

KARNATAKA STATE

1.0 BACKGROUND

Karnataka State situated on a tableland where the Western and Eastern Ghat ranges converge into the Nilgiri hill complex with a 320 sq km coastal line, spreads over an areal extent of about 1,91,791 sq km. It spans 750 kms from North to South and nearly 400 kms from East to West and ranks eighth in the country in terms of size and population.

Though the State is blessed with the bounties of nature, 63% of the land falls under dry tracts ranking second only to Rajasthan in having arid tracts. The State has been identified as one of the thirteen drought-prone States in the country. Hence, dry land agriculture is predominant in the State and is practiced in about 78% of the net cultivated area.

The Southern Indian State of Karnataka is dotted by 36,672 tanks with a potential command area of 6,90,000 ha. However, these tanks have an irrigation command area of less than 2,000 ha. with 90% having a command of less than 40 ha. The actual area irrigated by these tanks have shown a consistently declining trend with the current irrigation at 2,40,000 ha. This is only 35% of the total potential even though Karnataka is endowed with six riverine systems broadly classified into two types viz.,

- a) The East-flowing large rivers Krishna and Cauvery with their tributaries, and
- b) The short, West-flowing rivers.

The six rivers are Krishna, Cauvery, Godavari, West Flowing Rivers, Pennar and Palar; and the economically utilizable water for irrigation is estimated as 1695 TMC. Some of the vital statistics are given in Table 1.

The population in the State has been increasing at the rate of 1.59% (www.demographic.net) and coupled with the tremendous rate of urbanization and industrialization, and rising incomes, is continually laying stress on the available resources (both renewable and non-renewable) especially water resources. Different sectoral demands are growing rapidly on the limited water resources that are stressed and depleting. Unless water resources are properly developed and managed, the State will face acute water crisis within the next two decades. Serious destabilization of the water sector affecting the hydrology, economy and ecology of the State is likely (State Water Policy, 2002).

As majority of agriculture in the State is rain-fed, the spatial and temporal pattern of South-West monsoon plays a crucial role in determining the kharif area sown and its productivity. Irrigated area in the State constitutes only 25% of the net sown area. This shows that the irrigation potential has to be fully realized and it has to be done on a sustainable basis since 15% of the geographical area of the State has witnessed severe soil erosion in the past few years (The Hindu, 7th May, 2004) and 51% of the area is reported to be moderately eroded. Thus, there is a need to strike a balance with nature and this can be attained through the adoption of watershed development approach, which has been considered as the best approach.

Table 1: Karnataka at a Glance

1	Geographical area (lakh sq km)	1.92	10	Percent of net sown area vs. total cultivable area	81.38
2	Population 2001 (Million)	52.73	11	Percent of net area irrigated to the net area sown	24.83
3	Population density (person/sq km)	275	12	Cropping intensity (%)	117.92
4	Literacy rate (%)	67	13	Percent of cultivable wasteland	2.27
5	Annual normal rainfall (mm)	1,138	14	Fallow land (%)	7.81
6	Total cropped area (%)	65.00	15	Barren and uncultivable land (%)	4.18
7	Surface water availability	3418 TMC at 50% dependability and 2,934 TMC at 75% dependability	16	Forest area (%)	20
8	Ground water (TMC)	485	17	Per capita land available for cultivation (ha.)	0.25
9	Percent of net sown area vs. total geographical area (%)	53.85	18	Per capita food grains production (Kg)	186.96

(Source: State Water Policy, 2002; Water Resources Department, GOK, and Department of Economics and Statistics, GOK; Census of India, 2001)

2.0 DEFINITION

Watershed is a natural hydrological entity from which surface runoff flows to a defined drain, channel, stream or river at a particular point. It is also defined as topographically delineated area that is drained by a stream system and is characterized by a common outlet through which excess overland flow collected within the watershed is drained out (Khan *et al.*, 1990).

2.1 Watershed Concept

Watershed as a planning unit has been in practice since long. Catchments and watersheds have been identified as planning units for administrative purpose to conserve these precious resources (FAO, 1985; 1987; Honore, 1999; Khan, 1999). Land use pattern has a strong influence on the hydrological characteristics and soil erosion parameters. Soil being a non-renewable resource, damage to it beyond repair is a matter of concern. The conception of watershed management identifies the inter-relationships between land use, soil and water, and the linkage between uplands and downstream areas (Tideman, 1996). The hypothesis of watershed has been in India for long; however, it gained importance since 1974 when the Ministry of Agriculture, Government of India (GOI) initiated the programs on soil and water conservation, drought alleviation, dry farming, flood control, hill area development, etc. This conception has gained impetus since then and hence, watersheds are

being considered as the basis for preparing natural resources database for effective planning and sustainable development of land and water resources. Considering this, All India Soil and Land Use Survey (AIS&LUS, 1990) had taken up a massive investigation and based on the survey, they developed a 5-stage delineation system demarcating the country into Water Resource Region, Basin, Catchment, Sub-catchment and Watershed. The size of watershed is determined by the size of stream or river of interest or the point of interception on the stream or river, like a dam, barrage, etc. Accordingly, India has been divided into five classes (Table 2).

Table 2: Size Ranges of Various Hydrological Units of the Country (Up to 5-stage delineation)

Class	Nos.	Size Range (Lakh ha.)	Average Size (Lakh ha.)
Water Resource Region	6	270 - 1130	550
Basin	35	30 - 300	95
Catchment	112	10 - 50	30
Sub-catchment	500	2 - 10	7
Watershed	3237	0.2 - 3	1

Watershed development in large areas requires huge financial investments and time and also monitoring the progress of developmental activities becomes difficult. In view of this, Karnataka State Remote Sensing Applications Center (KSRSAC), Bangalore with the funding support from Indian Space Research Organization (ISRO), GOI and Government of Karnataka (GOK) undertook further systematic delineation and codification of watersheds into sub-, mini- and micro-watersheds using Indian Remote Sensing Satellite data for the entire State and the data has been compiled in the form of an Atlas. The hierarchical classes that are delineated in the State of Karnataka are given in Table 3.

Table 3: Size Ranges of Various Hydrological Units of Karnataka (Up to 8-stage Delineation)

Class	Size (Lakh ha.)	Nos.
Water Resource Region	270 - 1130	2
Basin	30 - 300	6
Catchment	10 - 50	15
Sub-catchment	2 - 10	48
Watershed	0.2 - 3	234
Sub-watershed	0.03 - 0.05	3515
Mini-watershed	0.01 - 0.03	7393
Micro-watershed	0.005 - 0.01	34299

3.0 STATE DETAILS

3.1 Location and Extent

Karnataka State lies between latitudes 11°31'00" to 18°45'00" N and longitudes 74°12'00" to 78°41'00" E. The State has 27 districts and 176 taluks. The list of districts with number of taluks and villages are listed in Table 4. Karnataka is bounded on the North by the States of Maharashtra, on the North-West by Goa, on the East by Andhra Pradesh, on the South and South-East by Tamil Nadu, on the South-West by Kerala and on the West by the Arabian Sea.

Table 4: District-wise Details of Karnataka

Sl. No.	Name of the District	Area (sq kms)	No. of Taluks	No. of Villages
1	Bangalore Urban	2190	4	946
2	Bangalore Rural	5815	8	1901
3	Belgaum	13415	10	1200
4	Bellary	8419	7	555
5	Bidar	5448	5	643
6	Bijapur	10475	5	683
7	Bagalkot	6594	6	621
8	Chamarajanagar	5685	4	464
9	Chikmagalur	7201	7	1142
10	Chitradurga	8388	6	1056
11	Davanagere	6018	6	924
12	Dakshina Kannada	4843	5	421
13	Dharwad	4230	5	436
14	Gadag	4657	5	338
15	Gulbarga	16224	10	1483
16	Hassan	6814	8	2592
17	Haveri	4851	7	704
18	Kolar	8223	11	3373
19	Koppal	8458	4	637
20	Kodagu	4102	3	511
21	Mandya	4961	7	1486
22	Mysore	6269	7	1366
23	Raichur	5559	5	891
24	Shimoga	8465	7	1620
25	Tumkur	10598	10	2731
26	Udupi	3598	3	267
27	Uttara Kannada	10291	11	1343
	Total	191791	176	30334

(Source: Dept. of Survey Settlement and Land Records, GOK)

3.2 Physiography

The major physiographic divisions of Karnataka State are the Deccan plateau, the hill ranges and the coastal plain. Based on their geographic location, they are sub-divided into four regions viz., a) South Deccan plateau, b) Western Ghats, c) Eastern Ghats, and d) West coast plains.

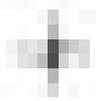
The South Deccan plateau covering an area of about 158 lakh ha. is divided into malnad and maidan regions. Malnad, a transitional zone between the Western Ghats and the maidan, is an area of rolling to undulating uplands with many valleys. It covers an area of about 62 lakh ha. in the districts of Belgaum, Uttara Kannada, Dharwad, Shimoga, Chikmagalur, Kodagu and Hassan. Maidan has a rolling surface with gentle slopes and occasional monadnocks. The highest surface is located in the South-Western part of the State and the lowest in the valleys of the Tungabhadra and Hagari rivers.

3.3 Agro-climatic Zones

The State of Karnataka lies in 10 different agro-climatic zones viz.,

1. North-Eastern dry zone
2. Northern dry zone
3. Central dry zone
4. South-Eastern dry zone
5. Southern dry zone
6. North-Eastern transition zone
7. Southern transition zone
8. Northern transition zone
9. Hilly zone
10. Coastal zone

Supplementary Table 1 of Kulkarni et al.



3.4 Soil Types

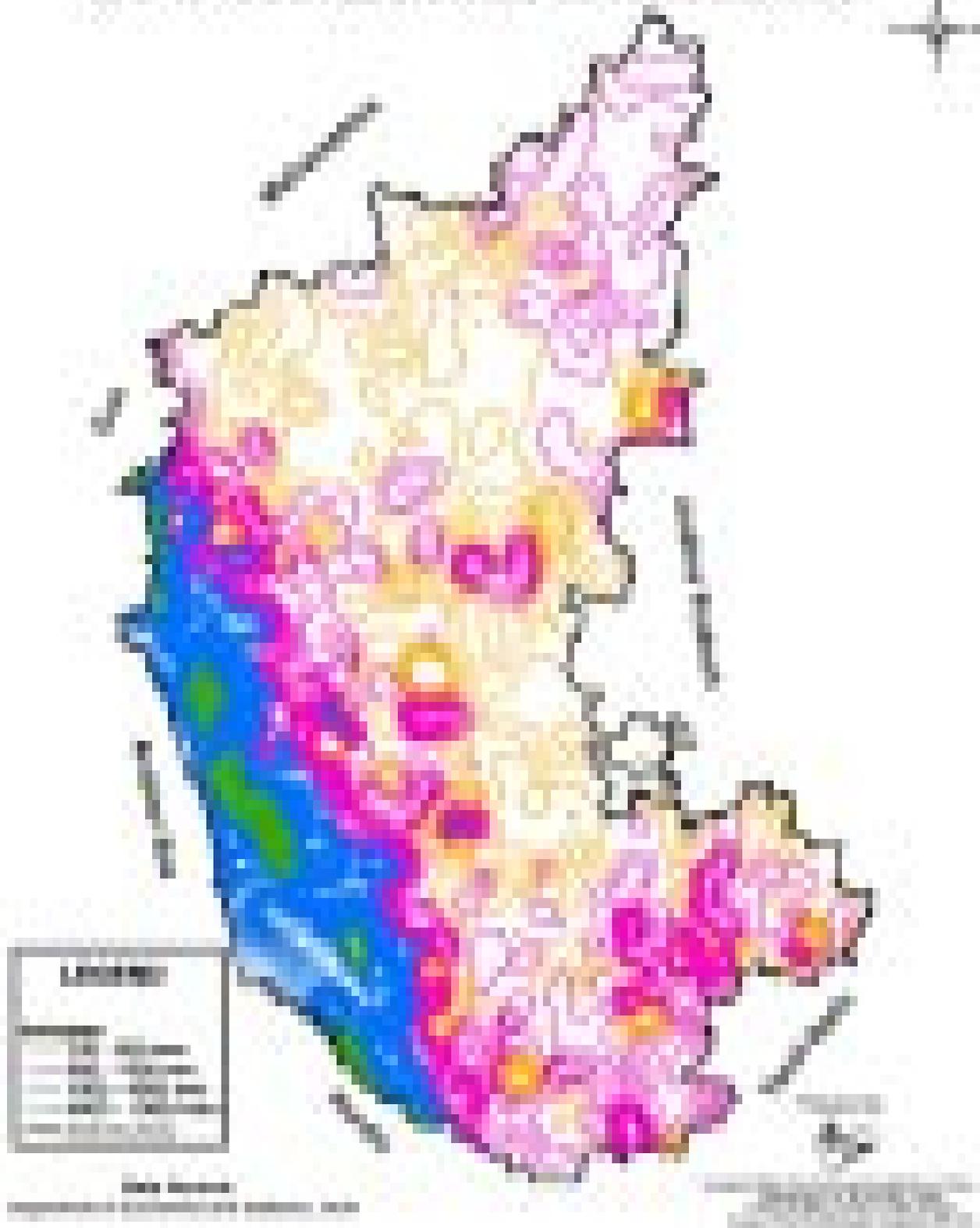
The main soil types of Karnataka State are:

1. Red Soils which are shallow to deep, well drained to excessively drained and gravelly or non-gravelly and are characterized by accumulation of clay. The surface texture ranges from loamy sand to sandy clay loam and sub-soil texture from sandy clay loam to sandy clay and clay. The red soils cover nearly 37.3% of the total geographical area of the State and are distributed in all the districts except Bidar.
2. Laterite Soils cover an area of about 6.16% of the total geographical area of the State. Lateritic soils of Bangalore, Kolar, Bidar and Gulbarga have been formed under paleoclimate and form a plateau that is presently under disintegration. The laterite soils of malnad i.e., Belgaum, Hassan, Chikmagalur, Uttara Kannada, Udupi and Kodagu districts have developed under the sub-humid and humid climate. They occur as plateau at the foothills of Western Ghats and have developed on gneisses, schists and phyllites.
3. Black Soils occupy around 27.77% of total geographical area of the State. They occur on plateau summits, slopes and valleys developed from basalt in northern Karnataka. They are also known as swell-shrink soils. This is due to alternative wetting and drying process. The infiltration rate and hydraulic conductivity of black soils is very low. Based on soil depth, these soils are grouped as shallow, medium and deep black soils.
4. Alluvial Soils are present in the Western Ghats and Deccan plateau and are transported from higher elevated areas by the flowing water and deposited in valleys and low lands. These soils occupy nearly 15.74% of the total geographical area of the State. Majority of the area is under irrigation in the plateau region and is under rain-fed cultivation in malnad and the Western Ghats. The alluvial soils are generally very deep, moderately well drained to imperfectly drained and well drained. They have textures of loam to clay loam, clay and cracking clay, stratified with light and heavy textures.
5. Brown Forest Soils occur mainly in the Western Ghats under forests, in humid and sub-humid climate. They cover 6% of the total geographical area and have developed on granites, gneisses and schists. They are deep to moderately deep, well drained to excessively drained and have sandy clay to clay and sandy loam surface soils and clay to sandy clay sub-soil with high content of clay.
6. Coastal Soils occur in the West Coast of Karnataka between the Western Ghats and the Arabian Sea. They occupy approximately 3.9% of the total geographical area of the State. They are of two types viz., a) Coastal laterite soils and b) Coastal alluvial soils.

3.5 Geology

The important rock types of Karnataka State are gneisses, granites, charnockites, basalt, sandstone, shale, limestone, schist and quartzites. The various varieties of gneisses and granites occur in the districts of Bangalore, Kolar, Tumkur, Mandya, Mysore, Chamarajanagar, Hassan, Dakshina Kannada, Uttara Kannada, Chikmagalur, Shimoga, Chitradurga, Davangere, Bellary, Raichur, Gadag, Koppal and Gulbarga. On weathering, they result into formations of red soils. Basalt occurs to a large extent in northern part of the State covering Bidar, Gulbarga, Bijapur and Belgaum districts. On weathering, basalt results into black soils. Sandstone, shale, limestone

MAP OF FAIRFAX COUNTY, VIRGINIA, BY WARD



of sedimentary origin are found in Gulbarga and Bagalkot districts. Laterite occurs in the districts of Bangalore, Kolar, Bidar, Gulbarga, Belgaum, Hassan, Kodagu, Uttara Kannada, Dakshina Kannada, Chikmagalur and Shimoga. Laterite on weathering results in lateritic soils.

3.6 Climate and Rainfall

The climate of the State is determined mainly by the geographical location with respect to the sea, monsoon winds and physiography. Karnataka State has very moist monsoon climate on the West Coast, semi-arid climate in the Western Ghats and Malnad areas, and arid (very warm) climate in the central and northern districts. The year is divided into four seasons viz., Summer season from March to May; South-West monsoon from June to September; North-East monsoon season from October to December; and Winter season from January to February.

In the North-East monsoon season, the wind regime changes from South-West or West to North-East. This is the season during which occasional depressions and cyclones from Bay of Bengal strikes the Chennai Coast and move towards West or North-West, causing widespread rain over the southern parts of the State.

The drainage area of the State is predominantly influenced by the South-West monsoon. The 101-year (1903-2003) average annual rainfall of the State is 1138 mm. The recorded monthly maximum and minimum rainfall of the State during monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	2763.0	0.0
July	4240.26	0.2
August	3854.0	0.4
September	2183.0	0.0
October	2560.0	0.0

3.7 Drainage

There are six river basins in the State of Karnataka – Cauvery, Krishna, Godavari, West flowing – Cape Comorin to Sharavathy and Sharavathy to Tapthi and between Cauvery and Krishna (Pennar, Palar). Major area of the State lies in the Krishna basin. In the Western Ghats and malnad regions, the drainage network is dense. Rivers Krishna and Godavari flow from Maharashtra State, whereas rivers Cauvery, Palar and Pennar rise in the State. The West flowing rivers rise in the Western Ghats and finally, find their way into the Arabian Sea.

3.8 Projects

There are a number of major and medium irrigation projects spread out in different river basins of Karnataka. Some of the notable projects are Krishnarajasagar reservoir, Kabini, Hemavathy, Harangi, Tungabhadra, Bhadra, Upper Krishna, Ghataprabha, Malaprabha, Tunga Anicut, Karanja and Bennithora. The notable hydroelectric power projects are Sharavathy, Kali, Varahi, Aganashini, Bedthi and Shivanasamudram. Thermal power project is located at Shakthinagar in Raichur district. The State is also being irrigated by about 36,672 irrigation tanks.

4.0 METHODOLOGY FOR WATERSHED DELINEATION

A framework of watershed is a prerequisite for giving practical shape to the systematic, scientific and rational approach for considering watersheds as units of planning and development. It is thus essential to have not only a hierarchical system of delineating bigger hydrological unit into watershed, but also systematic codification so that each watershed could be identified as an individual entity without losing linkage with bigger units viz., sub-catchment, catchment, river basin and water resource region to which it belongs.

5.0 STAGES OF DELINEATION FROM REGION TO WATERSHED

All India Soil and Land Use Survey (AIS&LUS, 1990) has developed a 5-stage delineation system demarcating Water Resource Region, Basin, Catchment, Sub-catchment and Watershed (Table 2). The size of watershed is determined by the size of stream or river of interest or the point of interception on the stream or river such as a dam, barrage, etc. Keeping in view the hurdles in managing large areas (watershed-wise), KSRSAC has further delineated the watersheds into sub-, mini- and micro-watersheds by adopting the methodology suggested under the Integrated Mission for Sustainable Development (IMSD) Programme of ISRO [National Remote Sensing Agency (NRSA)].

5.1 Stages of Delineation from Watershed to Sub-, Mini- and Micro-watersheds

Based on the concept – ridge to valley – All India Soil and Land Use Survey has given 5-stage delineation (Table 2) (AIS&LUS, 1990). The manual of IMSD (NRSA, 1995) provides the guidelines for delineating sub-, mini- and micro-watersheds. In order to facilitate planning and development at micro-watershed level, in the present Watershed Atlas of Karnataka State, 8-stage delineation has been carried out by further delineating the watersheds into sub-, mini- and micro-watersheds. The watershed map showing sub-, mini- and micro-watersheds is prepared on 1:50,000 scale. The 8-stage delineation is as follows:

Stage 1

Water Resource Regions (WRR): In all, 6 WRRs were suggested in the Watershed Atlas (AIS&LUS, 1990) starting with Indus drainage as 1. The 6 WRRs are

1. Indus drainage
2. Ganges drainage
3. Brahmaputra drainage
4. All drainages flowing into the Bay of Bengal, except the Ganges and the Brahmaputra
5. All drainages flowing into the Arabian Sea, except the Indus drainage
6. Western Rajasthan mostly ephemeral drainage

Stage 2

Basins: Each WRR has been divided into a Basin which consists of individual big rivers like the Krishna (4D), Cauvery (4B), etc. or a combination of smaller ones which are contiguous to each other such as the basin between the Krishna and the Cauvery (Pennar and Palar), Southern and Northern Western Ghats, etc. In some of the cases, very big drainage systems like the Ganges and the Brahmaputra have been divided into lower and upper basins, left and right bank basins.

Stage 3

Catchments: Each basin has been divided into a number of catchments which mainly pertains to the main tributaries or a group of contiguous small tributaries or individual major streams. For instance, the main tributaries of river Tungabhadra are rivers Tunga and Bhadra and Varada – the confluence of all these three beyond the Tungabhadra reservoir has been considered as Upper Tungabhadra catchment.

Stage 4

Sub-catchment: The catchments are further divided into a number of sub-catchments which comprise mainly of smaller tributaries and streams.

Stage 5

Watershed: Each sub-catchment has been divided into a number of watersheds.

Stage 6

Sub-watershed: Each watershed has been further divided into a number of sub-watersheds having an area in the range of 3000 – 5000 ha. (Table 3).

Stage 7

Mini-watershed: Each sub-watershed has been further divided into a number of mini-watersheds ranging in size from 1000 to 3000 ha. (Table 3).

Stage 8

Micro-watershed: Each mini-watershed has been further divided into a number of micro-watersheds ranging in size from 500 to 1000 ha. (Table 3) and are the smallest sized hydrological units.

The minimum area of watershed for implementation should be 500 ha. as recommended by Ministry of Rural Development and Employment and hence the delineation has been restricted upto micro-watershed.

6.0 CODIFICATION OF DIFFERENT HYDROLOGICAL UNITS

Alpha-numeric symbolic codes consisting of a combination of alternating Arabic numerals and English capital alphabet have been used to designate various stages of delineation (up to Stage 7 i.e. mini-watershed). In the eighth stage of delineation (Stage 8 – micro-watershed), English alphabet in lower case has been used by KRSRAC.

Water Resource Regions are assigned Arabic numerals – 1, 2, 3, 4, 5, 6

Basins are assigned English alphabet – A, B, C, D...

Catchments are assigned Arabic numerals – 1, 2, 3, 4, 5, 6 ...

Sub-catchments are assigned English alphabet – A, B, C, D...

Watersheds are assigned Arabic numerals – 1, 2, 3, 4, 5, 6 ...

Sub-watersheds are assigned English alphabet – A, B, C, D...

Thus the sub-watershed will have codes such as 4D3D1A, 5A1A4C, etc.

Mini-watersheds are assigned Arabic numerals – 1, 2, 3, 4, 5, 6 ...

Thus mini-watersheds will have code 4D3D1A1, 5A1A4C1, etc.

Micro-watersheds are assigned English alphabet – a, b, c, d...

Thus micro-watersheds will have code 4D3D1A1a, 5A1A4C1a, etc.

The coding of different stages (Stage 1 – 5) has been carried out from downstream upwards serially and from Stage 6 – 8, the delineation and codification has been carried out from ridge to valley.

7.0 PREPARATION OF WATERSHED MAP

The preparation of watershed map involves the following steps:

Boundaries of region, basin, catchment, sub-catchment and watershed from Watershed Atlas (AIS&LUS, 1990) of 1:1 million scale are transferred on 1:250,000 scale base map.

1. Extraction of drainage network from satellite data (IRS-1C/1D PAN+LISS III merged image) on 1:50,000 scale and Survey of India toposheets were used as reference.
2. Boundaries from 1:250,000 scale base maps are transferred to the drainage map prepared using satellite data.
3. Delineation of watershed into sub-, mini- and micro-watershed based on hydrological unit and the extent of area on 1:50,000 scale.
4. In order to have unique code for the stages of delineation of watershed into sub-, mini- and micro-watershed, alpha-numeric system of codification is followed.
5. Watersheds are named after stream/river by suffixing numerals 1, 2, 3 according to sequence of occurrences. The sub-watersheds are named after the village present at the outlet or the name of the stream itself. The mini- and micro-watersheds are named after the village present within their boundaries. If more than one village is present, then the village that is at or nearer to the outlet is chosen for naming. If there happens to be no villages in the micro-watershed, the micro-watershed is named after the nearest village in the neighbouring micro-watershed.

8.0 SALIENT FEATURES AND STATISTICS OF HYDROLOGICAL UNITS

KRSAC has initiated development of spatial database using advanced technology. Digital Watershed Atlas of Karnataka has been systematically delineated and codified into different levels of hydrological units (WRR to micro-watershed). The vital information contained in the Atlas and Compendium of Watersheds is summarized in Table 5 which contains WRR-wise distribution of various hydrological units.

Table : 5 Details of Hydrological Units in Karnataka

Sl. No.	Hydrological Units	In Region - 4	In Region - 5	Total
1	Water Resource Region (WRR)	1	1	2
2	Basin	4	2	6
3	Catchment	13	2	15
4	Sub-catchment	43	5	48
5	Watershed	204	30	234
6	Sub-watershed	3,054	461	3,515
7	Mini-watershed	6,386	1,007	7,393
8	Micro-watershed	29,319	4,980	34,299
9	Area of WRR (lakh ha.)	166.49	25.30	191.79

9.0 BASIN-WISE DISTRIBUTION OF HYDROLOGICAL UNITS

Karnataka is drained by 6 basins viz.,

- a) Godavari
- b) Krishna
- c) Cauvery
- d) Between Cauvery and Krishna (Pennar, Palar)
- e) Sharavathy to Tapti (Northern Western Ghats) and
- f) Cape Comorin to Sharavathy (Southern Western Ghats).

The basin-wise distribution of catchments, sub-catchments, watersheds, sub-, mini- and micro-watersheds is given in Table 6. From the table, it is observed that a major part of the State (113.6 lakh ha.) is covered by the Krishna basin (WRR 4) and the least by the Godavari basin (4.6 lakh ha.). In WRR 4, the total number of micro-watersheds is 29,319 and in WRR 5, there are 4,980 micro-watersheds.

Table: 6 Basin-wise Details of Hydrological Units

Region	Basin	Basin Area (Lakh ha.)	No. of Catchments	No. of Sub-Catchments	No. of Watersheds	No. of Sub-Watersheds	No. of Mini-Watersheds	No. of Micro-Watersheds
4	Godavari (4E)	4.600	1	6	13	96	180	688
	Krishna (4D)	113.600	6	22	131	2061	4291	19371
	Cauvery (4B)	34.890	3	8	38	647	1378	6594
	Between Cauvery and Krishna (4C)	13.400	3	7	22	250	537	2666
5	Sharavathy to Tapti (5B)	11.021	1	2	12	196	428	2107
	Cape Comorin to Sharavathy (5A)	14.280	1	3	18	265	579	2873
Total : 2	6	191.79	15	48	234	3515	7393	34299

Note : Numericals and alphabet in parentheses represent the code of the basins.

10.0 UTILITY OF SUB, MINI AND MICRO-WATERSHED MAPS

The delineation and codification of watershed into sub-, mini- and micro-watersheds carried out by KRSAC has the following utility:

1. Systematic methodology of delineation and unique codification has been followed as an extension of AIS&LUS (1990), hence it provides a uniform base for the entire State on hydrological unit basis.
2. Provides a basis for prioritization of micro-, mini- and sub-watersheds for implementation of watershed activity.

3. Provides special advantages in planning and development strategies from micro- to macro-watershed.
4. Provides a common basis for various Departments/Agencies involved in developmental activities based on watershed approach.
5. Provides a practical and uniform basis for watershed characterization.
6. Alpha-numeric codification is simple and can be integrated into other layers in digital domain.
7. Provides a framework of linkages from lower to higher categories in the hierarchy of drainages.

11.0 IMPORTANCE OF MICRO-WATERSHED DEVELOPMENT

Micro-watershed development involves development of land and water resources, improvement in the economic status of people and optimal resource use, and sustainable development of resources.

The main focus of development strategy is to minimize the risk to the farmers and to provide them with area-specific technological packages, inputs and services. Hence, the emphasis should be on small area improvement taking micro-watershed as a unit of development.

The developmental measures undertaken in the micro-watersheds include soil and moisture conservation, land shaping, bunding, construction of water harvesting structures, ground water recharge structures and drainage line treatment structures. Further, in order to provide adequate tree cover and promote subsidiary occupations, horticulture, afforestation and pasture development on micro-watershed wise implementation is ideal as it helps in concentrating on the smaller area with low financial burden and also to take care of all the villages coming under the area.

Watershed development at micro-level helps in conservation of soil moisture. In rain-fed areas, development of water storage structures provides life saving irrigation during moisture stress. It also helps in raising the water table to protect and to enhance drinking water sources and to provide protective irrigation for at least one crop.

Micro-watershed wise implementation provides good scope for quick post implementation assessments viz., ground water improvement, economic status, cropland, vegetation status, etc. and to plan or change the developmental strategies.

12.0 PRIORITIZATION OF WATERSHEDS

To combat the drought on a sustainable basis, developing the watershed area by adopting integrated approach is the only answer and is no more a secret. Since the majority of the area in the State is under rainfed agriculture, the ideal way is to educate all the farmers to take up the watershed activities on their own and conserve the natural resources.

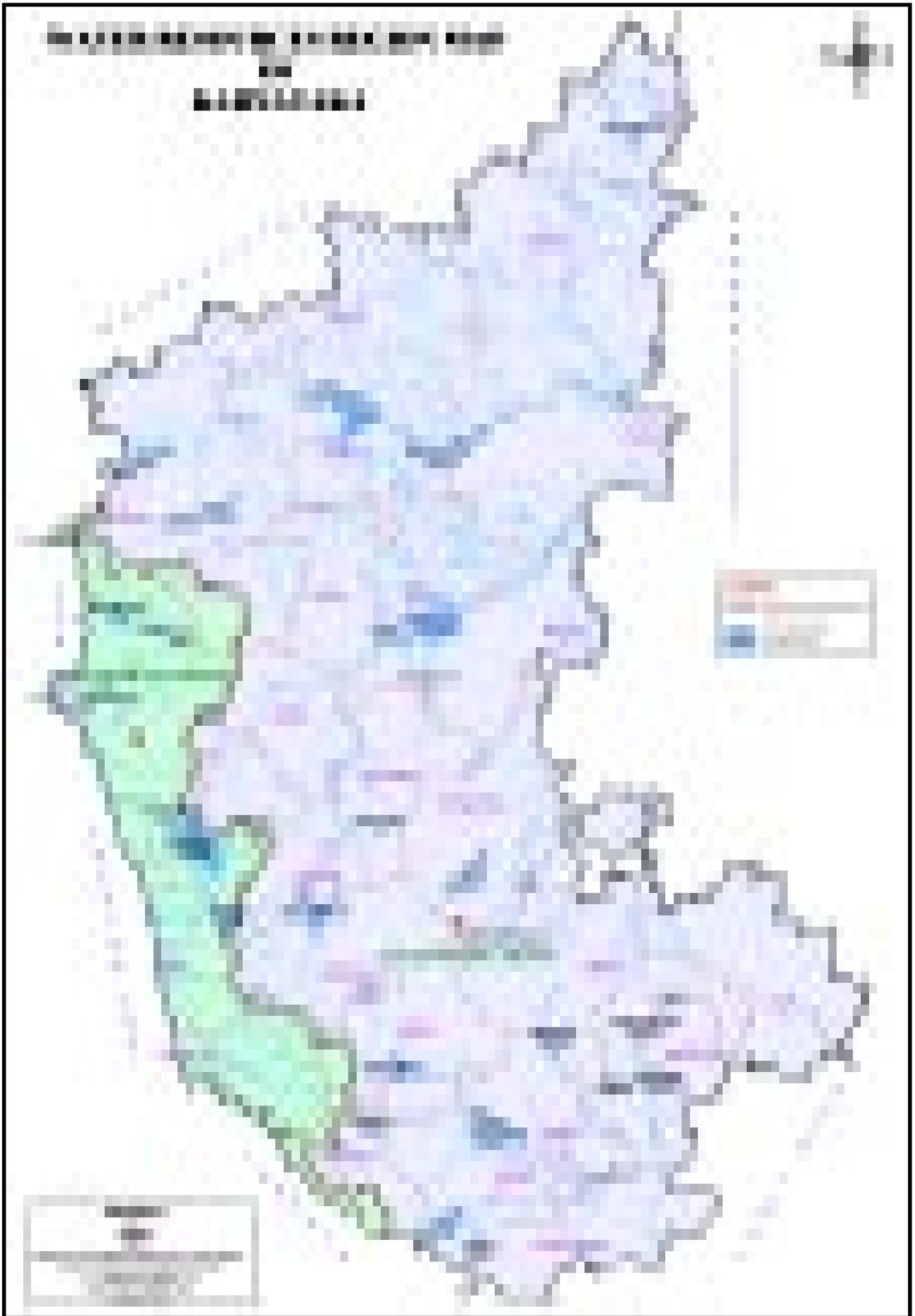
Though the Government with its intervention has developed some areas on watershed basis, the area to be developed is still very large. It is impossible for any Government to take up all the rainfed area for development on watershed basis at once, since it involves huge investment and efforts. Thus prioritization plays a key role in identifying the watersheds which need immediate attention, and those can be taken up for development with the available resources.

Prioritization of watersheds is nothing but selection of watersheds based on certain criteria and this can be achieved by comparing all the watersheds with one another for the selected criteria. This process of comparison is too cumbersome and tedious if it is done manually and on the contrary, it could be easily done digitally.

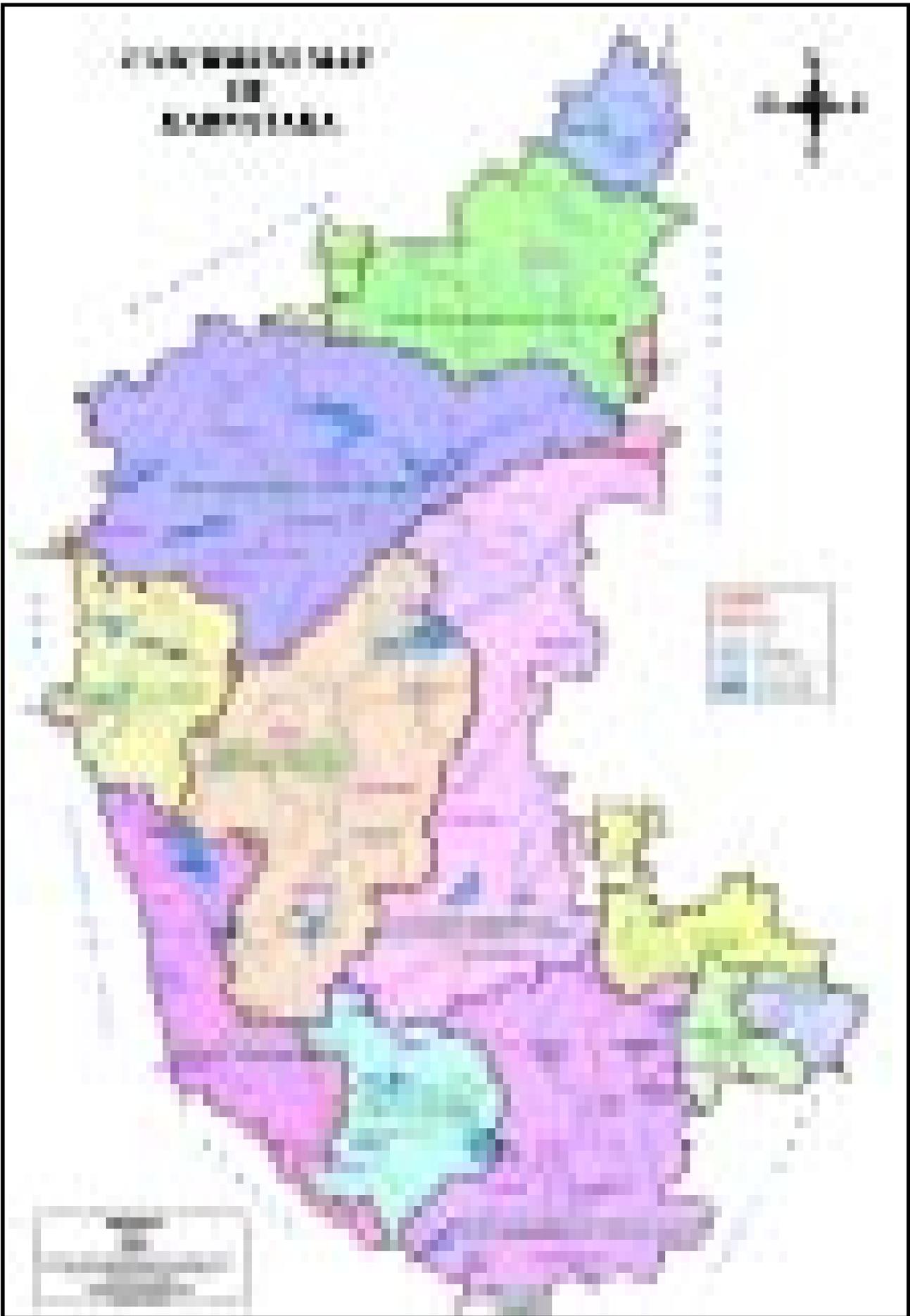
Since the watershed atlas is in the digital domain (GIS platform), it can be successfully adopted for various kinds of analysis including overlaying and thus can be effectively employed to prioritize the watersheds (micro, mini or sub).

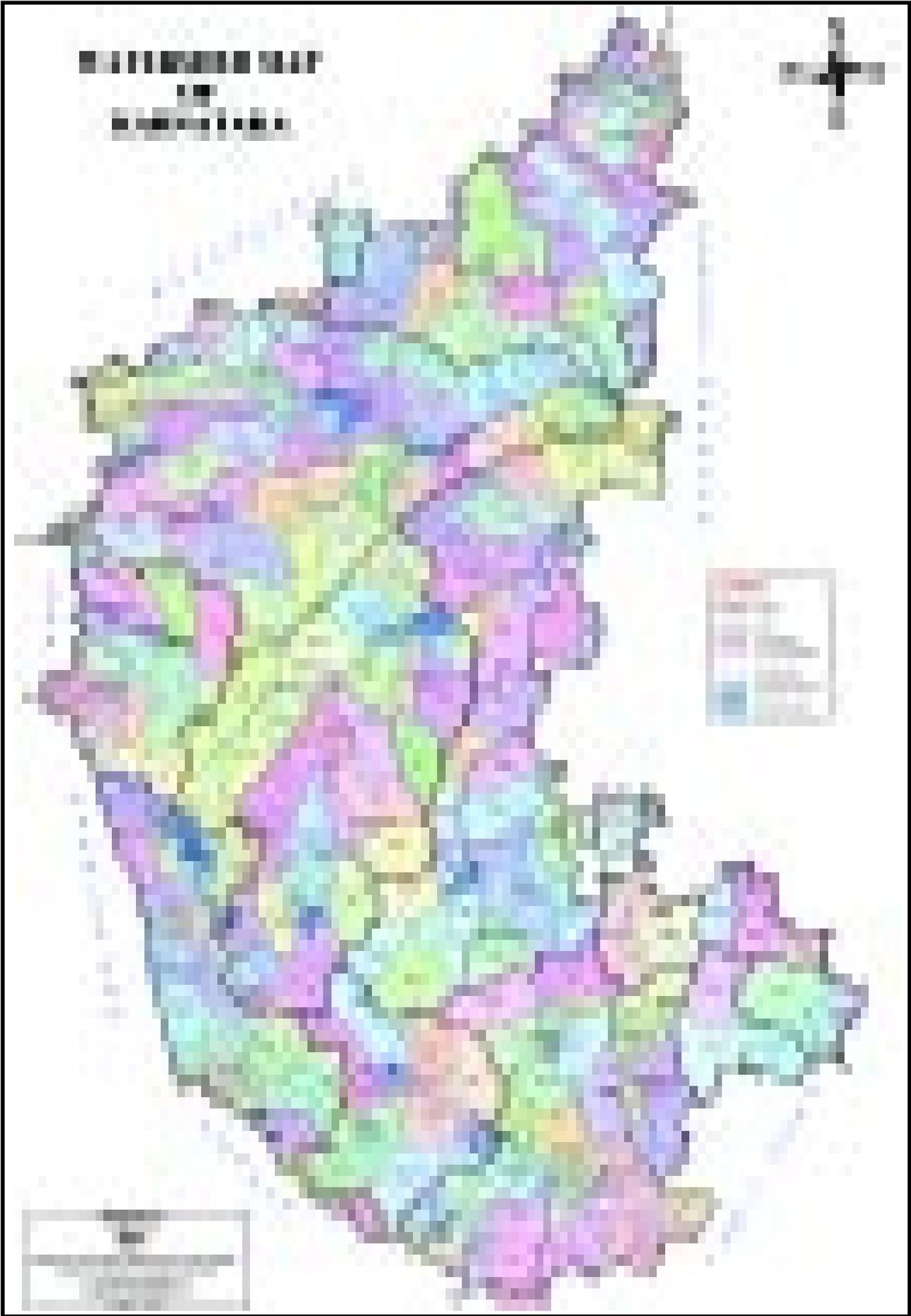
Data for the parameters taken for the prioritization forms the basis and plays an important role. Among the various sources, data derived from satellite remote sensing provides an excellent information for various natural resources evaluation because of its unique capabilities of acquiring spatial data in a synoptic view and at regular intervals as well as being cost effective. Apart from the natural resources, other parameters viz., socio-economic and climatic factors are also vital for prioritization. Sources of data for these factors are through conventional methods.

The first and the foremost requirement is to convert the data pertaining to different parameters into a spatial domain (map format). Since the watershed boundaries rarely coincides with the administrative boundaries and no data is available watershed wise, data pertaining to different parameters are at different levels. For instance, the socio-economic data is at village level and rainfall data is at taluk level and so on. Thus the challenge lies in converting data pertaining to different parameters to an uniform platform. For example, while prioritizing sub-watersheds, all the data should be at sub-watershed level. To achieve this task, Geographical Information System is an inevitable tool which not only stores the spatial and non-spatial data, but also offers an advantage to overlay different layers, analyze the data and finally, to arrive at a decision based on user defined programs.











13.0 COMPENDIUM OF WATERSHEDS

Region (4) : Bay of Bengal
Cauvery (4B)
Krishna (4D)
Godavari (4E)
Pennar and Palar (4C)

Region (5) : Arabian Sea
Cape Comorin to Sharavathy (5A)
Sharavathy to Tapti (5B)

Basin-wise Details of Hydrological Units

Basin	No. of Watersheds	Area (Lakh ha.)
Cauvery (4B)	38	34.89
Krishna (4D)	131	113.6
Godavari (4E)	13	4.6
Pennar and Palar (4C)	22	13.4
Cape Comorin to Sharavathy (5A)	18	14.28
Sharavathy to Tapti (5B)	12	11.021
Total	234	191.791

Basin : Cauvery (4B)

BASIN	CATCHMENT	SUB CATCHMENT	WATERSHED	WSD CODE	
Cauvery	Krishnarajasagar	Hemavathy	Torehalla 1	4B4B1	
			Torehalla 2	4B4B2	
			Yagachi	4B4B3	
			U. Hemavathy	4B4B4	
		Cauvery Main	Lakshamanathirtha	4B4A1	
			Harangi 1	4B4A2	
			Harangi 2	4B4A3	
			U. Cauvery	4B4A4	
		Krishnarajasagar to Stanley Reservoir	LB above Shimsha Reservoir	Viravaishnavi 1	4B3D1
				Viravaishnavi 2	4B3D2
	U. Shimsha 1			4B3D3	
	U. Shimsha 2			4B3D4	
	Kabini		Gundal 1	4B3E2	
			Gundal 2	4B3E1	
			Yennehole	4B3E3	
			Hebballa	4B3E4	
			Nuguhole	4B3E5	
			U. Kabini	4B3E6	
			Taraka	4B3E8	
	LB upto Shimsha Reservoir		Shimsha 1	4B3C5	
			Shimsha 2	4B3C4	
			Shimsha 3	4B3C3	
			Shimsha 4	4B3C2	
			Shimsha 5	4B3C1	
			LB Cauvery	4B3C6	
			Lokapavani	4B3C7	
			RB Cauvery	4B3C8	
	LB Cauvery		L. Arkavathy 1	4B3B7	
			L. Arkavathy 2	4B3B6	
			L. Arkavathy 3	4B3B5	
			Kumudvathy	4B3B8	
	RB Cauvery		Palar, Maleru 1	4B3A1	
			Palar, Maleru 2	4B3A2	
			Thatai	4B3A3	
Doddahole			4B3A4		
Suvarnavathy 1			4B3A5		
Suvarnavathy 2		4B3A6			
Amaravathy to Stanley Reservoir	Bhavani	Mayer	4B2D3		

Basin : Between Cauvery and Krishna (Pennar and Palar) (4C)

BASIN	CATCHMENT	SUB CATCHMENT	WATERSHED	WSD CODE
Between Cauvery and Krishna	Pennar	Upper most origin of Pennar	Upper Pennar 1	4C3H3
			Upper Pennar 2	4C3H2
			Jayamangali	4C3H4
			Pennar Pandi	4C3H5
		Lower part of Upper most Pennar	Era	4C3G6
		Chitravathy (RB)	Marahole	4C3F4
			Upper Chitravathy 1	4C3F7
			Upper Chitravathy 2	4C3F6
			Upper Chitravathy 3	4C3F5
		Papagni (RB)	Papagni	4C3D5
	Vandaman		4C3D6	
	Peddaeru		4C3D7	
	Between Ponnaiyar and Pennar	Cheyzeru (RB)	Satyavathy	4C3B6
		Upper Palar	Kaigal, Malattar	4C2B2
			U. Palar 1	4C2B5
			U. Palar 2	4C2B4
			U. Palar 3	4C2B3
			Kuvundinya	4C2B7
		Upper Ponnaiyar	U. Ponnaiyar 1	4C1C8
			U. Ponnaiyar 2	4C1C6
Koppakode			4C1C7	
South Pennar			4C1C9	

Basin : Krishna (4D)

BASIN	CATCHMENT	SUB CATCHMENT	WATERSHED	WSD CODE
Krishna	Main Krishna above confl. with Bhima	Panchaganga Varna	Panchganga	4D7G1
		LB Krishna upto confl. with Yerla near Sangli	Hirehalla	4D7F1
			Badchi	4D7F2
			Agrani 1	4D7F4
			Agrani 2	4D7F3
			LB Krishna	4D7F5
			RB along Krishna upto confl. and Panchaganga	RB Krishna 1
		RB Krishna 2		4D7E3
		RB Krishna 3		4D7E2
		RB Krishna 4		4D7E1
		Vedganga		4D7E5
		Dudhganga		4D7E6

BASIN	CATCHMENT	SUB CATCHMENT	WATERSHED	WSD CODE	
Krishna	Main Krishna above confl. with Bhima	Ghataprabha	Lower Ghataprabha 1	4D7D2	
			Lower Ghataprabha 2	4D7D1	
			Doddahalla, Ghataprabha	4D7D3	
			Hirehalla 3	4D7D4	
			Hirehalla 4	4D7D5	
			Markandeya	4D7D6	
			Hiranyakeshi 1	4D7D8	
			Hiranyakeshi 2	4D7D7	
			Tamraparni	4D7D9	
		Malaprabha	Hirehalla 1	4D7C2	
			Hirehalla 2	4D7C1	
			Chanl, Hirehalla	4D7C3	
			Nandigrama	4D7C4	
			Tuprinala	4D7C5	
			Yeran, Radi, Gugihalla	4D7C6	
			Jaul	4D7C7	
			Tas, Hirehalla	4D7C8	
			U. Malaprabha	4D7C9	
		RB Krishna upto confl. with Malaprabha	RB Krishna 1	4D7B2	
			RB Krishna 2	4D7B1	
			Huti 1	4D7B4	
			Huti 2	4D7B3	
			Ilkahlalla	4D7B5	
		LB Krishna	LB Krishna 1	4D7A2	
			LB Krishna 2	4D7A1	
			Hira Sogli	4D7A3	
			Don 1	4D7A6	
			Don 2	4D7A5	
			Don 3	4D7A4	
			LB Krishna	4D7A7	
			Parvatakati	4D7A8	
		Upper Bhima above confl. with Sina	RB Bhima Sina to Man	Bor 1	4D6D3
				Bor 2	4D6D2
				Bor 3	4D6D1
				Doddahalla	4D6D4
		Lower Bhima upto confl. with Sina	LB along with Bhima	LB Bhima1	4D5C1
	Amarja			4D5C2	
	Bori			4D5C3	
	Harni			4D5C4	
	Dhubdhubi			4D5C5	
Bennithora, Mullamari on LB Bhima	LB Bhima 2		4D5B2		
	LB Bhima 3		4D5B1		
	Machkula		4D5B3		
	Kamalavathy		4D5B4		
	Kagna		4D5B6		
	Mullamari		4D5B7		
	Gandhorinala		4D5B8		
	Bennithora		4D5B9		

BASIN	CATCHMENT	SUB CATCHMENT	WATERSHED	WSD CODE		
Krishna	Lower Bhima upto confl. with Sina	RB Bhima upto confl. with Sina	RB Bhima 1	4D5A2		
			RB Bhima 2	4D5A1		
			Chinamgiri	4D5A3		
			Sindi-Naobi	4D5A4		
			Satna	4D5A5		
			Doddahalla, Hirehalla	4D5A6		
			Indi-Doddahalla	4D5A7		
	Upper Tungabhadra above the reservoir	Upper (Bhadra) Tungabhadra		Kaggi, Kusi	4D4D1	
				Somavahini	4D4D2	
				Hulgi	4D4D3	
				L. Tunga	4D4D4	
				Bhadra	4D4D5	
				Malathy	4D4D6	
				Sitamma	4D4D7	
		Tungabhadra from confl. of Tunga and Bhadra upto confl. with Varada			RB Tungabhadra 2	4D4C1
					LB Tungabhadra 2	4D4C2
					Haridra	4D4C3
					Sulekere	4D4C4
					Kumudvathy	4D4C5
					Kumudvathy	4D4C6
					RB Tungabhadra 1	4D4C7
					LB Tungabhadra 1	4D4C8
		Chikkahagari			Meruru 1	4D4B4
					Meruru 2	4D4B3
					Meruru 3	4D4B2
					Meruru 4	4D4B1
					Vadagatti	4D4B5
		Misc LB Lower parts of Varada			Hire Halla	4D4A1
					Doddahalla 3	4D4A2
					Doddahalla 4	4D4A3
					Dharma 1	4D4A6
					Dharma 2	4D4A5
					Dharma 3	4D4A4
					Dandavathy	4D4A7
					Mavinhole, Varada River	4D4A8
	Lower Tungabhadra (between Tungabhadra and Srisailam reservoirs)	Directly into Right Bank		RB Tungabhadra 3	4D3F3	
RB Tungabhadra 4				4D3F1		
Narihalla				4D3F2		
Uppermost Vedavathy upto Vanivilasa Sagar				Vanivilasa Sagar	4D3E1	
				Gundihalla 1	4D3E2	
				Gundihalla 2	4D3E3	
				Kodi, Doddahalla	4D3E4	
				Vedavathy 1	4D3E5	
Vedavathy 2		4D3E6				

BASIN	CATCHMENT	SUB CATCHMENT	WATERSHED	WSD CODE
Krishna	Lower Tungabhadra (between Tungabhadra and Srisailem reservoirs)	Middle Vedavathy	Garanihalla 1	4D3D1
			Garanihalla 2	4D3D2
			Doddahalla 1	4D3D3
			Doddahalla 2	4D3D4
			Suvarnamukhi 1	4D3D7
			Suvarnamukhi 2	4D3D6
			Suvarnamukhi 3	4D3D5
			Borakanave Reservoir	4D3D8
		Lower Vedavathy (Hagari)	L. Vedavathy	4D3C1
			Peddevanka 1	4D3C2
			Peddevanka 2	4D3C3
			RB Vedavathy	4D3C4
			Chinnahagari 1	4D3C5
			Chinnahagari 2	4D3C6
			Jinagehalla 1	4D3C7
			Jinagehalla 2	4D3C8
		Hindri	Pedda, Garchi	4D3B7
	Misc. long left bank of Krishna	Along Left Bank of Tungabhadra 1	4D3A4	
		Along Left Bank of Tungabhadra 2	4D3A3	
		Maskinala 1	4D3A6	
		Maskinala 2	4D3A5	
		Sindhnur, Kanakanala	4D3A7	
		Hirehalla	4D3A8	
LB Tungabhadra 3		4D3A9		
Confl. of Tungabhadra with Krishna & Bhima with Krishna upto Nagarjuna Sagar	LB Krishna confl. with Bhima to Srisailem	LB Krishna	4D2D6	
		RB Krishna 1	4D2D8	
		RB Krishna 2	4D2D7	

Basin : Godavari (4E)

BASIN	CATCHMENT	SUB CATCHMENT	WATERSHED	WSD CODE
Godavari	Manjra	Upper Manjra beyond confl. with Karanja (both RB & LB)	RB Manjra	4E6G2
		Tirna	Tirna	4E6F1
		Karanja	Karanja 1	4E6E3
			Karanja 2	4E6E2
			Karanja 3	4E6E1
		Manjra LB from Karanja confl. to Nizamsagar	LB Manjra	4E6C3
			Hibalmandi	4E6C4
			Devan	4E6C5
		Manjra RB from Karanja confl. to Nizamsagar	RB Manjra	4E6D5
			RB Manjra	4E6D6
		Manjra LB	LB Manjra	4E6B1
			Kaulas	4E6B2
			Tiru	4E6B4

Basin : Cape Comorin to Sharavathy (5A)

BASIN	CATCHMENT	SUB CATCHMENT	WATERSHED	WSD CODE
Cape Comorin to Sharavathy	Mahe to Sharavathy	Mahe to Netravathy	Aralampuza	5A3A2
			Valarpattanam	5A3A3
			Kuppanm 1	5A3A4
			Kuppanm 2	5A3A5
			Payasawani	5A3A6
			Uppala, Shiriya	5A3A7
		Netravathy to Sita	L. Netravathy	5A3B1
			Kumaradhara	5A3B2
			U. Netravathy	5A3B3
			Gurpur	5A3B4
			Shisla, Mulki	5A3B5
			Swarna, Yennehole	5A3B6
			Sita Nadi	5A3B7
		Sita to Sharavathy	Haladi-Varahi	5A3C1
			Kolluru	5A3C2
Venkatapura River	5A3C3			
Swarna	5A3C4			
Sharavathy	5A3C5			

Basin : Sharavathy to Tapti (5B)

BASIN	CATCHMENT	SUB CATCHMENT	WATERSHED	WSD CODE
Sharavathy to Tapti	Sharavathy to Savitri	Sharavathy to Kalinadi	Tadri	5B1A1
			Gangavally	5B1A2
			Bedthi1	5B1A4
			Bedthi2	5B1A3
			Kali Nadi1	5B1A6
			Kali Nadi2	5B1A5
			Dogi	5B1A7
			Kaneri Barchi, Nagi	5B1A8
		Kalinadi to Vaghotan	Sal	5B1B1
			Rachol	5B1B2
			Mandavi	5B1B3
			Chapora	5B1B5

1. BAGALKOT DISTRICT

Location and Extent

Bagalkot district situated in the northern part of Karnataka State lies between the latitudes 15°50'00" to 16°10'30" N and longitudes 75°01'40" to 76°20'00" E. The district with the total geographical area of 6,594 sq km has a population of 16,21,034 (Census, 2001) and consists of six taluks viz., Badami, Bagalkot, Bilagi, Hunugund, Jamakandi and Mudhol. The district is bounded by the districts of Bijapur on the North, Gadag on the South, Raichur on the East, Koppal on the South-East and Belgaum on the West.

Physiography

Bagalkot district is made up of Deccan traps that include sedimentary and basaltic terrain with table-topped hills. The rivers flow from west to east direction indicating that the district is elevated in the western part and is sloping towards the eastern direction.

Agro-climatic Zones

The entire district lies in the Northern dry agro-climatic zone

Soil Types

Red soils occurring on sandstone ridges are shallow, excessively drained, loamy soils with moderately rapid permeability. Red soils developed on quartzites occurring on uplands are shallow to deep, well-drained loamy to clay with moderate permeability. The black soils on shale, limestone and basalt are deep, moderately well-drained, clay with slow permeability.

Geology

Bagalkot district consists of pink and grey granites, granodiorite and granite belongs to peninsular gneissic complex, phyllite, quartz-chlorite-schist, greywacks and metabasalt belongs to Dharwar super group. The main sedimentary rocks occurring in the district are dolomite, limestone, argillite, shale and breccia. In some of the parts, patches of undifferentiated flows of basalt are also noticed.

Climate and Rainfall

The climate of the district is dry. In summer, the temperature is normally high and May is the driest month. The district is mainly influenced by the South-West monsoon and enjoys all the four seasons viz.,

1. Summer season from mid of February to first week of June;
2. South-West monsoon season from second week of June to the end of September;
3. Post monsoon season starts with North-Eastern rains in the months of October and November; and
4. Winter season from December to the middle of February.

The drainage area of the district is predominantly influenced by the South-West monsoon. The 101-years (1903-2003) average annual rainfall of the district is 554.13 mm. The recorded monthly maximum and minimum rainfall of the district in the monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	276.43	1.0
July	330.0	1.25
August	592.7	0.5
September	460.0	1.7
October	457.65	0.7

Drainage

The major rivers flowing in the district are Krishna, Ghataprabha, Malaprabha and their tributaries and Malaprabha confluences river Krishna near Kudalasangama. The drainage network is dense and oblong in shape.

Projects

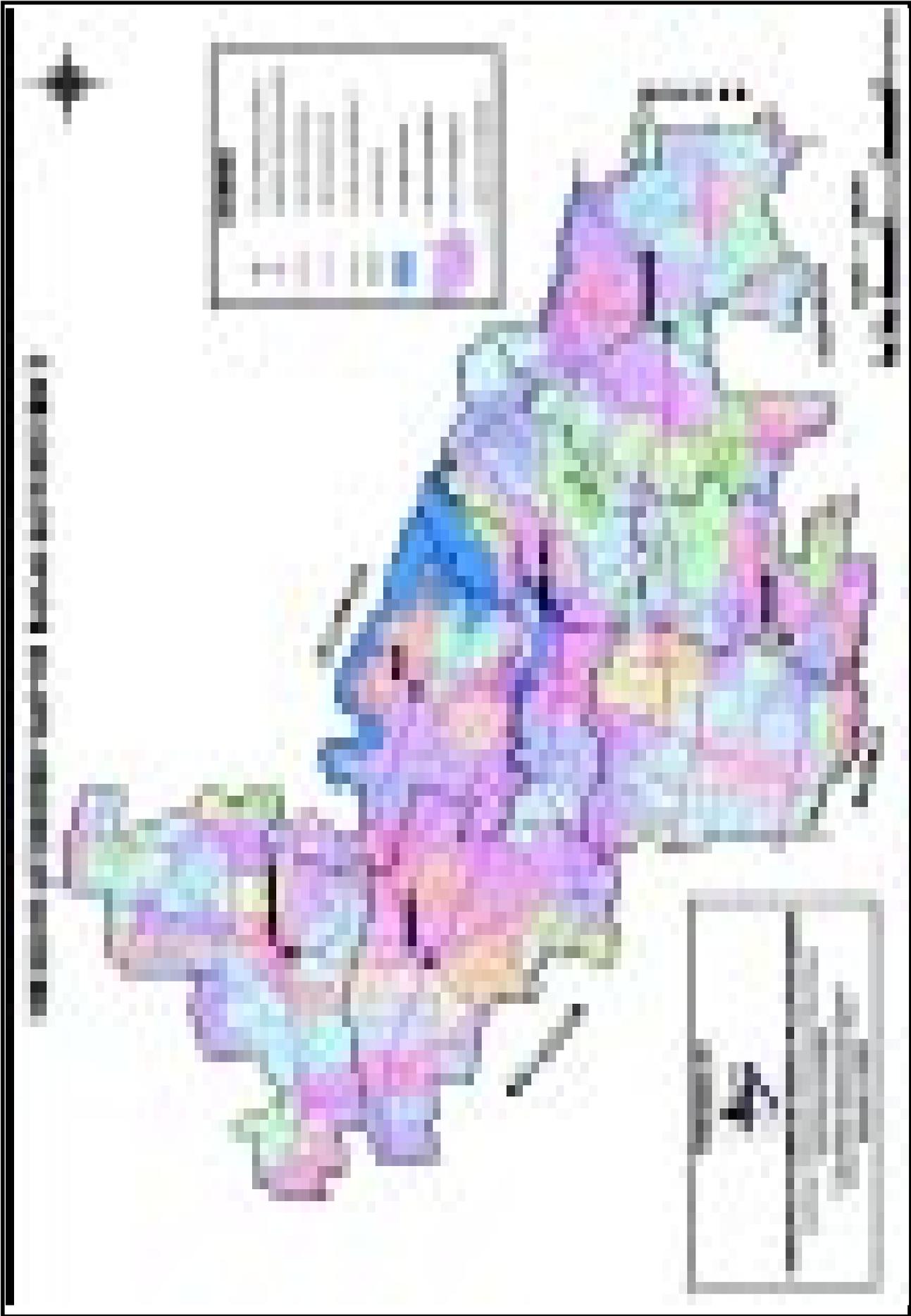
The irrigation projects in the district are Ramathal lift irrigation project, Kalaskoppa tank project and Chitawadagi. The district also receives irrigation facilities from the Hipparagi barrage, Kolchi weir, Ghataprabha stage I and II and Malaprabha irrigation projects.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF BAGALKOT DISTRICT

The district falls under the water resource regions – the Bay of Bengal (Region 4) drained by Krishna basin (4D). The Krishna basin (4D) includes the catchments Main Krishna above confluence with Bhima (4D7) (covers more than 90% of the district) and Lower Tungabhadra (between Tungabhadra and Srisaïlam reservoirs) (4D3). Further the two catchments are delineated into 7 sub-catchments, which in turn are delineated into 16 watersheds, 142 sub-watersheds 275 mini-watersheds and 1163 micro-watersheds and the details are given in Table 7. In Bagalkot district, the average area of the micro-watershed is 539.15 ha. and Alvalil (4D7C1G1b) is the biggest micro-watershed with an area of 1267.32 ha.

Table : 7 Watershed Details (up to Micro-watershed) of Bagalkot District

Hydrological Units		Name							
Region	1	Bay of Bengal (4)							
Basin	1	Krishna (4D)							
Catchment	2	Main Krishna above confluences with Bhima (4D7)							
Sub-catchment	7	Lower Tungabhadra (between Tungabhadra and Srisailem Reservoir) (4D3)	Misc. long left bank of Krishna (4D3A)	Ghataprabha (4D7D)	LB Krishna (4D7F)	LB Krishna upto confl. with Yerla near Sangli (4D7F)	Malaprabha (4D7C)	RB along Krishna upto confl. and Panchaganga (4D7E)	RB Krishna confl. with Malaprabha (4D7B)
Watershed	16	Maskinala 1 (4D3A6)	Don 1 (4D7A6)	Doddahalla Ghataprabha (4D7D3)	Badchi (4D7F2)	Chani Hirehalla (4D7C3)	RB Krishna 3 (4D7E2)	Hutti 1 (4D7B4)	Ilkal (4D7B5)
			Hirehalla 3 (4D7D4)	Hirehalla (4D7F1)	Hirehalla 1 (4D7C2)	Hirehalla 2 (4D7C1)	Jaul (4D7C7)	RB Krishna 4 (4D7E1)	
			Lower Ghataprabha 1 (4D7D2)						
			Lower Ghataprabha 2 (4D7D1)						
Sub-watershed	142	2	2	45	14	40	19	20	
Mini-watershed	275	2	3	90	27	82	36	35	
Micro-watershed	1163	9	9	425	83	339	160	138	



2. BANGALORE URBAN DISTRICT

Location and Extent

Bangalore Urban district situated in the south-eastern part of Karnataka State has an areal extent of about 2,190 sq km and population of 21,39,413 (Census, 2001). The district lies between the latitudes 12°39'00" to 13°13'00" N and longitudes 77°22'00" to 77°52'00" E. The district is surrounded by Bangalore Rural district in all the four directions except a part of the district on the South and East being bounded by Dharmapuri district of Tamil Nadu State. It consists of four taluks viz., Anekal, Bangalore North, Bangalore South and Bangalore East (Krishnarajapuram).

Physiography

There are uneven landscapes with an intermingling of hills and valleys. The western portion of Anekal taluk is rocky and bare rocky outcrops raising 60 – 90 m high are seen. The ground is susceptible to rapid erosion. Eastern part of Anekal taluk forms a plain country and Western portion is covered by forests and a continuous chain of hills. Bangalore North taluk is almost a level plateau and in the central part of the taluk, a prominent ridge running North to North-East and South to South-West is observed. Bangalore South taluk represents an uneven landscape with an intermingling of hills and valleys. The southern and western portions of the taluk are having a rugged topography consisting of granitic and gneissic masses. The hilly terrain in the southern part is covered by shrubs and bushes.

Agro-climatic Zones

Bangalore Urban district lies in the Eastern dry agro-climatic zone.

Soil Types

Bangalore Urban district is characterized by red and laterite soils. The soils are shallow to very deep, well-drained loam to clay with moderate to moderately rapid permeability. Red soils occur to a large extent on granite and gneiss and are moderately deep to deep and very deep, well-drained, loam to clay soils with moderately rapid to moderate permeability.

Geology

The chief rock types occurring in Bangalore Urban district are granites and gneisses that are highly jointed. The sheet joining parallel to the exposed surface is a particular characteristic of Bangalore gneisses. Granite and gneisses are intruded by a number of basic dykes. Dykes are oriented East-West as well as North-South. Lateritic capping is confined to higher elevations such as White Field and Ramagondahalli.

Climate and Rainfall

The district enjoys an agreeable climate and is free from extremes. The climate of the district is classified as the seasonally dry tropical savanna climate. April is usually the hottest month with the mean daily maximum temperature at 33.4°C and mean daily minimum at 21.2°C. Relative humidity is high during the South-West monsoon months and decreases thereafter. During the months from May to September, the winds are West to South-West to West, while during the period

from November to March, they are East to North-East and East to South-East. The year is divided into four seasons viz.,

1. Summer season from March to the end of May;
2. South-west monsoon season from June to September;
3. Post- monsoon season from October to November; and
4. Cold season from December to February.

The drainage area of the district is prominently influenced by the South-West monsoon. The 101-years (1903-2003) average annual rainfall of the district is 751.6 mm. The recorded monthly maximum and minimum rainfall of the district during the monsoon period is as follows :

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	272.0	4.4
July	313.45	4.8
August	415.33	2.1
September	561.7	3.6
October	518.6	2.9

Drainage

The drainage pattern of Bangalore North taluk is governed by the granitic ridge running North to North-East and South to South-East almost in the middle of the taluk. The drainage towards East is made up of a network of nalas generally flowing from West to East. There are no major rivers flowing in the district. River Arkavathy flows in the district for a small distance in Bangalore North taluk. Dakshina Pinakini touches the borders of the district to the North-East of Anekal taluk. Vrishabhavathy, a tributary of the Arkavathy flows in the district. Basavanahole originating beyond Muthyalamadu passes through Anekal taluk and joins the river Arkavathy near Kanakapura.

Projects

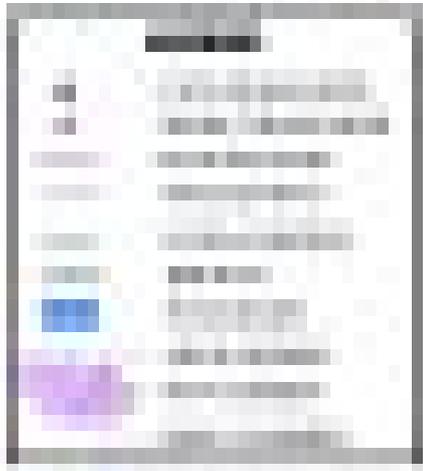
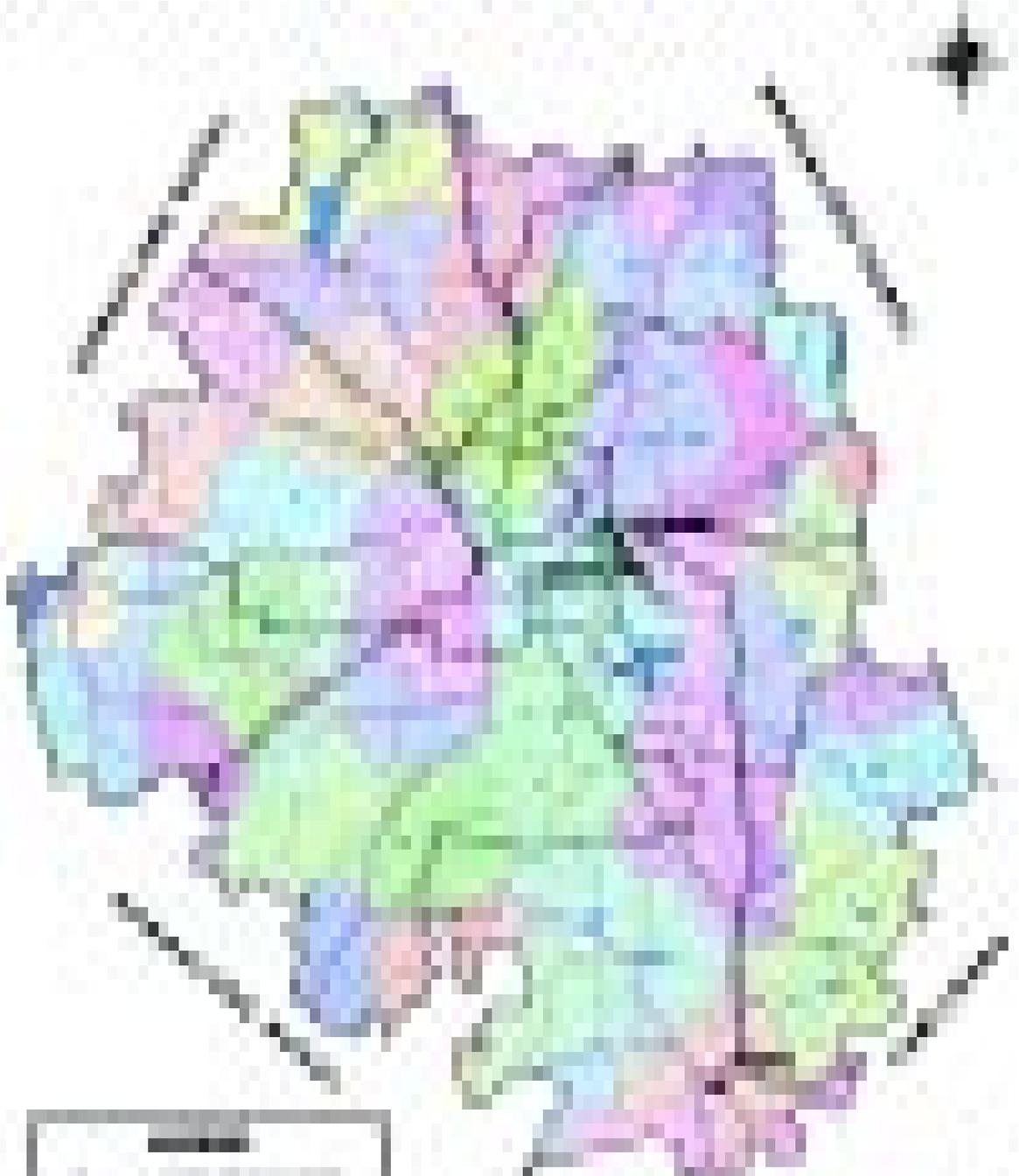
There are no major and medium irrigation projects in Bangalore Urban district. However, there are a number of minor irrigation tanks and lift irrigation schemes in the district.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF BANGALORE URBAN DISTRICT

The district lies in the water resource region, the Bay of Bengal (Region 4). Region 4 is drained by the Cauvery (4B) and rivers between Cauvery and Krishna basins (4C). Further, the two basins are delineated into 2 catchments, 2 sub-catchments, 6 watersheds, which in turn are delineated into 51 sub-watersheds, 99 mini-watersheds and 475 micro-watersheds and the details are given in Table 8. In Region 4 of the district, the average area of the micro-watershed is 457.39 ha. and Ibbalur (4C1C8G3d) is the biggest micro-watershed with an area of 1107.33 ha.

Table : 8 Watershed Details (up to Micro-watershed) of Bangalore Urban District

Hydrological Units	Total Nos.	Name	
Region	1	Bay of Bengal (4)	
Basin	2	Between Cauvery and Krishna (4C)	Cauvery (4B)
Catchment	2	Between Cauvery to Palar (4C1)	Krishnarajasagar to Stanley Reservoir (4B3)
Sub-Catchment	2	Upper Ponnaiyar (4C1C)	LB Cauvery (4B3B)
Watershed	6	S. Pennar (4C1C9)	Kumudavathy (4B3B8)
		U. Ponnaiyar (4C1C8)	L. Arkavathy 1 (4B3B7)
			L. Arkavathy 2 (4B3B6)
			L. Arkavathy (4B3B5)
Sub-watershed	51	23	28
Mini-watershed	99	46	53
Micro-watershed	475	240	235



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3. BANGALORE RURAL DISTRICT

Location and Extent

Bangalore Rural district is situated in the south-eastern corner of Karnataka. The district lies between the latitudes 12°14'00" to 13°30'00" N and longitudes 77°05'00" to 78°00'00" E with a total geographical area of 5,815 sq km and a population of 18,81,514 (Census, 2001). It consists of eight taluks viz., Channapatna, Devanahalli, Doddballapura, Hoskote, Kanakapura, Magadi, Nelamangala and Ramanagaram. The district is bounded by Tamil Nadu State on the East, Tumkur and Mandya districts on the West, Chamarajanagar on the South and Kolar and Tumkur districts on the North.

Physiography

The central, northern and eastern portion of the district consists of vast stretches of undulating plains. The uplands are bare or covered with scrub jungles, whereas low lands are covered with a series of irrigation tanks. A range of hills from Kanakapura in the South to Nijagal in the North is formed of coarse grain granite, which is a prominent physiographic feature. Shivaganga, Savanadurga, Nijagal, Muduvani Betta and Narashima Devara Betta are some of the notable hills in the district.

Agro-climatic Zones

The entire district lies in the Eastern dry zone.

Soil Types

Lateritic soils occurring in Hoskote and Devanahalli taluks are shallow to very deep, well-drained loam to clay with moderate to moderately rapid permeability. Red soils occur to a large extent on granite and gneiss and are moderately deep to deep and very deep, well-drained, loam to clay soils with moderately rapid to moderate permeability.

Geology

Bangalore Rural district forms part of the Deccan plateau and is covered by peninsular gneissic complex, basic dykes and laterites. Granites occurring in gneissic complex vary in colour, texture and structure.

Climate and Rainfall

The climate of the district is reasonably dry tropical savanna climate. The year is divided into four seasons viz.,

1. Summer season from middle of February to first week of June;
2. Monsoon season from middle of June till the end of September;
3. Post Monsoon season from October to November; and
4. Cold season from December to the middle of February.

The monthly mean diurnal range of temperature is maximum in the months of February and March when the sky is generally clear or lightly clouded and the

air is least humid. It is minimum in July and August months when the sky is nearly overcast and the air is very moist. Relative humidity is high during the period from June to October (80-85%) and decreases thereafter. During the period from May to September, the winds are West-South-West to West, while during the period from November to March they are East-North-East to South-East. April and October are the transition months when they change from the Easterly to the Westerly wind regime and vice-versa takes place.

The drainage area of the district is prominently influenced by the South-West monsoon. The 101-years (1903-2003) average annual rainfall of the district is 845.83 mm. The monthly recorded maximum and minimum rainfall of the district during monsoon period is as follows:

Months	Maximum Rainfall (mm)	Minimum Rainfall (mm)
June	551.33	1.5
July	3111.0	2.7
August	3854.0	5.3
September	1978.4	2.5
October	2295.5	4.8

Drainage

Arkavathy, Kanva, South Pennar are the main rivers in the district. These rivers flow in North-South direction. River Cauvery forms the southern boundary of the district. River South Pennar originates at Nandi hills and flows through Devanahalli and Hoskote taluks. Kanva, Kumudvathy, Vrishabhavathy and Suvarnamukh are semi-perennial streams in Bangalore Rural district.

Projects

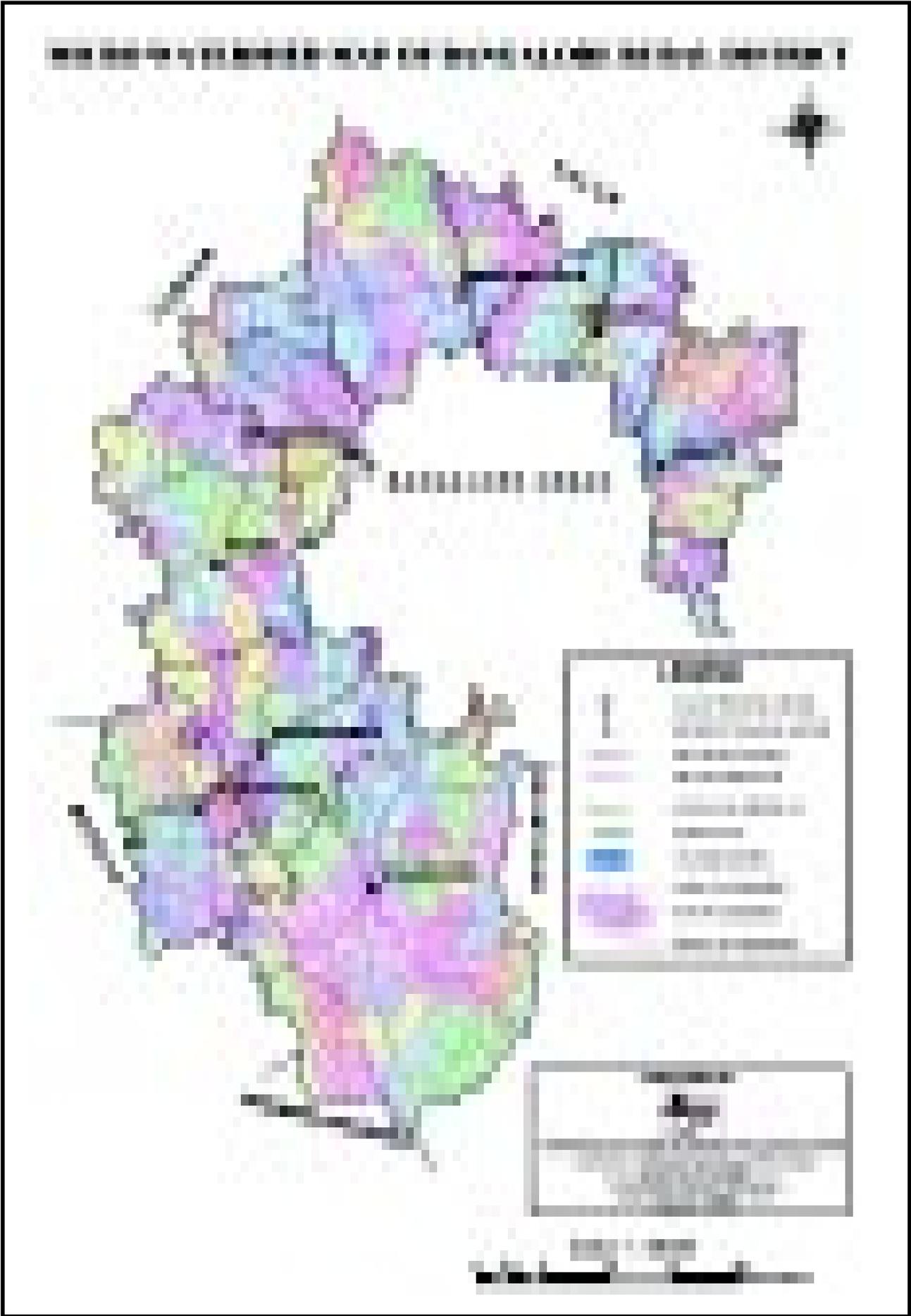
Chamarajasagar reservoir, Manchanabele, Kanva, Iglur and Arkavathy are the medium irrigation projects of the district.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF BANGALORE RURAL DISTRICT

The district lies in the water resource region, the Bay of Bengal (Region 4). Region 4 is drained by the Cauvery (4B) (covering more than 60% of the district area) and streams between the Cauvery and Krishna basins (4C). The basin between the Cauvery and Krishna includes Pennar (4C3), between Cauvery to Palar (4C1), and between Ponnaiyar to Pennar (4C2) catchments. Further, the 4 catchments are delineated into 6 sub-catchments, 14 watersheds and which in turn have been delineated into 146 sub-watersheds, 296 mini-watersheds and 1241 micro-watersheds. The details are given in Table 9. In Region 4 of the district, the average area of the micro-watershed is 467.78 ha. and Madhure Kere1 (4B3B811f) is the biggest micro-watershed with an area of 1117.06 ha.

Table : 9 Watershed Details (up to Micro-watershed) of Bangalore Rural District

Hydrological Units	Total Nos.	Name			
Region	1	Bay of Bengal (4)			
Basin	2	Between Cauvery and Krishna (4C)		Cauvery (4B)	
Catchment	4	Between Cauvery to Palar (4C1)	Between Ponnaiyar to Palar (4C2)	Pennar (4C3)	Krishnarajasagar to Stanley Reservoir (4B3)
Sub-Catchment	6	Upper Ponnaiyar (4C1C)	Upper Palar (4C2B)	Upper most origin of Pennar (4C3H)	LB Cauvery (4B3B)
Watershed	14	S. Pennar (4C1C9)	U. Palar 1 (4C2B5)	Jayamangali (4C3H4)	LB above Shimsha reservoir (4B3D)
		U. Ponnaiyar 1 (4C1C8)		Pennar Pandi (4C3H5)	Shimsha 5 (4B3C)
					Shimsha 3 (4B3C1)
					Shimsha 4 (4B3C2)
Sub-watershed	146	21	4	13	4
Mini-watershed	296	46	5	24	6
Micro-watershed	1241	184	21	96	19
					39
					78
					303



4. BELGAUM DISTRICT

Location and Extent

Belgaum district located in the north-western part of the State lies between latitudes 15°15'00" to 17°00'00" N and longitudes 73°59'00" to 75°30'00" E. The district has a total geographical area of 13,415 sq km with a population of 42,14,505 (Census, 2001) and consists of ten taluks viz., Belgaum, Athani, Bailahongala, Chikkodi, Gokak, Hukkeri, Khanapur, Raibagh, Ramadurga and Soundatti. The district is bounded on the North by Maharashtra State, on the South by Dharwar and Uttara Kannada districts, on the East by Bagalkot and part of Gadag district and on the West by Maharashtra State.

Physiography

The district is divided into four tracts viz., the western fringes, the northern belt, the central belt and the southern belt. The western fringes are in the elevated southern and western portions of the district. The northern belt is formed between the Ghataprabha and the Krishna and marked in the west by some plateaus of poor soil and the East is marked by low rolling bear hills on either side of the Krishna valley. To the north of central belt, the drainage of Malaprabha is separated by Ghataprabha valley. In the west of southern belt, Malaprabha valley is covered with high rugged hills and forests. The lands are more open, levelled and arable. A major part of the district has black soil; however, towards the northern portion, red soil is seen.

Agro-climatic Zones

Belgaum district lies in the three agro-climatic zones viz.,

1. Northern dry zone (Gokak, Athani, Raibagh, Ramadurga and Soundatti)
2. Northern Transition zone (Belgaum, Bailahongala, Chikkodi and Hukkeri)
3. Hilly zone (Khanapur)

Soil Types

The black soils developed on basalt occur in areas of Nippani, Chikkodi, Athani, Hukkeri, Belgaum and Bailahongala. They are shallow to moderately deep, well drained, loam to clay soils with moderate to moderately slow permeability. These soils occur in plateau surfaces and upper slopes. The lower slopes and valley have deep to very deep black clay soils that are moderately well drained with slow permeability. Red soils developed from sedimentary rocks in the areas of Ramdurga, Yargatti, Soundatti, Gokak and Belgaum are shallow to moderately deep, well drained, loamy soils with moderately rapid permeability. Laterite soils occurring in Belgaum and Khanapur areas are deep, excessively drained clay soils with iron gravels and have moderately rapid permeability. The forest brown soils occur in Malnad areas of Khanapur which are very deep, well drained loam to clay soils with moderate permeability.

Geology

Dharwars, gneissic system, Kaladgi series and the Deccan traps are the geological formations found in the district. In Belgaum and western parts of Khanapur taluks, mostly Dharwar formations (graywacke schists, phyllites, quartzite and banded ferruginous quartzite) are seen. Numerous beds of haematitic schists are found in the upper valley of Malaprabha in the Bailhongala schist rocks and small quantity of gold is found associated with haematite beds in some of the streamlets at Bailhongala and Belavadi. Basalt is the common type of rock, which is massive, tabular or columnar.

Climate and Rainfall

The climate of the district is healthy and is characterized by general dryness excepting monsoon season. The climate is not very hot even in May, the nights being cool and sometimes chilly. The year is divided into four seasons, viz.,

1. Summer season from March to May;
2. South-West monsoon season from June to September;
3. Post monsoon from October to November; and
4. Cold season from December to February.

The relative humidity is generally high (85%) in the monsoon season and decreases in the post monsoon period. The driest part of the year is from January to March when the relative humidity in the afternoons is about 30%. The winds are generally light and blow mainly from South-West and West during the period from April to September. In October, winds blow between North and East directions. During November and December the winds are mostly North-Easterly. The drainage area of the district is prominently influenced by the South-West monsoon. The 101-years (1903-2003) average annual rainfall of the district is 841.92 mm. The recorded monthly maximum and minimum rainfall of the district during the monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	1256.6	1.3
July	2652.5	1.2
August	1578.4	2.7
September	754.8	2.7
October	515.5	0.5

Drainage

Major part of the district lie in the Krishna basin in which major rivers viz., Krishna, Ghataprabha and Malaprabha flow. Markandeya, Dudhaganga, Vedaganga, Hiranya-Keshi, Ballary nala are some of the major streams in Krishna basin of Belgaum district. Mahadayi, a West flowing river is prominent in the district.

Projects

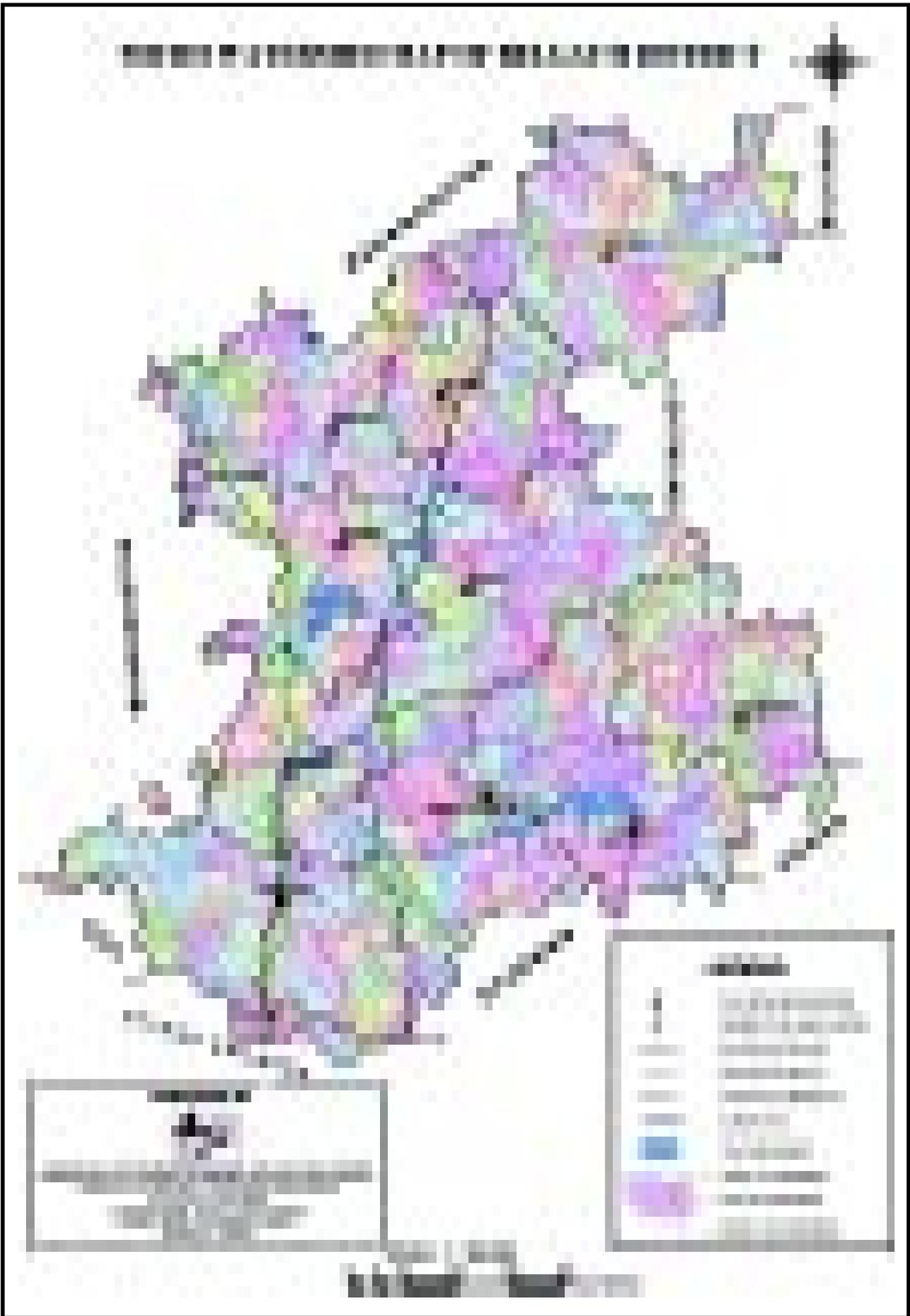
The major irrigation projects are Dudhaganga, Markandeya, Ghataprabha stage I and II, Malaprabha, Kolchiweir and Gokak canals are the medium irrigation projects of the district.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF BELGAUM DISTRICT

The district falls under two water resource regions viz., the Bay of Bengal (Region 4) and the Arabian Sea (Region 5). Region 4 is mainly drained by Krishna basin (4D) that includes the 2 catchments viz., Upper Bhima above confluence with Sina (4D6) and Main Krishna above confluence with Bhima (4D7). Region 5 is drained by Sharavathy to Tapti basin (5B) that includes Sharavathy to Savithri (5B1) catchment. Further, the 3 catchments are delineated into 9 sub-catchments, 29 watersheds and they in turn are delineated into 310 sub-watersheds, 594 mini-watersheds and 2512 micro-watersheds. The details are given in Table 10. The average area of the micro-watershed is 543.15 ha. and Yadawad2 (4D7D3I1d) is the largest micro-watershed with an area of 1382.32 ha. In Region 5, the average area of the micro-watershed is 397.01 ha. and the biggest micro-watershed in the region is Ghastoli Doddi2 (5B1A8A1b) having an areal extent of 799.52 ha.

Table : 10 Watershed Details (up to Micro-watershed) of Belgaum District

Hydrological Units		Name											
Total Nos.	Bay of Bengal (4)												
Region	2	Krishna (4D)											
Basin	2	Main Krishna above Confluence with Bhima (4D7)											
Catchment	3	Upper Bhima above confl. with Sina (4D6)											
Sub-catchment	9	Arabian Sea (5)	Sharavathy to Tapti (5B)	Sharavathy to Savithri (5B1)	Kalinadi to Vaghotan (5B1B)	Sharavathy to Kalinadi (5B1A)	RB Bhima Sina to Man (4D6D)	Ghataprabha (4D7D)	LB Krishna (4D7A)	LB Krishna up to confl. with Yerla near Sangli	Malaprabha (4D7C)	Pancha-ganga Varna (4D7G)	RB along Krishna upto confl. Panchaganga (4D7E)
Watershed	29	Chapora (5B1B5)	Dogi (5B1A7)	Kanerri Barch, Nagi (5B1A8)	Hirehalla (4D7D5)	Hiranyakeshi 2 (4D7D7)	Hiranyakeshi 1 (4D7D8)	Hirehalla 3 (4D7D4)	Badchi (4D7F2)	Agrani 1 (4D7F4)	Nandigrana (4D7C4)	Tas, Hirehalla (4D7C8)	RB Krishna 1 (4D7E4)
Sub-watershed	310	16	19	34	154	99	817	4	48	75	2	45	
													Markandeya (4D7D6)
Mini-watershed	594	32	34	154	187	187	6	94	151	2	84		
Micro-watershed	2512	107	154	154	817	817	19	339	728	7	334		



5. BELLARY DISTRICT

Location and Extent

Bellary district situated in eastern Karnataka spreads from South-West to North-East of the State. The district is geographically located between latitudes 14°33'33.49" to 15°50'1.34" N and longitudes 75°39'52.45" to 77°10'5.56"E and has a population of 20,27,140 (Census, 2001). Bellary district with an areal extent of 8,419 sq km consists of seven taluks viz., Bellary, Hadagali, Hospet, Hagari Bommanahalli, Kudligi, Sandur and Sirguppa. The district is bounded on the North by Raichur and Koppal, on the South by Davangere and Chitradurga, on the East by Andhra Pradesh and West by Haveri and Gadag District.

Physiography

Bellary district consists of two widely differing natural divisions, an Eastern and the other Western, separated by the Sandur hills that runs right across the district from North-West to South-East and slopes gradually North towards Tungabhadra. The western part contains scattered patches of black cotton soil and most of the part is covered with mixed and red ferruginous soils. The islands occur here and there in the bed of Thugabhadra and there are two tributaries of river Thugabhadra within Bellary district. There are two types of forests viz., dry deciduous forests and scrub forests that occur in the district.

Agro-climatic Zones

Bellary district lies in the Northern dry agro-climatic zone.

Soil Types

Red soils occurring are moderately deep, well drained loamy to clay, gravelly soils with moderately rapid to moderate permeability. The red soils have developed on granite. The shallow red gravelly clayey soils developed from quartzite and schist occur on ridges, excessively drained with moderately rapid permeability. The black soils developed on schist and limestone are deep, moderately well drained, clay with moderately slow to slow permeability.

Geology

The district consists mainly of Archaean complex composed of crystalline schists, epidiorites, granitic gneisses and granites. Basic and acidic dykes are commonly found. Dharwar series of rocks occur in the form of four prominent bands – hornblende schist, conglomerates, epidiorites, schists, quartzites and phyllitic schists – striking across the district in North-West to South-East direction.

Climate and Rainfall

The climate of the district is characterized by dryness in the major part of the year and a hot summer. Nearly 60% of the annual rainfall is received during the period from June to September and about 24% during October and November months. September is the month with the highest rainfall. Relative humidity is 45-65% in the mornings and 20-35% in the afternoons. Relative humidity is higher

in the South-West and post monsoon seasons (50-70%). The year may be divided into four seasons viz.,

1. Summer season from March to May;
2. South-West monsoon season from June to September;
3. Post monsoon season from October to November; and
4. Cold season from December to February.

The drainage area of the district is prominently influenced by the South-West monsoon. The 101-years (1903-2003) average annual rainfall of the district is 573.51 mm. The recorded monthly maximum and minimum rainfall of the district in the monsoon period is as follows :

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	274.1	0.8
July	403.85	1.1
August	385.4	2.0
September	1537.3	2.0
October	914.2	1.0

Drainage

A major part of the district lies in the catchment of river Tungabhadra and the river enters the district near Kadathi village in the Harpanahalli taluk and forms the western and northern boundary of the district covering the taluks of Hadagali, Hospet and Siruguppa. The tributaries of Tungabhadra within Bellary district are Hagari and Chikkahagari. Hagari drains the eastern taluks of Bellary and Siruguppa, whereas Chikkahagari traverses the western taluks i.e., Hadagali and Kudligi.

Projects

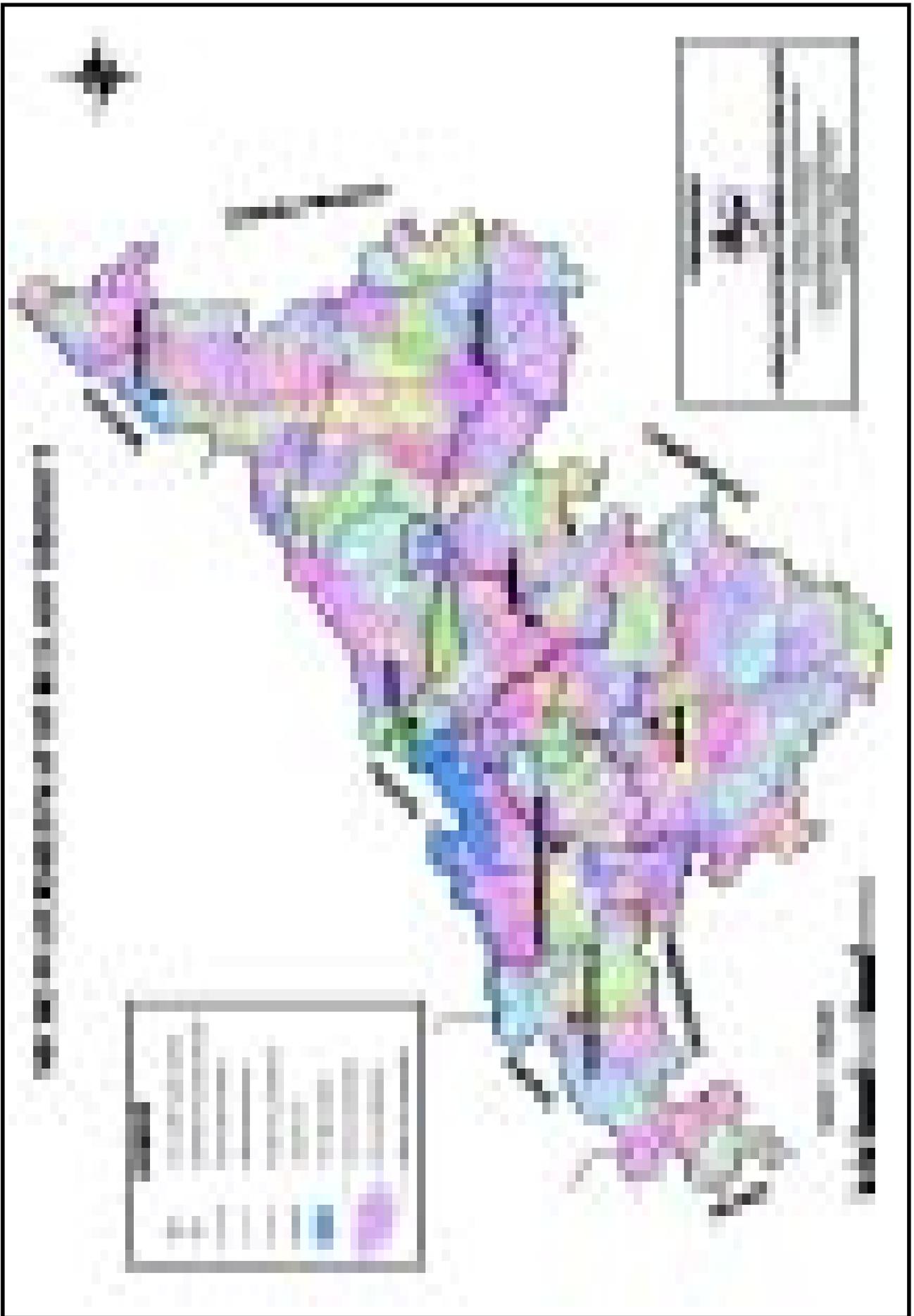
Hagari Bommanahalli and Narihalla are the medium irrigation projects in the district. The district is also having irrigation facilities from Tungabhadra right bank low level canal and Vijayanagar canals.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF BELLARY DISTRICT

The district falls under the water resource region 4 and it is drained by Krishna basin (4D) that includes the catchments 4D3 and 4D4. Further, the 2 catchments are delineated into 5 sub-catchments and 15 watersheds and which in turn are delineated into 158 sub-watersheds, 327 mini-watersheds and 1425 micro-watersheds. The details are given in Table 11. In Region 4 of Bellary district, the average area of the micro-watershed is 578.97 ha. and Kurekuppa2 (4D3F2P3h) is the biggest micro-watershed with an area of 2513.20 ha.

Table : 11 Watershed Details (up to Micro-watershed) of Bellary District

Hydrological Units	Total Nos.	Name			
Region	1	Bay of Bengal (4)			
Basin	1	Krishna (4D)			
Catchment	2	Lower Tungabhadra (between Tungabhadra and Srisailem reservoirs) (4D3)	Upper Tungabhadra above the reservoir (4D4)		
Sub-catchment	5	Directly into Right Bank (4D3F)	Hindri (4D3B)	Lower Vedavathy (Hagari) (4D3C)	Chikkahagari (4D4B)
Watershed	15	Narihalla (4D3F2)	Pedda Garchi (4D3B7)	Chinnahagari 1 (4D3C5)	Meruru 2 (4D4B3)
		RB Tungabhadra 3 (4D3F3)		Chinnahagari 2 (4D3C6)	Meruru 3 (4D4B2)
		RB Tungabhadra 4 (4D3F1)		Jinagehalla 1 (4D3C7)	Meruru 4 (4DdB1)
				L. Devadavathy (4D3C1)	Vedagatti (4D4B5)
				Peddevanka 1 (4D3C2)	
				Peddevanka 2 (4D3C3)	
Sub-watershed	158	38	5	59	52
Mini-watershed	327	83	11	121	104
Micro-watershed	1425	423	44	525	405
					4
					8
					28



6. BIDAR DISTRICT

Location and Extent

The district lies in the northern part of Karnataka State and is geographically located between latitude 17°35'00'' to 18°25'00'' N and longitudes 76°42'00'' to 77°39'00'' E. The district has an area extent of 5,448 sq km and a population of 15,02,373 (Census, 2001). Bidar district consists of five taluks viz., Bidar, Aurad, Basavakalyan, Bhalki and Humnabad. The district is bounded on the North-West by Maharashtra State, on the South by Gulbarga, on the East by Andhra Pradesh.

Physiography

Entire district forms a part of the Deccan trap and is made up of solidified lava. The northern part of the district is characterized by treeless, flat and undulating surfaces, hillocks, black soil, and basaltic rocks. The southern half of the district is a high plateau (715 m above MSL) and is well drained.

Agro-climatic Zones

The entire Bidar district lies in the Northern transition agro-climatic zone.

Soil Types

The black soils developed on basalt are shallow on plateau summits and slopes. They are loamy to clay in texture, well drained with moderate permeability. The black soils are very deep, moderately well drained to imperfectly drained, clayey alluvial soils and occur in valleys and plains. The soils have low permeability. The soils developed on laterite are shallow to deep and very deep, well drained with moderate to moderately rapid permeability. Lateritic red soil is mainly found in Bidar and Humnabad taluks. Black cotton soils are seen in Aurad and Bhalki taluks; however, Basavakalyan taluk has both the soil types.

Geology

The district is entirely covered by the Deccan trap. They generally form flat-topped hillocks and terrace-like features. Some volcanic flows are hard and massive, while others are weathered and soft. Due to this character, terraced landscapes are found. Laterites are generally found at an elevation of 618.7 m above mean sea level.

Climate and Rainfall

The climate of the district is dry throughout the year except in the South-West monsoon months. The relative humidity is high during the South-West monsoon season and low in summer. The district enjoys four seasons viz.,

1. Summer season from middle of February to first week of June;
2. Monsoon season from middle of June till the end of September;
3. Post monsoon season during October and November months; and
4. Cold season from December to middle of February.

The drainage area of the district is prominently influenced by the South-West monsoon. The 96-year (1908-2003) average annual rainfall of the district is 821.74 mm. The monthly recorded maximum and minimum rainfall of the district during monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	391.3	2.4
July	495.5	1.2
August	516.34	2.3
September	525.0	1.0
October	601.4	0.8

Drainage

The district lies in both the Krishna and the Godavari basins. Mullamari and Gandhorinala are the prominent rivers of the Krishna basin in Bidar district. Manjra and Karanja are the prominent rivers in the Godavari basin of Bidar district. Manik Nagar nala, Chulkinala, Hallikhednala are the tributaries of Karanja river. The drainage area is oblong shaped.

Projects

Karanja major irrigation project and Chulkinala medium irrigation project are constructed in the Godavari basin of Bidar district. Upper Mullamari medium irrigation project is constructed in the Krishna basin of Bidar district. Manjra lift irrigation project is yet to come up.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF BIDAR DISTRICT

The district falls under the Bay of Bengal water resource region (4) and is mainly drained by the Godavari basin (4E) which in turn is drained by Manjra river catchment (4E6); and a part is drained by the Krishna Basin (4D) that includes the catchment Lower Bhima up to confluence with Sina (4D5). Further, the 2 catchments are delineated into 7 sub-catchments, 16 watersheds and they in turn are delineated into 118 sub-watersheds, 221 mini-watersheds and 837 micro-watersheds. The details are given in Table 12. In Region 4, the average area of the micro-watershed is 645.78 ha. and Nirna (4E6E2C1a) is the largest micro-watershed with an area of 1230.24 ha.

Table: 12 Watershed Details (up to Micro-watershed) of Bidar District

Hydrological Units	Total Nos.	Name						
Region	1	Bay of Bengal (4)						
Basin	2	Godavari (4E)						
Catchment	2	Manjra (4E6)						
Sub-catchment	7	Karanja (4E6E)	Manjra LB (4E6B)	Manjra LB from Karanja confluence to Nizamsagar (4E6C)	Manjra RB from Karanja confluence to Nizamsagar (4E6D)	Tirna (4E6F)	Upper Manjra beyond confluence with Karanja (both RB and LB)	Mullamari on LB Bhima (4D5B)
Watershed	16	Karanja1 (4E6E3)	Kaulas (4E6B2)	Devan (4E6C5)	RB Manjra 2 (4E6D5)	Tirna (4E6F1)	RB Manjra (4E6G2)	Bennithora (4D5B9)
		Karanja2 (4E6E2)	LB Manjra (4E6B1)	Hibalmandi (4E6C4)	RB Manjra 1 (4E6D6)			Gandhorinala (4D5B8)
		Karanja3 (4E6E1)	Tiru (4E6B4)	LB Manjra (4E6C3)				Mullamari (4D5B7)
Sub-watershed	118	47	14	14	12	6	2	23
Mini-watershed	221	92	24	28	24	9	3	41
Micro-watershed	837	351	93	107	101	29	7	149

7. BIJAPUR DISTRICT

Location and Extent

Bijapur district is situated in the northern part of Karnataka State and lies between the latitudes 16°09'20.13" to 17°28.27'96" N and longitudes 75°19.53'30" to 76°28.11'77" E. The district with a total geographical area of 10,475 sq km is bounded on the North and North-West by Maharashtra State and East by Gulbarga, Raichur and Bagalkot districts on the South and Belgaum on the West. The population of the district is 18,06,918 (Census, 2001). It consists of five taluks viz., Bijapur, Indi, Sindagi, Basavana Bagevadi and Muddebihal.

Physiography

The entire district is a dry land with plain terrain bounded by river Bhima on the North and river Krishna in the South. Bhima and Don rivers with their tributaries drain the North and North-eastern parts of the district. The entire area of the district consists of Deccan Plateau with a small table-topped hill in the central part of the district along East to West and has elevated slope from West to East.

Agro-climatic Zone

The entire district lies in the Northern dry agro-climatic zone.

Soil Types

Major area of the district has black soils. The soils have developed on basalt and on plateau surfaces has shallow to moderately deep, loamy to clay well drained soils with moderate permeability. The plateau slopes have deep soils, mostly clayey, well drained with moderately low permeability. The valleys have very deep black. alluvial, moderately well drained clay soils with low permeability. The red soils developed on granites are moderately deep to deep, loamy to clay soils with quartz gravels. These are well drained with moderate to moderately rapid permeability and occur in Muddebihal area.

Geology

The main rock types in the Bijapur district consist of migmatites, granodiorite and tonalitic gneiss belonging to peninsular gneissic complex. Limestone, shale with thin sand stone, argillite quartz conglomerate belong to Bhima and Bagalkot group and recent formation of Deccan traps and laterite.

Climate and Rainfall

Climate of the district is dry. In summer, the temperature is normally high and May is the driest month. The district is mainly influenced by the South-West monsoon and enjoys the four seasons viz.,

1. Summer season from middle of February to first week of June;
2. South-West monsoon season from the second week of June till the end of September;
3. Post monsoon season starts with North-Eastern rains in the months of October and November; and
4. Cold season from December to the middle of February.

The drainage area of the district is predominantly influenced by the South-West monsoon. The 102-year (1902-2003) average annual rainfall of the district is 567.14 mm. The recorded monthly maximum and minimum rainfall of the district in the monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	296.4	2.5
July	334.9	0.7
August	303.4	0.5
September	670.0	1.0
October	452.5	0.2

Drainage

There are three major river systems viz., the Krishna, the Bhima, the Don and their tributaries flowing in the district. Bhima and Don Rivers with their tributaries lie to the North of central high lands and flows in the North and North-eastern part of the district. In the southern border of the district, Almatti reservoir is situated. The water spread of this reservoir covers nearly 20% of the district and the drainage density is good.

Projects

Ramanahalli, Nagathana and Areshankar are the medium irrigation projects of the district. The Upper Krishna project stage I is the major irrigation project in the district.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF BIJAPUR DISTRICT

The district falls under Bay of Bengal water resource (Region 4) and is mainly drained by Krishna Basin (4D). It is further delineated into 3 catchments, 4 sub-catchments and 17 watersheds. These 17 watersheds are further delineated into 201 sub-watersheds, 402 mini-watersheds and 1747 micro-watersheds. The watershed details (up to micro-watershed) are given in Table 13. In the Region 4 of Bijapur district, the average area of the micro-watershed is 590.90 ha. and Nimbale West2 (4D5A7F2a) is the largest micro-watershed with an area of 1195.70 ha.

Table : 13 Watershed Details (up to Micro-watershed) of Bijapur District

Hydrological Units	Total No.	Name			
Region	1	Bay of Bengal (4)			
Basin	1	Krishna (4D)			
Catchment	3	Lower Bhima up to confluence with Sina (4D5)	Main Krishna above confluence with Bhima (4D7)		Upper Bhima above confluence with Sina (4D6)
Sub-catchment	4	RB Bhima up to confluence with Sina (4D5)	LB Krishna (4D7A)	LB Krishna up to confluence with Yerla near Sangli (4D7F)	RB Bhima Sina to Man (4D6D)
Watershed	17	Chinamgiri (4D5A3)	Don1 (4D7A6)	Hirehalla (4D7F1)	Bori1 (4D6D3)
		Doddahalla Hirehalla (4D5A6)	Don2 (4D7A5)		Bori2 (4D6D2)
		Indi-Dodda halla (4D5A7)	Don3 (4D7A4)		Bori3 (4D6D1)
		Satna (4D5A5)	Hira Sogli (4D7A3)		Dodda halla (4D6D4)
		Sindi-Naobi (4D5A4)	LB Krishna (4D7A7)		
			LB Krishna1 (4D7A2)		
	Parvatakati (4D7A8)				
Sub-watershed	201	76	86	10	29
Mini-watershed	402	149	173	21	59
Micro-watershed	1747	669	766	92	220

8. CHAMARAJANAGAR DISTRICT

Location and Extent

Chamarajanagar district lies in the southern part of Karnataka State and is located between latitudes 11°35'21" to 12°8'59" N and longitudes 76°23'57" to 77°46'40"E. The district has a total geographical area of 5,685 sq km and a population of 11,40,905 (Census, 2001). It consists of four taluks viz., Chamarajanagar, Gundlupet, Kollegal and Yelandur. The district is bounded by Mysore district on the West, Mandya district in the North and Tamil Nadu State in the South and East.

Physiography

The terrain of the district is an undulating tableland with granite rocks and lofty mountain ranges covered with vast forest. The general elevation of the district is more than 800 m above MSL. The principal hill ranges are Biligiri Rangana Betta in Yelandur taluk and Mahadeshwara Betta in Kollegal taluk. Besides these, there are several other isolated hills such as the Gopalaswamy Betta in the South near Gundlupet.

The extreme south of the district forms a terrain of dense forests and a major portion of the land is uniformly covered by red soil. The main forest areas are located in the southern and south-western taluks of Kollegal, Yelandur, Chamarajanagar and Gudlupet.

Agro-climatic Zones

Chamarajanagar district lies in the Southern dry agro-climatic zone.

Soil Types

Major area of the district is covered by red soils which are shallow to deep, well drained, loam to clay gravelly and non-gravelly, developed on gneisses granites, and permeability is moderate to moderately rapid. The black soils occur in Yelandur and Chamarajanagar areas which are deep, poorly drained, clay soils with alkalinity problems having slow permeability. Shallow gravelly, loam, excessively drained, red gravelly soils occur in the Eastern Ghats with moderately rapid permeability and red soils developed on charnockytes and granites.

Geology

The oldest formations of the Sargur types occurs in the district. The rock types in Sargur are amphibolites, metaphylic schist and charnockytes. Magmatite and granodiorite to tonalitic gneissic of Archaean group of rocks are also present. Hornblende biotic gneiss, phyrozin granitoid and epidote hornblende gneissic occur in small patches in Chamarajanagar district. The dykes present in the district are of economical importance.

Climate and Rainfall

The climate of the district is moderate throughout the year. Gundlupet and Chamarajanagar taluks are prone to occasional droughts. Relative humidity is generally high during the South-West monsoon season. The district enjoys four seasons viz.,

1. Summer season from March to the end of May;
2. South-West monsoon from June till the end of September;
3. Post-monsoon season from October till the end of November; and
4. Cold season starts from December and lasts till the mid of February.

The drainage area of the district is prominently influenced by the South-West monsoon. The 101-years (1903-2003) average annual rainfall of the district is 721.17 mm. The recorded monthly maximum and minimum rainfall of the district in the monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	272.8	0.9
July	580.3	1.2
August	418.2	1.2
September	633.9	1.7
October	917.2	3.0

Drainage

The drainage of the district lies in the Cauvery basin in which the prominent streams are Kabini, Suvarnavathy, Uduthorehalla and Chikkahole. The drainage network is dense.

Projects

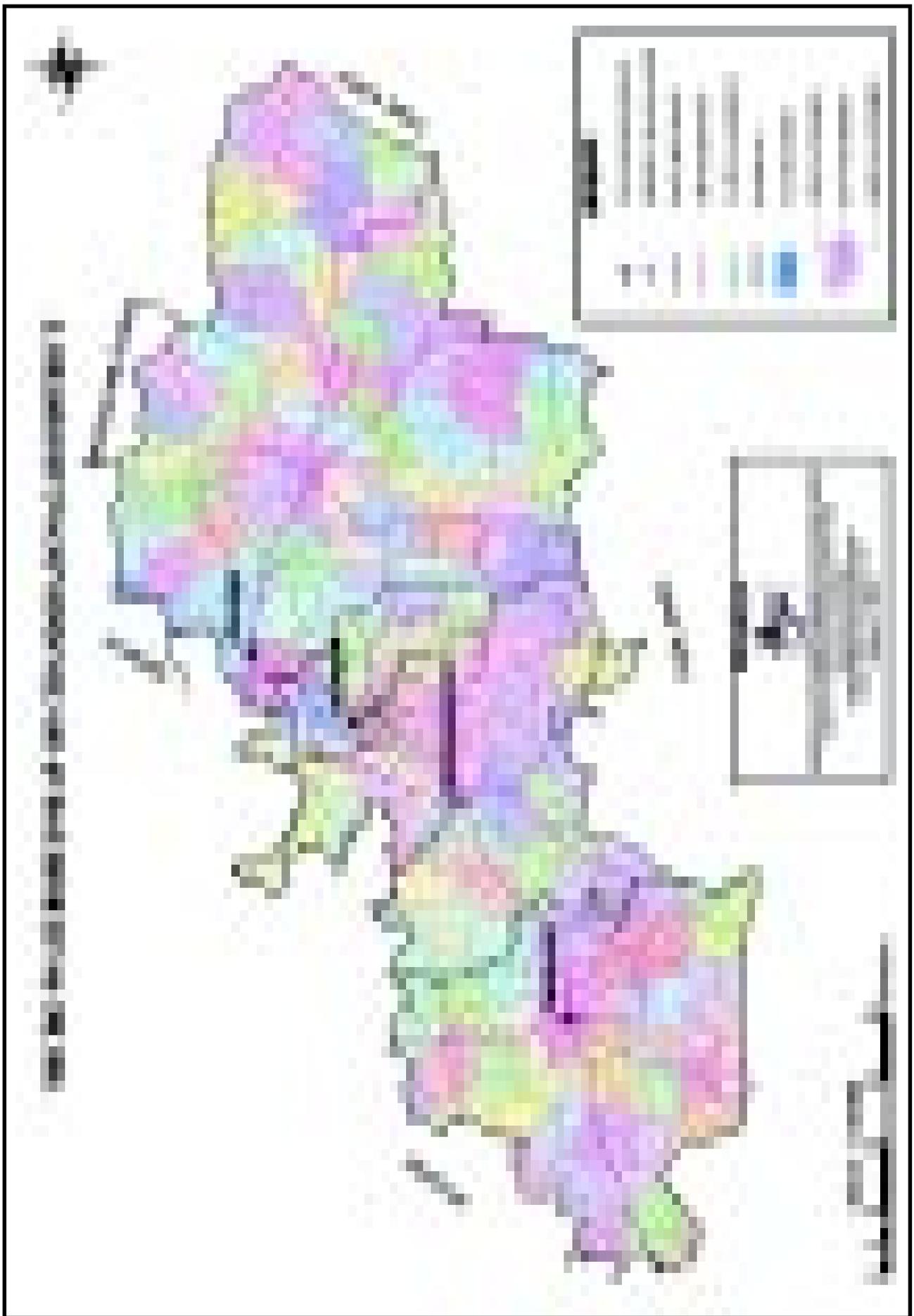
The Chikkahole, Gundal, Nallur Amani Kere, Suvarnavathy, Uduthorehalla are the medium irrigation projects of the district. Besides these, there are a number of minor irrigation tanks in the district.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF CHAMARAJANAGAR DISTRICT

The district falls under the water resource region, the Bay of Bengal (Region 4) mainly drained by Cauvery basin (4B), which includes the catchments of Krishnarajasagar reservoir (4B3) to Stanely reservoir and Amaravathy reservoir to Stanley reservoir (4B2). These 2 catchments are further delineated into 3 sub-catchments, 10 watersheds, 228 sub-watersheds, 249 mini-watersheds and 1194 micro-watersheds as presented in Table 14. Nearly 95% of the district falls under the catchment 4B3. In Region 4 of Chamarajanagar district, the average area of the micro-watershed is 472.86 ha. and Somavarpet (4B3A5J2f) is the largest micro-watershed with an area of 962.62 ha.

Table : 14 Watershed Details (up to Micro-watershed) of Chamarajanagar District

Hydrological Units	Total Nos.	Name		
Region	1	Bay of Bengal (4)		
Basin	1	Cauvery (4B)		
Catchment	2	Stanley reservoir to Amaravathy (4B2)	Krishnarajasagar to Stanley reservoir (4B3)	
Sub-catchment	3	Bhavani (4B2D)	LB above Shimsha reservoir (4B3E)	RB Cauvery (4B3A)
Watershed	10	Mayer (4B2D3)	Gundal2 (4B3E1)	Doddahole (4B3A4)
			Gundal1 (4B3E2)	Palar Maleru (4B3A1)
			Nuguhole (4B3E5)	Palar Maleru (4B3A2)
				Suvarnvathy1 (4B3A5)
				Suvarnvathy2 (4B3A6)
				Thatai (4B3A3)
Sub-watershed	128	6	33	89
Mini-watershed	249	13	60	176
Micro-watershed	1194	51	279	864



9. CHIKMAGALUR DISTRICT

Location and Extent

Chikmagalur district situated in the south-western part of Karnataka State is having a total geographical area of about 7,201 sq km and a population of 11,40,905 (Census, 2001). It lies between latitudes 12°54'42" to 13°53'53" N and longitudes 75°04'46" to 76°21'15" E. The district comprises of seven taluks viz., Chikmagalur, Kadur, Koppa, Mudigere, Narasimharajapura, Sringeri and Tarikere. The district is bounded on the East by Hassan district, on the South by Hassan and Dakshina Kannada districts, on the West by the Udupi district, on the North-East by Chitradurga district and on the North by Shimoga and Davanagere districts.

Physiography

Major part of the district is covered by mountains and there is a formidable ghat range in the west of this area which has some of the loftiest peaks. The stupendous barrier of the Baba-Budan chain of superior elevation is in the center. The magnificent Merti peak of Kalasa is a conspicuous landmark. The Eastern parts of Kadur and Tarikere taluks have the features of Maidan, an open tract. The transition from Malnad to Maidan is very abrupt and striking on approaching Lakkavalli from the West.

Agro-climatic Zones

Chikmagalur district lies in three agro-climatic zones viz.,

1. Central dry zone (Kadur)
2. Hilly zone (Chikmagalur, Koppa, Mudigere, Narasimhajapura and Sringeri)
3. Southern transition zone (Tarikere)

Soil Types

Laterite soils occurring in Mudigere, Koppa and Sringeri areas are very deep, well drained, clay soils with moderately rapid permeability. Forest brown soils occurring in the Western Ghats are deep, well drained, loam to clay soils with moderate permeability. Red soils developed from quartzite occur in Chikmagalur, Tarikere, and Narasimharajapura areas. They are very deep, well drained, loam to clay soils with moderate permeability.

Small patches of black soils occur in Tarikere and Kadur areas which are moderately well drained with moderately slow permeability. Red soils developed from granite occur in Tarikere, Kadur and Chikmagalur taluks which are deep to very deep, well drained, clay soils with moderate permeability.

Geology

The district mainly consists of Archaean schist and gneisses. About 50% of the area of the district is covered by Dharwar schists and they occur in three well claimed belts viz., the Kudremukh-Ganga moola belt, the Koppa belt and the Baba-Budan belt. The rest of the area consists of peninsular gneissic complex. Granites are found near Chikmagalur town and the gneisses around Balehonnur.

Climate and Rainfall

The climate of the district is agreeable and cool. April is generally the hottest month with the mean daily maximum temperature at 30.7°C. The humidity is very high during the monsoon season generally exceeding 90%. Skies are mostly heavily clouded during the monsoon season and decreases during the post monsoon period. Winds are generally very light. The year is divided into four seasons viz.,

1. Hot season from March to May;
2. South-West monsoon season from June to September;
3. Post-monsoon season from October to November; and
4. Cold season from December to February.

The drainage system of the district is mainly influenced by South-West monsoon. The 101-years (1903-2003) annual average rainfall of the district is 2095.43 mm. The recorded monthly maximum and minimum rainfall of the district during monsoon period is as follows :

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	1781.7	3.3
July	4240.3	12.1
August	2029.1	3.2
September	1896.7	0.0
October	524.1	1.4

Drainage

A major part of the district is drained by the catchments of Bhadra and Tunga rivers. The western part of Mudigere taluk is drained by small streams that finally join the river Nethravathy. River Hemavathy flows in the southern part of the district. The drainage network is dense.

Projects

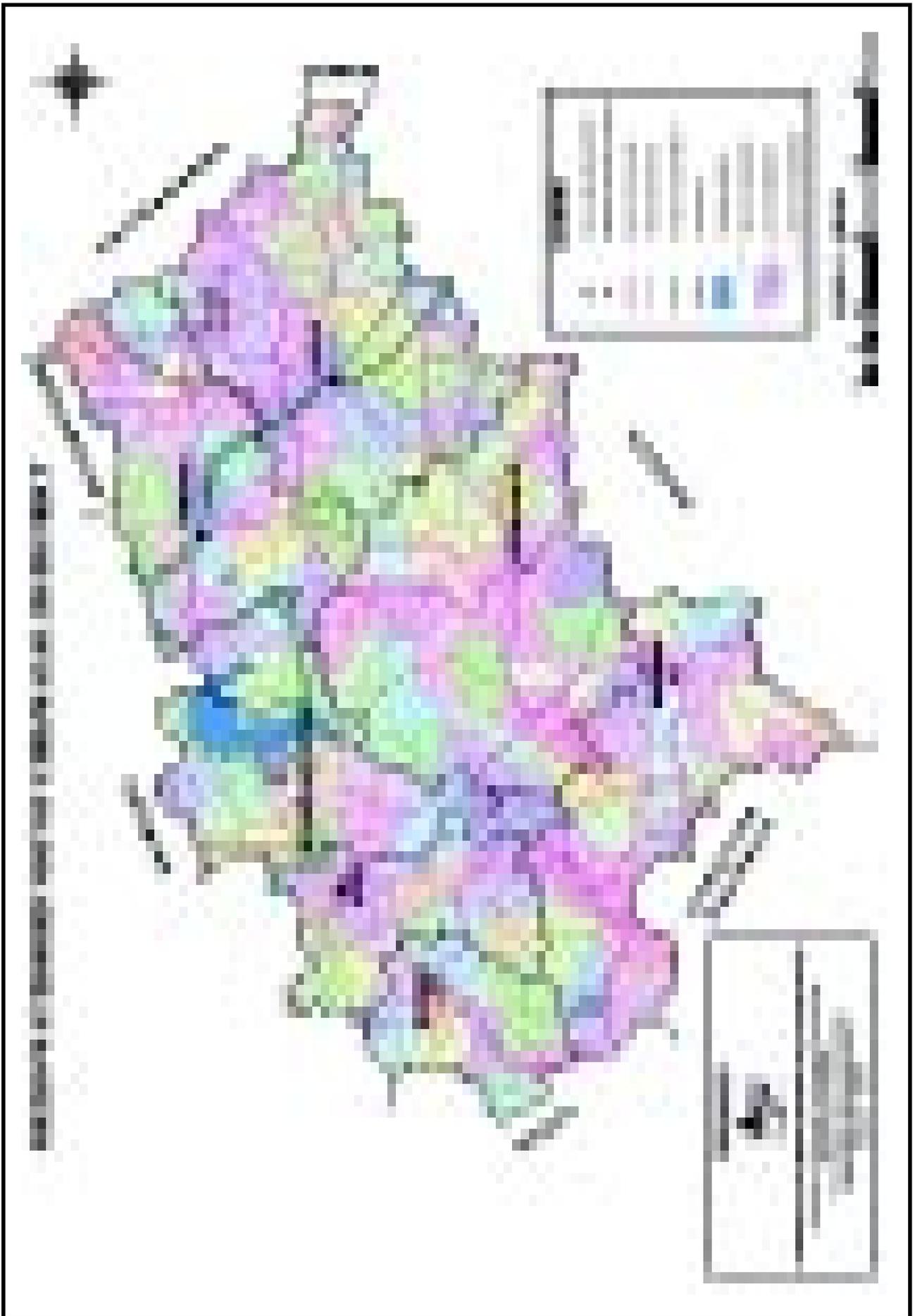
The Bhadra reservoir major irrigation project and the Jambadahalla medium irrigation projects are the prominent irrigation projects of the Chikmagalur district. Besides these, there are a number of minor irrigation tanks in the district.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF CHIKMAGALUR DISTRICT

The district lies in two water resource regions, the Bay of Bengal (Region 4) drained by Krishna (4D) and Cauvery basins (4B), and the Arabian Sea (Region 5) drained by Cape Comorin to Sharavathy (5A) covering less than 20% of the district area. The basins have been further delineated into 4 catchments, 5 sub-catchments and 18 watersheds. These 18 watersheds have been further delineated into 158 sub-watersheds, 305 mini-watersheds and 1171 micro-watersheds. The details are given in Table 15. In Region 4 of Chikmagalur district, the average area of the micro-watershed is 609.08 ha. and Kunkanadu (4D3E3I2b) is the largest micro-watershed with an area of 1352.69 ha. In Region 5, the average area of the micro-watershed is 481.51 ha. and Kokkekallu (5A3B3I1c) is the largest micro-watershed with an area of 870.04 ha.

Table : 15 Watershed Details (up to Micro-watershed) of Chikmagalur District

Hydrological Units	Total Nos.	Name			
		Arabian Sea (5)	Cauvery (4B)	Bay of Bengal (4)	
Region	2	Arabian Sea (5)	Cauvery (4B)	Bay of Bengal (4)	
Basin	3	Cape Comorin to Sharavathy (5A)	Krishnaraja-sagar (4B4)	Krishna (4D)	
Catchment	4	Mahe to Sharavathy (5A3)	Krishnaraja-sagar (between Tungabhadra reservoir and Srisailem) (4D3)	Upper Tungabhadra beyond the reservoir (5A3)	
Sub-catchment	5	Netravathy to Sita (5A3B)	Hemavathy (4B4B)	Middle up to Shimoga (4D4C)	Upper (Bhadra) Tungabhadra (4D4D)
Watershed	18	Kumaradhara (5A3B2)	U. Netravathy (4B4B4)	Sulekere (4D4C4)	Bira (4D4D5)
		Sita (5A3B7)	Yagachi (4B4B3)	Gundihalla2 (4D3E3)	Hulgi (4D4D3)
		U. Netravathy (5A3B3)	Vanivilasa Sagar (4D3E1)	Kodi, Dodda halla (4D3E4)	Kaggi (4D4D1)
			Vedavathy1 (4D3E5)	L. Tunga (4D4D4)	
			Vedavathy2 (4D3E6)	Malathy (4D4D6)	
				Sitamma (4D4D7)	
				Somavahini (4D4D2)	
Sub-watershed	158	7	16	2	84
Mini-watershed	305	13	30	2	167
Micro-watershed	1171	31	123	4	678



10. CHITRADURGA DISTRICT

Location and Extent

The district is situated in the eastern part of Karnataka. It is having an areal extent of around 8,388 sq km and is located between latitudes 13°34'00" to 15°02'00" N and longitudes 76°0'00" to 77°01'00" E. The district has a population of 15,17,896 (Census, 2001). Chitradurga district consists of six taluks viz., Chitradurga, Challakere, Hiriyur, Holalkere, Hosadurga and Molakalmur. The district is bounded on the North by Bellary, on the South by Chikmagalur and Tumkur districts, on the East by part of Tumkur and Andhra Pradesh and West by Davangere.

Physiography

The district consists of dry land and is characterized by huge undulating plains. The entire district lies in the valley of the Vedavathy River (Hagari). The river Tungabhadra flows along the boundary in the North-West direction. The West-Central part is occupied by a long range of flat-topped, steep-sided hills running in the South-East direction right across the district. Chitradurga comes under the Eastern Ghat range with a marked interior belt running from the Biligiri Rangan ranges in the South to Molakalmuru in the North.

Agro-climatic Zones

Chitradurga district lies in the Central dry agro-climatic zone.

Soil Types

The district to a large extent has red soils that are moderately deep to deep, well drained gravelly and non-gravelly loam to clay with moderately rapid to moderate permeability. Black soils occurring in Hiriyur, Challakere, Chitradurga and Holalkere are shallow to deep, moderately well drained to well drained, clay soils with moderately slow to slow permeability. Saline sodic soils occur in the valley region which are deep, imperfectly drained clay soils with slow permeability.

Geology

The district is largely composed of crystalline schists, granitic gneisses and the newer granites with a few later intrusive basic dykes, all belonging to the oldest rock formations recognized in India. The schists and their associated rocks constitute a portion of the Dharwar system and are designated as the Chitradurga and the Chiknayakanahalli schist belt. The schist belts in the district forms a part of the Dambal-Chiknayakanalli band of Dharwar schists. The occurrence of asbestos is seen near Hosadurga taluk near Budihal and Ganjigere also, in the East of Holalkere, Kudinirakatte and Sunkalhatti.

Climate and Rainfall

The climate of Chitradurga district is dry and the relative humidity is high during the period from June to November. The district enjoys four seasons viz.,

1. Summer season from March till the beginning of June;
2. Monsoon season from June till the end of September;

3. Post-monsoon season during October and November; and
4. Cold season from December to mid of February.

The drainage area of the district is prominently influenced by the South-West monsoon. The 101-years (1903 - 2003) annual average rainfall of the district is 655.97 mm. The recorded monthly maximum and minimum rainfall of the district in the monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	785.2	0.0
July	1534.16	0.2
August	501.1	2.0
September	1307.0	1.13
October	856.7	1.0

Drainage

The entire district lies in the Krishna basin. Chikkahagari, Vedavathy and Suvarnamukhi are the prominent streams flowing in the district. The drainage area is oblong shaped with dense network of nalas.

Projects

Vanivilas sagar, Gayathri reservoir, Rangayyana Durga and Narayanpur anicut are the medium irrigation projects of the district. Besides these, there are a number of minor irrigation tanks.

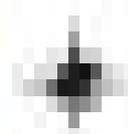
SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF CHITRADURGA DISTRICT

The district falls under the water resource region – the Bay of Bengal (Region 4) drained by the Krishna basin (4D). It is further delineated into two catchments viz., lower Tungabhadra (between Tungabhadra reservoirs and Srisailam, 4D3, covers more than 70% of the district area) and Upper Tungabhadra beyond the reservoir (4D4), 6 sub-catchments and 20 watersheds. These 20 watersheds have been further delineated into 203 sub-watersheds, 393 mini-watersheds and 1284 micro-watersheds (Table 16). In Region 4, the average area of the micro-watershed is 649.51 ha. and Bommasandra3 (4D3D4O2d) is the biggest micro-watershed with an area of 1802.85 ha.

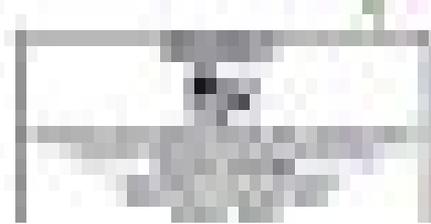
Table : 16 Watershed Details (up to Micro-watersheds) of Chitradurga District

Hydrological Units	Total Nos.	Name					
Region	1	Bay of Bengal (4)					
Basin	1	Krishna (4D)					
Catchment	2	Lower Tungabhadra (between Tungabhadra reservoir and Srisailem) (4D3)					
Sub-catchment	6	Directly into right bank (4D3F)	Lower Vedavathy (Hagari) (4D3C)	Middle Vedavathy (4D3D)	Uppermost Vedavathy beyond Vanivilas Sagar (4D3E)	Chikka-hagari (4D4B)	Upper Tungabhadra (above the reservoirs) (4D4)
Watershed	20	Narihalla (4D3F2)	Chinnahagari1 (4D3C5) Chinnahagari2 (4D3C6) Jinagehalla1 (4D3C7) Jinagehalla 2 (4D3C8) RB Vedavathy (4D3C4)	Doddahalla1 (4D3D3) Doddahalla2 (4D3D4) Garanihalla1 (4D3D1) Garanihalla2 (4D3D2) Suvarnamukhi3 (4D3D5) Suvarnamukhi2 (4D3D6) Borankanive Reservoir (4D3D8)	Gundihalla1 (4D3E2) Gundihalla2 (4D3E3) Kodi, Doddahalla (4D3E4) Vanivilas Sagar (4D3E1)	Meruru1 (4D4B4)	Tungabhadra from confl. of Tunga and Bhadra upto confl. with Varada (4D4C3) Sulekere (4D4C4)
Sub-watershed	203	2	42	91	38	8	22
Mini-watershed	393	4	77	185	71	14	42
Micro-watershed	1284	10	245	624	239	44	122

**REKAM JEJAK RUMAH KELUARGA BERKUALITI
 DAN
 BERKUALITI RUMAH BERKUALITI**



KUALITI	
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8	BERKUALITI
9	BERKUALITI
10	BERKUALITI



MAJLIS PERSEKUTUAN NEGARA
 MALAYSIA

11. DAKSHINA KANNADA DISTRICT

Location and Extent

Dakshina Kannada district situated in the south-western part of Karnataka State lies between latitudes 12°52'00" to 13°15'00" N and longitudes 74°00'00" to 75°15'00" E. The total geographical area of the district is 4,843 sq km and has a population of 18,97,730 (Census, 2001). It comprises of five taluks viz., Belthangadi, Buntwal, Mangalore, Puttur and Sulya. Dakshina Kannada is bounded by the districts of Hassan and Chikmagalur on the East, the Arabian Sea on the West, Udupi on the North and Kodagu on the South.

Physiography

Dakshina Kannada district forms a broken low plateau, spreading from the foot of the Western Ghats to the Arabian Sea and forms a narrow strip with rapidly flowing rivers. In the northern part, the Ghat range assumes the form of steep cliffs; however, in the south it has got the parallel ridges intersected by deep valleys. From these valleys, important rivers of the district flow. The mountain ranges present in the West are having surfaces almost perpendicular to the horizon.

Agro-climatic Zones

The entire district lies in the Coastal agro-climatic zone.

Soil Types

Major area of the district is covered by laterite soils and to a small extent by coastal alluvial soils and forest brown soils in Western Ghats similar to Udupi district.

Geology

Except in the coastal region, the rest of the area of the district belongs to Archaean epoch. The main rock types occurring in the district are recent and sub-recent, intrusives and the Dharwars. The recent and sub-recent formations occurring in coastal region consists of alluvial formation red clay and dark clay soils; laterite-like intrusives consists of dolomite, charnockites and granitic gneisses; and Dharwars consists of older metamorphic rock, quartz, talc-schists hornblende-schists, fluorite-schists. Laterite-like formations cover fairly large area along the coast and a small area to the interior. The biotic gneisses are intruded by the basic and ultra basic sills and dykes giving rise to narrow ridges rising between 30 to 60 m above the gneissic country.

Climate and Rainfall

The climate of this district is marked by heavy rainfall, high humidity and oppressive weather in the hot season. The year is divided into four seasons viz.,

1. The hot season from March to May;
2. The South-West monsoon season from June to September;
3. Post-monsoon season from October to November; and
4. The cold season from December to February.

Dakshina Kannada being a coastal district, the seasonal variations in the temperature are low. In the South-West monsoon season, the humidity is high. Skies are generally lightly clouded. Winds are mainly from directions between North and East in the forenoons and Westerly or North-Westerly in the afternoons. The drainage area of the

district is mainly influenced by the South-West monsoon. The 92-years (1912-2003) average annual rainfall of the district is 3871.27 mm. The recorded monthly maximum and minimum rainfall of the district during the monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	2229.95	12.4
July	2684.6	5.0
August	2918.13	255.35
September	1180.2	15.7
October	741.3	8.8

Drainage

The entire district lies in the West flowing river basin. The important rivers of Dakshina Kannada district are Nethravathy, Kumaradhara, Gurpur, Pavanje, Gowrihole, Gangolli, Kalluhole and Nandini. All the rivers are perennial and they all flow in East to West direction.

Projects

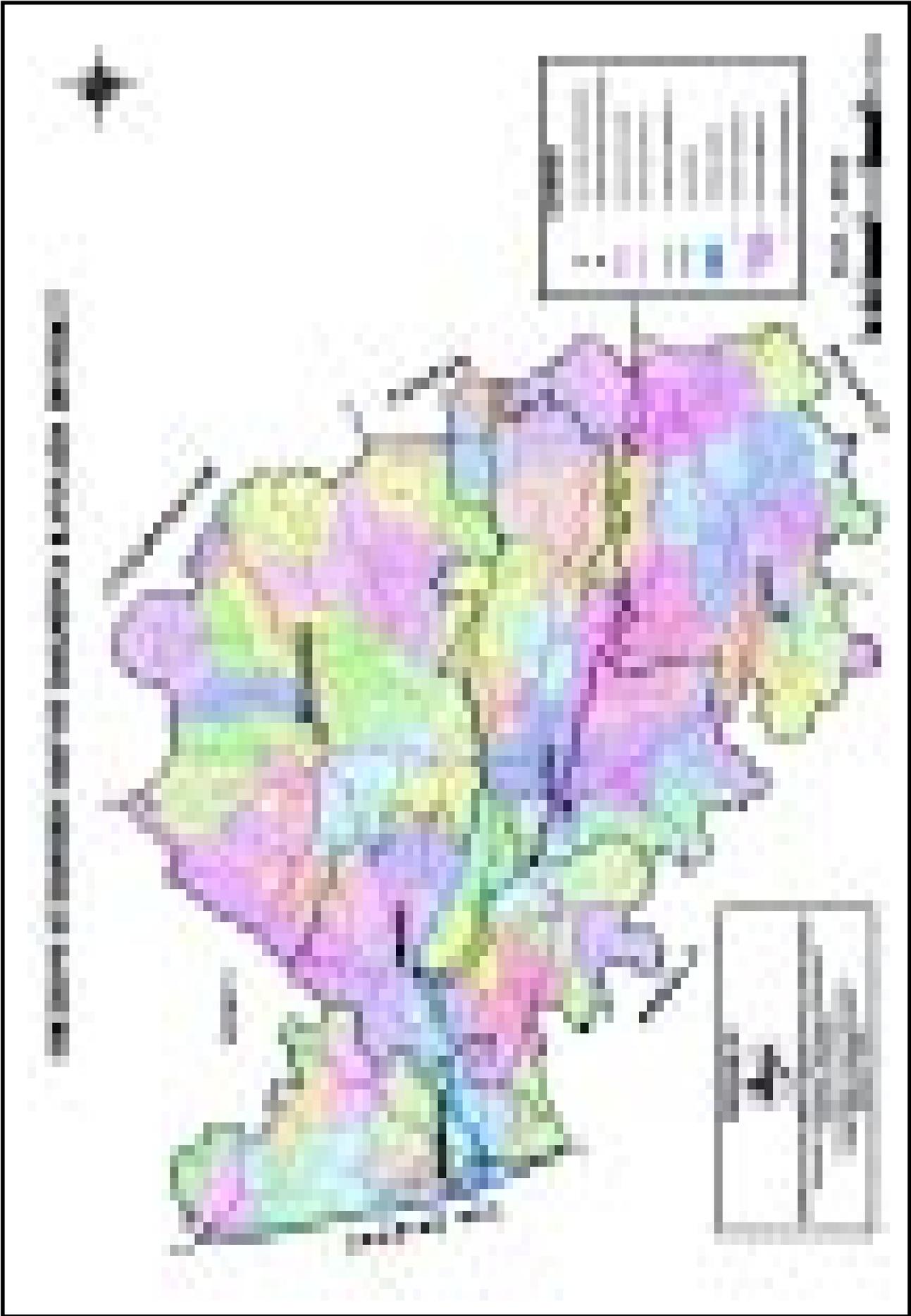
There are no major and medium irrigation projects in the district.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF DAKSHINA KANNADA DISTRICT

The district falls under the water resource region – the Arabian Sea (Region 5) drained by Cape Comorin to Sharavathy basin (5A). It is further delineated into one catchment viz., Cape Comorin to Sharavathy (5A), 2 sub-catchments and 7 watersheds. These 7 watersheds have been further delineated into 99 sub-watersheds, 213 mini-watersheds and 1003 micro-watersheds. The details are given in Table 17. In Region 5, the average area of the micro-watershed is 453.87 ha. and Perumunnuru (5A3B1J2d) is the biggest micro-watershed with an area of 1183.35 ha.

Table : 17 Watershed Details (up to Micro-watershed) of Dakshina Kannada District

Hydrological Units	Total Nos.	Name	
Region	1	Arabian Sea (5)	
Basin	1	Cape Comorin to Sharavathy (5A)	
Catchment	1	Mahe to Sharavathy (5A3)	
Sub-catchment	2	Mahe to Netravathy (5A3A)	Netravathy to Sita (5A3B)
Watershed	7	Payaswani (5A3A6)	Gurpur (5A3B4)
		Uppala, Shiriya (5A3A7)	Kumaradhara (5A3B2)
			L. Netravathy (5A3B1)
			Shisla, Mulki (5A3B5)
		U. Netravathy (5A3B3)	
Sub-watershed	99	24	75
Mini-watershed	213	49	164
Micro-watershed	1003	224	779



12. DAVANAGERE DISTRICT

Location and Extent

Davanagere district is situated in the central part of Karnataka State. It lies between latitudes 13°42'17.87" to 14°55'51.2" N and longitudes 75°23'59.22" to 76°32'5.4" E. The total geographical area of the district is 6,018 sq km and the population is 17,90,952 (Census, 2001). It consists of six taluks viz., Channagiri, Davanagere, Harapanahalli, Harihara, Honnali and Jagalur. The district is bounded on the North by Bellary district, Haveri and Shimoga districts on the West, Shimoga and Chikmagalur districts on the South and Chitradurga district on the East.

Physiography

The entire terrain of the district forms large undulating plains and hilly ranges that extend from Mayakonda to Anaji. Except in the region of the hilly belt, the entire area of the district in the North and East is open and plain.

Agro-climatic Zones

Davanagere district lies in three agro-climatic zones viz.,

1. Northern dry zone (Harapanahalli)
2. Central dry zone (Davanagere, Harihara and Jagalur)
3. Southern transition zone (Channagiri and Honnali)

Soil Types

Red soils occur extensively and are shallow to deep, well drained, gravelly clay and loam, with moderate to moderately rapid permeability. Black soils developed on schist occur to a limited extent in Harapanahalli, Jagalur, Honnali and Harihar areas. They are deep, moderately well drained clay soils with slow permeability. Shallow red soils are found to occur on ridges. They are excessively drained, loamy with moderate permeability.

Geology

The Dharwar group of rocks viz., amphibolitic-metapelitic-schist, quartz-chlorite-schist and graywacke/argillite are found in the district. In some patches of pink and gray granite of closepet group are also present. The migmatites and tonalitic gneiss of Archean group occurs in some parts of the district.

Climate and Rainfall

Climate of the district is dry with low rainfall and a pleasant monsoon. The year is divided into four seasons viz.,

1. Hot season from March till the end of May;
2. South-West monsoon season from June to September;
3. Post-monsoon season during October and November; and
4. Cold season from December to February.

The temperature increases during the months from March to May. During this period, the maximum temperature may sometimes reach 42°C. Relative humidity is more during monsoon season. Generally, skies are heavily clouded during the period from June till the end of October and winds are moderate. The drainage area of the district is prominently influenced by the South-West monsoon. The 101-years (1903-2003) average annual rainfall of the district is 631.09 mm. The recorded monthly maximum and minimum rainfall of the district during the monsoon period is as follows :

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	565.3	2.0
July	1293.45	5.5
August	344.2	1.5
September	1562.45	1.0
October	469.95	0.8

Drainage

Davanagere district falls under Krishna basin. The important rivers of the district are Tungabhadra and its tributary Chikka Hagari. The drainage network is influenced by South-West monsoon.

Projects

There are no major and medium irrigation projects in the district. However, parts of the district are being irrigated by Bhadra and Tunga Anicut canals.

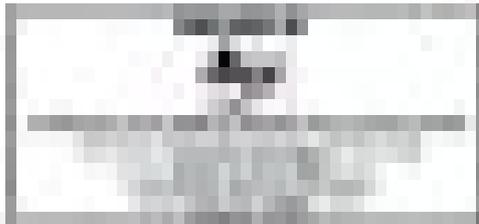
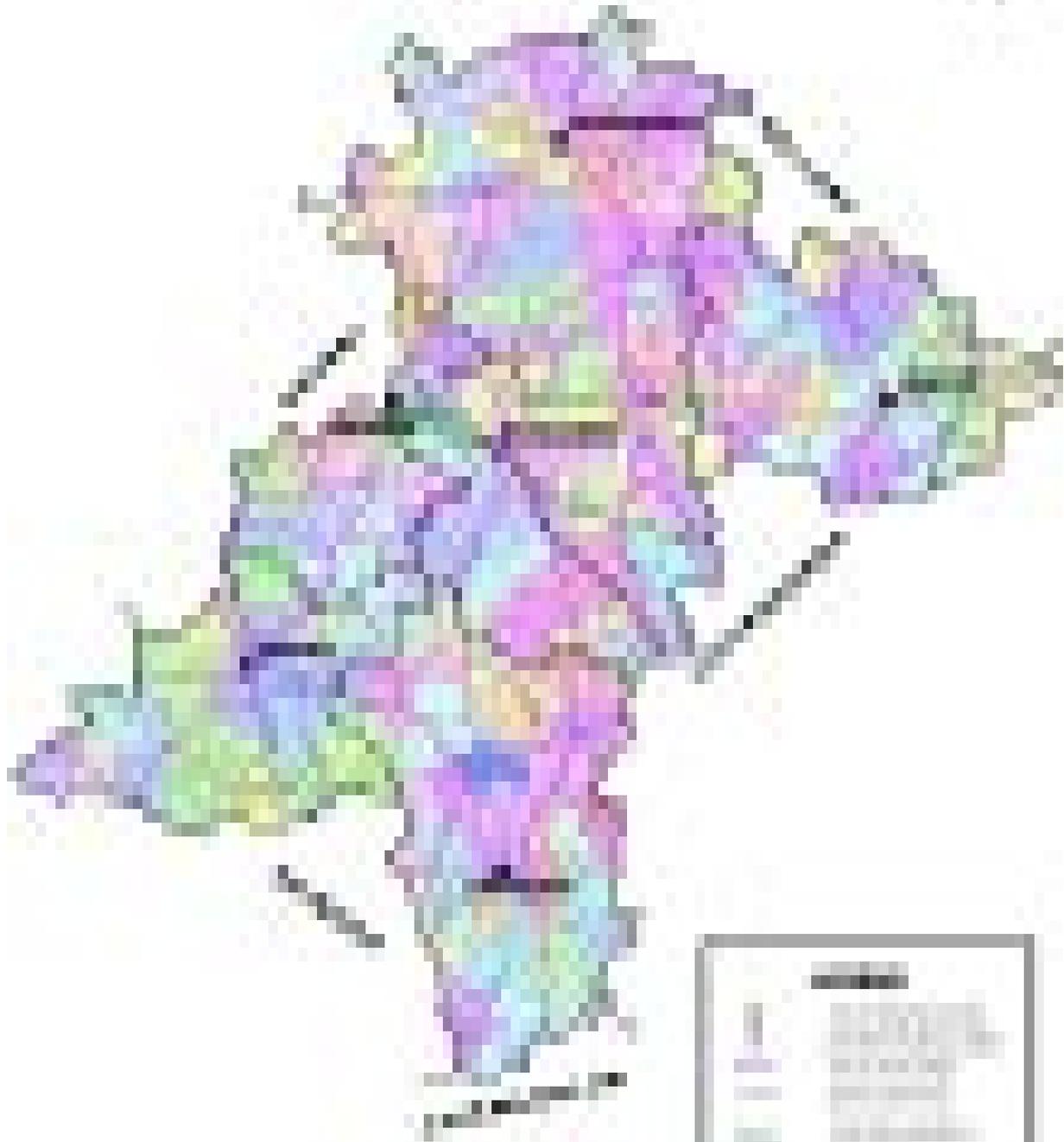
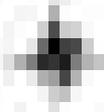
SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF DAVANAGERE DISTRICT

The district falls under the water resource region – the Bay of Bengal (Region 4) drained by the Krishna basin (4D). It is further delineated into 2 catchments, 6 sub-catchments and 14 watersheds. These 14 watersheds have been further delineated into 154 sub-watersheds, 296 mini-watersheds and 1068 micro-watersheds. The details are given in Table 18. In Region 4, the average area of the micro-watershed is 552.35 ha. and Mudihadadi2 (4D4C3T2e) is the biggest micro-watershed with an area of 1768.41 ha.

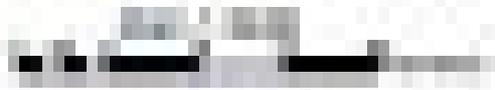
Table : 18 Watershed Details (up to Micro-watershed) of Davanagere District

Hydrological Units	Total Nos.	Name					
Region	1	Bay of Bengal (4)					
Basin	1	Krishna (4D)					
Catchment	2	Lower Tungabhadra (4D3)		Upper Tungabhadra beyond the reservoir (4D4)			
Sub-catchment	6	Lower Vedavathy (4D3C)	Middle Vedavathy (4D3D)	Uppermost Vedavathy beyond Vanivilas Sagar (4D3E)	Chikkahagari (4D4B)	Middle upto Shimoga (4D4C)	Upper Tungabhadra (4D4D)
Watershed	14	Jinagehalla1 (4D3C7)	Garanihalla2 (4D3D2)	Kodi Doddahalla (4D3E4)	Meruru1 (4D4B4)	Haridra (4D4C3)	Kaggi, Kusi (4D4D1)
					Meruru2 (4D4B3)	Kumudavathy (4D4C6)	
					Meruru3 (4D4B2)	RB Tungabhadra (4D4C8)	
					Vedagatti (4D4B5)	RB Tungabhadra1 (4D4C7)	
						RB Tungabhadra2 (4D4C1)	
						Sulekere (4D4C4)	
Sub-watershed	154	13	2	3	37	94	5
Mini-watershed	296	25	2	5	74	184	6
Micro-watershed	1068	72	2	14	273	689	18

MAP OF THE DISTRICTS OF THE DISTRICT OF WESTMIDLANDS



LEGEND	
[Purple]	Birmingham
[Blue]	Coventry
[Green]	Leamington Spa
[Yellow]	Warwick
[Orange]	Solihull
[Light Blue]	North Warwickshire
[Light Green]	North Avon
[Pink]	Sandwell
[Grey]	West Midlands
[Dark Blue]	Walsley



13. DHARWAR DISTRICT

Location and Extent

The district lies in the north-western part of Karnataka State and is geographically located between latitudes 15°02'4.13" and 15°42'8.3" N and 74°43'17.17" and 75°34'00" E longitudes. The district has an areal extent of 4,230 sq kms and a population of 8,18,058 (Census, 2001). Dharwar district consists of five taluks viz., Dharwar, Hubli, Kalghatgi, Kundgol and Navalgund. The district is bounded on the North by Belgaum, on the South by Haveri, on the East by Gadag and West by Uttara Kannada.

Physiography

The district can be divided into two physiographic divisions viz., the Malnad region and the Maidan region. Dharwar district is almost flat except for the undulating and hilly regions in the western parts of the Kalghatgi, Dharwar and Hubli taluks.

Agro-climatic Zones

Dharwar district lies in three agro-climatic zones viz., northern dry zone, northern transition zone and hilly zone.

Soil Types

The soil types are black cracking clay soils with low permeability in the plains and red soils with moderate to high permeability in the hilly regions.

Geology

Dharwar district represents the oldest rocks and the main rock types exposed are greywacke/argillite, pink and grey granite. The enclaves of greywacke/sericite phyllite and quartz chlorite schist, actinolite schist/amphibolite biotite schist are noticed in the grey and pink granite. The pink and grey granite belongs to Archaean age, whereas greywacke/argillite belongs to the Archaean to lower proterozoic age.

Climate and Rainfall

The climate of the district is on the whole, healthy and pleasant. The district enjoys four seasons (Dharwar District Gazetteer, 1959) viz.,

- 1) Hot season from the middle of February to the end of May with harsh easterly winds till the middle of April and sometimes, thunder showers during the rest of the period;
- 2) The south-west monsoon season from June to September when the climate is cool and damp;
- 3) Post-monsoon season with the north-east rains in October and November; and
- 4) The cold season during December, January and the first half of February.

The drainage area of the district is prominently influenced by the South-West monsoon. The 100-years (1904 – 2003) average annual rainfall of the district is

870.3 mm. The recorded monthly maximum and minimum rainfall of the district during the monsoon period is as follows:

Month	Monthly Maximum (mm)	Monthly Minimum (mm)
June	539.0	2.1
July	658.6	12.4
August	448.65	7.1
September	570.2	0.9
October	709.1	3.3

Drainage

The major part of the district lies in the Malaprabha catchment of river Krishna basin. There are no major rivers flowing in the district; however, a major stream of importance flowing in the district is Bennihalla. It joins river Malaprabha near Hebballi in the border of Dharwar and Bagalkot districts. The drainage network of Kalghatgi, part of Dharwar and Hubli taluks is heavily dense than the rest of the area of the district. Nearly 40% of the Dharwad and Hubli taluks and entire Kalghatgi taluk lies in the west flowing river catchment, wherein the tributaries of river Kali and Bedthi flows. The stream Bennihalla flows in the Kundgol, Hubli and Naval Gund taluks. In Hubli taluk, there are two minor streams viz., Yernahalla and Radi halla, which confluences with Bennihalla and then flows in the Naval Gund taluk where two other minor streams, Tupri Halla and Handigar Halla confluences.

Projects

A major hydropower project is constructed on Tattehalla at the border of Kalghatgi taluk of Dharwar and North Canara districts. There are no major and medium projects in the district except a few minor irrigation tanks. In Naval Gund taluk, irrigation facilities are provided by the Right Bank Canal of Malaprabha irrigation project.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF DHARWAR DISTRICT

The district falls under two water resource regions – the Arabian Sea (Region 5) is mainly drained by Sharavathy to Tapti (5B) basin and the Bay of Bengal (Region 4) mainly drained by Krishna Basin (4D). It is further delineated into 3 catchments, 3 sub-catchments and 9 watersheds. These 9 watersheds have been further delineated into 95 sub-watersheds, 177 mini-watersheds and 682 micro-watersheds. The details are given in Table 19. The average area of the micro-watersheds is 631.10 ha. and Javur (4D7C5Q2b) is the largest micro-watershed of Region 4 (1229.29 ha.) in the district. The Arabian Sea (Region 5) is drained by the basin Sharavathy to Tapti (5B) which in turn is drained by the catchment Sharavathy to Savitri (5B1). In this region, the average area of the micro-watershed is 611.36 ha. and the largest micro-watershed of the region is Nirsagar (5B1A4I2e) covering an area of 1354.92 ha.

Table : 19 Watershed Details (up to Micro-watershed) of Dharwar District

Hydrological Units	Total Nos.	Name		
Region	2	Arabian Sea (5)	Bay of Bengal (4)	
Basin	2	Sharavathy to Tapti (5B)	Krishna (4D)	
Catchment	3	Sharavathy to Savithri (5B1)	Upper Tungabhadra beyond the reservoir (4D4)	Main Krishna above confluence with Bhima (4D7)
Sub-catchment	3	Sharavathy to Kalinadi (5B1A)	Misc. LB lower parts of Varada (4D4A)	Malaprabha (4D7C)
Watershed	9	Bedthi (5B1A4)	Dharma1 (4D4A6)	Nandigram (4D7C4)
		Bedthi (5B1A3)	Doddahalla1 (4D4A3)	Tas Hirehalla (4D7C8)
		Kaneri Barchi Nagi (5B1A8)		Tuprinala (4D7C5)
				Yeran, Radi, Gugihalla (4D7C6)
Sub-watershed	95	30	62	3
Mini-watershed	177	57	115	5
Micro-watershed	682	236	433	13

THE MAP OF THE ENVIRONMENTAL ZONES IN THE BULGARIAN REPUBLIC

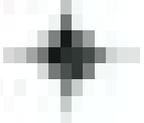
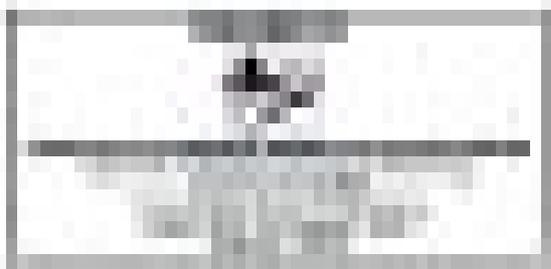


Figure 1



Legend	
[Green]	Forest zone
[Yellow]	Steppe zone
[Orange]	Mountain zone
[Red]	Coastal zone
[Pink]	Urban zone
[Purple]	Industrial zone
[Blue]	Water zone
[Light Green]	Protected zone



14. GADAG DISTRICT

Location and Extent

Gadag district situated in the northern-central part of Karnataka State lies between the latitudes 14°52'22.66" to 15°53'2.40" N and longitudes 75°16'28.45" to 76°02'50.11" E. The total geographical area of the district is 4,657 sq km with a population of 9,71,835 (Census, 2001). Gadag district consists of five taluks viz., Gadag, Mundargi, Naragund, Ron and Shirahatti. Gadag district is bounded by Koppal district on the East, Dharwar district on the West, Bagalkot district on the North and Haveri and Bellary districts towards the South.

Physiography

Gadag district has an undulating terrain and river Malaprabha forms the part of the northern boundary of the district. The district is mainly having landscapes of the black soil plain. Towards Shirahatti, the landscape changes into small hills and rounded mounds influenced by granitic outcrops.

Agro-climatic Zones

Gadag district lies in two agro-climatic zones viz.,

1. Northern dry zone (Gadag, Mundargi, Naragund and Ron)
2. Northern transition zone (Shirahatti)

Soil Types

Major area is covered by black soils that are very deep, moderately deep and shallow, moderately well drained to well drained clay with slow to moderately slow permeability. Red soil developed on granite and schist occur to limited extent and are moderately deep to deep well drained, loamy to clay soils with moderate permeability. Red soils have moderate to high permeability.

Geology

The oldest formation of Dharwar group of rocks are found in and around Gadag schist belt. The rock types are metavolcanics, graywacke and actinolite schist and in some patches pink and gray granite of closepet granite are also found. Conglomerate, arinite and shale of sedimentary group of rocks are also found in some parts of the district.

Climate and Rainfall

The climate of the district is healthy and agreeable. The year is divided into four seasons viz.,

1. Summer season from March to May;
2. South-West monsoon season from June to September;
3. Post-monsoon season from October to November; and
4. Cold season from December to February.

The district is characterized by large diurnal variations of temperature in the winter and summer months. The relative humidity during the monsoon months is more than 60%. The skies are covered with clouds during the monsoon period. The winds from the South are very rare. During monsoon the winds are Westerly and during October to December winds are Easterly. The drainage area of the district is prominently influenced by the South-West monsoon. The 101-years (1903-2003) average annual rainfall of the district is 607.79 mm. The recorded monthly maximum and minimum rainfall of the district during the monsoon period in as follows :

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	2131	2.5
July	926.2	3.8
August	575.0	0.4
September	1296.8	0.7
October	1318.2	0.5

Drainage

There are no prominent rivers flowing in Gadag district. River Malaprabha forms a part of northern boundary of the district and river Tungabhadra forms South-eastern boundary of the district. The drainage network of the district is dense and includes the minor tributaries of Malaprabha and Tungabhadra rivers.

Projects

There are no major and medium irrigation projects in the district. The district is being irrigated by the canals of Malaprabha major irrigation project, Itagi and Susalwada irrigation projects. Besides these, the district is irrigated by a number of minor irrigation tanks.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF GADAG DISTRICT

The district falls under the water resource region – the Bay of Bengal (Region 4) drained by the Krishna basin (4D). It is further delineated into 2 catchments, 3 sub-catchments and 11 watersheds. These 11 watersheds have been further delineated into 111 sub-watersheds, 221 mini-watersheds and 1066 micro-watersheds. The details are given in Table 20. The Krishna basin (4D) includes two catchments viz., Main Krishna above confluence with Bhima (4D7) (covering more than 50% of the district area) and Upper Tungabhadra beyond the reservoir (4D4). In Gadag district, the average area of the micro-watershed is 436.10 ha. and Surkodi5 (4D7C4M1b) is the biggest micro-watershed with an area of 900.22 ha.

Table : 20 Watershed Details (up to Micro-watershed) of Gadag District

Hydrological Units	Total Nos.	Name		
Region	1	Bay of Bengal (4)		
Basin	1	Krishna (4D)		
catchment	2	Main Krishna above confluence with Bhima (4D7)	Upper Tungabhadra beyond the reservoir (4D4)	
Sub-Catchment	3	Malaprabha (4D7C)	RB Krishna up to confluence with Malaprabha (4D7B)	Misc. LB lower parts of Varada (4D4A)
Watershed	11	Chanl, Hirehalla (4D7C3)	Ilkalnala (4D7B5)	Dharma3 (4D4A4)
		Hirehalla (4D7C1)		Doddahalla1 (4D4A3)
		Jaul (4D7C7)		Doddahalla2 (4D4A2)
		Nandigrama (4D7C4)		Hirehalla (Tungabhadra) (4D4A1)
		Tuprinala (4D7C5)		
		Yeran, Radi, Gugi (4D7C6)		
Sub-watershed	111	64	2	45
Mini-watershed	221	125	2	94
Micro-watershed	1066	592	2	472

15. GULBARGA DISTRICT

Location and Extent

Gulbarga district situated in the northern part of Karnataka State lies between latitudes 16°11'00" to 17°46'00" N and longitudes 76°02'00" to 77°42'00" E. It is having a total geographical area of 16,224.4 sq km and a population of 31,30,922 (Census, 2001). It consists of ten taluks viz., Gulbarga, Afazalpur, Aland, Chincholi, Chittapur, Jevargi, Sedam, Shahapura, Shorapur and Yadgir. The district is bounded on the North by Bidar, on the South by Raichur, on the East by Andhra Pradesh and West by Bijapur.

Physiography

The entire district is situated in the Deccan Plateau. There are hill ranges which enter the district from the North-West and continue in the South-East direction. The remaining part of the terrain is flat. The major river of the district is Bhima and river Krishna forms the southern boundary of the district.

Agro-climatic Zones

Gulbarga district lies in two agro-climatic zones viz.,

1. North-Eastern dry zone (Gulbarga, Afazalpur, Chittpur, Jevargi, Sedam, Shahapura, Shorapur and Yadgir)
2. North-Eastern Transition zone (Aland and Chincholi)

Soil Types

Black soils developed from basalt are shallow on plateau surfaces, loamy to clay in texture, well drained with moderate permeability. The deep black soils occur in valleys and plains which are clayey, moderately well drained with moderately slow to slow permeability. The deep black soils developed on sedimentary formation are clayey moderately well drained with moderately slow permeability. These soils occur in Jevargi, Chitapur, Sedam, Shorapur and Shahapur areas.

The red soils in Yadgir and Shorapur areas are shallow to moderately deep, loamy to clayey soils developed on granite and have high gravel content. They are well drained to excessively drained with moderately rapid permeability.

Geology

Northern part of the district is entirely covered by the Deccan trap. Limestone and shale of Bhima series are found in the central parts of the district. The Archaean rocks composed of the peninsular gneisses with lenses and patches of older Dharwar rocks are confined in the southern and eastern parts of the district. The main geological formations found in the district are:

1. Pleistocene and recent formations consisting of soil and laterite, alluvium and recent conglomerates;
2. Tertiary composed of Deccan traps and inter- and infra-trappeans;
3. Puranas (Precambrian) composed of Upper Bhima shales and sandstones, middle Bhima limestone and lower Bhima shales and sandstone; and
4. Archaean comprising peninsular gneiss with associated younger granites and Dharwar schists.

Climate and Rainfall

The climate of the district is generally dry and healthy. The period from December to May is the driest part of the year. Humidity increases by about 20 to 30% during

the South-West monsoon months. Winds are from the direction South-West and North-West in the monsoon season. The district is seldom affected by cyclonic storms. In the post monsoon months, some of the depressions are from the Bay of Bengal. The district enjoys four seasons viz.,

1. Summer season from mid February to first week of June;
2. South-West monsoon season from the second week of June till the end of September;
3. Post-monsoon season starts with North-Eastern rains in the months of October and November; and
4. Cold season starts from December and continues till the middle of February.

The drainage area of the district is prominently influenced by the South-West monsoon. The 101-years (1903–2003) average annual rainfall of the district is 738.54 mm. The recorded monthly maximum and minimum rainfall of the district in the monsoon period is as follows:

Month	Monthly Maximum (mm)	Monthly Minimum (mm)
June	380.46	3.6
July	611.7	2.5
August	738.4	5.6
September	1096.0	4.15
October	518.6	0.8

Drainage

The entire district lies in the Krishna basin in which the major catchment is of river Bhima. River Bhima is the major river flowing in the district that confluences with river Krishna at the southern boundary of the district. Mullamari and Kamalavathy nala are the tributaries of river Kagna. Amarja and Gandhorinala are the major streams of the district. The drainage area of the district is almost fan shaped and drainage network is not dense.

Projects

Narayanapura dam of Upper Krishna multipurpose project is constructed at the south-western boundary of the district. Amarja, Gandhorinala and Lower Mullamari are the medium irrigation projects of the district. Further, the Bhima lift irrigation project is under progress.

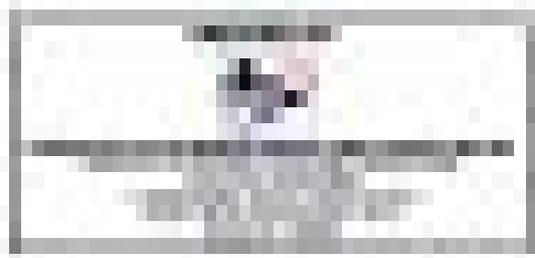
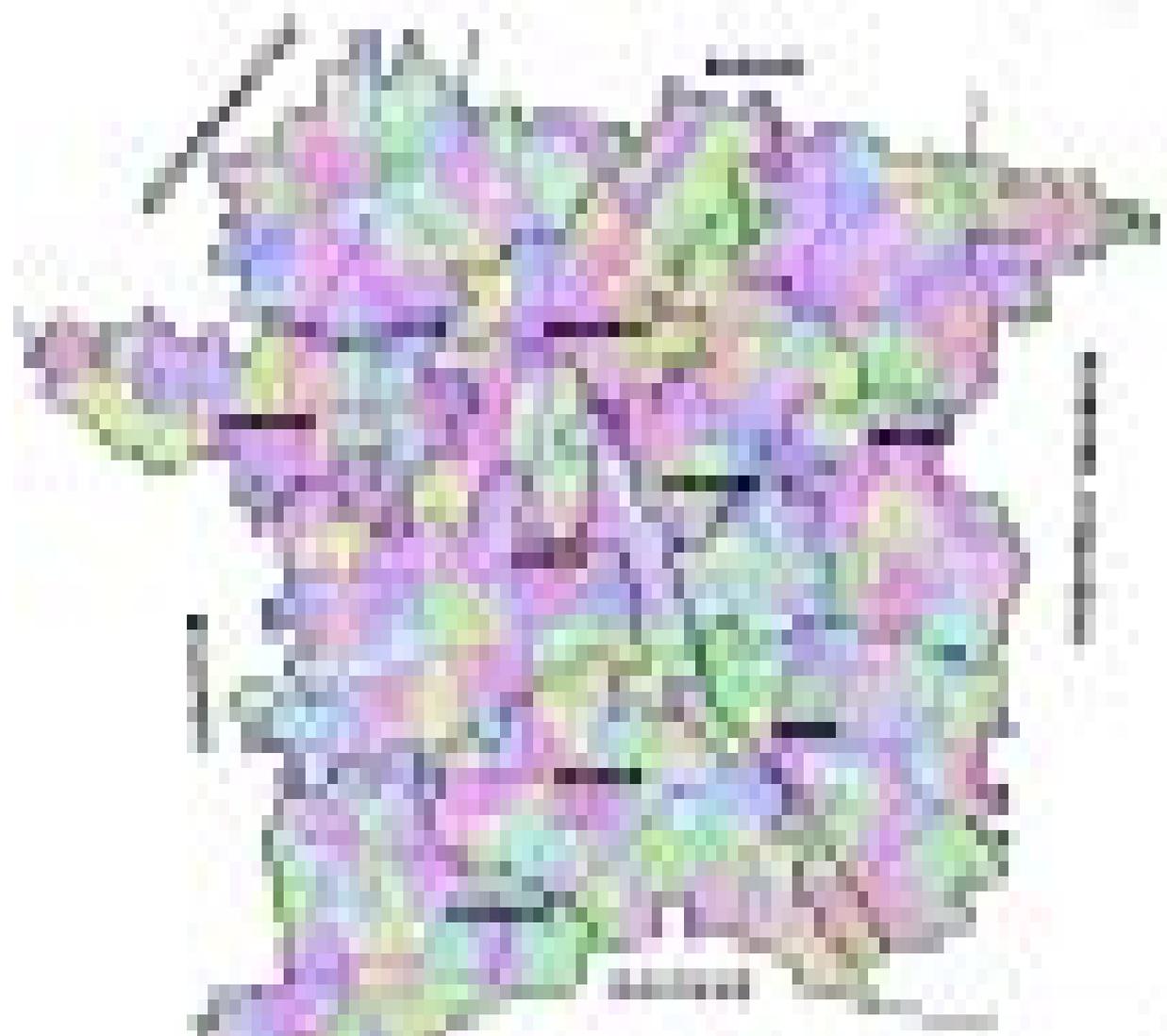
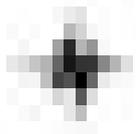
SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF GULBARGA DISTRICT

The district falls under the Bay of Bengal water resource region (4) drained by Krishna basin (4D). It is further delineated into 3 catchments, 5 sub-catchments and 21 watersheds. These 21 watersheds have been further delineated into 308 sub-watersheds, 617 mini-watersheds and 2876 micro-watersheds. The details are given in Table 21. Region 4 is mainly drained by Krishna basin (4D) that includes the catchments Lower Bhima up to confluence with Sina (4D5), Main Krishna above confluence with Bhima (4D7) and Nizamsagar to Srisailam, confluence of Tungabhadra with Krishna and Bhima with Krishna (4D2). In Region 4 of Gulbrga district, the average area of the micro-watershed is 564.10 ha. and Bhosgal (4D5B3D2h) is the largest micro-watershed with an area of 1111.51 ha.

Table : 21 Watershed Details (up to Micro-watershed) of Gulbarga District

Hydrological Units	Total Nos.	Name				
Region	1	Bay of Bengal (4)				
Basin	1	Krishna (4D)				
Catchment	3	Lower Bhima up to confluence with Sina (4D5)		Krishna above confluence with Bhima (4D7)		
Sub-catchment	5	Bennithora Mullamari on LB Bhima (4D5B)	LB along Bhima (4D5C)	RB Bhima up to confluence with Sina (4D5A)	N'Sagar to Srisaillam confluence of Tungabhadra with Krishna and Bhima with Krishna (4D2)	
		Bennithora (4D5B9)	Amarja (4D5C2)	Chinamagiri (4D5A3)		
		Gandhori nala (4D5B8)	Bori (4D5C3)	RB Bhimal (4D5A2)		
		Kagna (4D5B6)	Dhubdhubi (4D5C5)	RB Bhima2 (4D5A1)		
		Kamalavathy (4D5B4)	Harni (4D5C4)	Sind-Naobi (4D5A4)		
Watershed	21	LB Bhima2 (4D5B2)			LB Krishna (4D2D6)	
		LB Bhima3 (4D5B1)				
		Machkula (4D5B3)				
		Mullamari (4D5B7)				
		133	55	54		50
		265	112	112		98
Sub-watershed	308	548	522	432	16	
Mini-watershed	617				30	
Micro-watershed	2876				110	

THE REPUBLIC OF INDONESIA MAP OF THE MARSHALL ISLANDS



LEGEND	
	INTERNATIONAL BOUNDARY
	NATIONAL BOUNDARY
	PROVINCE BOUNDARY
	SEA
	UNINCORPORATED AREA
	INCORPORATED AREA

MAP OF THE MARSHALL ISLANDS

16. HASSAN DISTRICT

Location and Extent

Hassan district situated in the south-western part of the State is having a total geographical area of 6,814 sq km and a population of 17,21,669 (Census, 2001). It lies between the latitudes 12°30'39.29'' to 13°13'36.5'' N and longitudes 75°32'49.7'' to 72°38'0.5'' E. The district consists of eight taluks viz., Alur, Arasikere, Arakalgudu, Belur, Channarayapatna, Hassan, Holenarsipura and Sakalehpura. The district is bounded on the North by Chikmagalur district, on the East by Tumkur and Mandya districts, on the South by Kodagu and Mysore districts and on the West by Dakshina Kannada district.

Physiography

Hassan district lies partly in the malnad region and partly in the southern maidan region. The southern malnad is a forest-clad hilly region with heavy rainfall. On the eastern periphery, there are Ghats extending from Bisle Ghat to the Jenkal betta with some lofty peaks in them. The terrain is generally undulating until it approaches the Ghats. The southern maidan consists of an undulating plain country which is generally cultivated.

Agro-climatic Zones

Hassan district lies in four agro-climatic zones viz.,

1. Central dry zone (Arasikere)
2. Southern dry zone (Channarayapatna)
3. Southern transition zone (Hassan, Holenarsipura, Alur, Belur and Arakalgud)
4. Hilly zone (Sakaleshapura)

Soil Types

Red soils that occur to a large extent are moderately deep to deep, well drained, loam to clay, gravelly and non-gravelly with moderate to moderately rapid permeability. Laterite soils occur in Sakleshapura, Alur and Belur areas which are very deep, well drained, clay soils with moderate permeability. Forest brown soils occur in the Western Ghats and are very deep, well drained, clay soils with moderate permeability.

Geology

Hassan district belongs to the most ancient period of Earth's history that consists of an older series of schists and is intruded by granitic gneisses. The Holenarsipur taluk is important from the geological point of view on account of the different types of rock formations. The schistose rocks occur in well defined bands running in North-North-West and South-South-East directions. The Seegegudda schist belt consists mainly of hornblendic schists and quartzites. The Doddagudda schist belt is mainly composed of ferruginous quartzites and schists.

Climate and Rainfall

The climate of the district is agreeable. The temperature increases steadily in the beginning of March and April is the hottest month. Relative humidity is generally high

in the South-West and post monsoon seasons. The sky is heavily clouded during the monsoon season and moderately clouded during the post monsoon season. During the summer season, there is a slight increase in cloudiness during afternoons.

In October and November months, some of the depressions and cyclonic storms that originate in the Bay of Bengal cross the East Coast and move across the peninsula. The year is divided into four seasons viz.,

1. Summer season from March till the end of May;
2. South-West monsoon season from June to the end of September;
3. Post-monsoon season from October to November; and
4. Cold season from December to February.

The drainage area of the district is mainly influenced by the South-West monsoon. The 101-years (1903-2003) average annual rainfall of the district is 1080.71 mm. The recorded monthly maximum and minimum rainfall of the district during the monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly minimum (mm)
June	865.63	3.0
July	2163.48	3.3
August	1620.62	2.0
September	919.06	1.2
October	1472.72	0.5

Drainage

The important rivers that flow through Hassan district are Cauvery, Hemavathy and Yagachi. Cauvery flows only through a small portion of Arkalgudu taluk. The area of the district consists mainly of Hemavathy sub-basin of the Cauvery basin. In the western border of the district, some streams drain into river Nethravathy. In Arasikere taluk, a few tributaries of river Vedavathy flow.

Projects

Hemavathy reservoir is the major irrigation project, while the Votehole and Yagachi are the medium irrigation projects in the district. Hutchana Koppal and Kamasamudra are some of the lift irrigation projects in the district. Besides these, the district is being irrigated by Cauvery Anicut canals and Harangi reservoir irrigation project.

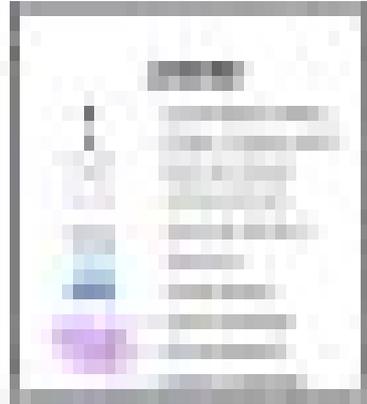
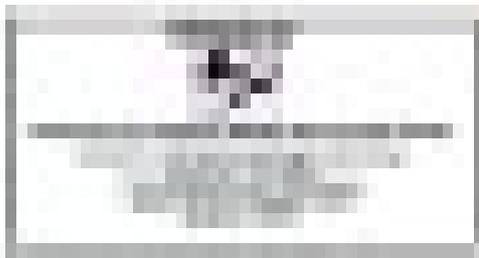
SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF HASSAN DISTRICT

The district falls under two water resource regions viz., (i) The Arabian Sea (Region 5) drained by the basin Cape Comorin to Sharavathy and (ii) The Bay of Bengal (Region 4) (covering more than 60% of the district area) drained by Cauvery and Krishna basins. They are further delineated into 4 catchments, 6 sub-catchments and 13 watersheds. These 13 watersheds have been further delineated into 162 sub-watersheds, 307 mini-watersheds and 1318 micro-watersheds. The details are given in Table 22. In Region 5, the average area of the micro-watershed is 482.16 ha. and Hadlahalli (5A3B2L1d) is the biggest micro-watershed with an area of 824.85 ha. In Region 4, the average area of the micro-watershed is 517.30 ha. and Hassan (4B4B3Q2d) is the biggest micro-watershed with an area of 1182.82 ha.

Table : 22 Watershed Details (up to Micro-watershed) of Hassan District

Hydrological Units		Total Nos.		Name		
Region	2	Arabian Sea (5)	Bay of Bengal (4)			
Basin	3	Cape Comorin to Sharavathy (5A)	Cauvery (4B)			
Catchment	4	Mahe to Sharavathy (5A3)	Krishnarajasagar (4B4)	Krishnarajasagar Reservoir to Stanley (4B3)	Lower Tungabhadra (4D3)	
Sub-catchment	6	Netravathy to Sita (5A3B)	Cauvery Main (4B4A)	Hemavathy (4B4B)	Middle Vedavathy (4D3D)	
Watershed	13	Kumaradhara (5A3B2)	Harangi (4B4A2)	Torehalla1 (4B4B1)	Borakanive Reservoir (4D3D8)	
			Harangi (4B4A3)	Torehalla2 (4B4B2)	Viravaishnavi (4B3D1)	Uppermost Vedavathy beyond Vanivilas Sagara (4D3E)
Sub-watershed	162	11	21	78	2	33
Mini-watershed	307	24	38	154	2	59
Micro-watershed	1318	97	137	707	2	261

THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES



STATE OF CALIFORNIA

17. HAVERI DISTRICT

Location and Extent

Haveri district lies in the central part of Karnataka State and is geographically located between latitudes 14°16'18" to 15°00'36" N and longitudes 75°00'36" to 75°49'30" E. The total geographical area of the district is 4,851 sq km. Haveri district has a population of 14,39,116 (Census, 2001) and comprises of seven taluks viz., Byadgi, Hanagal, Haveri, Hirekerur, Ranebennur, Savanur and Shiggaon. The district is bounded on the North by Dharwad and Gadag, on the South by Shimoga and Davangere, on the East by Bellary and part of Davangere and West by Uttara Kannada.

Physiography

The entire district is a plain terrain excepting Hirekerur taluk where the undulating terrain exists with hill ranges and dense mixed jungle to the South-West of Masur and western parts of Hanagal taluk. River Tungabhadra forms the eastern boundary of the district.

Agro-climatic Zones

Haveri district lies in two agro-climatic zones viz.,

1. Northern transition zone (Byadgi, Haveri, Hirekerur, Ranebennur, Savanur and Shiggaon)
2. Hilly zone (Hanagal).

Soil Types

Red soils developed from quartzite, ferruginous quartzite and schist are moderately deep, well drained, loamy to clay, gravelly with moderate to moderately rapid permeability. The black soils developed from schist are deep to very deep, moderately well drained, clay soils with slow permeability.

Geology

The Chitradurga groups of rocks are found in Haveri district. They are greywacke, argillite, meta-basalt and quartz-chlorite-schist. The tertiary groups of recent formations of laterites occur in small patches in some parts of the district.

Climate and Rainfall

The climate of the district is agreeable. The skies are clouded heavily during South-West monsoon season. The humidity is very low and the winds are Westerly. The Northerly component pre-dominates during April to September months and the Southerly component predominates in May, June and July months. The winds are mainly Easterly during October to December. The districts enjoys four seasons viz.,

1. Summer season from middle of February till the end of May;
2. South-West monsoon season from June to the end of September;

3. Post-monsoon season during October and November; and
4. Cold season from December to the middle of February.

The drainage area of the district is mainly influenced by the South-West monsoon. The 99-years (1905-2003) annual average rainfall of the district is 820.68 mm. The recorded monthly maximum and minimum rainfall of the district in the monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	1776.4	2.6
July	4030.8	15.9
August	983.3	8.2
September	1796.9	1.2
October	611.5	0.7

Drainage

The entire district lies in the Tungabhadra catchment of the Krishna basin. The important river of the area is Varada. The drainage is mainly influenced by the South-West monsoon.

Projects

There are no major and medium irrigation projects in the district. However, the district is proposed to be irrigated by the on-going Upper Tunga project.

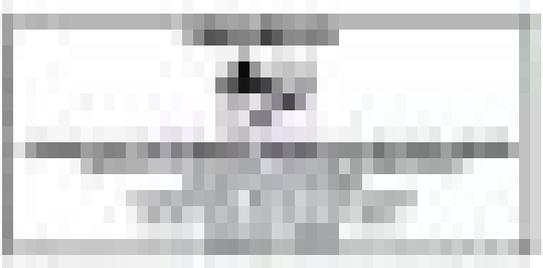
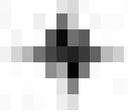
SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF HAVERI DISTRICT

The district falls under two water resources region – the Bay of Bengal (Region 4) drained by Krishna basin (more than 90% of the district area) and the Arabian Sea (Region 5) drained by Sharavathy to Tapti. It is further delineated into 3 catchments, 5 sub-catchments and 14 watersheds. These 14 watersheds have been further delineated into 109 sub-watersheds, 219 mini-watersheds and 1042 micro-watersheds. The details are given in Table 23. In Region 4, the average area of the micro-watershed is 467.63 ha. and Balambidu (4D4C5J2e) is the biggest micro-watershed with an area of 1028.45 ha. In Region 5, the average area of the micro-watershed is 346.54 ha. and Avadi Somapur2 (5B1A4N1a) is the biggest micro-watershed with an area of 910.04 ha.

Table : 23 Watershed Details (up to Micro-watershed) of Haveri District

Hydrological Units	Total Nos.	Name				
Region	2	Arabian Sea (5)	Bay of Bengal (4)			
Basin	2	Sharavathy to Tapti (5B)	Krishna (4D)			
Catchment	3	Sharavathy to Savitri (5B1)	Main Krishna above confluence with Bhima (4D7)	Upper Tungabhadra beyond the reservoir (4D4)		
Sub-catchment	5	Sharavathy to Kalinadi (5B1A)	Malaprabha (4D7C)	Chikkahagari (4D4B)	Misc LB lower parts of Varada (4D4A)	
Watershed	14	Bedthi1 (5B1A4)	Yaren, Radi Gugi (4D7C6)	Vadagatti (4D4B5)	Dandavathy (4D4A7)	
		Bedthi2 (5B1A3)			LB Tungabhadra1 (4D4C8)	Dharma1 (4D4A6)
Sub-watershed	109	8	3	1	LB Tungabhadra2 (4D4C2)	
					RB Tungabhadra2 (4D4C1)	Dharma2 (4D4A5)
					Dharma3 (4D4A4)	Doddahalla1 (4D4A3)
Mini-watershed	219	10	7	1	Mavina hole Varada (4D4A8)	
Micro-watershed	1042	39	22	1	613	
Sub-watershed	109	8	3	1	36	
Mini-watershed	219	10	7	1	75	
Micro-watershed	1042	39	22	1	367	

THE DISTRICT OF COLUMBIA OFFICIAL BOUNDARY MAP



Color	Description
Light Purple	...
Light Blue	...
Light Green	...
Light Yellow	...
Light Orange	...
Light Red	...

18. KODAGU DISTRICT

Location and Extent

Kodagu district situated in the South-West of Karnataka State lies between the latitudes 11°56'00" to 12°50'00" N and longitudes 75°22'00" to 76°11'00" E. The total geographical area of the district is 4,102 sq km and it has a population of 5,48,561 (Census, 2001). It consists of three taluks viz., Madikeri, Somwarpet and Virajpet. The district is bounded on the North by Hassan district, on the East by Mysore district, on the West by South Kanara districts of Karnataka State and on the South by the Cannanore district of Kerala State.

Physiography

Kodagu is a picturesque highland occupying the eastern and western slopes of the Western Ghats, clothed with primeval forests or grassy glades and broken by a few cultivated valleys. Kodagu is a land-locked hilly country and is mostly covered by forest with coffee plantations here and there, paddy fields or the park-like open glades (bare) with their beautiful green sword and varied foliage, lending a charming variety to the landscape.

Agro-climatic Zones

Kodagu district lies in the Hilly agro-climatic zone.

Soil Types

Forest brown soils occur in the Western Ghats, which are very deep, well drained, loam to clay soils with moderate permeability. Laterite soils occur in malnad region with coffee plantation. There are very deep, well drained, clay soils with moderately rapid permeability.

Geology

The various rock formations occurring in the district are recent, but the sub-recent deposits occurring in the area belong to the most ancient Archaean system.

Dharwars consists of the older metamorphic rocks and are represented by thinly foliated garnetiferous kyaonite-mica-schists, hornblende-schists and quartz. The granites and granitic gneisses occur over extensive areas. Charnockites are exposed prominently in the South, South-West Virajpet, South-West of Napoklu, around Velekotti and in the Harangi and Cauvery river basins.

Climate and Rainfall

The climate of the district is characterized by high humidity, heavy rainfall (Ghats), cool, equable and pleasant climate. The year may be divided into four seasons viz.,

1. Summer season from March to May;
2. South-West monsoon season from June to September;
3. Post-monsoon season from October to November; and
4. Cold season from December to February.

The rainfall in the district decreases from West towards East. On account of the nature of the terrain which consists of hills and valleys, the variation in the rainfall within the district is considerable. Temperatures begin to increase from March till April, which is the hottest month with the mean daily maximum temperature at 28.6°C. The relative humidity is more during the monsoon months. Skies are heavily clouded in the monsoon season and in the rest of the year, skies are highly to moderately clouded. The winds are high to moderate with some strengthening during the South-West monsoon months.

The drainage area of the district is prominently influenced by the South-West monsoon. The 103-years (1901-2003) average annual rainfall of the district is 2802.8 mm. The recorded monthly maximum and minimum rainfall of the district during the monsoon period is as follows :

Month	Monthly Maximum (mm)	Monthly Minimum (mm)
June	3486.0	66.3
July	1887.5	112.0
August	1438.3	94.3
September	702.6	11.2
October	797.4	11.1

Drainage

Kodagu district lies in the Cauvery basin. River Cauvery is the largest river with its principal tributaries Lakshmanathirtha and Harangi flowing in the eastern direction, and Barapole that flows towards the West.

Projects

Harangi reservoir major irrigation project and Chiklihole medium irrigation project are the only two projects in Kodagu district.

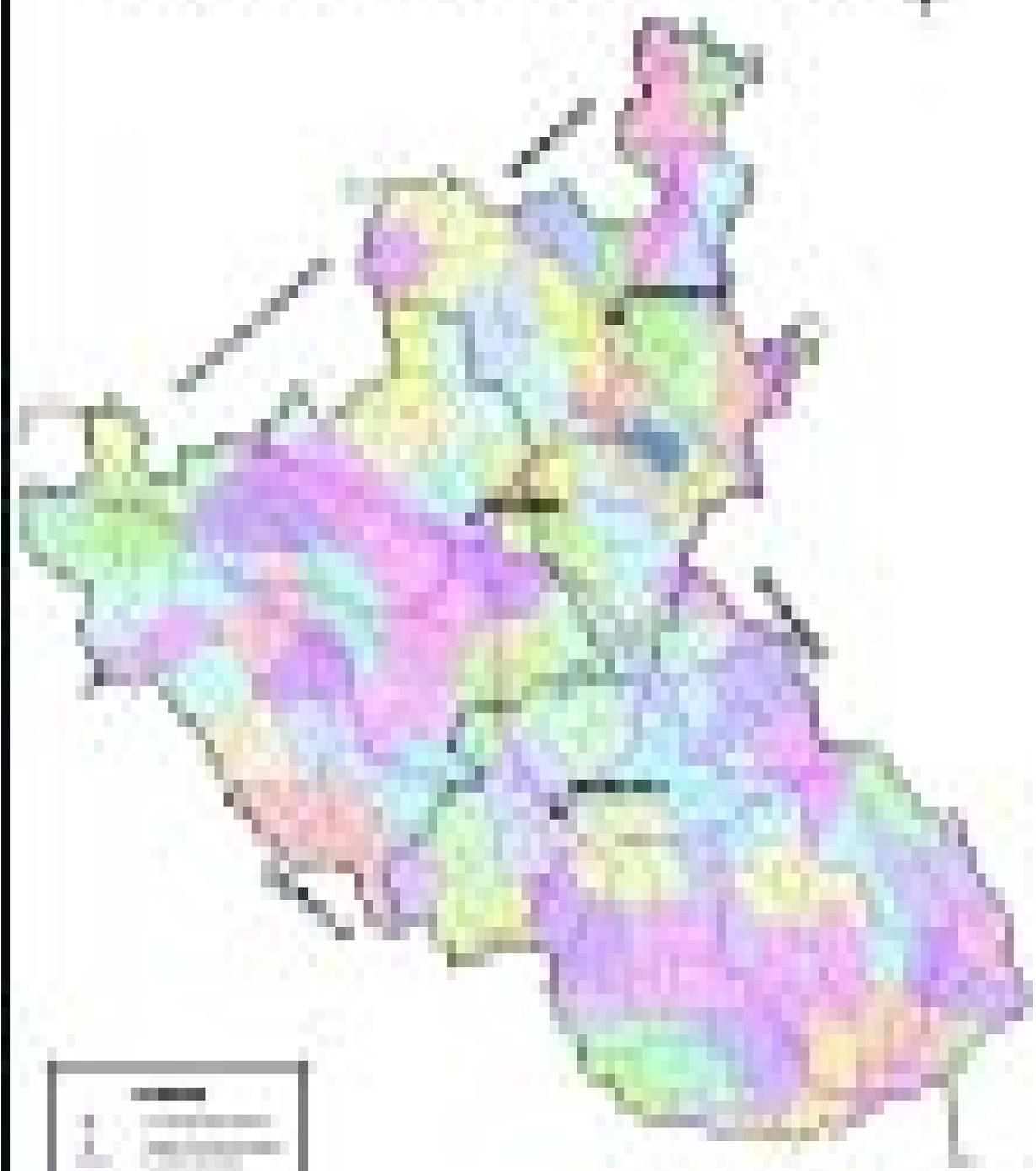
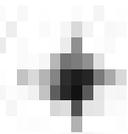
SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF KODAGU DISTRICT

The district falls under two water resource regions, the Arabian Sea (Region 5) drained by the basin Cape Comorin to Sharavathy and the Bay of Bengal (Region 4) drained by the Cauvery basin. They are further delineated into 3 catchments, 5 sub-catchments and 12 watersheds. These 12 watersheds have been further delineated into 97 sub-watersheds, 189 mini-watersheds and 844 micro-watersheds. The details are given in Table 24. In Region 5, the average area of the micro-watershed is 494.63 ha. and Uppugalahole (5A3B2F1a) is the biggest micro-watershed with area of 845.13 ha. In Region 4, the average area of the micro-watershed is 480.83 ha. and Kudluru (4B4B4W2c) is the biggest micro-watershed with an area of 890.80 ha.

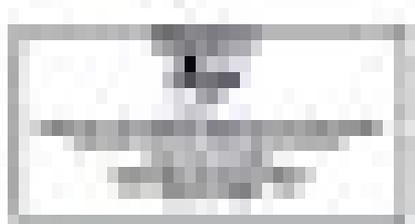
Table : 24 Watershed Details (up to Micro-watershed) of Kodagu District

Hydrological Units	Total Nos.	Name			
Region	2	Arabian Sea (5)	Bay of Bengal (4)		
Basin	2	Cauvery (4B)			
Catchment	3	Cape Comorin to Sharavathy (5A)	Krishnarajasagar (4B4)		
Sub-catchment	5	Mahe to Sharavathy (5A3)	Cauvery Main (4B4A)	Hemavathy (4B4B)	Krishnarajasagar reservoir to Stanley (4B3)
		Mahe to Netravathy (5A3A)	Netravathy to Sita (5A3B)		LB above Shimsha reservoir (4B3E)
Watershed	12	Aralampuza (5A3A2)	Harangi2 (4B4A3)	U. Hemavathy (4B4B4)	Taraka (4B3E8)
		Kuppam1 (5A3A4)	Lakshmanathirtha (4B4A1)		U. Kabini (4B3E6)
		Kuppam2 (5A3A5)	U. Cauvery (4B4A4)		
		Payaswani (5A3A6)			
		Valarapattanam (5A3A3)			
Sub-watershed	97	28	52	5	6
Mini-watershed	189	55	102	11	9
Micro-watershed	844	226	502	40	35

MAP OF THE DISTRICTS OF THE STATE OF KERALA



LEGEND	
[Symbol]	State Boundary
[Symbol]	District Boundary
[Symbol]	Major Road
[Symbol]	Water Body
[Symbol]	Urban Area
[Symbol]	Rural Area
[Symbol]	Forest Area
[Symbol]	Coastal Area
[Symbol]	Mountainous Area
[Symbol]	Plateau Area
[Symbol]	Valley Area
[Symbol]	Plain Area
[Symbol]	Island Area



19. KOLAR DISTRICT

Location and Extent

Kolar district is situated in the eastern part of Karnataka State and lies between latitudes 12°46'00" to 13°58'00" N and longitudes 72°21'00" to 78°35'00" E. It has a total geographical area of 8,223 sq km and the population is 25,36,069 (Census, 2001). Kolar district consists of eleven taluks viz., Bagepalli, Bangarpet, Chikballapur, Chintamani, Gouribidnur, Gudibanda, Kolar, Malur, Mulbagal, Sidlaghatta and Srinivaspura. The district is bounded by the districts of Bangalore Rural and Tumkur on the West, by Anantapur and Chittoor (Andhra Pradesh State) on the North and East, respectively and on the South by the districts of North Arcot and Dharmapuri of Tamil Nadu State.

Physiography

Kolar district has a plain terrain. The border of the district touches the Eastern Ghats in North-East and South. The Central and Eastern part of the district that forms the Palar valley is undulating. A considerable depression occurs in the valley of North Pennar. Kolar district is having a number of hills and peaks of varying heights particularly in the North. The principal chain of mountains is the Nandidurga range.

Agro-climatic Zones

Kolar district lies in the Eastern dry agro-climatic zone.

Soil Types

Lateritic soils and red soils occur to a large extent in the district. Lateritic soils are shallow to moderately deep on mounds and deep on plains, loamy to clay soils with iron gravels, well drained with moderately rapid permeability. Red soils are shallow to deep, excessively drained to well drained, sandy, loamy and clay with lot of quartz gravels and have moderate to moderately rapid permeability.

Geology

The main rock types occurring in Kolar district are:

1. Dharwar – Dark hornblendic schists, amphibolites; tremolite-actinolite schists
2. Gneissic complex – Fine grained dark grey micaceous gneiss with opalescent quartz, banded gneiss, gneissic granites
3. Dolerite dykes and
4. Laterite.

The Dharwar schists form the oldest Archaean complex. The Kolar schist belt runs North and South for a distance of 65 kms with maximum width of about 6.5 kms, covering an area of 260 sq km. The famous Kolar Gold Mines are situated in this schist belt. Numerous dykes of dolerite traverse all the rocks of the schist belt and also granitic complex. These dykes run generally in two directions viz., North-South and East-West. The various types of peninsular gneisses and basic dykes serve as good building and decorative stones.

Climate and Rainfall

The district enjoys an agreeable climate. The year is divided into four seasons viz.,

1. Dry season from December to February;
2. Hot season from March to May;
3. South-West monsoon season from June to September; and
4. Post-monsoon season from October to November.

The Nandi hills, which are at a higher elevation than the Kolar Gold fields, enjoy a cooler climate throughout the year. During the period March to May, there is a continuous rise in temperature. Relative humidity is high in the South-West monsoon season and moderate during the rest of the year. Skies are heavily clouded and overcast during the period from June to September. Winds are generally moderate with some increase in force in the monsoon months. Occasional fog occurs in the cold season.

The South-West monsoon is prominently influencing the drainage area of the district. The 100-years (1904-2003) average annual rainfall of the district is 694.46 mm. The recorded monthly maximum and minimum rainfall of the district during monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	1124.2	1.0
July	2905.2	1.8
August	1372.7	3.7
September	2085.2	2.2
October	1064.8	0.5

Drainage

The important rivers of Kolar district are Palar, North Pennar and South Pennar. The Palar River flows in the South-East direction. Chitravathy and Papagni are the major tributaries of the river Pennar.

Projects

There are no major and medium irrigation projects in the district. However, the district has abundant minor irrigation tanks that are used for irrigation purposes.

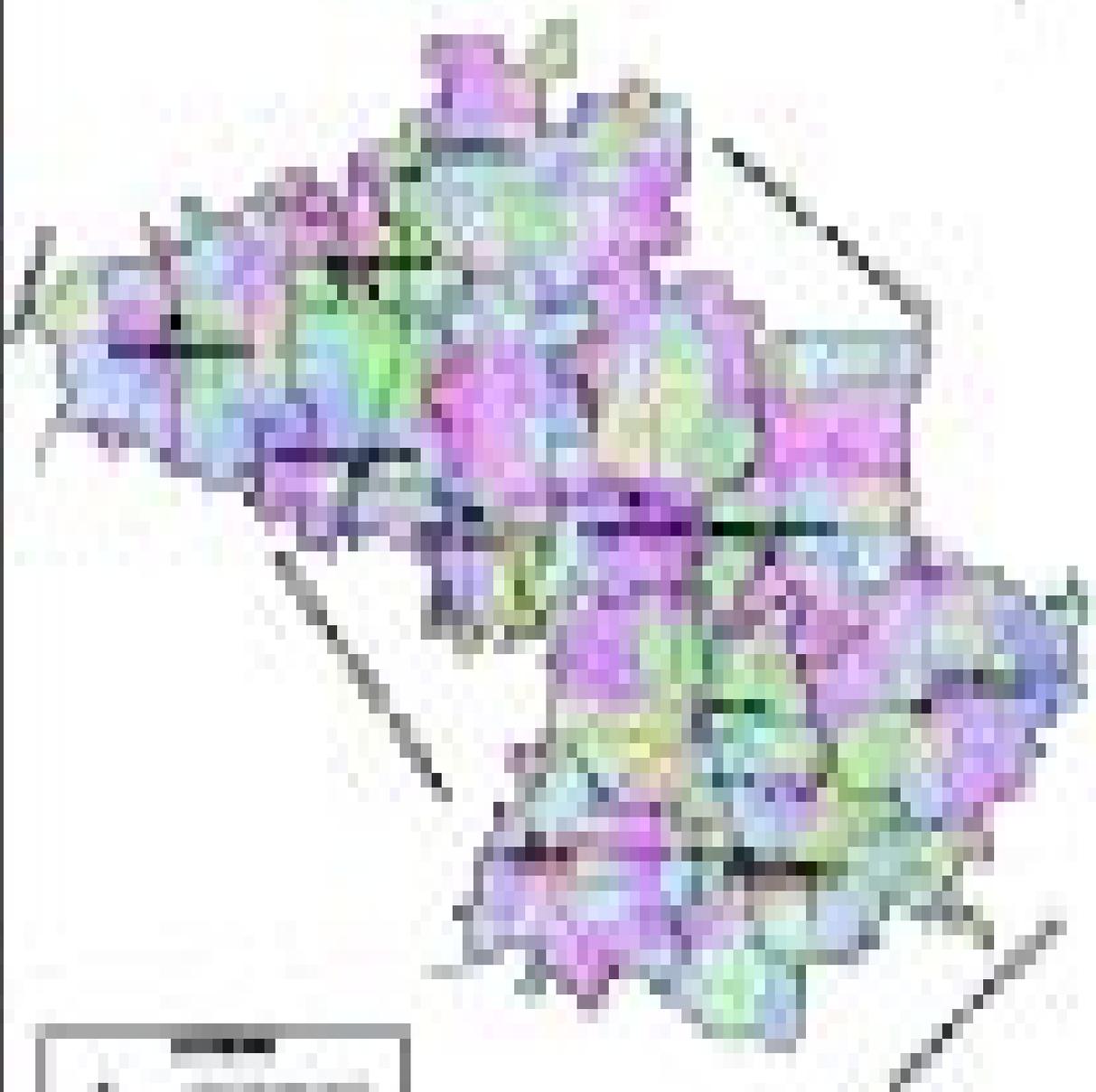
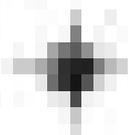
SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF KOLAR DISTRICT

The district lies in the water resource region, the Bay of Bengal (Region 4) drained by two basins – between Cauvery and Krishna (covering more than 90% of the district area) and Cauvery. It is further delineated into 4 catchments, 7 sub-catchments and 19 watersheds. These 19 watersheds have been further delineated into 171 sub-watersheds, 344 mini-watersheds and 1678 micro-watersheds. The details are given in Table 25. In Region 4, the average area of the micro-watershed is 490.32 ha. and Kutandahalli (4C1C9D2e) is the biggest micro-watershed with an area of 998.78 ha.

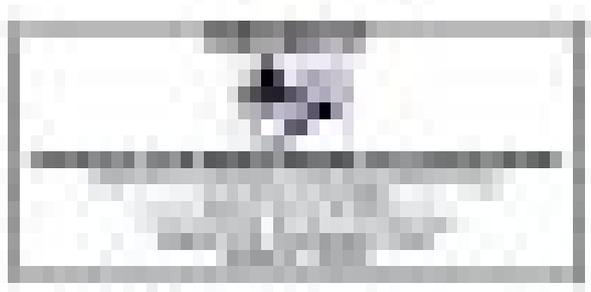
Table : 25 Watershed Details (up to Micro-watershed) of Kolar District

Hydrological Units		Total Nos.		Name														
Region		1		Bay of Bengal (4)														
Basin		2		Between Cauvery and Krishna (4C)														
Catchment		4		Between Ponnaiyar to Pannar (4C2)	Pannar (4C3)			Cauvery (4B)										
Sub-catchment		7		Between Cauvery to Palar (4C1)	Upper Ponnaiyar beyond Satnur Dam (4C1C)	Upper Palar (4C2B)	Chitravathy (RB) (4C3F)	Papagni (RB) (4C3D)	Upper most origin of Pannar (4C3H)	LB Cauvery (4B3B)								
Watershed		19		Koppakode (4C1C7)	S. Pinakini (4C1C9)	U. Ponnaiyar (4C1C8)	U. Ponnaiyar (4C1C6)	Kaigal, Malattar (4C2B2)	Kuvundinya (4C2B7)	U. Palar (4C2B3)	U. Palar1 (4C2B5)	U. Palar2 (4C2B4)	Satyavathy (4C3B6)	Mara (4C3F4)	Papagni (4C3D5)	Jayamangali (4C3H4)	Pennar Pandi (4C3H5)	Kumadvathy (4B3B8)
Sub-watershed		171		39	50	1	17	37	26	1	37	26	1					
Mini-watershed		344		74	108	1	34	76	49	2	76	49	2					
Micro-watershed		1678		342	533	3	180	367	249	4	367	249	4					

MAPA DE LA DISTRIBUCIÓN DE LAS ZONAS DE RIESGO EN EL MUNICIPIO DE SAN CARLOS



LEYENDA	
	ALTA RIESGO
	RIESGO INTERMEDIO
	RIESGO BAJO
	RIESGO MUY BAJO
	RIESGO NULO
	RIESGO EXTREMAMENTE BAJO



ESCALA: 1:50,000

20. KOPPAL DISTRICT

Location and Extent

The district lies in the north-eastern part of Karnataka State and is located between the latitudes 16°00'32.40'' to 15°08'17.27'' N and longitudes 75°46'38.34'' to 76°48'45.74'' E. It has a total geographical area of 8,458 sq km and population of 11,96,089 (Census, 2001). Koppal district consists of four taluks viz., Koppal, Gangavathi, Kushtagi and Yelburga. The district is bounded on the North by Bagalkot and Raichur districts, on the South-East by Bellary district, and West by Gadag district.

Physiography

River Tungabhadra and Tungabhadra dam forms the southern boundary of the district and is within the northern maidan region. The terrain of the district consists of rolling lands, sloping lands, plains and valleys. There are no continuous hill ranges and the entire district is elevated. From these, the streams flow in the South-West and North-East directions. The South-West portion of the district lies in the Tungabhadra catchment.

Agro-climatic Zones

Koppal district lies in the Northern dry agro-climatic zone.

Soil Types

Red soils which occur in about 40% of the district area are moderately deep, well drained loamy to clay and gravelly developed in granites. The permeability of red soils is moderately rapid. The black soils occurring on granites are deep to shallow, well drained to moderately well drained, clay with moderately slow to slow permeability and are found to occur in all the four taluks.

Geology

Koppal district consists of six groups of rock formations which belong to pre-cambrian to Baba-Budan groups. The oldest rock formations are peninsular gneissic complex rocks. The recent formations are Badami group of rocks. The main rock types of the district are migmatite, tonalitic gneiss, granodiorite granite, pink and gray granite, Chitradurga group volcanic, conglomerate, phyllite and quartz chlorite schist.

Climate and Rainfall

Climate of the entire district is dry. South-West monsoon predominately influences the district. The district enjoys four seasons viz.,

1. Hot season from middle of February till the end of May;
2. South-West monsoon season from June to the end of September;
3. Post-monsoon season in the months of October and November; and
4. Cold season from December to the middle of February.

South-West monsoon prominently influences the drainage system of the district. The 52-years average annual rainfall of the district is 557.2 mm. The recorded monthly maximum and minimum rainfall of the district during the monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	256.9	2.0
July	280.3	9.0
August	278.3	2.5
September	380.7	5.1
October	448.2	3.0

Drainage

The district is drained by two river systems – Tungabhadra and Krishna. The drainage area of Gangavathi, Yelburga and Koppal taluks lie in the catchment area of Tungabhadra River and the drainage area of Kushtagi taluk lie partly in the catchment area of rivers Krishna and Tungabhadra. The drainage network is well distributed and almost circular in shape. Hirehalla is the only major stream flowing in the district. Somanna nala and Marli nala are some of the other streams of the district.

Projects

Hirehalla medium irrigation project is the only irrigation project of the district. There are a number of minor irrigation tanks in the district.

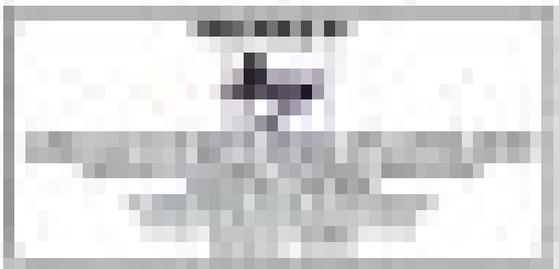
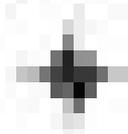
SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF KOPPAL DISTRICT

The district falls under the water resource region – the Bay of Bengal (Region 4) drained by the Krishna basin. It is further delineated into 3 catchments, 4 sub-catchments and 9 watersheds. These 9 watersheds have been further delineated into 115 sub-watersheds, 235 mini-watersheds and 1058 micro-watersheds. The details are given in Table 26. The Krishna basin (4D) includes three catchments viz., Lower Tungabhadra (between Tungabhadra and Srisaïlam reservoirs) (4D3), Upper Tungabhadra beyond the reservoir (4D4) and Main Krishna above the confluence with Bhima (4D7). In Koppal district, the average area of the micro-watershed is 514 ha. and Naregallu1 (4D4A1T2e) is the biggest micro-watershed with an area of 1115.26 ha.

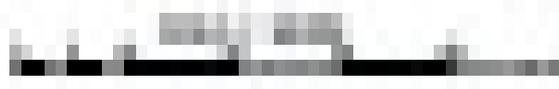
Table : 26 Watershed Details (up to Micro-watershed) of Koppal District

Hydrological Units	Total Nos.	Name		
Region	1	Bay of Bengal (4)		
Basin	1	Krishna (4D)		
Catchment	3	Main Krishna above confluences with Bhima (4D7)	Lower Tungabhadra (between Tungabhadra reservoir and Srisailam) (4D3)	Upper Tungabhadra beyond the reservoir (4D4)
Sub-catchment	4	Malaprabha (4D7C)	Misc. long left bank (4D3A)	Misc. LB lower parts of Varada (4D4A)
Watershed	9	Chanl, Hirehalla (4D7C3)	Hirehalla (4D3A8)	Doddahalla2 (4D4A2)
		Hirehalla2 (4D7C1)	LB Tungabhadra3 (4D3A9)	Hirehalla (Tungabhadra) (4D4A1)
			Maskinala1 (4D3A6)	
			Sindhnur, Kanakanala (4D3A7)	
Sub-watershed	115	10	61	34
Mini-watershed	235	17	120	79
Micro-watershed	1058	58	519	404

THE MAP OF SUBDIVISIONS OF THE STATE OF TEXAS



LEGEND	
(Symbol)	UNINCORPORATED TOWNSHIP
(Symbol)	INCORPORATED TOWNSHIP
(Symbol)	COUNTY
(Symbol)	STATE
(Symbol)	WATER
(Symbol)	RAILROAD
(Symbol)	ROAD
(Symbol)	UNINCORPORATED TOWNSHIP
(Symbol)	INCORPORATED TOWNSHIP



21. MANDYA DISTRICT

Location and Extent

Mandya district is situated in the southern part of Karnataka State and lies between latitudes 12°13'00" to 13°04'00" N and longitudes 76°19'00" to 77°20'00" E. The district has a geographical area of 4,961 sq km and a population of 17,55,212 (Census, 2001). The district consists of seven taluks viz., Mandya, Maddur, Malavalli, Pandavapura, Krishnarajpet, Nagamangala and Srirangapatna. The district is bounded by Tumkur district on the North, Hassan district on the West, Mysore and Chamarajanagar districts on the South and Bangalore Rural district on the East.

Physiography

The terrain is almost plain and the only mountain range of the district is in the South-eastern part. A group of low hills appear along the southern boundary of the district and also in the eastern parts of Malavalli taluk. The presence of dense and valuable forest is observed near Shivanasamudram.

Agro-climate Zones

Mandya district lies in the Southern dry agro-climatic zone.

Soil Types

Red soils, shallow to deep well drained, gravelly and non-gravelly, loam to clay with moderately rapid permeability occur in the district. These soils are also under canal irrigation.

Geology

The rock formations in the district belong to the most ancient period and they are mainly of two groups viz., (a) the Dharwar schists and (b) the Peninsular gneisses.

Dykes of dolerite are comparatively few and there are several felsites and porphyry dykes. These dykes show great diversity and range in colour from dark grey, pink to chocolate.

Climate and Rainfall

The climate of the district is moderate throughout the year. The year is divided into four seasons viz.,

1. Summer season from March to May;
2. South-west monsoon season from June to September;
3. Post-monsoon season from October to November; and
4. Winter season from December to February.

There is a continuous rise in the temperature from March to May. The relative humidity is high in the South-West monsoon season and moderate in the post monsoon season. Skies are heavily clouded during the South-West monsoon period and less clouded during the post monsoon season. Winds are South-Westerly or Westerly in the period from May to September and North-Easterly and Easterly from October to February. Winds are generally moderate with slight strengthening during South-West monsoon period.

The drainage area of the district is prominently influenced by the South-West monsoon. The 101-years (1903-2003) average annual rainfall of the district is 821.74 mm. The monthly recorded maximum and minimum rainfall of the district during monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	360.3	1.0
July	279.0	1.7
August	332.3	1.0
September	482.6	1.5
October	483.2	2.5

Drainage

The drainage of the district lies in the Bay of Bengal Region. The entire district lies in the Cauvery basin in which the rivers Cauvery, Shimsha and Lokapavani are prominent. The drainage network of the district is moderately dense.

Projects

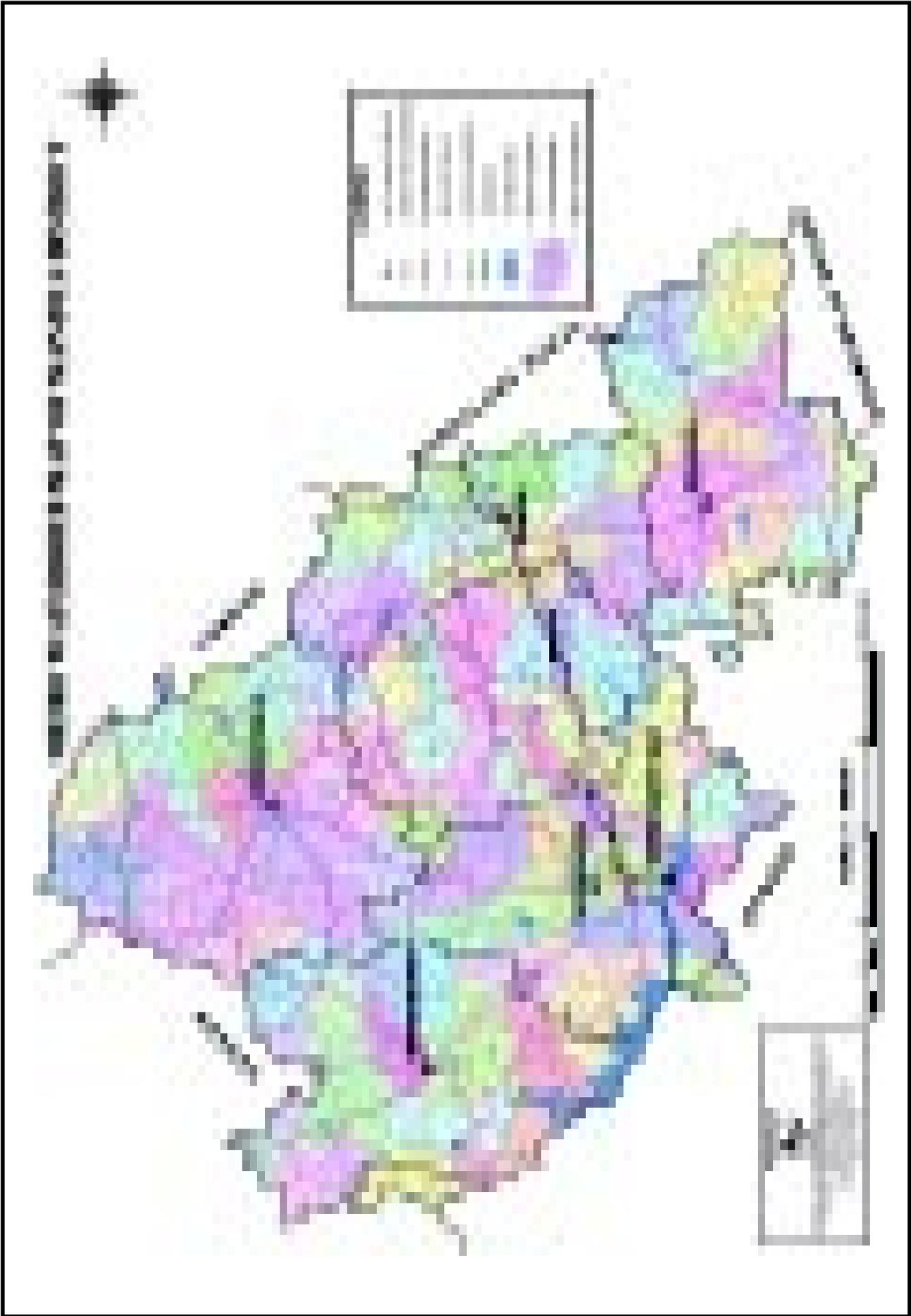
Krishnarajasagar is the major irrigation project in the district. Some parts of the district are being irrigated by Hemavathy canals. Shimsha and Shivasamudram hydro-electric power projects are the important power projects situated in the district.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF MANDYA DISTRICT

The district lies in the water resource region, the Bay of Bengal (Region 4) drained by the Cauvery basin (4B) and includes the catchments Krishnarajasagar (4B4) and Krishnarajasagar Reservoir to Stanley (4B3). It is further delineated into 2 catchments, 3 sub-catchments and 13 watersheds. These 13 watersheds have been further delineated into 119 sub-watersheds, 247 mini-watersheds and 994 micro-watersheds. The details are given in Table 27. In Region 4, the average area of the micro-watershed is 494.06 ha. and Sunnakoppalu (4B3C7D3c) is the biggest micro-watershed with an area of 1296.33 ha.

Table : 27 Watershed Details (up to Micro-watershed) of Mandya District

Hydrological Units	Total Nos.	Name		
Region	1	Bay of Bengal (4)		
Basin	1	Cauvery (4B)		
Catchment	2	Krishnarajasagar (4B4)	Krishnarajasagar Reservoir to Stanley (4B3)	
Sub-catchment	4	Cauvery Main (4B4A)	Hemavathy (4B4B)	LB above Shimsha Reservoir (4B3D)
Watershed	12	Lakshmanathirtha (4B4A1)	Torehalla1 (4B4B1)	Viravaishnavi1 (4B3D1)
			Viravaishnavi2 (4B3D2)	LB up to Shimsha Reservoir (4B3C)
				LB Cauvery (4B3C6)
				Lokapavani (4B3C7)
				RB Cauvery (4B3C8)
				Shimsha5 (4B3C1)
Shimsha4 (4B3C2)				
Shimsha3 (4B3C3)				
Shimsha2 (4B3C4)				
Shimsha1 (4B3C5)				
Sub-watershed	119	1	18	15
Mini-watershed	247	1	39	28
Micro-watershed	994	1	182	106
				85
				179
				705



22. MYSORE DISTRICT

Location and Extent

Mysore district situated in the southern part of Karnataka State lies between the latitudes 11°44'10.2" to 12°39'15.54" N and longitudes 75°54'37.68" to 77°08'11.82" E. The district is having a total geographical area of 6,269 sq km with a population of 26,41,027 (Census, 2001). The district consists of seven taluks viz., Mysore, K. R. Nagar, T. Narasipura, Nanjanagud, H. D. Kote, Hunsur and Periyapatna. The district is bounded by Kodagu district on the West, Mandya district on the East, Hassan district on the North and Chamarajanagar district on the South.

Physiography

Mysore district is a tableland situated at the angle where the Eastern and Western Ghat ranges converge into a group of hills called the Nilgiri hills. The terrain is an undulating tableland with granite rocks protruding at odd intervals. The general elevation of the district is more than 800 m above the MSL. The principal ranges of hills are the Chamundi hills near the city of Mysore.

Agro-climatic Zones

Mysore district lies in two agro-climatic zones viz.,

1. Southern dry zone (Mysore, K.R. Nagar, T.Narasipura and Nanjanagud)
2. Southern transition zone (H.D. Kote, Hunsur and Periyapatna)

Soil Types

A major area is covered by red soils that have developed on gneisses and schist. Red soils are shallow, moderately deep and deep, well drained, loam to clay, gravelly and non-gravelly with moderately rapid permeability. The forest brown soils occur in the Western Ghats which are very deep to deep, well drained clay soils with moderate permeability and are found in H.D Kote area.

Geology

Mysore district consists of the peninsular gneissic complex within which elongated rafts and enclaves of supra-crustal rocks consisting of high-grade schists occur. These high-grade schists belong to the oldest group of supra-crustal rocks. The Chamundi granites represent the youngest igneous rocks in the district.

Climate and Rainfall

The climate of the district is moderate throughout the year. The year is divided into four seasons viz.,

1. Summer season from March to the end of May;
2. South-West monsoon season from June to September;
3. Post-monsoon season from October to November; and
4. Cold season from December to February.

Relative humidity is generally high during the South-West monsoon season. From January to April, the relative humidities are low. The skies are heavily clouded

during South-West monsoon period and moderately clouded during the post-monsoon period. The winds are generally moderate. They are strengthened during the South-West monsoon season.

The drainage area of the district is prominently influenced by the South-West monsoon. The 101-years (1903-2003) average annual rainfall of the district is 755.83 mm. The recorded monthly maximum and minimum rainfall of the district during the monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	431.6	2.92
July	716.3	1.5
August	348.08	2.6
September	359.76	0.7
October	592.4	3.0

Drainage

The district lies mainly in the Cauvery basin. Kabini and Lakshmanathirtha are the tributaries of the Cauvery flowing in the district. River Cauvery is a perennial river and the drainage network is dense.

Projects

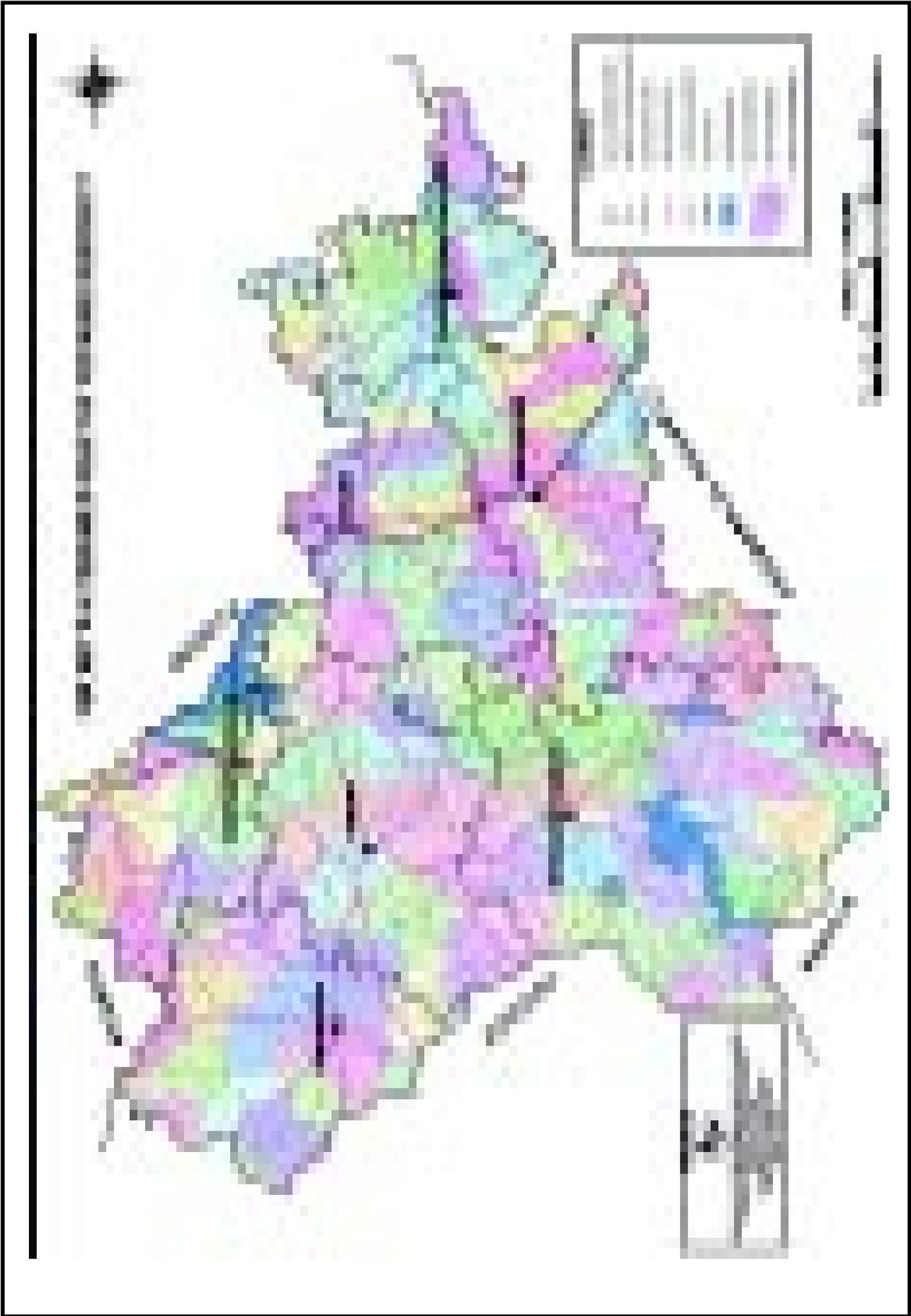
The Kabini reservoir is the major irrigation project; Hebballa and Taraka are the medium irrigation projects of Mysore district. Besides these, the district receives irrigation facilities from Krishnarajasagar and Harangi irrigation projects.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF MYSORE DISTRICT

The district lies in the water resource region, the Bay of Bengal (Region 4) drained by Cauvery basin (4B) and includes the catchments Krishnarajasagar (4B4) and Krishnarajasagar to Stanley Reservoir (4B3). It is further delineated into 2 catchments, 4 sub-catchments and 16 watersheds. These 16 watersheds have been further delineated into 140 sub-watersheds, 275 mini-watersheds and 1268 micro-watersheds. The details are given in Table 28. In Region 4, the average area of the micro-watershed is 485.42 ha. and Kurubarahalli2 (4B3E3D1b) is the biggest micro-watershed with an area of 941.74 ha.

Table : 28 Watershed Details (up to Micro-watershed) of Mysore District

Hydrological Units	Total Nos.	Name			
Region	1	Bay of Bengal (4)			
Basin	1	Cauvery (4B)			
Catchment	2	Krishnarajasagar (4B4)	Krishnarajasagar to Stanley reservoir (4B3)		
Sub-catchment	4	Cauvery main (4B4A)	Kabini (4B3E)		
Watershed	16	Harangi1 (4B4A2)	Gundal (4B3E1)		
		Harangi2 (4B4A3)	Hebballa (4B3E4)		
		Lakshmanathirtha (4B4A1)	Nuguhole (4B3E5)		
		U. Cauvery (4B4A4)	Taraka (4B3E8)		
			U. Kabini (4B3E6)		
			Yenna (4B3E3)		
Sub-watershed	140	1	72	17	10
Mini-watershed	275	2	143	31	18
Micro-watershed	1268	6	679	115	59



23. RAICHUR DISTRICT

Location and Extent

The district lies in the North-eastern part of Karnataka State and is geographically located between latitudes 12°13'14" to 13°33'30" N and longitudes 75°32'26" to 76°39'32" E with a population of 16,69,762 (Census, 2001). Rivers Krishna and Tungabhadra forms the northern and southern boundaries of the district. The district has an areal extent of 5,559 sq km and consists of five taluks viz., Raichur, Manvi, Devadurga, Lingasugur and Sindhanur. The district is bounded on the North by Gulbarga, on the South by Bellary and Koppal, on the East by Andhra Pradesh and West by Bagalkot and part of Koppal.

Physiography

Raichur district lies between two rivers the Krishna in the North and the Tungabhadra in the South. The western part of the district is a plain country with scanty vegetation, while the eastern part has a few hillocks and scrub jungles. The eastern part has an undulating surface with red soils and western part contains black alluvial soil.

Agro-climatic Zones

Raichur district lies in two agro-climatic zones viz.,

1. North-eastern dry zone (Raichur, Manvi and Devadurga)
2. Northern dry zone (Lingasugur and Sindhanur)

Soil Types

The deep black soils occurring in Raichur, Devadurga, Sindhanur, Manvi and Lingasugur areas have developed on schist and meta-basalts. Alluvial black soils are found along the Krishna river bank. They are clayey with shrinking and swelling characteristics and are well drained to moderately well drained with moderately slow to slow permeability. The red soils developed from granite occurring in Raichur, Devadurga, Lingsugur and Manvi areas are shallow to moderately deep, sandy to loamy with high gravel content. These soils are excessively drained to well drained with rapid to moderately rapid permeability.

Geology

The Dharwar series occur in the form of three prominent bands viz., the Kushtagi band, the Maski band and the Raichur band. The Kushtagi and Maski bands consist of metamorphic series that includes the chlorite schists, talc schists banded ferruginous quartzites, hornblende schists and diabasic schists. The rock continuing in the Raichur band consists of chlorite, hornblende and diabasic schists. The Hutti gold mine is situated in the Maski band. The main rock types of the district are Dharwars, Peninsular gneissic complex and dykes.

Climate and Rainfall

The district on the whole has a dry climate. The period from November to May is the driest part of the year. The district is predominantly influenced by South-West monsoon and humidity during this period is not high. The winds are stronger during the South-West monsoon and light in post-monsoon and cold seasons. The district enjoys four seasons viz.,

1. Hot season from middle of February to the end of May;
2. South-West monsoon season from June till the end of September;
3. Post-monsoon season during the months October and November; and
4. Cold season from December to the middle of February.

The drainage area of the district is prominently influenced by the South-West monsoon. The 101-years (1903-2003) average annual rainfall of the district is 634.4 mm. The recorded monthly maximum and minimum rainfall of the district in the monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	376.5	4.3
July	510.7	5.8
August	380.3	7.3
September	507.8	0.7
October	760.4	1.2

Drainage

A major part of the district lies in the Tungabhadra River catchment and the rest in the Krishna River catchment. In Raichur and Devadurga taluks, the drainage network is denser compared to that in Manvi, Sidhanur and Lingasugur taluks. River Krishna enters Raichur district to the North of Uppinhal village in Lingasugur taluk and flows for a distance of about 269 sq km. River Bhima confluences with river Krishna to the North of Kadlur in Raichur taluk. Some of the major streams that join river Krishna are Huttinala, Chiksugurnala, Ramdurgnala, Mandarginala, Kodihallanala and Ramanhallanala. River Tungabhadra enters the district near Singapura village of Sindhanur taluk. Major tributaries of Tungabhadra flowing in the district are Maskinala and Sindhanur nala.

Projects

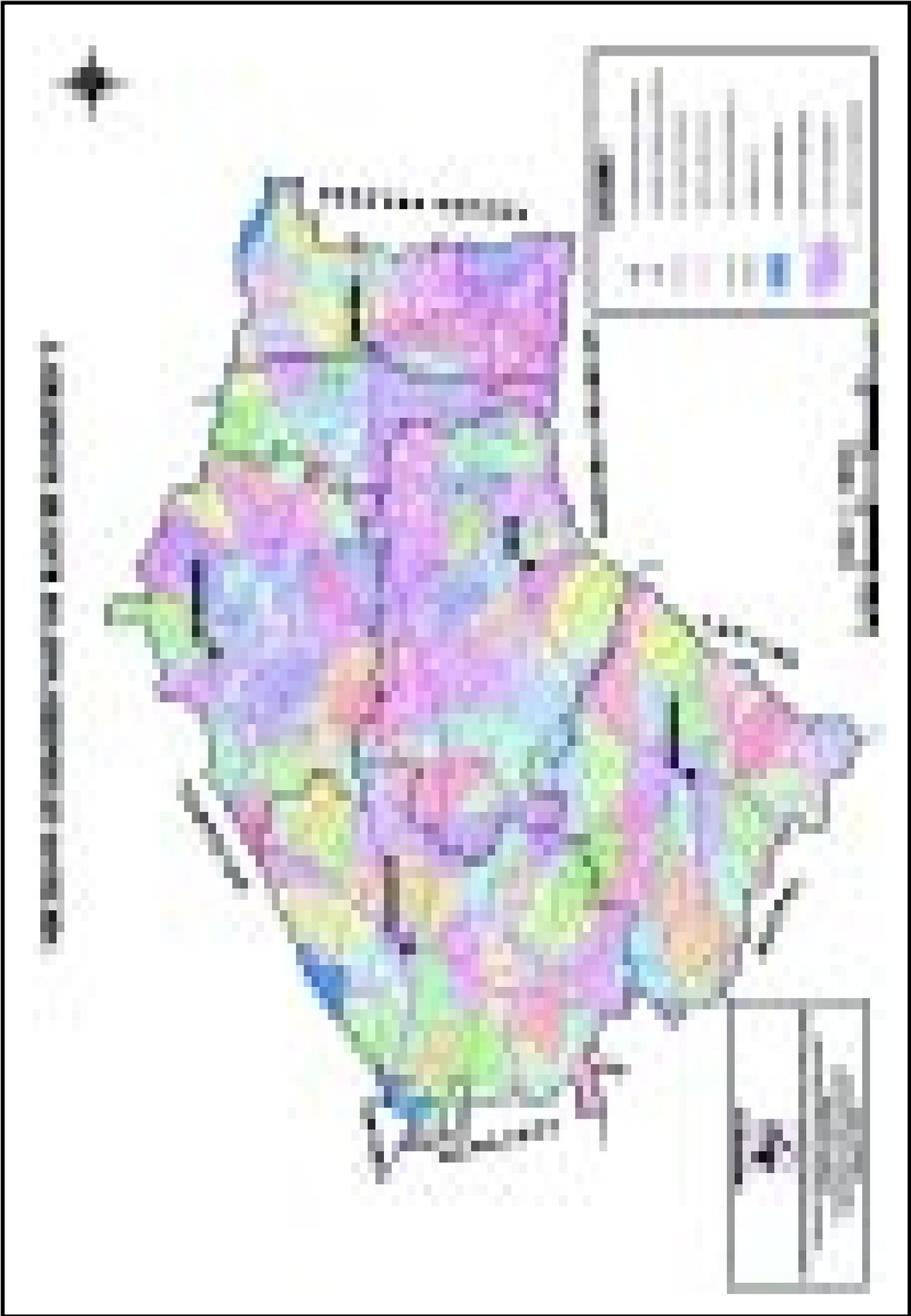
Kanakanala, Maskinala and Rajolibanda are the medium irrigation projects of the district. In addition, the district is being irrigated by the left bank canal of the Tungabhadra project. Shakthinagar thermal power project is in the district.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF RAICHUR DISTRICT

The district falls under the water resource region, the Bay of Bengal (Region 4). It is further delineated into 3 catchments, 4 sub-catchments and 14 watersheds. These 14 watersheds have been further delineated into 171 sub-watersheds, 336 mini-watersheds and 1452 micro-watersheds. The details are given in Table 29. Region 4 is drained by the Krishna basin (4D) that includes the catchments Lower Tungabhadra (between Tungabhadra reservoir and Srisailam) (4D3), Main Krishna above confluence with Bhima (4D7) and Nizamsagar to Srisailam confluence of Tungabhadra with Krishna and Bhima with Krishna (4D2). In Region 4 of Raichur district, the average area of the micro-watershed is 579.35 ha. and Sarjapuram2 (4D2D7E2c) is the largest micro-watershed with an area of 1369.02 ha.

Table : 29 Watershed Details (up to Micro-watershed) of Raichur District

Hydrological Units	Total Nos.	Name			
Region	1	Bay of Bengal (4)			
Basin	1	Krishna (4D)			
Catchment	3	Lower Tungabhadra (between Tungabhadra reservoir and Srisailam) (4D3)	Main Krishna above confluence with Bhima (4D7)	N'Sagar to Srisailam confluence of Tungabhadra with Krishna and Bhima (4D2)	
Sub-catchment	4	Misc. long left bank of Krishna (4D3A)	LB Krishna (4D7A)	RB Krishna upto confluence with Malaprabha (4D7B)	LB Krishna confluence with Bhima to Srisailam (4D2D)
Watershed	14	Along left bank of Tungabhadra1 (4D3A4)	LB Krishna (4D7A7)	Hutti1 (4D7B4)	RB Krishna (4D2D7)
		Along left bank of Tungabhadra2 (4D3A3)		Hutti2 (4D7B3)	RB Krishna (4D2D8)
		Hirehalla (4D3A8)		Ilkalnala (4D7B5)	
		Maskinala1 (4D3A6)		RB Krishna1 (4D7B2)	
		Maskinala2 (4D3A5)		RB Krishna2 (4D7B1)	
		Sindhur Kakananala (4D3A7)			
Sub-watershed	171	97	1	54	19
Mini-watershed	336	193	1	105	37
Micro-watershed	1452	900	1	434	117



24. SHIMOGA DISTRICT

Location and Extent

Shimoga district is situated in the western part of Karnataka State. It lies between latitudes 13°27'00" to 14°39'00" N and longitudes 74°38'00" to 76°04'00" E and is having the total geographical area 8,465 sq km and a population of 16,42,545 (Census, 2001). The district consists of seven taluks viz., Bhadravathi, Hosanagar, Sagar, Shikaripura, Shimoga, Soraba and Thirthahalli. The district is bounded by the districts of Davangere on the East, Haveri on the North, Dakshina Kannada and Udupi on the West and Chikmagalur on the South.

Physiography

The entire district lies in the malnad region excepting the eastern parts that lie in the maidan region. Shikaripura, Shimoga and Bhadravathi taluks of the district lie in the semi-malnad region. In the western portion, there are tropical forests and mountains. There are three Ghats viz., the Agumbe Ghat in Thirthahalli taluk, the Hulikal and Kollur Ghats in Hosanagar taluks. The district slopes from West to East. The western side of the district rests upon the Western Ghats called the Sahyadri. The interior part of the district is crossed by a chain of hills running from Mandagadde on the Tunga towards North between Anandapuram and Kumshi.

Agro-climatic Zones

Shimoga district lies in two agro-climatic zones viz.,

1. Southern transition zone (Bhadravathi, Shimoga and Shikaripura)
2. Hilly zone (Soraba, Hosanagar, Sagar and Thirthahalli)

Soil Types

Red soils developed from granites occur in the western part of the district. Soils are deep, well drained loam and clay, gravelly with moderate permeability. Laterite soils occur in Thirthahalli, Hosanagar, Soraba and Sagar areas. Soils are deep to very deep excessively drained, clay with iron concretions and moderately rapid permeability. Forest brown soils occurring in eastern parts of the district are deep, well drained, loam to clay with moderate permeability.

Geology

Shimoga district consists of most ancient formations of Archaean complex, which are mainly composed of two systems, the Dharwar schists and gneissic system. Nearly two-thirds of the area of the district is covered by the Dharwar Schists. The gneissic system is much younger than the Dharwar system and mainly consists of granites and granitic gneisses. Laterite is another geological formation that occurs in patches in the western parts of the district.

Climate and Rainfall

There is a rapid increase in temperature after the month of January, and April is the hottest month. The relative humidity during the mornings throughout the year generally exceeds 75%. In the monsoon months, the relative humidity is high during afternoons and usually exceeds 60%. Skies are most heavily clouded and cloudiness decreases in the post monsoon season. Winds are generally light with some increase in force during the monsoon season. Winds are mostly from the directions North-West and South-West.

The climate of the district is very agreeable and cool. The year is divided into four seasons viz.,

1. Hot season from March to May;
2. South-West monsoon from June to September;
3. Post-monsoon from October to November; and
4. Cold season from December to February.

The drainage area of the district is mainly influenced by the South-West monsoon. The 101-years (1903-2003) average annual rainfall of the district is 2264.7 mm. The recorded monthly maximum and minimum rainfall of the district during monsoon period is as follows :

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	778.5	157.9
July	1758.4	124.6
August	1515.2	120.9
September	317.4	36.3
October	319.9	31.6

Drainage

The major rivers of the district are Tunga, Bhadra, Tungabhadra and Varada. Tunga and Bhadra confluences at Kudali and thereafter forms the river Tungabhadra. Kumudavathy and Varada are the major tributaries of the river Tungabhadra. Dandavathy is a major stream, which is a tributary to the river Varada. All the above are in the Krishna basin. Besides the above streams, West flowing rivers like Gangavalli, Varahi and Sharavathy flow in the district

Projects

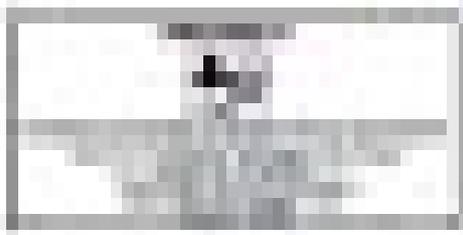
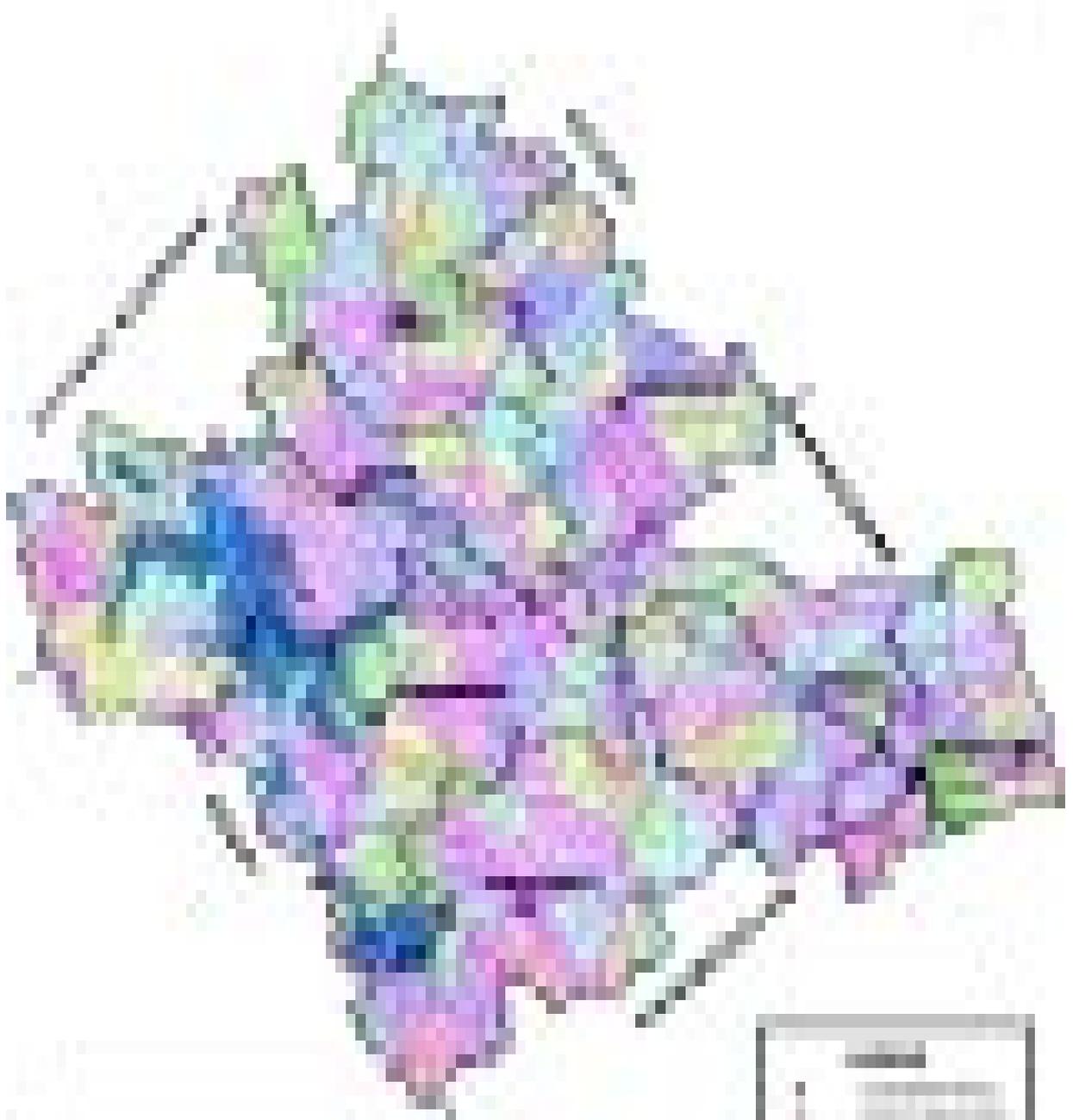
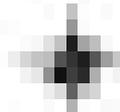
Tunga Anicut, Upper Tunga project, Ambligola and Anjanapura irrigation projects are the medium irrigation projects of the district. The district is also being irrigated by the canals of Bhadra reservoir irrigation project. The gigantic Sharavathy hydro-electric project is in this district. Besides the above, there are a number of minor irrigation works.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF SHIMOGA DISTRICT

The district falls under two water resource regions, the Bay of Bengal (Region 4) drained by the Krishna basin and includes the catchment Upper Tungabhadra beyond the reservoir (more than 60% of the basin area in the district) and Region 5 (the Arabian Sea) drained by two basins Cape Comorin to Sharavathy and Sharavathy to Tapti basins. They are further delineated into 3 catchments, 6 sub-catchments and 19 watersheds. These 19 watersheds have been further delineated into 192 sub-watersheds, 395 mini-watersheds and 1682 micro-watersheds. The details are given in Table 30. In Region 4, the average area of the micro-watershed is 481.99 ha. and Adrihalli1 (4D4C7D1d) is the biggest micro-watershed with an area of 1259.08 ha. and in Region 5, the average area of the micro-watershed is 478.18 ha. and Hasnad (5A3C5A1b) is the biggest micro-watershed with an area of 879.82 ha.

Table : 30 Watershed Details (up to Micro-watershed) of Shimoga District

Hydrological Units	Total Nos.	Name				
Region	2	Arabian Sea (5)		Bay of Bengal (4)		
Basin	3	Cape Comorin to Sharavathy (5A)	Sharavathy to Tapti (5B)			
Catchment	3	Mahe to Sharavathy (5B3)		Upper Tungabhadra beyond the reservoir (4D4)		
Sub-catchment	6	Netravathy Sita (5A3B)	Sita to Sharavathy (5A3C)	Middle up to Shimoga (4D4C)	Misc. LB lower Parts of Varada (4D4A)	Upper Tungabhadra (4D4D)
Watershed	19	Sita (5A3B7)	Haladi-Varahi (5A3C7)	Kumudvathy (4D4C5)	Dandavathy (4D4A7)	Bira (4D4D5)
			Kolluru (5A3C2)	Kumudvathy (4D4C6)	Dharma1 (4D4A6)	Kaggi, Kusi (4D4D1)
			Venkatapura River (5A3C3)	LB Tungabhadra1 (4D4C8)	Mavinahole-Varada (4D4A8)	L. Tunga (4D4D4)
			Sharavathy (5A3C5)	RB Tungabhadra1 (4D4C7)		Malathy (4D4D6)
			Swarna (5A3C4)			Somavahini (4D4D2)
Sub-watershed	192	4	51	42	39	54
Mini-watershed	395	5	105	85	87	110
Micro-watershed	1682	11	472	365	375	451



Color	Description
Blue	Major Highway
Purple	Interstate
Green	State Road
Yellow	County Road

25. TUMKUR DISTRICT

Location and Extent

The district lies in the eastern part of Karnataka State and is located in between latitudes 12°45'00" to 14°20'00" N and longitudes 76°20'00" to 77°31'00" E. The district is having a total geographical area of 10,598 sq km and a population of 25,84,711 (Census, 2001). Tumkur district consists of ten taluks viz., Chiknayakanahalli, Gubbi, Koratagere, Kunigal, Madhugiri, Pavagada, Sira, Tiptur, Tumkur and Turuvekere. The district is bounded on the North by the Anantapur district of Andhra Pradesh, on the East by Kolar and Bangalore districts, on the South by Mandya district and on the West by Chitradurga, Chikmagalur and Hassan districts.

Physiography

The district is an open tract consisting of undulating plains except on the South of Kunigal taluk, where it is wooded and hilly. In the eastern part of Tumkur and to the North of Devarayanadurga, hilly ranges exist. The western parts of Tumkur district are occupied by hill ranges. These ranges of hills form the extension of Chitradurga schist. The eastern part of the district is occupied by a narrow range of granitic hills. The eastern range of hills covers Kamadurga and Nidugal. There are no perennial streams in the district. The most important rivers of the district are the Shimsha and the Jayamangali.

Agro-climatic Zones

Tumkur district lies in three agro-climatic zones viz.,

1. Central dry zone (Madhugiri, Pavagada, Sira, Koratagere, Chiknayakanahalli and Tiptur)
2. Eastern dry zone (Gubbi, Tumkur)
3. Southern dry zone (Kunigal, Turuvekere)

Soil Types

Red soils developed on granite, gneiss and schist are found to occur in the district. These are generally deep, well drained gravelly and non-gravelly, loam to clay soils with moderate permeability. Red soils of Pavagada taluk are shallow to moderately deep, sandy to loamy with a lot of gravel, well drained with moderately rapid permeability.

Geology

The rock formations of Tumkur district belongs to Archaean complex and mainly consists of crystalline schists, the granitic gneisses and the newer granites. The highly calciferous limestones show distinct signs of stratifications and bedding. The thin patches of schists scattered about in the gneissic complex show evidences of repeated metamorphism. A major portion of the district is covered by this complex of granitic gneisses which are classed under a separate group named the peninsular gneiss. The four major components are (i) banded gneisses, (ii) granitic gneisses, (iii) gneissic granites and granites, and (iv) grano-diorites, diorites, inter-action diorites and other varieties.

Climate and Rainfall

The climate of the district excluding Pavagada and Sira taluks is generally agreeable. The year may be divided into four seasons viz.,

1. Dry season from December to February;
2. Hot season from March to May;
3. South-West monsoon season from June to September; and
4. Post-monsoon season October to November.

The post-monsoon month of October has the heaviest rainfall. There is a continuous rise in temperature from March to May, and April is the hottest month. The relative humidities are high during South-West monsoon period and generally moderate in the rest of the year. Skies are heavily clouded in the South-West monsoon season and less clouded during the post-monsoon months. During the rest of the year, the skies are clear and winds are generally moderate with slight increase in strength during the monsoon months.

South-West monsoon predominantly influences the drainage area of the district. The 100-years (1904-2003) average annual rainfall of the district is 617.8 mm. The recorded monthly maximum and minimum rainfall of the district during the monsoon period is as follows :

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	189.8	24.0
July	274.9	32.6
August	383.8	13.0
September	400.8	37.6
October	436.4	27.9

Drainage

The most important rivers in the district are Shimsha, Jayamangali and Suvarnamukhi. River Shimsha rises in Devarayanadurga and flows in southern direction, and finally joins river Cauvery. Jayamangali also originates in Devarayanadurga and flows in North-West direction in the initial stages, and then changes its direction towards North and finally joins river Pennar.

Projects

Mangala, Marchonahalli and Teetha are the medium irrigation projects of the district. Besides these, the district receives other irrigation facilities from Gayathri medium and Hemavathy major irrigation projects.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF TUMKUR DISTRICT

The district lies in the water resource region, the Bay of Bengal (Region 4) drained by three river basins viz., Krishna, Cauvery and between Cauvery and Krishna. It is further delineated into 3 catchments, 7 sub-catchments and 21 watersheds. These 20 watersheds have been further delineated into 229 sub-watersheds, 488 mini-watersheds and 2,068 micro-watersheds. The details are given in Table 31. In Region 4 of the district, the average area of the micro-watershed is 511.15 ha. and Karethimmanahalli (4D3D3M3d) is the biggest micro-watershed with an area of 1105.96 ha.

Table : 31 Watershed Details (up to Micro-watershed) of Tumkur District

Hydrological Units	Total Nos.	Name					
		Bay of Bengal (4)					
Region	1	Cauvery (4B)					
Basin	3	Between Cauvery and Krishna (4C)		Krishnarajasagar reservoir to Stanley (4B3)		Krishna (4D)	
Catchment	3	Pennar (4C3)		LB above Shimsha river (4B3D)		Lower Tungabhadra (between Tungabhadra reservoir and Srisaillam) (4D3)	
Sub-catchment	7	Chitravathy (4C3F)	Lower part of upper most Pennar (4D3D)	Upper most origin of Pennar (4C3H)	LB up to Shimsha reservoir (4B3C)	Middle Vedavathy (around Chitradurga)	Upper most Vedavathy beyond Vanivilas sagar (4D3E)
Watershed	20	Upper Chitravathy (4C3F5)	Era (4C3G6)	Jayamangali (4C3H4)	Shimsha1 (4B3C5)	Borakanave reservoir (4D3D8)	Gundihalla2 (4D3E3)
				Pennar Pandi (4C3H5)	Shimsha2 (4B3C4)	Doddahalla1 (4D3D3)	Vanivilas sagar (4D3E1)
				Upper Pennar1 (4C3H3)	Shimsha4 (4B3C2)	Suvarnamukhi1 (4D3D7)	Veda2 (4D3E6)
				Upper Pennar2 (4C3H2)	Viravaishnavi2 (4B3D2)	Suvarnamukhi 2 (4D3D6)	
Sub-watershed	229	2	2	58	63	21	73
Mini-watershed	488	3	4	119	131	46	169
Micro-watershed	2068	7	14	544	540	193	725

26. UDUPI DISTRICT

Location and Extent

Udupi district is situated in the western part of Karnataka State and lies between latitudes 12°58'00" to 13°58'00" N and longitudes 74°35'00" to 75°2'00" E. The geographical area of the district is 3,598 sq km. The district is bounded by Shimoga and Chikmagalur districts in the East, the Arabian Sea in the West, Dakshina Kannada district in the South and Karwar district in the North. Udupi district has a population of 11,12,243 (Census, 2001) and comprises of three taluks viz., Udupi, Karkala and Kundapura.

Physiography

The Western Ghats are within a distance of 40 kms from the sea. The district has a vast area of coastal line and Ghat region. The coastal line is low and sandy with broken and rugged rocks.

Agro-climatic Zones

All the three taluks of the district lie in the Coastal agro-climatic zone.

Soil Types

A major area of the district is covered with laterite soils. Soils are moderately deep to deep, excessively drained to well drained, clay with iron gravels and moderately rapid permeability. Coastal and valley regions have sandy and clay soils moderately well drained with rapid to slow permeability with high water table. Forest brown soils occur in Western Ghats which are very deep, well drained, loam to clay soils with moderate permeability.

Geology

Udupi district consists of different types of rocks that belong to schist, gneisses, acidic rocks and granites. Nearly 65% of the district is covered by gneisses that show different ages as demonstrated by the peninsular gneissic complex. The main rock types occurring in the district are arranged in the following sequence:

1. Recent and sub-recent alluvial formations, clay, red and dark clay soils and laterite formations;
2. Intrusives, dolomite basic and ultra basic rocks, and granitic gneisses; and
3. Dharwar older metamorphic rocks, garnetiferous quartz, talc-schists, hornblende schists, chlorite schists.

Climate and Rainfall

The climate of this district is marked by heavy rainfall, high humidity and oppressive weather in the hot season. The year may be divided into four seasons viz.,

1. Hot season from March to May;
2. South-West monsoon season from June to September;
3. Post-monsoon season from October to December; and
4. Cold season from December to February.

The air is highly humid throughout the year and particularly in the South-West monsoon months. Skies are heavily clouded in the South-West monsoon season. Winds are strong and mainly Westerly or South-Westerly in the South-West monsoon months. During the rest of the year, winds are mainly from the directions between North and East in the forenoons and Westerly or North-Westerly in the afternoons.

The drainage area of the district is predominantly influenced by the South-West monsoon. The 95-years (1909-2003) average annual rainfall of the district is 4295.2 mm. The monthly recorded maximum and minimum rainfall of the district during monsoon period is as follows:

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	1467.2	389.9
July	3329.9	350.0
August	1536.88	277.1
September	846.9	54.0
October	481.3	20.0

Drainage

The entire district lies in the West flowing river basins. The main rivers of Udupi district are Varahi, Sita, Swarna and Chakra. The drainage network is dense in the Ghats.

Projects

Varahi major irrigation project is the only irrigation project of Udupi district.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF UDUPI DISTRICT

The district falls under the water resource region – the Arabian Sea (Region 5) drained by the basin Cape Comorin to Sharavathy. It is further delineated into 1 catchment, 2 sub-catchments and 7 watersheds. These 7 watersheds have been further delineated into 94 sub-watersheds, 190 mini-watersheds and 912 micro-watersheds. The details are given in Table 32. In Region 5, the average area of the micro-watershed is 424.81 ha. and Hangluru (5A3C1Q2e) is the biggest micro-watershed with an area of 915.77 ha.

Table : 32 Watershed Details (up to Micro-watershed) of Udupi District

Hydrological Units	Total Nos.	Name	
Region	1	Arabian Sea (5)	
Basin	1	Cape Comorin to Sharavathy (5A)	
Catchment	1	Mahe to Sharavathy (5A3)	
Sub-catchment	2	Netravathy to Sita (5A3B)	Sita to Sharavathy (5A3C)
Watershed	7	Gurpur (5A3B4)	Haladi-Varahi (5A3C1)
		Shisla, Mulki (5A3B5)	Kolluru (5A3C2)
		Sita (5A3B7)	Venkatapura River (5A3C3)
		Swarna, Yennehole (5A3B6)	
Sub-watershed	94	57	37
Mini-watershed	190	117	73
Micro-watershed	912	557	355



27. UTTARA KANNADA DISTRICT

Location and Extent

This district located in the mid-western part of Karnataka State lies between the latitudes 13°55'00" to 15°31'00" N and longitudes 74°09'00" to 75°07'00" E. The total geographical area of the district is 10,291 sq km and the population is 13,00,354 (Census, 2001). It consists of eleven taluks viz., Ankola, Bhatkal, Haliyal, Honnavar, Karwar, Kumta, Mundgod, Siddapur, Sirsi, Joida and Yellapur. The district is bounded by Belgaum district and Goa State in the North, Dharwar district in the East, Dakshina Kannada and Shimoga districts in the South and the Arabian Sea in the West.

Physiography

Major part of the district is hilly and thickly wooded and is essentially a high land. The low lands are restricted to pockets along the courses of rivers. The district has three main and distinctive regions viz., the coastal lands, the Sahyadrian interior and the eastern margin where the tableland begins. The coastal lands are the best developed areas with high density of population.

Agro-climatic Zones

Uttara Kannada district lies in two agro-climatic zones viz.,

1. Hilly zone (Haliyal, Mundgod, Siddapur, Sirsi, Joida and Yellapur)
2. Coastal zone (Ankola, Bhatkal, Honnavara, Kumta and Karwar)

Soil Types

Forest brown soils occur in the Western Ghats and are deep, well drained, clay, gravelly, rich in organic matter with moderate permeability. Laterite soils that occur in the coastal region and Malnad regions of Sirsi and Siddapur are moderately deep to deep, well drained, clay with iron gravels and moderate to moderately rapid permeability. Sandy and clay soils of alluvial origin that occur in the coastal plains are moderately well drained to poorly drained with rapid moderately slow permeability.

Geology

The district consists of rock formation of Archaean complex. The Archaean formations are divisible into an older group of sediments which are classified as the Dharwar systems and peninsular gneisses. Granites and schists are found in the coastal line. The Dharwar consists of quartzite, limonite-quartzite, magnetic-quartzite, senicite-quartz-schist, epidiorite and other basic igneous rocks. The Archaean granites and gneisses with their bonds of Dharwar are capped by laterite at many places in the district.

Climate and Rainfall

The climate of the district is generally agreeable. The year is divided into four seasons viz.,

1. Summer season from March to May;
2. South-West monsoon season from June to September;
3. Post-monsoon season from October to November; and
4. Cold season from December to February.

The temperature increases steadily from the end of February till May. April and May are the hottest months with the mean temperature at about 32° to 33°C. The relative humidity is generally high throughout the year and particularly during South-West monsoon season. The sky is mainly clear or lightly clouded in the period from December to February. The cloudiness gradually increases from March till the end of September. Winds are light to moderate with slight strengthening in the mornings and blow from the directions South-West and North-West.

The drainage area of the district is mainly influenced by South-West monsoon. The 101-years (1903-2003) average annual rainfall of the district is 2947.6 mm. The recorded monthly maximum and minimum rainfall of the district during the monsoon period is as follows :

Months	Monthly Maximum (mm)	Monthly Minimum (mm)
June	2233.5	4.9
July	2722.1	21.4
August	2101.1	13.0
September	2183.6	15.3
October	2560.0	2.0

Drainage

The major rivers of the district are Kali, Bedthi, Aghanashini and Sharavathy. All the above rivers are west flowing with huge quantities of flows during the monsoon period. The drainage network is dense.

Projects

Bachanki medium irrigation project and Kali hydro-electric power projects such as Bommanahalli, Thattehalla and Supa are in Uttara Kannada district.

SALIENT FEATURES AND WATERSHEDS (UP TO MICRO-WATERSHED) OF UTTARA KANNADA DISTRICT

The district lies in the water resource regions, the Arabian Sea (Region 5) and the Bay of Bengal (Region 4). Region 5 covering more than 75% of the district area is drained by Sharavathy to Tapti and Cape Comorin to Sharavathy basins. Region 4 is drained by Krishna basin. They are further delineated into 3 catchments, 4 sub-catchments and 16 watersheds. These 16 watersheds have been further delineated into 202 sub-watersheds, 432 mini-watersheds and 2085 micro-watersheds. The details are given in Table 33. In Region 5 of the district, the average area of the micro-watershed is 491.95 ha. and Mulakong (5B1A5Q2e) is the biggest micro-watershed with an area of 2154.91 ha.

In Region 4 of the district, the average area of the micro-watershed is 413.07 ha. and Hosakoppa (4D4A6G1h) is the biggest micro-watershed with an area of 888.67 ha.

**Table : 33 Watershed Details (up to Micro-watershed) of
Uttara Kannada District**

Hydrological Units	Total Nos.	Name			
Region	2	Arabian Sea (5)			Bay of Bengal (4)
Basin	3	Cape Comorin to Sharavathy (5A)	Sharavathy to Tapti (5B)		Krishna (4D)
Catchment	3	Mahe to Sharavathy (5A3)	Sharavathy to Savithri (5B1)		Upper Tunga beyond reservoir (4D4)
Sub-catchment	4	Sita to Sharavathy (5A3C)	Kalinadi to Vaghotan (5B1B)	Sharavathy to Kalinadi (5B1A)	Misc. LB Lower Parts Varada (4D4A)
Watershed	16	Swarna (5A3C4)	Mandavi (5B1B3)	Bedthi1 (5B1A4)	Dandavathy (4D4A7)
		Venkatapura River (5A3C3)	Rachol (5B1B2)	Bedthi2 (5B1A3)	Dharma (4D4A6)
			Sal (5B1B1)	Dogi (5B1A7)	Mavinahole, Varada (4D4A8)
				Gangavally (5B1A2)	
				Kalinadi1 (5B1A6)	
				Kalinadi2 (5B1A5)	
				Kaneri, Barchi, Nagi (5B1A8)	
				Tadri (5B1A1)	
Sub-watershed	202	25	9	148	
Mini-watershed	432	52	12	330	38
Micro-watershed	2085	247	37	1641	160

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