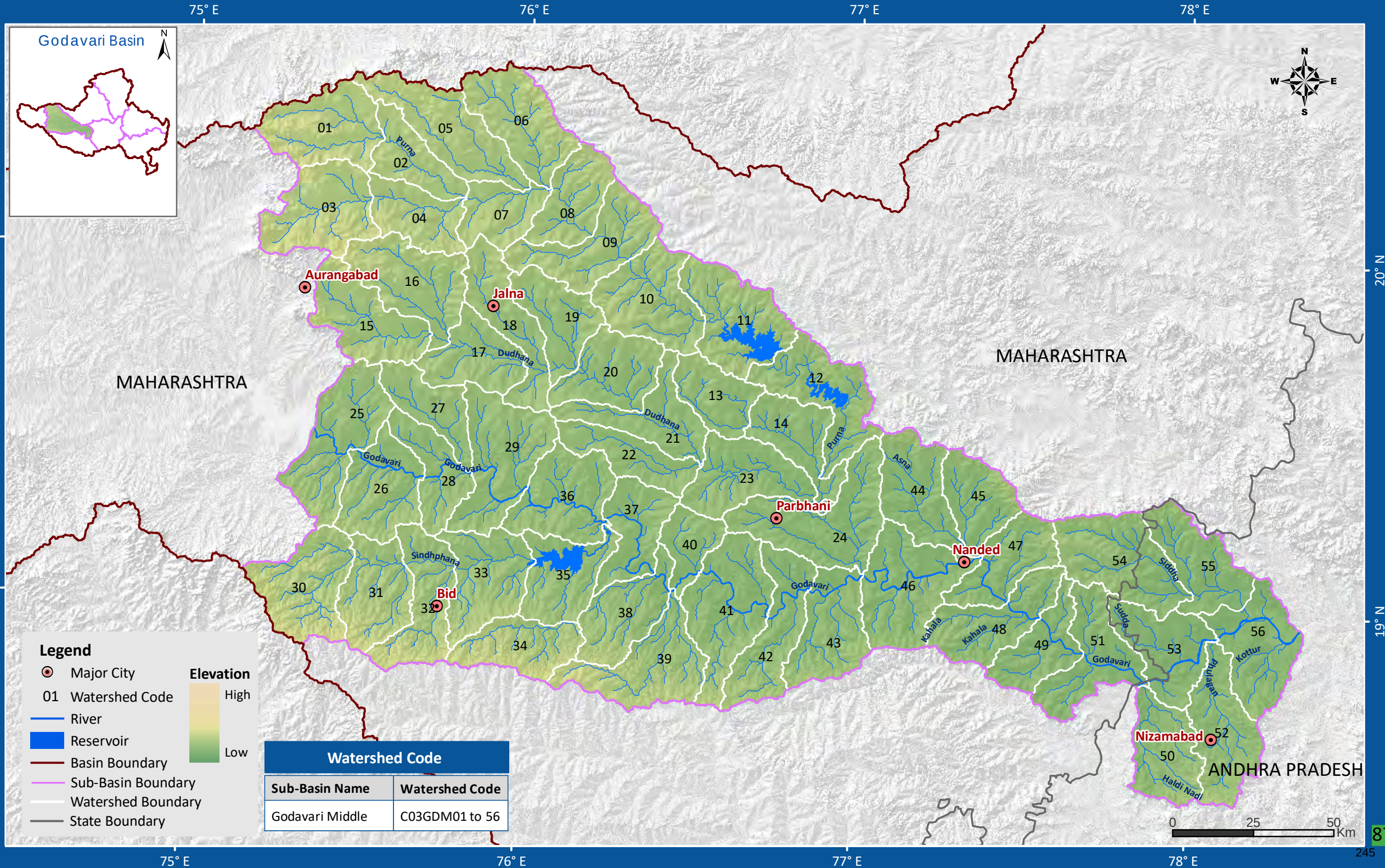
	Agricultural	186347.17	59.57
	Forest	93142.06	29.78
	Grassland	85.84	0.03
	Wasteland	16785.92	5.36
	Waterbodies	11263.75	3.60



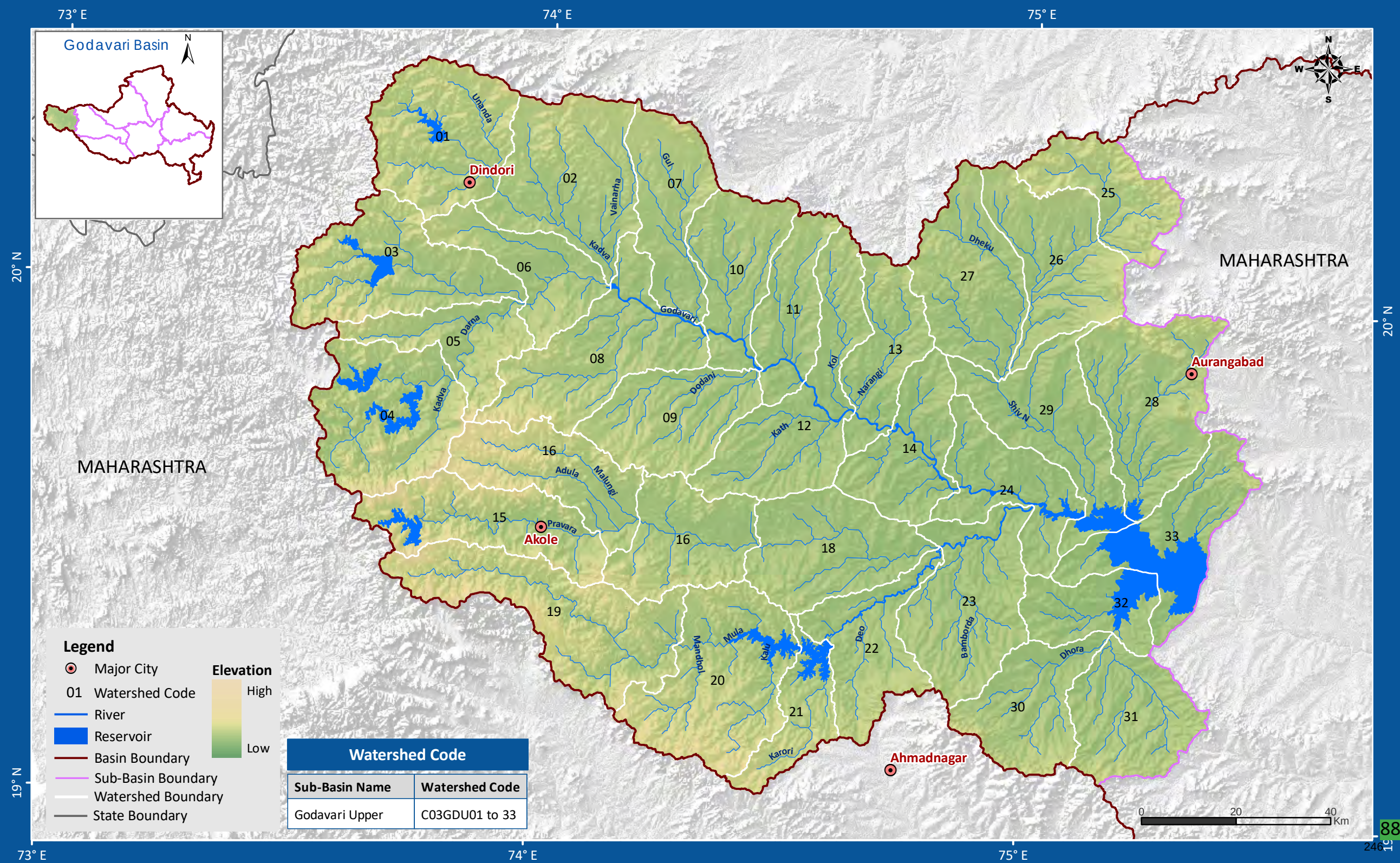
1. Godavari Lower Sub-Basin



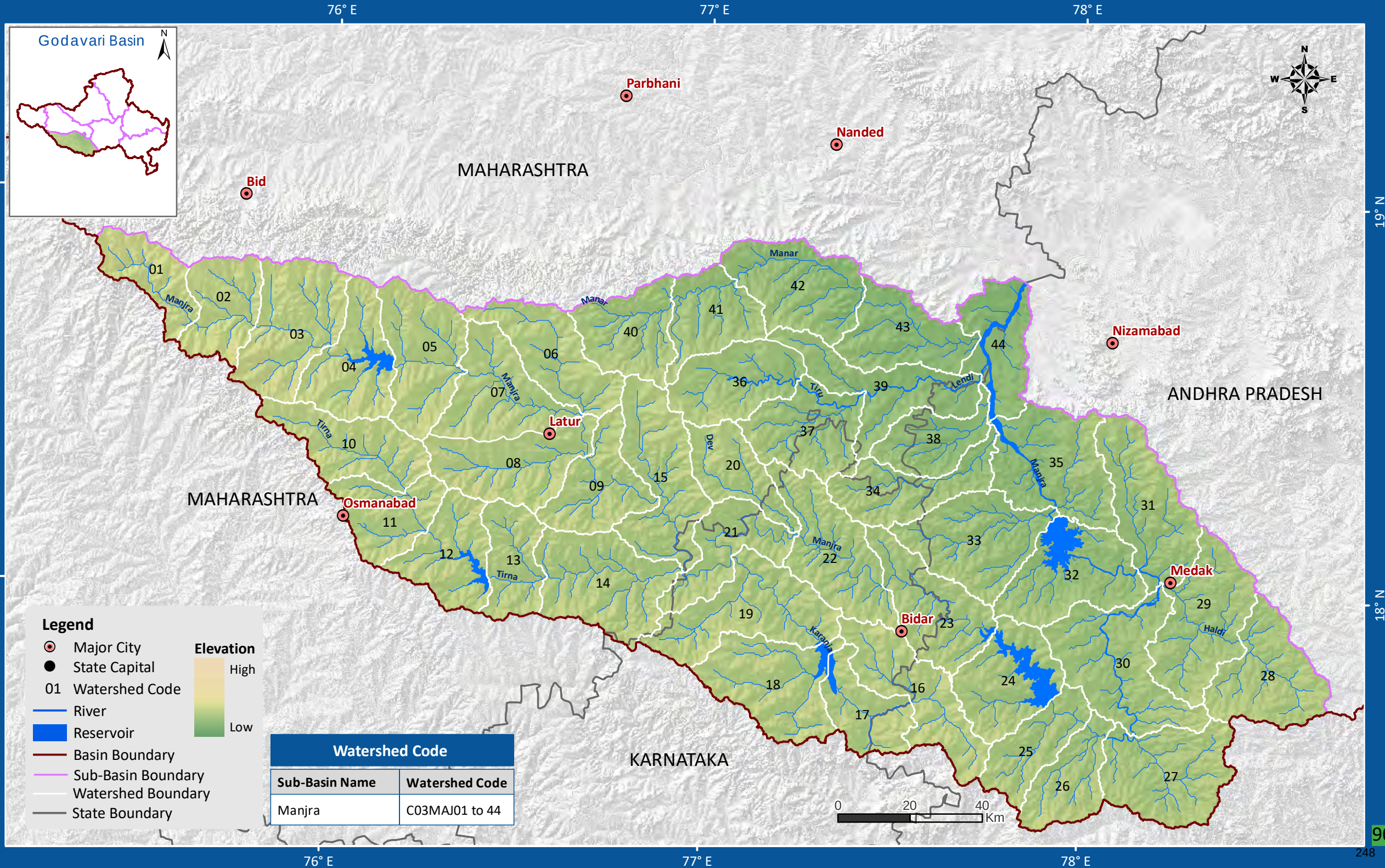
2. Godavari Middle Sub-Basin



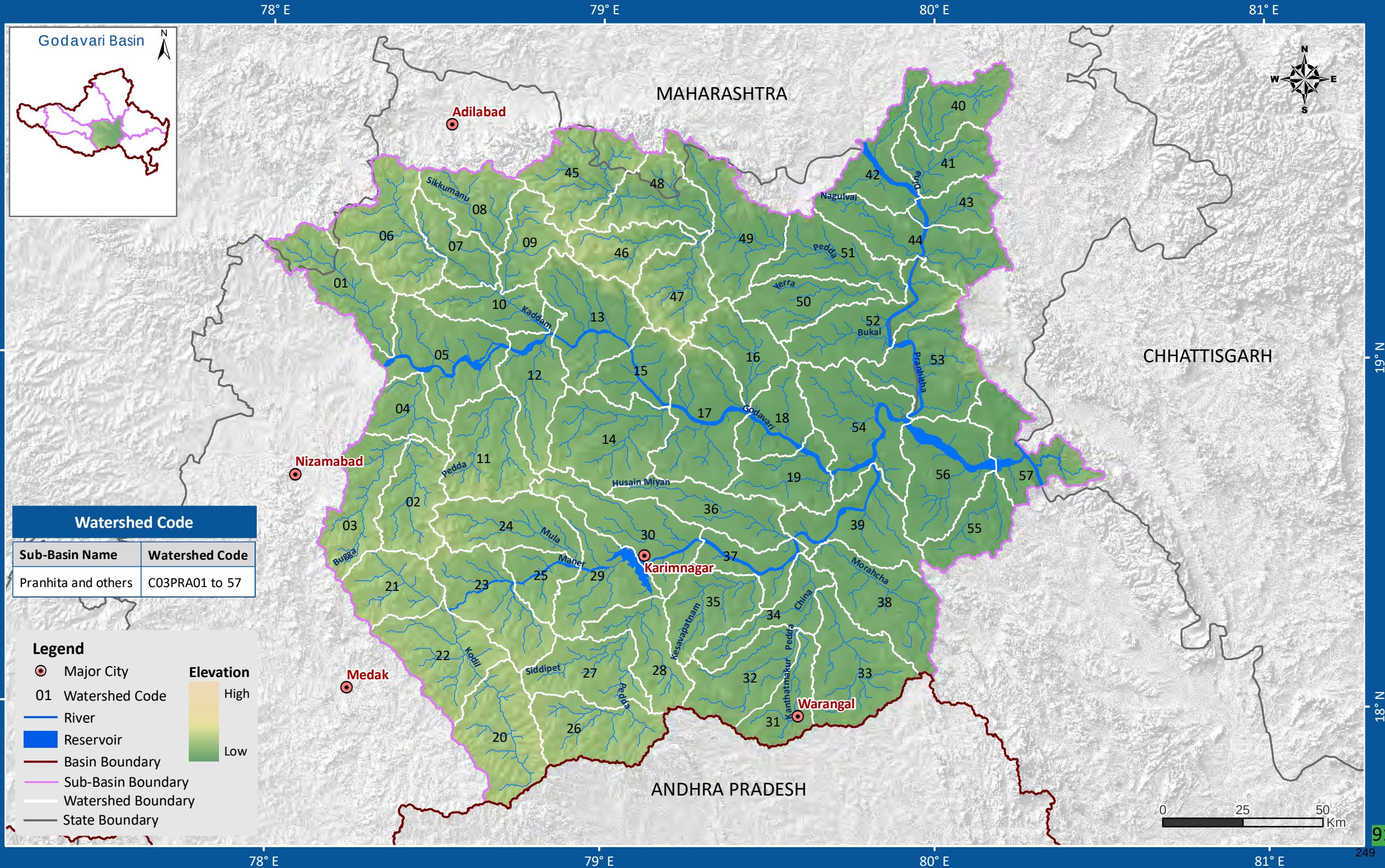
3. Godavari Upper Sub-Basin



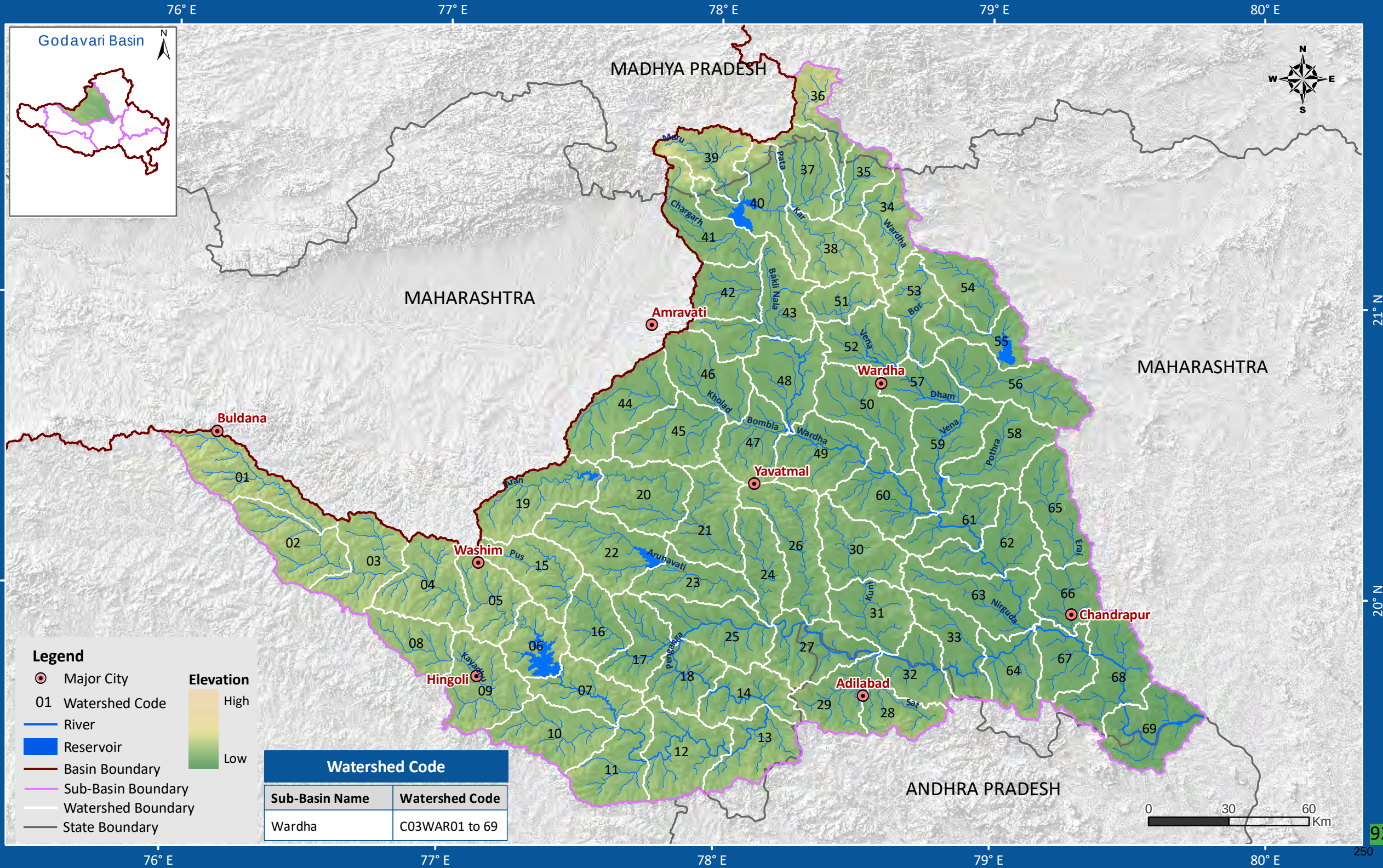
445 5. Manjra Sub-Basin



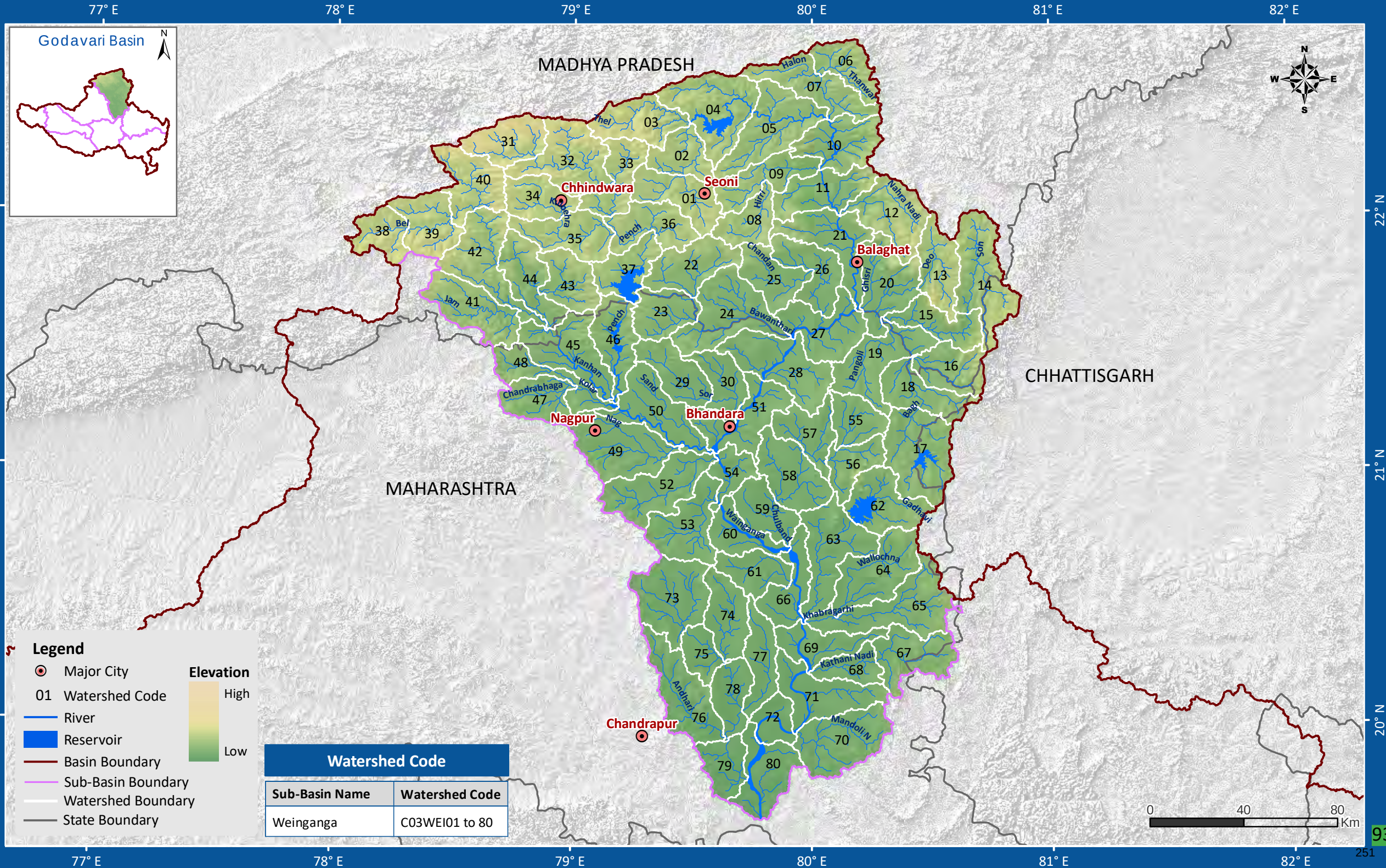
6. Pranhita and others Sub-Basin



7. Wardha 447 Sub-Basin



8. Weinganga Sub-Basin



5.6 KRISHNA BASIN



The Krishna Basin extends over Andhra Pradesh, Maharashtra and Karnataka having a total area of 2,58,948 Sq.km which is nearly 8% of the total geographical area of the country. The basin has a maximum length and width of about 701 km and 672 km and lies between 73°17' to 81°9' east-longitudes and 13°10' to 19°22' north latitudes. It is bounded by Balaghat range on the north, by the Eastern Ghats on the south and the east and by the Western Ghats on the west.

The Krishna River rises from the Western Ghats near Jor village of Satara district of Maharashtra at an altitude of 1,337 m just north of Mahabaleshwar. The total length of river from origin to its outfall into the Bay of Bengal is 1,400 km. Its principal tributaries joining from right are the Ghatprabha, the Malprabha and the Tungabhadra where as those joining from left are the Bhima, the Musi and the Munneru are joining the river from left. The major part of basin is covered with agricultural land accounting to 75.86% of the total area and 4.07% of the basin is covered by water bodies.

Salient Features of Krishna Basin

Basin Extent	Longitude	73° 17' to 81° 9' E
	Latitude	13° 10' to 19° 22' N
Length of Krishna River (Km)		1400
Catchment Area (Sq.km.)		258948
Average Water Resource Potential (MCM)		78120
Utilizable Surface Water Resource (MCM)		58000
Live Storage Capacity of Completed Projects		41803.98
Live Storage Capacity of Projects Under Construction (MCM)		7743.54
Total Live Storage Capacity of Projects		49547.52
No. of Hydrological Observation Stations		72
No. of Flood Forecasting Stations		9

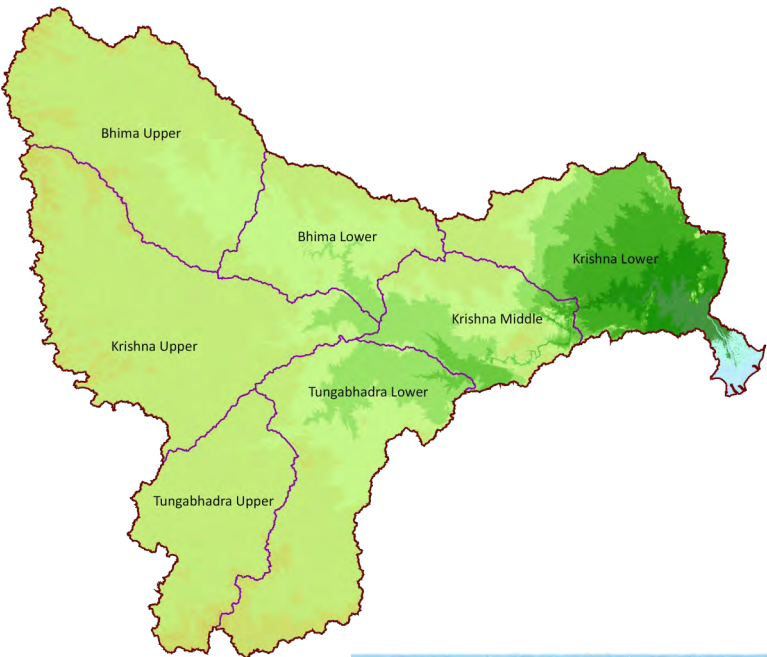
Major Water Resource Assets

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Bhima Lower	23652.7	68	5	49	1621	4
2	Bhima Upper	44793.32	273	1	256	5456	10
3	Krishna Lower	39494.33	29	4	16	6638	12
4	Krishna Middle	22229.12	34	0	13	2804	6
5	Krishna Upper	54504.77	188	61	155	5011	23
6	Tungabhadra Lower	41556.48	37	3	35	10243	8
7	Tungabhadra Upper	28519.41	31	2	12	7806	9

Watershed Statistics

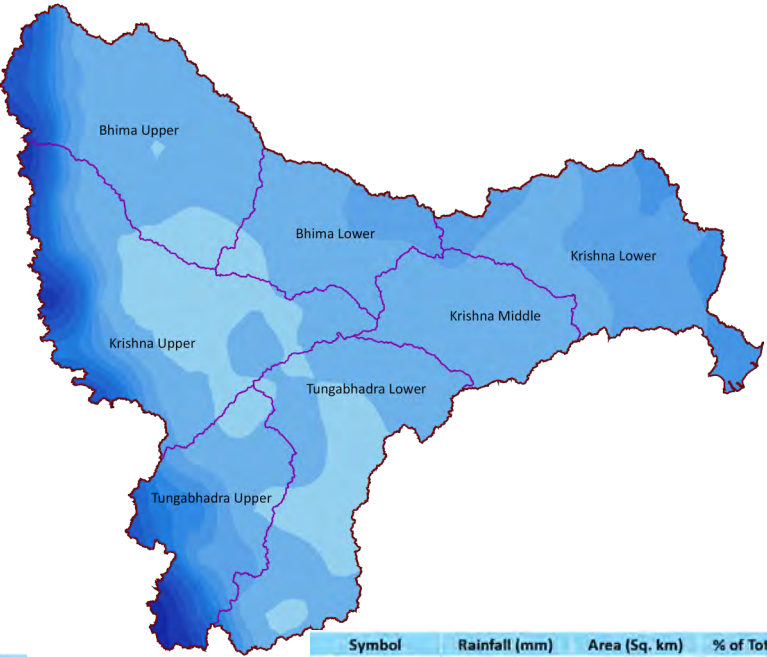
Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Water-shed (sq. km)	Max. size of Water-shed (sq. km)	Avg. size of Water-shed (sq. km)
1	Bhima Lower	36	396.71	928.25	657.02
2	Bhima Upper	71	351.72	939.84	630.89
3	Krishna Lower	59	277.58	970.03	669.40
4	Krishna Middle	36	341.29	962.56	617.48
5	Krishna Upper	85	322.33	963.80	641.23
6	Tungabhadra Lower	59	357.51	975.84	704.35
7	Tungabhadra Upper	45	331.60	923.94	633.76

Elevation Zone

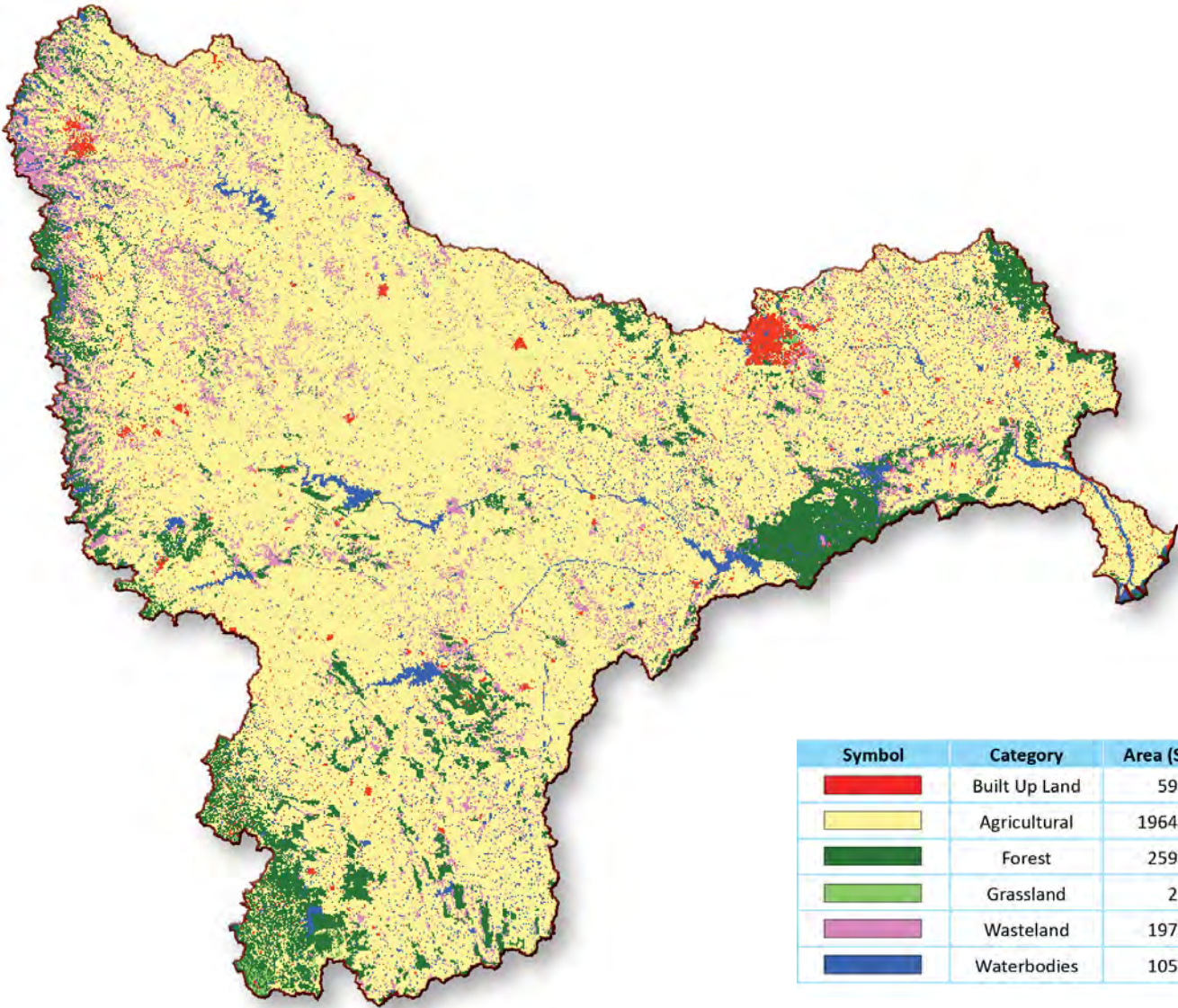


Symbol	Elevation (m)	Area (Sq. km)	% of Total Area
	< 5	1057	0.41
	5-10	1235	0.48
	10-50	2539.88	0.98
	50-100	4703.20	1.82
	100-200	10996.29	4.25
	200-300	11776.93	4.55
	300-400	22153.55	8.56
	400-500	42362.64	16.36
	500-750	141635.72	54.70
	750-1000	18344.96	7.08
	1000-1500	2089.03	0.81
	1500-2000	54.04	0.02

Average Annual Rainfall (1971-2005)

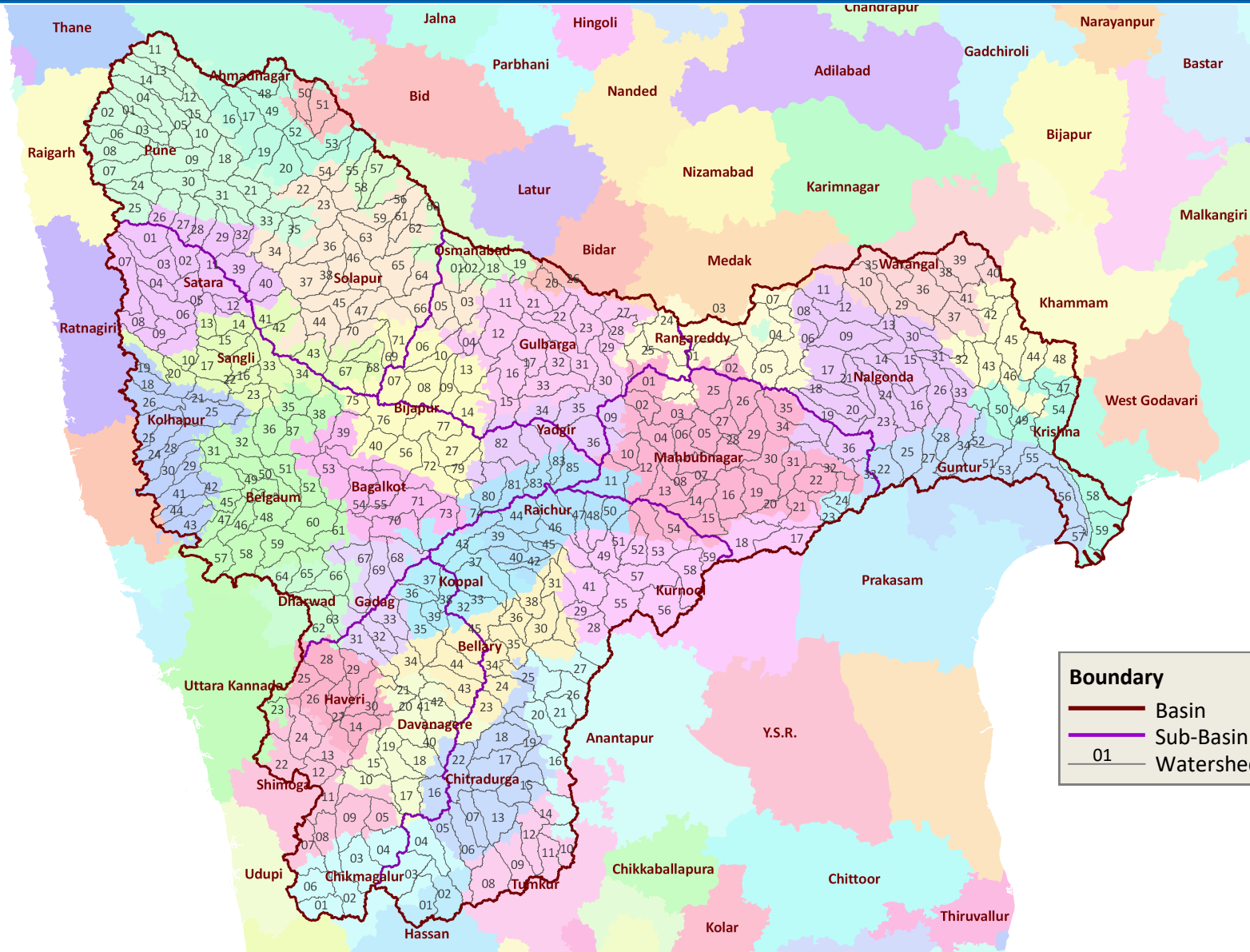


Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	400-600	42261.09	16.32
	600-800	134560.81	51.96
	800-1000	39219.11	15.15
	1000-1200	13321.59	5.14
	1200-1400	6118.23	2.36
	1400-1600	4978.22	1.92
	1600-2000	6757.12	2.61
	2000-2500	6196.21	2.39
	2500-3000	2740.19	1.06
	3000-4000	2095.65	0.81
	4000-5000	699.77	0.27



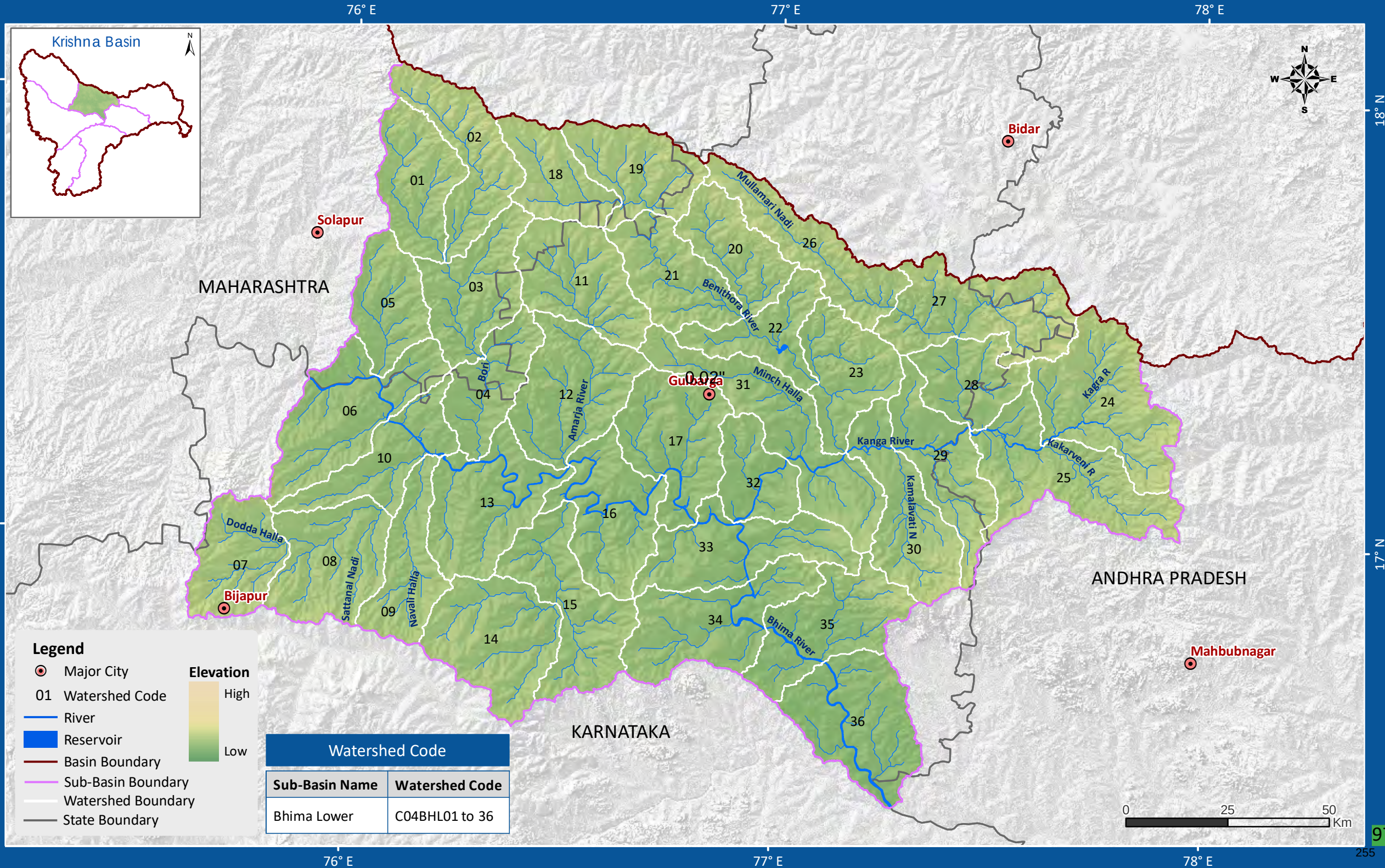
Symbol	Category	Area (Sq. km)	% of Total Area
■	Built Up Land	5931.50	2.29
■	Agricultural	196434.14	75.86
■	Forest	25986.84	10.04
■	Grassland	273.54	0.11
■	Wasteland	19781.85	7.64
■	Waterbodies	10540.13	4.07

Districts

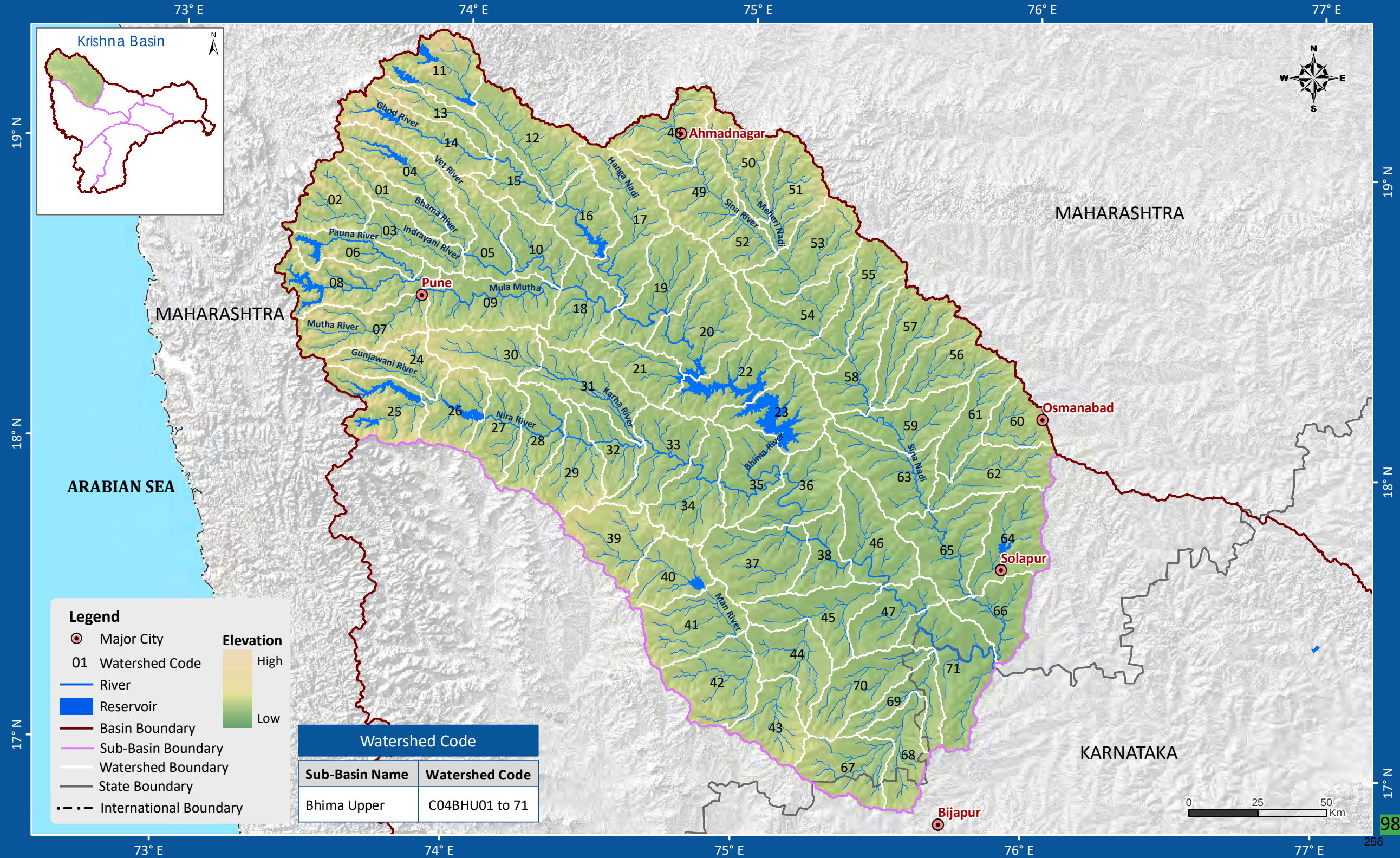


Boundary	
—	Basin
—	Sub-Basin
—	Watershed

1. Bhima Lower Sub-Basin



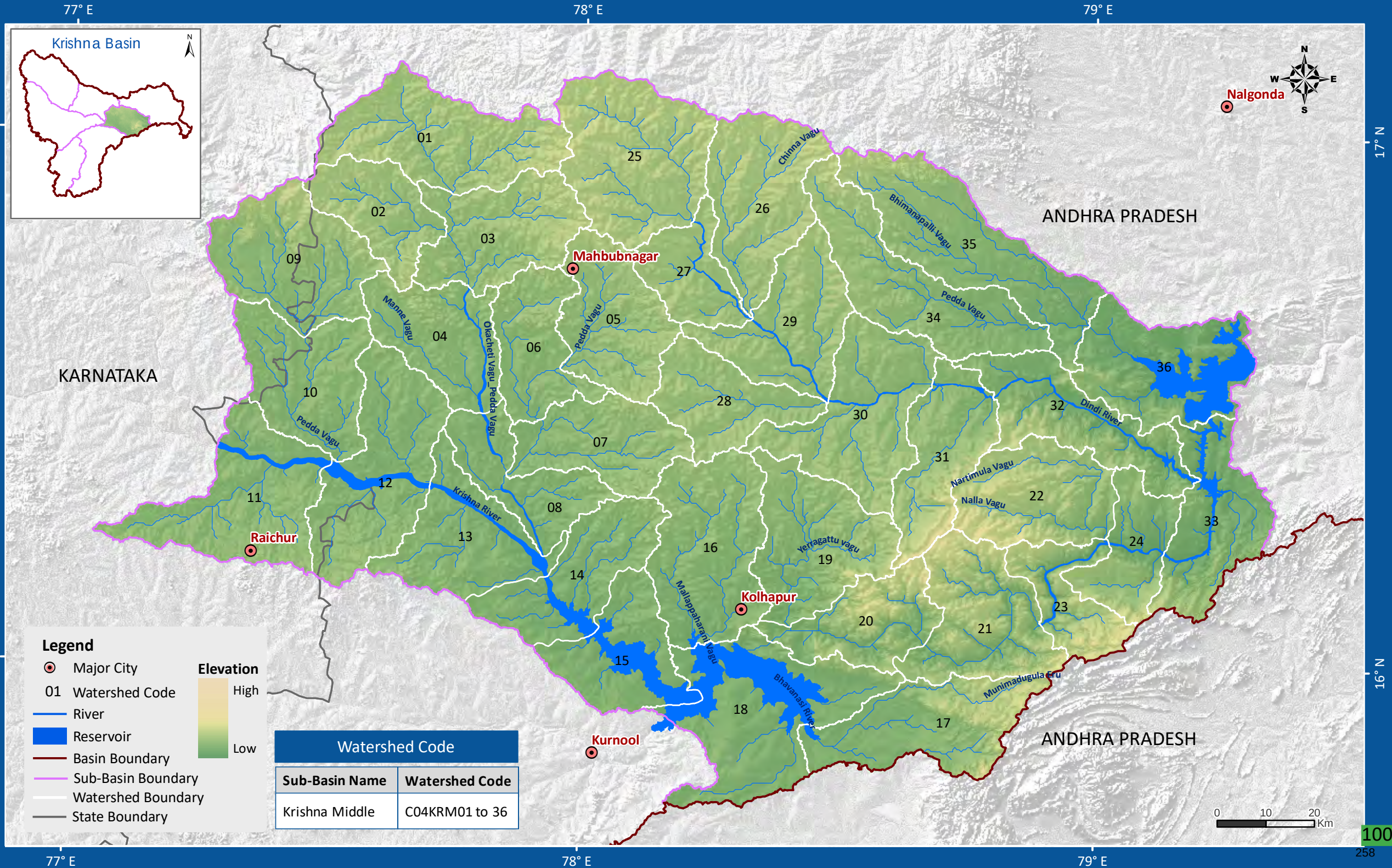
2. Bhima Upper Sub-Basin



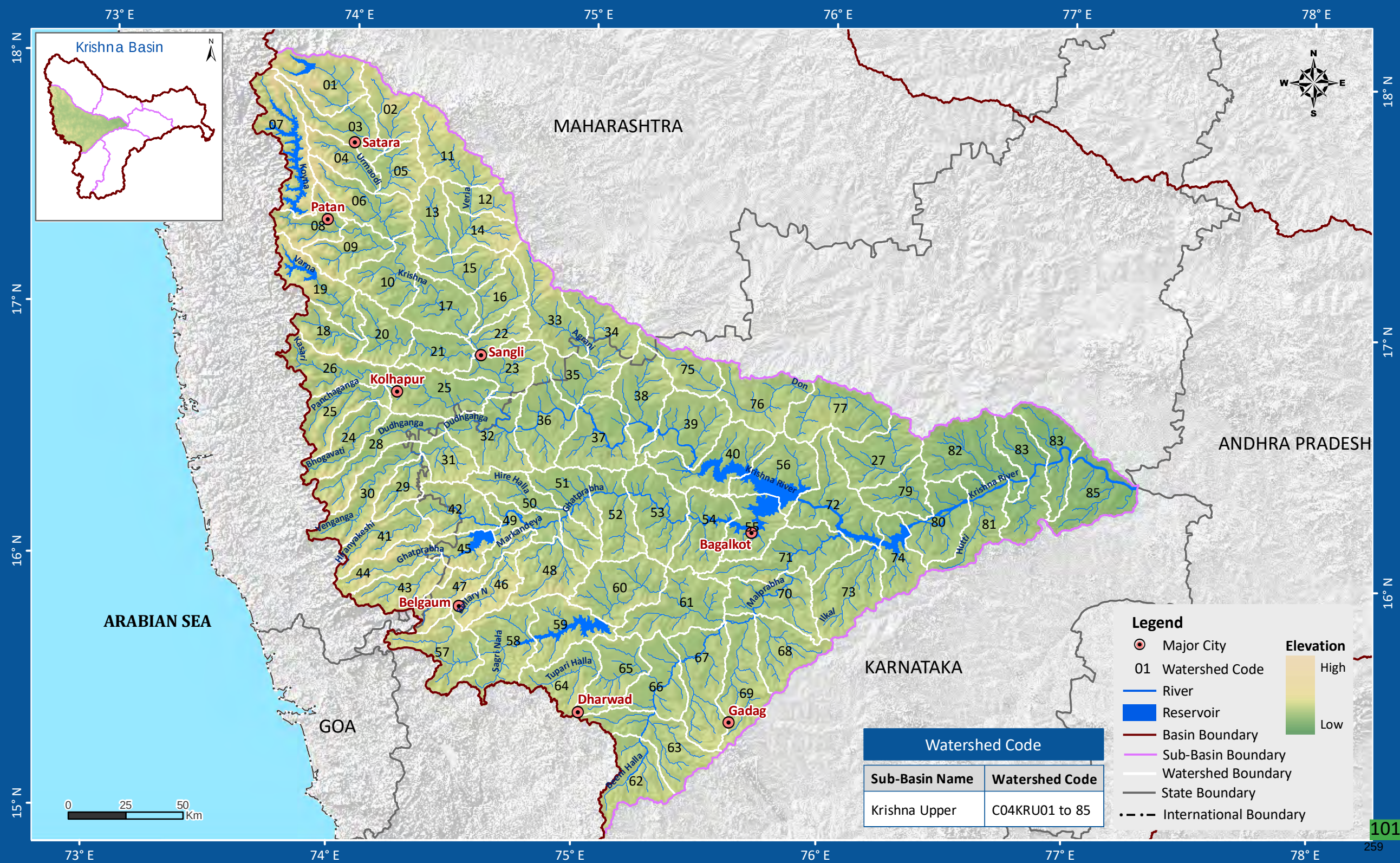
3. Krishna Lower Sub-Basin



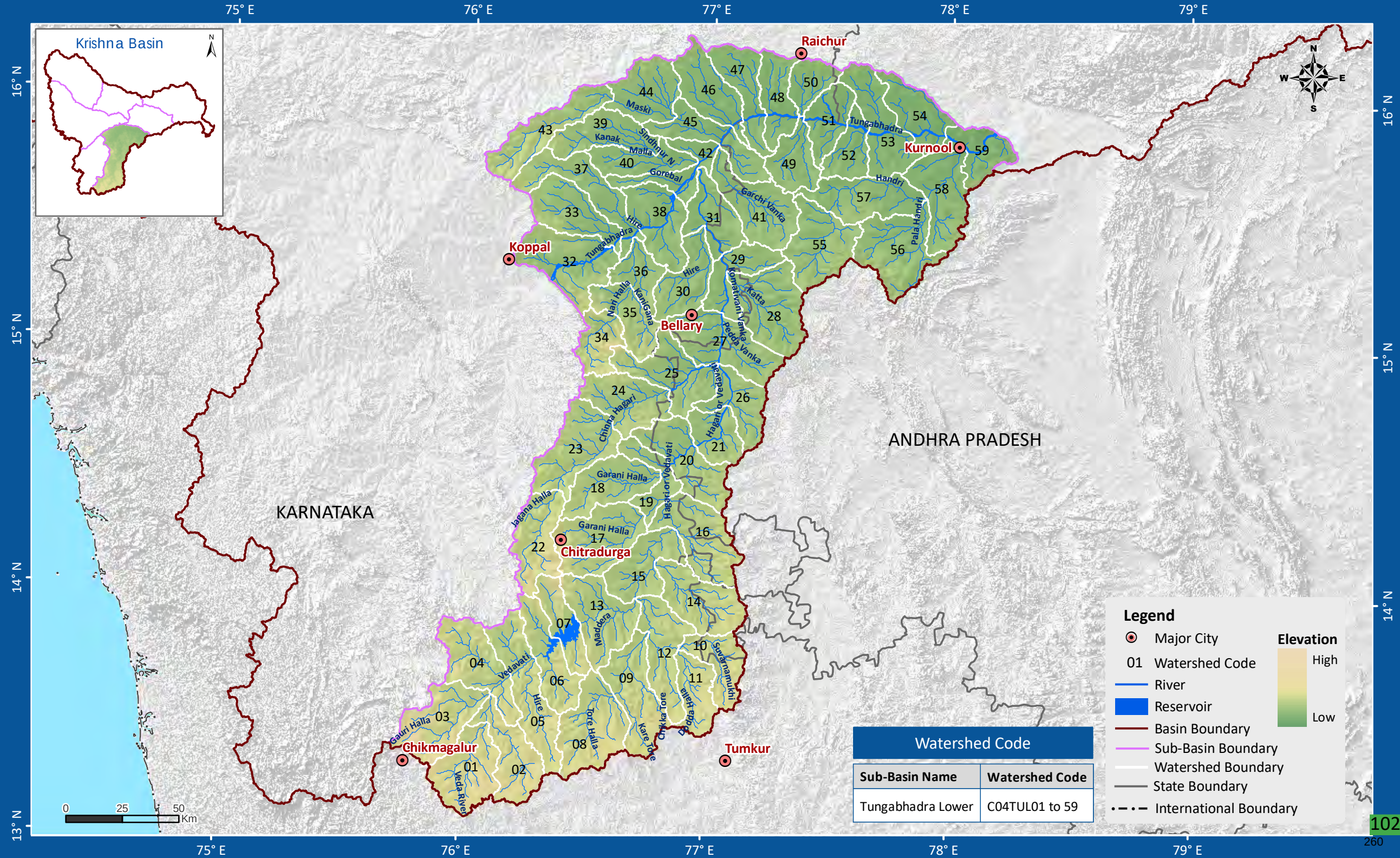
4. Krishna Middle Sub-Basin



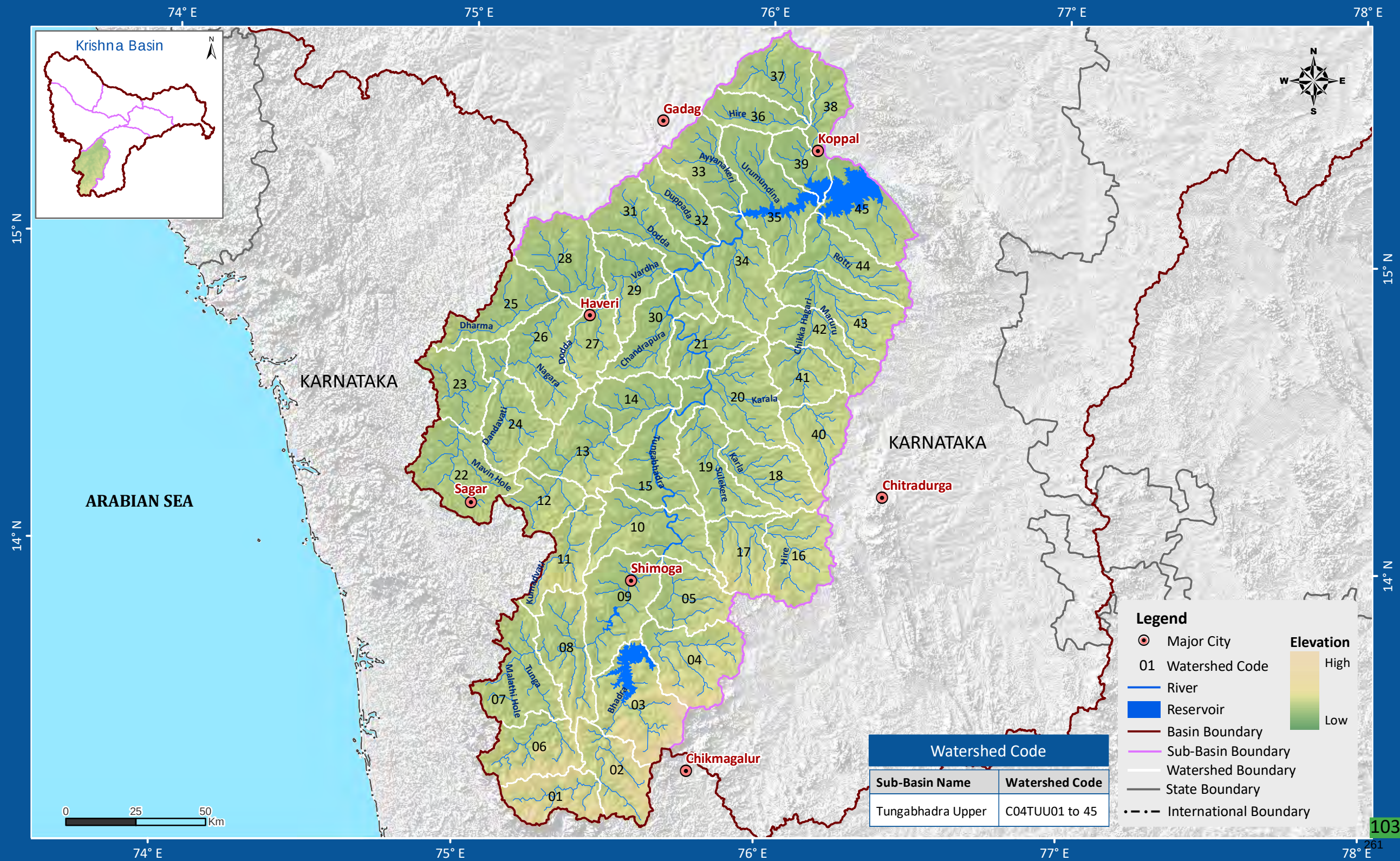
5. Krishna Upper Sub-Basin⁴⁵⁶



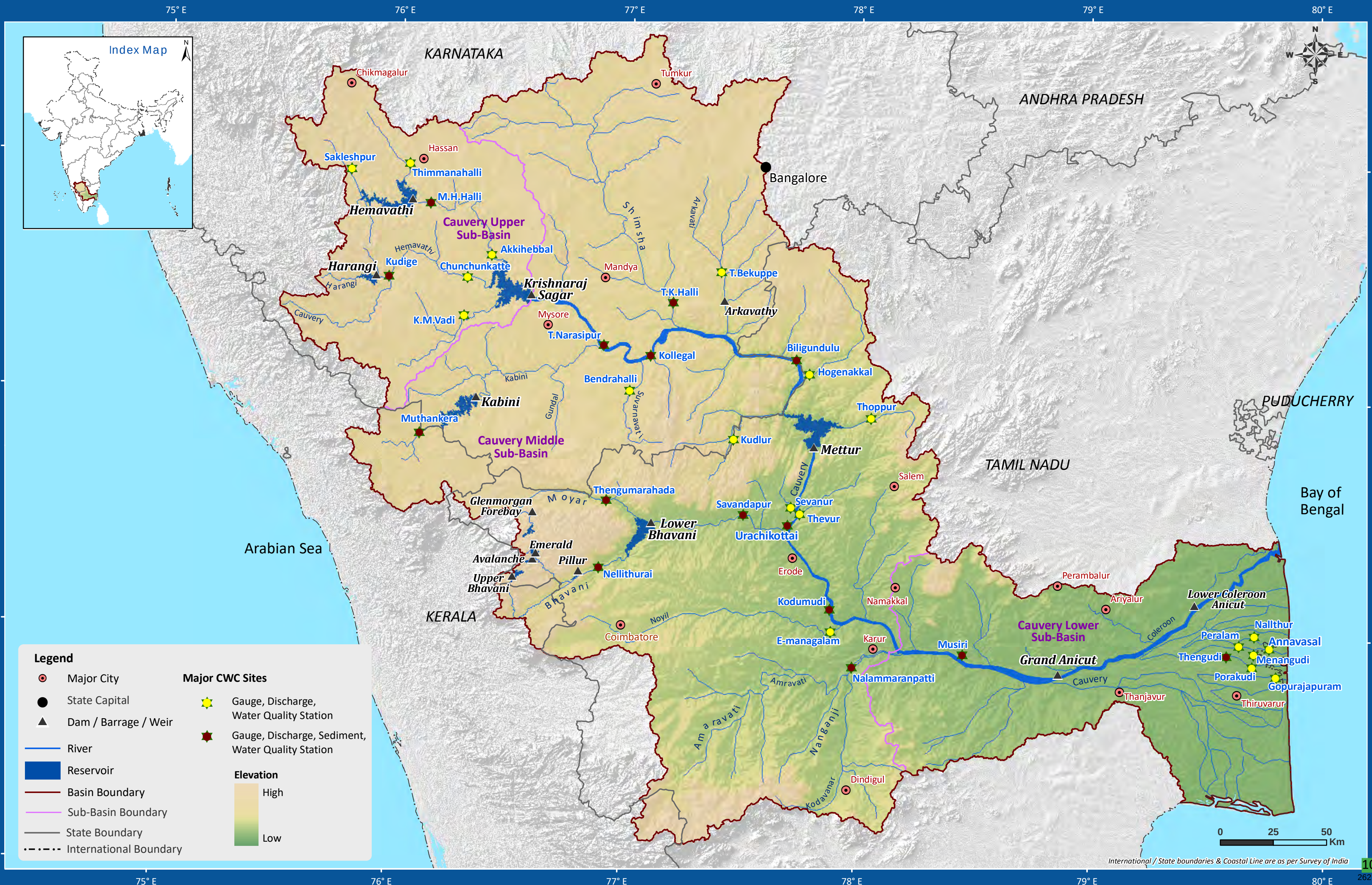
6. Tungabhadra Lower Sub-Basin



7. Tungabhadra Upper Sub-Basin



5.7 CAUVERY BASIN



The Cauvery basin extends over states of Tamil Nadu, Karnataka, Kerala and Union Territory of Puducherry draining an area of 81,155 Sq.km which is nearly 2.7% of the total geographical area of the country with a maximum length and width of about 560 km. and 245 km. It lies between 75°27' to 79°54' east longitudes and 10°9' to 13°30' north latitudes. It is bounded by the Western Ghats on the west, by the Eastern Ghats on the east and the south and by the ridges separating it from Krishna basin and Pennar basin on the north.

The Cauvery River is one of the major rivers of the peninsula. It rises at an elevation of 1,341 m at Talakaveri on the Brahmagiri range near Cherangala village of Kodagu district of Karnataka. The total length of the river from origin to outfall is 800 km. Its important tributaries joining from left are the Harangi, the Hemavati, the Shimsha and the Arkavati where as the Lakshmantirtha, the Kabbani, the Suvarnavati, the Bhavani, the Noyil and the Amaravati joins from right. The river drains into the Bay of Bengal. The major part of basin is covered with agricultural land accounting to 66.21% of the total area and 4.09% of the basin is covered by water bodies.

Salient Features of Cauvery Basin

Basin Extent	Longitude Latitude	75° 27' to 79° 54' E 10° 9' to 13° 30' N
Length of Cauvery River (Km)		800
Catchment Area (Sq.km.)		81155
Average Water Resource Potential (MCM)		21358
Utilizable Surface Water Resource		19000
Live Storage Capacity of Completed Projects (MCM)		8597.2
Live Storage Capacity of Projects Under Construction (MCM)		269.82
Total Live Storage Capacity of Projects (MCM)		8867.02
No. of Hydrological Observation Stations		36
No. of Flood Forecasting Stations		0

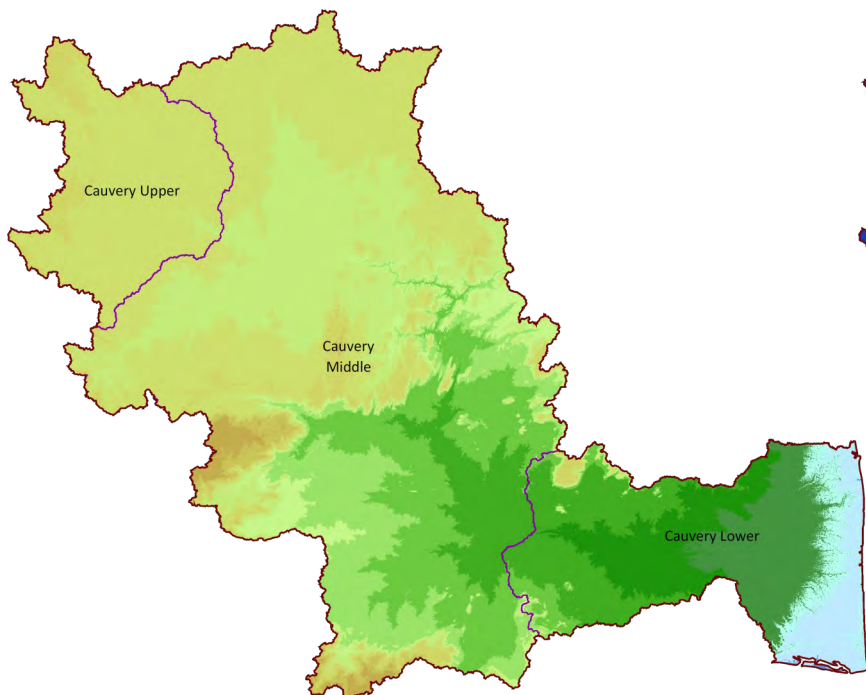
Major Water Resource Assets

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Cauvery Lower	17386.45	02	04	02	17136	09
2	Cauvery Middle	57280.98	85	22	91	11579	20
3	Cauvery Upper	10958.80	09	00	08	13912	07

Watershed Statistics

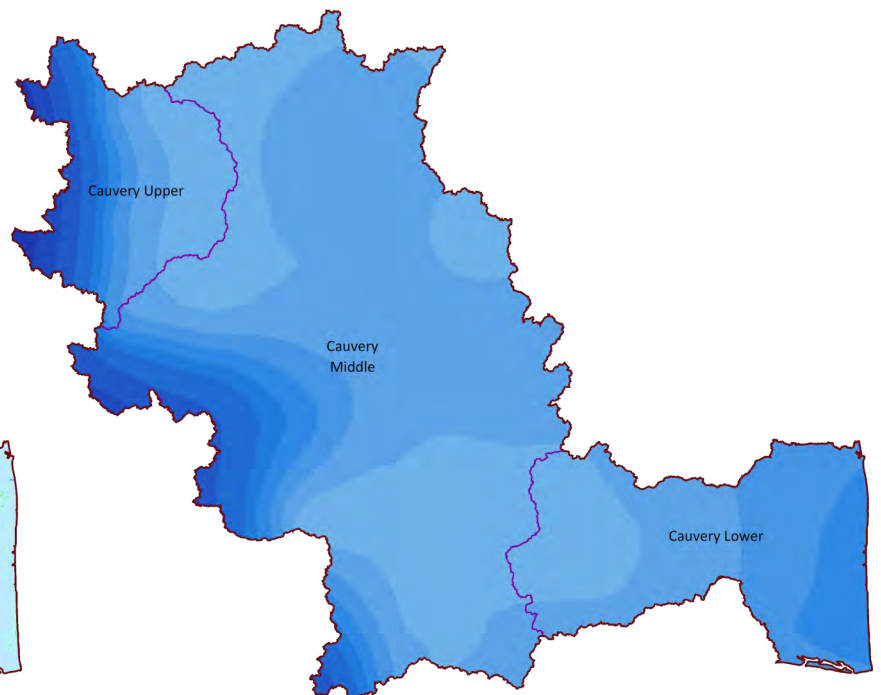
Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Cauvery Lower	28	320.70	979.20	620.94
2	Cauvery Middle	86	377.45	934.52	666.06
3	Cauvery Upper	18	362.94	991.25	608.82

Elevation Zone



Symbol	Elevation (m)	Area (Sq. km)	% of Total Area
	< 5	2058.03	2.54
	5-10	1444.14	1.78
	10-50	4120.77	5.08
	50-100	3297.20	4.06
	100-200	7202.59	8.88
	200-300	8903.69	10.97
	300-400	6957.78	8.57
	400-500	2837.79	3.50
	500-750	12718.66	15.67
	750-1000	25890.97	31.90
	1000-1500	3938.50	4.85
	1500-2000	975.24	1.20
	2000-3000	809.63	1.00

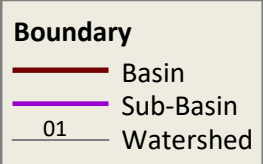
Average Annual Rainfall (1971-2005)



Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	600-800	24247.84	29.88
	800-1000	32471.31	40.01
	1000-1200	9216.18	11.36
	1200-1400	5664.54	6.98
	1400-1600	2422.55	2.99
	1600-2000	3748.45	4.62
	2000-2500	2408.66	2.96
	2500-3000	748.84	0.92
	3000-4000	226.64	0.28



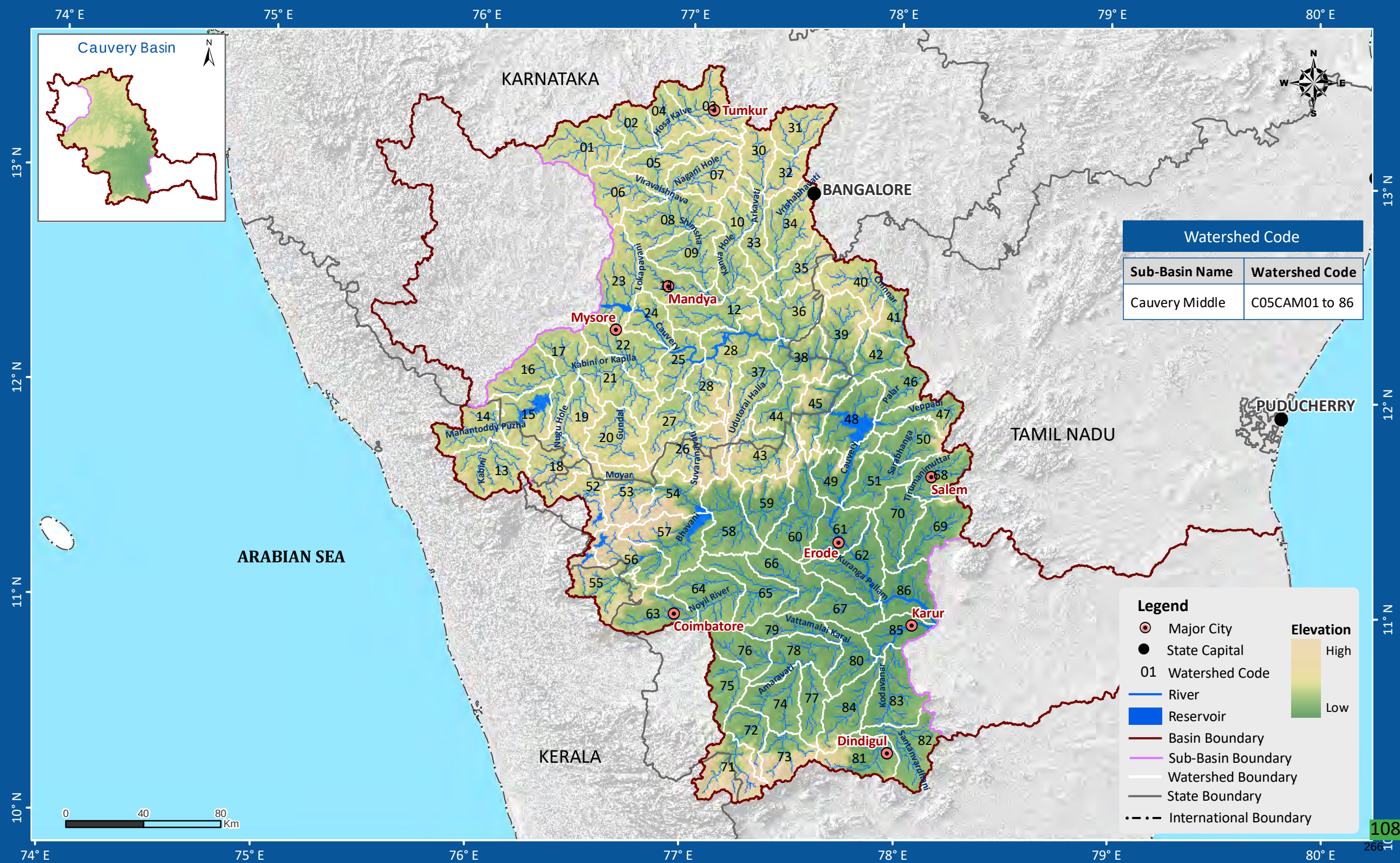
Districts



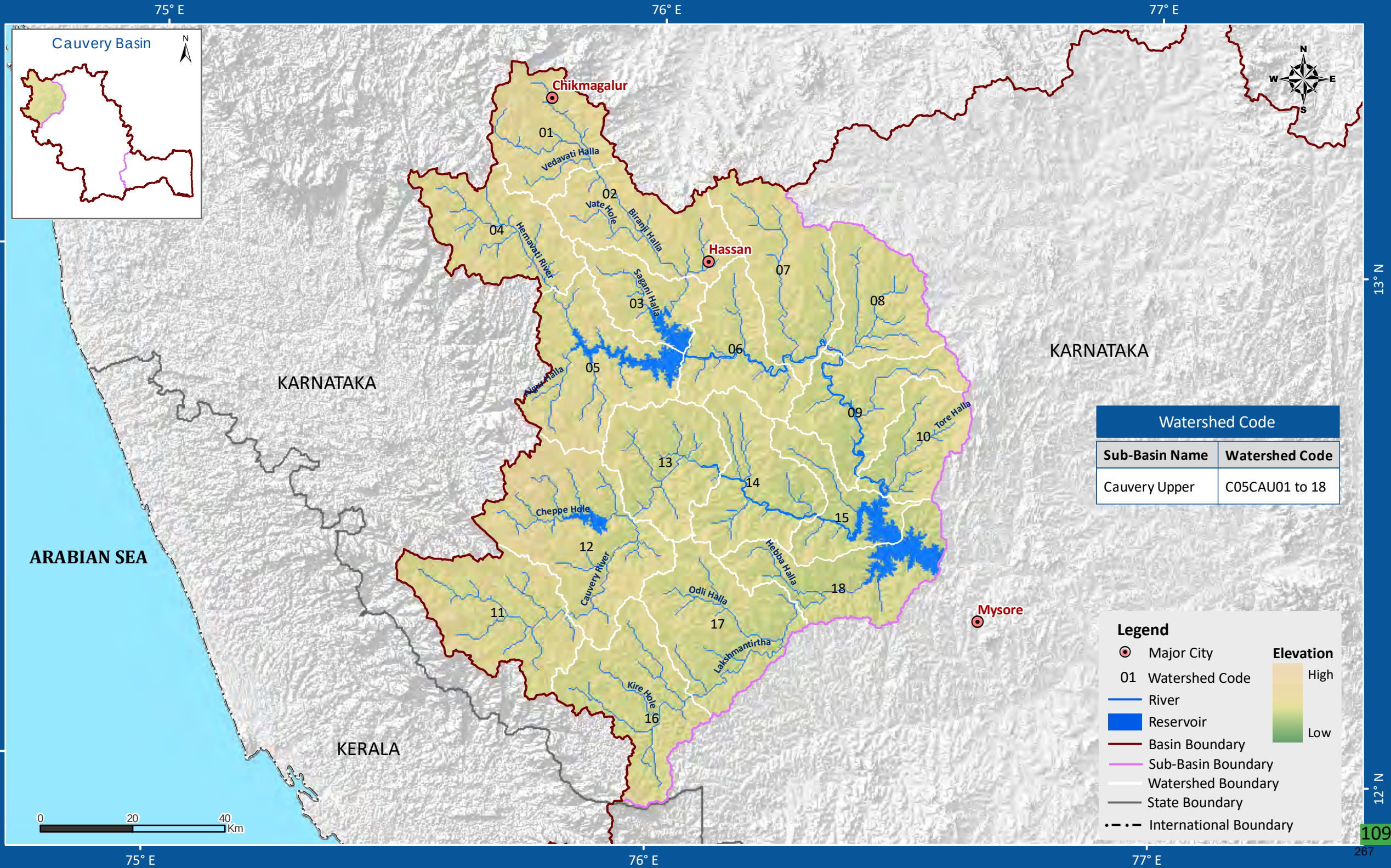
1. Cauvery Lower Sub-Basin

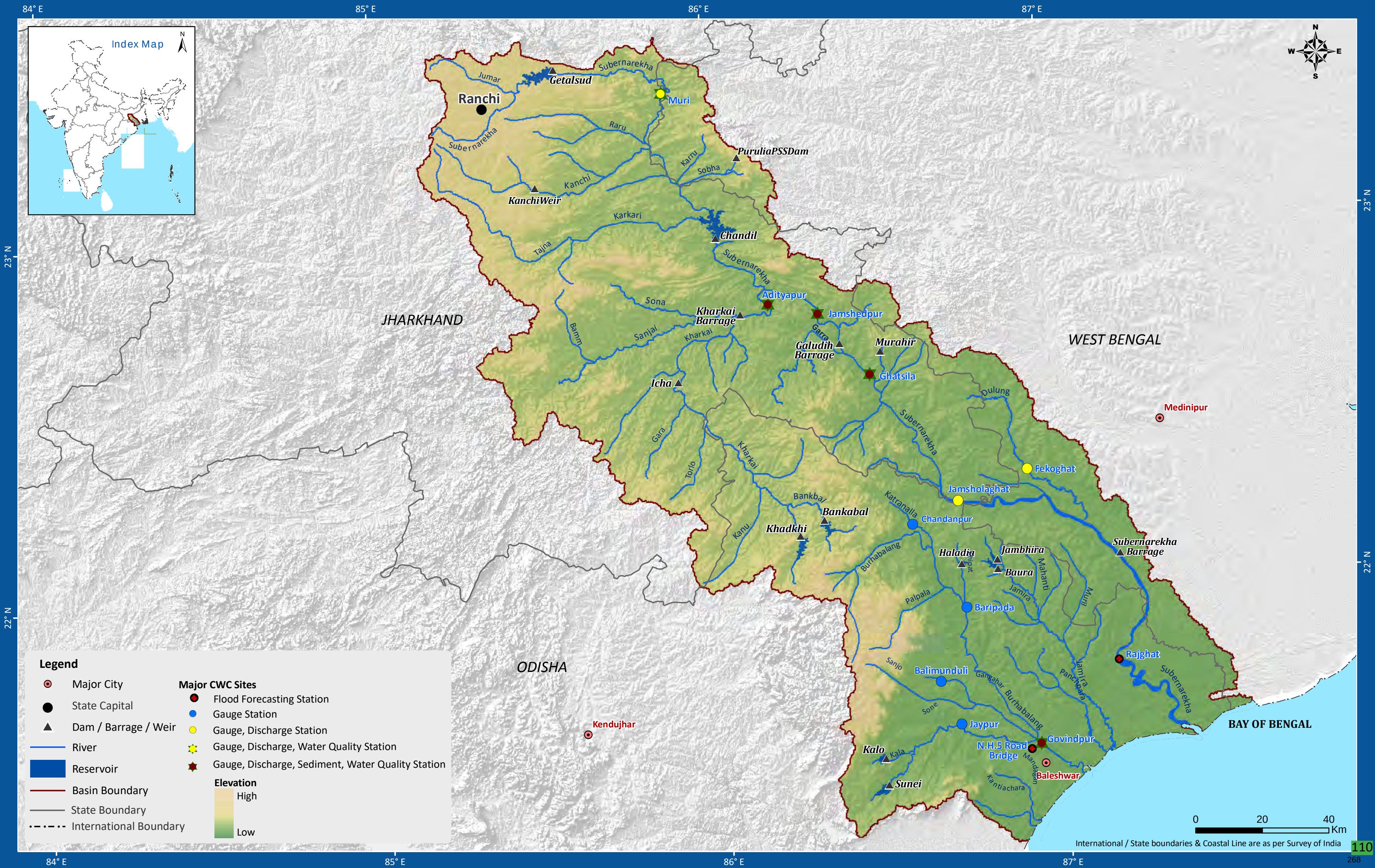


2. Cauvery Middle Sub-Basin



3. Cauvery Upper Sub-Basin





The Subernarekha basin extends over States of Jharkhand, Odisha and comparatively smaller part in West Bengal having a total area of 29,196 Sq.km with a maximum length and width of about 297 km and 119 km. It lies between 85°8' to 87°32' east longitudes and 21°15' to 23°34' north latitudes. Situated in the north-east corner of the Peninsular India, the basin is bounded by the Chhotanagpur plateau on the north and the west, by the ridges separating it from Baitarani basin on the south, by the Bay of Bengal on the south-east and by the Kasai Valley of Kangsabati River on the east.

The Subernarekha and the Burhabalang forms the major river systems in the basin. The Subernarekha River rises near Nagri village in the Ranchi District of Jharkhand at an elevation of 600 m. It flows for a length of 395 km before out falling into the Bay of Bengal. Its principal tributaries joining from right are the Kanchi, the Karkari and the Kharkai. The Burhabalang rises from south of Similipal village in the Mayurbhanj district of Odisha at an elevation of about 800 m and flows for a length of 164 km and drains into the Bay of Bengal. The major part of basin is covered with agricultural land accounting to 53.76% of the total area and 2.39% of the basin is covered by water bodies.

Salient Features of Subernarekha Basin

Basin Extent	Longitude	85° 8' to 87° 32' E
	Latitude	21° 15' to 23° 34' N
Length of River (Km)	Subernarekha – 395 Burhabalang – 164	
Catchment Area (Sq.km.)	29196	
Average Water Resource Potential (MCM)	12370	
Utilizable Surface Water Resource (MCM)	6800	
Live Storage Capacity of Completed Projects (MCM)	672.02	
Live Storage Capacity of Projects Under Construction (MCM)	1650.19	
Total Live Storage Capacity of Projects (MCM)	2322.21	
No. of Hydrological Observation Stations	12	
No. of Flood Forecasting Stations	2	

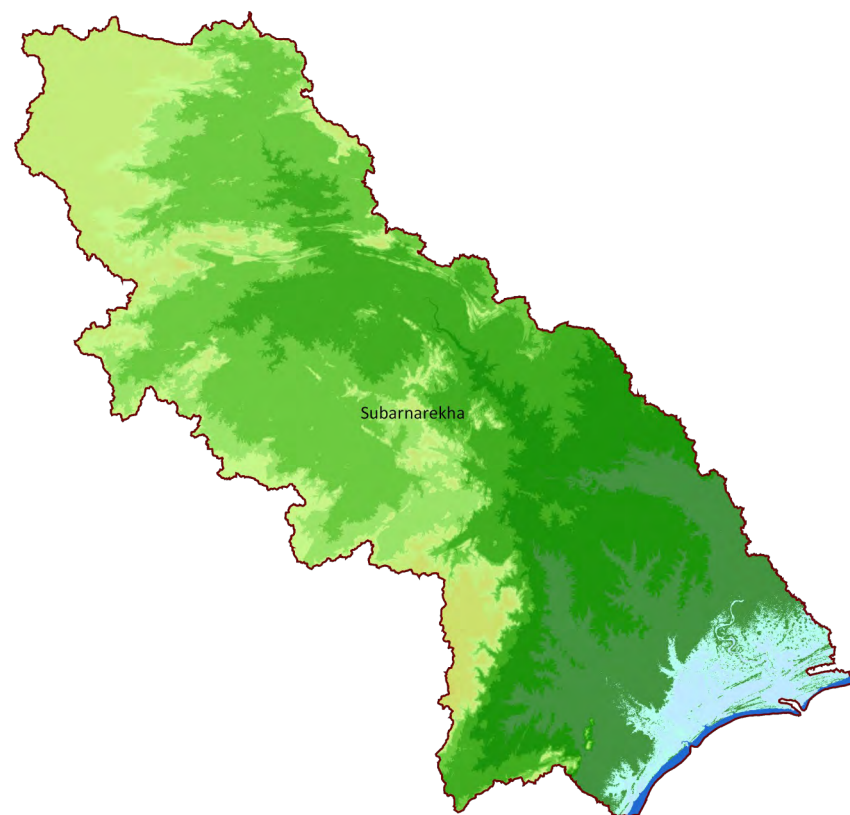
Major Water Resource Assets

Sl. No.	Basin Name	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Subarnarekha	25792.16	38	16	30	22197	12

Watershed Statistics

Sl. No.	Basin Name	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Subarnarekha	45	387.02	962.40	573.16

Elevation Zone

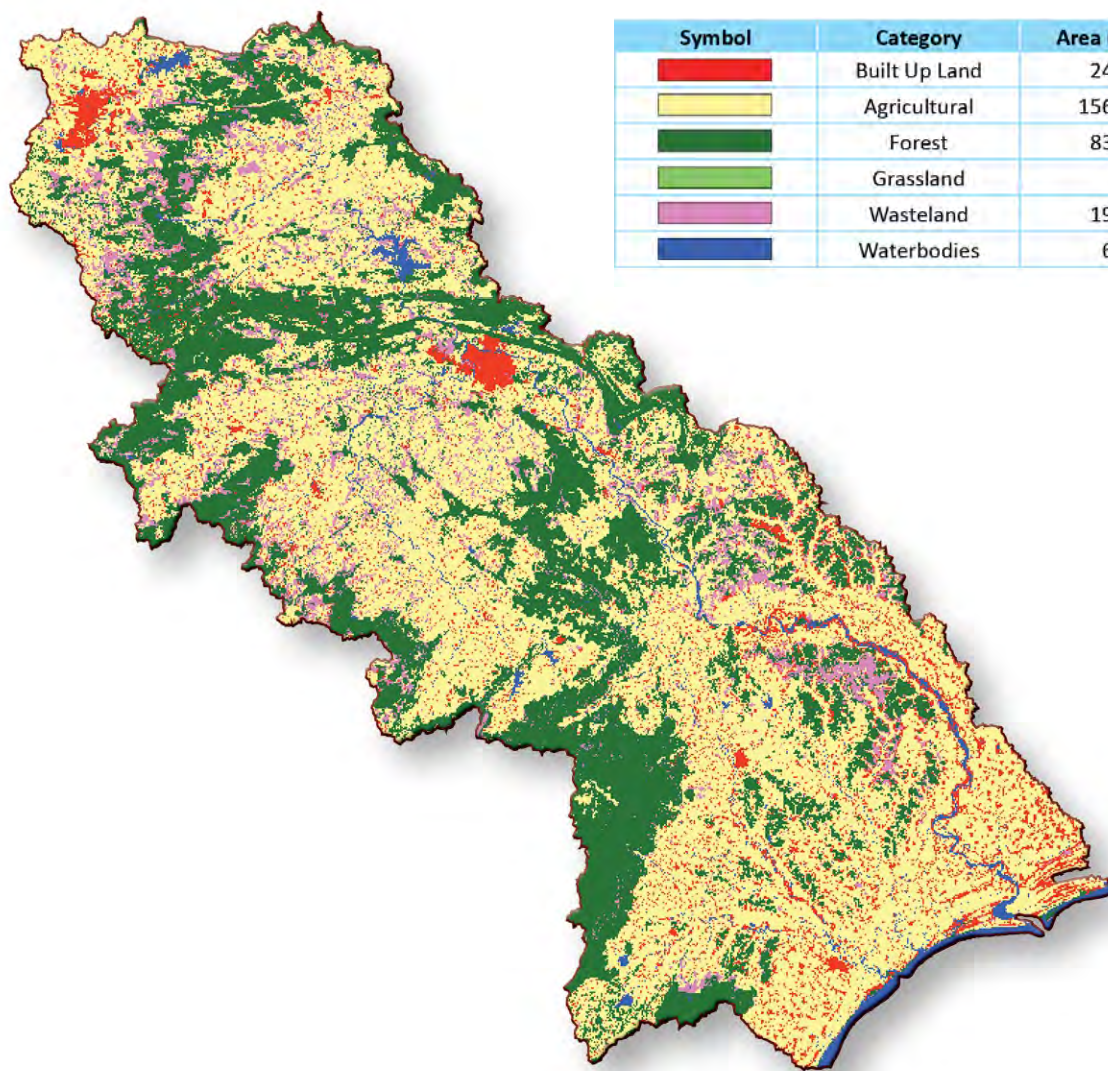


Average Annual Rainfall (1971-2005)



Symbol	Elevation (m)	Area (Sq. km)	% of Total Area
	< 5	901.74	3.09
	5-10	852.66	2.92
	10-50	3838.89	13.15
	50-100	4000.33	13.70
	100-200	4636.81	15.88
	200-300	6586.52	22.56
	300-400	2904.88	9.95
	400-500	1670.44	5.72
	500-750	3255.08	11.15
	750-1000	524.07	1.80
	1000-1500	24.59	0.08

Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	1000-1200	403.54	1.38
	1200-1400	13869.42	47.50
	1400-1600	4493.15	15.39
	1600-2000	10429.90	35.73



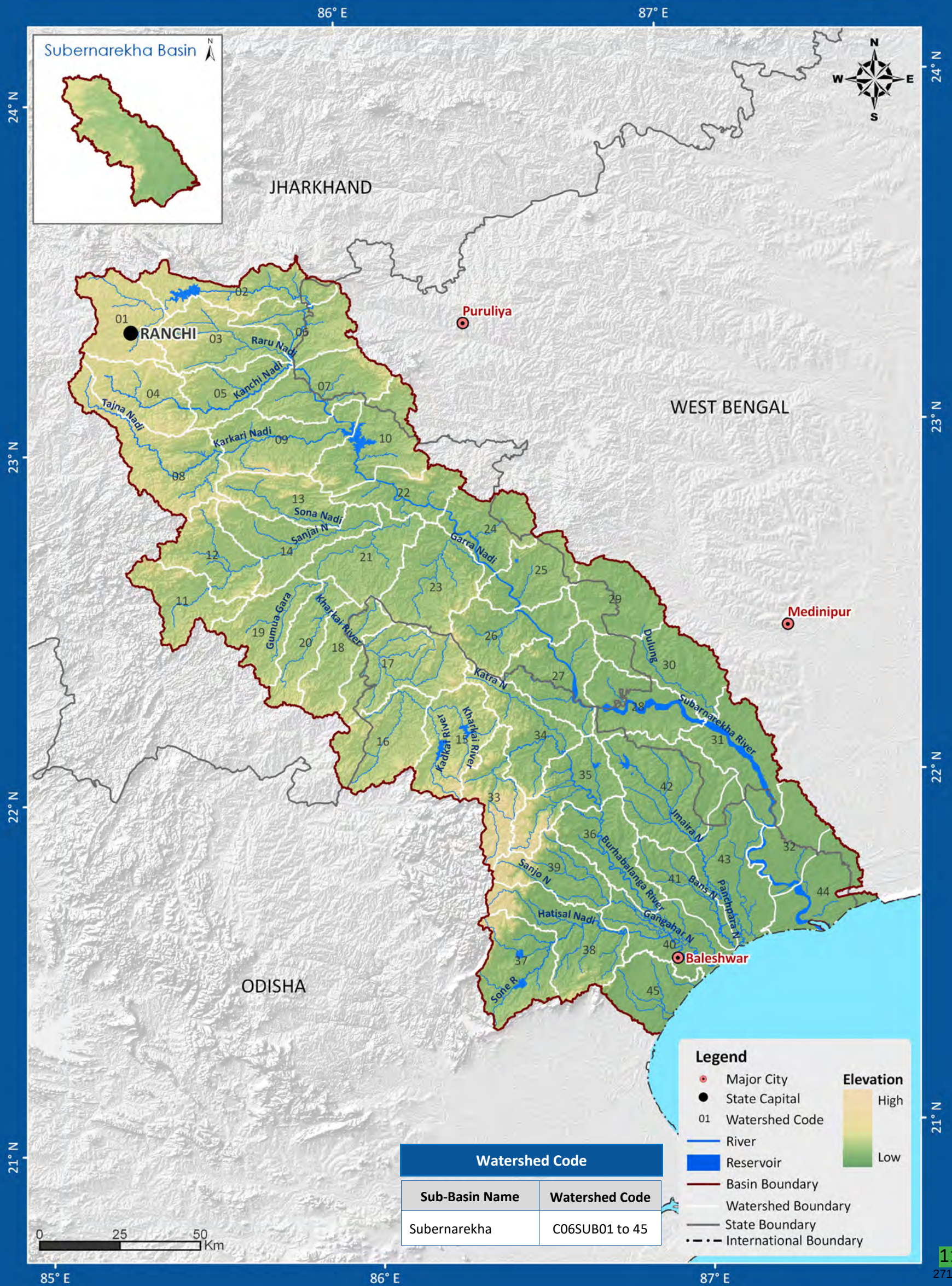
Symbol	Category	Area (Sq. km)	% of Total Area
	Built Up Land	2429.14	8.32
	Agricultural	15696.76	53.76
	Forest	8394.62	28.75
	Grassland	0.78	0.01
	Wasteland	1977.39	6.77
	Waterbodies	697.32	2.39

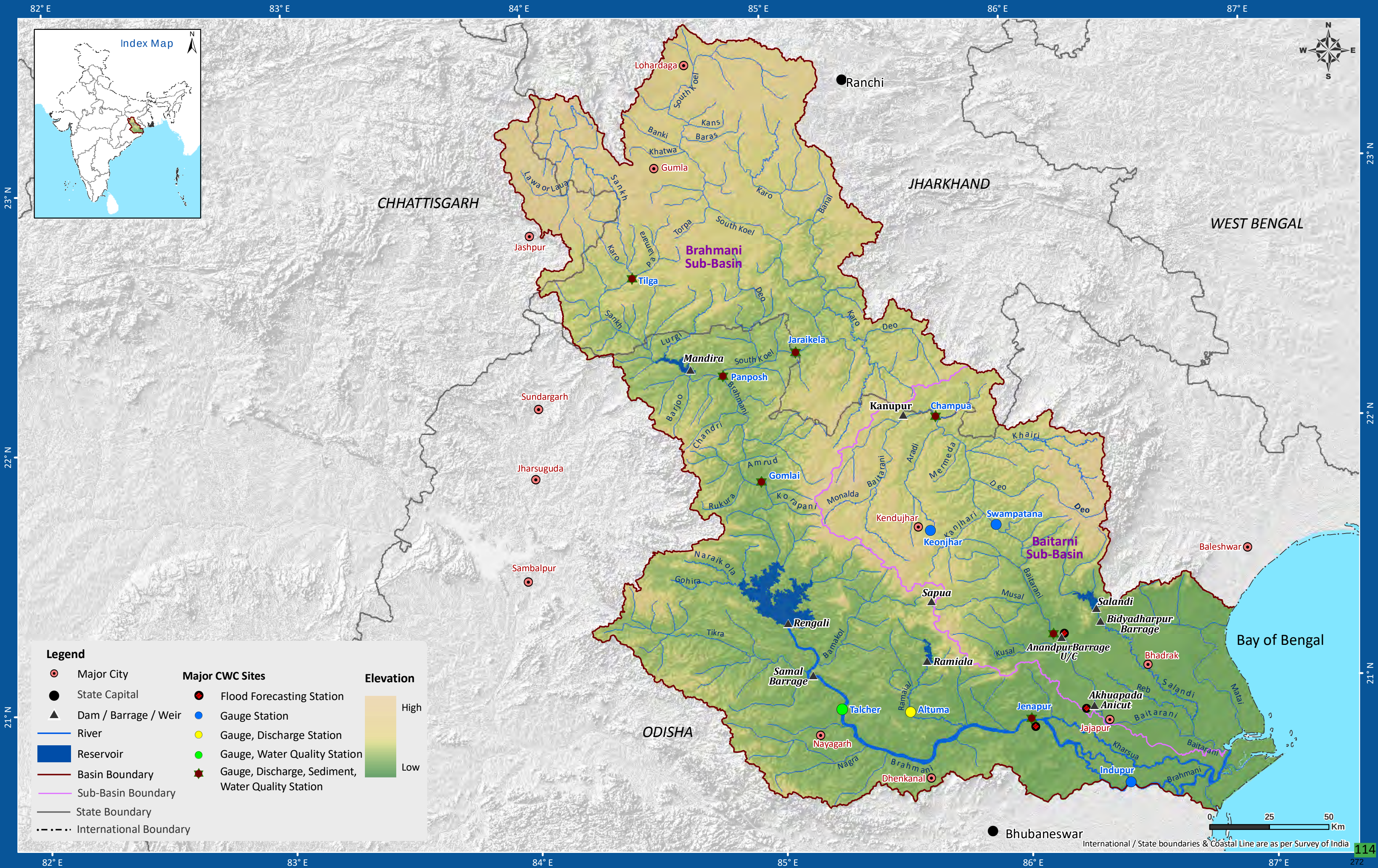
Districts



1. Subernarekha Sub-Basin

468





The basin consisting of Brahmani and Baitarni extends over states of Odisha, Jharkhand and Chhattisgarh having an area of 51,822 Sq.km which is nearly 1.7 % of the total geographical area of the country with a maximum length and width of 403 km and 193 km. It lies between 83° 55' to 87° 3' east longitudes and 20° 28' to 23° 38' north latitudes. The basin is bounded by the Chhotanagpur Plateau on the north, by the ridge separating it from Mahanadi basin on the west and the south and by the Bay of Bengal on the east. The Brahmani sub basin covers 39,033 Sq.km and has a long sausage shape. The Baitarni sub basin extends over 12,789 Sq.km and is roughly circular in shape. The Brahmani, known as South Koel in its upper reaches, rises near Nagri village in Ranchi district of Jharkhand at an elevation of about 600 m. The river has a total length of 799 km. In its tail reach, the river is known as Maipura. The Baitarni River rises near Dumuria village in the hill ranges of Kendujhar district of Odisha at an elevation of about 900 m and has a length of about 355 km. The river is known as Dhamra in its lower reaches. The important tributaries of Brahmani joining it from left are the Karo, and the Sankh whereas the Tikra joins from right. The main tributaries of Baitarni joining from left are the Salandi and the Matai. Brahmani and Baitarni form common delta area before out falling into the Bay of Bengal. The major part of basin is covered with agricultural land accounting to 52.04% of the total area and 2.95% of the basin is covered by water bodies.

Basin Extent	Longitude Latitude	83° 55' to 87° 3' E 20° 28' to 23° 38' N
Length of River (Km)	Brahmani – 799 Baitarni – 355	
Catchment Area (Sq.km.)	51822	
Average Water Resource Potential (MCM)	28480	
Utilizable Surface Water Resource (MCM)	18300	
Live Storage Capacity of Completed Projects (MCM)	4648.09	
Live Storage Capacity of Projects Under Construction (MCM)	875.60	
Total Live Storage Capacity of Projects (MCM)	5523.69	
No. of Hydrological Observation Stations	15	
No. of Flood Forecasting Stations	3	

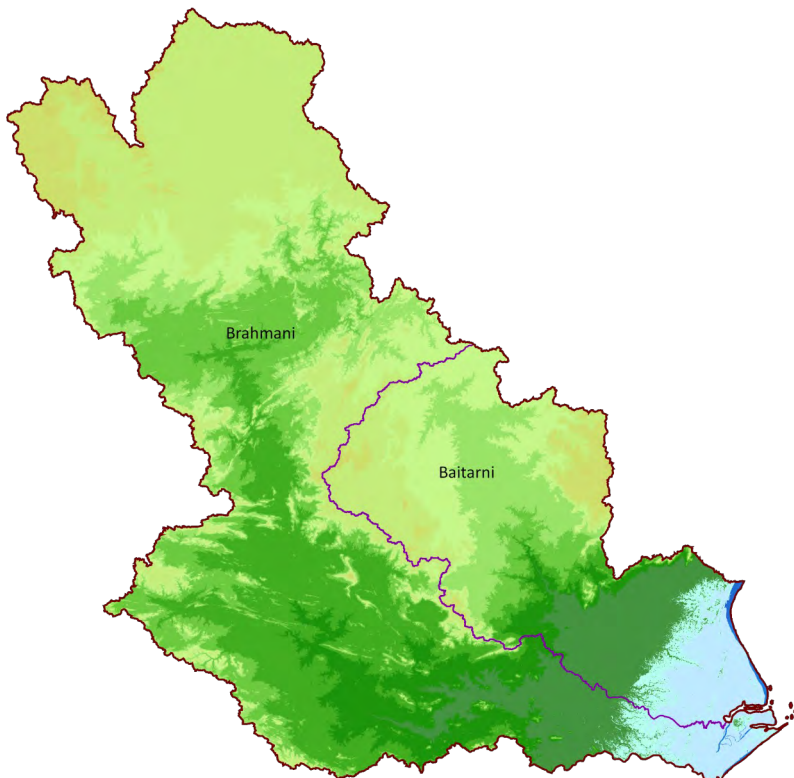
Major Water Resource Assets

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Baitarni	14351.23	18	4	15	11867	6
2	Brahmani	37545.83	43	6	37	14632	9

Watershed Statistics

Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Baitarni	21	472.27	974.99	683.39
2	Brahmani	58	332.75	964.48	647.34

Elevation Zone

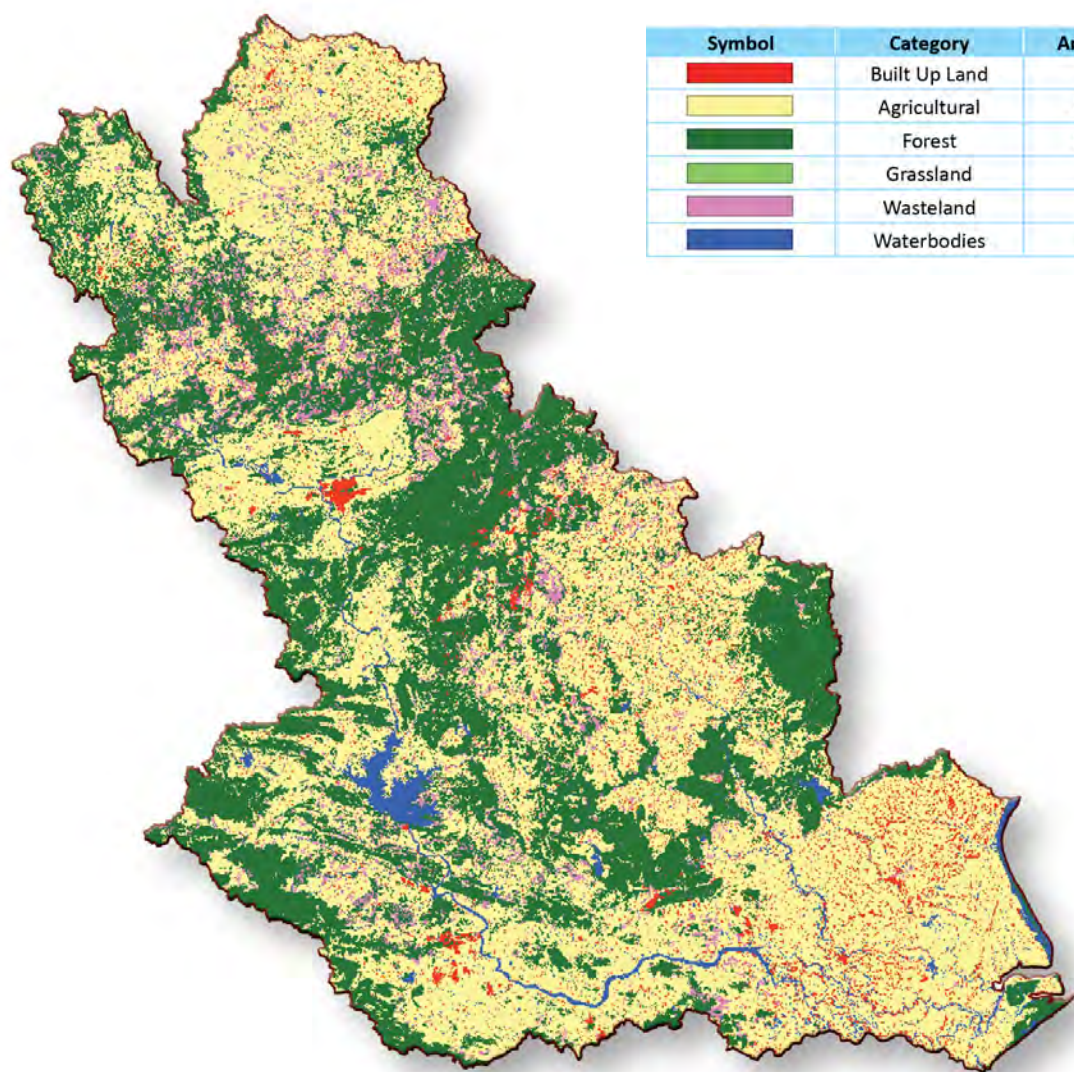


Symbol	Elevation (m)	Area (Sq. km)	% of Total Area
	< 5	2111.46	4.07
	5-10	1074.88	2.07
	10-50	4227.90	8.16
	50-100	3193.50	6.16
	100-200	6989.44	13.49
	200-300	6632.59	12.81
	300-400	6643.69	12.82
	400-500	6689.90	12.91
	500-750	11511.45	22.21
	750-1000	2563.31	4.95
	1000-1500	183.88	0.35

Average Annual Rainfall (1971-2005)

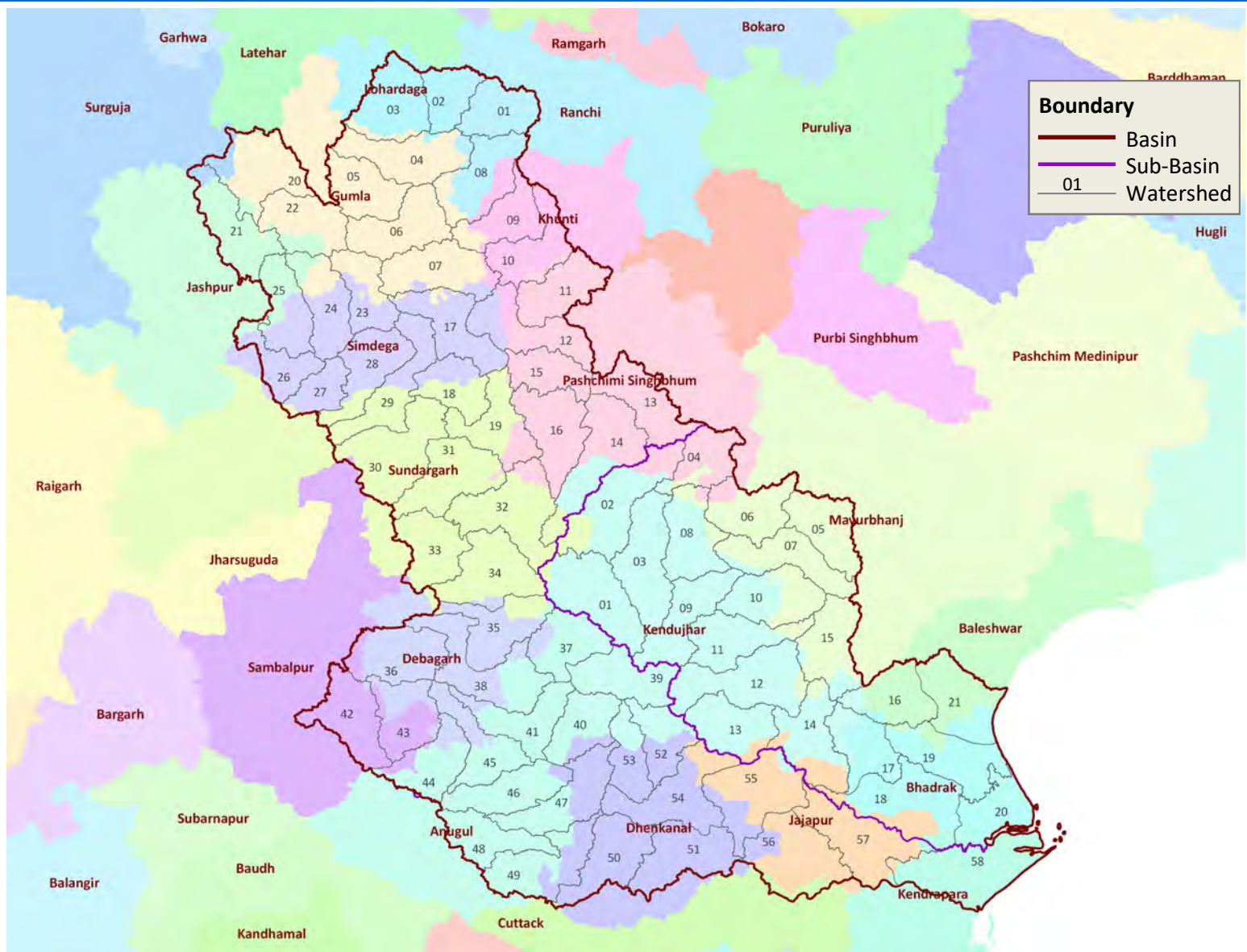


Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	1200-1400	13697.80	26.43
	1400-1600	33835.23	65.29
	1600-2000	4288.97	8.28



Symbol	Category	Area (Sq. km)	% of Total Area
■	Built Up Land	2395.95	4.62
■	Agricultural	26966.96	52.04
■	Forest	17811.93	34.36
■	Grassland	0.79	0.01
■	Wasteland	3117.16	6.02
■	Waterbodies	1529.21	2.95

District s



1. Baitarni Sub-Basin



86° E

87° E

22° N

21° N

22° N

21° N



● BHUBANESWAR

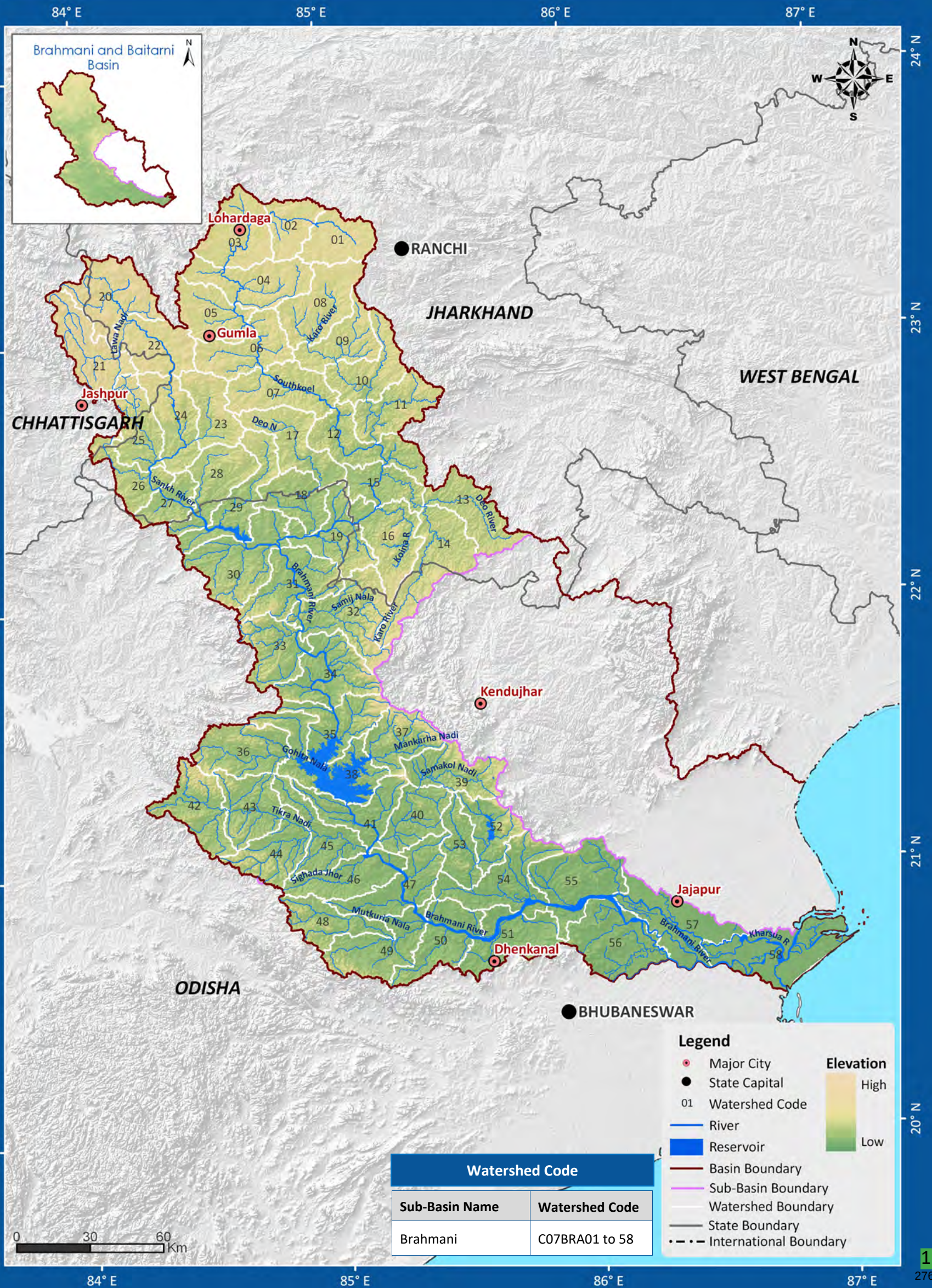
Legend

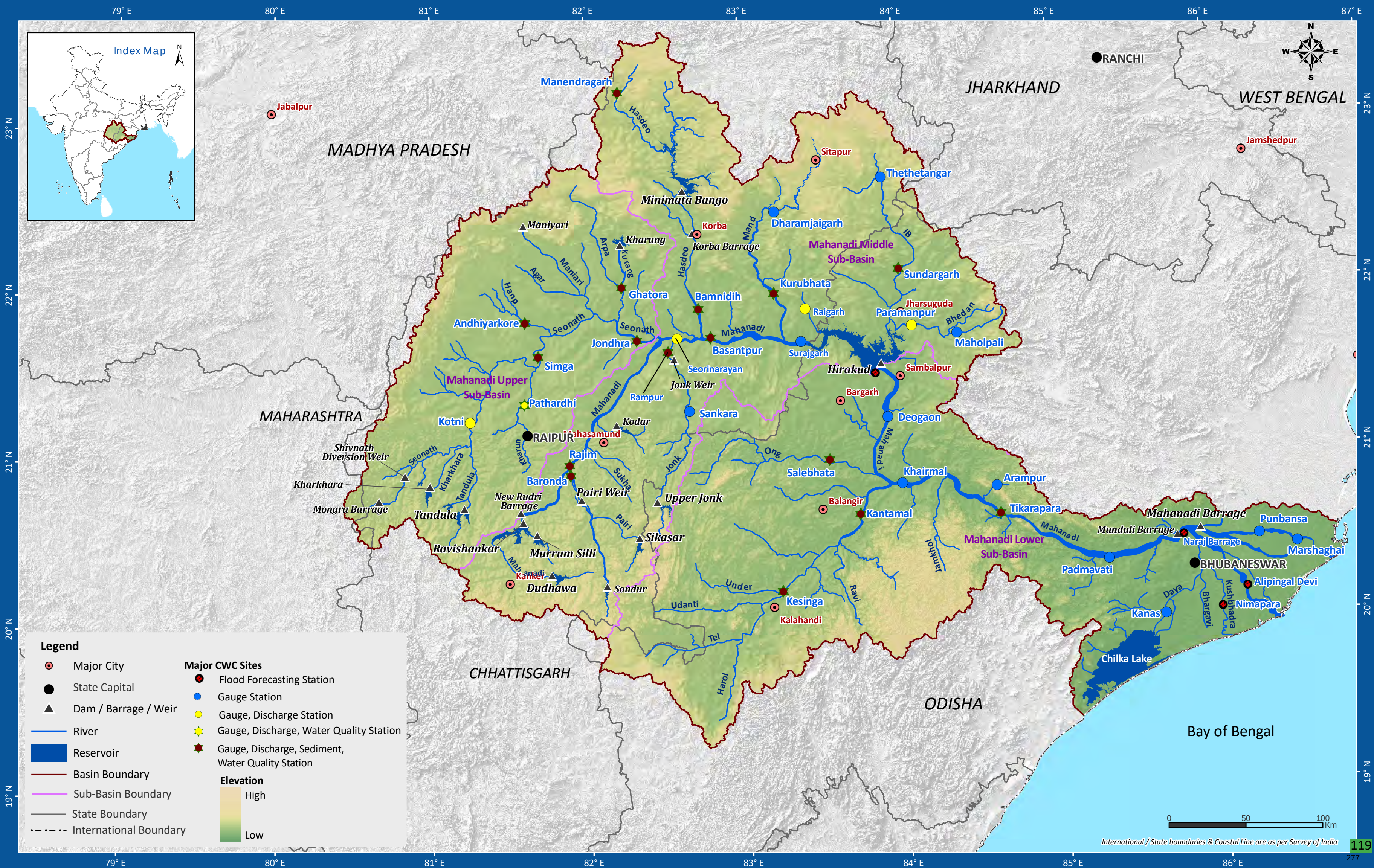
- Major City
 - State Capital
 - 01 Watershed Code
 - River
 - Reservoir
 - Basin Boundary
 - Sub-Basin Boundary
 - Watershed Boundary
 - State Boundary
 - International Boundary
- Elevation**
- High
- Low

Watershed Code

Sub-Basin Name	Watershed Code
Baitarni	C07BAI01 to 21

2. Brahmani Sub-Basin





475 The Mahanadi basin extends overstates of Chhattisgarh and Odisha and comparatively smaller portions of Jharkhand, Maharashtra and Madhya Pradesh, draining an area of 1,41,589 Sq.km which is nearly 4.3 % of the total geographical area of the country. The geographical extent of the basin lies between 80° 28' and 86° 43' east longitudes and 19° 8' and 23° 32' north latitudes. The basin has maximum length and width of 587 km and 400 km. It is bounded by the Central India hills on the north, by the Eastern Ghats on the south and east and by the Maikala range on the west.

The Mahanadi is one of the major rivers of the country and among the peninsular-rivers, in water potential and flood producing capacity, it ranks second to the Godavari. It originates from a pool, 6 km from Farsiya village of Dhamtari district of Chhattisgarh. The total length of the river from origin to its outfall into the Bay of Bengal is 851 km. The Seonath, the Hasdeo, the Mand and the Ib joins Mahanadi from left whereas the Ong, the Tel and the Jonk joins it from right. Six other small streams between the Mahanadi and the Rushikulya draining directly into the Chilka Lake also forms the part of the basin. The major part of basin is covered with agricultural land accounting to 54.27% of the total area and 4.45% of the basin is covered by water bodies.

Salient Features of Mahanadi Basin

Basin Extent	Longitude	80° 28' to 86° 43' E
	Latitude	19° 8' to 23° 32' N
Length of Mahanadi River (Km)		851
Catchment Area (Sq.km.)		141589
Average Water Resource Potential (MCM)		66880
Utilizable Surface Water Resource (MCM)		50000
Live Storage Capacity of Completed Projects (MCM)		12334.80
Live Storage Capacity of Projects Under Construction (MCM)		1873
Total Live Storage Capacity of Projects (MCM)		14207.80
No. of Hydrological Observation Stations		50
No. of Flood Forecasting Stations		4

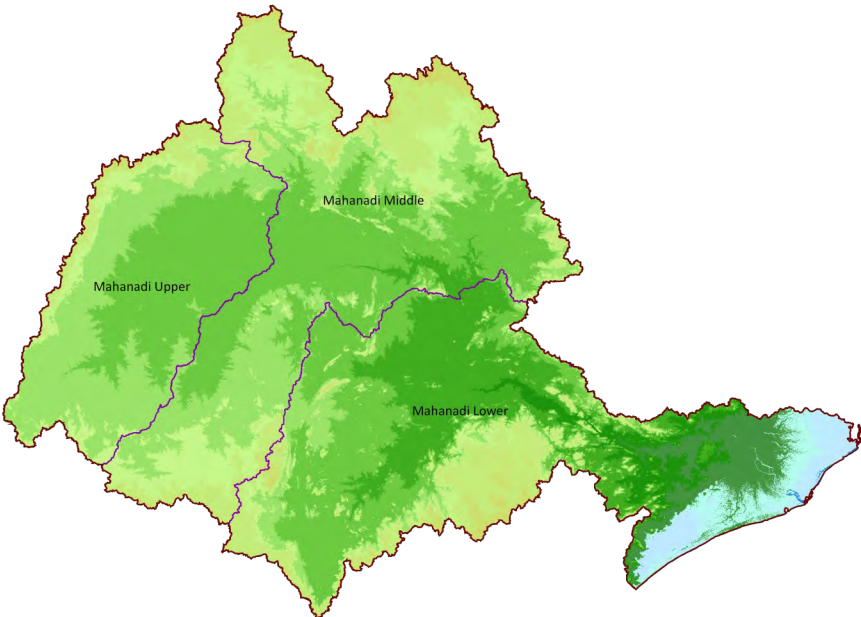
Major Water Resource Assets

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Mahanadi Lower	57958.88	75	11	54	38360	20
2	Mahanadi Middle	51895.91	116	8	77	50874	22
3	Mahanadi Upper	29796.64	62	8	69	34782	8

Watershed Statistics

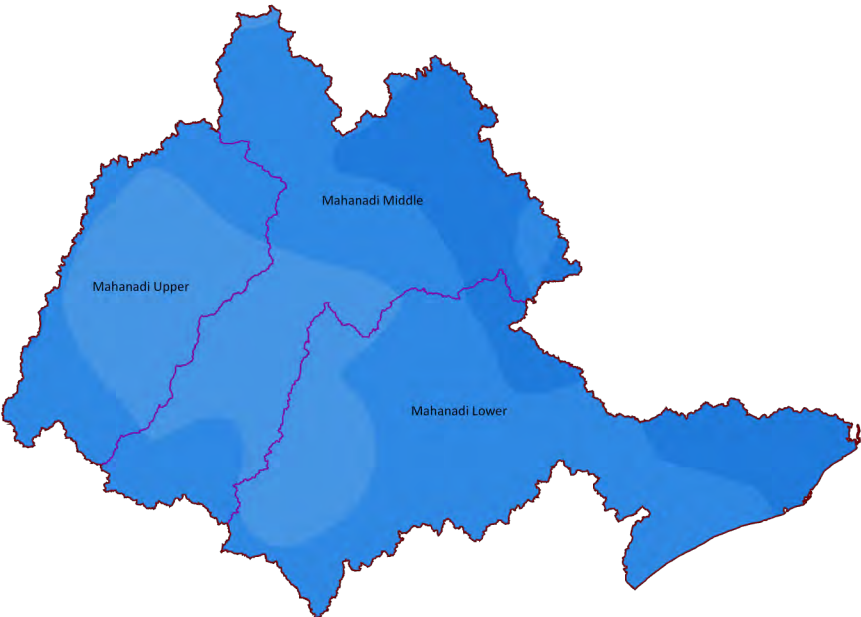
Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Mahanadi Lower	91	320.05	1457.59	636.91
2	Mahanadi Middle	88	301.22	902.46	589.73
3	Mahanadi Upper	48	314.34	907.63	620.76

Elevation Zone

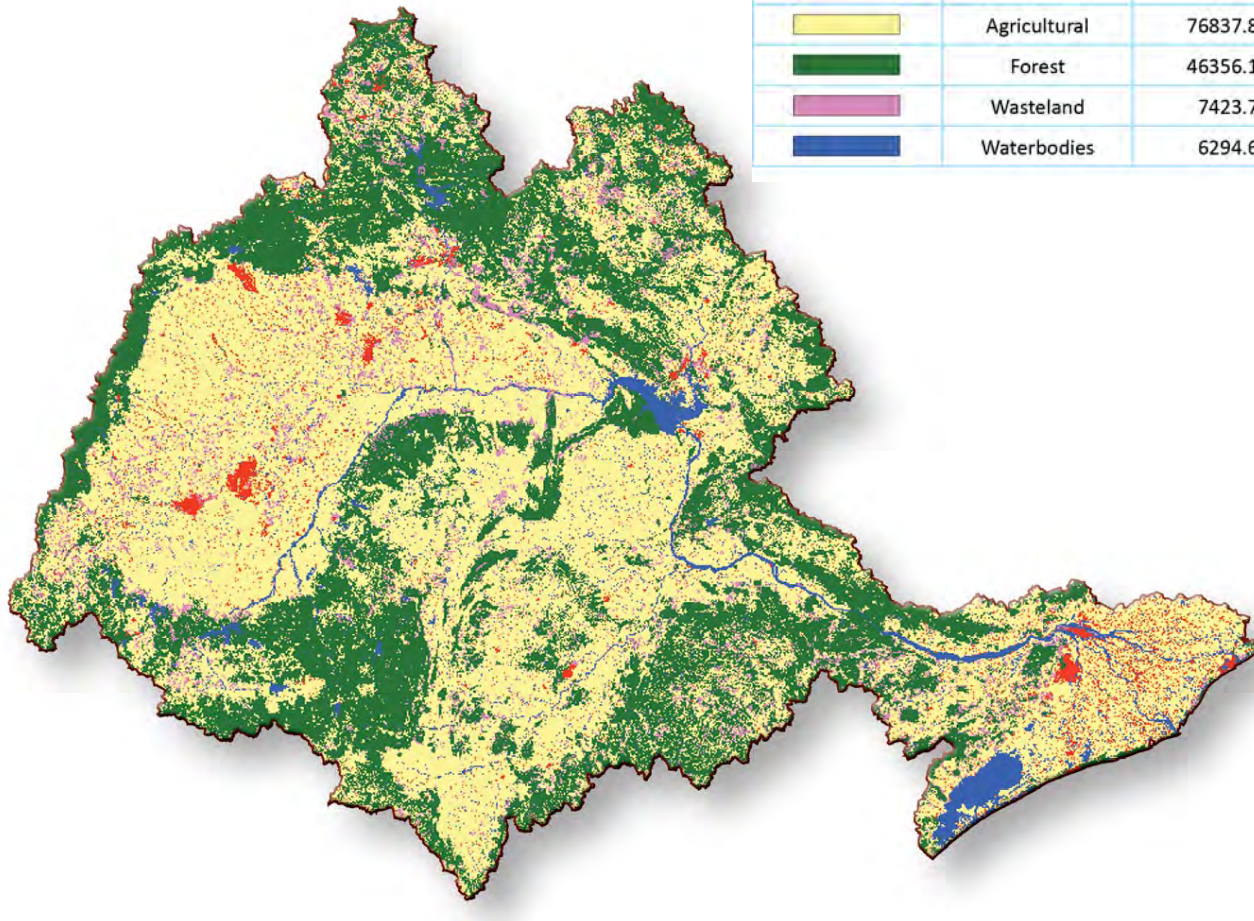


Symbol	Elevation (m)	Area (Sq. km)	% of Total Area
	< 5	2834.10	2.00
	5-10	2970.44	2.10
	10-50	5131.71	3.62
	50-100	3360.71	2.37
	100-200	14657.03	10.35
	200-300	44912.56	31.73
	300-400	31308.55	22.11
	400-500	14322.56	10.12
	500-750	18353.10	12.96
	750-1000	3403.39	2.40
	1000-1500	334.84	0.24

Average Annual Rainfall (1971-2005)

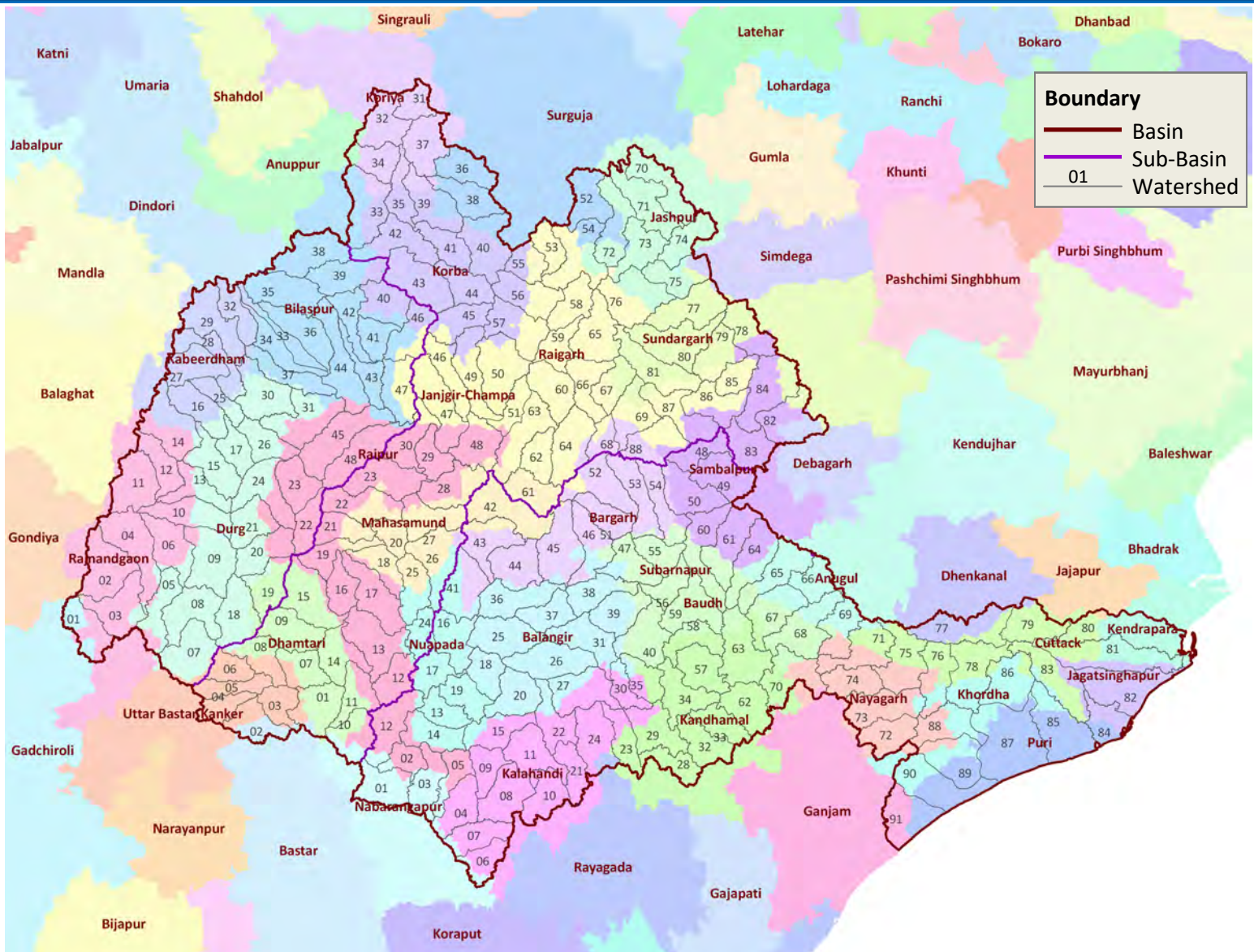


Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	1000-1200	42542.58	30.05
	1200-1400	73592.87	51.97
	1400-1600	25453.55	17.98

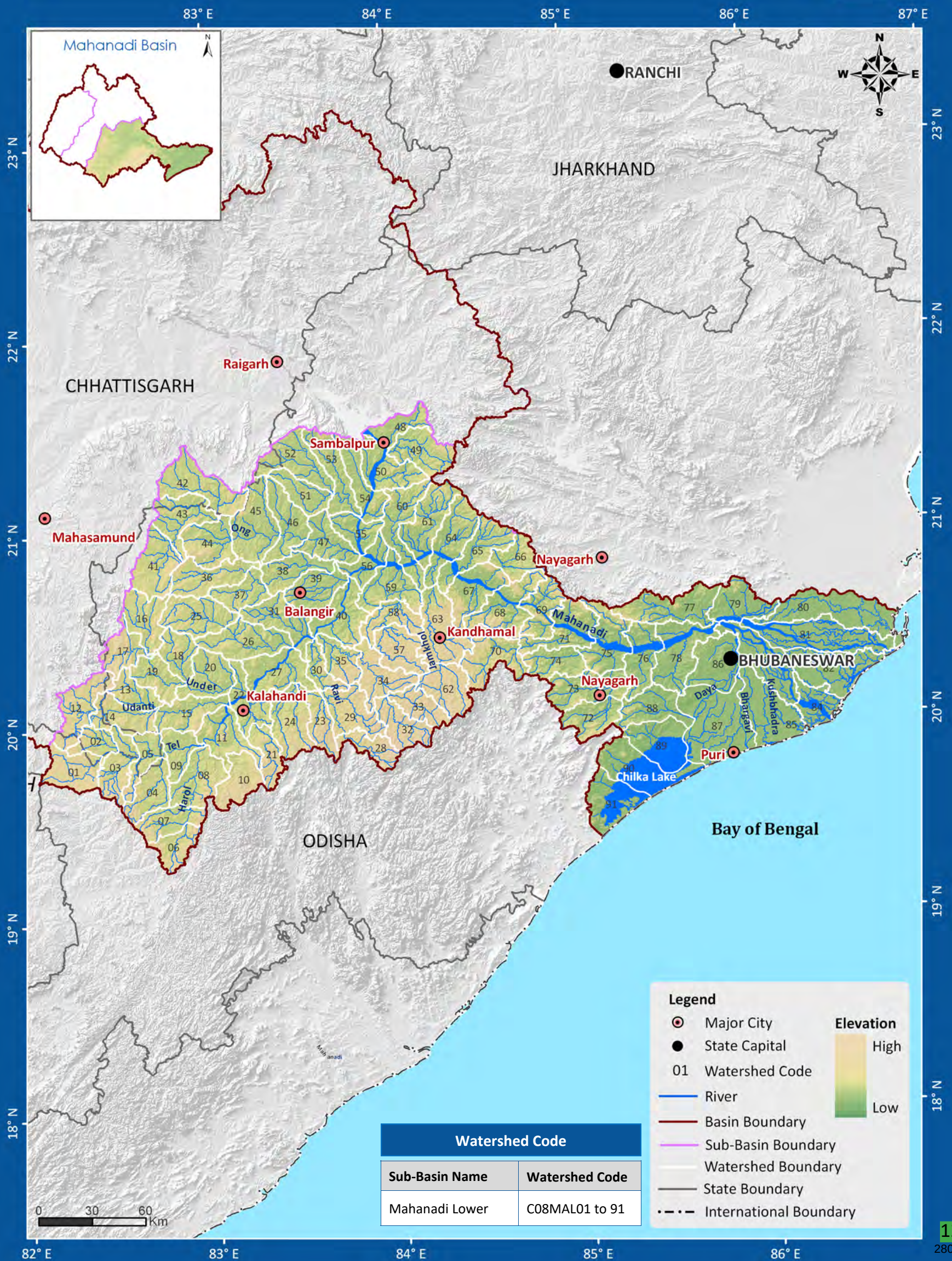


Symbol	Category	Area (Sq. km)	% of Total Area
■	Built Up Land	4676.64	3.30
■	Agricultural	76837.89	54.27
■	Forest	46356.11	32.74
■	Wasteland	7423.76	5.24
■	Waterbodies	6294.60	4.45

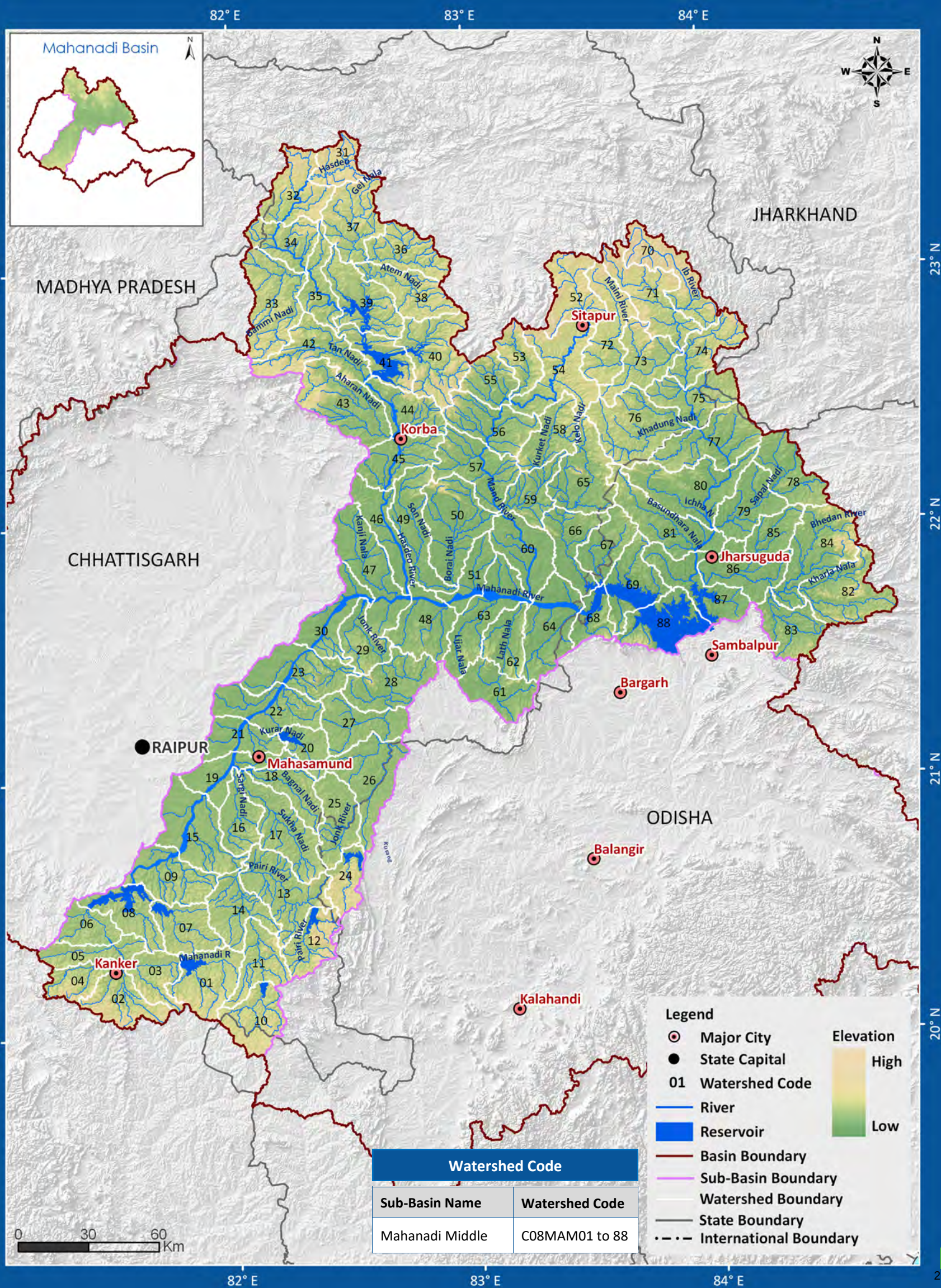
Districts



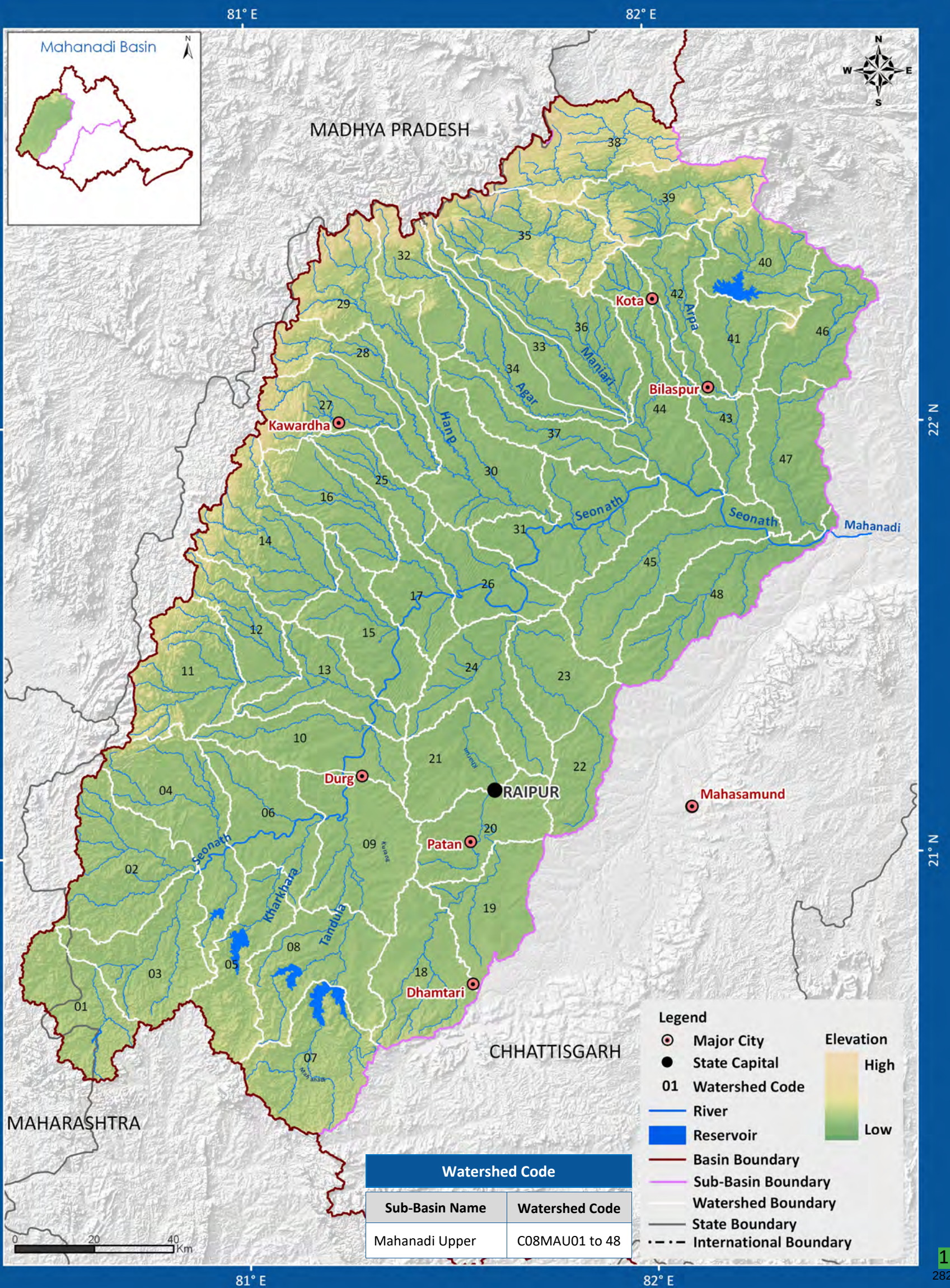
1. Mahanadi Lower Sub-Basin



2. Mahanadi Middle Sub-Basin

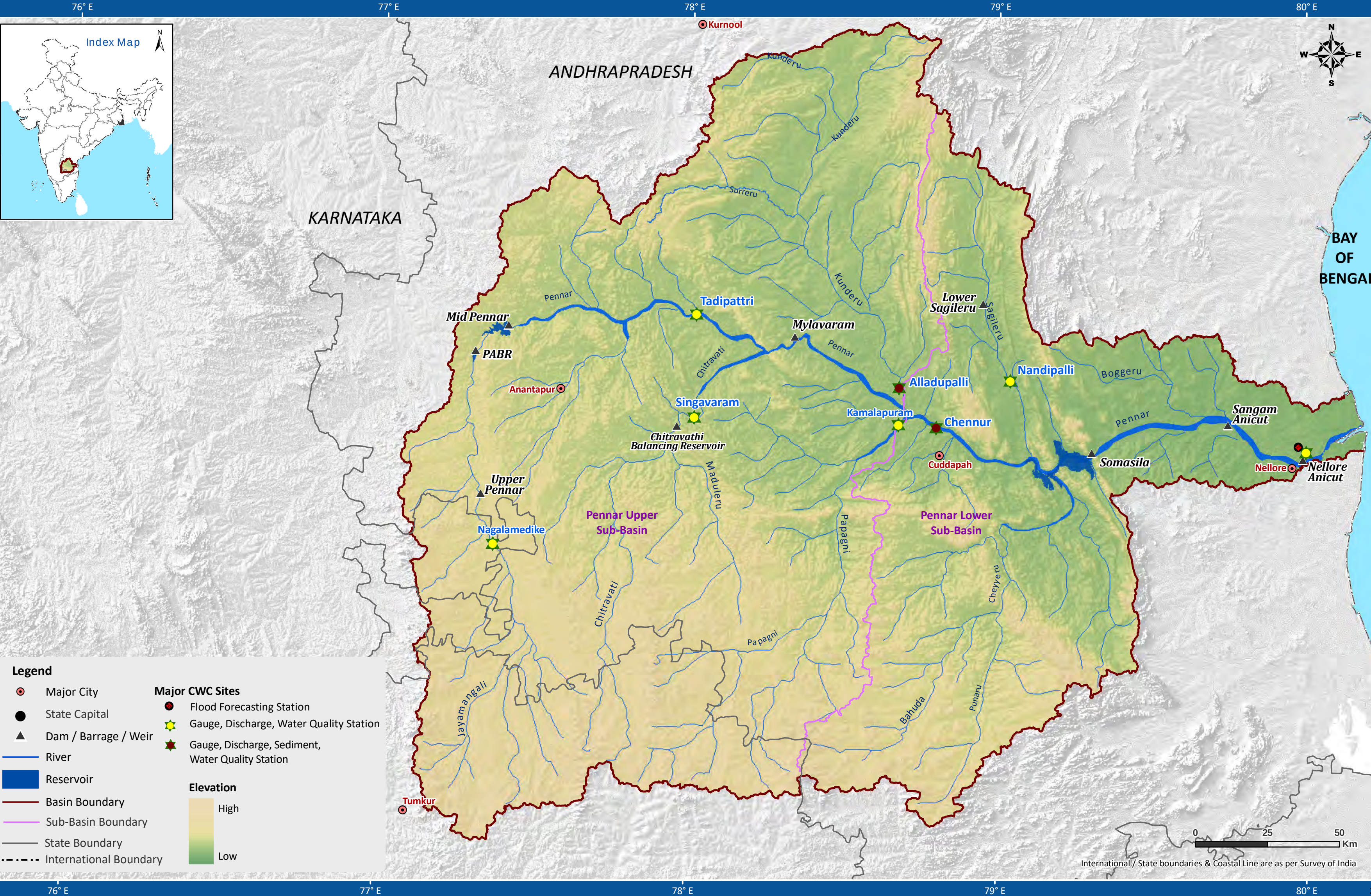


3. Mahanadi Upper Sub-Basin



5.11 PENNAR BASIN

480



Located in peninsular India, the Pennar basin extends over states of Andhra Pradesh and Karnataka having an area of 55,213 Sq.km with maximum length and width of 433 km and 266 km. The basin lies between 77° 1' to 80° 10' east longitudes and 13° 18' to 15° 49' north latitudes. The fan shaped basin is bounded by the Erramala range on the north, by the Nallamala and Velikonda ranges of the Eastern Ghats on the east, by the Nandidurg hills on the south and by the narrow ridge separating it from the Vedavati valley of the Krishna Basin on the west. The other hill ranges in the basin to the south of the river are the Seshachalam and Paliconda ranges.

The Pennar (also known as Uttara Pinakini) is one of the major rivers of the peninsula. The Pennar rises in the Chenna Kasava hill of the Nandidurg range, in Chikkaballapura district of Karnataka and flows towards east eventually draining into the Bay of Bengal. The total length of the river from origin to its outfall in the Bay of Bengal is 597 km. The principal tributaries of the river joining from left are the Jayamangali, the Kunderu and the Sagileru whereas the Chiravati, the Papagni and the Cheyyeru joins it from right. The major part of basin is covered with agriculture accounting to 58.64% of the total area and only 4.97% of the basin is covered by water bodies.

Salient Features of Pennar Basin

Basin Extent	Longitude	77° 1' to 80° 10' E
	Latitude	13° 18' to 15° 49' N
Length of Pennar River (Km)		597
Catchment Area (Sq.km.)		55213
Average Water Resource Potential		6320
Utilizable Surface Water Resource		6900
Live Storage Capacity of Completed Projects (MCM)		2649.40
Live Storage Capacity of Projects Under Construction (MCM)		2170.71
Total Live Storage Capacity of Projects		4820.11
No. of Hydrological Observation Sta-		8
No. of Flood Forecasting Stations		1

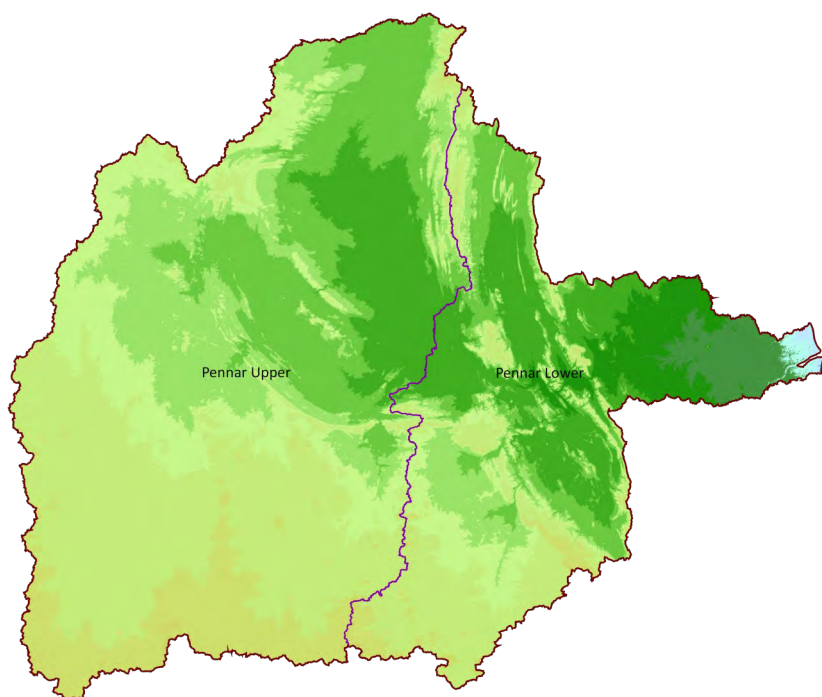
Major Water Resource Assets

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Pennar Lower	17979.85	19	2	8	3065	3
2	Pennar Upper	36263.58	39	1	21	5856	5

Watershed Statistics

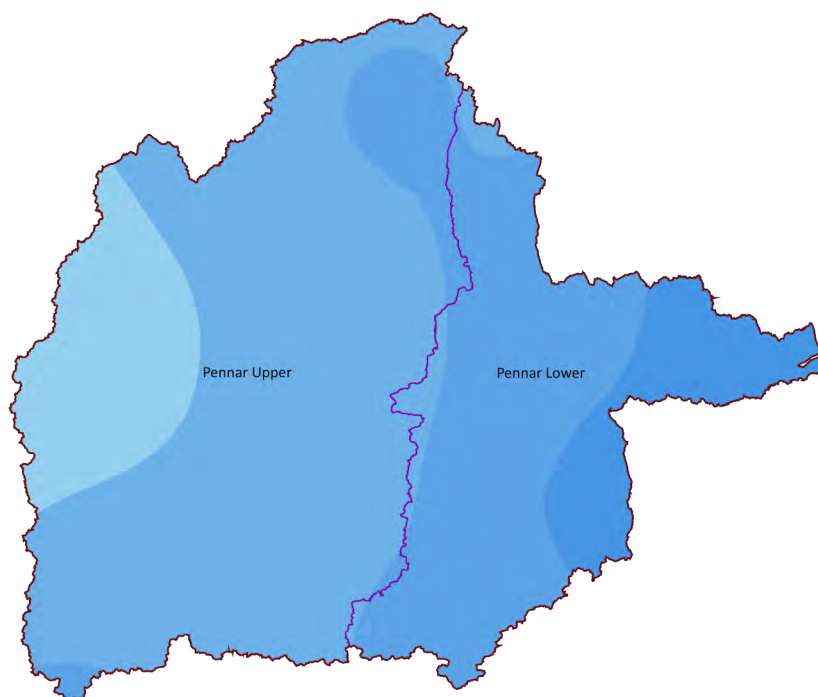
Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Pennar Lower	29	357.62	850.70	619.99
2	Pennar Upper	61	310.23	926.97	594.48

Elevation Zone



Symbol	Elevation (m)	Area (Sq. km)	% of Total Area
	< 5	88.90	0.16
	5-10	155.75	0.28
	10-50	1249.81	2.26
	50-100	1798.92	3.26
	100-200	7682.56	13.91
	200-300	9128.45	16.53
	300-400	8302.98	15.04
	400-500	7530.27	13.64
	500-750	14740.46	26.70
	750-1000	4381.96	7.94
	1000-1500	152.94	0.28

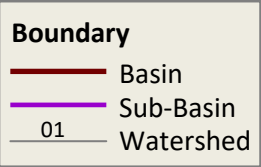
Average Annual Rainfall (1971-2005)



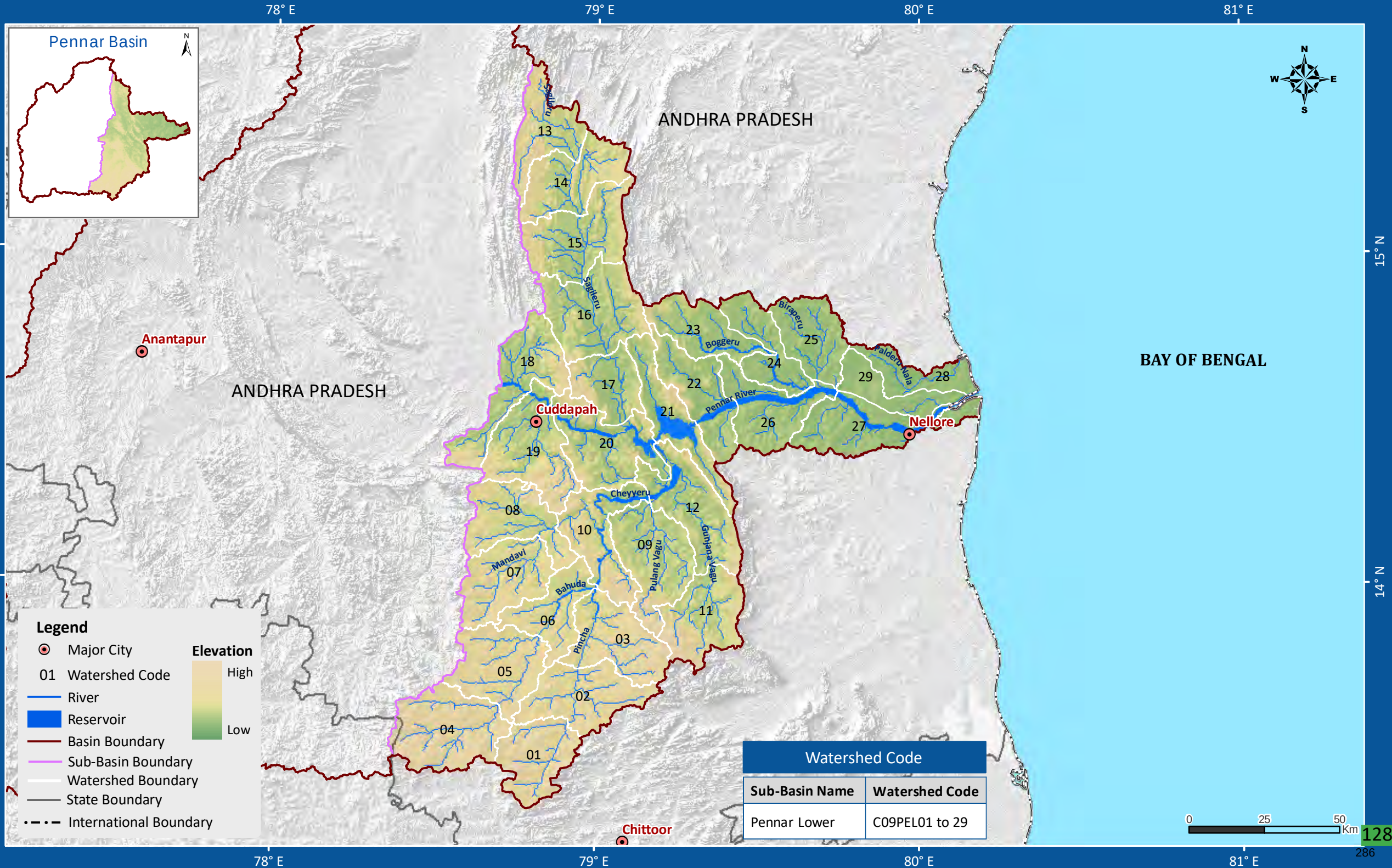
Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	400-600	6806.26	12.33
	600-800	28176.11	51.03
	800-1000	15507.36	28.09
	1000-1200	4723.27	8.55



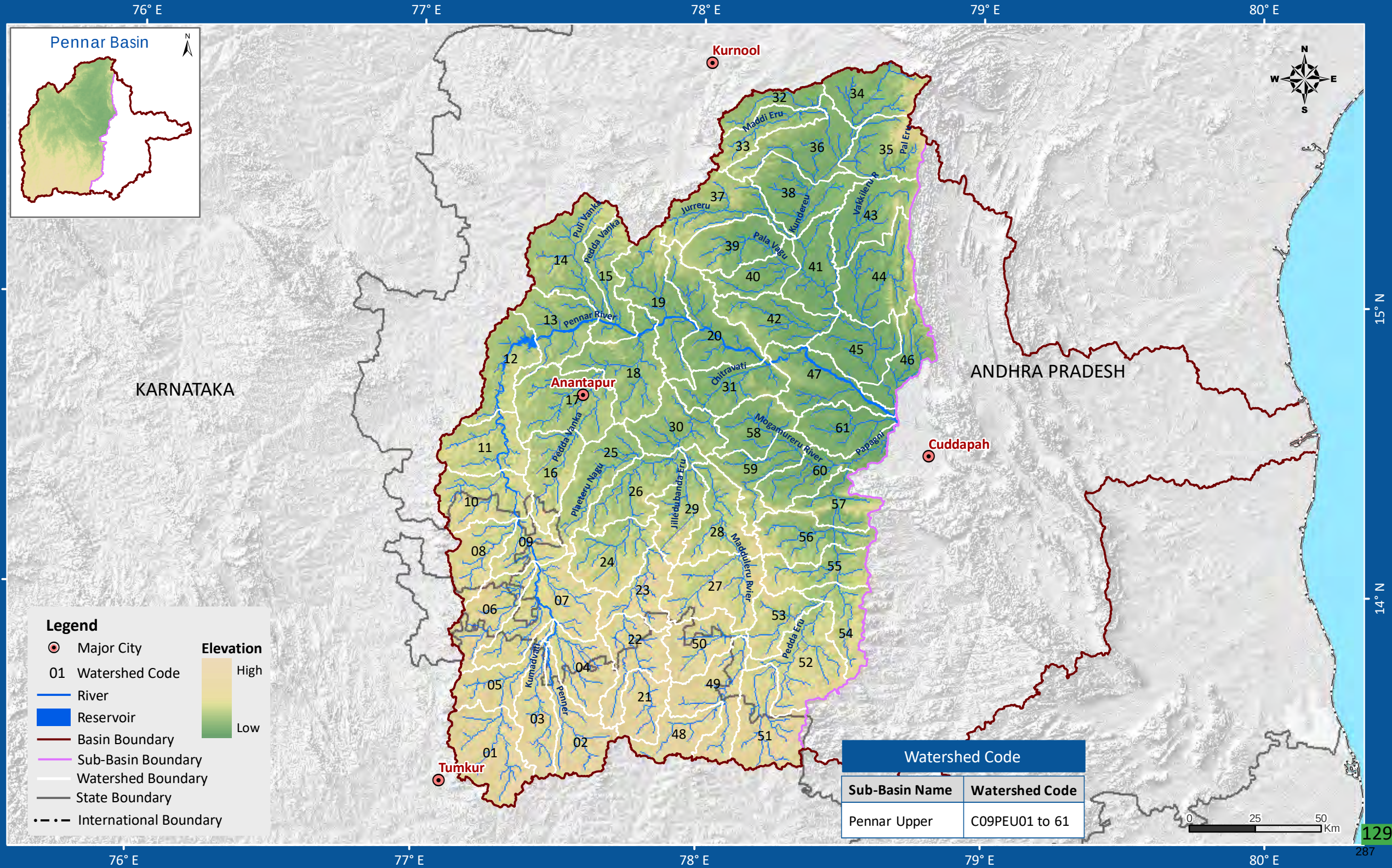
Districts



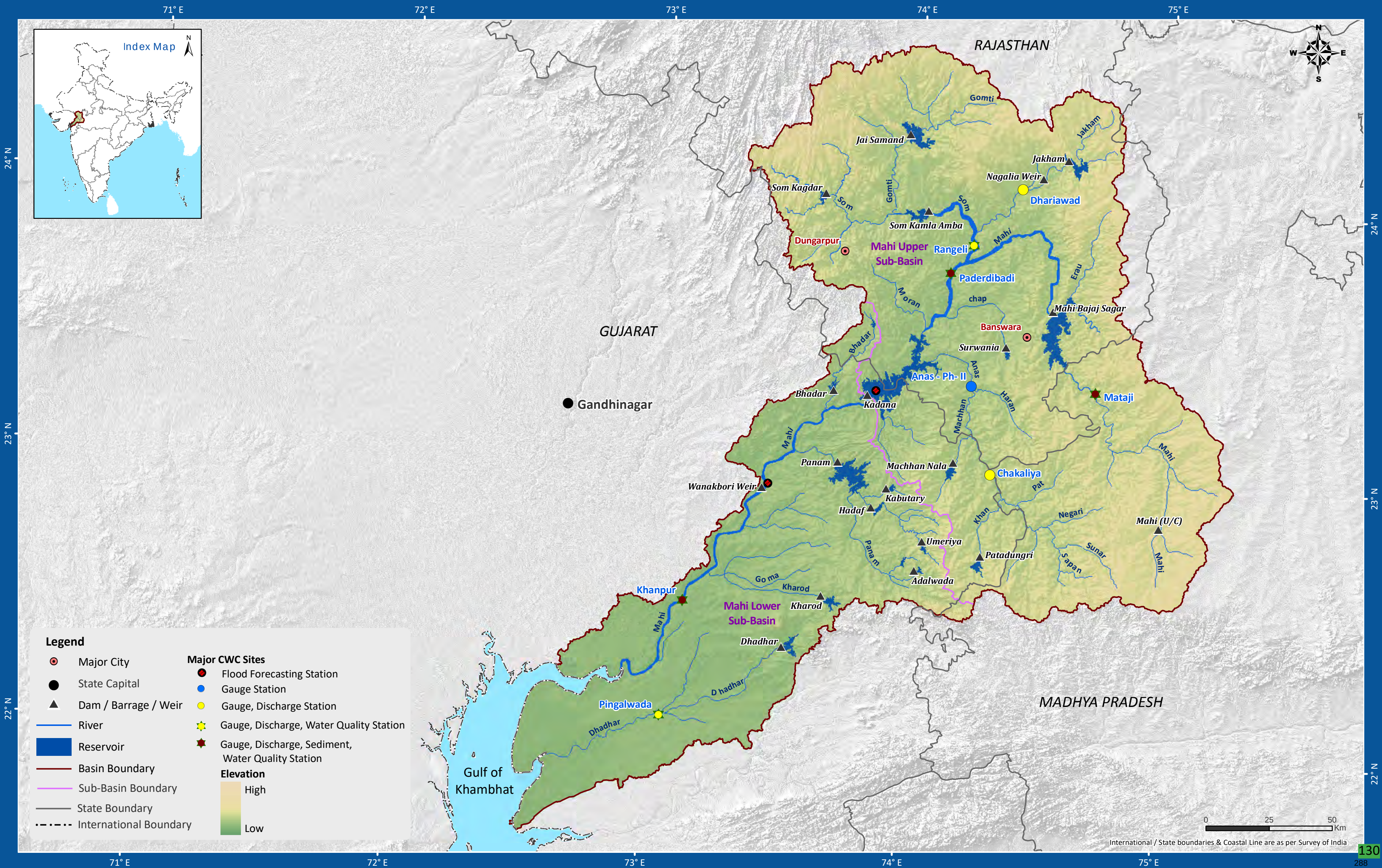
1. Pennar Lower Sub-Basin



2. Pennar Upper Sub-Basin



5.12 MAHI BASIN



The Mahi basin extends overstates of Madhya Pradesh, Rajasthan and Gujarat having total area of 34,842 Sq. km with a maximum length and width of about 330 km and 250 km. It lies between 72°21' to 75°19' east longitudes and 21° 46' to 24° 30' north latitudes. It is bounded by Aravalli hills on the north and the north-west, by Malwa Plateau on the east, by the Vindhyas on the south and by the Gulf of Khambhat on the west. Mahi is one of the major interstate west flowing rivers of India. It originates from the northern slopes of Vindhyas at an altitude of 500 m near village Bhopawar, Sardarpur tehsil in Dhar district of Madhya Pradesh. The total length of Mahi is 583 km. The Som is its principal tributary which joins from right, and the Anas and the Panam joins the river from left. It drains into the Arabian Sea through the Gulf of Khambhat. The major part of basin is covered with agricultural land accounting to 63.63% of the total area and 4.34% of the basin is covered by water bodies.

Salient Features of Mahi Basin

Basin Extent	Longitude Latitude	72° 21' to 75° 19' E 21° 46' to 24° 30' N
Length of Mahi River (Km)		583
Catchment Area (Sq.km.)		34842
Average Water Resource Potential (MCM)		11020
Utilizable Surface Water Resource (MCM)		3100
Live Storage Capacity of Completed Projects (MCM)		4722.6
Live Storage Capacity of Projects Under Construction (MCM)		261.43
Total Live Storage Capacity of Projects (MCM)		4984.03
No. of Hydrological Observation Stations		14
No. of Flood Forecasting Stations		2

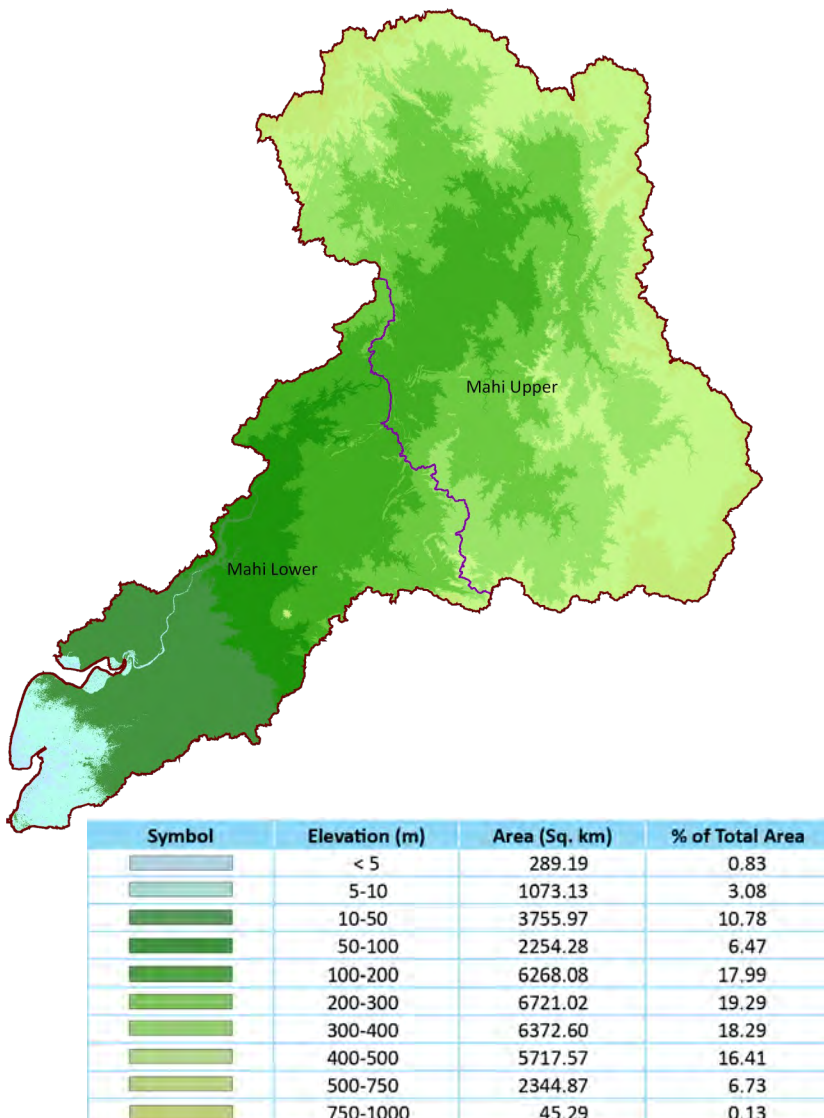
Major Water Resource Assets

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Mahi Lower	13377.00	47	2	53	1809	6
2	Mahi Upper	24959.80	87	2	160	3467	8

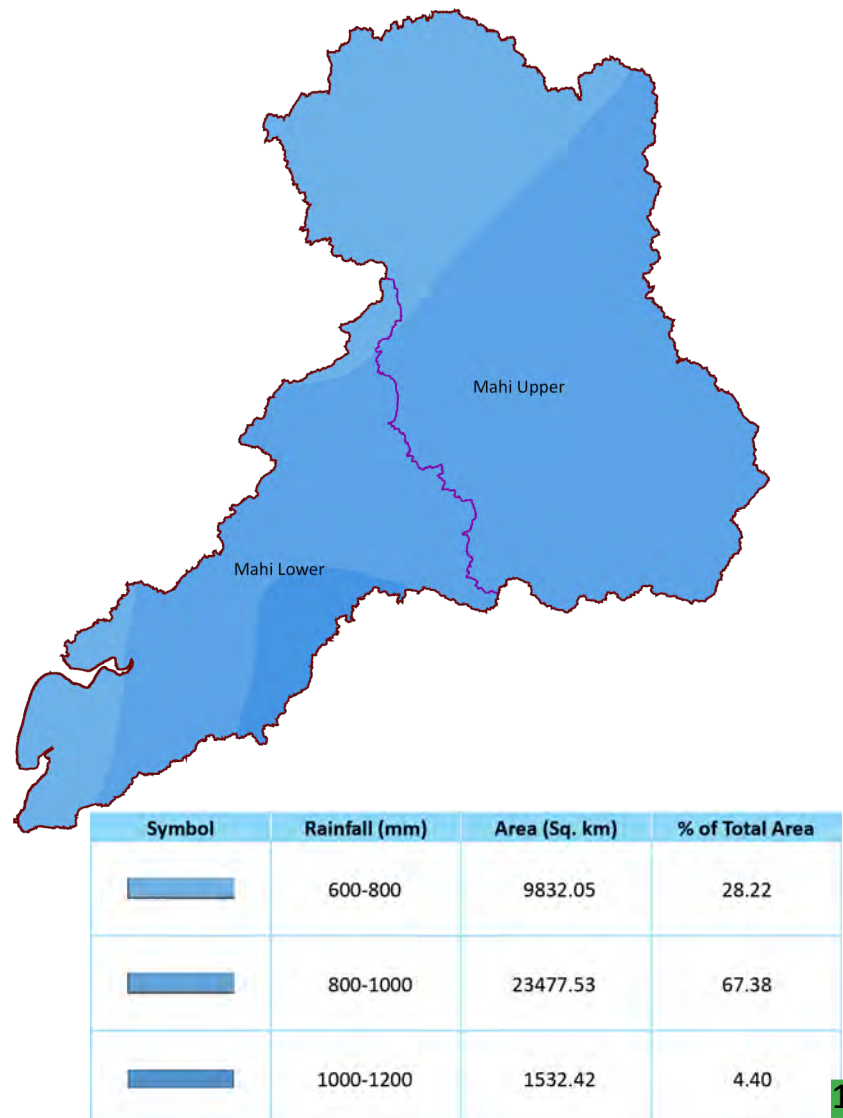
Watershed Statistics

Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Mahi Lower	22	371.05	872.94	608.05
2	Mahi Upper	41	330.18	953.44	608.78

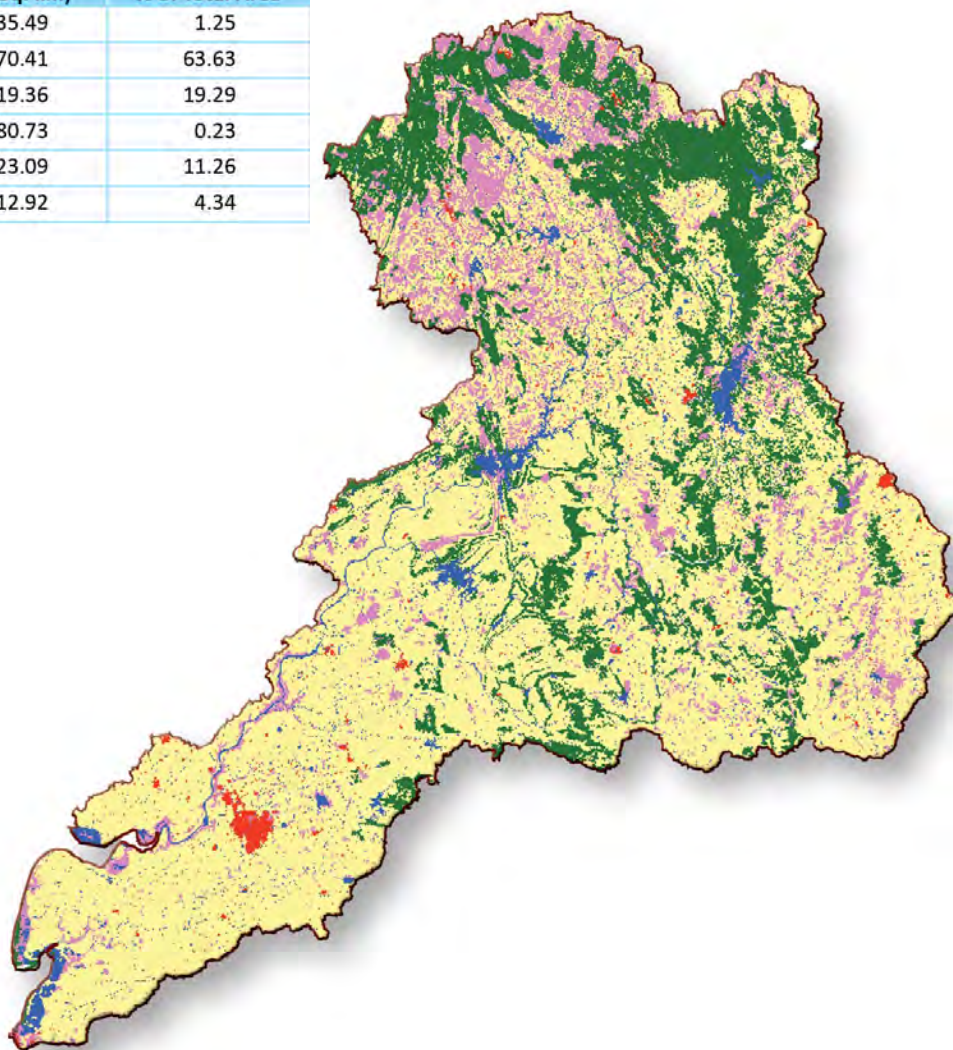
Elevation Zone



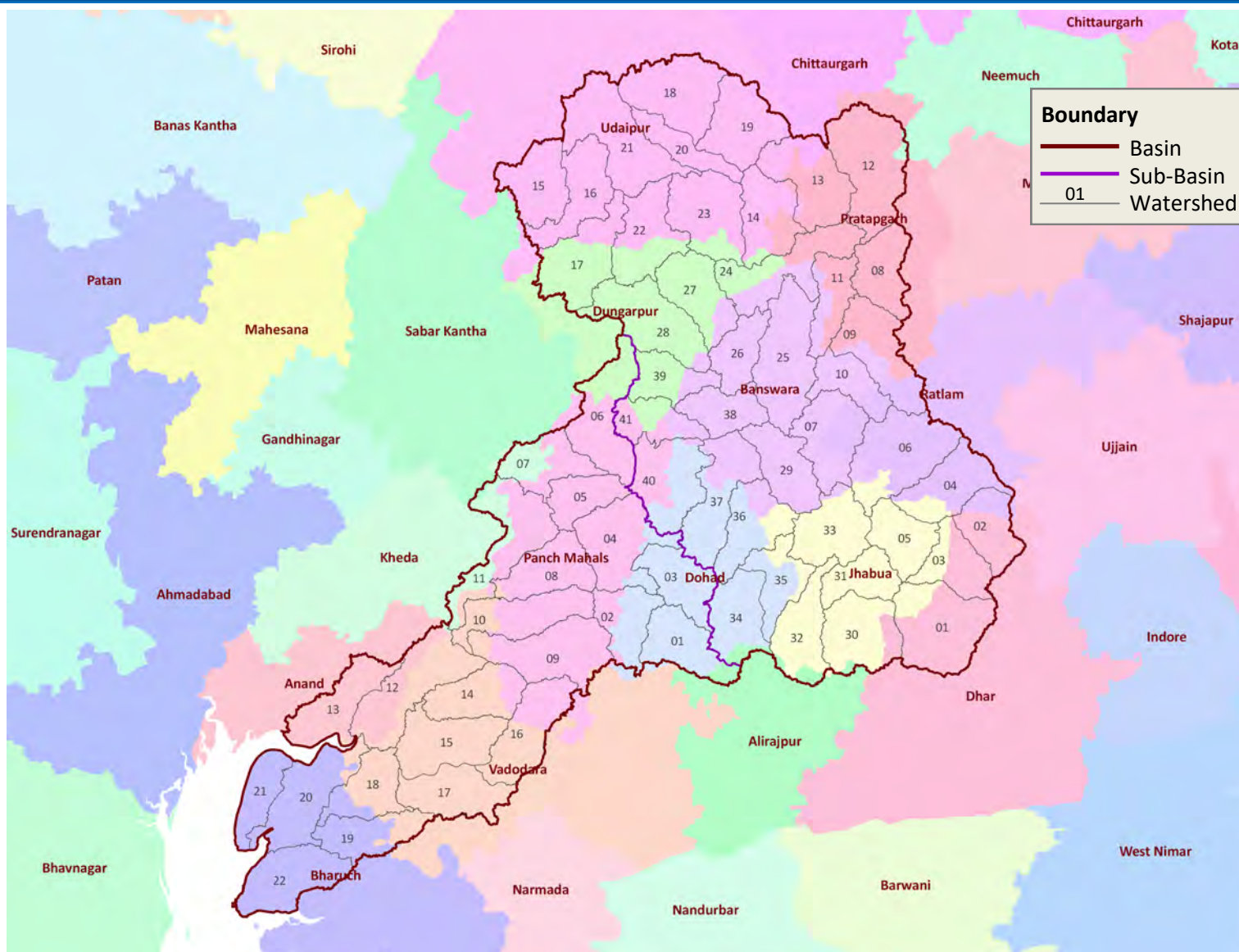
Average Annual Rainfall (1971-2005)



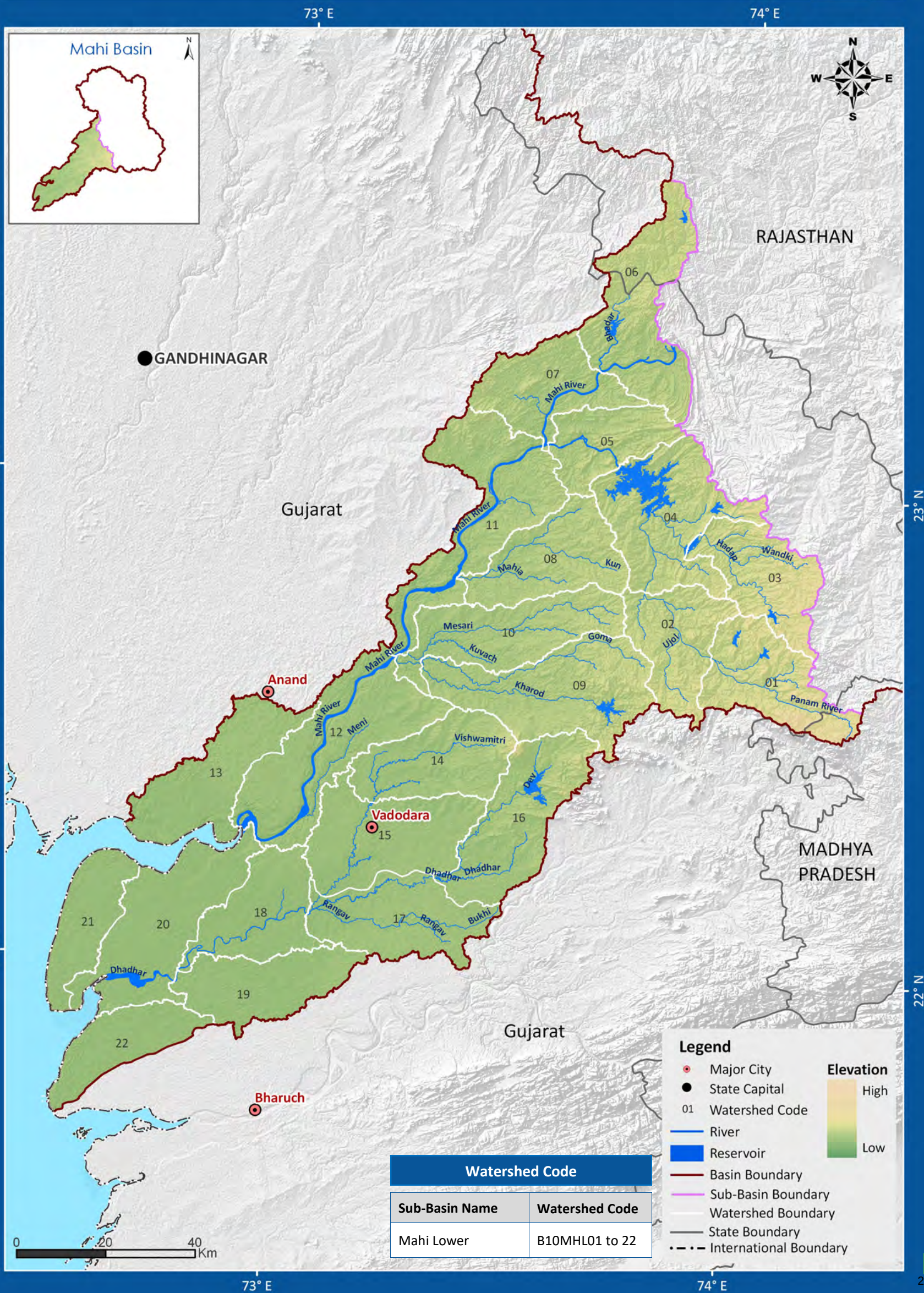
Symbol	Category	Area (Sq. km)	% of Total Area
	Built Up Land	435.49	1.25
	Agricultural	22170.41	63.63
	Forest	6719.36	19.29
	Grassland	80.73	0.23
	Wasteland	3923.09	11.26
	Waterbodies	1512.92	4.34



Districts

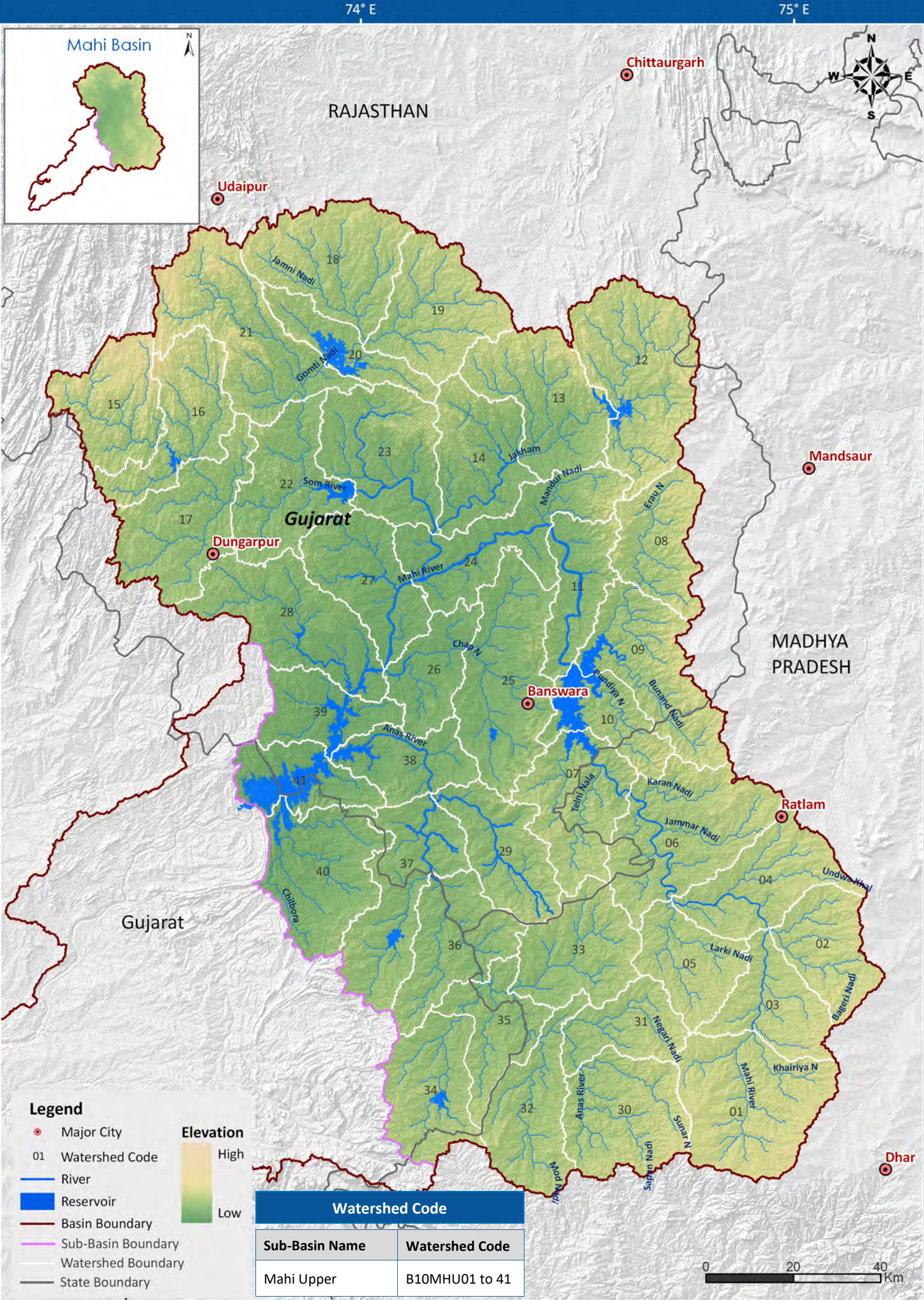


488 1. Mahi Lower Sub-Basin

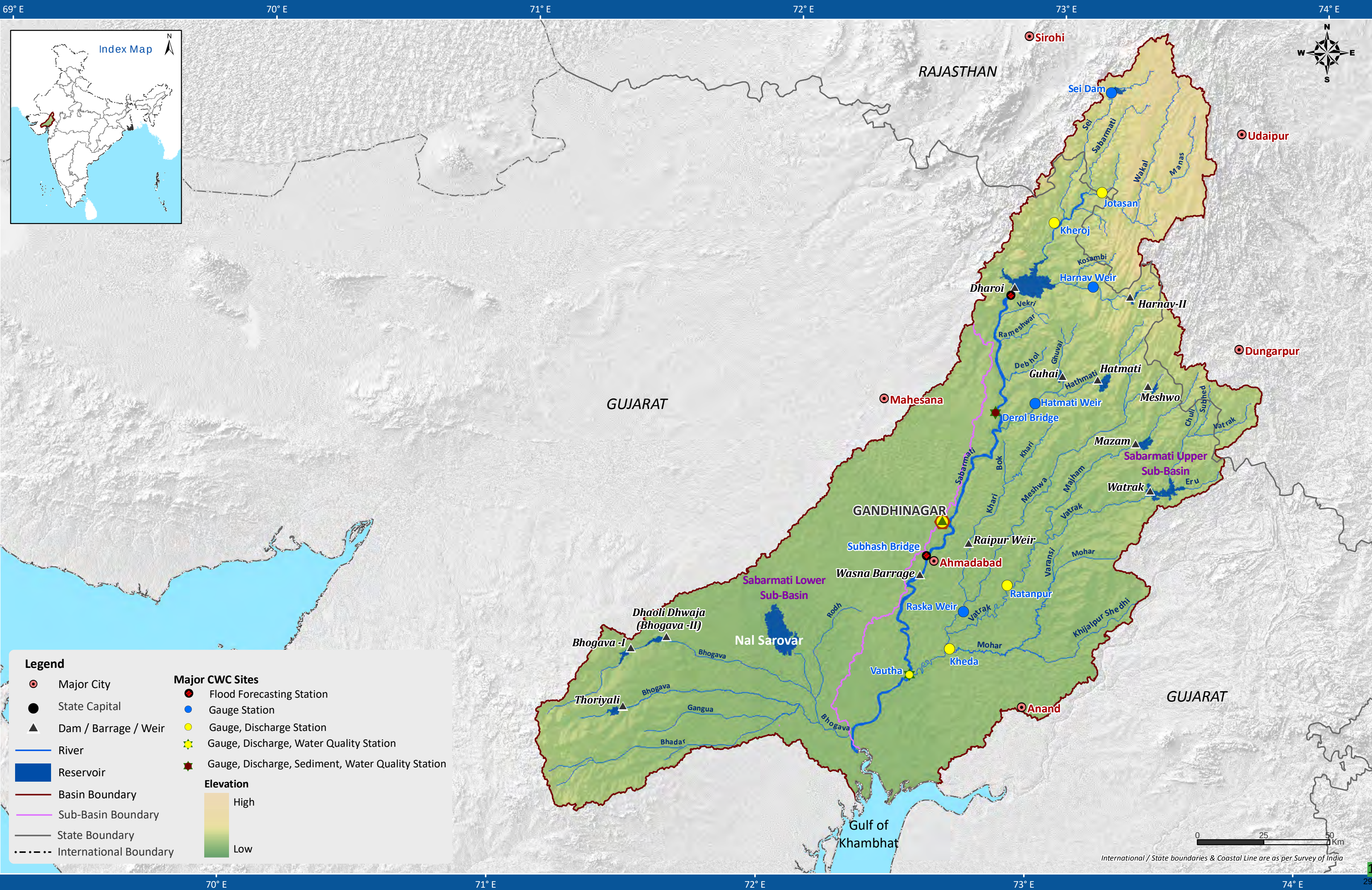


489

2. Mahi Upper Sub-Basin



5.13 SABARMATI BASIN



The Sabarmati basin extends over states of Rajasthan and Gujarat having an area of 21,674 Sq.km with maximum length and width of 300 km and 150 km. It lies between 70° 58' to 73° 51' east longitudes and 22° 15' to 24° 47' north latitudes. The basin is bounded by Aravalli hills on the north and north-east, by Rann of Kutch on the west and by Gulf of Khambhat on the south. The basin is roughly triangular in shape with the Sabarmati River as the base and the source of the Vatrak River as the apex point. Sabarmati originates from Aravalli hills at an elevation of 762 m near village Tepur, in Udaipur district of Rajasthan. The total length of river from origin to outfall into the Arabian Sea is 371 km and its principal tributaries joining from left are the Wawal, the Hathmati and the Vatrak whereas the Sei joins the river from right. The major part of basin is covered with agriculture accounting to 74.68% of the total area. 4.19% of the total basin area is covered by water bodies.

Salient Features of Sabarmati Basin

Basin Extent	Longitude	70° 58' to 73° 51' E
	Latitude	22° 15' to 24° 47' N
Length of Sabarmati River (Km)		371
Catchment Area (Sq.km.)		21674
Average Water Resource Potential (MCM)		3810
Utilizable Surface Water Resource (MCM)		1900
Live Storage Capacity of Completed Projects (MCM)		1306.77
Live Storage Capacity of Projects Under Construction (MCM)		60.77
Total Live Storage Capacity of Projects (MCM)		1367.54
No. of Hydrological Observation Stations		15
No. of Flood Forecasting Stations		2

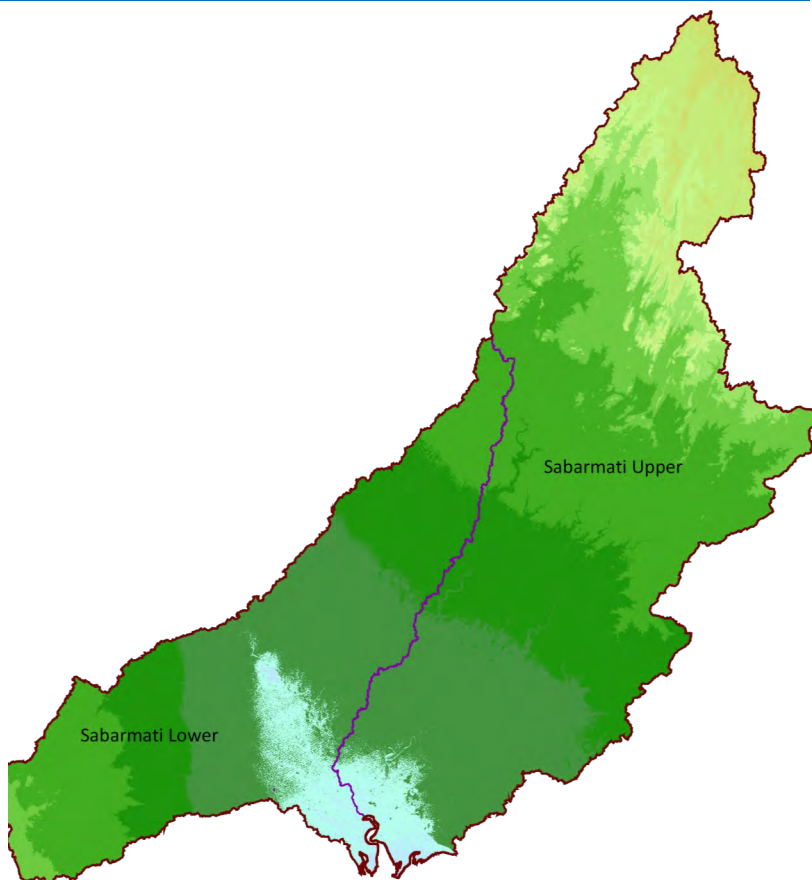
Major Water Resource Assets

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Sabarmati Lower	10865.32	17	0	17	1244	0
2	Sabarmati Upper	19813.27	33	12	44	1991	15

Watershed Statistics

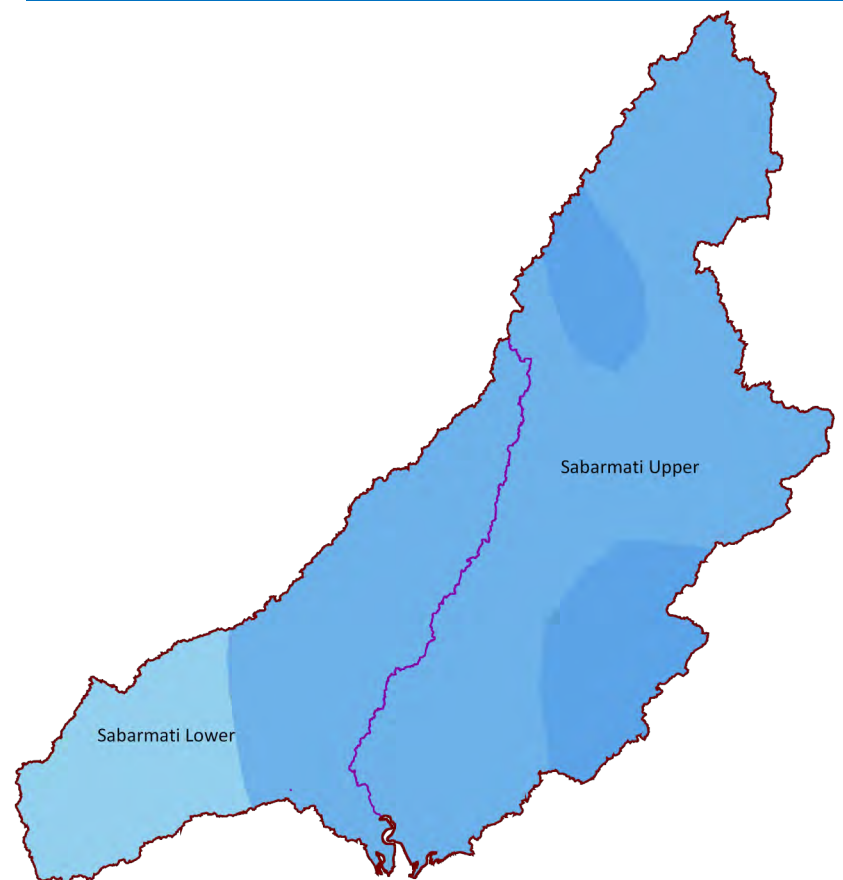
Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Sabarmati Lower	17	397.55	986.46	639.14
2	Sabarmati Upper	34	313.38	828.34	582.74

Elevation Zone



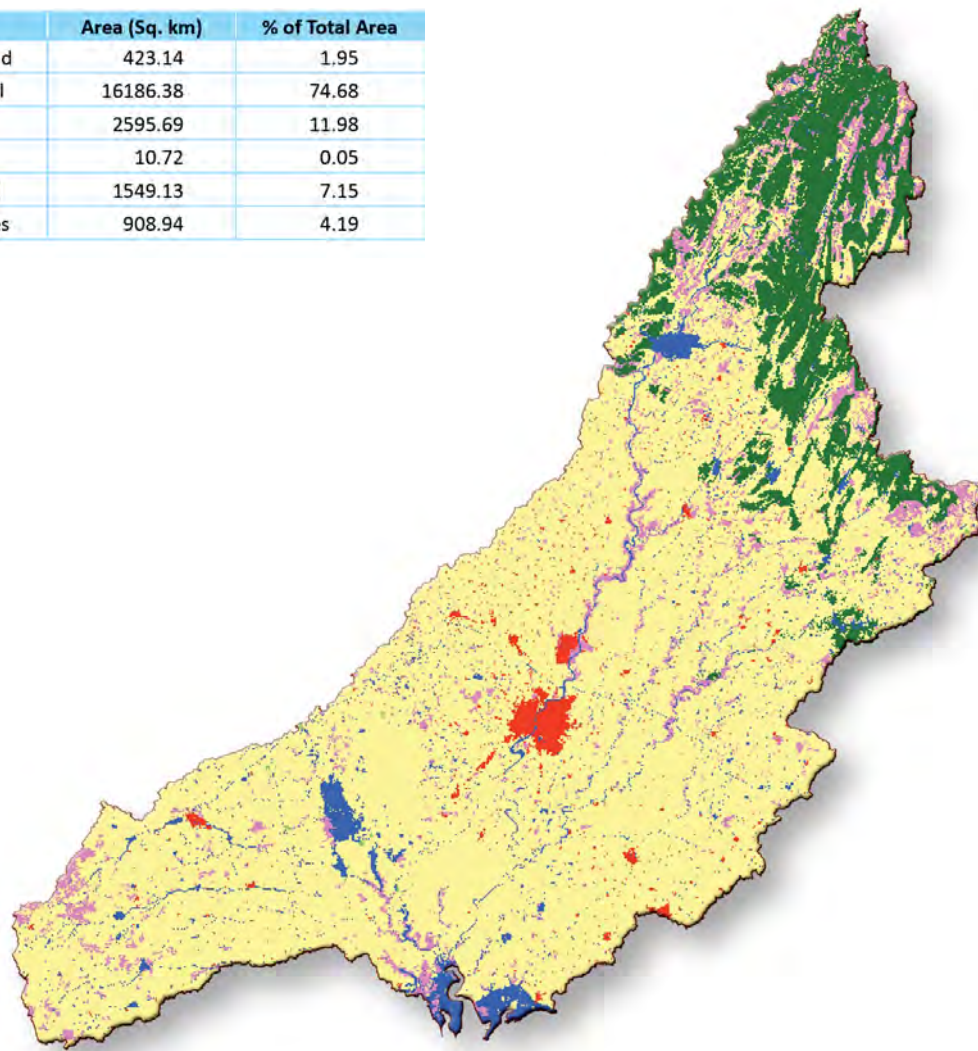
Symbol	Elevation (m)	Area (Sq. km)	% of Total Area
	< 5	184.20	0.85
	5-10	1113.85	5.14
	10-50	5554.80	25.62
	50-100	4303.09	19.85
	100-200	5345.61	24.66
	200-300	2063.20	9.52
	300-400	883.49	4.08
	400-500	612.57	2.83
	500-750	1206.61	5.57
	750-1000	396.40	1.83
	1000-1500	10.18	0.05

Average Annual Rainfall (1971-2005)

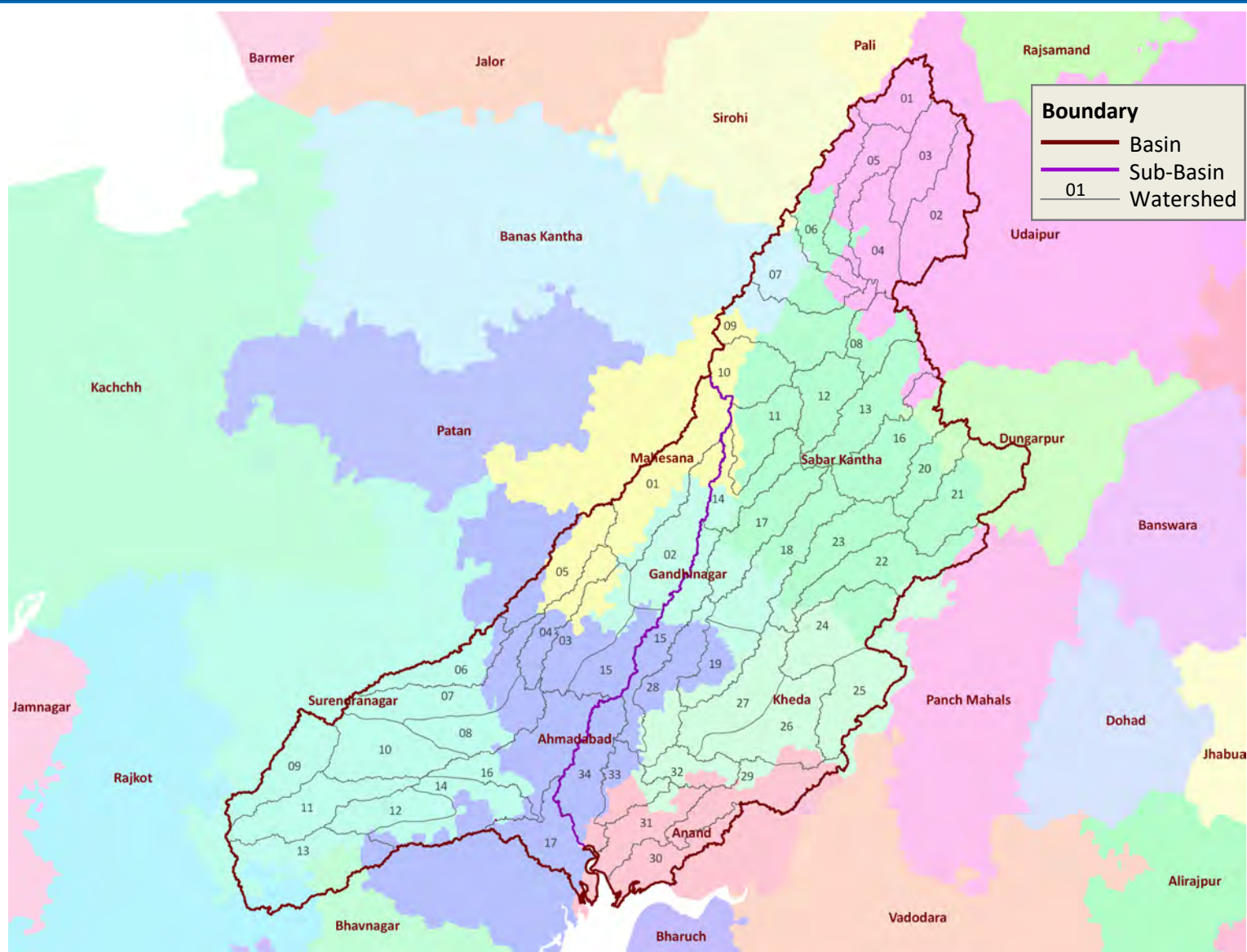


Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	400-600	2856.65	13.18
	600-800	15732.67	72.59
	800-1000	3084.68	14.23

Symbol	Category	Area (Sq. km)	% of Total Area
	Built Up Land	423.14	1.95
	Agricultural	16186.38	74.68
	Forest	2595.69	11.98
	Grassland	10.72	0.05
	Wasteland	1549.13	7.15
	Waterbodies	908.94	4.19

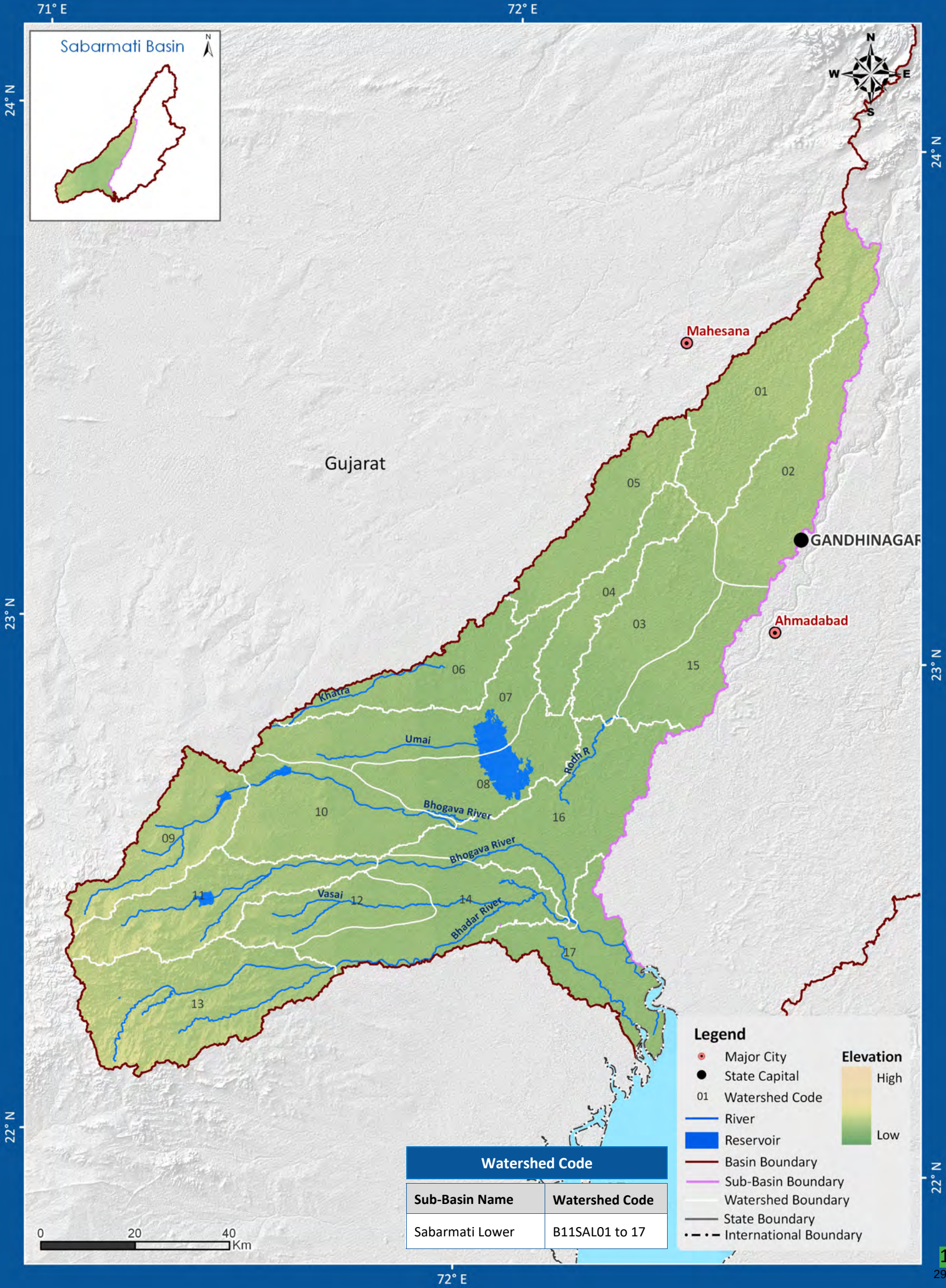


Districts

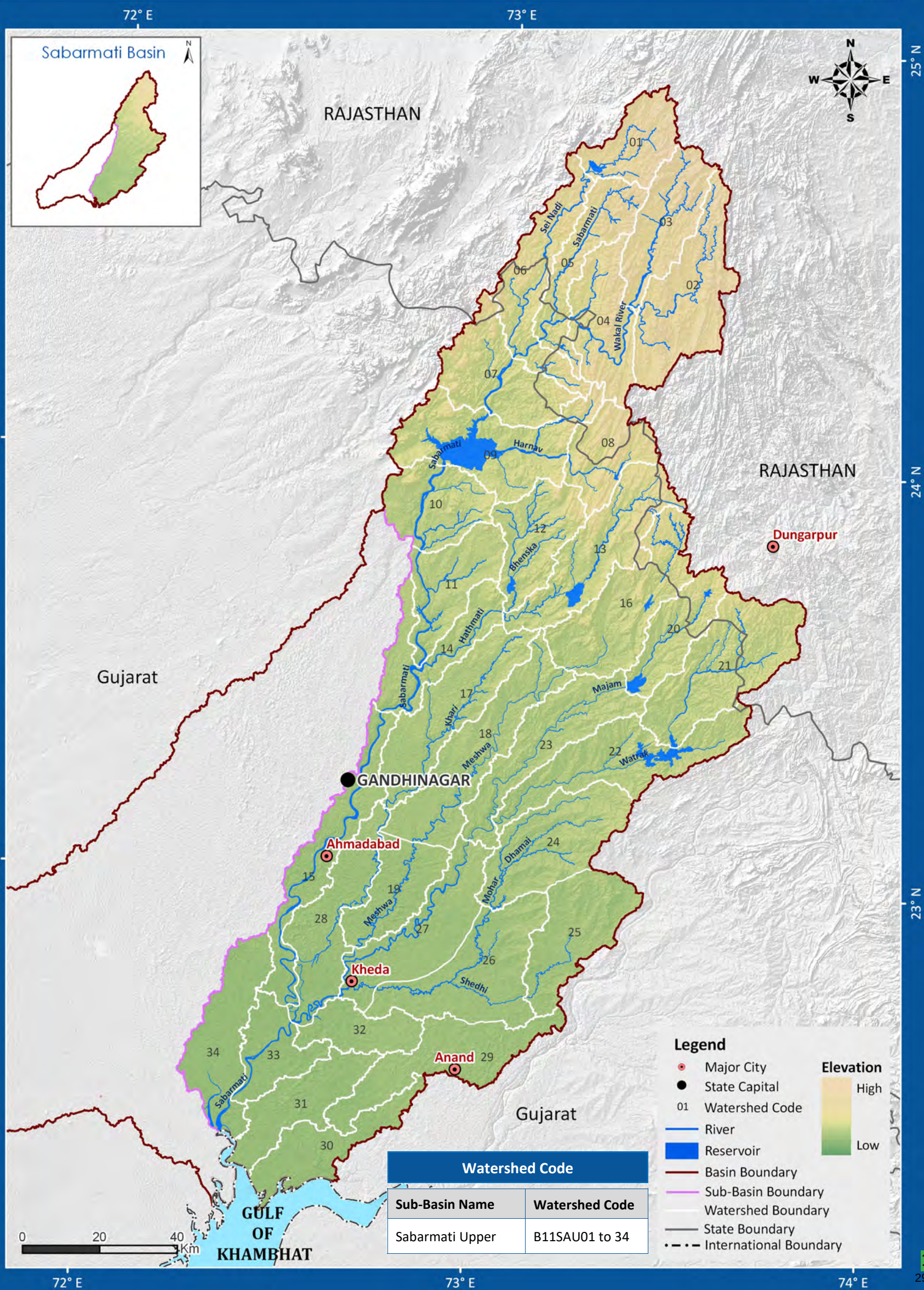


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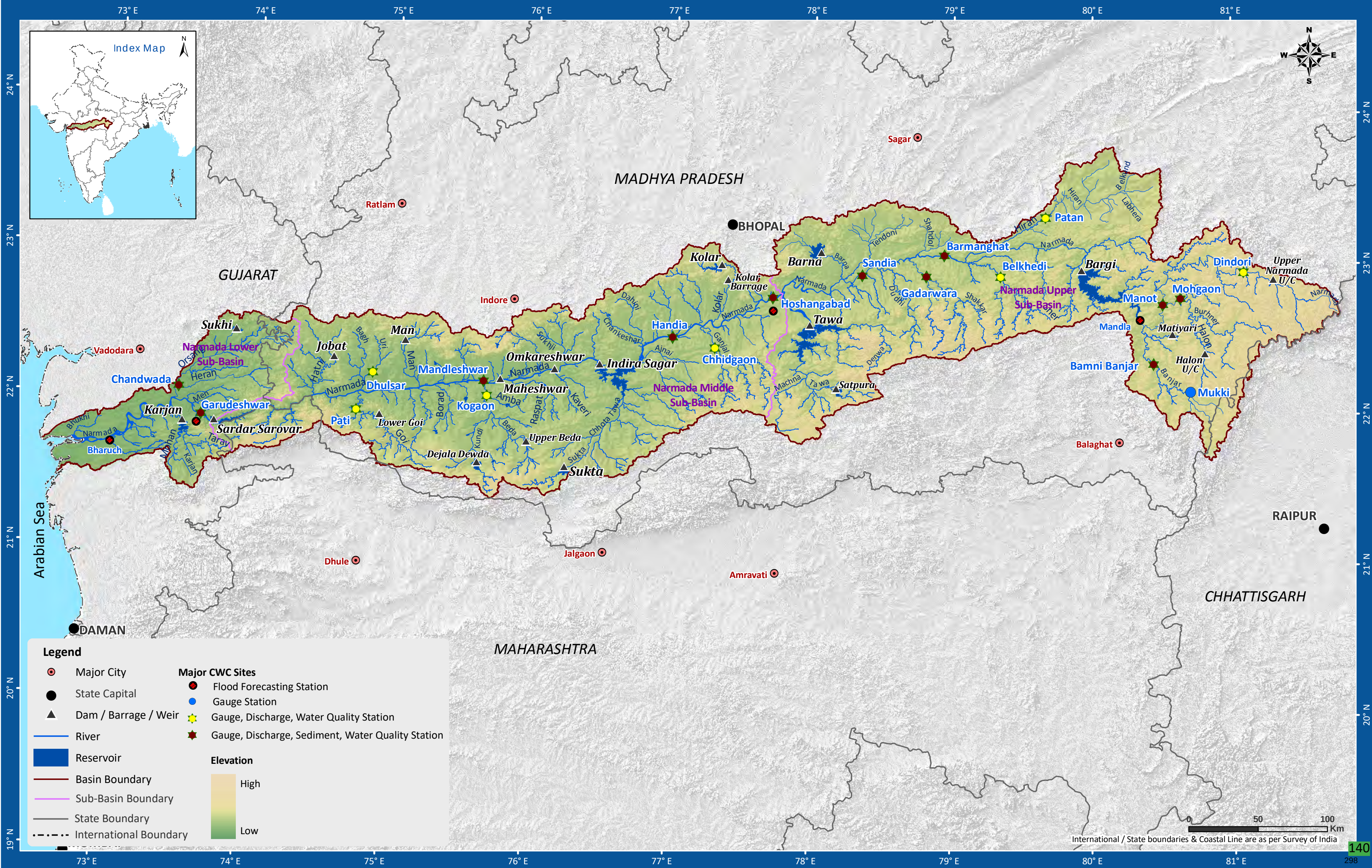
1. Sabarmati Lower Sub-Basin



494 2. Sabarmati Upper Sub-Basin



5.14 NARMADA BASIN



Narmada basin extends over states of Madhya Pradesh, Gujarat, Maharashtra and Chhattisgarh having an area of 98,796 Sq.km which is nearly 3% of the total geographical area of the country with maximum length and width of 923 & 161 km. It lies between 72° 38' to 81° 43' east longitudes and 21° 27' to 23° 37' north latitudes. It is bounded by the Vindhyas on the north, by the Maikala range on the east, by the Satpuras on the south and by the Arabian Sea on the west. The hilly regions are in the upper part of the basin, and lower middle reaches are broad and fertile areas well suited for cultivation.

Narmada is the largest west flowing river of the peninsular India. It rises from Maikala range near Amarkantak in Anuppur district of Madhya Pradesh, at an elevation of about 900 m. The total length of the river is 1,312 km and its important tributaries are the Burhner, the Banjar, the Sher, the Shakkar, the Dudhi, the Tawa, the Ganjal, the Kundi, the Goi and the Karjan which joins from left whereas the Hiran, the Tendonji, the Barna, the Kolar, the Man, the Uri, the Hatni and the Orsang joins from right. Narmada drains into the Arabian Sea through the Gulf of Khambhat. The major part of basin is covered with agriculture accounting to 56.90%. Water bodies cover 2.95% of the total basin area.

The Narmada water Disputes Tribunal has allocated the Narmada water amongst the States as below:

Madhya Pradesh 18.25 Million Acre Feet, Gujarat 9.0 Million Acre Feet, Rajasthan 0.5 Million Acre Feet, Maharashtra 0.25 Million Acre Feet, Total 28.0 Million Acre Feet .

Salient Features of Narmada Basin

Basin Extent	Longitude Latitude	72° 38' to 81° 43' E 21° 27' to 23° 37' N
Length of Narmada River (Km)		1312
Catchment Area (Sq.km.)		98796
Average Water Resource Potential		45639
Utilizable Surface Water Resource		34500
Live Storage Capacity of Completed Projects (MCM)		16979.50
Live Storage Capacity of Projects Under Construction (MCM)		6625.10
Total Live Storage Capacity of Projects		23604.60
No. of Hydrological Observation Stations		31
No. of Flood Forecasting Stations		4

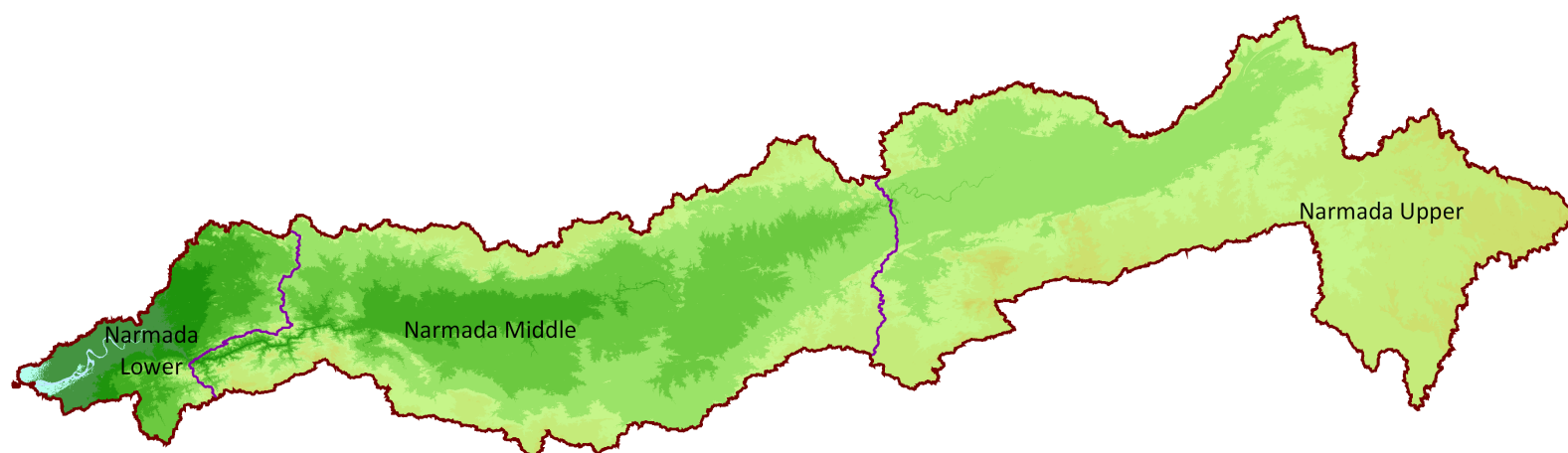
Major Water Resource Assets

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Narmada Lower	8904.02	22	1	24	440	5
2	Narmada Middle	40575.72	134	1	128	4351	10
3	Narmada Upper	43192.68	121	2	120	9191	16

Watershed Statistics

Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Narmada Lower	16	307.94	750.24	556.50
2	Narmada Middle	63	338.11	957.42	644.06
3	Narmada Upper	71	327.06	986.00	608.35

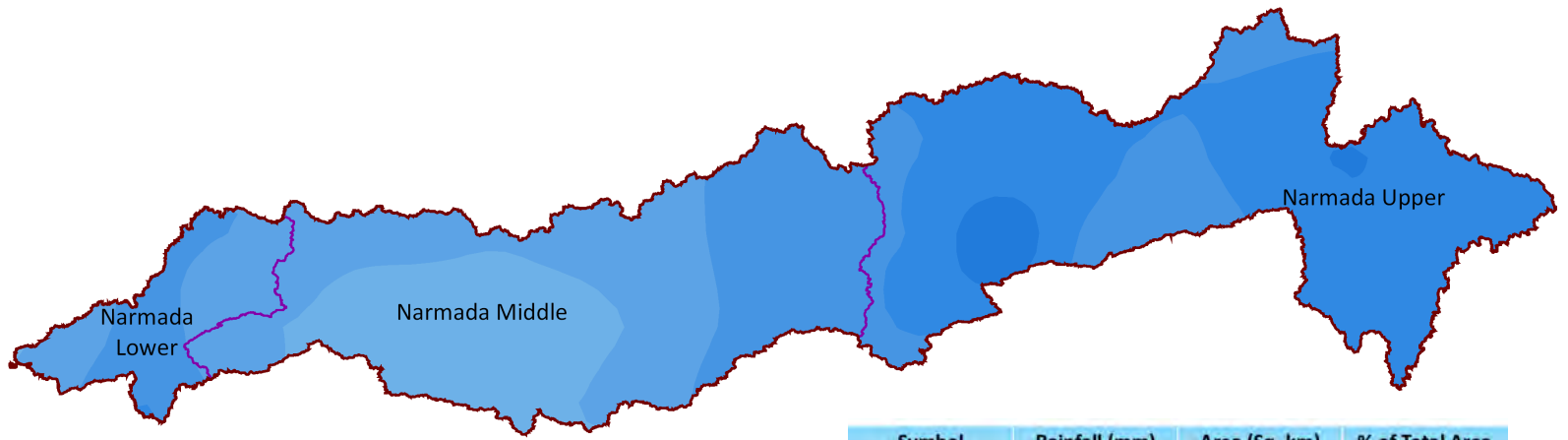
Elevation Zone



Symbol	Elevation (m)	Area (Sq. km)	% of Total Area
	< 5	102.28	0.10
	5-10	275.65	0.28
	10-50	2157.65	2.18
	50-100	1641.89	1.66
	100-200	6277.07	6.35
	200-300	16606.80	16.81
	300-400	27421.75	27.76
	400-500	15595.16	15.79
	500-750	22850.90	23.13
	750-1000	5499.81	5.57
	1000-1500	367.04	0.37

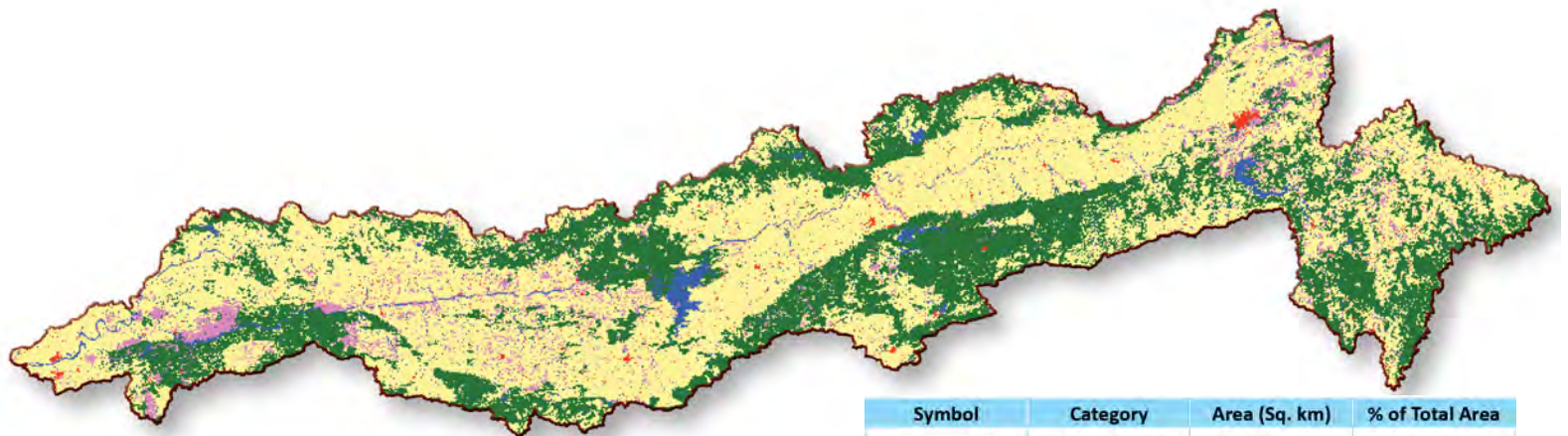
497

Average Annual Rainfall (1971-2005)



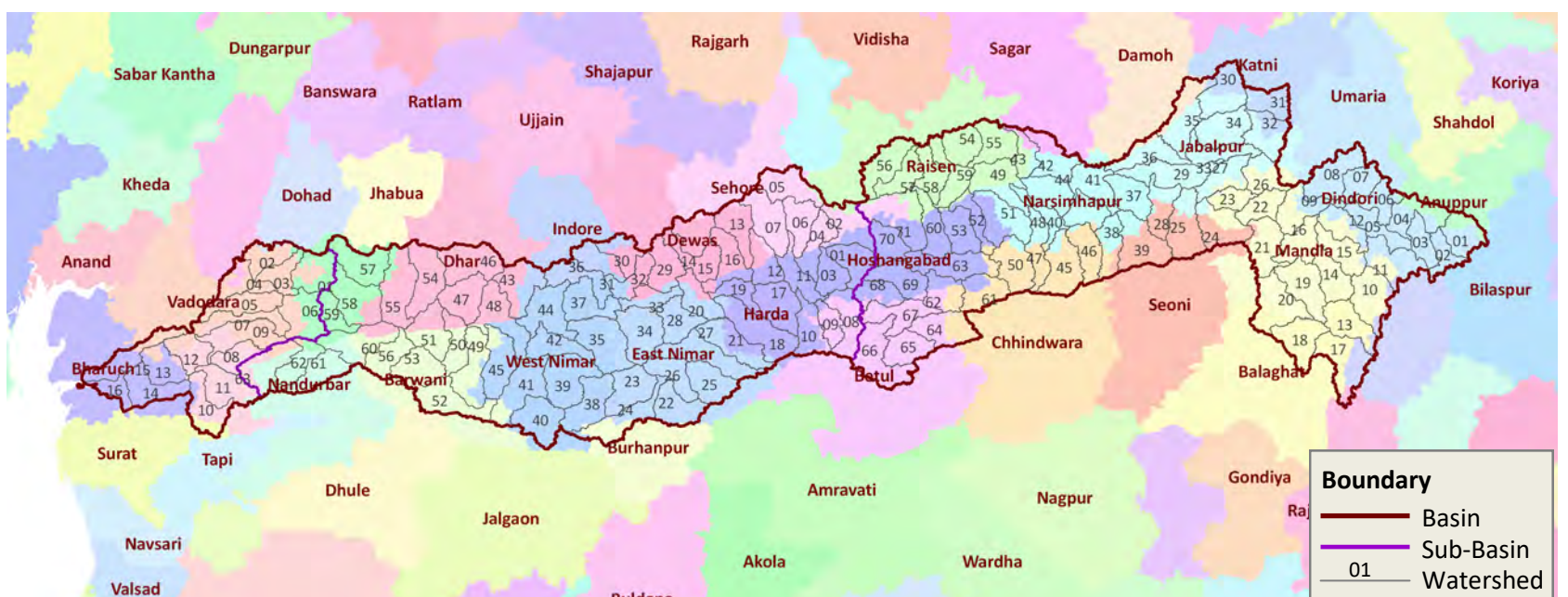
Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	600-800	14714.08	14.89
	800-1000	21897.29	22.16
	1000-1200	25993.40	26.31
	1200-1400	33732.03	34.15
	1400-1600	2459.20	2.49

Land Use / Land Cover (2005-06)



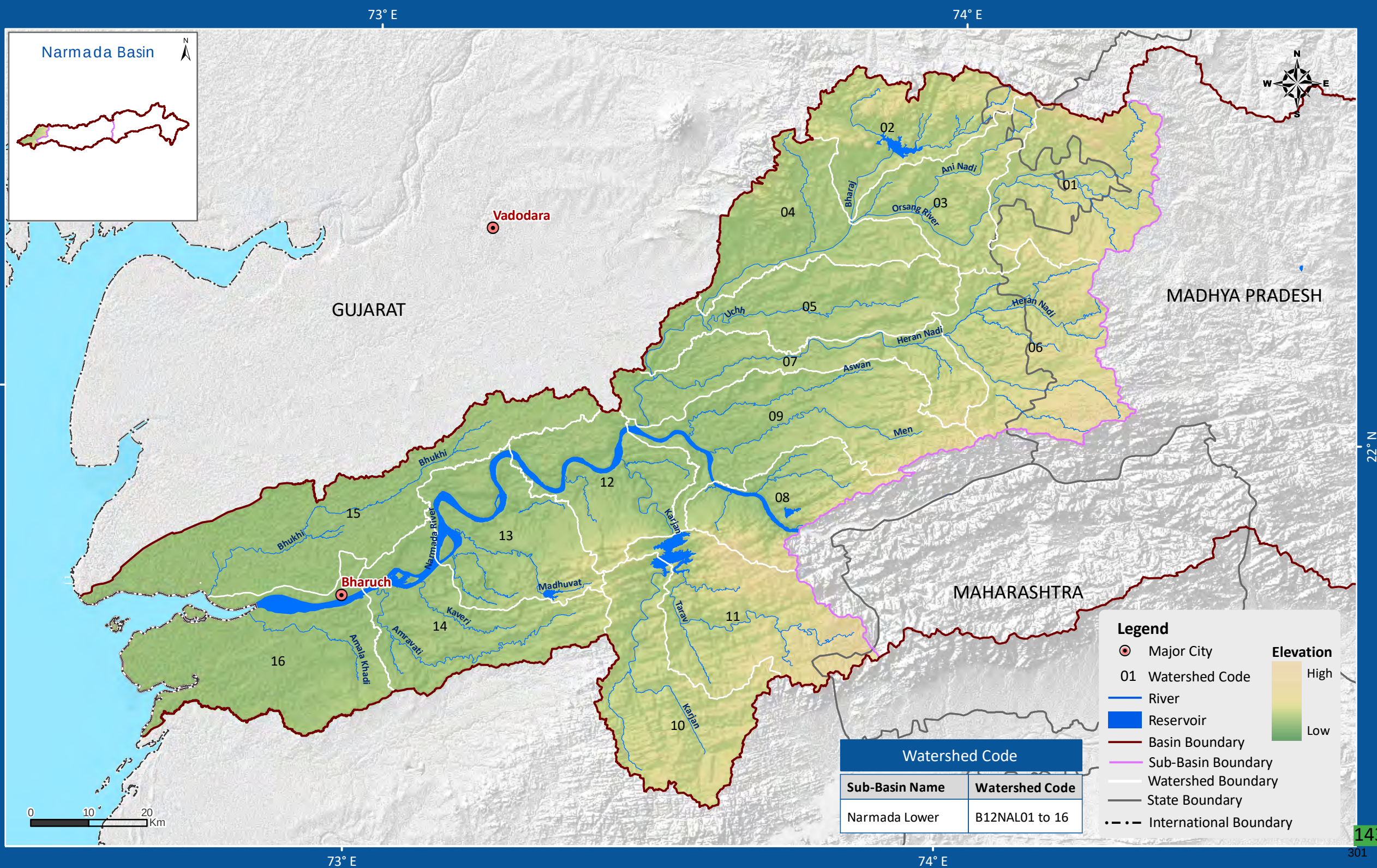
Symbol	Category	Area (Sq. km)	% of Total Area
	Built Up Land	1114.36	1.13
	Agricultural	56243.09	56.90
	Forest	32483.29	32.88
	Grassland	2.20	0.01
	Wasteland	6033.74	6.13
	Waterbodies	2919.32	2.95

Districts

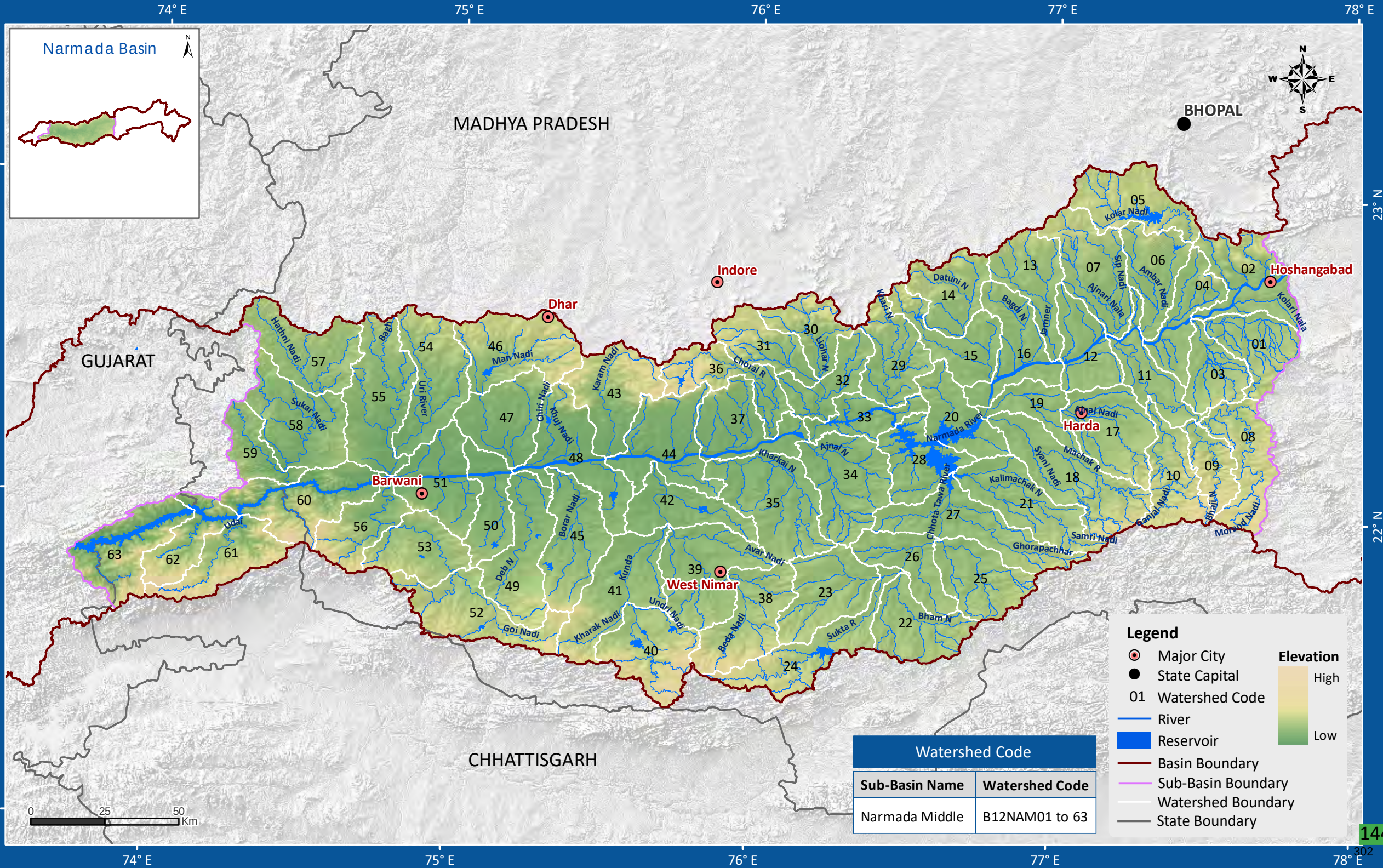


Boundary	
	Basin
	Sub-Basin
	Watershed

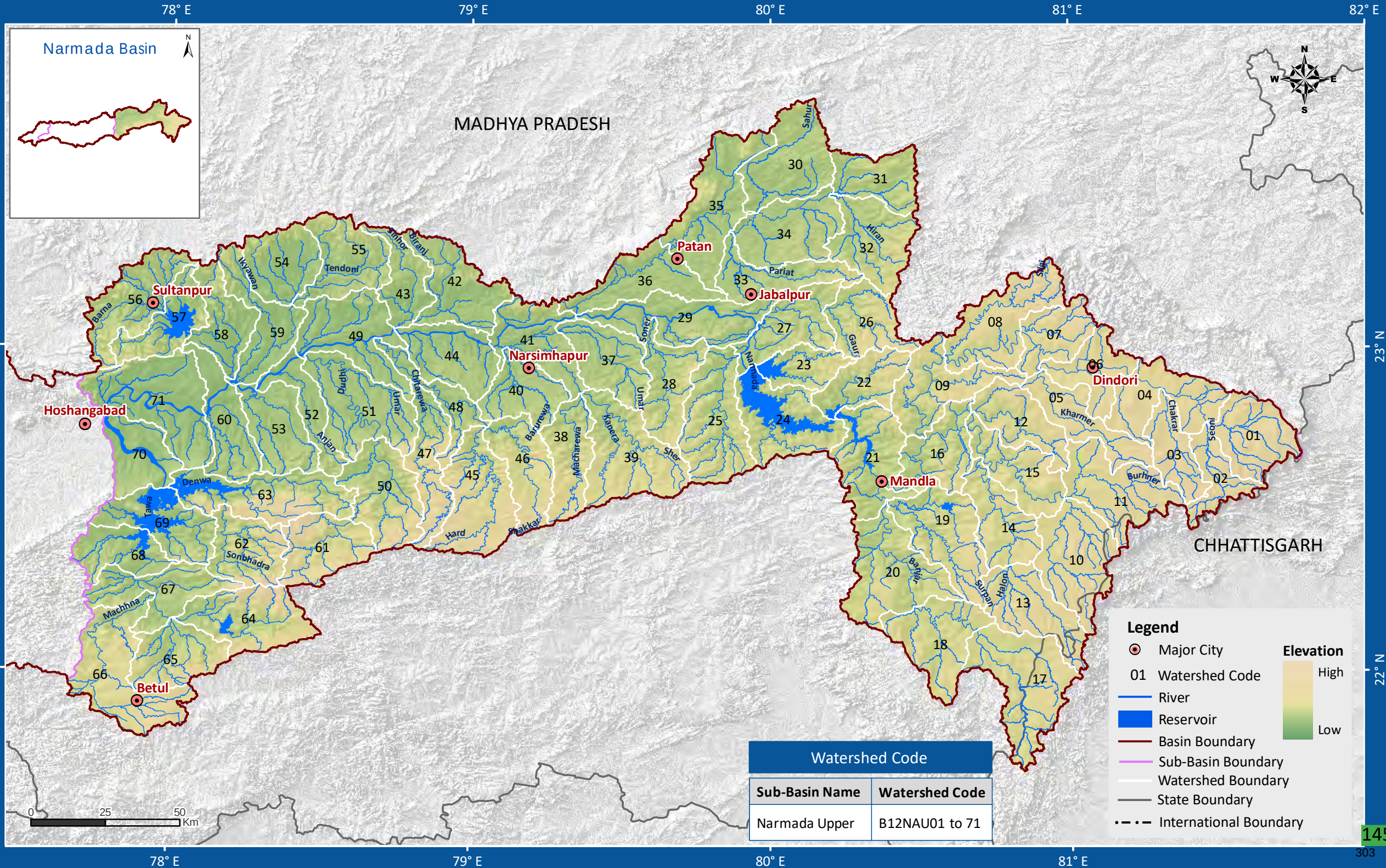
1. Narmada Lower Sub-Basin

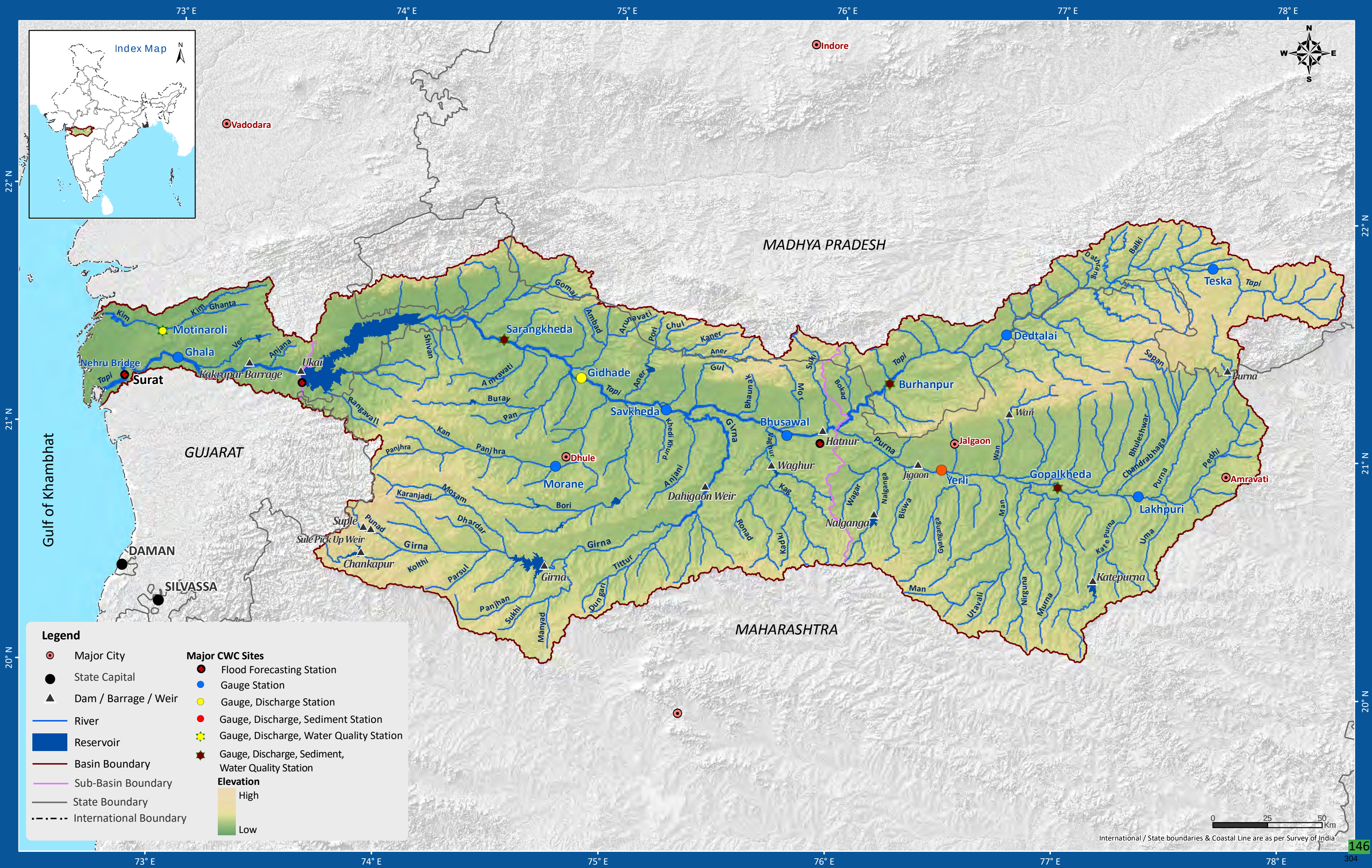


2. Narmada Middle Sub-Basin



3. Narmada Upper Sub-Basin





The basin extends over states of Madhya Pradesh, Maharashtra and Gujarat having an area of 65,145 Sq.km with a maximum length and width of 534 & 196 km. It lies between 72° 33' to 78° 17' east longitudes and 20° 9' to 21° 50' north latitudes. Situated in the Deccan plateau, the basin is bounded by the Satpura range on the north, by the Mahadev hills on the east, by the Ajanta Range and the Satmala hills on the south and by the Arabian Sea on the west. The hilly region of the basin is well forested while the plains are broad and fertile areas suitable for cultivation. The Tapi is the second largest westward draining river of the Peninsula. It originates near Multai reserve forest in Betul district of Madhya Pradesh at an elevation of 752 m. The total length of the river from origin to outfall into the Arabian Sea is 724 km and its important tributaries are the Suki, the Gomai, the Arunavati and the Aner which joins it from right, and those joining from left are the Vaghur, the Amravati, the Buray, the Panjhra, the Bori, the Girna, the Purna, the Mona and the Sipna. The major part of basin is covered with agriculture accounting to 66.19% of the total area. 2.99% of the basin is covered by water bodies.

Salient Features of Tapi Basin

Basin Extent	Longitude Latitude	72° 33' to 78° 17' E 20° 9' to 21° 50' N
Length of Tapi River (Km)		724
Catchment Area (Sq.km.)		65145
Average Water Resource Potential (MCM)		14880
Utilizable Surface Water Resource (MCM)		14500
Live Storage Capacity of Completed Projects (MCM)		9408.37
Live Storage Capacity of Projects Under Construction (MCM)		847.42
Total Live Storage Capacity of Projects (MCM)		10255.79
No. of Hydrological Observation Stations		21
No. of Flood Forecasting Stations		3

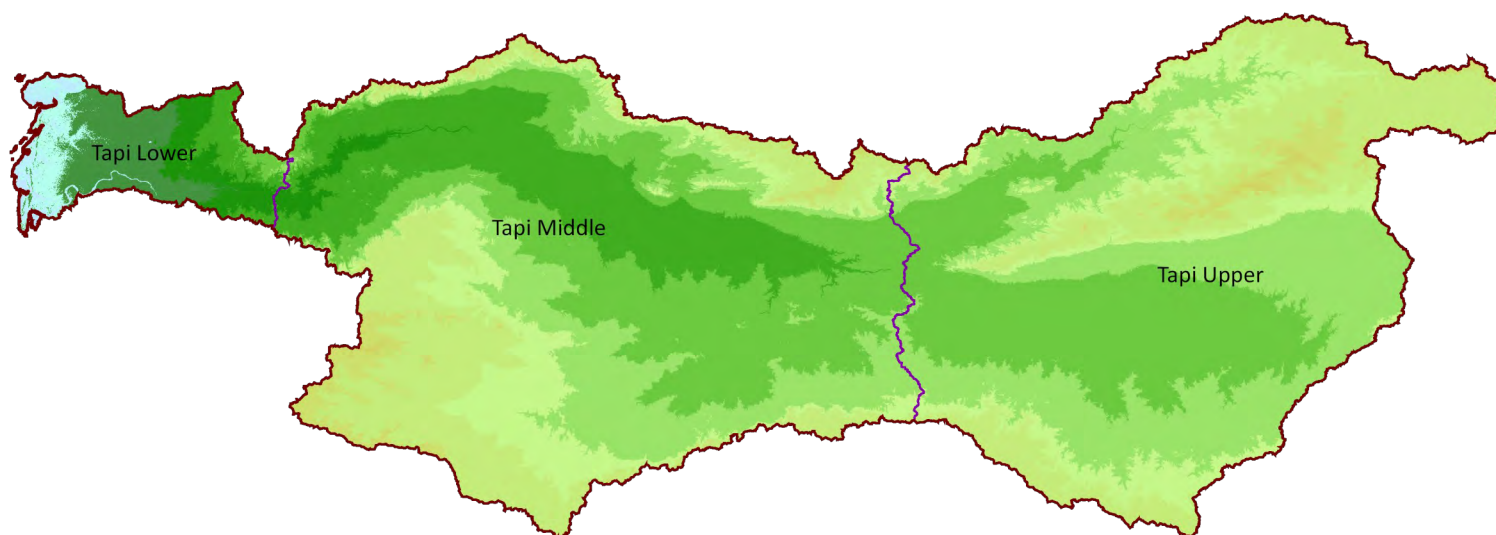
Major Water Resource Assets

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Tapi Lower	4108.90	6	2	6	382	4
2	Tapi Middle	31766.67	225	13	191	2323	10
3	Tapi Upper	28047.34	125	4	121	2614	7

Watershed Statistics

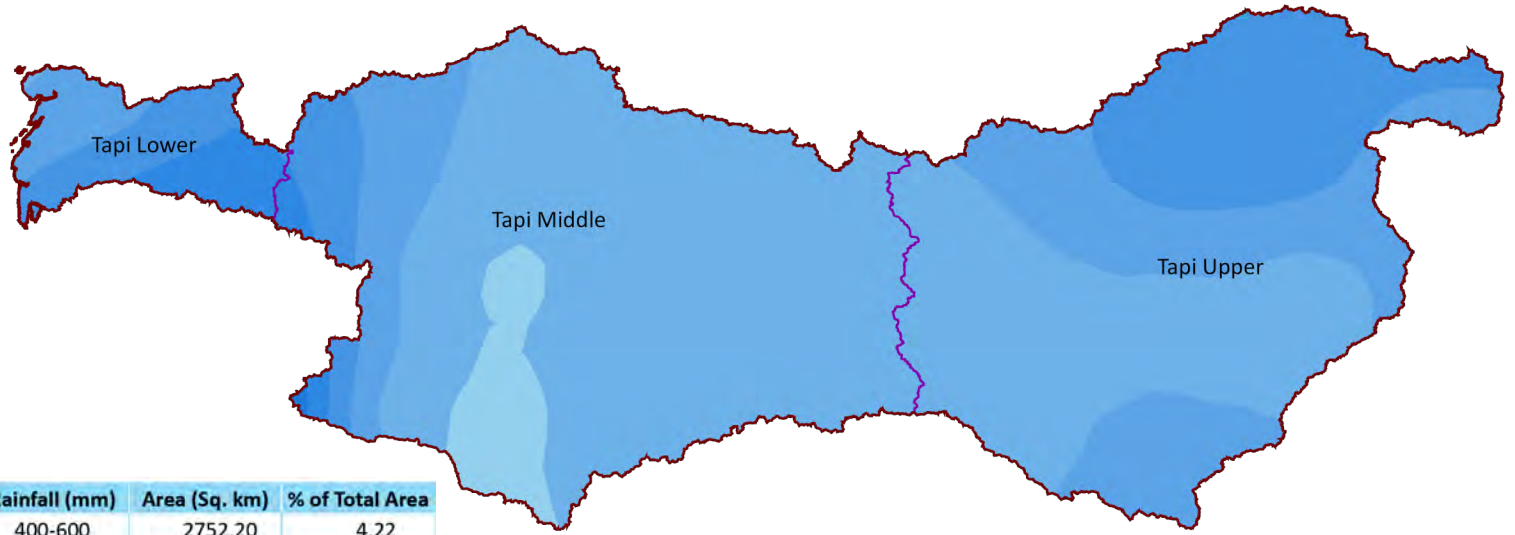
Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Tapi Lower	7	427.18	781.84	586.99
2	Tapi Middle	47	365.64	937.44	675.89
3	Tapi Upper	46	322.12	937.28	609.72

Elevation Zone



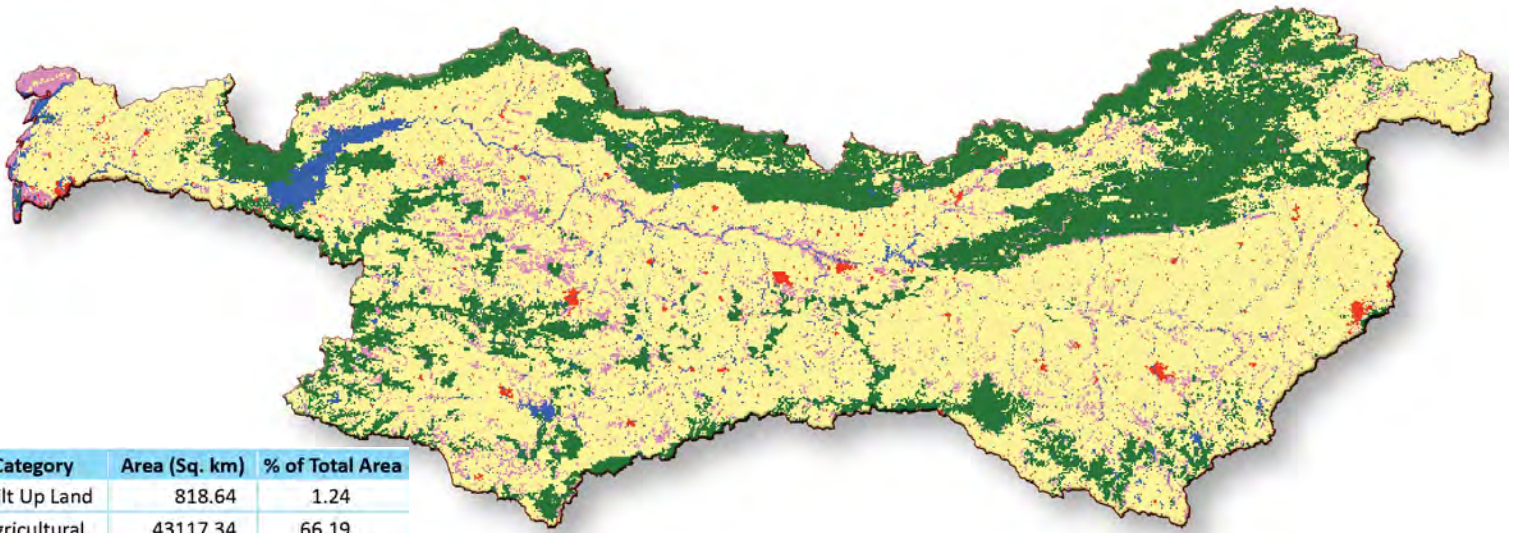
Symbol	Elevation (m)	Area (Sq. km)	% of Total Area
	< 5	333.67	0.51
	5-10	651.42	1.00
	10-50	1640.17	2.52
	50-100	1244.03	1.91
	100-200	6981.73	10.72
	200-300	16540.58	25.39
	300-400	15549.11	23.87
	400-500	7536.85	11.57
	500-750	12339.79	18.94
	750-1000	2123.10	3.26
	1000-1500	204.55	0.31

Average Annual Rainfall (1971-2005)



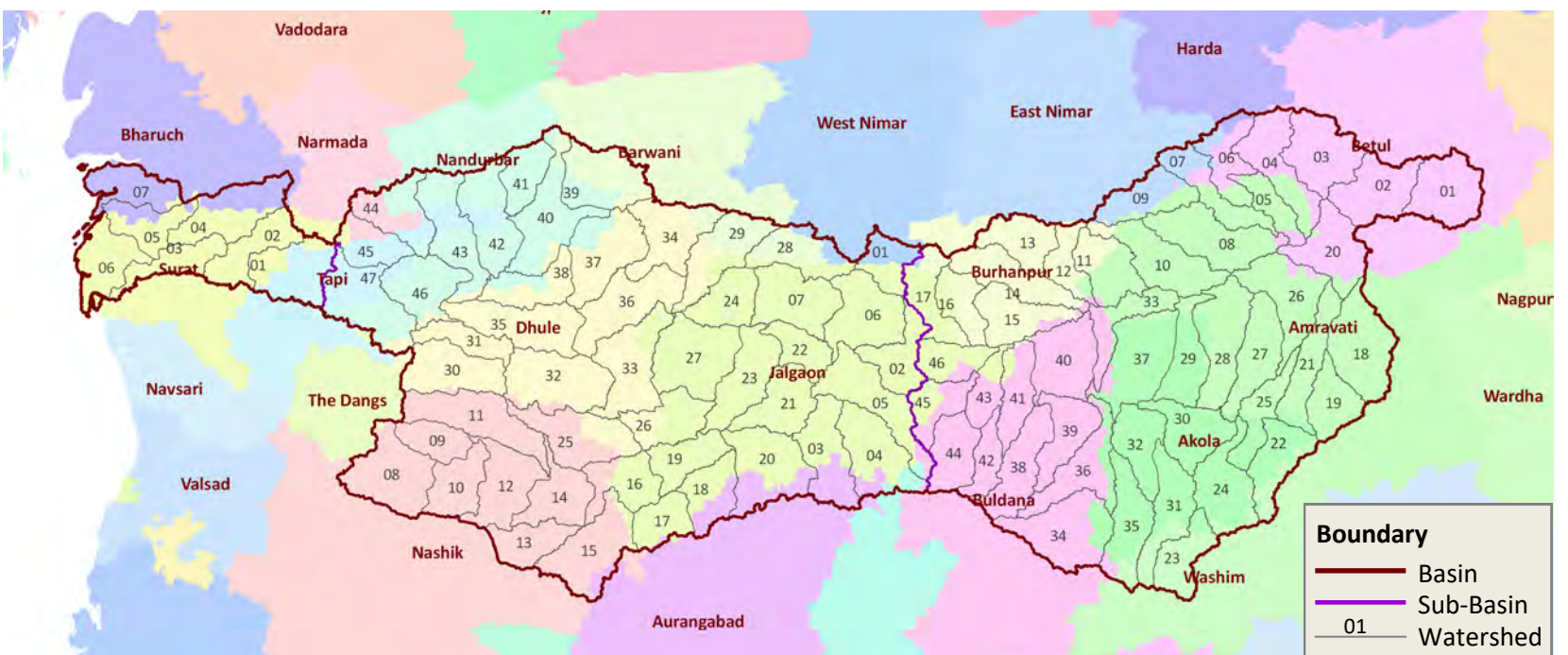
Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	400-600	2752.20	4.22
	600-800	36466.69	55.98
	800-1000	13420.94	20.60
	1000-1200	10850.94	16.66
	1200-1400	1604.78	2.46
	1400-1600	49.45	0.08

Land Use / Land Cover (2005-06)



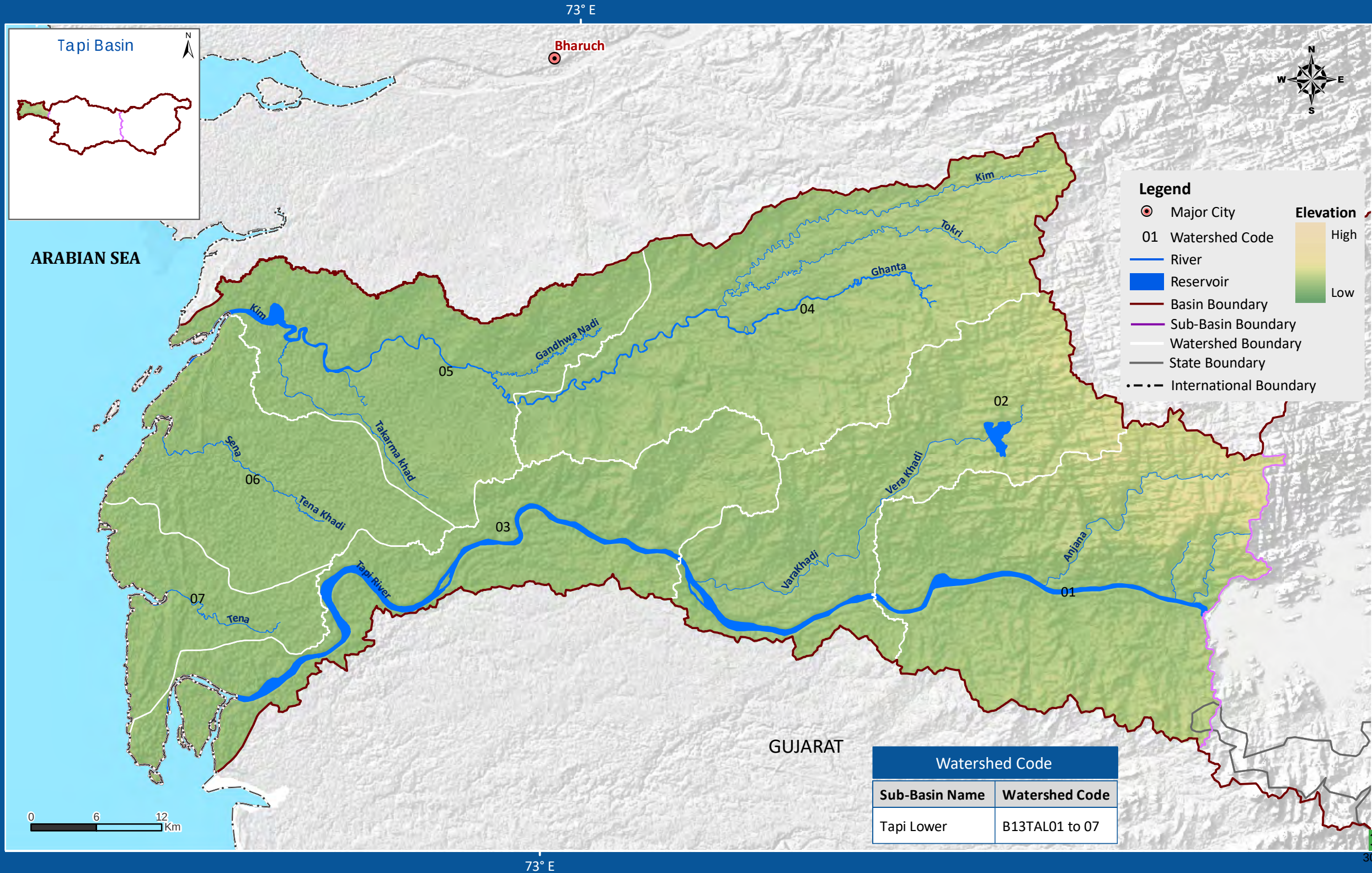
Symbol	Category	Area (Sq. km)	% of Total Area
	Built Up Land	818.64	1.24
	Agricultural	43117.34	66.19
	Forest	15899.92	24.41
	Grassland	1.47	0.01
	Wasteland	3362.92	5.16
	Waterbodies	1944.71	2.99

Districts

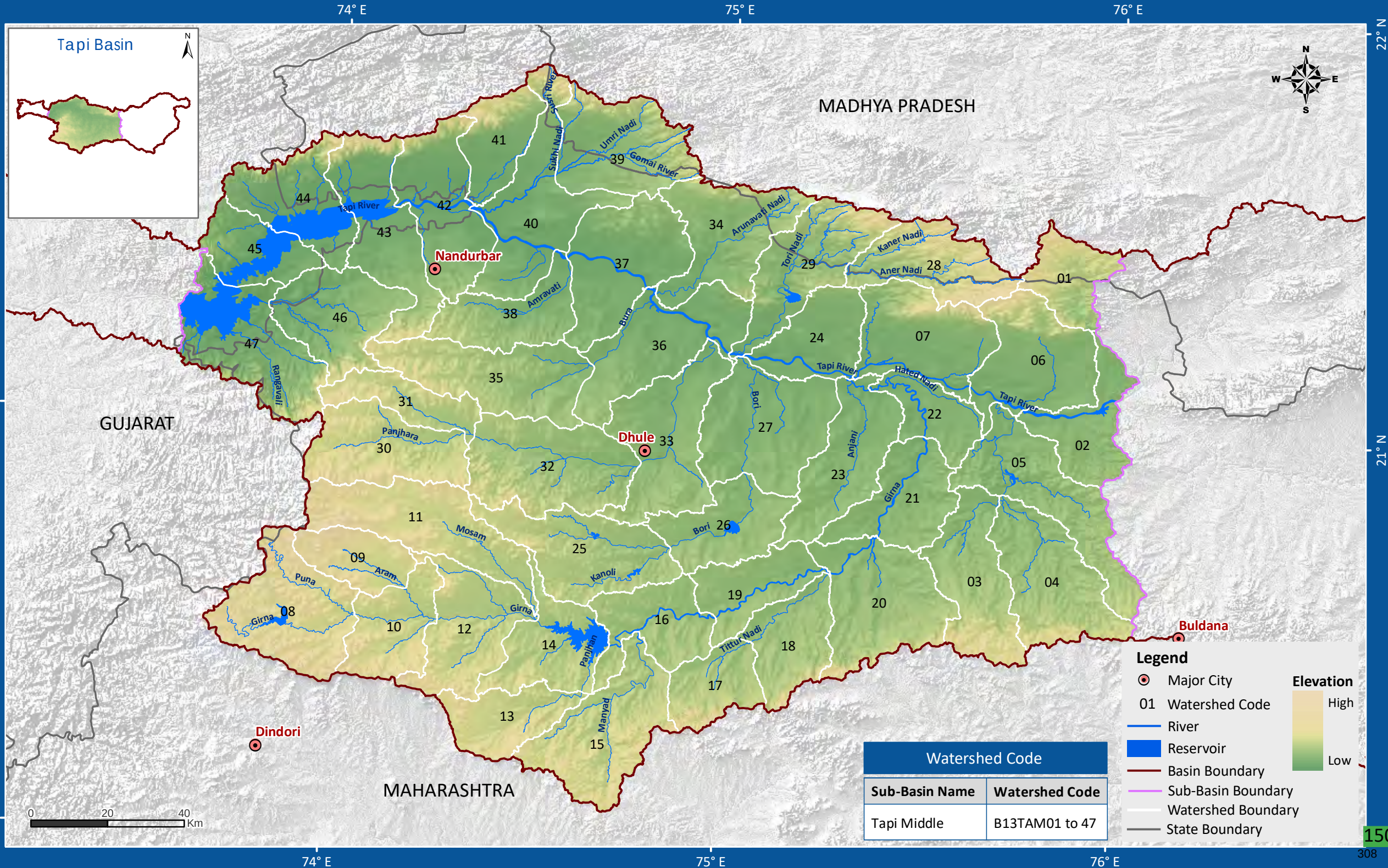


Boundary	
	Basin
	Sub-Basin
01	Watershed

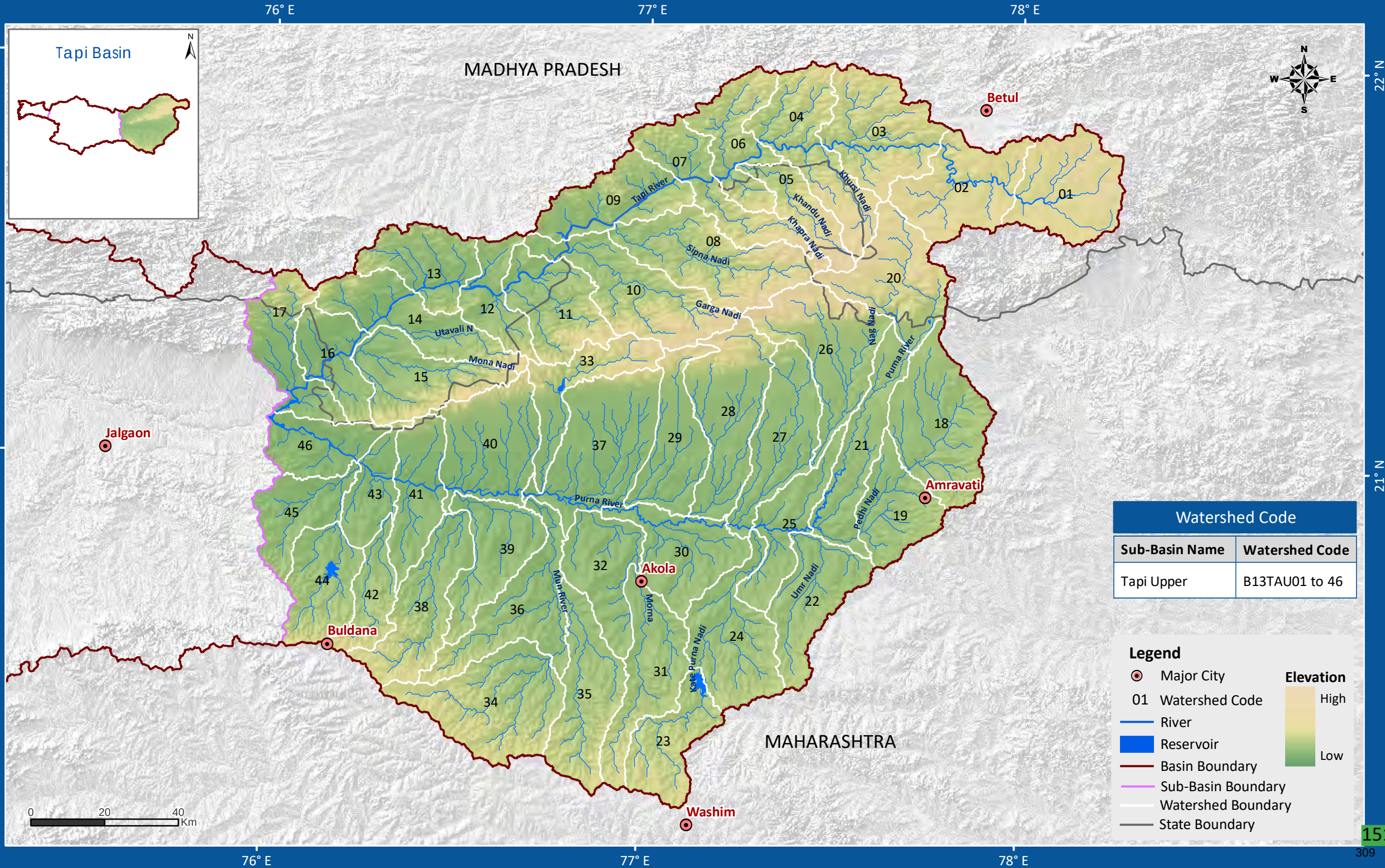
1. Tapi Lower Sub-Basin



2. Tapi Middle Sub-Basin



3. Tapi Upper Sub-Basin



5.16 WEST FLOWING RIVERS SOUTH OF TAPI BASIN

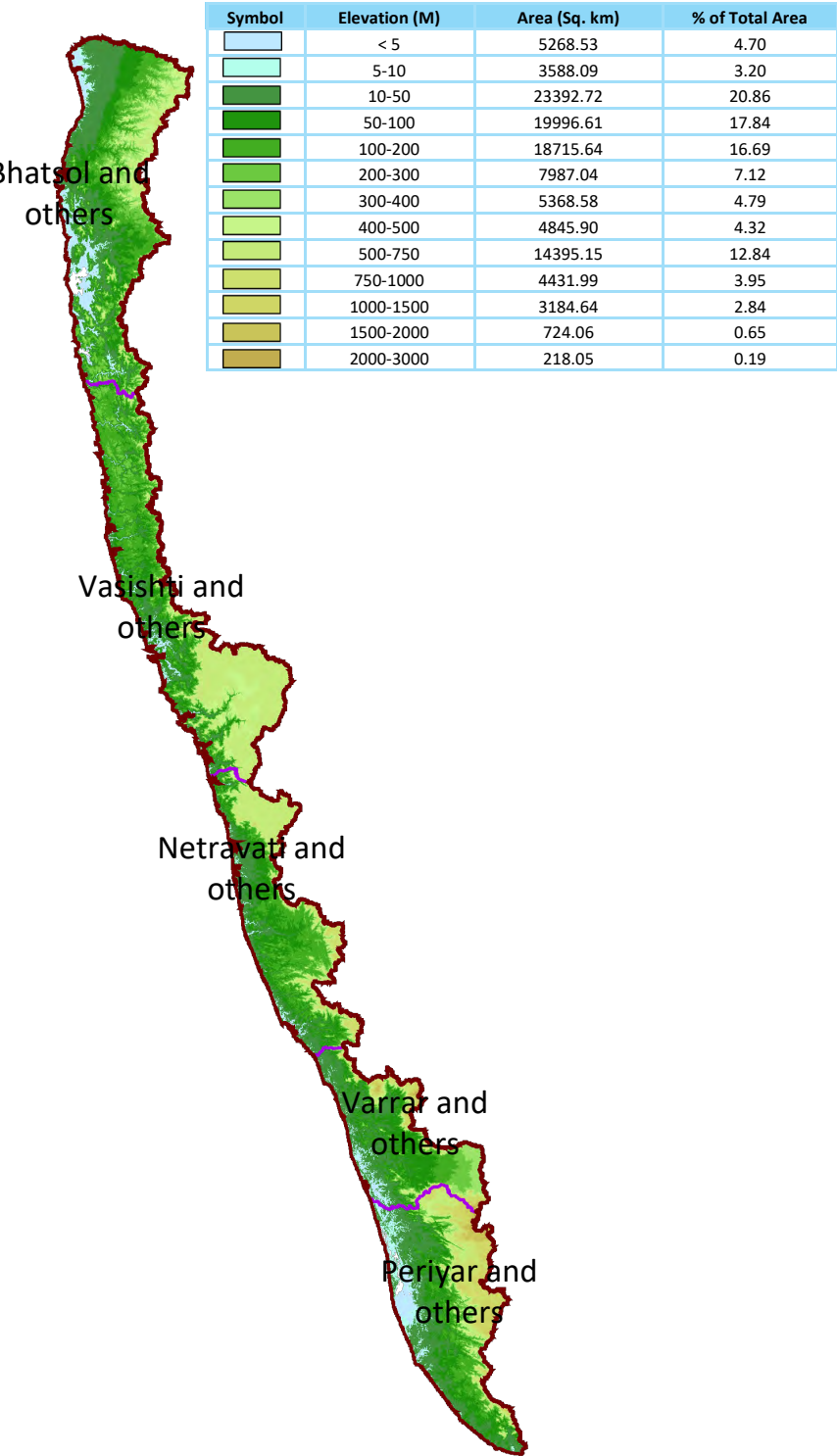


The basin covers parts Gujarat, Maharashtra, Dadara & Nagar Haveli, Goa, Daman & Diu, Kerala, Tamil Nadu, Puducherry and Karnataka having an area of 1,12,117 Sq.km which is nearly 3.41% of the total geographical area of the country. The geographical extent of the basin is between 72°38'34" to 77°35'43" east longitudes and 8°4'40" to 21°15'42" north latitudes with maximum length and width of around 1533 km and 137 km respectively. The basin is bounded by Gujarat plains on the north, by Western Ghats on north-east and east, by Arabian Sea in the west and by Indian Ocean on the south. The various rivers in the basin does not meet into one forming a major stream, rather they flow independently and drains directly into the Arabian Sea. The independent rivers (directly draining into Arabian Sea) in the basin are the Purna, the Ambika, the Damanganga, the Vaitarna, the Ulhas, the Amba, the Savitri, the Vashishti, the Kajvi, the Vaghotan, the Gad, the Mandavi, the Kalinadi, the Gangavali (Bedti), Tadri, Varahi, the Netravati, the Payaswani, the Valapattanam, the Chaliyar, the Kadalundi, the Bharathapuzha, the Periyar, the Muvattupula, the Minachil, the Pamba, the Achankovil, the Kallada and the Vamanapuram. The major part of basin is covered with agriculture accounting to 47.39% of the total area while 4.17% of the basin area is covered by water bodies.

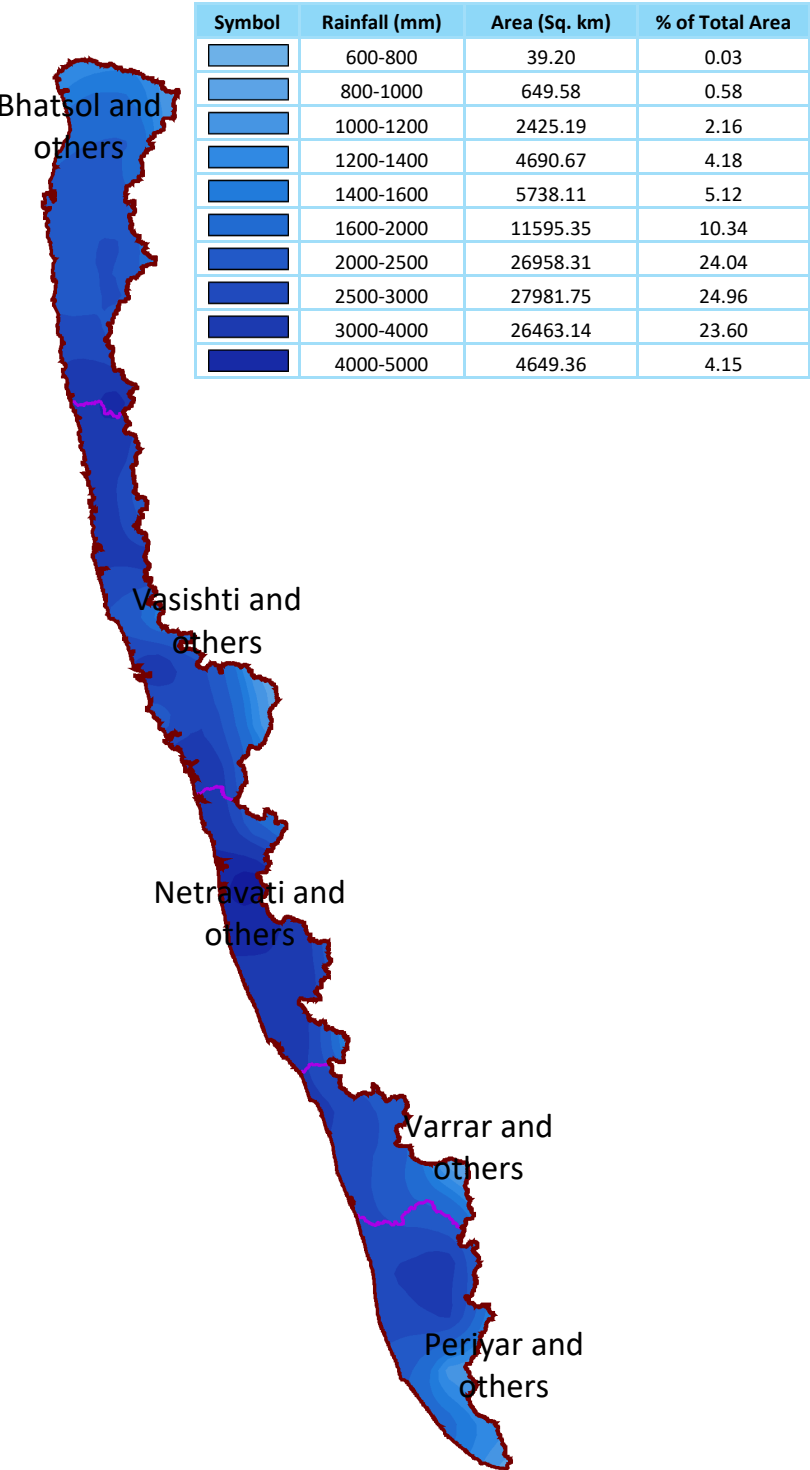
Salient Features of West Flowing Rivers South of Tapi Basin

Basin Extent	Longitude Latitude	72°38'34" to 77°35'43" E 8°4'40" to 21°15'42" N
Length of River (Km)		Many independent rivers flowing
Catchment Area (Sq.km.)		112117
Average Water Resource Potential (MCM)		200941
Utilizable Surface Water Resource (MCM)		36200
Live Storage Capacity of Completed Projects (MCM)		21504.19
Live Storage Capacity of Projects Under Construction (MCM)		4781.92
Total Live Storage Capacity of Projects (MCM)		26286.11
No. of Hydrological Observation Stations		60
No. of Flood Forecasting Stations		3

Elevation Zone



Average Annual Rainfall (1971-2005)



Major Water Resource Assets

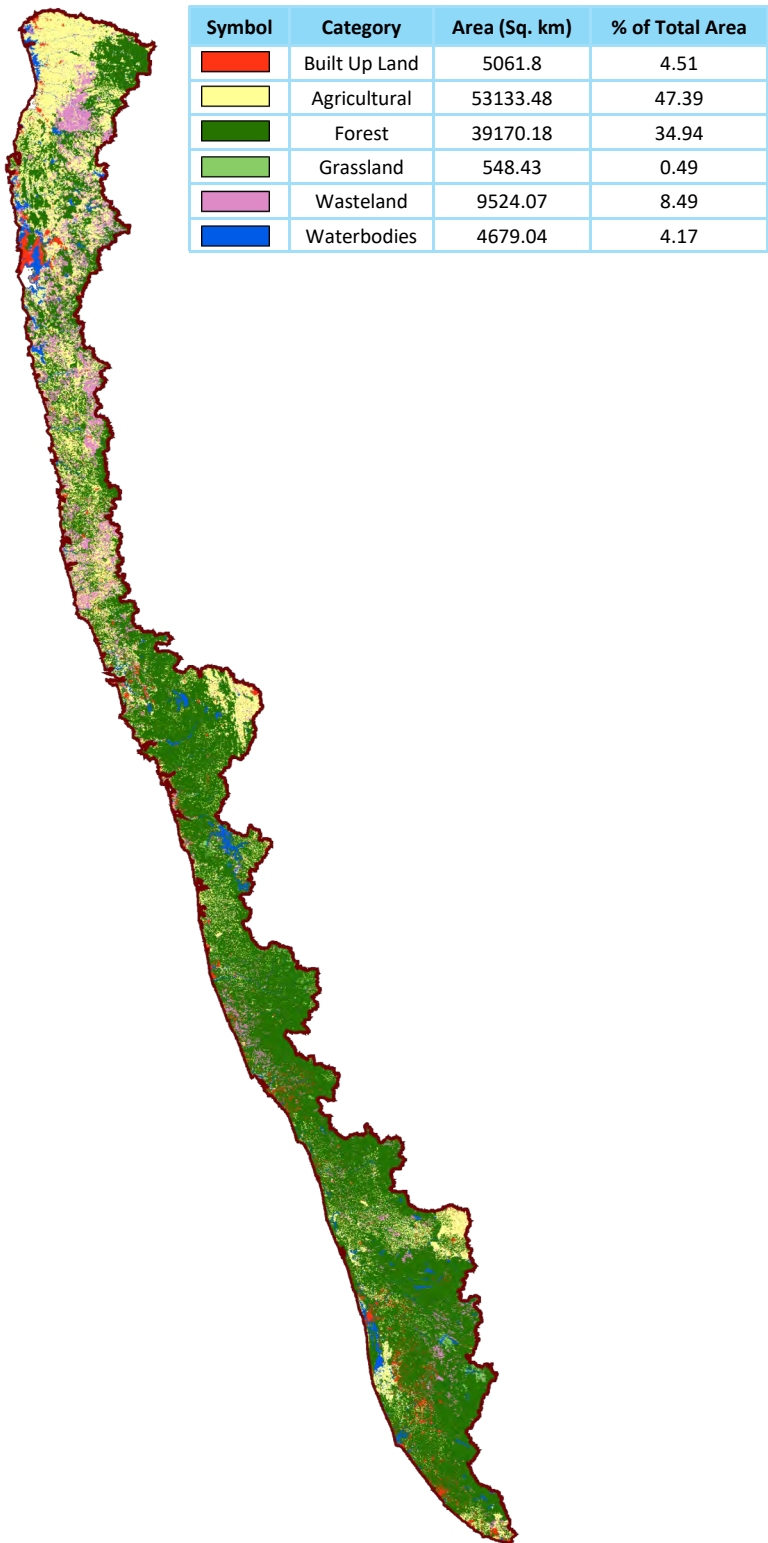
509

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Bhatsol and others	29348.90	113	2	110	3444	23
2	Netravati and others	18762.09	9	3	5	1855	7
3	Periyar and others	21895.21	40	6	37	6852	13
4	Varrar and others	14164.70	20	7	17	6876	8
5	Vasishti and others	27473.95	106	1	93	2226	9

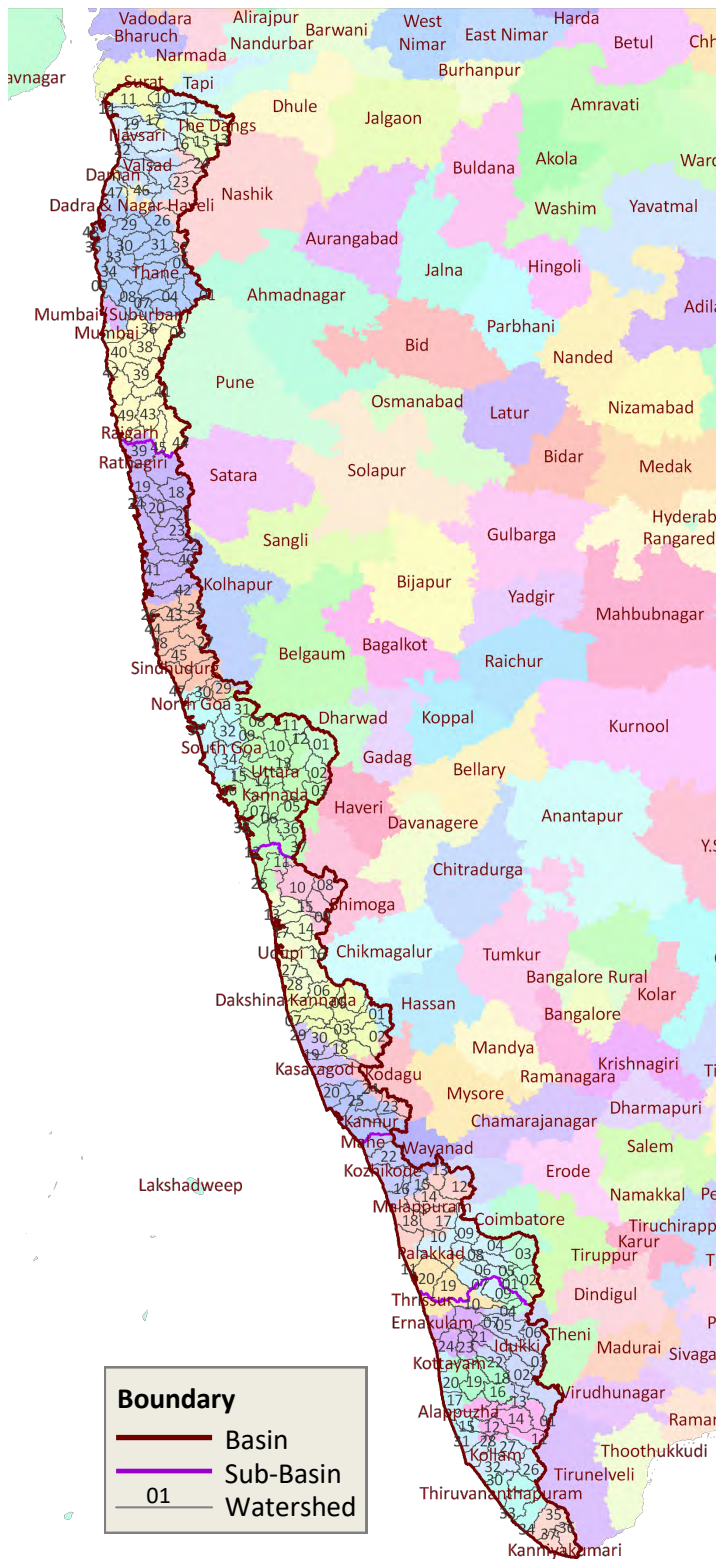
Watershed Statistics

Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Water-shed (sq. km)	Max. size of Water-shed (sq. km)	Avg. size of Water-shed (sq. km)
1	Bhatsol and others	49	310.70	932.29	598.96
2	Netravati and others	32	317.42	928.92	586.32
3	Periyar and others	37	340.11	933.86	591.76
4	Varrar and others	23	363.17	978.16	615.86
5	Vasishti and others	47	335.12	979.25	584.55

Land Use / Land Cover (2005-06)



Districts



510

1. Bhatsol and others Sub-Basin



511

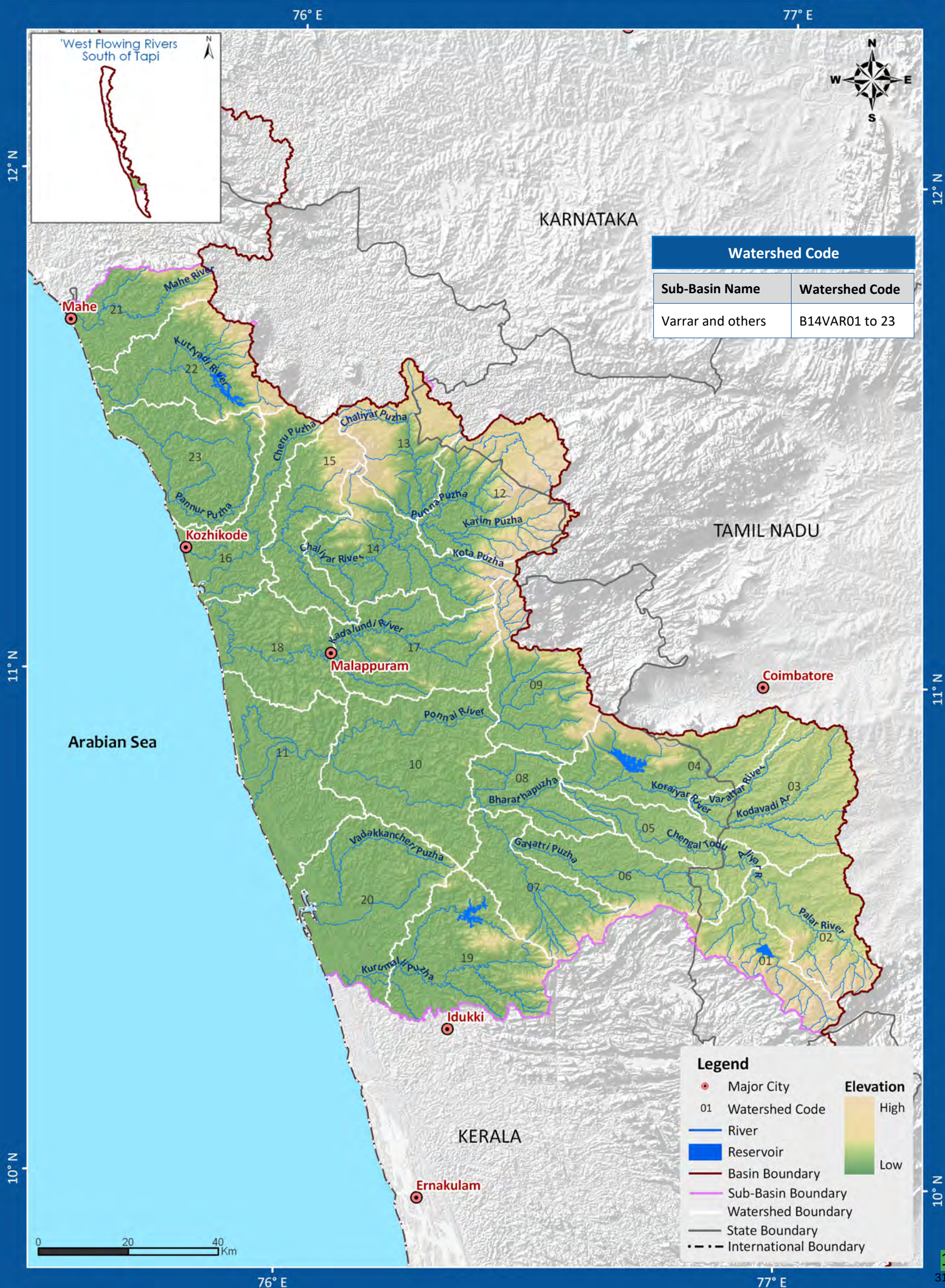
2. Netravati and others Sub-Basin



512 3. Periyar and others Sub-Basin



513 4. Varrar and others Sub-Basin

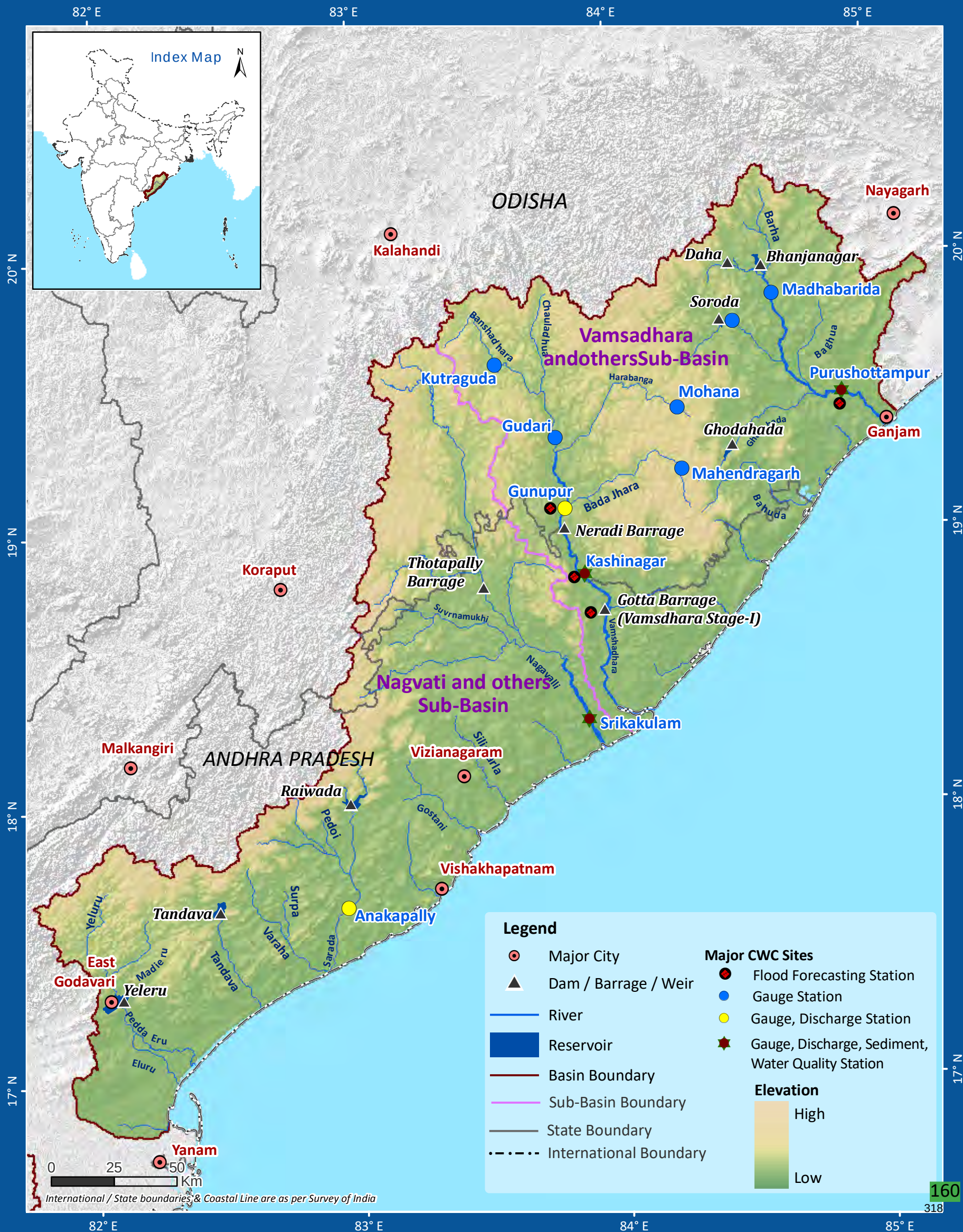


514 5. Vasishti and others Sub-Basin



515

5.17 EAST FLOWING RIVERS BETWEEN MAHANADI AND GODAVARI BASIN



The basin covers parts of Andhra Pradesh and Odisha having an area of 49,685 Sq.km which is nearly 1.51% of the total geographical area of the country. The geographical extent of the basin is between 81°45'1" to 85°13'49" east longitudes and 16°49'17" to 20°19'34" north latitudes with maximum length and width of around 475 km and 175 km respectively.

It is bounded by the Eastern Ghats on the north and west, by Andhra plains on the south and by the Bay of Bengal on the east. The various rivers in the basin does not meet into one forming a major stream, rather they flow independently and drains directly into the Bay of Bengal. The independent rivers (directly draining into Bay of Bengal) in the basin are the Rushikulya, the Bahuda, the Vamsadhara, the Nagavali, the Sarada, the Varaha, the Tandava and the Eluru. The major part of basin is covered with agricultural land accounting to 47.73% of the total area and 3.01% of the basin is covered by water bodies.

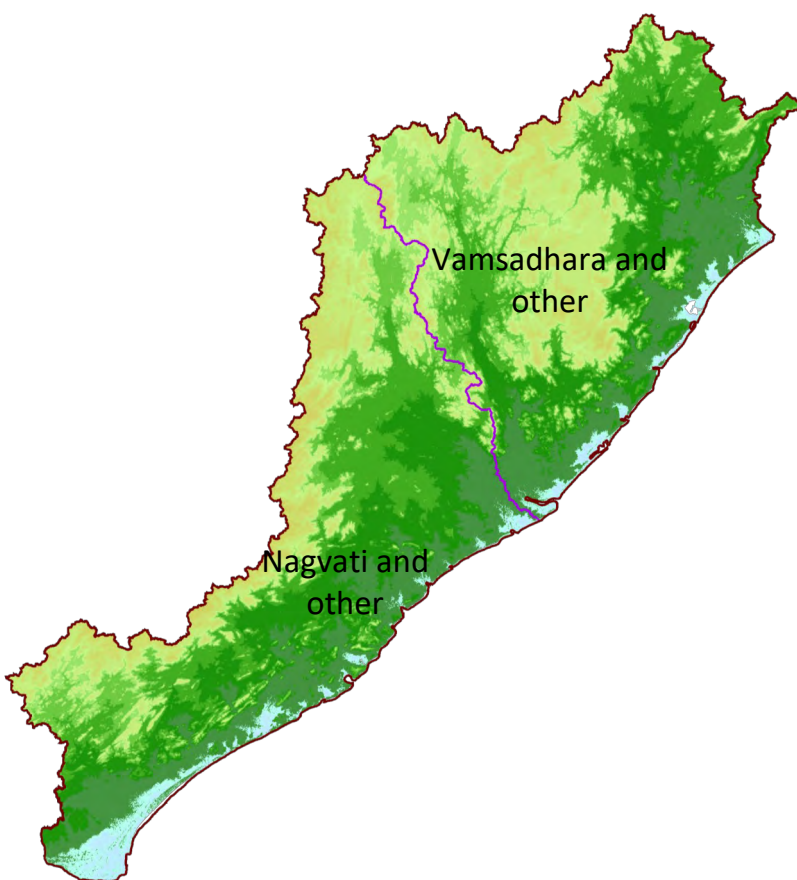
Salient Features of : East Flowing Rivers between Mahanadi and Godavari Basin

Basin Extent	Longitude Latitude	81°45'1" to 85°13'49" E 16°49'17" to 20°19'34" N
Length of River (Km)	Many independent rivers flowing	
Catchment Area (Sq.km.)	49685	
No. of Hydrological Observation Stations	12	
No. of Flood Forecasting Stations	4	

Major Water Resource Assets

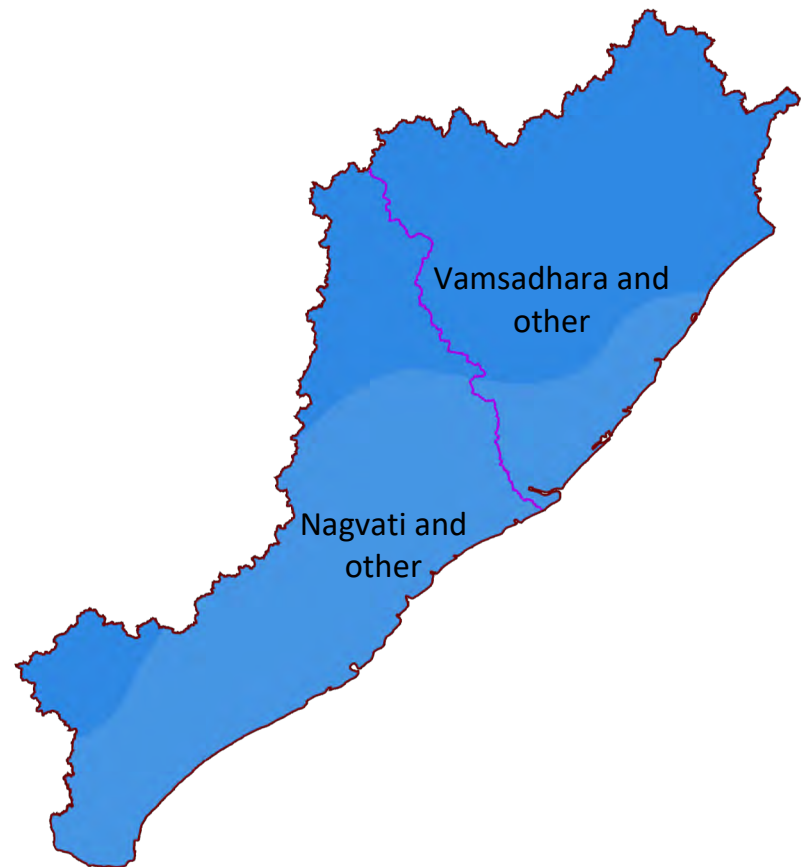
Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Nagvati and other	24372.24	21	5	19	9257	2
2	Vamsadhara and other	21870.63	27	20	22	11794	10

Elevation Zone



Symbol	Elevation (M)	Area (Sq. km)	% of Total Area
	<5	893.27	1.80
	5-10	1249.70	2.52
	10-50	7865.77	15.83
	50-100	8652.10	17.41
	100-200	8534.88	17.18
	200-300	4535.75	9.13
	300-400	3863.21	7.78
	400-500	3008.14	6.05
	500-750	6507.71	13.10
	750-1000	3542.36	7.13
	1000-1500	1028.76	2.07
	1500-2000	3.35	0.01

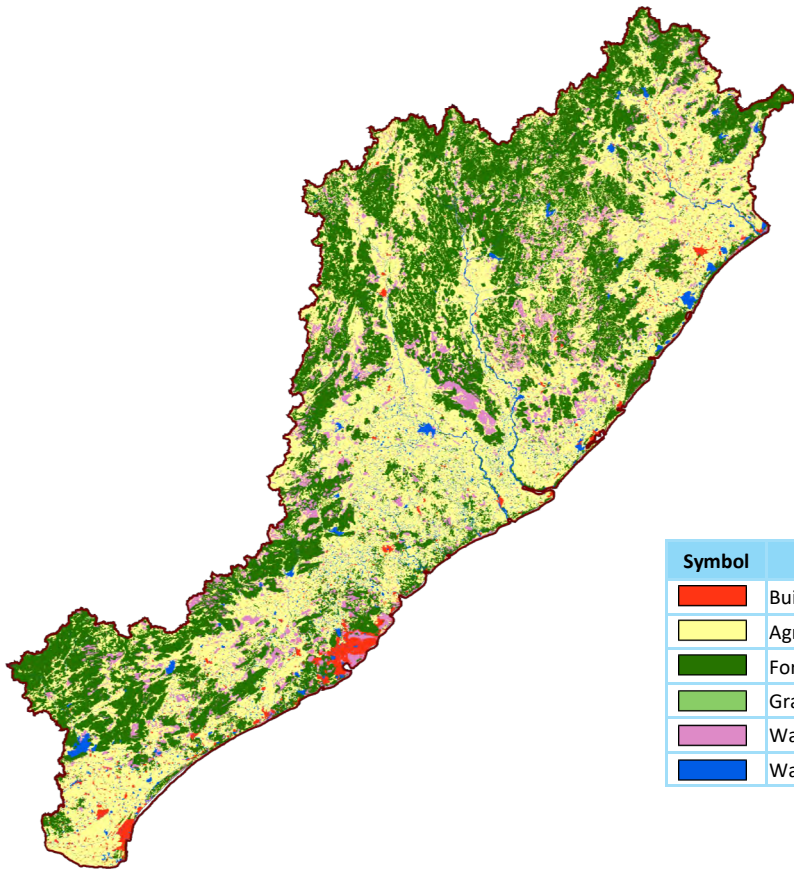
Average Annual Rainfall (1971-2005)



Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	1000-1200	23094.44	46.48
	1200-1400	26590.56	53.52

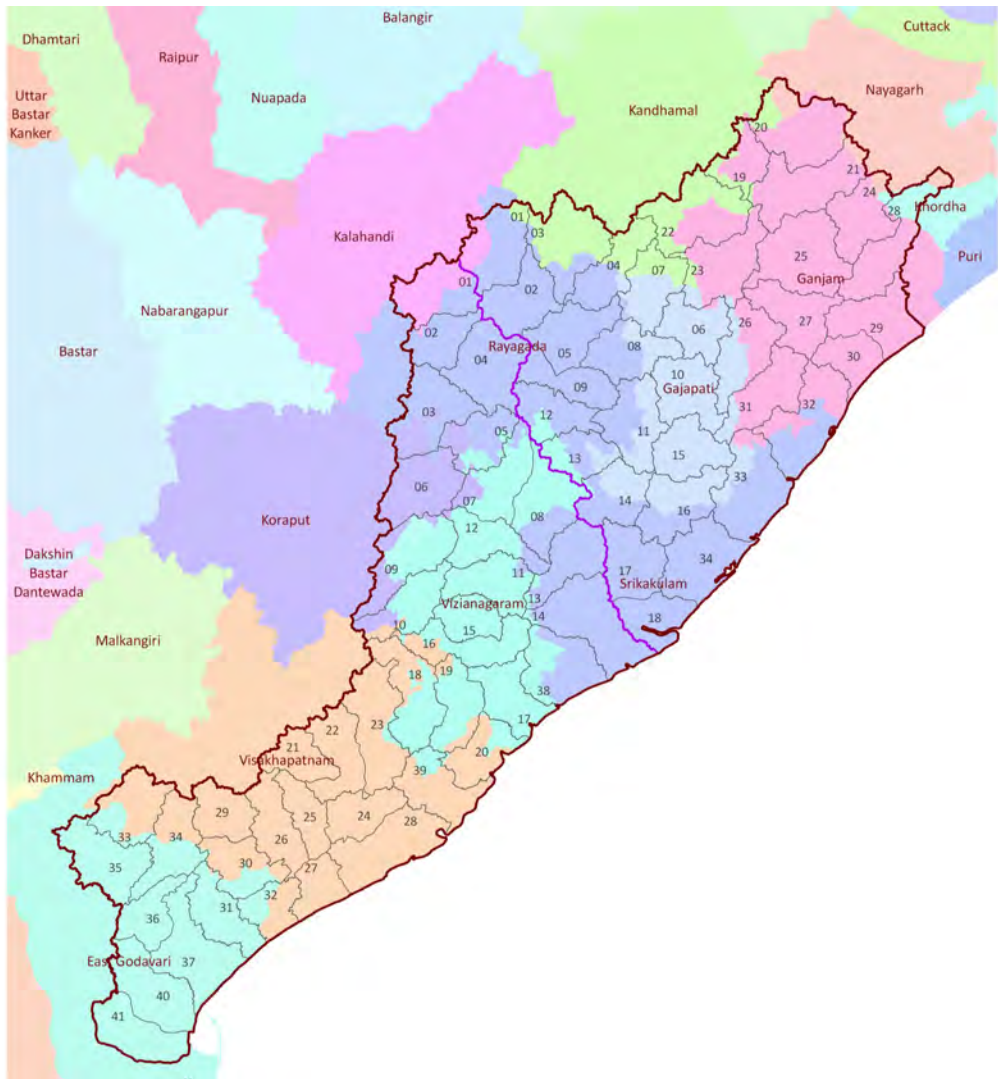
Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Water-shed (sq. km)	Max. size of Wa-tershed (sq. km)	Avg. size of Water-shed (sq. km)
1	Nagvati and other	41	357.79	928.45	594.44
2	Vamsadhara and other	34	392.23	930.46	643.25

Land Use / Land Cover (2005-06)



Symbol	Category	Area (Sq. km)	% of Total Area
■	Built Up Land	1101.62	2.22
■	Agricultural	23715.21	47.73
■	Forest	19141.00	38.52
■	Grassland	16.25	0.03
■	Wasteland	4217.37	8.49
■	Waterbodies	1493.56	3.01

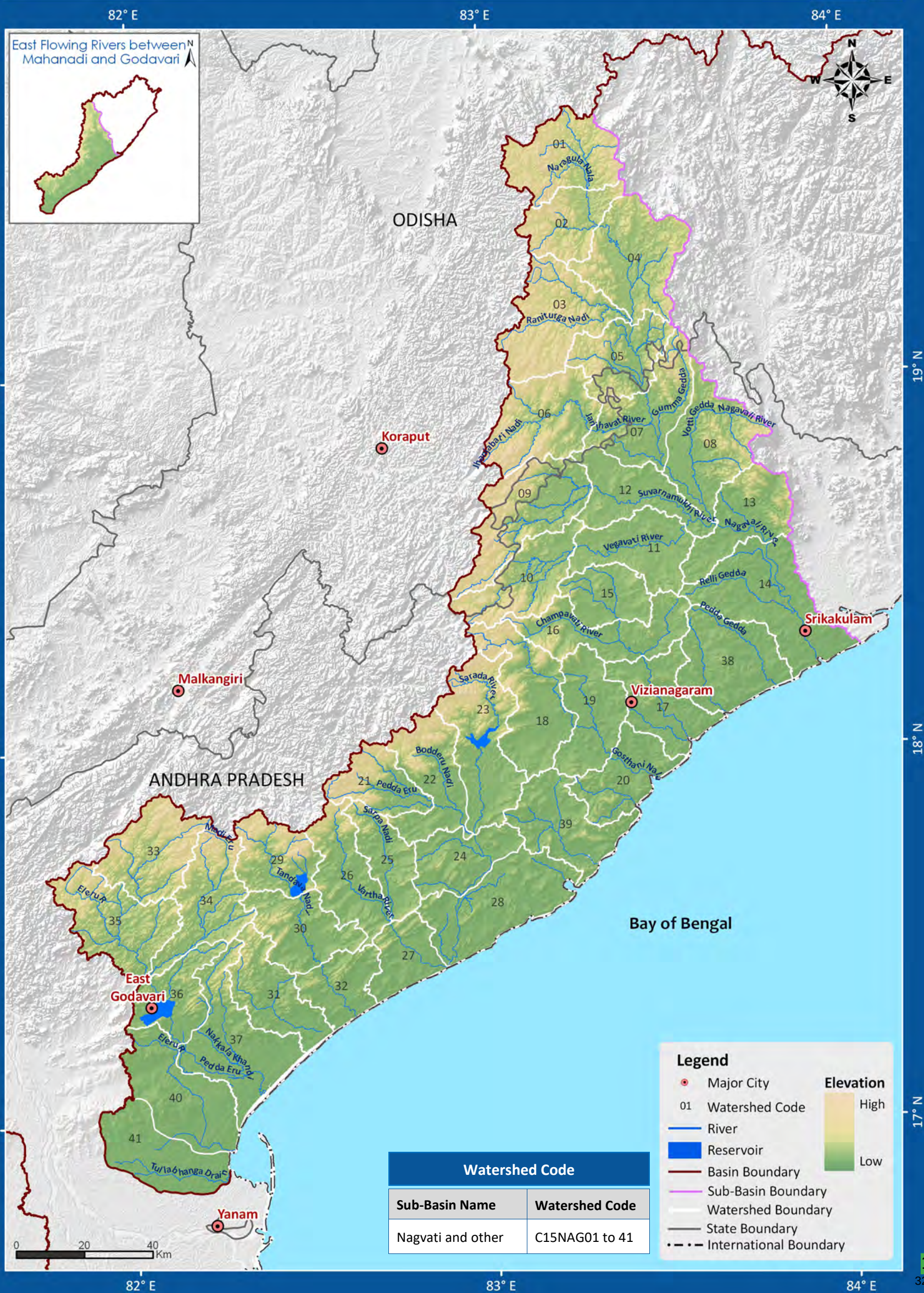
Districts



Boundary	
—	Basin
—	Sub-Basin
—	Watershed

1. Nagvati and others Sub-Basin

518

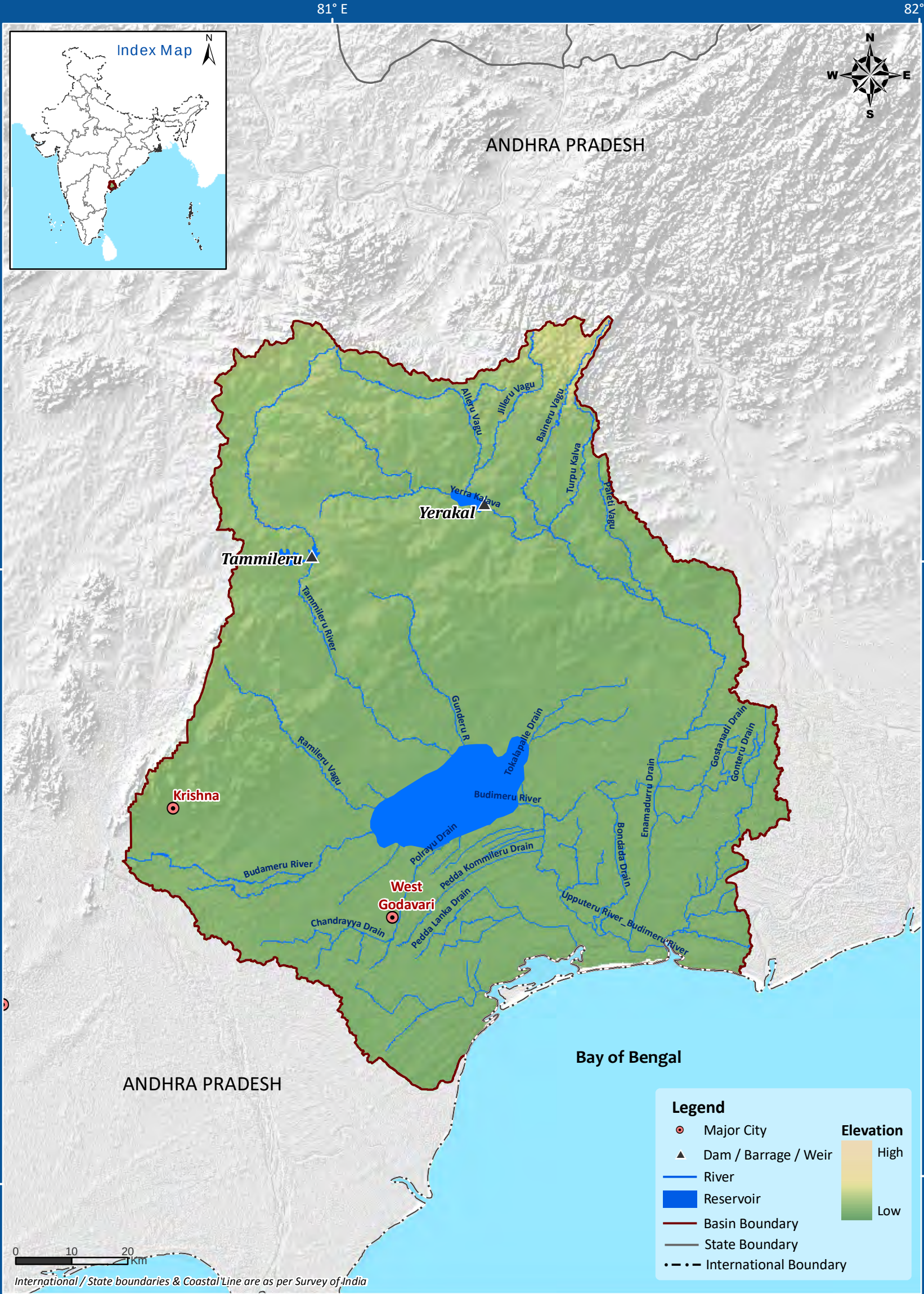


2. Vamsadhara and others Sub-Basin

519



5.18 EAST FLOWING 520 RIVERS BETWEEN GODAVARI AND KRISHNA



The basin spreads over state of Andhra Pradesh having an area of 12,289 Sq.km which is nearly 0.37% of the total geographical area of the country. The geographical extent of the basin is between 80°38'9" to 81°45'48" east longitudes and 16°8'58" to 17°24'24" north latitudes with maximum length and width of around 130 km and 125 km respectively. It is bounded by the Eastern Ghats on the north and west, by Andhra plains on the south and by the Bay of Bengal on the east. The various rivers in the basin does not meet into one forming a major stream, rather they flow independently and drains directly into the Bay of Bengal. The independent rivers (directly draining into Bay of Bengal) in the basin are the Errakalva, the Uppeteru, the Gunderu, the Tammileru and the Bhudimeru. The major part of basin is covered with agricultural land accounting to 62.77% of the total area and 14.31% of the basin is covered by water bodies.

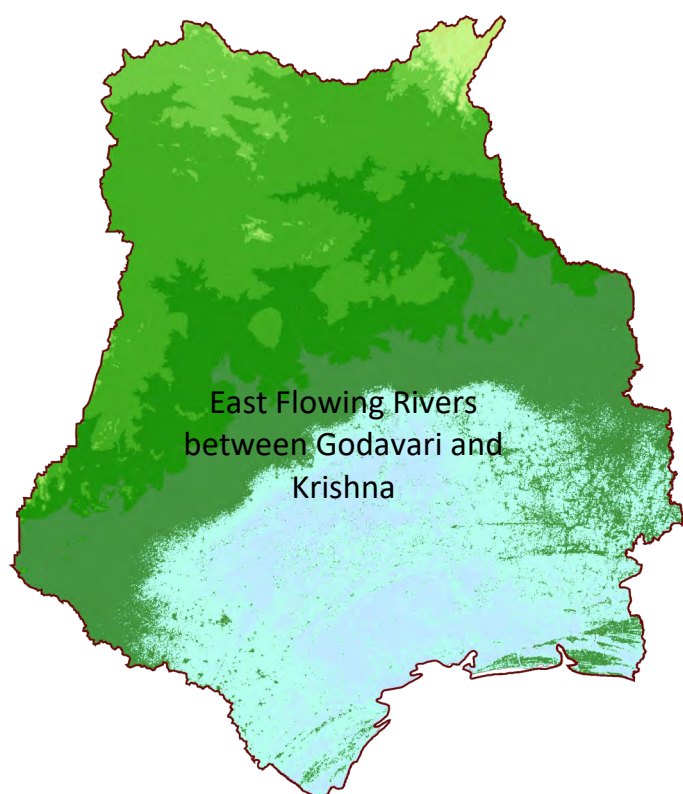
Salient Features of East Flowing Rivers between Godavari and Krishna

Basin Extent	Longitude	80°38'9" to 81°45'48" E
	Latitude	16°8'58" to 17°24'24" N
Length of River (Km)	Many independent rivers flowing	
Catchment Area (Sq.km.)	12289	

Major Water Resource Assets

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	East Flowing Rivers between Godavari and Krishna	10342.29	3	0	2	4426	0

Elevation Zone



Symbol	Elevation (M)	Area (Sq. km)	% of Total Area
	<5	1568.233	12.76
	5-10	2772.25	22.56
	10-50	2811.064	22.87
	50-100	1907.191	15.52
	100-200	2516.322	20.48
	200-300	530.0036	4.31
	300-400	69.15304	0.56
	400-500	59.85721	0.49
	500-750	54.92647	0.45

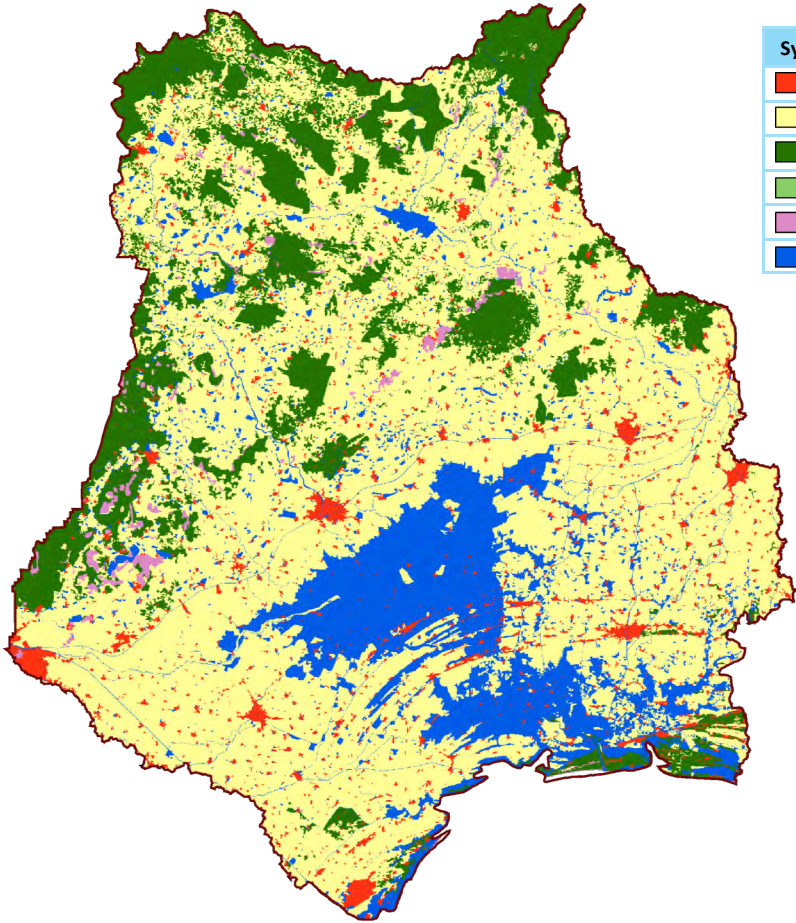
Average Annual Rainfall (1971-2005)



Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	1000-1200	12289	100

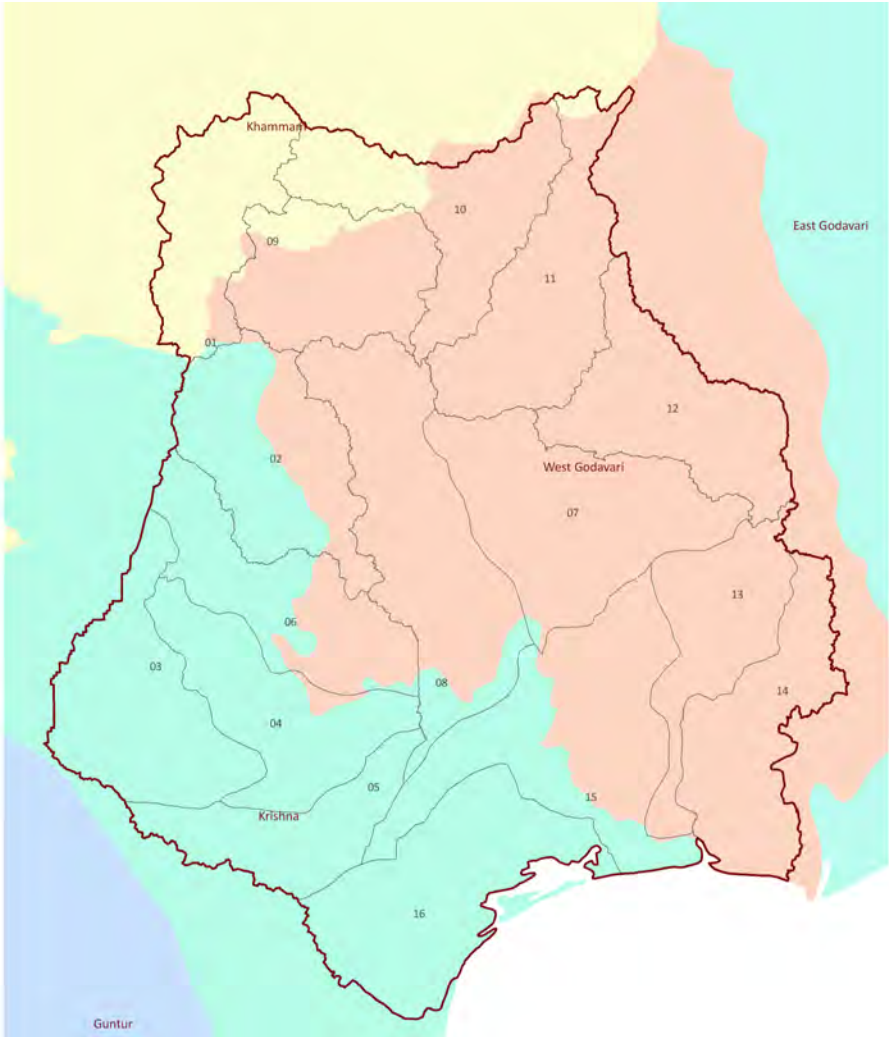
Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Water-shed (sq. km)	Max. size of Wa-tershed (sq. km)	Avg. size of Water-shed (sq. km)
1	East Flowing Rivers between Godavari and Krishna	16	472.32	902.04	646.39

Land Use / Land Cover (2005-06)



Symbol	Category	Area (Sq. km)	% of Total Area
	Built Up Land	539.22	4.39
	Agricultural	7714.22	62.77
	Forest	2137.52	17.39
	Grassland	1.12	0.01
	Wasteland	138.56	1.13
	Waterbodies	1758.36	14.31

Districts



Boundary	
	Basin
	Sub-Basin
	Watershed

1. East Flowing Rivers between Godavari and Krishna Sub-Basin

523



81° E

East Flowing Rivers between Godavari and Krishna



ANDHRA PRADESH

17° N

17° N

Krishna

ANDHRA PRADESH

West Godavari

Bay of Bengal

Watershed Code

Sub-Basin Name	Watershed Code
East Flowing Rivers between	C16GTK01 to 16

Legend

- Major City
 - Watershed Code
 - River
 - Reservoir
 - Basin Boundary
 - Watershed Boundary
 - State Boundary
 - International Boundary
- Elevation**
- High
- Low

0 8 Km

81° E

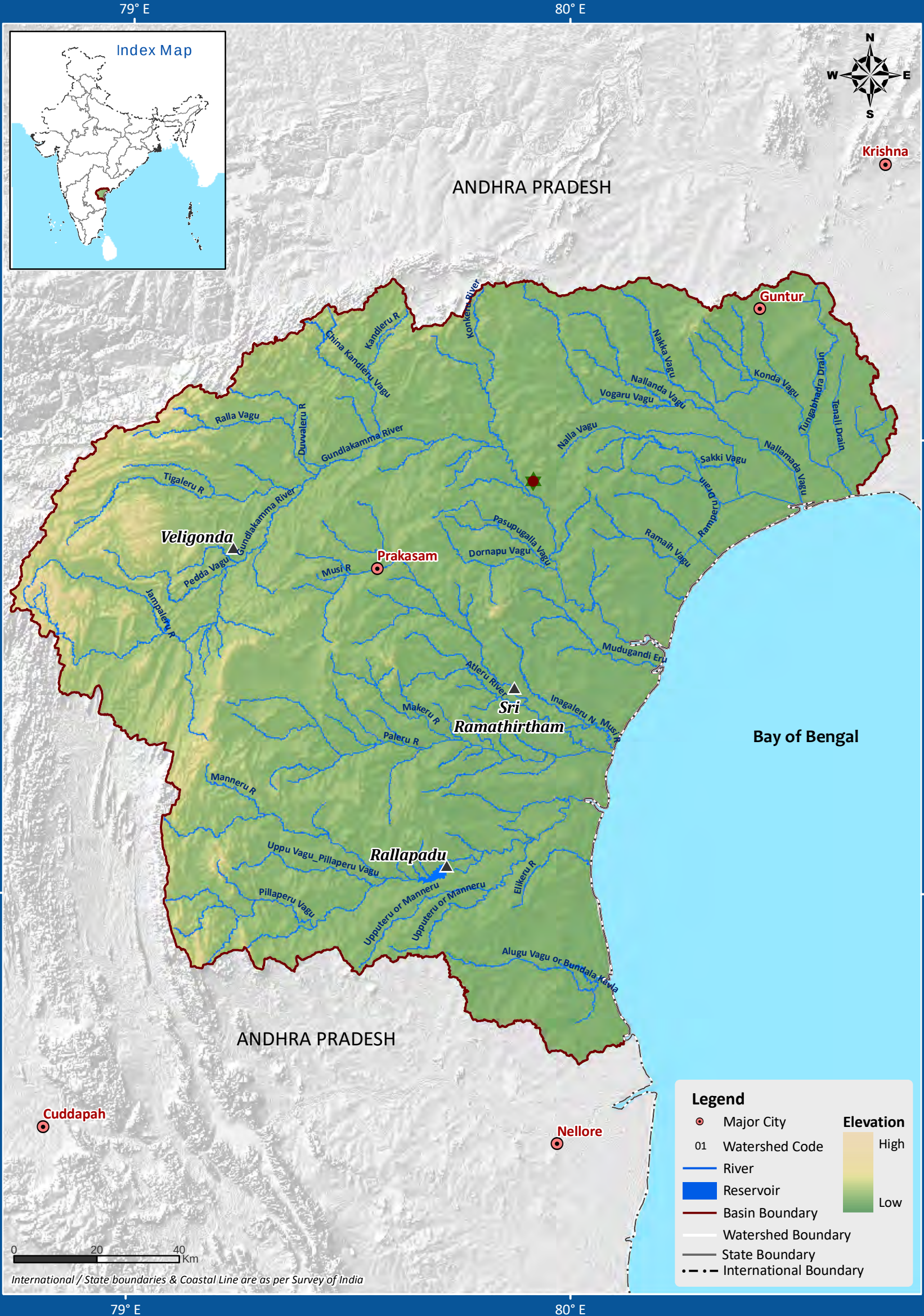
16° N

16° N

168

326

5.19 EAST FLOWING 524 RIVERS BETWEEN KRISHNA AND PENNAR BASIN



The basin spreads over state of Andhra Pradesh having an area of 24,669 Sq.km which is nearly 0.75% of the total geographical area of the country. The geographical extent of the basin is between 78°43'35" to 80°44'41" east longitudes and 14°37'41" to 16°22'25" north latitudes with maximum length and width of around 160 km and 195 km respectively. It is bounded by the Eastern Ghats on the west and north west, by Andhra plains on the north east, by Nallamala Range on the south and the Bay of Bengal on the east. The various rivers in the basin does not meet into one forming a major stream, rather they flow independently and drains directly into the Bay of Bengal. The independent rivers (directly draining into Bay of Bengal) in the basin are the Gundlakamma, the Musi, the Paleru and the Manneru. The major part of basin is covered with agricultural land accounting to 61.83% of the total area and 5.41% of the basin is covered by water bodies.

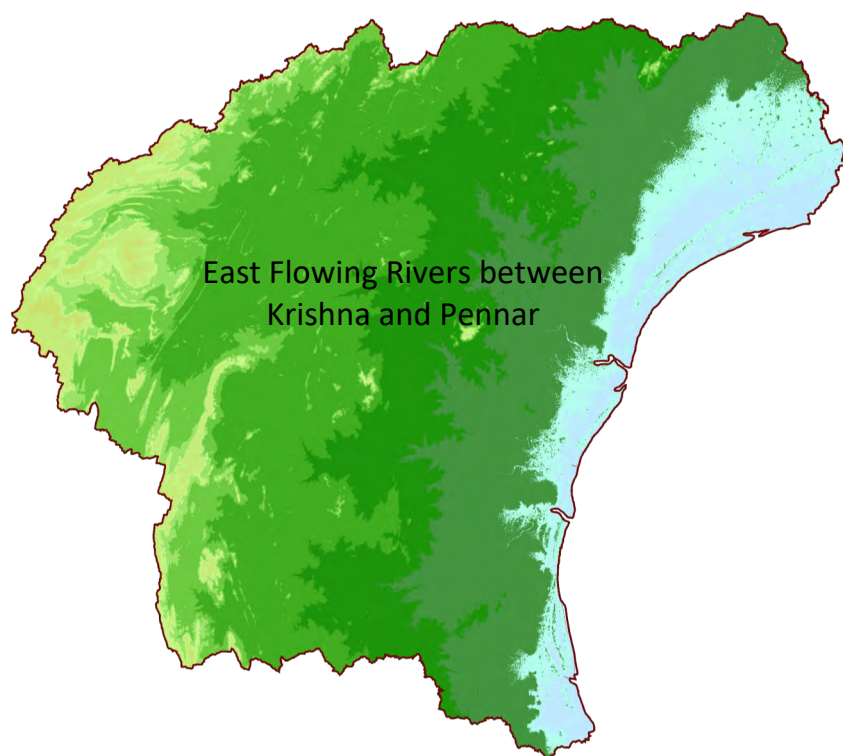
Salient Features of East Flowing Rivers between Krishna and Pennar Basin

Basin Extent	Longitude Latitude	78°43'35" to 80°44'41" E 14°37'41" to 16°22'25" N
Length of River (Km)	Many independent rivers flowing	
Catchment Area (Sq.km.)	24669	
No. of Hydrological Observation	3	

Major Water Resource Assets

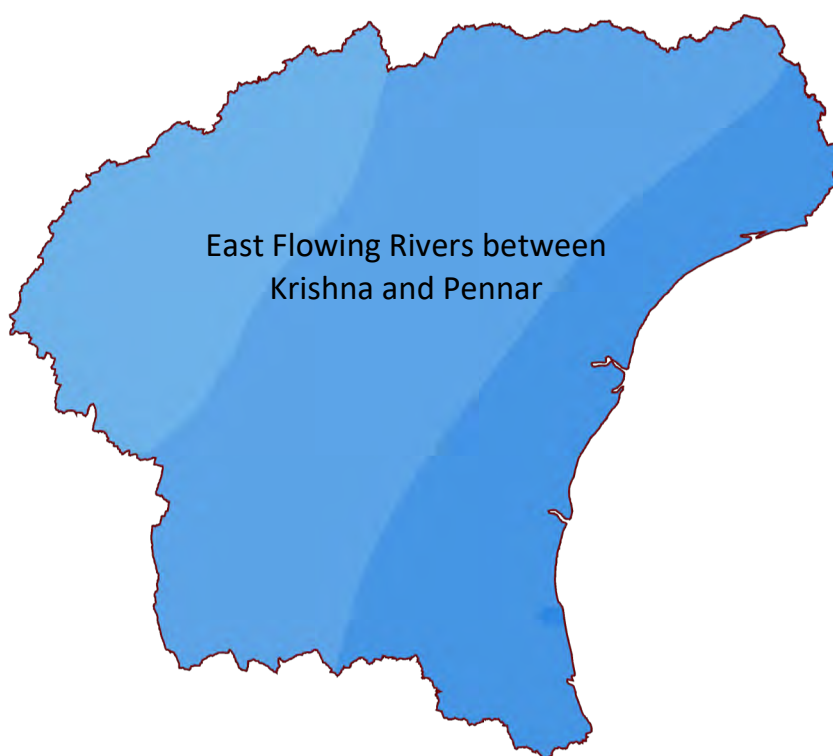
Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	East Flowing Rivers between Krishna and Pennar	23334.63	13	4	9	4010	3

Elevation Zone



Symbol	Elevation (M)	Area (Sq. km)	% of Total Area
	<5	1346.54	5.46
	5-10	1760.40	7.14
	10-50	5464.40	22.15
	50-100	4794.55	19.44
	100-200	6460.35	26.19
	200-300	2301.58	9.33
	300-400	959.33	3.89
	400-500	578.38	2.34
	500-750	873.70	3.54
	750-1000	129.73	0.53

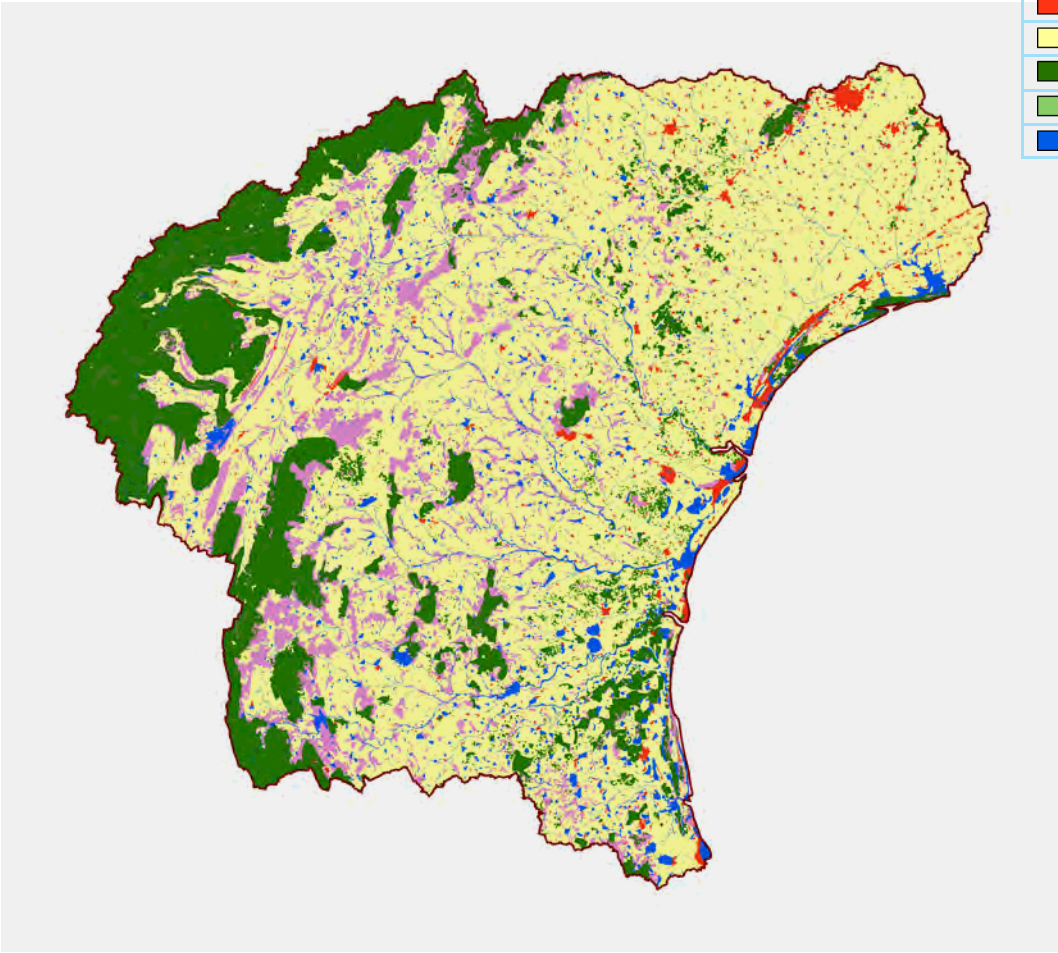
Average Annual Rainfall (1971-2005)



Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	600-800	5481.90	22.22
	800-1000	12212.78	49.51
	1000-1200	6946.33	28.16
	1200-1400	27.99	0.11

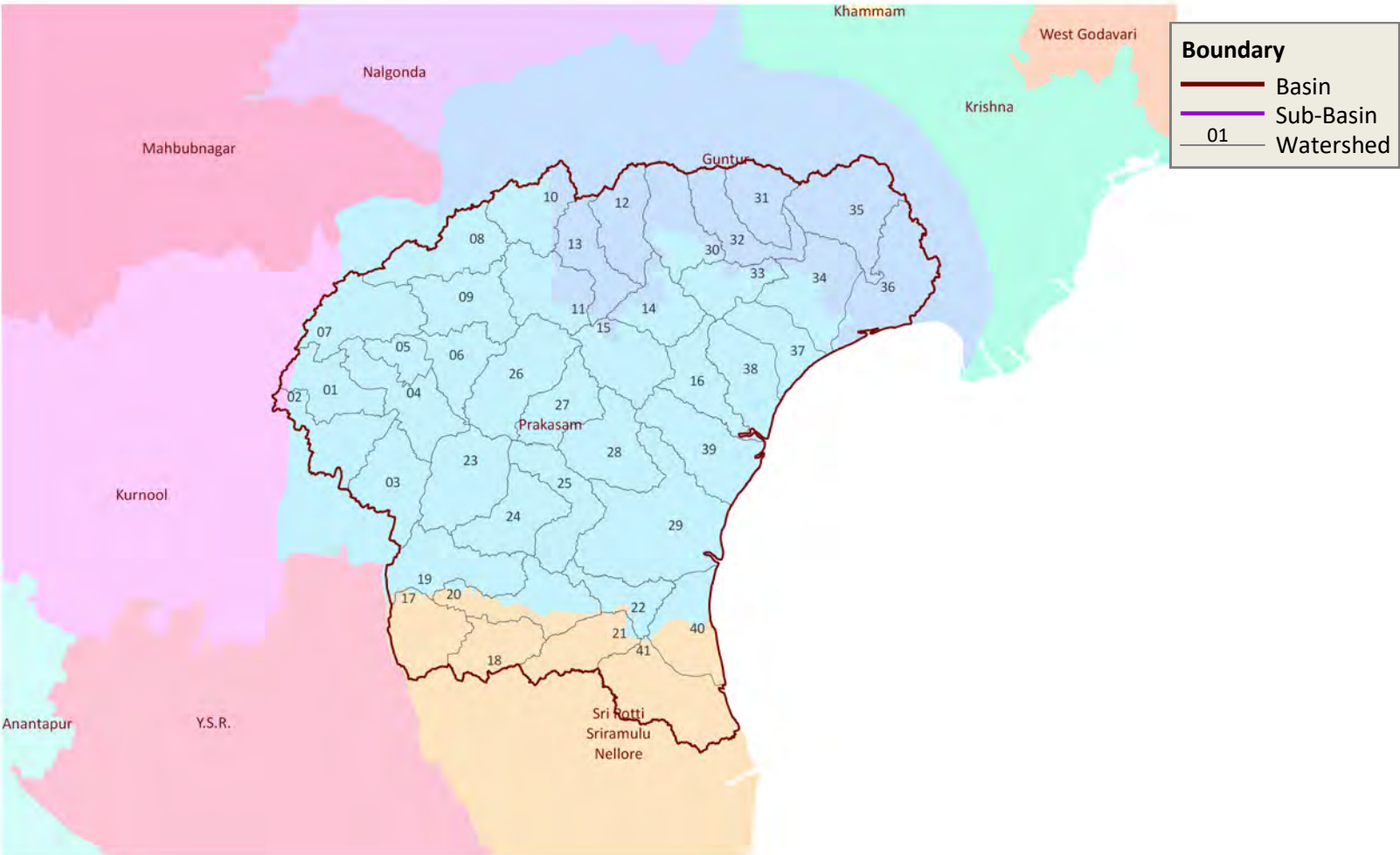
Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	East Flowing Rivers between Krishna and Pennar	41	204.66	1404.19	569.14

Land Use / Land Cover (2005-06)



Symbol	Category	Area (Sq. km)	% of Total Area
	Built Up Land	628.28	2.55
	Agricultural	15253.05	61.83
	Forest	4755.31	19.28
	Wasteland	2697.81	10.94
	Waterbodies	1334.55	5.41

Districts



1. East Flowing Rivers between Krishna and Pennar Sub-Basin



5.20 EAST FLOWING RIVERS BETWEEN PENNAR AND CAUVERY BASIN



The basin extends over states of Tamil Nadu, Andhra Pradesh, Karnataka and Union Territory of Puducherry having a total area of 65,049 Sq.km and accounts for 1.98% of the total geographical area of the country. The basin extends between 77°31'45" to 80°20'46" east longitudes and 11°10'56" to 14°30' 25" north latitudes with maximum length and width of around 290 km and 395 km respectively. It is bounded by the Eastern Ghats on the north, by Tamil Nadu uplands on the west, by Tamil Nadu plains on the south and by the Bay of Bengal on the east. The various rivers in the basin does not meet into one forming a major stream, rather they flow independently and drains directly into the Bay of Bengal. The independent rivers (directly draining into Bay of Bengal) in the basin are the Kandleru, the Swarnamukhi, the Arani, the Korttalaiyar, the Cooum, the Adyar, the Palar and the Ponnaiyar. The major part of basin is covered with agricultural land accounting to 56.75% of the total area and 9.19% of the basin is covered by water bodies.

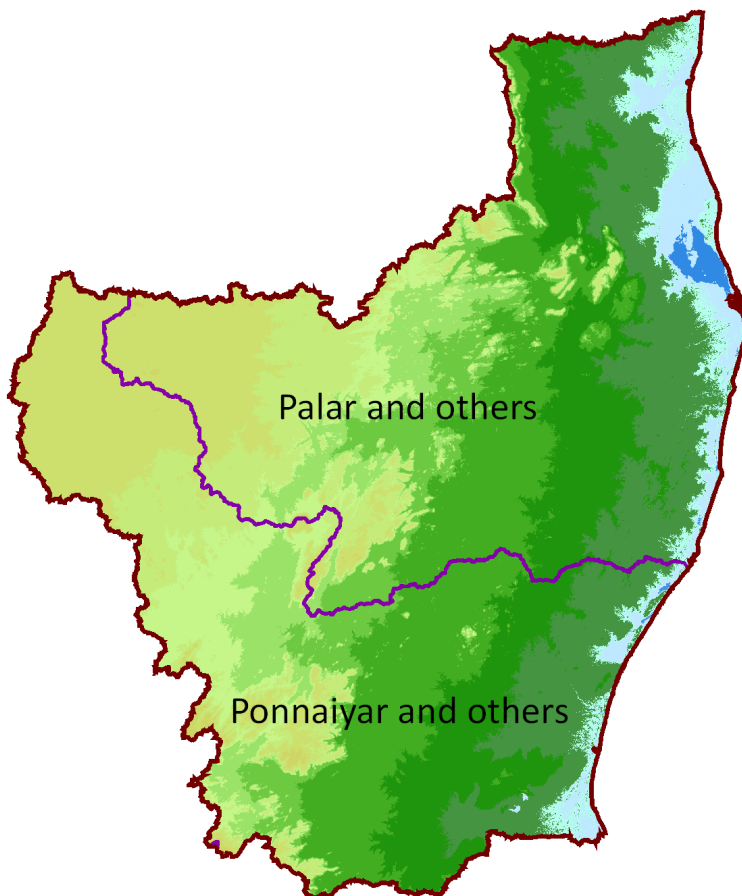
Salient Features of East Flowing Rivers between Pennar and Cauvery Basin

Basin Extent	Longitude Latitude	77°31'45" to 80°20'46" E 11°10'56" to 14°30' 25" N
Length of River (Km)	Many independent rivers flowing	
Catchment Area (Sq.km.)	65049	
No. of Hydrological Observation Stations	11	

Major Water Resource Assets

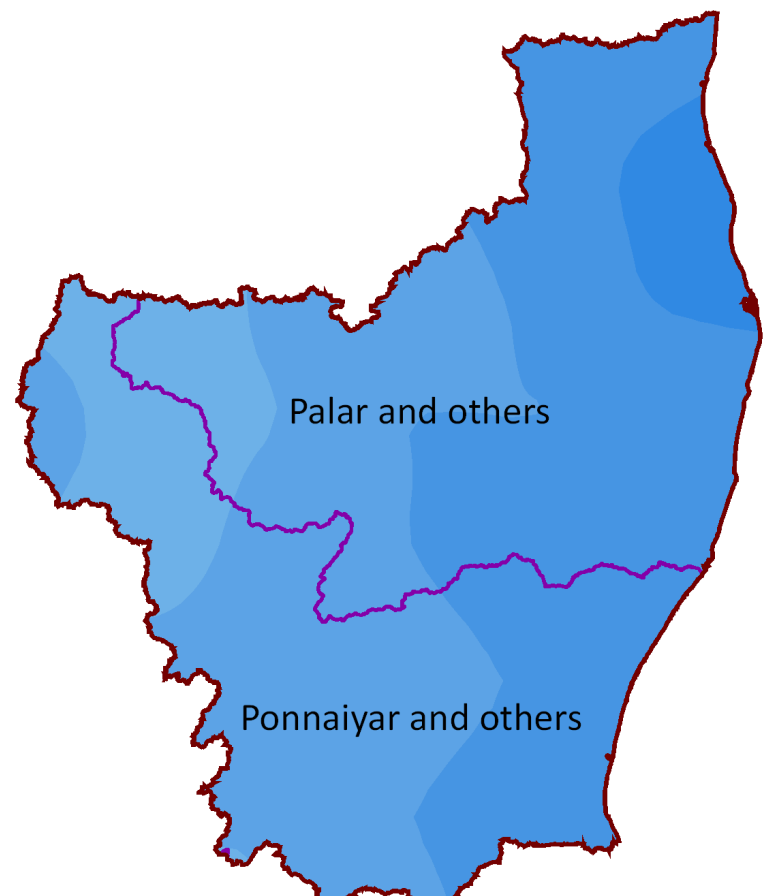
Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Palar and others	35392.34	18	7	16	18040	6
2	Ponnaiyar and others	28249.49	18	5	16	11716	5

Elevation Zone



Symbol	Elevation (M)	Area (Sq. km)	% of Total Area
	<5	2634.03	4.05
	5-10	1960.91	3.01
	10-50	10231.98	15.73
	50-100	9590.04	14.74
	100-200	10521.00	16.17
	200-300	4453.17	6.85
	300-400	4768.81	7.33
	400-500	4492.12	6.91
	500-750	7012.61	10.78
	750-1000	9075.26	13.95
	1000-1500	306.04	0.47

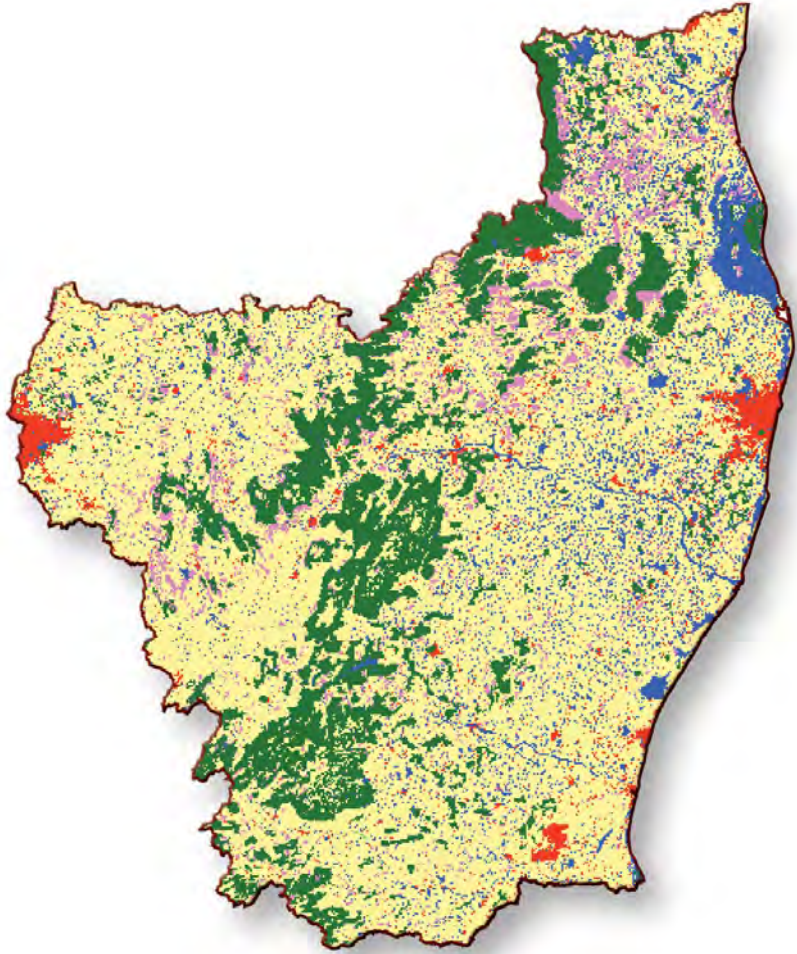
Average Annual Rainfall (1971-2005)



Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	600-800	8209.53	12.62
	800-1000	25217.73	38.77
	1000-1200	28170.64	43.31
	1200-1400	3451.10	5.31

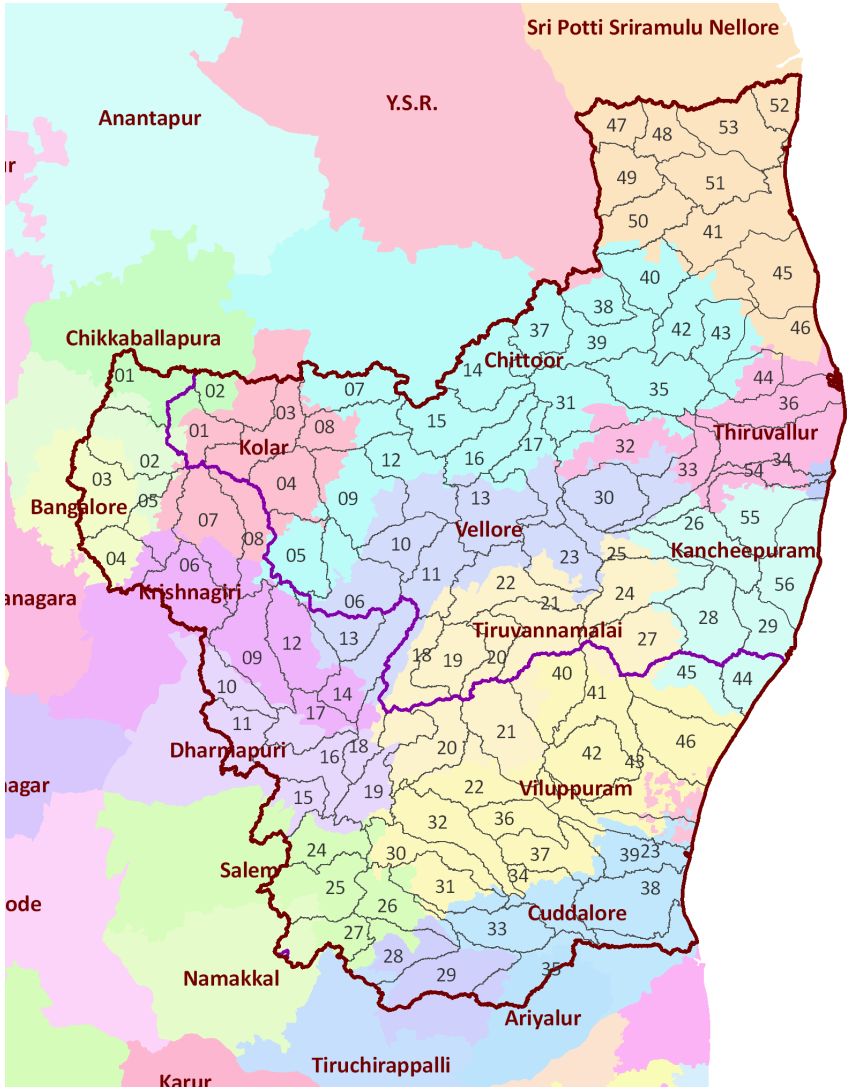
Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Palar and others	56	321.81	957.25	632.01
2	Ponnaiyar and others	46	356.72	900.11	614.12

Land Use / Land Cover (2005-06)



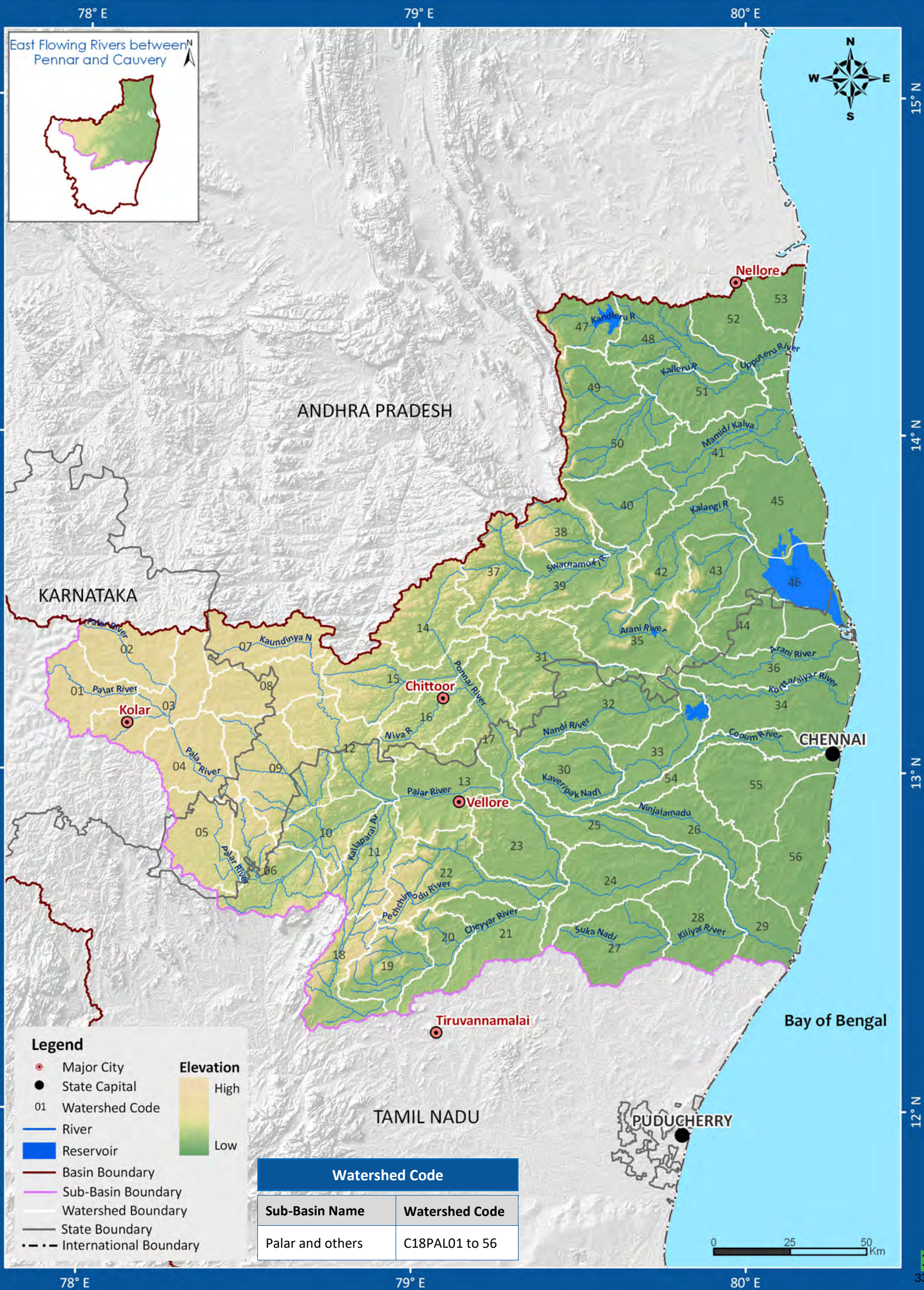
Symbol	Category	Area (Sq. km)	% of Total Area
■	Built Up Land	2584.08	3.97
■	Agricultural	36918.11	56.75
■	Forest	15329.85	23.57
■	Grassland	7.69	0.01
■	Wasteland	4230.63	6.50
■	Waterbodies	5978.63	9.19

Districts



Boundary	
—	Basin
—	Sub-Basin
01	Watershed

531 1. Palar and others Sub-Basin



2. Ponnaiyar and others Sub-Basin

532



533

5.21 EAST FLOWING RIVERS SOUTH OF CAUVERY BASIN



The basin extends over state of Tamil Nadu having a total area of 35,090 Sq.km and accounts for 1.07% of the total geographical area of the country. The basin extends between 77°8'8" to 79°24'58" east longitudes and 8°8'32" to 10°45'8" north latitudes with maximum length and width of around 230 km and 318 km respectively. It is bounded by Tamil Nadu plains on the north, by South Ghats on the west, by the Indian Ocean on the south and by the Bay of Bengal on the east. The various rivers in the basin does not meet into one forming a major stream, rather they flow independently and drains directly into the Bay of Bengal. The independent rivers (directly draining into Bay of Bengal) in the basin are the Vellar, the Varshalei, the Vaigai, the Gundar, the Vaippar and the Tambraparni. The major part of basin is covered with agricultural land accounting to 65.97% of the total area and 9.32% of the basin is covered by water bodies.

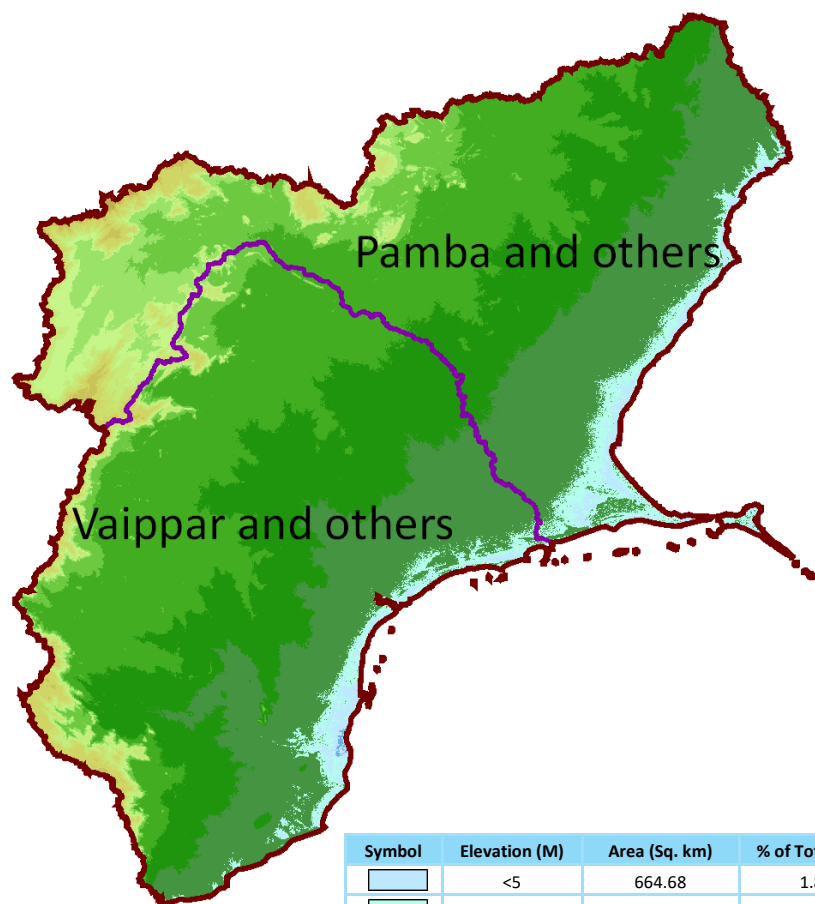
Salient Features of East Flowing Rivers South of Cauvery Basin

Basin Extent	Longitude Latitude	77°8'8" to 79°24'58" E 8°8'32" to 10°45'8" N
Length of River (Km)	Many independent rivers flowing	
Catchment Area (Sq.km.)	35090	
No. of Hydrological Observation Stations	6	

Major Water Resource Assets

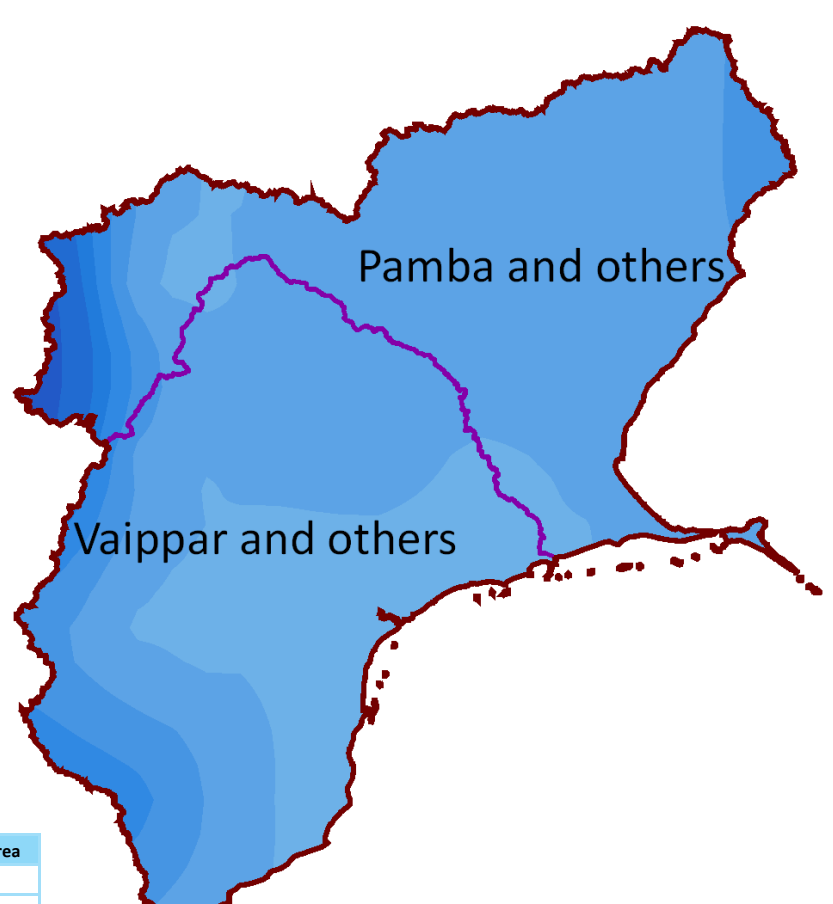
Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Pamba and others	18289.41	7	2	7	19059	3
2	Vaippar and others	20356.69	18	1	15	9490	3

Elevation Zone



Symbol	Elevation (M)	Area (Sq. km)	% of Total Area
	<5	664.68	1.89
	5-10	1289.64	3.68
	10-50	8643.72	24.63
	50-100	8372.86	23.86
	100-200	9058.60	25.82
	200-300	2239.65	6.38
	300-400	1415.27	4.03
	400-500	850.17	2.42
	500-750	949.17	2.70
	750-1000	579.21	1.65
	1000-1500	792.05	2.26
	1500-2000	187.95	0.54
	2000-3000	47.02	0.13

Average Annual Rainfall (1971-2005)



Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	600-800	7626.15	21.73
	800-1000	21849.59	62.27
	1000-1200	3359.65	9.57
	1200-1400	1183.91	3.37
	1400-1600	337.57	0.96
	1600-2000	508.69	1.45
	2000-2500	220.35	0.63
	2500-3000	4.10	0.01

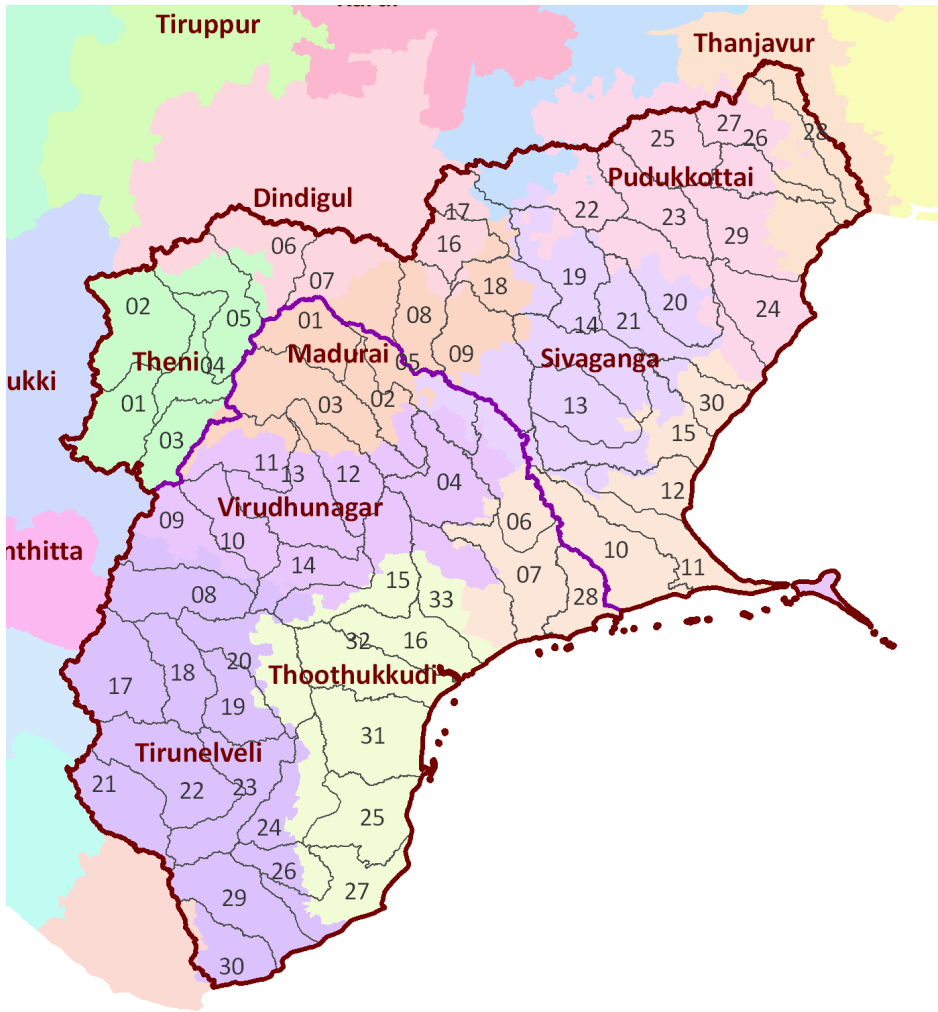
Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Pamba and others	30	316.52	937.66	609.65
2	Vaippar and others	33	318.37	887.70	616.87

Land Use / Land Cover (2005-06)



Symbol	Category	Area (Sq. km)	% of Total Area
	Built Up Land	989.90	2.82
	Agricultural	23148.82	65.97
	Forest	5945.14	16.94
	Grassland	2.00	0.01
	Wasteland	1735.08	4.94
	Waterbodies	3271.05	9.32

Districts



Boundary	
	Basin
	Sub-Basin
01	Watershed



537 2. Vaippar and others Sub-Basin



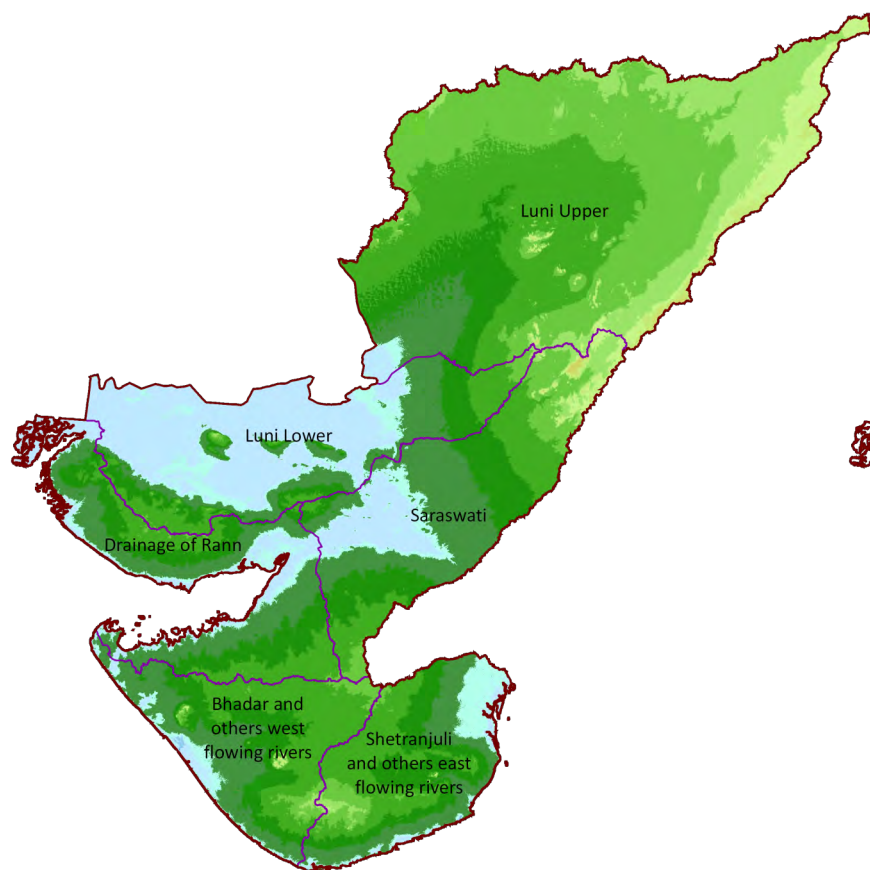
This map illustrates the Luni and Saraswati river basins in Rajasthan, India, and their confluence into the Arabian Sea. The map is divided into several sub-basins: Luni Upper Sub-Basin, Luni Lower Sub-Basin, Drainage of Rann Sub-Basin, Little Rann, Saraswati Sub-Basin, Bhadar and other West Flowing Rivers Sub-Basin, and Shetranjuli and other East Flowing Rivers Sub-Basin. Major cities shown include Jaisalmer, Jodhpur, Barmer, Gandhinagar, Ahmedabad, Anand, Vadodara, Bhavnagar, Junagadh, Rajkot, Jamnagar, and Porbandar. The map also shows the Gulf of Kutch, Gulf of Khambhat, and the Arabian Sea. A legend in the bottom left corner defines symbols for Major City, State Capital, Dam / Barrage / Weir, River, Reservoir, Basin Boundary, Sub-Basin Boundary, State Boundary, International Boundary, Major CWC Sites (Flood Forecasting Station, Gauge, Discharge Station, Gauge, Discharge, Water Quality Station, Gauge, Discharge, Sediment, Water Quality Station), and Elevation (High, Low). An index map in the top left corner shows the location of the study area within India. A scale bar in the bottom right corner indicates distances up to 100 Km. The map is titled 'Luni and Saraswati River Basins' and is dated 2024.

The basin extends over large areas in Rajasthan and Gujarat and covers whole of Diu having an area of 321,851 Sq.km with maximum length and width of 865 km and 445 km. It lies between 67° 52' to 75° 19' east longitudes and 20° 53' to 26° 57' north latitudes. The basin is bounded by Aravalli range and Gujarat plains on the east, by Rajasthan desert on north, and by the Arabian Sea on the south and the west.

Luni is the major river system of the basin and it originates from western slopes of the Aravalli ranges at an elevation of 772m in Ajmer district of Rajasthan. The total length of the river is 511 km and it drains a total area of 32,879 Sq.km. The river flows up to Rann of Kutch forming a delta where the water spreads out and does not contribute any runoff. The main tributaries of Luni joining from left are the Lilri, the Guhiya, the Bandi (Hemawas), the Sukri, the Jawai, the Khari Bandi, the Sukri Bandi and the Sagi whereas the Jojri joins it from right. Other independent rivers of the basin are the Shetrunji, the Bhadar, the Machhu, the Rupen, the Saraswati and the Banas. The Shetrunji drains into the Gulf of Khambhat, the Bhadar out falls into Arabian Sea, and the Machhu, the Rupen, the Saraswati and the Banas drains into Little Rann of Kutch. The major part of basin is covered with agriculture accounting to 65.06% of the total area and only 5.25% of the basin is covered by water bodies.

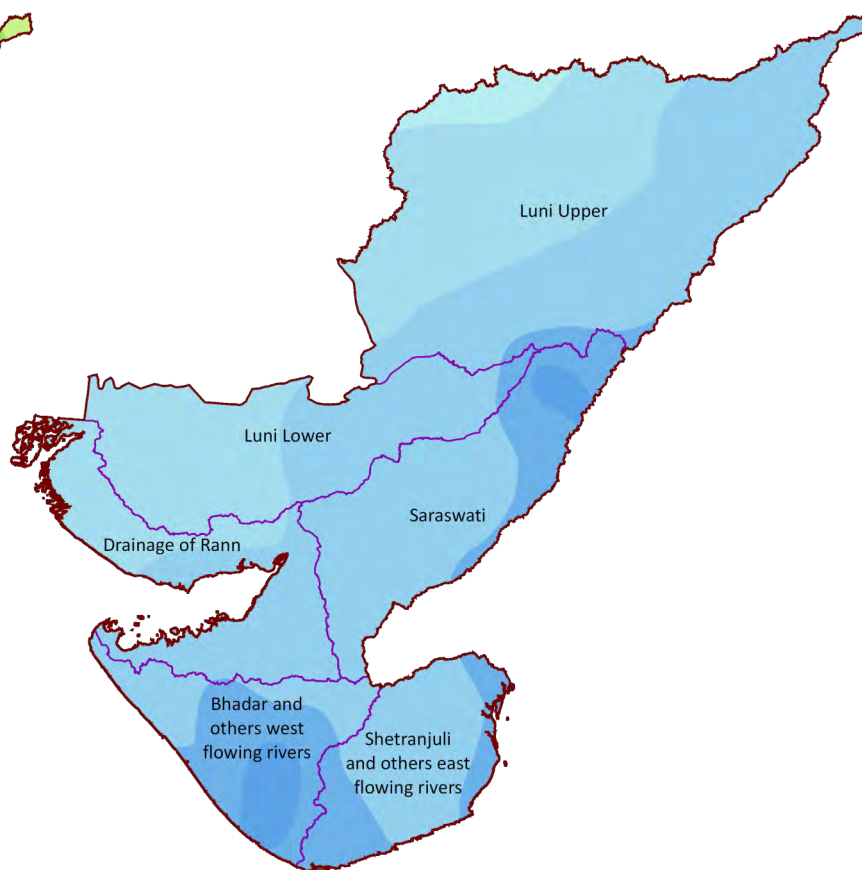
Basin Extent	Longitude Latitude	67° 52' to 75° 19' E 20° 53' to 26° 57' N
Length of Luni River (Km)		511
Catchment Area (Sq.km.)		321851
Average Water Resource Potential (MCM)		15100
Utilizable Surface Water Resource (MCM)		15000
Live Storage Capacity of Completed Projects (MCM)		4726.92
Live Storage Capacity of Projects Under Construction (MCM)		797.23
Total Live Storage Capacity of Projects (MCM)		5524.15
No. of Hydrological Observation Stations		15
No. of Flood Forecasting Stations		1

Elevation Zone



Symbol	Elevation (m)	Area (Sq. km)	% of Total Area
	< 5	41148.74	12.79
	5-10	15999.86	4.97
	10-50	55116.65	17.12
	50-100	47974.78	14.90
	100-200	74692.74	23.21
	200-300	52278.49	16.25
	300-400	22864.59	7.10
	400-500	8182.26	2.54
	500-750	2846.14	0.88
	750-1000	549.36	0.17
	1000-1500	186.36	0.06
	1500-2000	11.03	0.01

Average Annual Rainfall (1971-2005)



Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	<200	6229.14	1.94
	200-400	97372.89	30.25
	400-600	168715.00	52.42
	600-800	40841.77	12.69
	800-1000	8692.20	2.70

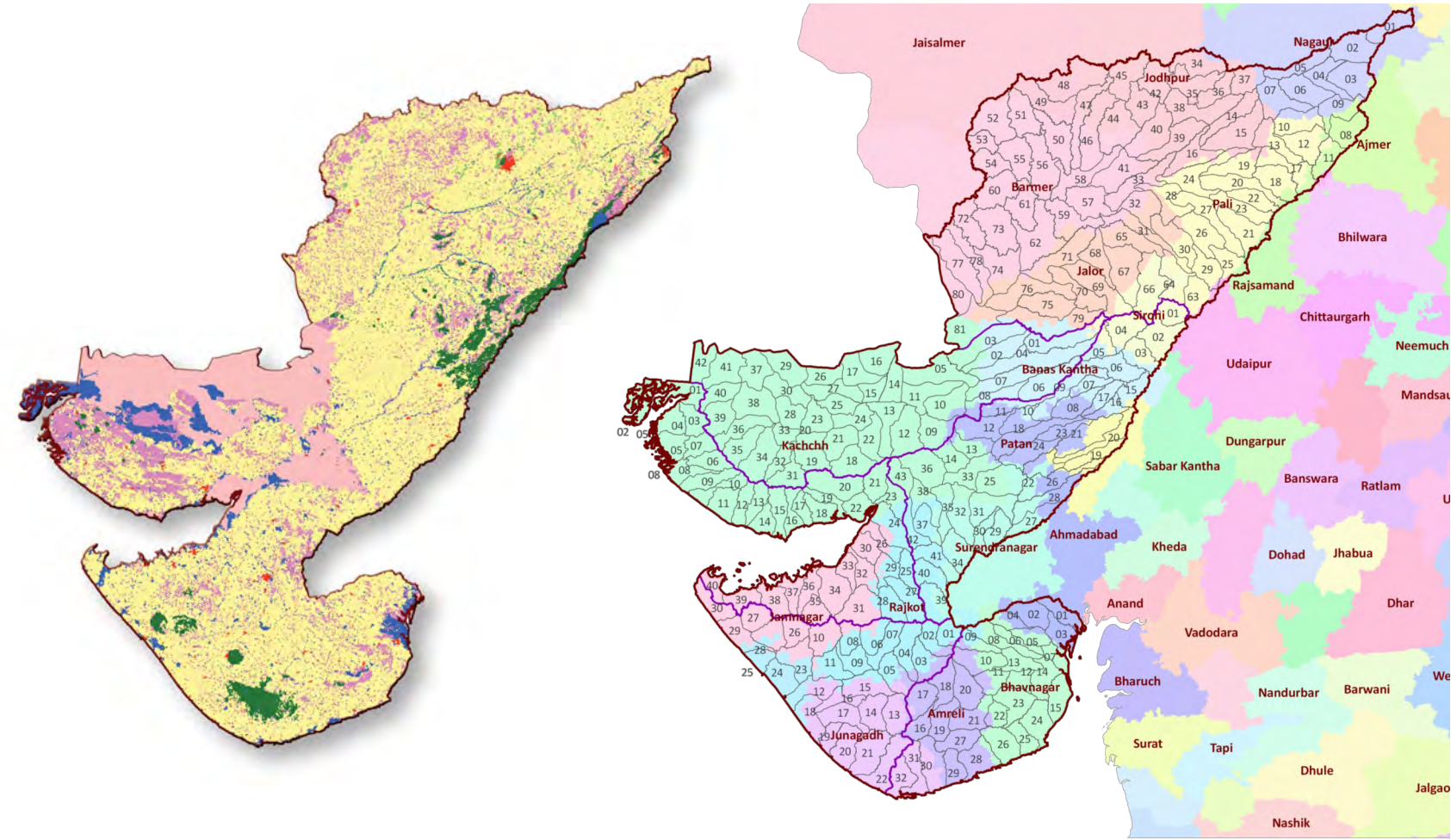
Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Bhadar and others West Flowing Rivers	18489.70	70	6	64	978	1
2	Luni Lower	29180.12	55	0	49	1801	0
3	Luni Upper	70202.58	27	0	51	10605	2
4	Drainage of Rann	21229.90	107	1	104	2150	0
5	Saraswati	27260.84	50	1	67	3267	11
6	Shetrunji and others East Flowing Rivers	18221.67	99	3	98	813	1

Watershed Statistics

Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Water-shed (sq. km)	Max. size of Wa-tershed (sq. km)	Avg. size of Water-shed (sq. km)
1	Bhadar and others West Flowing Rivers	30	331.14	964.84	616.32
2	Luni Lower	42	315.95	1418.64	694.76
3	Luni Upper	81	381.48	1447.71	866.70
4	Drainage of Rann	40	310.82	968.30	530.75
5	Saraswati	43	308.99	1017.93	633.97
6	Shetrunji and others East Flowing Rivers	32	300.06	855.86	569.43

Land Use / Land Cover (2005-06)

Districts



Symbol	Category	Area (Sq. km)	% of Total Area
	Built Up Land	3720.44	1.16
	Agricultural	209392.77	65.06
	Forest	11456.12	3.56
	Grassland	4009.37	1.25
	Wasteland	46115.23	14.32
	Waterbodies	16908.29	5.25
	Rann	30248.78	9.40

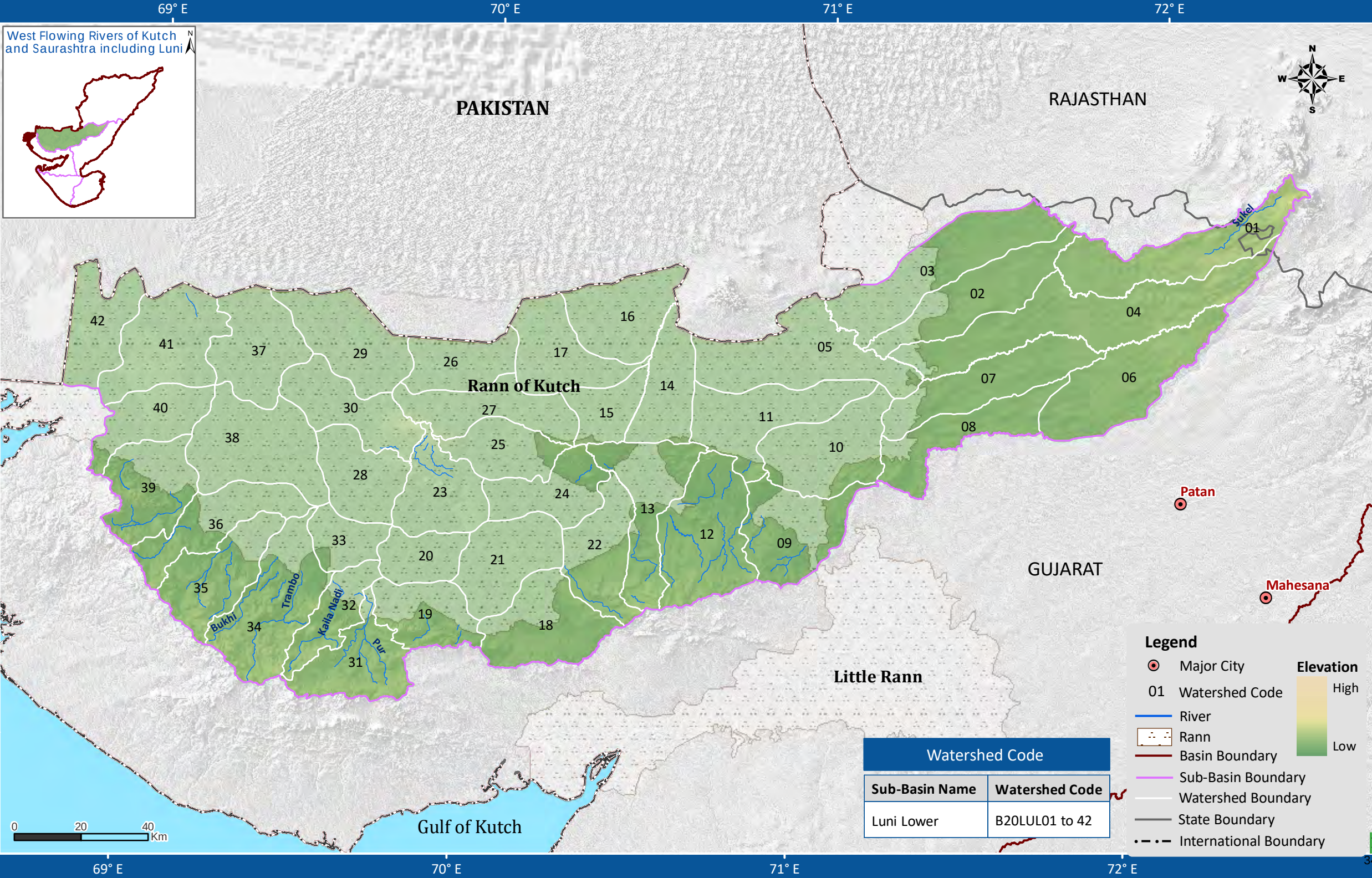
Boundary	
	Basin
	Sub-Basin
	Watershed

1. Bhadar and other West Flowing Rivers Sub-Basin

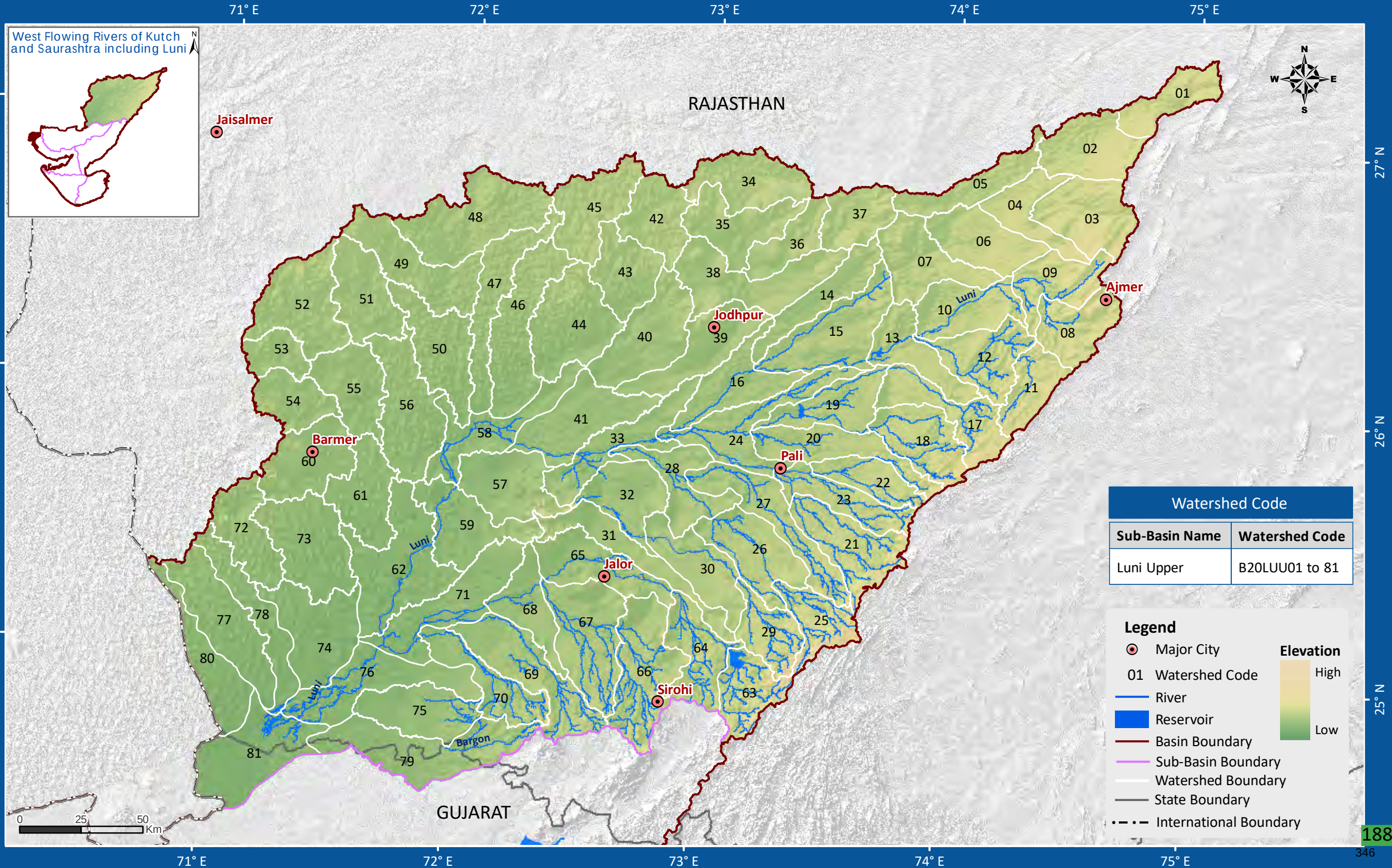


542

2. Luni Lower Sub-Basin



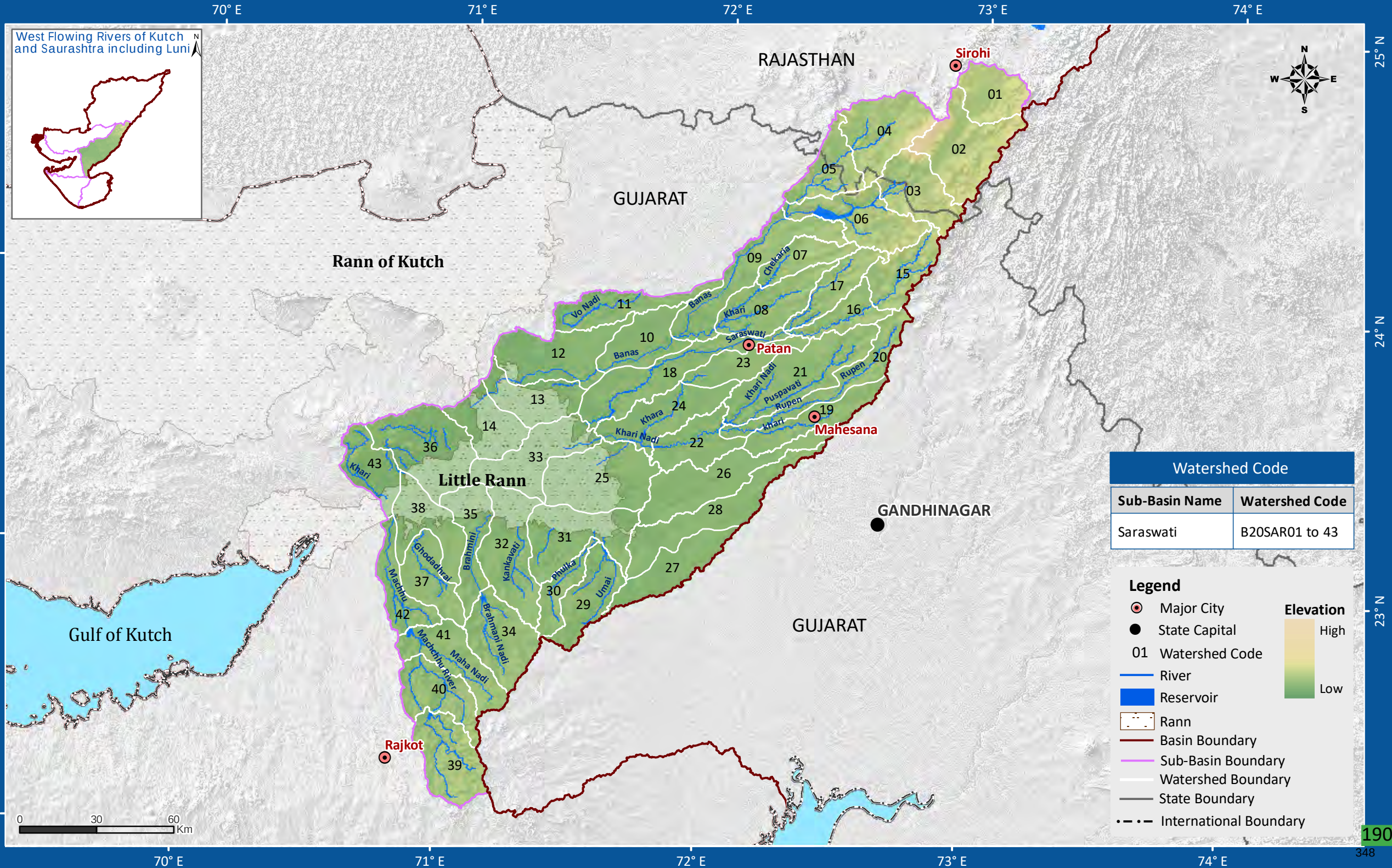
3. Luni Upper Sub-Basin



544 4. Drainage of Rann Sub-Basin



545



6. Shetrunji and other East Flowing Rivers Sub-Basin

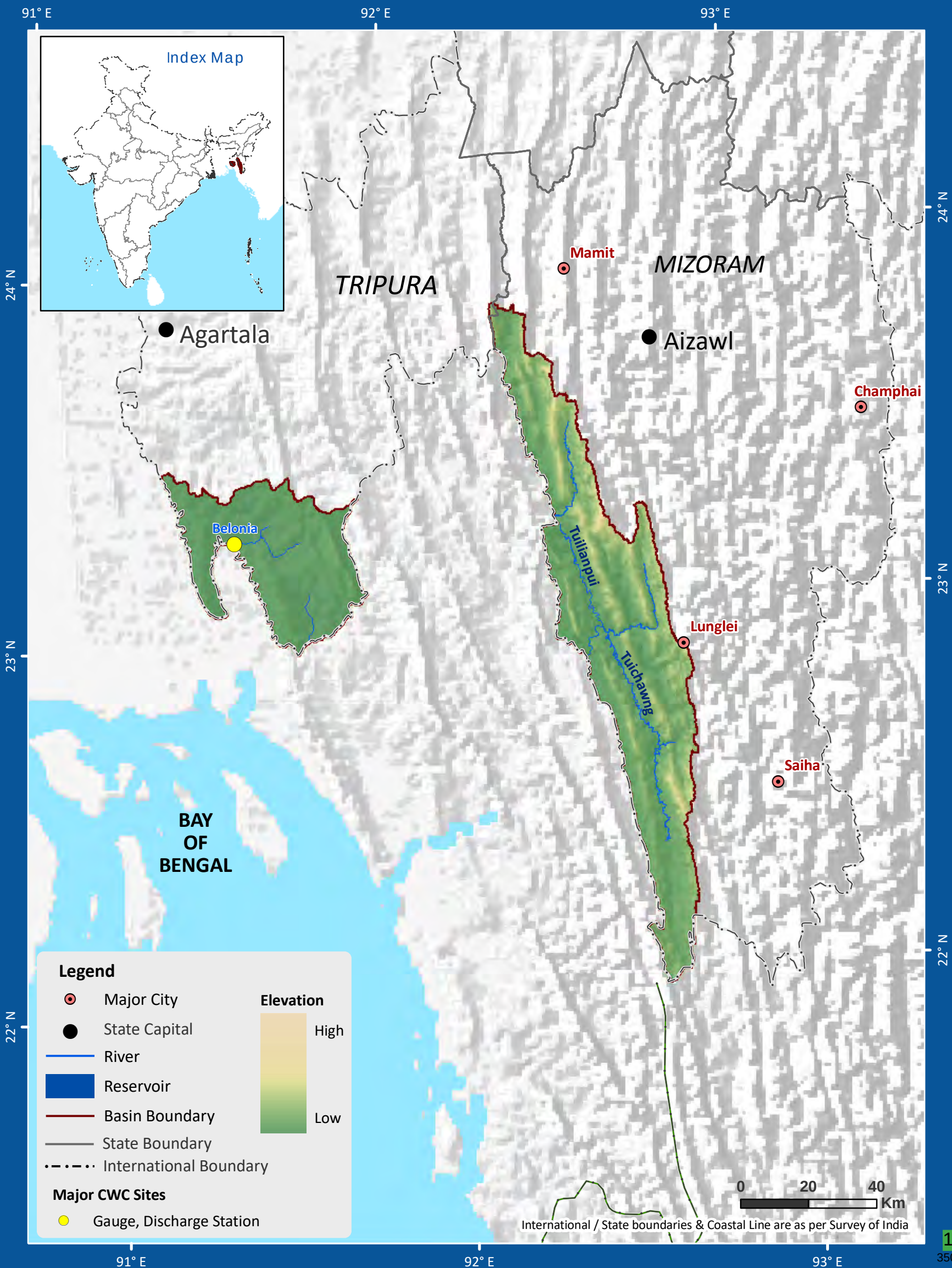


546



547

5.23 MINOR RIVERS DRAINING INTO BANGLADESH BASIN

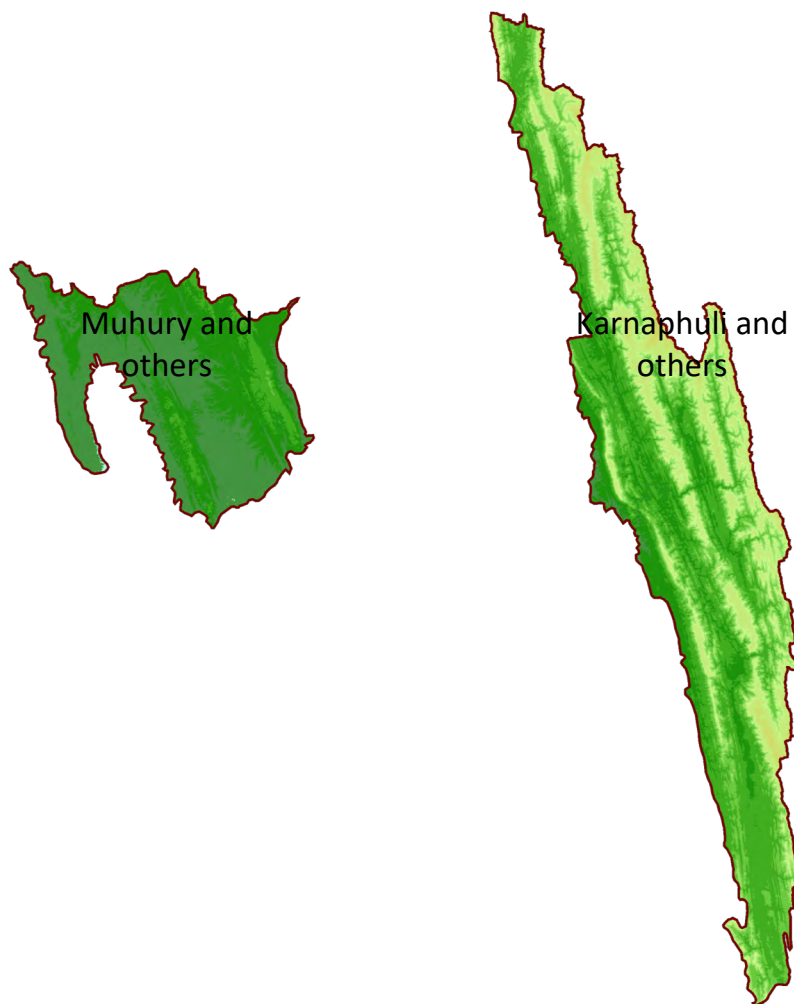


The basin extends over states of Mizoram and Tripura having a total area of 5,453.23 Sq.km and its geographical extent is between 91°15'29" to 92°45'54" east longitudes and 21°58'44" to 23°50'56" north latitudes. The basin is bounded by Purvanchal range in the north and the east and by Bangladesh in the west and the south. Some of the rivers in the basin are Muhury in Tripura and Karnaphuli, Tuilianpui and Tuichawng in Mizoram. The major part of basin is covered with forest accounting to 80.49% of the total area and only 0.53% of the basin is covered by water bodies.

Salient Features of Minor River Draining into Bangladesh Basin

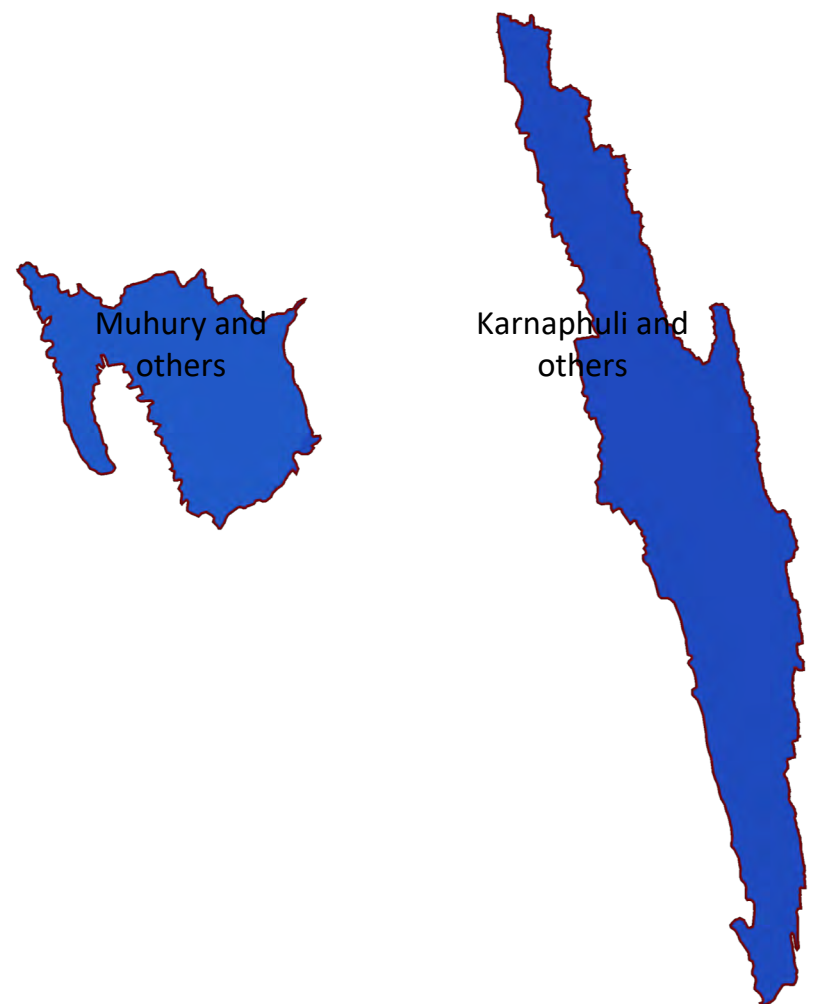
Basin Extent	Longitude Latitude	91°15'29" to 92°45'54" E 21°58'44" to 23°50'56" N
Length of River (Km)	Many independent rivers flowing	
Catchment Area (Sq.km.)	5453	
No. of Hydrological Observation Stations	1	

Elevation Zone



Symbol	Elevation (M)	Area (Sq. km)	% of Total Area
	10-50	949.86	17.42
	50-100	1051.62	19.28
	100-200	1262.76	23.16
	200-300	710.57	13.03
	300-400	484.42	8.88
	400-500	379.33	6.97
	500-750	497.31	9.12
	750-1000	106.06	1.94

Average Annual Rainfall (1971-2005)



Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	2000-2500	1661.7	30.47
	2500-3000	3791.53	69.53

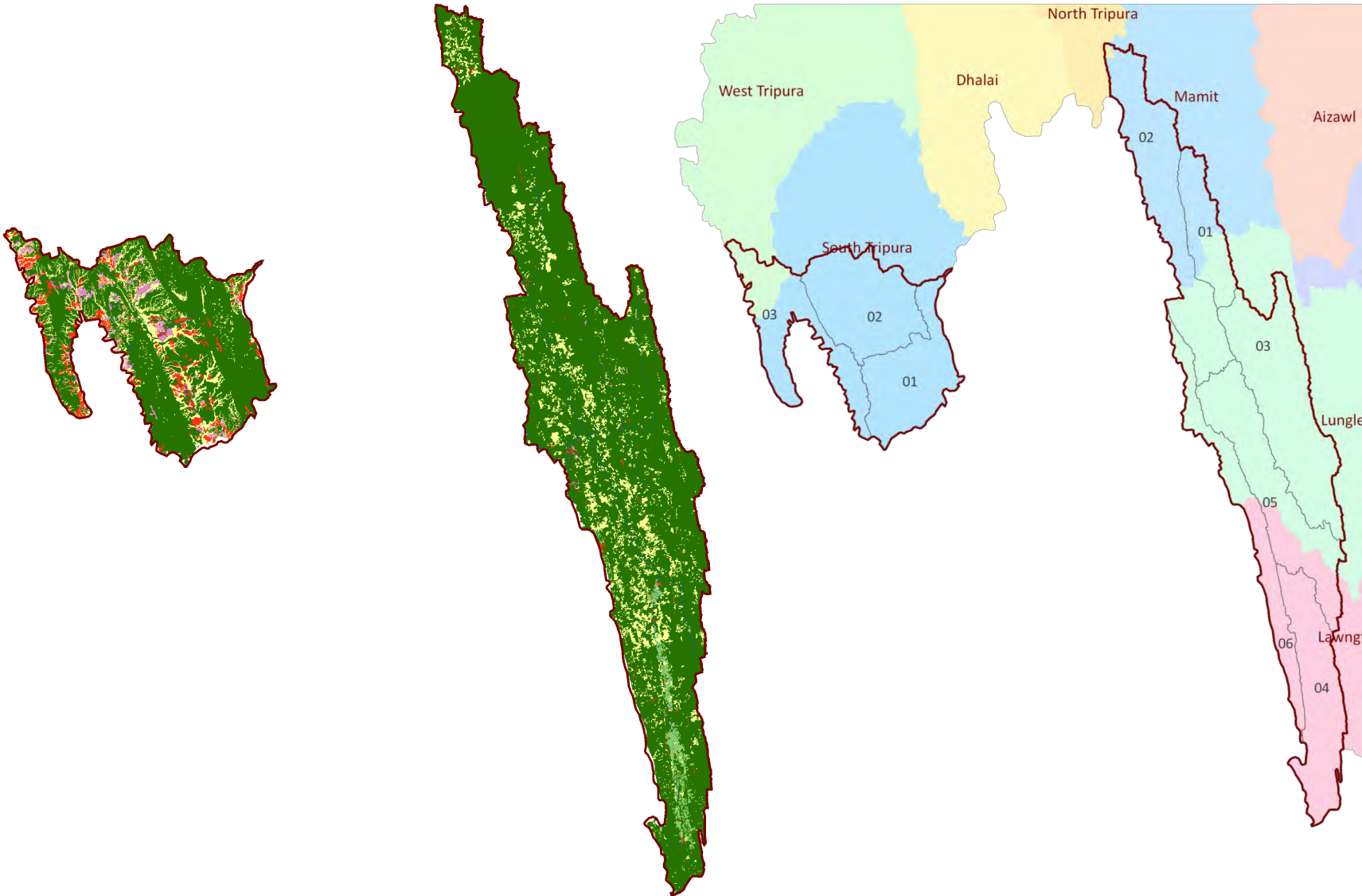
Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Karnaphuli and others	3776.84	0	0	0	13	0
2	Muhury and others	1676.39	0	0	0	28	1

Watershed Statistics

Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Karnaphuli and others	6	312.58	881.89	629.47
2	Muhury and others	3	532.77	6.7.58	558.80

Land Use / Land Cover (2005-06)

Districts

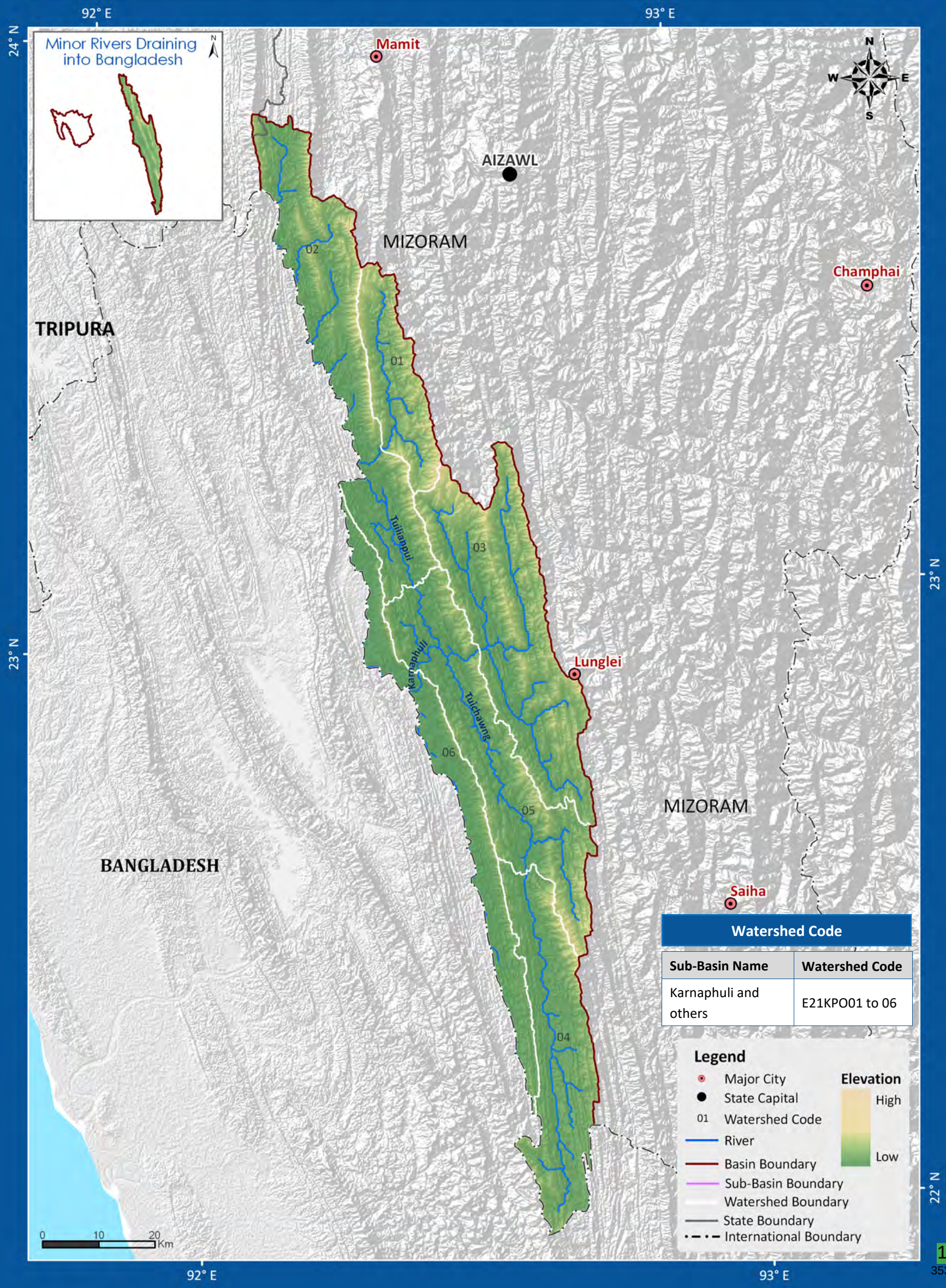


Symbol	Category	Area (Sq. km)	% of Total Area
■	Built Up Land	144.94	2.66
■	Agricultural	649.07	11.90
■	Forest	4389.04	80.49
■	Grassland	81.78	1.50
■	Wasteland	159.55	2.93
■	Waterbodies	28.85	0.53

Boundary	
—	Basin
—	Sub-Basin
—	01 Watershed

1. Karnaphuli and others Sub-Basin

550



Watershed Code

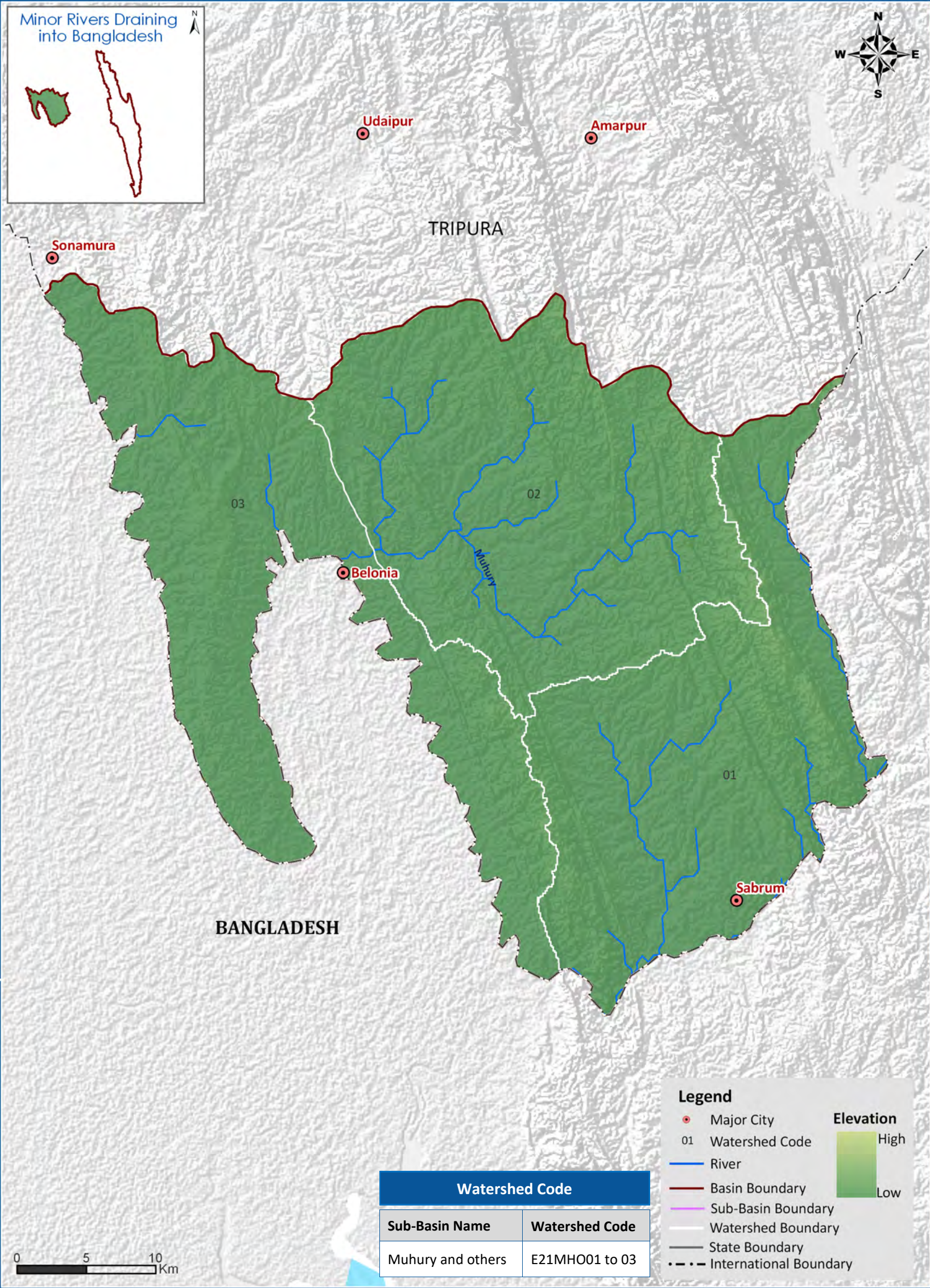
Sub-Basin Name	Watershed Code
Karnaphuli and others	E21KPO01 to 06

Legend

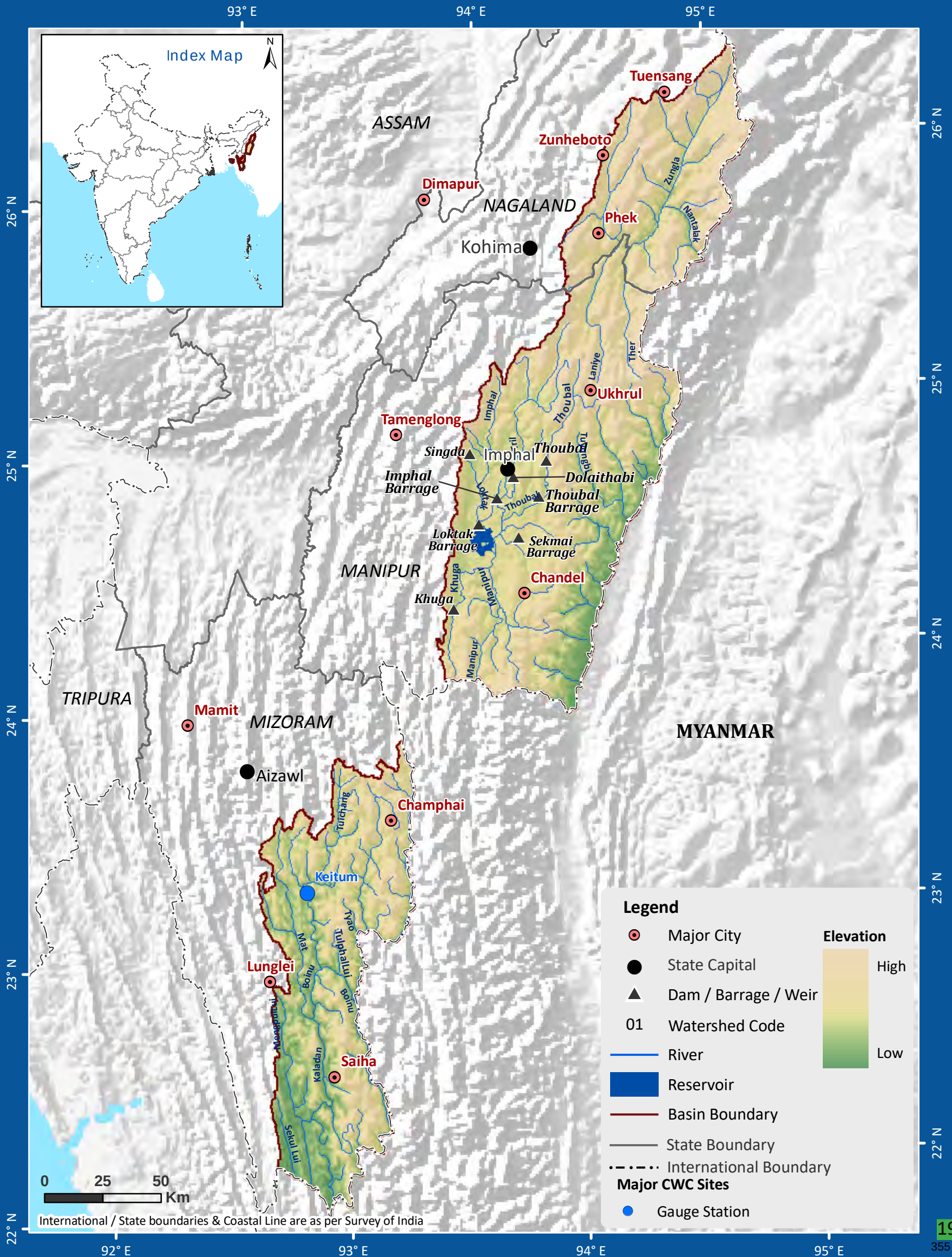
- Major City
 - State Capital
 - 01 Watershed Code
 - River
 - Basin Boundary
 - Sub-Basin Boundary
 - Watershed Boundary
 - State Boundary
 - International Boundary
- Elevation**
- High
 - Low

551

2. Muhury and others Sub-Basin



5.24 MINOR RIVERS DRAINING INTO MYANMAR BASIN

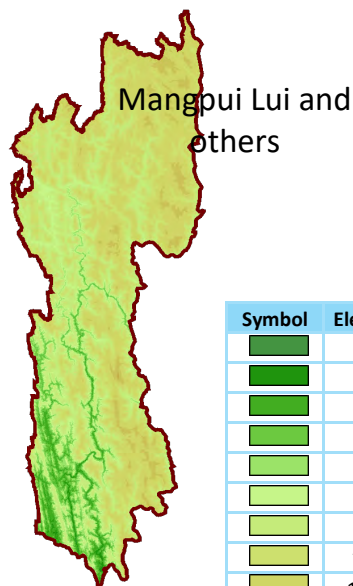
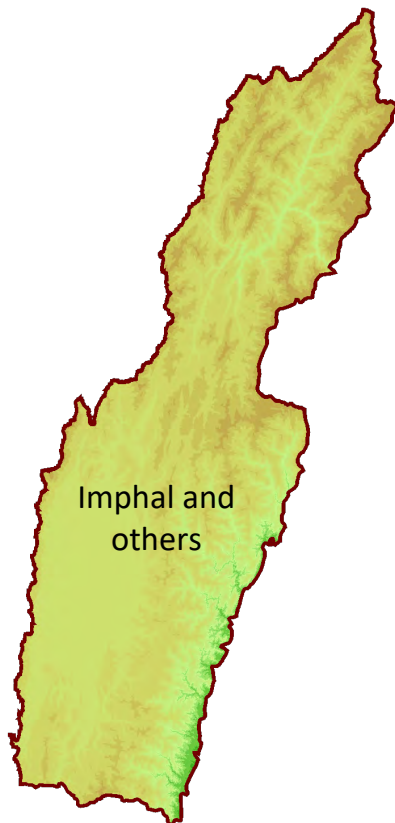


The basin extends over states of Manipur, Mizoram and Nagaland having a total area of 24,731.08 Sq.km and its geographical extent is between 92°41'49" to 95°11'3" east longitudes and 21°56'39" to 26°23'45" north latitudes. The basin is bounded by Purvanchal range in the north and the west and by Myanmar in the east and the south. The Imphal is the main river of the basin and it rises near Kangpokpi in Senapati district of Manipur and receives the Iril from the south and the Thoubal from the east. It also receives the Khuga from the south-west and is known as Manipur River below its confluence. The Chakpi River joins Imphal from the opposite direction 3 km below Shuganuand the combined water flows southward through a narrow gorge to fall into the Chindwin river of Burma. Other rivers in the basin are Mengpui Lui, Tulphal Lui, Tuichang, Kaladan etc. The major part of basin is covered with forest accounting to 74.16% of the total area and only 2.44% of the basin is covered by water bodies.

Salient Features of Minor Rivers Draining into Myanmar Basin

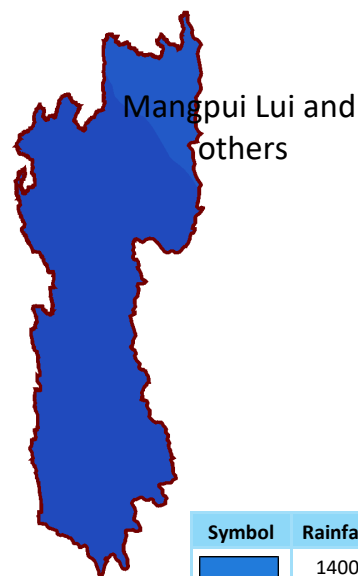
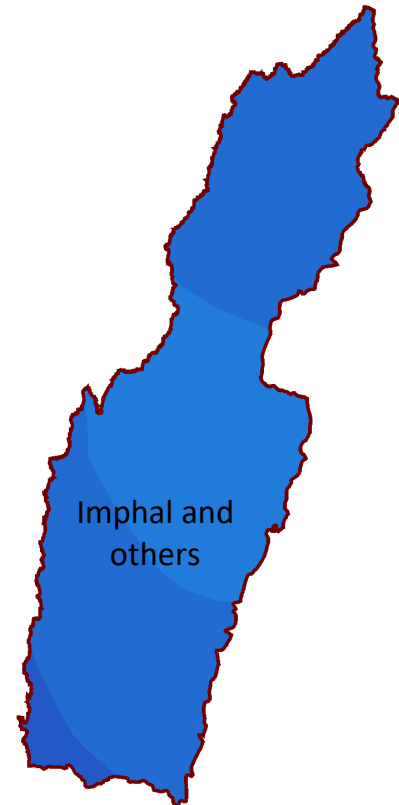
Basin Extent	Longitude Latitude	92°41'49" to 95°11'3" E 21°56'39" to 26°23'45" N
Length of River (Km)	Many independent rivers flowing	
Catchment Area (Sq.km.)	24731	
No. of Hydrological Observation Stations	7	

Elevation Zone



Symbol	Elevation (M)	Area (Sq. km)	% of Total Area
	10-50	31.00	0.13
	50-100	225.16	0.91
	100-200	575.40	2.33
	200-300	726.18	2.94
	300-400	871.50	3.52
	400-500	2857.97	11.56
	500-750	6884.07	27.84
	750-1000	8281.35	33.49
	1000-1500	3179.22	12.86
	1500-2000	1078.24	4.36
	2000-3000	20.12	0.08

Average Annual Rainfall (1971-2005)



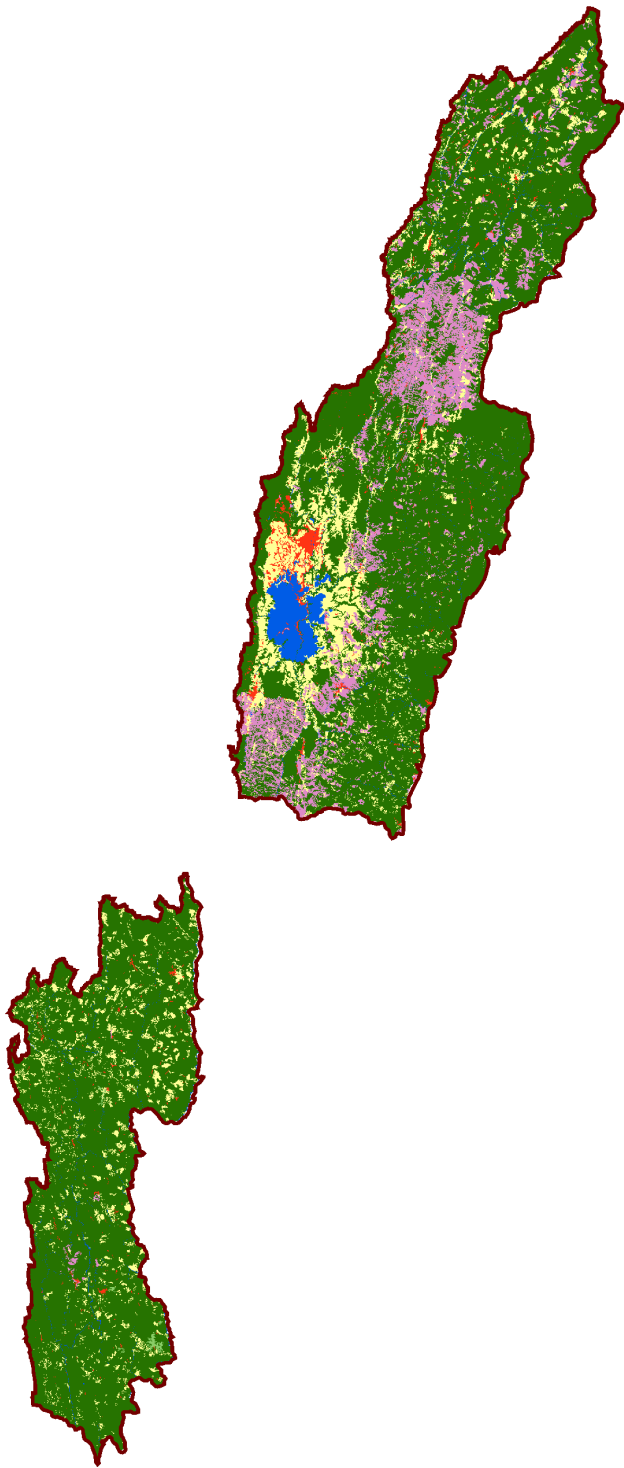
Symbol	Rainfall (mm)	Area (Sq. km)	% of Total Area
	1400-1600	5689.59	23.01
	1600-2000	10475.64	42.36
	2000-2500	1647.84	6.66
	2500-3000	6918.01	27.97

Sl. No.	Name of Sub-basin	Area (sq. km)	No. of Dam	No. of B/W/A	No. of Reservoirs	No. of Surface water bodies	No. of HO Stations
1	Imphal and others	16754.90	3	5	3	1525	0
2	Mangpui Lui and others	7976.18	0	0	0	89	7

Watershed Statistics

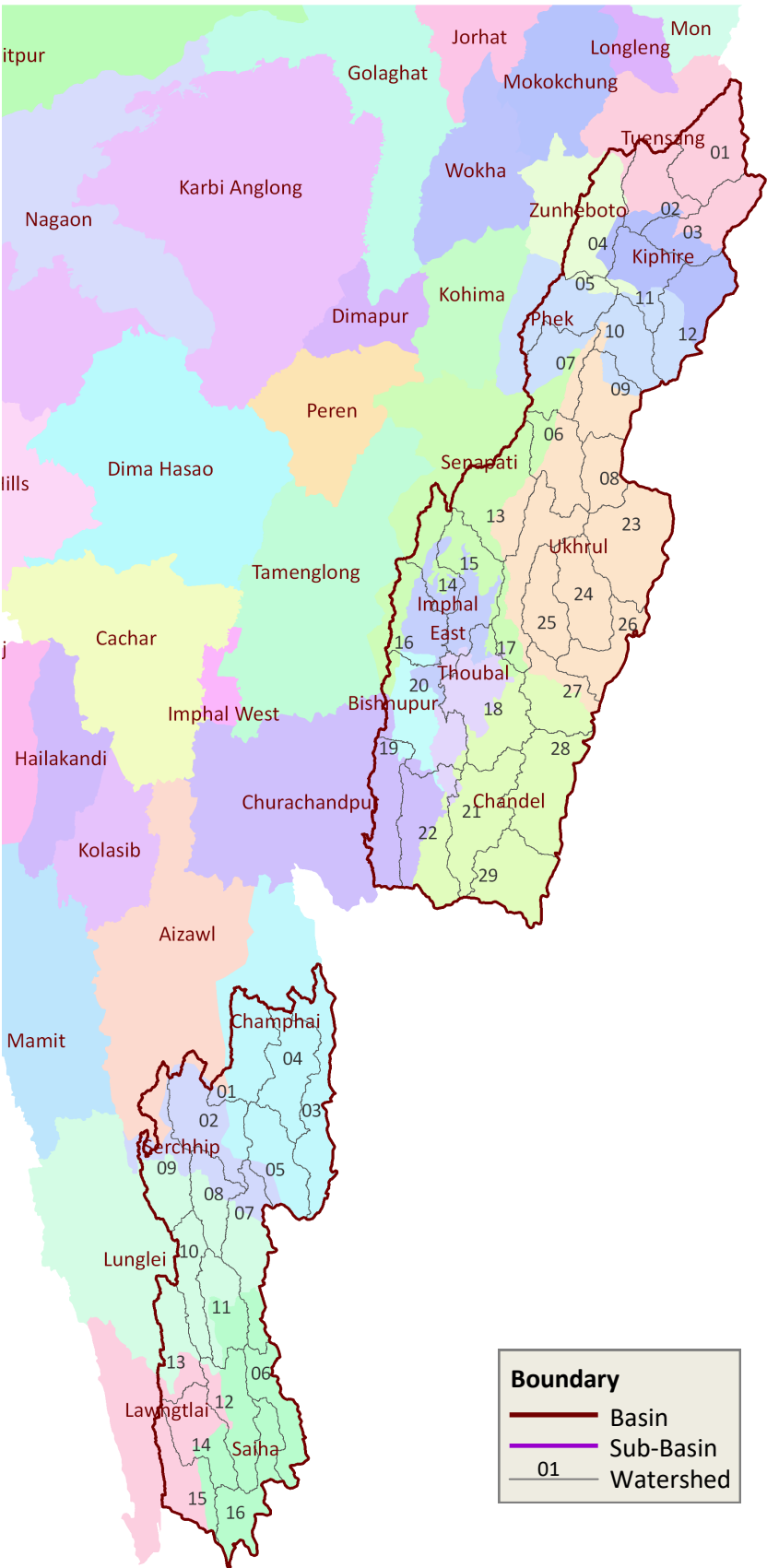
Sl. No.	Name of Sub-basin	No. of Watersheds	Min. size of Watershed (sq. km)	Max. size of Watershed (sq. km)	Avg. size of Watershed (sq. km)
1	Imphal and others	29	321.26	899.22	577.76
2	Mangpui Lui and others	16	359.61	655.10	498.51

Land Use / Land Cover (2005-06)



Symbol	Category	Area (Sq. km)	% of Total Area
	Built Up Land	371.21	1.50
	Agricultural	2696.53	10.90
	Forest	18340.80	74.16
	Grassland	25.68	0.10
	Wasteland	2693.74	10.89
	Waterbodies	603.12	2.44

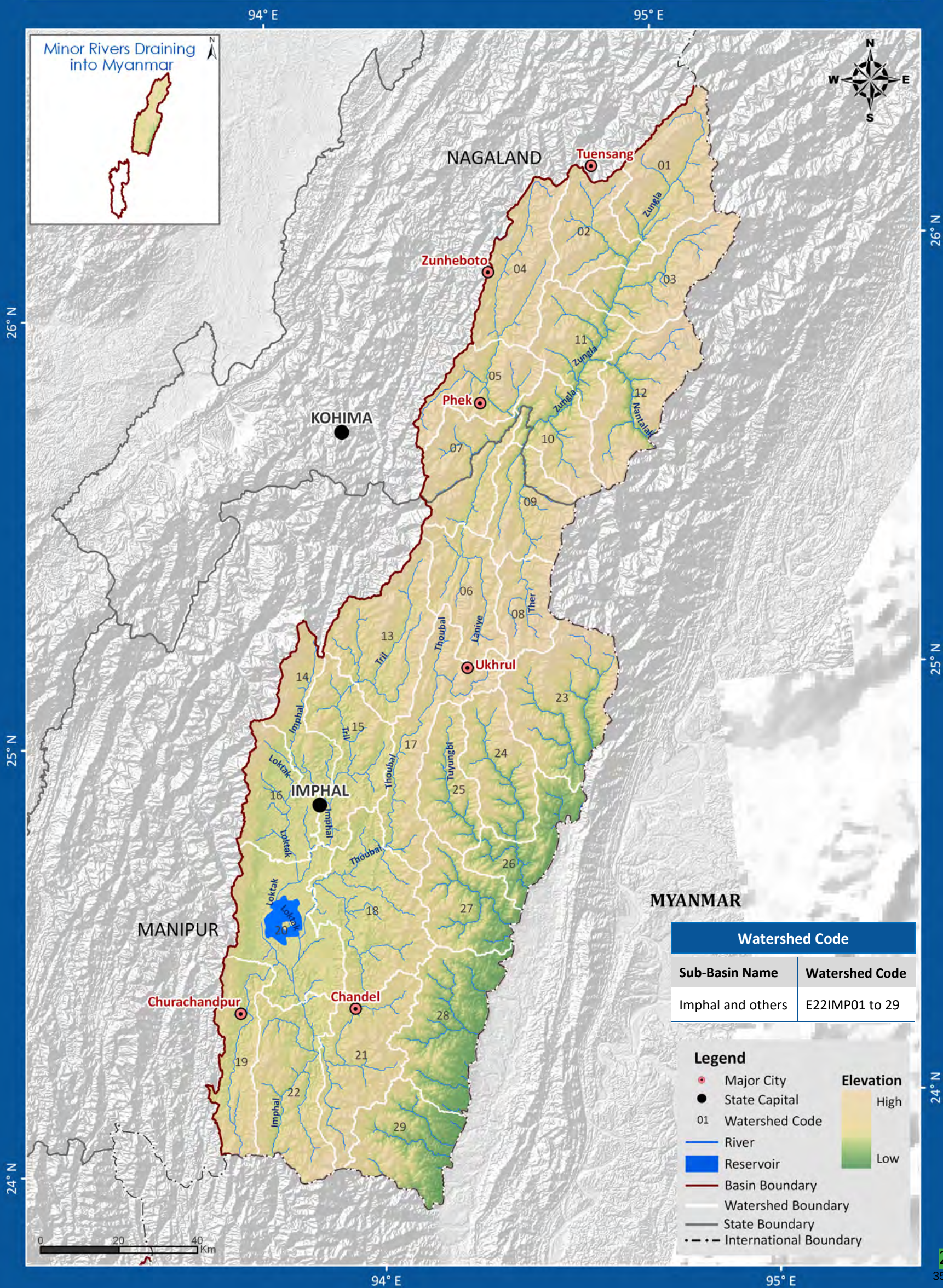
Districts



Boundary	
	Basin
	Sub-Basin
	Watershed

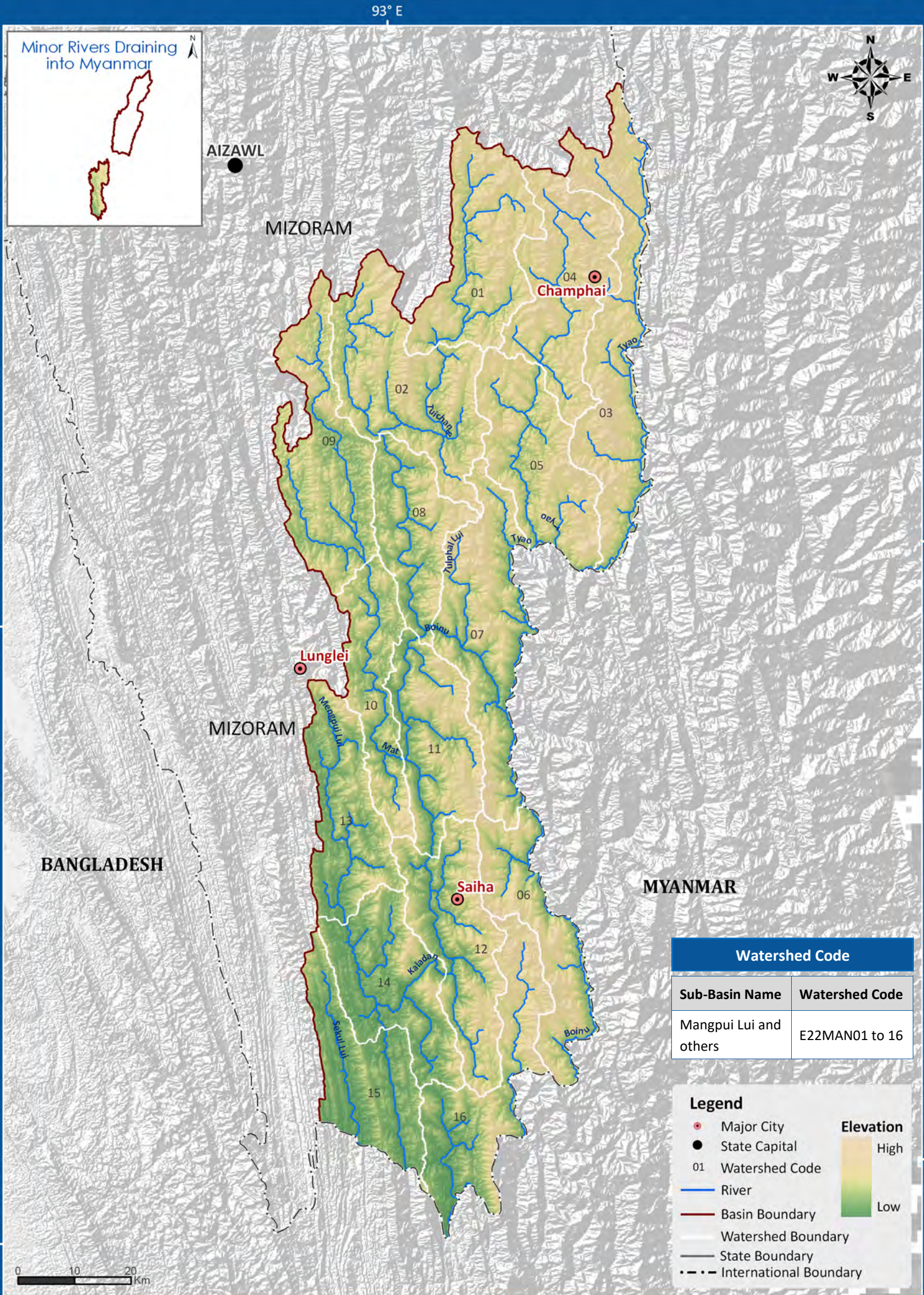
1. Imphal and others Sub-Basin

555



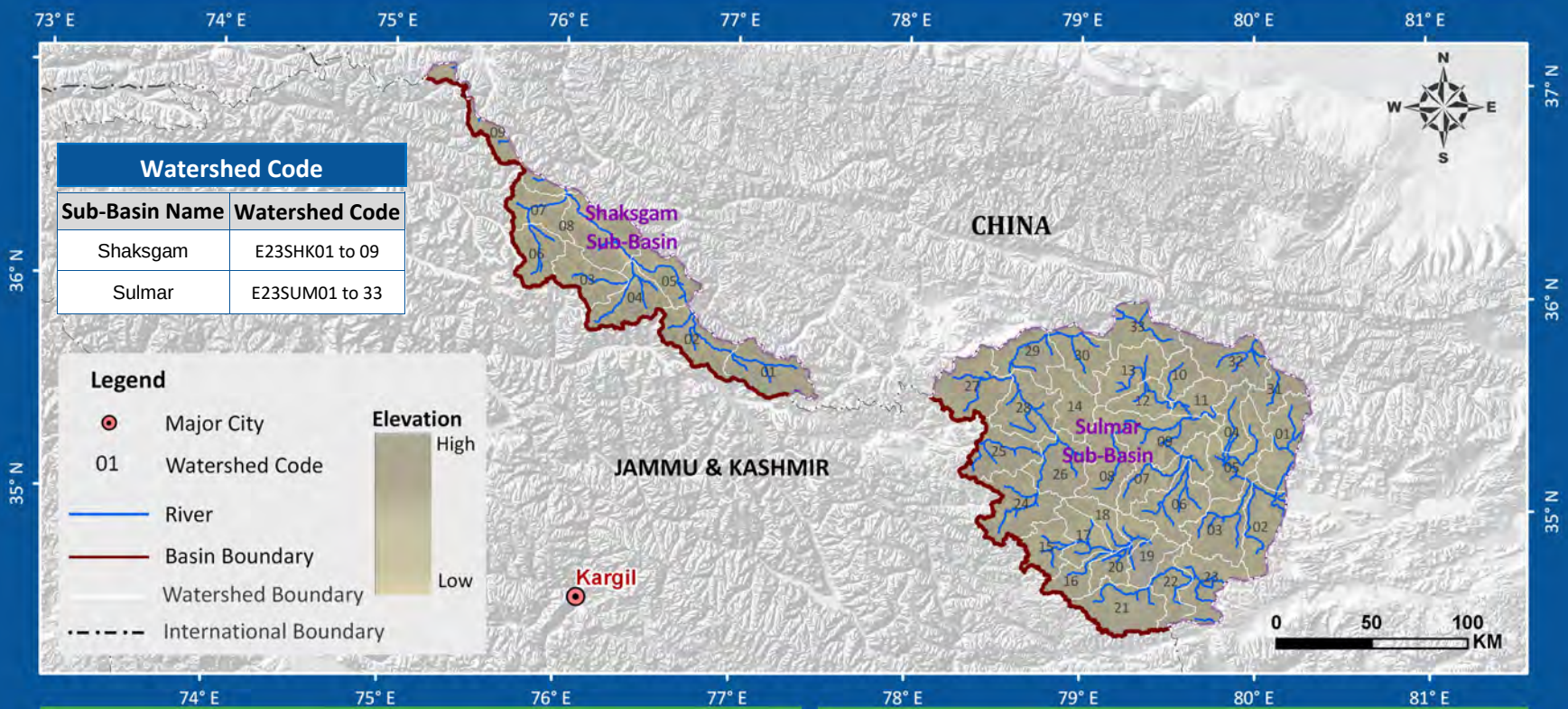
2. Mangpui Lui and others Sub-Basin

556



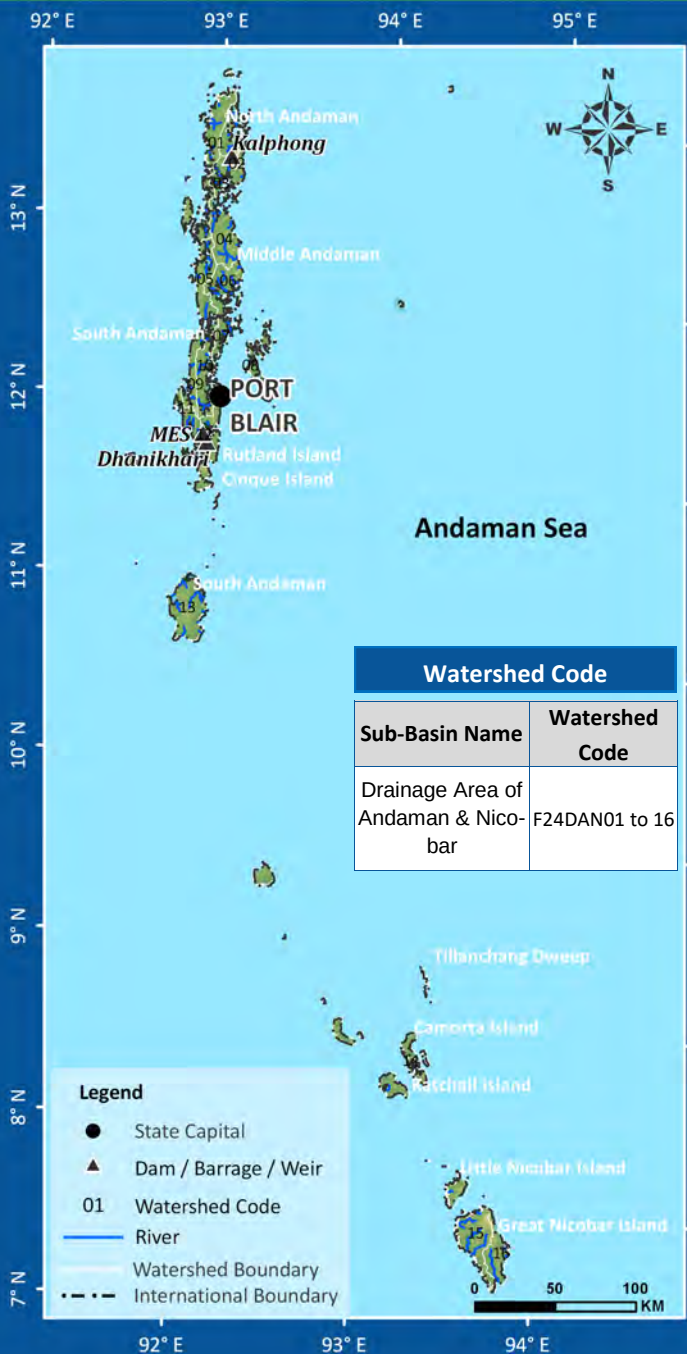
5.25 AREA OF NORTH LADAKH NOT DRAINING INTO INDUS

557



5.26 DRAINAGE AREA OF ANDAMAN & NICOBAR ISLANDS

5.27 DRAINAGE AREA OF LAKSHADWEEP ISLANDS



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561



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India-WRIS

A Joint Project of CWC and ISRO

देश में जल संसाधन आँकड़ों का जनन व वेब सामर्थ्य
सूचना प्रणाली का क्रियान्वयन
Generation of Database and Implementation of Web Enabled Water
Resources Information System (India-WRIS) in the Country