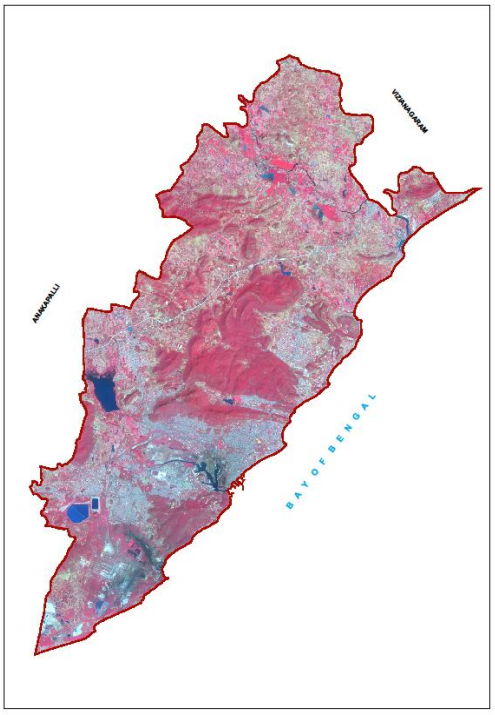
DISTRICT SURVEY REPORT
FOR
SAND AND OTHER MINOR MINERALS
VISAKHAPATNAM DISTRICT, ANDHRA PRADESH

(FOR THE DEPARTMENT OF MINES AND GEOLOGY, GOVT. OF AP)

As per Notification No. S.O. 141 (E), 15.01.2016, S.O. 3611(E), 25.07.2018, and Enforcement and Monitoring Guidelines for Sand Mining 2020 of MOEF and CC, GoI



Prepared by

ANDHRA PRADESH SPACE APPLICATIONS CENTRE (APSAC)
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Submitted to

DEPARTMENT OF MINES AND GEOLOGY
Government of Andhra Pradesh

December 2023

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Report Scrutiny Mechanism

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PREFACE

The Natural resource inventory is the assessment of the status of a given natural resource of an area at a given point in time. Population pressure results in over- exploitation of resources. The baseline information on the resources would help the administration for better planning and decision making. The main purpose of the report is to disseminate data on the natural resource up to the lowest administrative functionary to facilitate micro level planning and development. The efforts have been made to assess and document the information on land use/land cover, crop, surface water resource, soils, slope, groundwater prospects, groundwater quality, geological information, and minerals resources in Visakhapatnam district, Andhra Pradesh, based on the satellite remote sensing data and socioeconomic information.

The Department of Mines and Geology (DMG), Government of Andhra Pradesh (AP) requested the Andhra Pradesh Space Applications Center (APSAC) to update the district survey reports with availability of sand mineral information, major and minor mineral details, and river morphology for all the districts in the State. The District Survey report emphasizes and updated the major and minor minerals in the districts of AP. The District Survey reports are updated following the "Sustainable Sand Mining guidelines" issued in 2016 and 2020 and SO 741of 2016 of the Ministry of Environment, Forests and Climate Change provided by the DMG. The comments received from the public, if found fit, shall be incorporated in the report. A list of leases in the district will be provided by the concerned Assistant Directors of Mines and Geology.

The report is an outcome of the efforts of the Scientists and Project Associates at APSAC. I heartily congratulate the team for compiling the report.

(Dr.Sundar Balakrishna, IFS)
Vice-Chairman
APSAC

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We are grateful to the **Sri. V.G. Venkata Reddy**, **Director**, Department of Mines and Geology, Govt. of Andhra Pradesh for entrusting the work for the preparation of District Survey Reports of Andhra Pradesh.

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We are also thankful to the **District Mines and Geology Officer,** Visakhapatnam District for their support in providing information

Our sincere thanks are due to the scientific staff of APSAC who has generated all the thematic maps for District Survey Reports.

APSAC

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List of Abbreviations

APSAC	: Andhra Pradesh Space Applications Centre
APMMC	: Andhra Pradesh Minor Mineral Concession
AMSL	: Above Mean Sea Level
AWiFS	: Advanced Wide Field Sensor
APWALTA	: Andhra Pradesh State Water, Land and Trees Authority
APMDC	: Andhra Pradesh Mineral Development Corporation
Bgl	: Below ground level
BT Road	: Bituminous Road
Cl	: Chlorine
CC Road	: Cement concrete
CRZ	: Coastal Regulatory Zone
CPSU	: Central Public Sector Undertaking
CGWB	: Central Ground Water Board
cu.m/day	: Cubic meter per day
DMF	: District Mineral Fund
DSR	: District Survey Report
DMG	: Directorate of Mines and Geology
DM&GO	: District Mines and Geology Officer
DES	: Directorate of Economics and Statistics
DEM	: Digital Elevation Model
dS/m	: Decisiemens per meter
EIA/EMP	: Environmental Impact Assessment
F	: Fluorine
FAC	: Full Additional Charge
FASAL	: Forecasting Agricultural output using Space, Agrometeorology and Land-based observations
Fe	: Iron
Ft	: feet
GD	: Geosciences Division
GIS	: Geographical Information System
GSI	: Geological Survey of India
Ha	: Hectare
Km	: Kilometre
IRS	: Indian Remote Sensing Satellite
ITE and C	: Information Technology Electronics and Communications
LISS	: Linear Imaging Self Scanning
LULC	: Land Use / Land Cover

Lps	: Litres per second
M	: meter
Mi	: mile
mm	: millimetre
MT	: Million Tonne
MERIT	: Mineral Exploration Research Innovation Trust Fund
MoEF	: Ministry of Environment and Forests
MSL	: Mean Sea Level
NIRD	: National Institute of Rural Development
NH	: National Highway
$NaNO_3$	: Sodium nitrate
NRSA	: National Remote Sensing Agency
NRSC	: National Remote Sensing Centre
PESA	: Panchayats Extension to Scheduled Areas
pH	: Power of hydrogen
PSD	: Performance Security Deposit
PSU	: Public sector Undertakings
R2	: ResourceSat-2
RGNDWM	: Rajiv Gandhi National Drinking Water Mission
RWS and S	: Rural Water Supply and Sanitation
SAR	: Synthetic Aperture Radar
SEB	: Special Enforcement Bureau
SO_4	: Sulfate
Sq.Km	: Square Kilometre
Sq.m	: Square metre
TA	: Tantalum
TIN	:Triangular Irregular Network
TGA	: Total Geographical Area
TIS	: Tank Information System
TTD	: Tirumala Tirupati Devasthanams
WBM	: Water Bound Macadam

Chapter I – Introduction &General Profile

1.1 Administrative Setup

Visakhapatnam district is one of the districts in Uttarandhra in the state of Andhra Pradesh established on 4th April 2022 to become one of the resultant districts. The administrative headquarter is Visakhapatnam.

Geographically, Visakhapatnam district is bounded to the north by the Vizianagaram district, south by the Bay of Bengal, west by the Anakapalli district and east by the Bay of Bengal. The total geographical area of the district is 993.38 Sq.km. It is covered with 2 Revenue divisions namely Visakhapatnam and Bheemunipatnam: 11 Revenue mandals and 156 Revenue villages. Anandapuram mandal is having maximum number of villages (33) and Seethammadara mandals having minimum number of villages each (2). Out of 11 mandals of the district, the maximum area (185.71 Sq.km) is occupied by Anandapuram mandal and minimum area in Seethammadara mandal (3.95 Sq.km).

The mandals covered in each Revenue division are shown in Table-1 and its spatial distribution is shown in the Figure-1.

Table 1 List of mandals covered in each Revenue division

Bheemunipatnam Division	Visakhapatnam Division
Anandapuram	Gajuwaka
Bheemunipatnam	Gopalapatnam
Padmanabham	Maharanipeta
-	Mulagada
-	Pedagantyada
-	Pendurthi
-	Seethammadara
-	Visakhapatnam

Data Source: APSAC, Vijayawada.

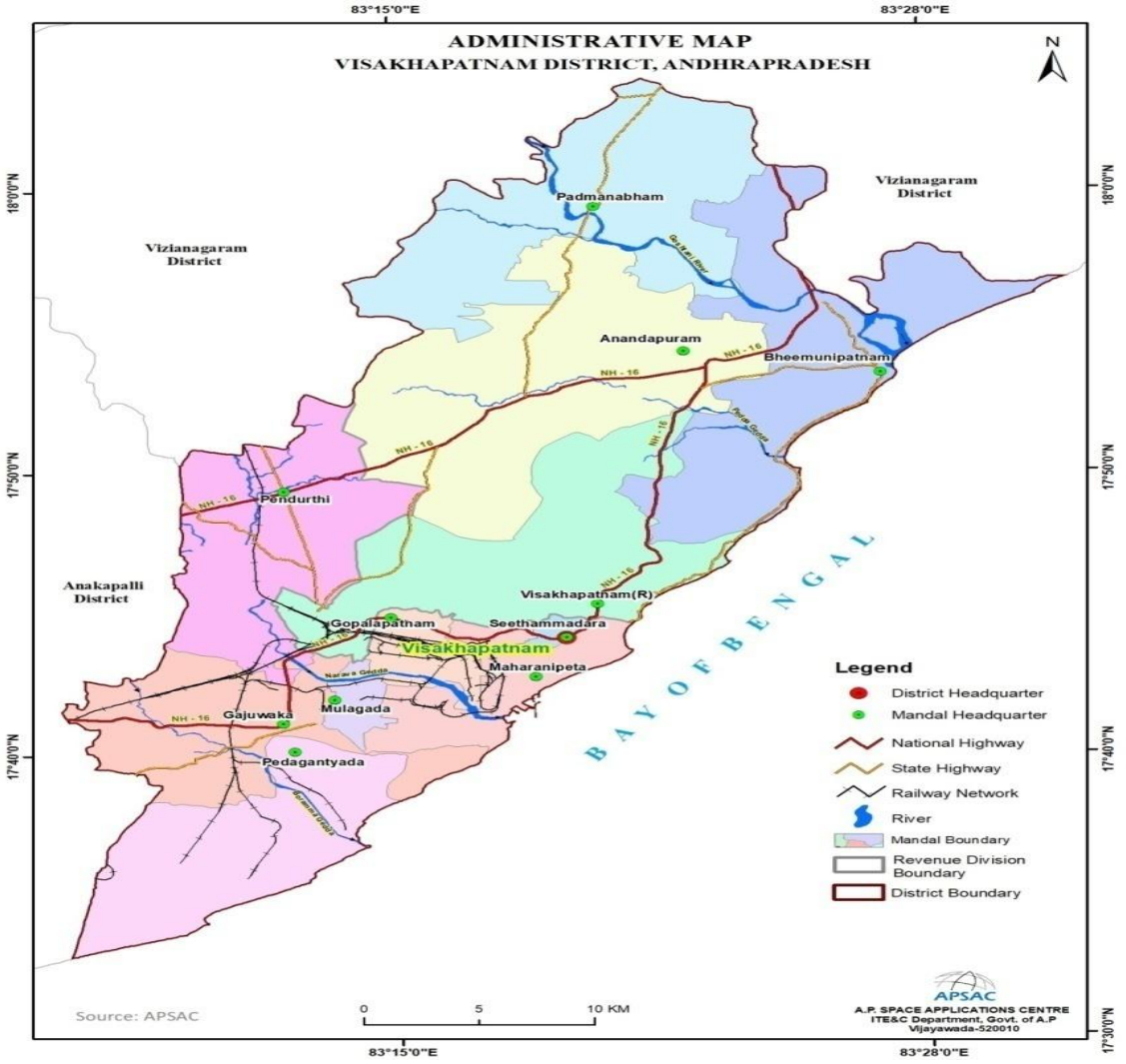

Figure-1: Administrative Map of Visakhapatnam district, Andhra Pradesh

1.2 Physiography

Visakhapatnam district is an undulated terrain and is having major two distinct Geographic divisions. The plains division consists of the strip of the land along the coast and the interior is of hilly area belonging to the Eastern Ghats. On the east it is bounded by Bay of Bengal. It appears like a stretch along the coastal belt with prominent geological features like Yerramattidibbalu.

1.2.1 Relief

The slope distribution clearly shows that the district terrain is undulating Figure-2 and slopes are ranging from nearly level to very steep. The nearly level sloping areas are found in the plains and valley portions of the district along with very gently sloping areas. Nearly level and very gently sloping areas account for approximately 19% and 38% of the district's total geographical area, respectively. The gently sloping area is distributed along the scrubs and forests, which account for 17% of the total district area. The remaining slope classes, which include those that are moderately, strongly, moderately steep to steep, and very steeply sloping, contribute 5%, 8%, 6%, and 7%, respectively. Very steep slopes are observed at the peak of the hills and are concentrated more in the west and southern parts of the district.

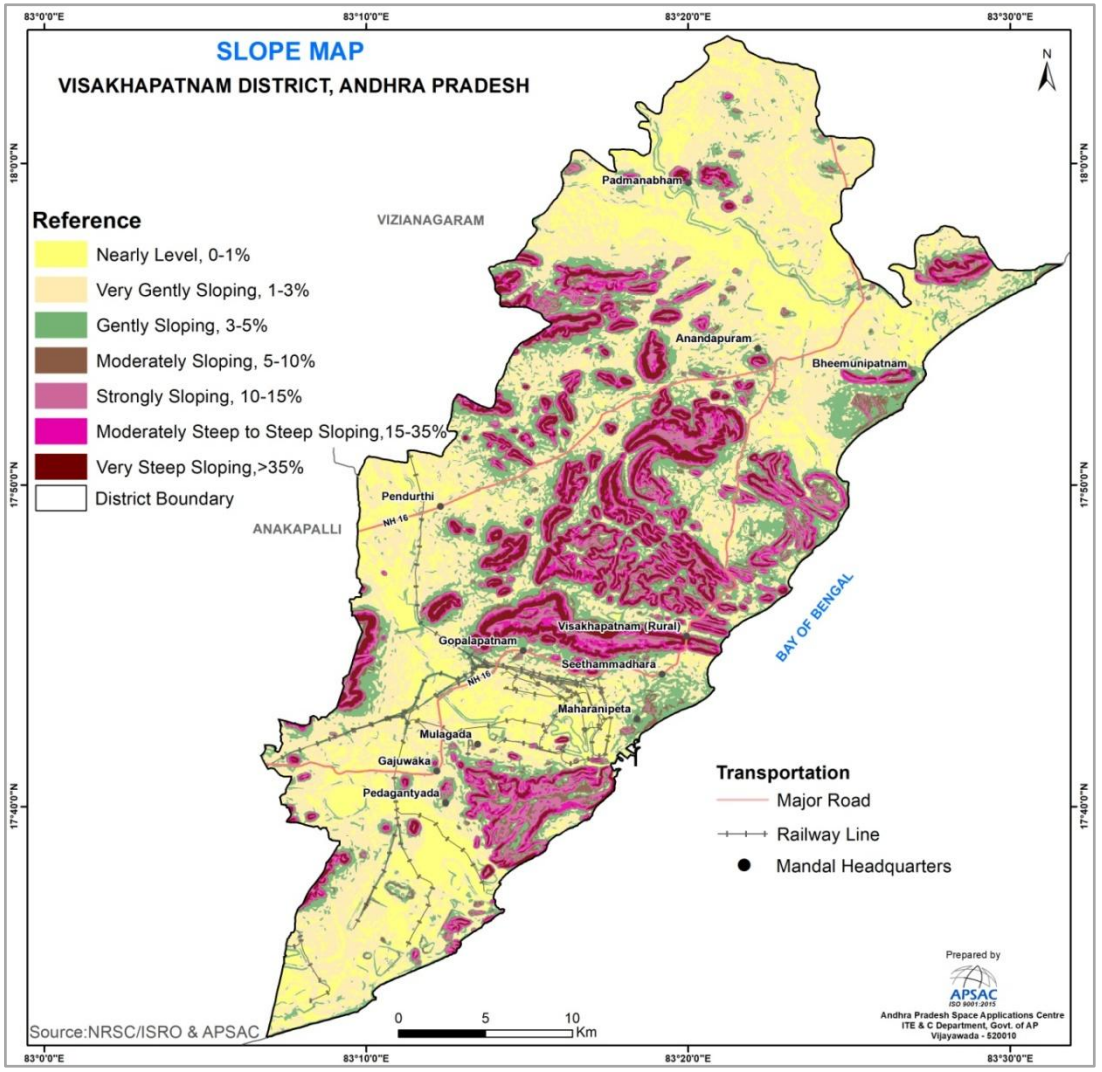

Figure-2: Slope Map of Visakhapatnam District

1.2.2 Climate & Rainfall

1.2.2.1. Climate:

Visakhapatnam has a tropical wet and dry climate (Köppen Aw). The annual mean temperatures range between 24.7–30.6° C, with the maximum in May and the minimum in January; the minimum temperatures range between 20–27° C. The climate of the district is varied and has differing climatic conditions in different parts. Near the coast, the air is humid and moist and relaxing, but gets warmer towards the interior and cools down in the hilly areas on account of elevation and dense vegetation. April to June is the warmest months. The temperature (at Visakhapatnam Airport) decreases with the onset of Southwest monsoon and tumbles to a mean minimum of 21.0° C by December after which there is a reversal trend till the temperature reaches a mean maximum of 32.6° C by the end of May during the year 2006-2007. Summers season in Visakhapatnam is are from March to May and during this time, humidity is high and the temperature reaches up to 45° C and above. The maximum and minimum temperatures 18° C and 36.2° C are recorded in the month of May and December respectively. The Automatic weather stations (AWS) are established at all mandals by A.P. State Developmental Planning Society (APSDPS), Planning Department, and Govt. of A.P. The locations Automatic Weather Stations (AWS) in Visakhapatnam District shown in Figure-3.

1.2.2.2. Rainfall:

The average annual rainfall of the district is 1024.72mm, of which 608.13 mm falls as South-West (June-September) monsoon and 303.37 mm as North-East (October-December) monsoon. The mean minimum and maximum temperatures recorded in the district are 18° C and 36.2° C in May, respectively. The average annual rainfall for the last 25 years is used for the analysis. The average annual rainfall is shown in Figure-4 and details are given in Table-2.

Table 2 Average Annual Rainfall (mm) in the district, during the year 1999-2021

S.No	Month	Average Annual Rainfall (mm)
1	January	5.81
2	February	13.33
3	March	10.77
4	April	22.43
5	May	60.89
6	June	124.70
7	July	129.94
8	August	160.90
9	September	192.59
10	October	199.49
11	November	88.30
12	December	15.57
	Total	**1024.72**

Data source: AWS & APSDPS, Planning Dept., Vijayawada

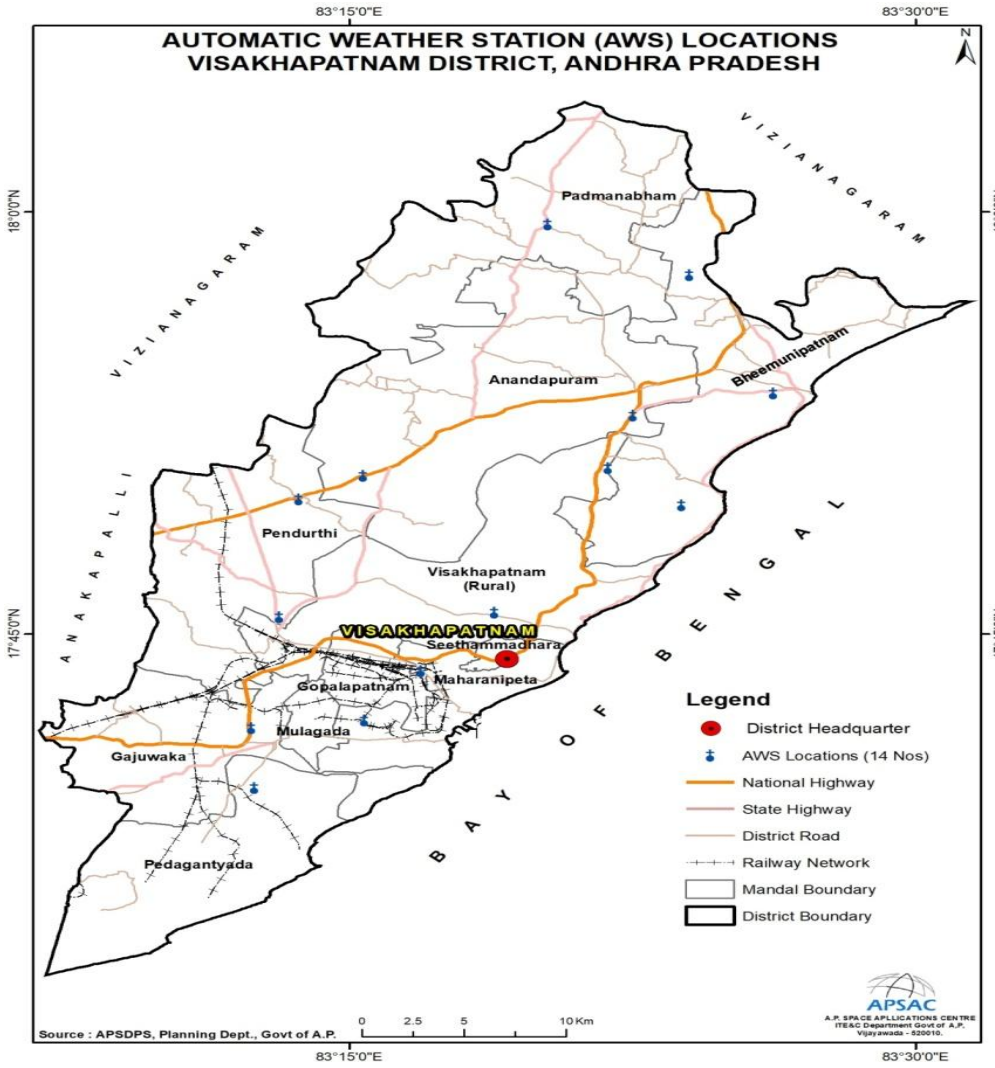

Figure-3: Locations of Automatic Weather Stations (AWS) in Visakhapatnam District

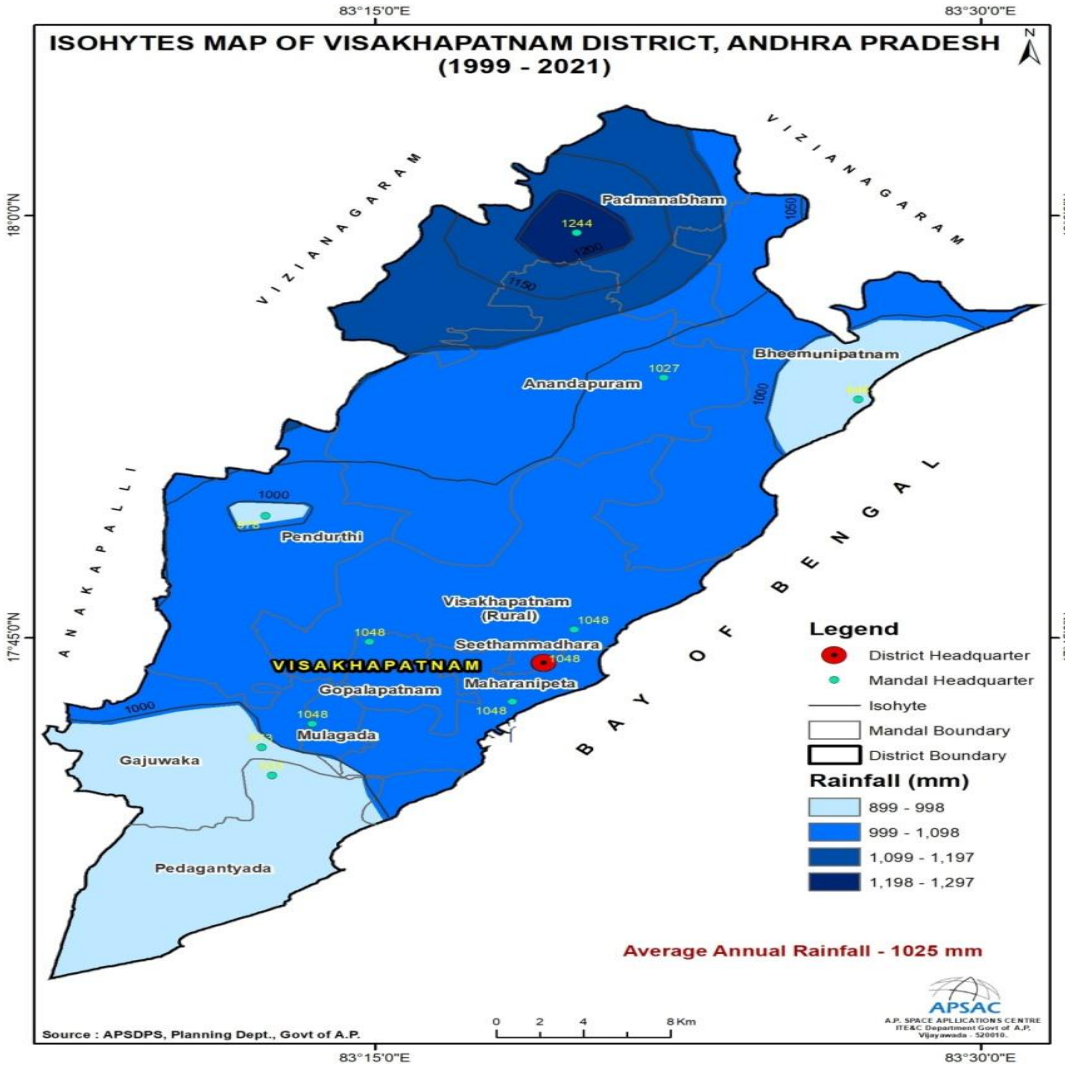

Figure-4: Rainfall distribution in Visakhapatnam District

1.2.3 Drainage

There are four rivers draining the district, viz. Gosthani, Naravagedda, Pedda Gedda and Borramma Gedda. They originate in the Eastern Ghats and after flowing through the district, finally joining Bay of Bengal. The drainage pattern is mainly sub-dendritic to dendritic type. The Meghadrigedda reservoir supplies around 8 million gallons/day of water to the needs of Visakhapatnam city for domestic and industrial purposes.

1.3 Population and Literacy

1.3.1. Population:

The total population of the district is 19,59,544; of which male and female are 9,88,393 and 9,71,151 respectively as per the 2011 census of India. Among all mandals, Visakhapatnam(U) mandal is having maximum population of 9,77,771; whereas Padmanabham mandal is having minimum population of 52,079.

The total schedule caste (SC) population in the district is 1,67,272; of which male and female are 83,331 and 83,941 respectively. The schedule tribe (ST) population is 22,574; of which male and female are 11,626 and 10,948 respectively. The mandal wise population is shown in the Table-3, The mandal wise spatial distribution of total population is depicted in theFigure-5.

1.3.2. Literacy:

The total literacy in the district is 13,98,807; of which male and female are 7,55,546 and 6,43,261 respectively. The total illiterates is 5,60,737; of which male and female are 2,32,847 and 3,27,890 respectively, as per the 2011 census of India.

1.3.3. Details of the Occupational Health issues in the District (Last five-year data of number of patients of Silicosis): No cases were reported during last 5 years due to mining activity.

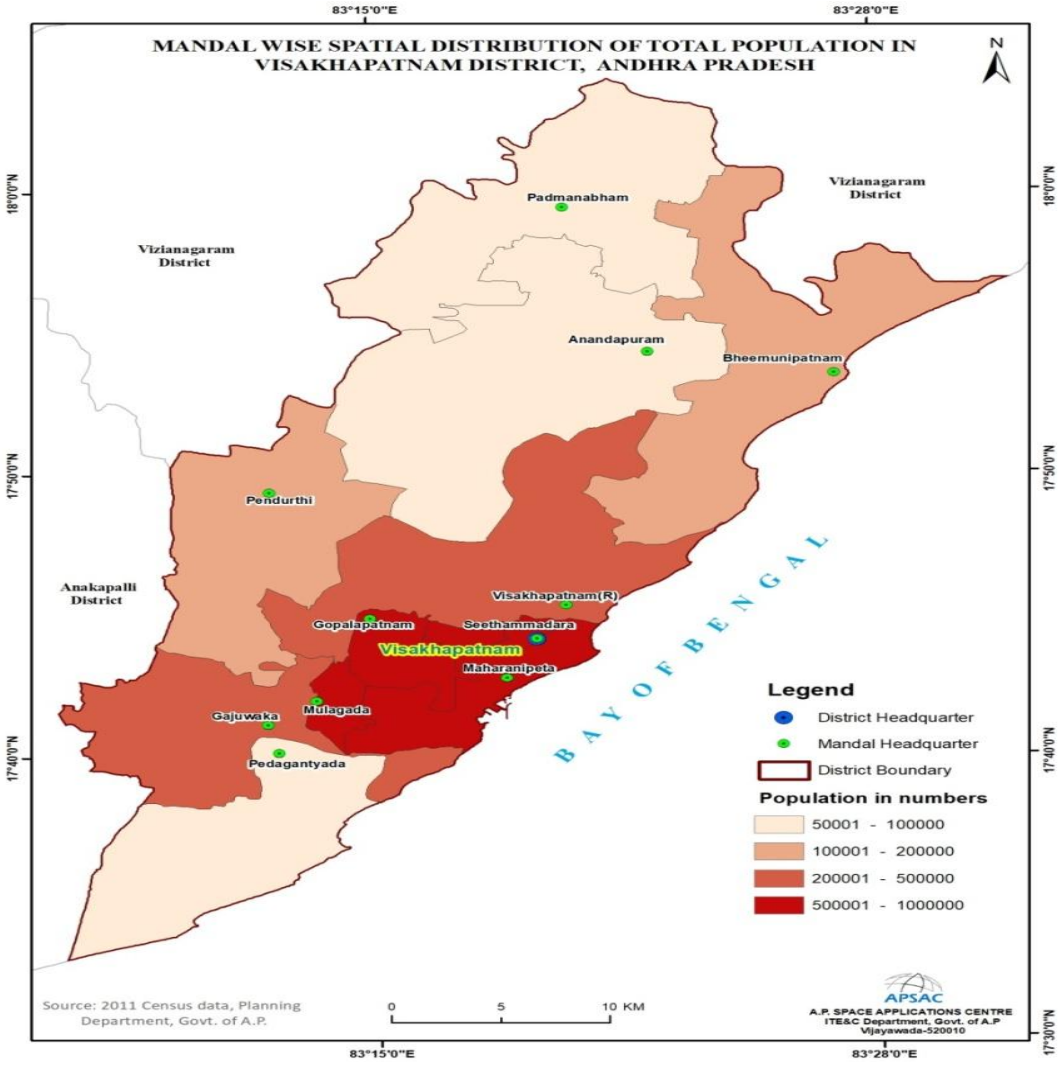

Figure-5: Mandal wise Spatial Distribution of Population in Visakhapatnam district, Andhra Pradesh

Table 3 Population Statistics Summary of 2011 Census

S.No	Mandal Name	Total House Holds	Total Population	Total Male Population	Total Female Population	Total SC Population	Male SC Population	Female SC Population	Total ST Population	Male ST Population	Female ST Population
1	Anandapuram	15265	60789	30739	30050	5273	2651	2622	1119	558	561
2	Bheemunipatnam	28364	116349	57408	58941	9775	4823	4952	412	195	217
3	Gajuwaka	63788	250423	127577	122846	16325	8287	8038	4098	2137	1961
4	Padmanabham	13274	52079	25946	26133	5227	2616	2611	253	127	126
5	Pedagantyada	24025	95291	48797	46494	3865	1950	1915	1126	623	503
6	Pendurthi	37440	146650	73434	73216	9381	4673	4708	1684	830	854
7	Visakhapatnam(R)	66573	260192	131477	128715	24465	12263	12202	4068	2135	1933
8	Visakhapatnam(U)	248162	977771	493015	484756	92961	46068	46893	9814	5021	4793
Grand Total		**496891**	**1959544**	**988393**	**971151**	**167272**	**83331**	**83941**	**22574**	**11626**	**10948**

Data Source: 2011 Census data, Planning Department & DES.

Table 4 Literacy statistics summary of 2011 Census

S.No	Mandal Name	Total Literacy	Male Literacy	Female Literacy	Total Illiterates	Male Illiterates	Female Illiterates
1	Anandapuram	29497	17057	12440	31292	13682	17610
2	Bheemunipatnam	68663	36999	31664	47686	20409	27277
3	Gajuwaka	184847	100508	84339	65576	27069	38507
4	Padmanabham	23512	13504	10008	28567	12442	16125
5	Pedagantyada	63106	35845	27261	32185	12952	19233
6	Pendurthi	105069	56935	48134	41581	16499	25082
7	Visakhapatnam(R)	184699	100052	84647	75493	31425	44068
8	Visakhapatnam(U)	739414	394646	344768	238357	98369	139988
Grand Total		**1398807**	**755546**	**643261**	**560737**	**232847**	**327890**

Data Source: 2011 Census data, Planning Department & DES

1.4 Land Utilization Pattern

1.4.1 Land Use / Land Cover

The Land Use / Land Cover (LULC) pattern of any region is an outcome of various physical and cultural factors and their utilization by man in time and space. Land use refers to the type of utilization to which man has put the land. It also refers to the evaluation of the land with respect to various natural characteristics. But land cover describes the vegetal attributes of the land. Land use/land cover data is essential for planners, decision-makers, and those concerned with land resource management. For the proper understanding of the influence of the various human-induced land-use practices with regard to environmental change, it is essential to help simulate the land-use changes. Remote sensing technology is considered the most effective as it provides timely and authentic information about the spatial distribution of land use/land cover, while the Geographical Information System (GIS) provides a flexible digital environment for collecting, storing, visualizing, and analyzing spatial data. Remote sensing as a vital tool helps for rapid assessment and monitoring of a natural resource. When combined with GIS, it makes it possible to map land use/ land cover phenomena in detail for further planning, development, and decision-making, which is essential for meeting the increasing demands and welfare of the ever-growing population.

1.4.2 Spatial Distribution of Land Use / Land Cover

The major common LULC categories, including built-up (294.02 sq km), agriculture (420.09 sq km), forest (162.41 sq km), wastelands (116.09 sq km), wetlands (11.09 sq km), and water bodies (44.30 sq km), were identified and delineated using on-screen interpretation techniques. The study area has been divided into 31 LULC classes at the level III classification (NRSA, 2006). Agriculture land is the most prevalent, followed by built-up land. About 84% of the district's total land area is under agricultural land. The spatial distribution of land use / land cover map of Visakhapatnam district is presented in Figure-6 and the area statistics are shown in Table-5.

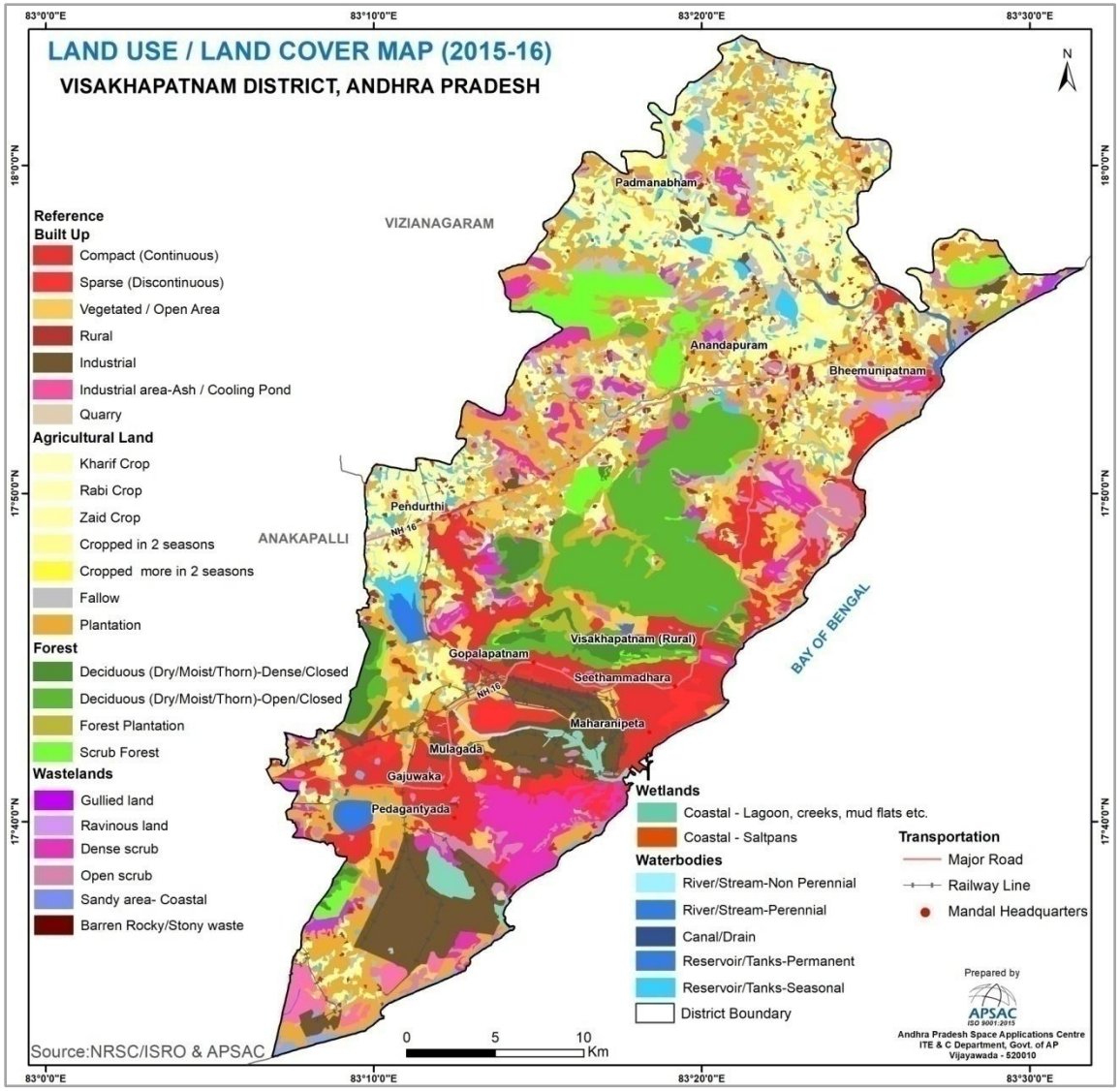

Figure-6: Land use / land cover map of Visakhapatnam District 2015-16

Table 5 Category-wise distributions of Land Use/Land Cover during 2015-16

S. No	LULC categories	Area in sq. km	% to total
Built up		**294.02**	**28.05**
1	Compact (Continuous)	101.25	9.66
2	Sparse (Discontinuous)	35.93	3.43
3	Vegetated / Open Area	53.88	5.14
4	Rural	17.91	1.71
5	Industrial	72.57	6.92
6	Industrial area-Ash / Cooling Pond	9.02	0.86
7	Quarry	3.46	0.33
Agricultural Land		**420.09**	**40.08**
8	Kharif Crop	95.46	9.11
9	Rabi Crop	12.85	1.23
10	Zaid Crop	0.90	0.09
11	Cropped in 2 seasons	85.07	8.12
12	Cropped more in 2 seasons	1.21	0.12
13	Fallow	48.23	4.60
14	Plantation	176.37	16.83
Forest		**162.41**	**15.50**
15	Deciduous (Dry/Moist/Thorn)-Dense/Closed	20.38	1.94
16	Deciduous (Dry/Moist/Thorn)-Open/Closed	89.00	8.49
17	Forest Plantation	16.49	1.57
18	Scrub Forest	36.55	3.49
Wastelands		**116.09**	**11.08**
19	Gullied land	9.06	0.86
20	Ravinous land	2.87	0.27
21	Dense scrub	55.03	5.25
22	Open scrub	39.68	3.79
23	Sandy area -Coastal	8.67	0.83
24	Barren Rocky/Stony waste	0.79	0.07
Wetlands		**11.09**	**1.06**
25	Coastal - Lagoon, creeks, mud flats etc.	10.14	0.97

26	Coastal - Saltpans	0.95	0.09
Water bodies		**44.30**	**4.23**
27	River/Stream-Perennial	3.90	0.37
28	River/Stream-Non Perennial	7.07	0.67
29	Canal/Drain	0.45	0.04
30	Reservoir/Tanks-Permanent	8.11	0.77
31	Reservoir/Tanks-Seasonal	24.77	2.36
Total		**1048.00**	**100.00**

Data source: NR Census 3rd cycle mapping, NRSC/ISRO & APSAC, GoAP

1.4.2.1. Built-up

These are the areas where people live, and they are supported by infrastructure such as buildings, roads, and other modes of transportation, as well as utilities linked to water, vegetation, and open spaces. It consists of built-up (Compact and Sparse), Vegetated / Open Area, Rural, Industrial, and Mining/Quarry. It occupies an area of 294.02 sq. km, which is about 28.05% of the total geographical area of the district. The built-up category includes district headquarters, some mandal headquarters, industrial areas, and rural settlement areas based on size and population. Many vacant lands with layouts and fencing are being developed for real estate development on the outskirts of Visakhapatnam, Bheemunipatnam, etc.

1.4.2.2. Built-up - Compact (Continuous)

Most of the land is covered by buildings, roads, and artificially surfaced areas and covers almost all the ground. The built-up-compact class is assigned where the impermeable surfaces such as the transportation network and urban structures take up more than 80% of the surface area. This category occupied 101.25 sq. km, which are found in Visakhapatnam and Bheemunipatnam municipalities.

1.4.2.3. Built-up - Sparse (Discontinuous)

The majority of the land is covered by structures such as buildings, roads, and artificially surfaced areas that are associated with vegetated areas and bare soil, occupying discontinuous but significant surfaces. Between 30 to 80 % of the total surface should be impermeable. This category delineates scattered blocks of residential flats, hamlets, and small villages. It covers an area of 35.93 sq. km and is in the fringe areas of Visakhapatnam and Bheemunipatnam.

1.4.2.4. Vegetated / Open Area

These are vegetated areas within an urban agglomeration (areas located within or adjacent to urban areas). The vegetation cover of trees, shrubs, and herbs has been delineated and covers the surface area. Open areas used as parks, sports, and leisure facilities, camping grounds, sports grounds, leisure parks, golf courses, and racecourses, including formal parks, etc are considered in this category. This category covers an area of 53.88 sq. km and is found in and around the towns of Visakhapatnam and Bheemunipatnam.

1.4.2.5. Built-up – Rural

These are lands used for human settlement of a size comparable to urban settlements, in which more than 80% of the people are engaged in primary agricultural activity and are associated with non-commercial and allied classes, and are classified as built-up (rural). The rural built-up area is the most prevalent of the built-up categories and is spread throughout the district. It contributed an area of 17.91 sq. km of the district's total geographical area.

1.4.2.6. Industrial

Non-linear impervious surfaces are included in this class, which is related to trade, manufacturing, distribution, and commerce. These are areas where human activity is observed in the form of manufacturing along with other supporting establishments for maintenance. The industrial area occupies an area of 72.57 sq. km, which is observed in and around the Greater Visakhapatnam Municipal Corporation (GVMC).

1.4.2.7. Industrial area-Ash / Cooling Pond

These are the portions of the industry which are used for temporary storage of ash, contaminated soil, rubble, cooling of hot water, or tailing ponds associated with the industry. The areas where industrial waste is permanently kept are categorized as other waste which is delineated under this category. A stockpile of a storage dump of industrial raw material or slag/effluents or waste material or quarried/mixed debris from the earth’s surface is considered under this category. It is observed that this category is found around the industrial areas with an area of 9.02 sq. km.

1.4.2.8. Quarry

These are manifestations of surface mining operations, which involve small-scale land surface excavation for quarries of quartzite, granite, sand, and other materials. They are primarily distinguished by their proximity to cities. It covers 3.46 sq. km and accounts for 0.33% of the district's total area.

1.4.2.9. Agricultural Land

Agriculture land is primarily used to produce food, fiber, and other commercial and horticultural crops. It includes land under crops, namely cropland, fallow land, agricultural plantations, and aquaculture. The district's economy is primarily based on agriculture, which was found to account for 420.09 sq. km (40.08%) of its total area during the period. Major food crops grown are Paddy, Black gram, Bengal gram, Red gram, Sugarcane, Chillies, Banana, Sapota, and Vegetables.

1.4.2.10. Kharif Crop

The agricultural area cultivated between June/July to September/October coinciding with the South-West monsoon season is considered as Kharif crop. It is associated with rain-fed crops under dry land farming with limited or no irrigation and areas of rain-fed paddy and other dry crops. Kharif cropland is the second-largest agricultural category, covering 95.46 sq. km (9.11%). During the Kharif season, a variety of crops including paddy, sugarcane, redg ram, cotton, groundnut, and others are widely grown in the district.

1.4.2.11. Rabi Crop

These areas are cultivated between November/December to February/March. It is associated with areas under assured irrigation irrespective of the source of irrigation. However, rain-fed areas with residual soil moisture, particularly in areas with black soil and high rainfall during the Kharif season, also have areas that are planted with Rabi crops. During the Rabi season, primarily irrigated crops like rice, sugarcane, and vegetables are grown using canals, tanks, and groundwater resources. In the years 2015–16, Rabi cropland covered 12.85 sq. km of the district total.

1.4.2.12. Zaid Crop

These are the cropped areas that are mostly associated with irrigated areas with fertile soils and are confined to plains and delta areas during the summer (April-May). Summer crops grown from April to June were mapped under Zaid cropland and occupied an area of 0.90 sq. km.

1.4.2.13. Cropped in two seasons

These are the cropping areas that are commonly associated with irrigated areas during the two cropping seasons. Three combinations are possible in this category viz., - Kharif + Rabi, Kharif + Zaid, and Rabi + Zaid. Cropped areas in any two seasons are mapped under cropped in the two seasons category, occupying an area of 85.07 sq. km (8.12%). These can be found

in the plains, with reliable irrigation provided by canals, tanks, and groundwater.

1.4.2.14. Cropped in more than two seasons

These are the areas that are cropped in more than two cropping seasons. It includes triple-cropped areas (Kharif, Rabi, and Zaid) under multiple cropping. Long-duration crops like sugarcane, cotton, banana, and tobacco are considered under this category. This category accounts for .21 sq. km of the district's total geographical area.

1.4.2.15. Fallow land

Fallow land is agricultural land that is used for cultivation but is temporarily allowed to rest or un-cropped for one or more seasons, but not less than a year and not more than five years. The fallow land covers an area of 48.23 sq. km and is devoid of crops during both cropping seasons for various reasons.

1.4.2.16. Agricultural Plantation

These are the areas where agricultural tree crops have been planted using agricultural management techniques. These also include the areas of land use systems and practices wherein the cultivation of herbs, shrubs, and vegetable crops are deliberately integrated with crops mostly in irrigated conditions for ecological and economic reasons. These areas can be distinguished from cropland, especially using data collected during the Rabi/Zaid season. Plantations appear in varying sizes with regular and sharp edges, indicating the presence of a fence around them. Plantations such as banana, cashew, eucalyptus, teak, and others are grown throughout the district. The plantations category accounts for 176.37 sq. km (16.83%) of the district's total geographical area.

1.4.2.17. Forest

The term forest is used to refer to land with a tree canopy cover of more than 30 percent and an area of more than 0.5 ha. Forest is determined both by the presence of trees and the absence of other predominant land uses within the notified forest boundaries. The trees should be able to reach a minimum height of 5 m within the notified forest boundaries. The forest area occupies an area of 162.41 sq. km (15.50%) and is found along central parts of the district where several forest species grow. The important species are teak, nalla maddi, rosewood, devadari, etc.

1.4.2.18. Deciduous (Dry/Moist/Thorn)-Dense

This category is predominantly composed of species, which shed their leaves once a year, especially during summer. These are mostly broad-leaved tropical forests with a tendency to shed their leaves annually. This category includes all the areas where the canopy cover/density is more than 40 % and contributed 20.38 sq. km in the district.

1.4.2.19. Deciduous (Dry/Moist/Thorn)-Open

This category is predominantly composed of species, which shed their leaves once a year, especially during summer. These are mostly broad-leaved tropical forests with a tendency to shed their leaves annually. This category includes all the forest areas where the canopy cover/density ranges between 10% - 40%. In addition to timber, these forests also contain a large variety of fauna like tigers, leopards, wolves, bears, etc. An area of 89.00 sq. km (8.49%) is attributed to this category.

1.4.2.20. Forest Plantation

These are the locations where important tree species for forestry are grown and managed, particularly in notified forest areas. The majority of these are found in uplands and coastal regions. Many of these can be identified based on the sharp boundaries exhibited by them. Forest plantations, mainly teak, bamboo, casuarinas, etc have been delineated with an area of 16.49 sq. km during the period.

1.4.2.21. Scrub Forest

These are the forest areas that are generally seen on the fringes of dense/open forest cover and settlements, where there is biotic and abiotic interference. Most times they are located closer to habitations. Forest blanks which are the openings amidst forest areas, devoid of tree cover, observed as openings of assorted sizes and shapes as manifested in the imagery are also included in this category. The scrub forests accounted for 36.55 sq. km (3.49%), which are generally prone to the conversion of forest plantations and other development activities within the notified forest.

1.4.2.22. Wastelands

Wasteland is described as degraded land which can be brought under vegetative cover with reasonable effort and which is currently underutilized and land which is deteriorating due to lack of appropriate water and soil management or on account of natural causes. Wastelands can result from inherent/imposed disabilities such as location, environment, chemical and physical properties of the soil, or financial or management constraints. During the study, the area under the wasteland category was mapped at

116.09 sq. km (11.08%), which includes the subcategories of gullied land, dense scrub, open scrub, coastal sand, and barren rocky/stony waste.

1.4.2.23. Gullied land

Gullies are formed because of localized surface run-off affecting the unconsolidated material resulting in the formation of perceptible channels causing the undulating terrain. Gullies develop from rills which are tiny water channels a few centimeters deep, formed as a resultant impact of heavy rainfall and the wearing action of runoff generated there from. They are commonly found on sloping lands, developed as a result of concentrated runoff. Further classification of this category is possible based on the depth, width, bed slope, frequency, and morphology of the bed material of the ravines. They appear in light yellow to bluish-green depending on the surface moisture and depth of erosion. They vary in size and shape with irregular broken network patterns. The gullied lands are mapped in the areas of pediment and the foothill zones, accounting for 9.06 sq. km (0.86%).

1.4.2.24. Ravinous land

The word ravine is usually associated not with an isolated gully but an intricate network of gullies formed generally in deep alluvium and entering a nearby river, flowing much lower than the surroundings. Ravines are extensive systems of gullies developed along the river course. It covers an area of 2.87 sq. km.

1.4.2.25. Dense scrub

The scrub is usually confined to topographically elevated areas, on the hill slopes generally surrounded by agricultural lands. These areas possess shallow and skeletal soils, at times chemically degraded, extremes of slopes, severely eroded, and lands subjected to excessive aridity with scrubs dominating the landscape. It is found with varying sizes of small to large areas having a contiguous or dispersed pattern. The dense scrub areas can be found in the district with moderate sloping areas. The area was mapped over 55.03 sq. km.

1.4.2.26. Open scrub

This category has a similar description as mentioned in the dense scrub except that they possess sparse vegetation or are devoid of scrub and have a thin soil cover. The open scrub areas are found at the foothills and moderate to gentle slopping areas are surrounded by agricultural lands. The area mapped under this category is about 39.68 sq. km in the district's western parts.

1.4.2.27. Coastal Sand

Coastal sands are the sands that are accumulated as a strip along the sea coast. Very high reflectance exhibited by this category, especially in the near-infrared region of the spectrum enables their separation from the salt-affected land. It is found along the coast and occupies an area of 8.67 sq. km (0.83%).

1.4.2.28. Barren Rocky/Stony waste

The barren rock exposures are especially confined to hilly terrain with down slopes with rock outcrops, stony waste, and fragments. Barren rocky areas have been observed as rocky outcrops in the forest and scrubland. It is found that most of the barren rocky areas are being quarried for various construction activities in the district. The area under this category is 0.79 sq. km and it occupies 0.07 % of the district.

1.4.2.29. Wetlands

All submerged or water-saturated lands, natural or man-made, inland or coastal, permanent or temporary, static or dynamic which necessarily have a land-water interface, are defined as wetlands. Hence, the portions of the water body (partial or full) having emergent vegetation or observable submerged vegetation is placed in the Wetlands category. The wetland category contributes 11.09 sq. km and is found along the coastal areas of the district.

1.4.2.30. Coastal - Lagoon, creeks, mud flats, etc.

These are the areas which are submerged by high tides at some stage of the annual tidal cycle. Non-wooded areas are tidally, seasonally, or permanently waterlogged with brackish or saline water. These include estuaries, lagoons, creeks, backwaters, bay tidal flat/mud flat, mangrove, salt marsh/marsh with vegetation and other hydrophytic vegetation. These contributed to an area of 10.14 sq. km.

1.4.2.31. Coastal - Saltpans

The saltpans are flat expanses of salt-covered land, usually white under the Sum. Saltpans are manmade saline ecosystems from which crude salt is extracted during summer. These are un-drained, usually small and shallow, natural depressions or hollows in which brackish water accumulates and evaporates leaving behind salt deposits. Only 0.95 sq. km of area is occupied by this category in the district along the coast.

1.4.2.32. Water Bodies

This category comprises areas with surface water, either impounded in the form of ponds, lakes, and reservoirs or flowing as streams, rivers, canals,

etc are delineated. These can be seen clearly in the satellite image in blue to dark blue or cyan depending on the depth of the water. This category includes rivers, streams, canals, lakes, ponds, reservoirs, and tanks. The total area of water bodies, including all sub-categories, is about 44.30 sq. km (4.23%).

1.4.2.33. River/Stream-Perennial

Rivers/streams are the natural course of water flowing on the land surface along a definite channel/slope regularly or intermittently towards a sea in most cases or a lake or an inland basin in desert areas or a marsh or another river. The rivers/streams that flow continuously throughout the year are considered as perennial. It contributes an area of 3.90 sq. km. The important river and rivulets in the district are the Gosthani. It is the largest river flowing through the district in the west-east direction.

1.4.2.34. River/Stream-Non Perennial

When the water covers the surface for less than nine months each year, it is considered non-perennial. This also includes the dry part of the river generally characterized by the presence of sand or exposed rocks. It contributes an area of 7.07 sq. km under this category.

1.4.2.35. Canal/Drain

Canals and drains are artificial watercourses constructed for irrigation, navigation or to drain out excess water from agricultural lands. It contributes an area of 0.45 sq. km.

1.4.2.36. Reservoir/Tanks-Permanent

The reservoir is an artificial lake created by the construction of a dam across the river specifically for hydel power generation, irrigation, and water supply for domestic/ industrial needs, and flood control, either singly or in combination. Tanks are small lakes of impounded waterways constructed on land surfaces for irrigation. They are associated with croplands, lowlands, and reservoirs surrounded by hills without vegetation. This includes all reservoirs/tanks with water spread seen at least during one season in a year is considered under the permanent category. The reservoir/tanks-permanent category was delineated with an area of 8.11 sq. km. These are one of the sources of irrigation and spread over the district. MeghadriGedda Reservoir, Mudasarlova Reservoir, and Gambhiramgedda Reservoirs are the main water sources of the district.

1.4.2.37. Reservoir/Tanks-Seasonal

Dry reservoirs/tanks are those which do not have water spread throughout the year and are considered seasonal. During the mapping period, where the water spread is not found in the three seasons, those areas are mapped in this category. Many of the tanks are found to be seasonal, with a total area of 24.77 sq. km.

1.4.3 Forest Cover Distribution

The forest cover maps were created by interpreting multiple sources of topographical maps and satellite data. Land with a tree canopy cover of more than 10% and a size of more than 0.5 ha is referred to as a forest. The forest is defined by the presence of trees and the absence of other dominant land uses within the notified forest boundaries. The trees should be able to reach a minimum height of 5 m within the notified forest boundaries. The spatial distribution of forest cover and its statistics are presented in Figure-7 and Table-6. As per the Forest Department, Government of Andhra Pradesh the Wildlife Sanctuary boundary map and Forest boundary map is presented in Figure-7A and Figure-8.

Table 6 Forest cover distribution in Visakhapatnam District

S. No	Forest Category	Area in sq. km	% to district total
1	Deciduous (Dry/Moist/Thorn)-Dense/Closed	20.38	1.94
2	Deciduous (Dry/Moist/Thorn)-Open/Closed	89.00	8.49
3	Forest Plantation	16.49	1.57
4	Scrub Forest	36.55	3.49
	Total	**162.41**	**15.50**

Data source: NR Census 3rd cycle mapping, NRSC/ISRO & APSAC, GoAP

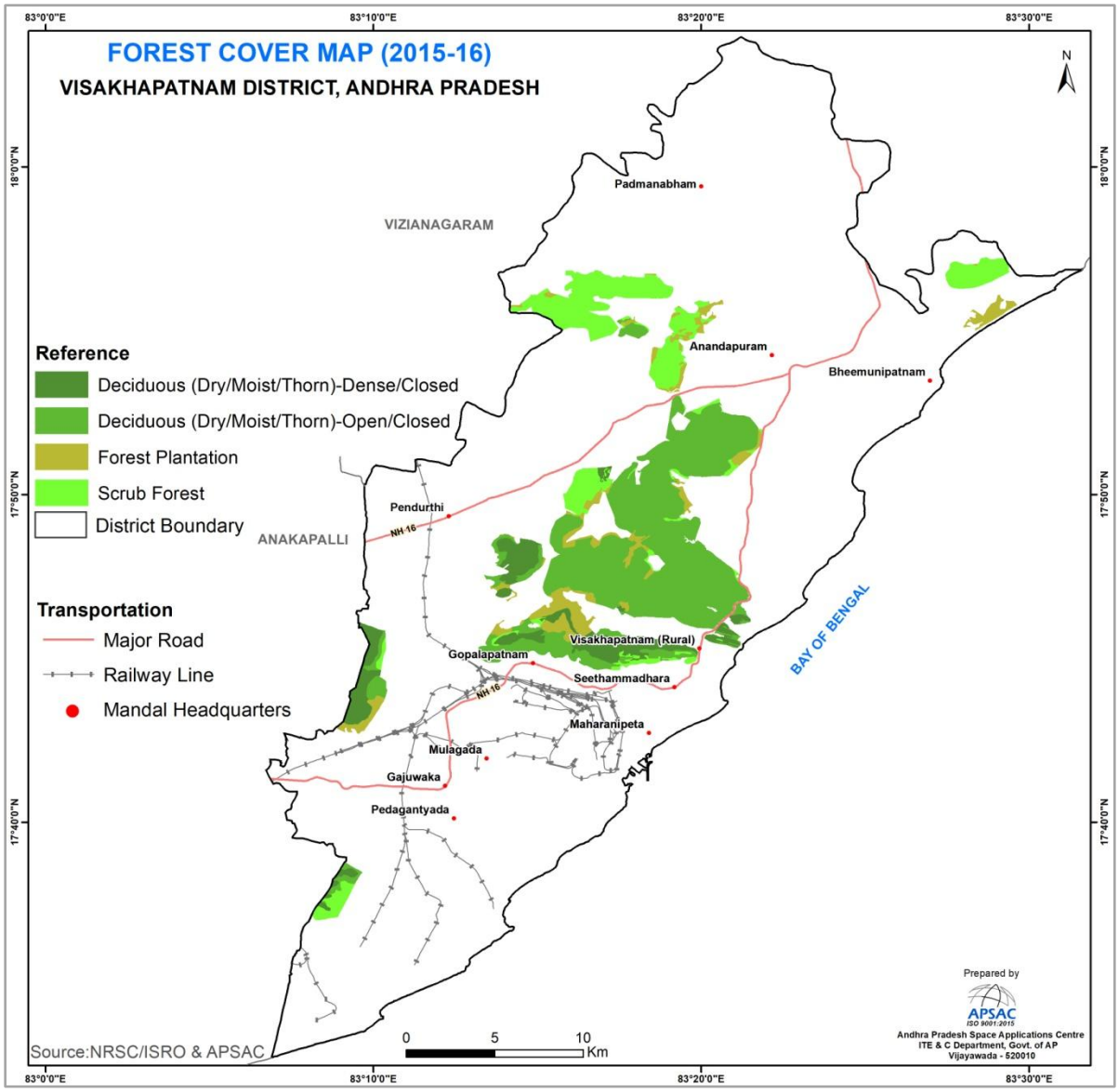

Figure-7: Forest cover map of Visakhapatnam District

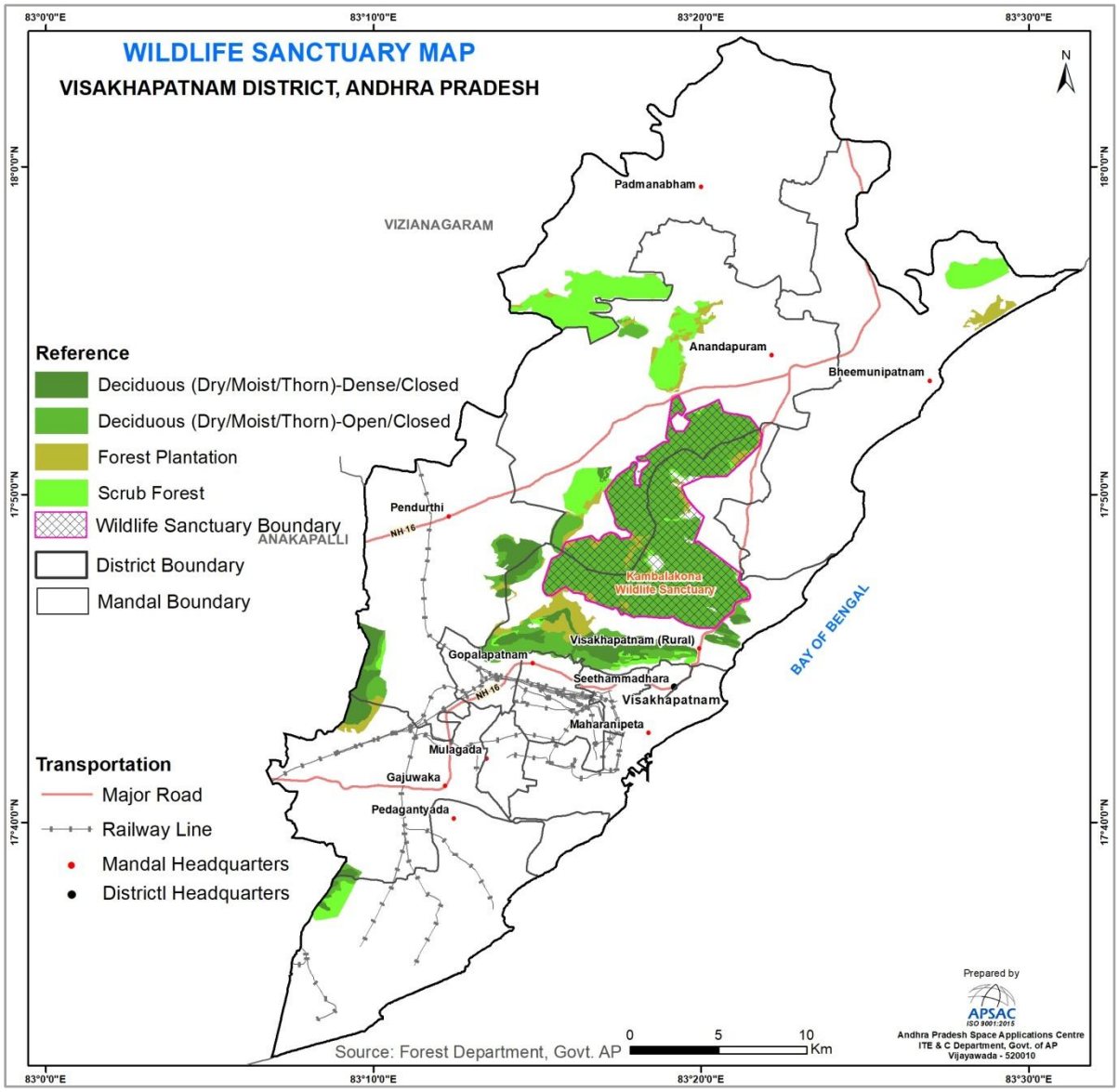

Figure-7A: Wildlife Sanctuary map of Visakhapatnam District

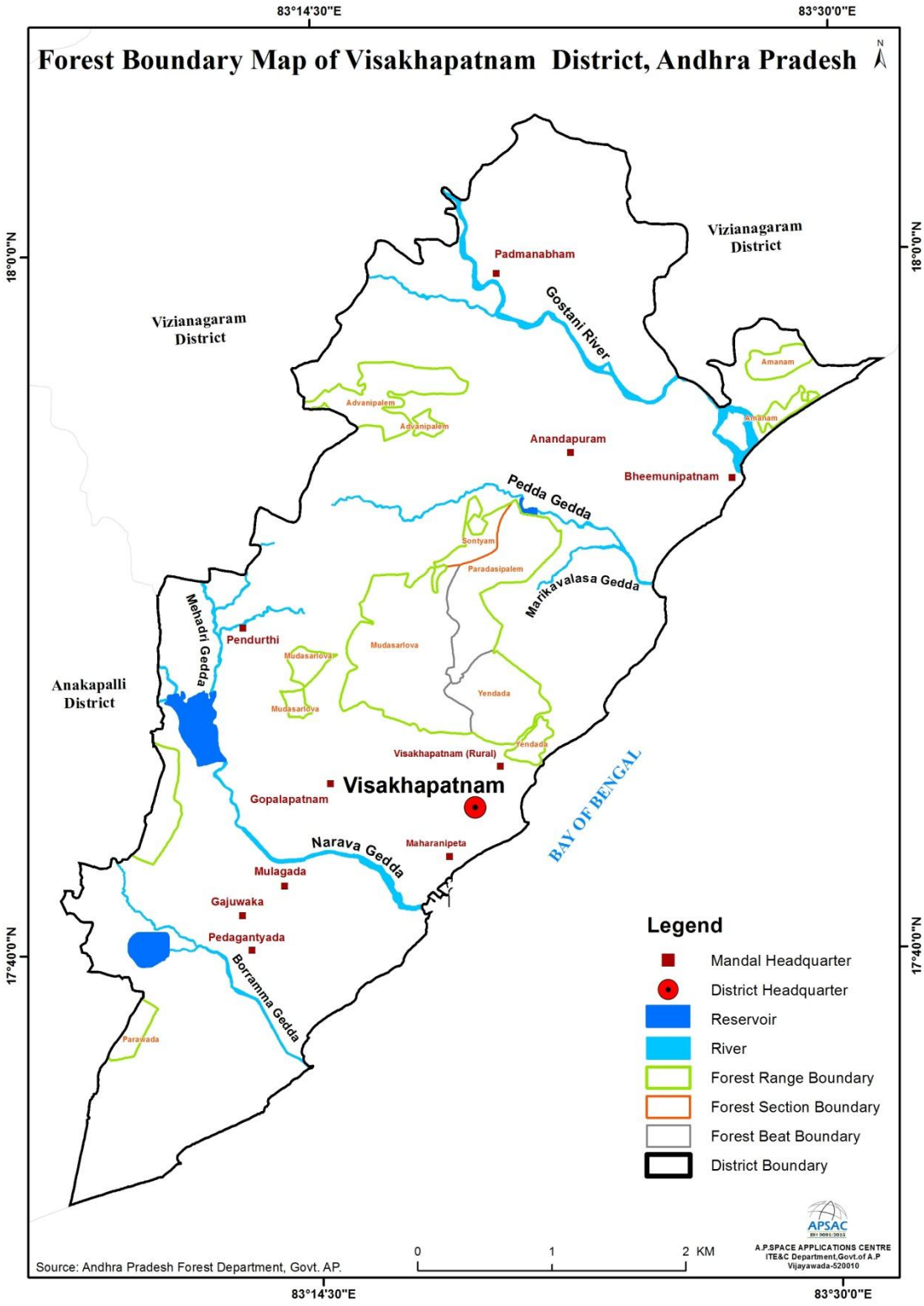

Figure-8: Forest boundary map of Visakhapatnam District

1.4.4 Agricultural Resources in Visakhapatnam District

Over the past two decades, APSAC has effectively employed remote sensing technology in agriculture, encompassing both spatial and temporal dimensions across various projects. The continuous evolution of satellite remote sensing technology has facilitated systematic monitoring of crop conditions and vigor across extensive regions. Within the realm of spectral vegetation indices derived from remote sensing data, the Normalized Difference Vegetation Index (NDVI) stands out as the most widely utilized for operational drought assessment. Its popularity stems from its straightforward calculation, ease of interpretation, and the capacity to mitigate the impacts of atmospheric conditions, illumination geometry, and other variables.

APSAC conducted in-season crop condition assessments at the Mandal level in Andhra Pradesh. This initiative aimed to provide administrators and planners with crucial insights for strategic decision-making regarding drought management, import-export policies, and trade negotiations. The NDVI is calculated using the formula (NIR–Red)/(NIR+Red), where NIR and Red represent the reflectance in the visible and near-infrared channels, respectively. Water, clouds, and snow exhibit higher reflectance in the visible region, causing NDVI to assume negative values for these features. Bare soil and rocks, with similar reflectance in both visible and near-infrared regions, yield index values close to zero. NDVI values for vegetation typically range from 0.2 to 0.6, with higher values associated with greater green leaf area and biomass. The Shortwave Infrared (SWIR) band is sensitive to soil and crop canopy moisture. Early in the cropping season, when soil background dominates, SWIR is sensitive to top 12 cm soil moisture. As crop growth progresses, SWIR becomes sensitive to leaf moisture content, providing surface wetness information.

The Normalized Difference Wetness Index (NDWI), computed using SWIR data, complements NDVI for drought assessment, especially in the early cropping season. NDWI is derived as follows: NDWI=(NIR-SWIR)/(NIR+SWIR), where NIR and SWIR represent reflected radiation in the Near-Infrared and Shortwave Infrared channels. Higher NDWI values indicate increased surface wetness.

For satellite-based crop condition anomalies indicating agricultural drought, the Vegetation Condition Index (VCI) of both NDVI and NDWI can be computed. When combining VCI values of NDVI and NDWI, the minimum of the two can be considered. For instance, if at least one is categorized as severe, the overall category is considered severe. If at least one is moderate, the overall category is taken as moderate. The vegetation conditions and corresponding ranges are detailed in Table-7.

Table 7 Vegetation condition and range in percentage

VCI range (%)	Vegetation Condition	Description
60-100	Normal	Crop condition is Normal
40-60	Moderate	Crop condition is Moderate
0-40	Severe	Crop condition is Severe

1.4.4.1 Kharif Crop Condition Assessment

Andhra Pradesh Space Applications Centre (APSAC) conducted a crop condition assessment in Visakhapatnam district during Kharif 2022-23 utilizing MODIS (Moderate Resolution Imaging Spectroradiometer) satellite data. The assessment revealed that the 07 mandals in the district were categorized as having a normal crop condition. Notably, urban and forest cover mandals were excluded from the vegetation condition assessment. This comprehensive evaluation provides valuable insights into the agricultural landscape of Visakhapatnam district, aiding in targeted interventions and resource allocation to mitigate the impacts of varying crop conditions.

1.4.4.2 Rabi Crop Condition Assessment

During Rabi 2022-23, The assessment identified 03 mandals with normal crop conditions, 01 mandal categorized as moderate, and 03 mandals categorized as severe. Notably, mandals predominantly covered by urban or forest areas were excluded from the vegetation condition assessment. This evaluation provides valuable insights into the agricultural status of Visakhapatnam district during the Rabi season, facilitating informed decision-making and resource allocation to support agricultural sustainability and productivity.

1.4.5 Soil Resources of the Visakhapatnam District

In Visakhapatnam district of Andhra Pradesh, various soil types are encountered. The most prevalent soil type is clayey to gravelly clayey moderately deep dark brown soils covering an area of 395.27 sq.km (40.11%). Following this, loamy to clayey skeletal deep reddish brown soils occupy 133.92 sq.km (13.59%), gravelly clayey moderately deep grassland soils cover 117.16 sq.km (11.89%), and fine loamy gravelly clayey shallow reddish brown soils span 108.44 sq.km (11%). Moderately deep calcareous black soils are found over an area of 91.35 sq.km (9.27%), very dark brown moderately deep wet silty soils cover 69.72 sq.km (7.07%), light gray deep sandy soils occupy 40.49 sq.km (4.11%), loamy to gravelly clay deep dark reddish brown soils span 23.1 sq.km (2.34%), and gravelly loamy moderately deep grassland soils cover 6.11 sq.km (0.62%). The soil resource map of the district is shown in Figure-9 and the soil category with area is shown in Table-8.

Table 8 Soil classes in Visakhapatnam district

S.No	Classification	Area in Sq.km	Percentage (%)
1	Clayey to gravelly clayey moderately deep dark brown soils	395.27	40.11
2	Fine loamy gravelly clayey shallow reddish brown soils	108.44	11.00
3	Gravelly clayey moderately deep grass land soils	117.16	11.89
4	Gravelly loamy moderately deep grass land soils	6.11	0.62
5	Light gray deep sandy soils	40.49	4.11
6	Loamy to clayey skeletal deep reddish brown soils	133.92	13.59
7	Loamy to gravelly clay deep dark reddish brown soils	23.1	2.34
8	Moderately deep calcareous black soils	91.35	9.27
9	Very dark brown moderately deep wet silty soils	69.72	7.07
	Total[#]	985.56	100.00

[#]*Excluding the Urban and Water bodies area*

Data Source: APSAC, Vijayawada

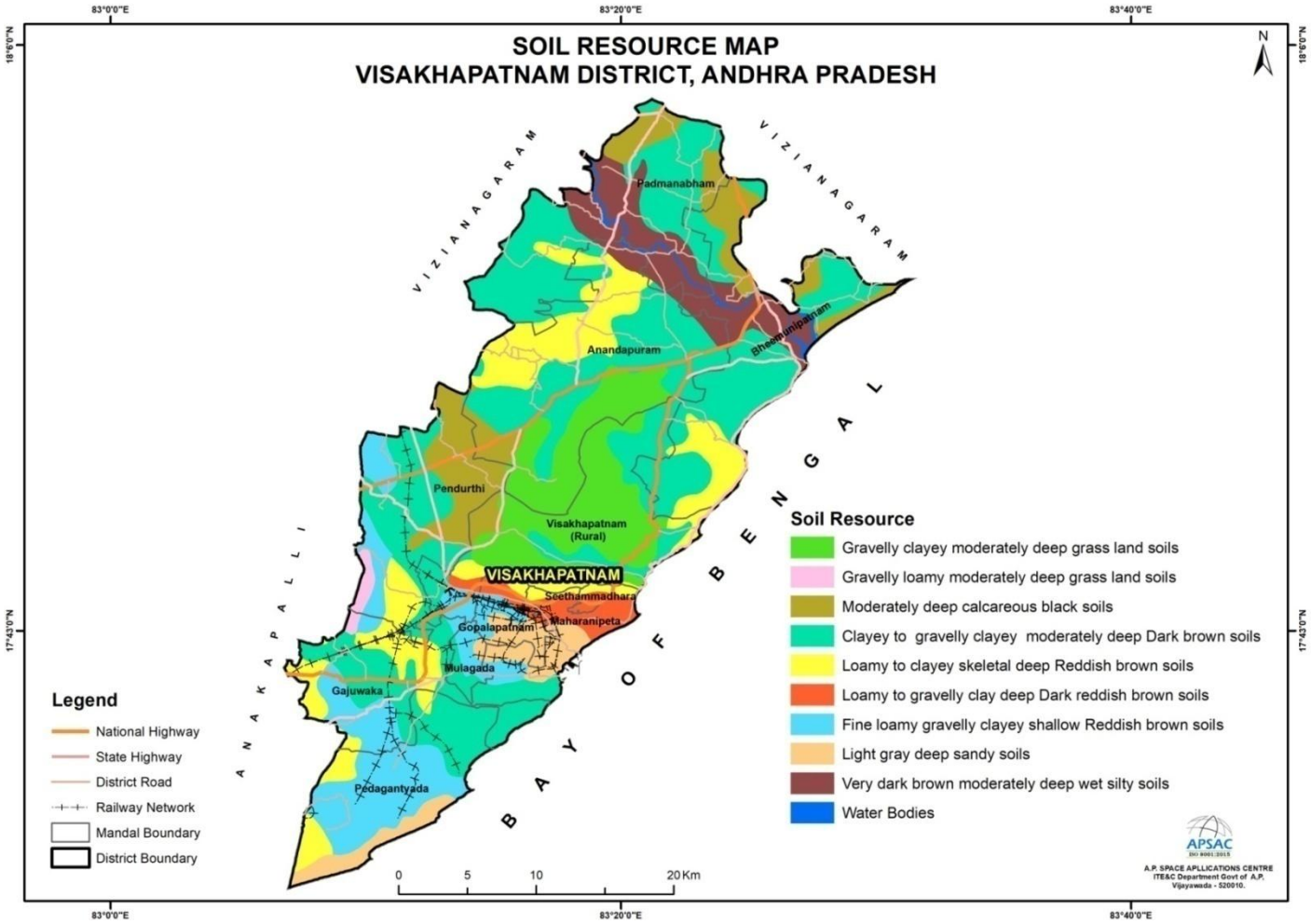

Figure-9: Soil resource map of Visakhapatnam District

1.4.6 Horticulture

Horticulture encompasses both the science and art of producing, utilizing, and enhancing various horticultural crops, including fruits, vegetables, spices, ornamental plants, plantation crops, medicinal herbs, and aromatic plants. It also involves activities such as plant conservation, landscape restoration, garden design, construction, maintenance, arboriculture, and the cultivation of ornamental trees and lawns.

In the Visakhapatnam district, mangoes dominate as the primary horticultural crop, cultivated across an area of 10.59 hectares, followed by coconut (2.54 hectares), banana (1.44 hectares), and mulberry (1.07 hectares). The total area dedicated to horticultural crops in the district amounts to 16.46 hectares. The crop-wise detail is shown in the Table-9.

Table 9 Area of horticultural crops in Visakhapatnam district

S.No	Crop	Area in ha
1	Papaya	0.82
2	Banana	1.44
3	Mangoes	10.59
4	Coconut	2.54
5	Mulberry	1.07
	Total Area	**16.46**

Source: Government of Andhra Pradesh RashtriyaKrishi Vikas Yojana-2022-23.

1.5 Ground Water Prospects in the District:

In a major part of the district within the Eastern Ghats Supergroup of rocks, groundwater is controlled by fractures. Its potentiality is high along these fractures, but low to moderate away from them. Permeability in these rocks ranges from 0.50 to 20 m/day, with a specific yield of 0.005 to 0.025 liters/second. Groundwater occurs at shallow depths in floodplains. However, its quality deteriorates in coastal plains, though potable water can be obtained from shallow depths in beach ridges.

Groundwater exists under water table conditions in weathered residuum, becoming semiconfined to confined in deeper fracture zones. The thickness of weathering varies from 4 to 20 meters. The weathered zone is porous, extending to deeper levels in Khondalites compared to other formations. Groundwater abstraction is primarily done through dug wells or shallow bore wells, with dug wells ranging from 2 to 22 meters below ground level and bore wells from 15 to 80 meters. Yields from bore wells range between 0.5 and 3 liters per second, with higher yields observed in Khondalites than in quartz-feldspathic gneisses and Charnockites. Unconsolidated sediments in the MVP area and sandy aquifers in the old city area serve as good aquifers, but groundwater development is limited to shallow zones only. In areas close to Kailasa hills and Waltair highlands, water levels are deeper. Groundwater exploitation is conducted through deep open wells and bore wells, with areas like MVP colony, Isukathota, parts of Lawson's Bay, and Mudusarlova Valley exhibiting good groundwater prospects. However, in industrial areas like R.Venkatapuram (L.G. Polymers), Mindi, and Chukkavanipalem (Hindustan Zinc Ltd.), groundwater is highly contaminated. Furthermore, in the port and surrounding areas, groundwater has been contaminated initially due to seawater and subsequently due to industrial effluents, while domestic pollution is high in urban residential localities.

The total groundwater resource of the district is approximately 114,150 hectares per meter (ha m). Its distribution is uneven, with the hard rock hilly regions in the north having very low resources, while the southern alluvial plains are better endowed. The groundwater resource is equivalent to 9 percent of the average rainfall contribution. Generally, the recuperation rate of alluvial wells is 10 times that of wells in hard rock terrain. Shallow wells hardly yield water for irrigation and dry up in the summer months. The plains area, with its alluvium, has higher resources compared to the hilly northern part, which has hard rock terrain. The hilly area serves as a runoff zone, while the plains act as both recharge and discharge zones. The groundwater resource of the district represents about 9 percent of the average rainfall. The Groundwater Prospects map of Visakhapatnam District is shown in Figure-10.

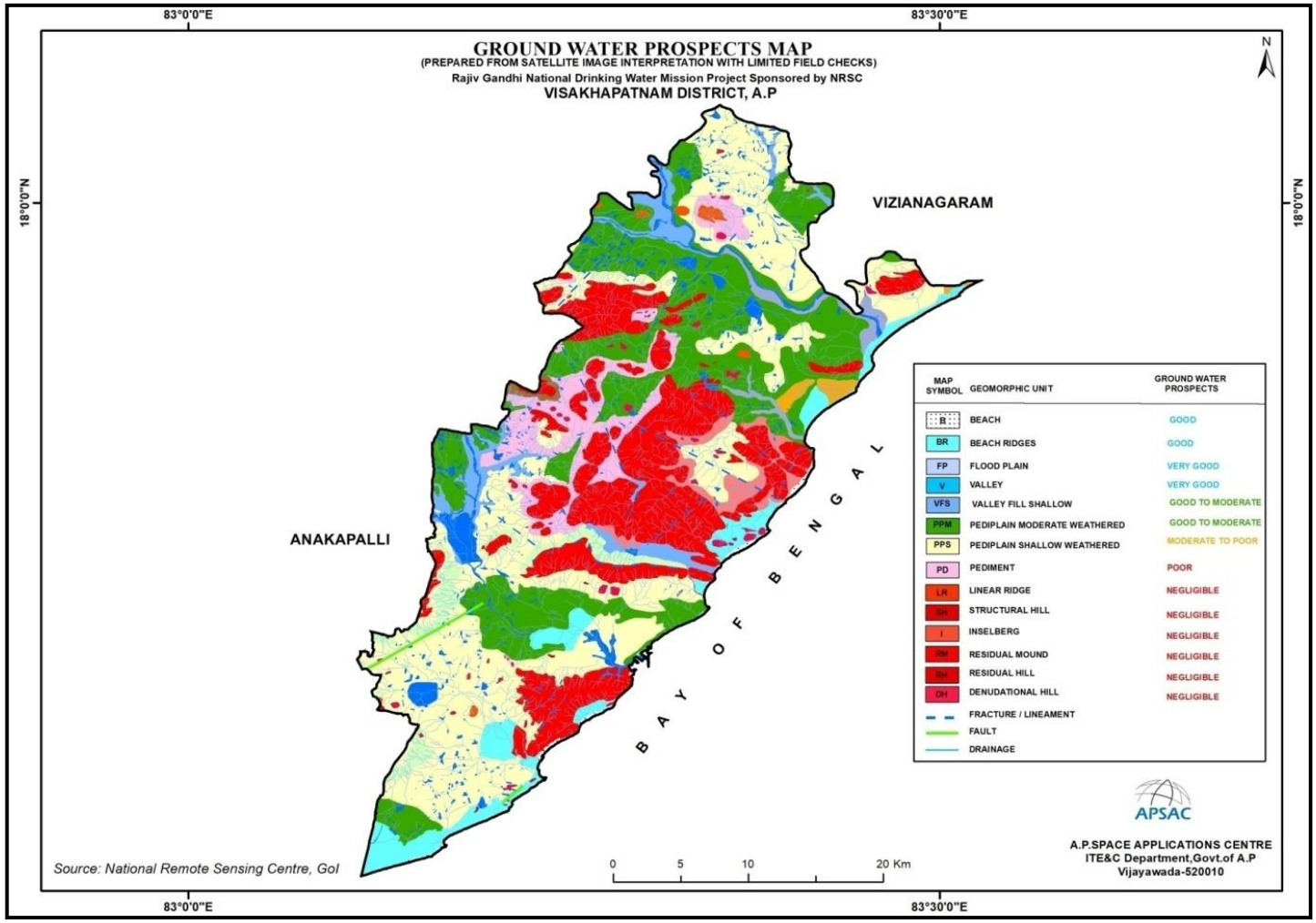

Figure-10: Ground Water prospects in Visakhapatnam District, Andhra Pradesh

1.6 Infrastructure

1.6.1 Transport Network

Visakhapatnam district has a well-connected by various modes of transportation such as Road, Rail and Seaports. The connectivity of each category is also depicted in Figure-11.The details of each transport network distribution in the district are given below.

1.6.1.1. Road Transport: The road network of the district has been delineated by using high resolution satellite data under Space Based Information Support for Decentralized Planning (SIS-DP) project and arrived the lengths of the each type of road network. It can be observed that Visakhapatnam district has a well-developed road network that facilitates connectivity to all towns within the district, and to other major cities and towns of nearby districts. The major road network includes National Highways (NH), State Highways (SH), and District Roads (DR). The rural areas of the district also good connectivity by Panchayat Raj roads / village roads.

The total length of the road network in the district is about 2871.68 km. Of which, the length of the National Highways is about 87.08 km, State Highways connecting all major towns and cities in the district is having a length of about 102.05 km. The district roads are having a length of 91.21 km. The length of each road category covered in the district is shown in Table-10.

Table 10 Road Category wise Lengths.

S.No	Road Type	Length in Km
1	National Highway	87.088
2	State Highway	102.058
3	District Road	260.661
4	City Road	738.890
5	Village road	810.748

6	Car track	810.965
7	Foot Path	61.273
Total		**2871.683**

Data Source: R&B Department & APSAC, Vijayawada.

Visakhapatnam district is traversed by one National Highway. The traverse and description of each highway is as given below:

1.6.1.1.1. National Highway 16 (NH16): The NH16 is a major National Highway in India that runs along east coast of West Bengal, Odisha, Andhra Pradesh and Tamil Nadu states. It is a part of the Golden Quadrilateral project to connect India's major cities.
The NH16 starts at Odisha border which passes through the coastal districts in Andhra Pradesh and enters at Ichchapuram mandal in Srikakulam district. It traverses through Visakhapatnam District via Anandapuram and Bheemunipatnam mandals and connects Vizianagaram district, Pendurthi and Gajuwakamandals connects to Anakapalli district.

Bheemunipatnam road via Anandapuram (SH0092)
Anandapuram – PadmanabhamRoad (SH138)
Bheemunipatnam - Visakhapatnam Road (SH144)
Gajuwaka - Mulagada road (SH157)
Gopalapatnam - Pendurthi (SH-135) Road (SH153 and 151)

1.6.1.2. Railways: The Indian Railway line traversing from North to South in Visakhapatnam district covering the various stations to cater the transportation needs of the people. The length of Rail network in the district is about 748.02 km covering 6 railway stations. Among these, the important railway stations in the district are Visakhapatnam junction, Marripalem, Simhachalam, Simhachalam North, Pendurthi and Duvvada.
Visakhapatnam district is traversed by significant railway lines are South Central railway line and Southeastern railway line that connects various parts of the district and provides connectivity to neighbouring regions.
The South-Central railway line that passes through Visakhapatnam district is 341.98 km. This railway line passes through Visakhapatnam junction, Marripalem and Duvvada stations in Visakhapatnam district and connects Anakapalli district. One branch line starts with south central railway line that line passes through Gajuwaka and Pedagantyada mandals and

connects Gangavaram Port and another one branch line passes through Gopalapatnam and Maharanipeta mandal connects Visakhapatnam Port. South Eastern Railway line length in Visakhapatnam district is 251.40 km. South Eastern railway line passes through Simhachalam, Simhachalam North and Pendurthi stations in Visakhapatnam district and connects Vizianagaram district.

1.6.1.3. Visakhapatnam Airport: Visakhapatnam International Airport is the busiest airport in the state of Andhra Pradesh. It is located 12 km from the Visakhapatnam city**.** It is a customs airport in Visakhapatnam. It also operates as a civil enclave on an Indian Navy airbase named INS Dega. It lies between the city localities of NAD X road and Gajuwaka. The airport covers an area of 350 acres. The airport has experienced significant growth since the beginning of the 21st century, with the construction of a new terminal and runway and the commencing of international flights. The airport has two adjacent terminals. Currently the integrated terminal handles both international and domestic flights. The Airports Authority of India(AAI) has converted the old terminal into a cargo complex.

Visakhapatnam Airport operates domestic flights to major India cities such as Delhi, Chennai, Bhuvaneswar, Hyderabad, Mumbai, Kolkata, Bangalore and Pune. The main domestic airlines that connect Visakhapatnam to other cities in the country are Air India, Air Asia Indigo Airlines, Spice Jet and Jetkonnet operate flights to various domestic and international destinations. (Source: https://en.m.wikipedia.org)

1.6.1.4. Sea Transport: Andhra Pradesh has the 2nd longest coastline of 974 km in the eastern peninsular India, which accounts for 12% of the country's total coastline with one major port at Visakhapatnam under the administrative control of Central government. Visakhapatnam district has three Green Field ports namely Bheemunipatnam Port, Visakhapatnm Port and Gangavaram Port.

The description of each port is as given below:

1.6.1.4.1. Bheemunipatnam Port: Bheemunipatnam, the mandal Headquarters is situated at a distance of 34 km from Visakhapatnam. It is one of the oldest Municipalities in the country having been established as early as 1861AD. This place was a settlement of the Dutch, who built a Fort and a factory in the 17th Century AD. The most important aspect of

interest at the place is the beach which is perhaps matchless for its beauty all along the east coast. It is a usual resort for sea bathers as it is free from dangerous depth and sharks. Nearer the sea and facing the flagstaff is a well equipped round bungalow which it is said was originally the Vizianagaram Raja's resort. The view of the seascape from the verandah of the bungalow is captivating. This place was an important port in the olden days. It has a light house and it is a minor port though it is seldom used now. Bheemunipatnam is undoubtedly a place of the holiday resort. European merchants disembarked from the ships and made it their port. It was a major port and Europeans resided here during East India Company regime. Until 1958, huge ships from Malaysia and Singapore arrived at this port. The port consists of an open roadstead anchorage with cargo being worked using small boats. Facilities for handling break bulk are available. Principal exports leaving this port are hemp, myrobalans and ground nuts; and main imports entering this port include general merchandise and jute. Perfumes, textiles etc were exporting to other countries from here. There was a huge coco plantation spread across the local beaches that were also exported.

1.6.1.4.2. Visakhapatnam Port: Port of Visakhapatnam is one of the leading major ports of India and is located on the east coast midway between Kolkata and Chennai. The Port has three harbours viz., outer harbour, inner harbour, and the fishing harbour. The outer harbour with a water spread of 200 Ha has 6 berths and the inner harbour with a water spread of 100 Ha has 18 berths. Bestowed with natural deep-water basins, the outer harbour is capable of accommodating 150,000 DWT vessels and draft up to 17 meters. The inner harbour berths are PANAMAX compatible and are capable of accommodating vessels up to 230 meters LOA and draft up to 11 meters. The Port is catering to key industries like petroleum, steel, power, and fertilizers besides other manufacturing industries and playing catalyst role for the agricultural and industrial development of its hinterland spreading from the south to the north During the FY 201011 the Port handled a record quantity of 68.01 million tonnes of cargo. The Port is equipped with an array of cargo transfer systems. The mechanical ore handling plant consists of fully mechanized receiving and shipping systems designed to loads iron ore directly into the vessels through conveyors. The Port is operating its Railway network of about 200 km., which is linked to the Trunk Railways. The Port is well connected to the NH5 by a 4-lane connectivity road. The Port has Electric Wharf Cranes of capacities ranging from 10 to 20 T and 2 nos., Harbour

Mobile Cranes of 140-tonne capacity. Mechanical loading facilities exist for handling Alumina and fertilizers. The Off-Shore Tanker Terminal in the Outer harbour discharges crude oil directly to the tanks of the Refinery. The Container terminal operated by Visakha Container Terminal Private Ltd. is the deepest container terminal among major ports and is equipped with modern container handling equipment. The BOT operator, Vizag Sea Port Pvt., Ltd., is operating two berths (EQ8and9) in the inner harbour. These berths are equipped with 3 nos., Harbour Mobile Cranes which can handle cargo at 18,000 tonnes per day per crane.

1.6.1.4.3. Gangavaram Port: Gangavaram Port is located about 15 km south of Visakhapatnam Port and has been developed as all-weather, multipurpose port with water depth up to 21 meters, making it the deepest and only port in the country capable of handling fully laden Super Cape size vessels of up to 200,000 DWT. Gangavaram Port with its deep draft berths and efficient operations has become the gateway port for a hinterland spread over 8 states across Eastern, Western, Southern, and Central India. Its ability to handle larger vessels efficiently has resulted in substantial savings to trade and port users. Gangavaram Port provides efficient cargo handling services for a variety of bulk and break-bulk cargo groups including Coal, Iron Ore, Fertilizer, Limestone, Bauxite, Raw Sugar, Project Cargo, Alumina, Steel products, etc. The Port, its related facilities, and material handling system are among the most advanced in Asia and meet the highest standards in terms of pollution prevention and safety.
(Source: http://en.m.wikipedia.org)

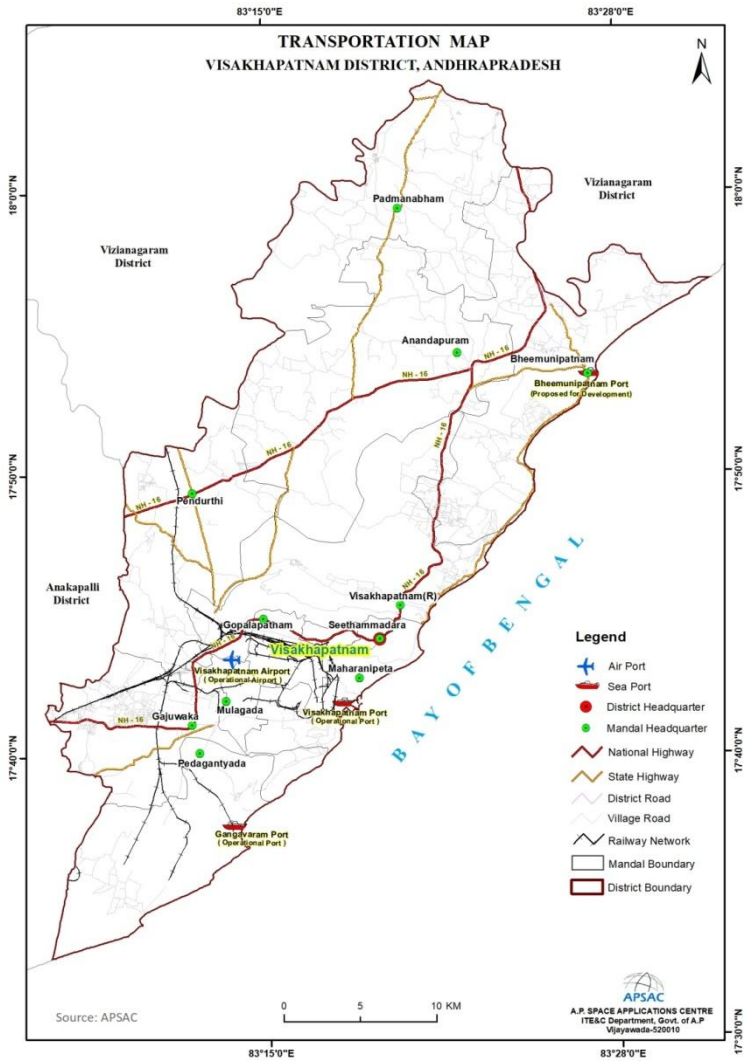

Figure-11: Transport Network of Visakhapatnam district, Andhra Pradesh

1.6.2 Irrigation

Irrigation has assumed an increasing significance in agriculture in the context of new technology, where high yielding varieties and multiple cropping are being practiced. The main reasons for low yields are inadequate rainfall, uneven and uncertain rains during the period of crop growth. It is generally found that the introduction of irrigation is associated with changes in the cropping pattern. The shift from a traditional cropping pattern to the most advantageous cropping pattern is possible only in the presence of irrigation facilities. The new agricultural technology is highly based on sufficient moisture conditions. Thus, the development of irrigation is crucial for increasing agricultural production. The irrigation projects are classified as major, medium, and minor irrigation details are shown inTable-11 and Figure-2

1.6.2.1. Major Irrigation Projects:

In Visakhapatnam district there are two major irrigation projects (Ongoing) i.e., Babu Jagjeevana Ram UttarandhraSujalaSravathi (BJRUSS) and Polavaram Irrigation Project. The Babu Jagjeevana Ram UttarandhraSujalaSravathi (BJRUSS) project is covered an ayacut of 47,664 Ac falling in three assembly constituencies namely as Pendurthi, Gajuwaka and Bhimili.

The Polavaram Irrigation Project is ongoing Multipurpose project and 23.44 TMC of water supply to the fast-growing major harbour city of Visakhapatnam, other Towns and Villages enroute and the Visakhapatnam Steel Plant and also for the various industries viz: Outer Harbour, Ship building yard, Port trust, Eastern Naval Command, Bharat Heavy Plates & Vessels, Cattex Oil Refinery, Coramandal Fertilisers, Zinc Smelter Plant in and around Visakhapatnam city.

1.6.2.2. Medium Irrigation Projects:

In Visakhapatnam district there are six minor irrigation projects (Completed) i.e., Gambhiramgedda Reservoir Project, Madupaka Reservoir Project, Gurrampalem Reservoir Project, Jaggammagedda, MeghadriGedda Reservoir and Kanithi Balancing Reservoir. The Raiwada Reservoir(Anakapalli), Thatipudi Reservoir(Vizianagaram), MeghadriGedda Reservoir, Kanithi Balancing Reservoir and Gambhiramgedda Reservoirs

are contributing water supply to Drinking water and Industrial needs to Visakhapatnam Town.

There are 3Nos minor lift irrigation schemes (Completed) in the district under Andhra Pradesh State Irrigation Development Corporation Limited (APSIDC), an extent of 441 Ac. The Water Resources Department 36Nos of minor irrigation tanks (above 100 Ac ayacut) covered in the district an extent of 7,479 Ac and 439Nos of Small minor irrigation and P.R tanks (bellow 100 Ac ayacut) an extent of 11,136 Ac. Open Head Channels, Anicuts, Groynes & Other sources (M.I Sources - Above 100 Ac) an extent of 3,390 Ac.

Table 11 Major and Medium Irrigation Projects in Visakhapatnam District

S. No	Project Type	Name of the Project	Status	Ayacut in Ac
1	Major	Babu Jagjeevan Ram UttarndhraSujalaSravanthi (BJRUSS)	Ongoing	47,664
		Reservoirs contributing for Drinking water and Industrial needs to Visakhapatnam Town		-
2		Polavaram Irrigation Project *(23.44 TMC/Year)*		-
3	Medium	Raiwada Reservoir (Anakapalli) *(1.577 TMC/Year)*	Completed	
4		Thatipudi Reservoir(Vizianagaram) *(0.642 TMC/Year)*		-
5	Minor	Meghadri Gedda Reservoir (*0.467 TMC/Year)*	Completed	-
6		Kanithi Balancing Reservoir		-
7		Gambhiramgedda Reservoir Project *(0.038-TMC/120 days)*		640
8		Madupaka Reservoir Project		120
9		Gurrampalem Reservoir Project		133
10		Jaggammagedda		347
11		Minor Lift Irrigation Schemes under APSIDC - 3Nos		441

12		M.I Sources-19Nos *(Anicuts, Groynes, Open Head Channels)*		3,390
13		Minor Irrigation Tanks - 36Nos *(Ayacut above 100 Acres)*		7,479
14		Minor Irrigation Tanks (M.I Small & P.R Tanks)-439Nos *(Ayacut bellow 100 Acres)*		11,136
			Total	**71,350**

Data source: WRD, APWRIMS, Govt. of A.P.

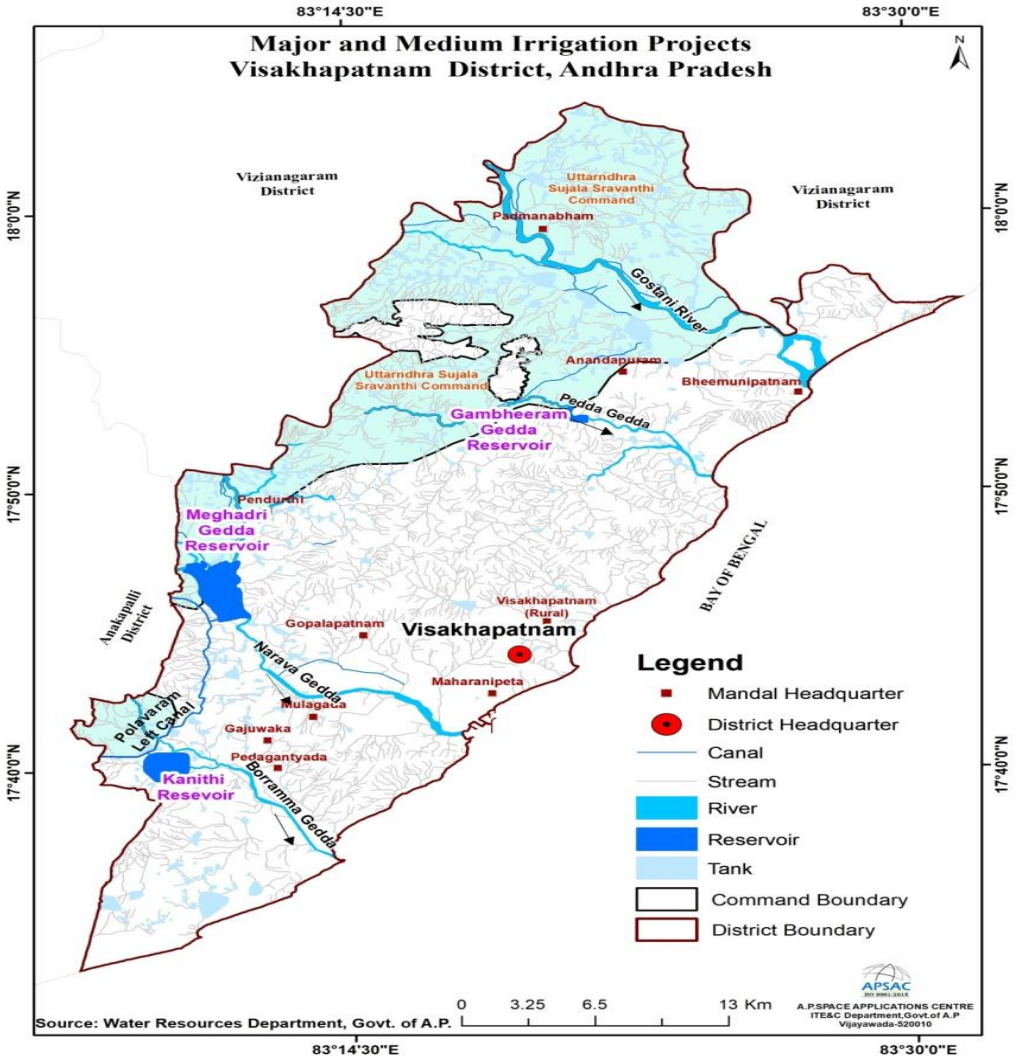

Figure-12: Major and Medium Irrigation Projects of Visakhapatnam District

1.6.2.3. Tank Information System

As per the information of Water Resources Departmental portal, Andhra Pradesh Water Resources Information & Management System (APWRIMS) and the URL:https://apwrims.ap.gov.in/ in Visakhapatnam District have 526minor irrigation tanks. The Designed Storage Capacity of minor irrigation tanks in Visakhapatnam District is 1,237.09 mcft and Current Storage Capacity is 965.26mcft. The mandal wise minor irrigation tanks details of Visakhapatnam District are shown in Table-12.

Table 12 Mandal wise Minor Irrigation Tanks details of Visakhapatnam district

S.No	Mandal	No. of MI Tanks	Designed Storage Capacity (mcft)	Current Storage Capacity (mcft)
1	ANANDAPURAM	161	201.97	169.84
2	BHEEMUNIPATNAM	65	299.22	267.6
3	GAJUWAKA	1	4.01	4.01
4	PADMANABHAM	164	390.86	350.39
5	PENDURTHI	134	340.34	172.74
6	VISAKHAPATNAM	1	0.68	0.68
TOTAL		**526**	**1,237.09**	**965.26**

Data source: WRD, APWRIMS, Govt. of A.P.

1.6.3 Eco-sensitive areas and Important places

Visakhapatnam district is blessed with several tourist attractions that offer a mix of historical, cultural, and natural wonders. The important popular tourist, religious and cultural places to visit in the Visakhapatnam district are shown in the Table-13 and the geographical location of each place is depicted in Figure-13.

Table 13 Important places of Tourism in Visakhapatnam district.

S.No	Name	Village	Mandal
1	Bavikonda Buddist Site	Kapuluppada	Bheemunipatnam
2	Bheemunipatnam Beach	Bheemunipatnam	Bheemunipatnam
3	Dr.Y.S.Rajasekhara Reddy Central Park	Visakhapatnam	Visakhapatnam(U)
4	Erramattidibbalu	Nerallavalasa	Bheemunipatnam
5	Kailasagiri rope way entry point	Chinagadili	Visakhapatnam
6	Kambalakonda Eco Tourism Spot	Endada	Visakhapatnam
7	KanakamahalakshmiAmmavari Temple	Visakhapatnam	Visakhapatnam(U)
8	Lumbini Park	Visakhapatnam	Maharanipeta
9	Mudasaralova park	Mudasarlova	Visakhapatnam (R)
10	Padmanabha Swamy Temple	Padmanabham	Padmanabham
11	Ramanaidu film studio	Madhuravada	Visakhapatnam
12	RK Beach	Visakhapatnam	Visakhapatnam(U)
13	Rushikonda Beach	Rushikonda	Visakhapatnam
14	Submarine Museum	Visakhapatnam	Visakhapatnam(U)
15	Tenneti park	Chinagadili	Visakhapatnam
16	Thotlakonda Beach	Kapuluppada	Bheemunipatnam
17	ThotlakondaBuddist Site	Kapuluppada	Bheemunipatnam
18	TU-142 (Museum)	Visakhapatnam	Visakhapatnam(U)
19	Varaha Lakshmi Narasimha temple	Adiviram	Visakhapatnam
20	Visakha Museum	China Waltair	Visakhapatnam(U)

S.No	Name	Village	Mandal
21	VMRDA Park, Kailasgiri	Chinagadili	Visakhapatnam
22	Vuda Park	Visakhapatnam	Visakhapatnam(U)
23	Water Fleet at Fishing Harbour	Visakhapatnam	Visakhapatnam(U)
24	Water Fleet at Rushikonda	Rushikonda	Visakhapatnam
25	World Telugu Museum	Chinagadili	Visakhapatnam
26	Yerrada Beach	Yarada	Gajuwaka
27	Zoo Park VSP	Endada	Visakhapatnam

Data Source: Tourism Department, Government of Andhra Pradesh.

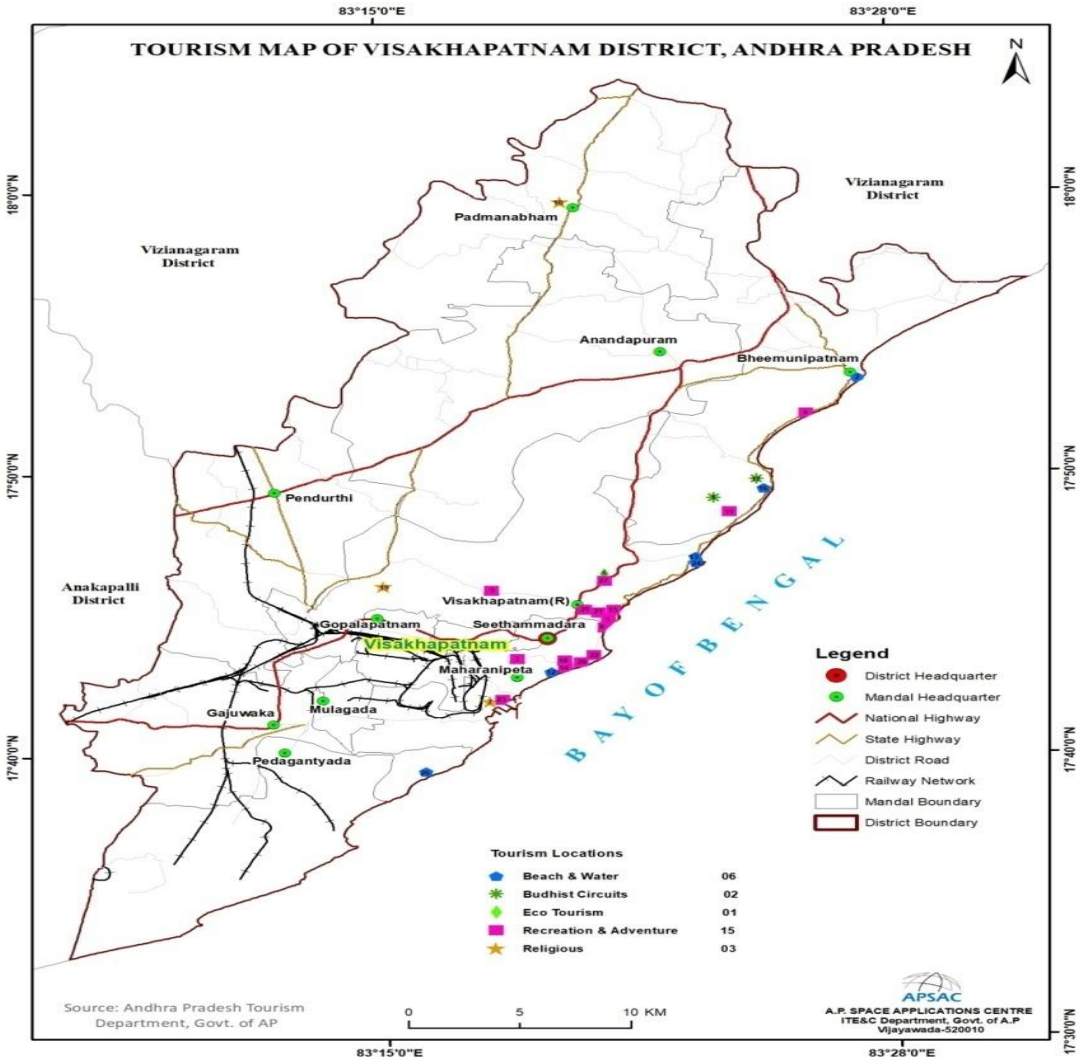

Figure: 13 Tourism Map of Visakhapatnam District, Andhra Pradesh

A brief description of certain tourist places are given below:

1.6.3.1. Bavikonda Buddist Site: Bavikonda is a hill on the North west of Timmapuram is situated in between Visakhapatnam and Bheemunipatnam Beach road and located at 2 km Interior from the beach road point. On the hill noticed a Buddist site in the middle of the plain with antiquities like religious structures, stupas, Chaitya gruhas, congregation hall, platforms, viharas, stucco figures, and coins are found here. The entire complex comprises 26 structures belonging to 3 phases. The artifacts recovered here include Roman coins and Satavahana coins apart from pottery dating back to the 3rd century BC and 2nd Century A.D. The discovery of relic caskets in the Maha Chaitya is significant.

1.6.3.2. Bheemunipatnam Beach: Bheemunipatnam, the Mandal Headquarters is situated at a distance of 34 km from Visakhapatnam. It is one of the oldest Municipalities in the country having been established as early as 1861 AD. This place was a settlement of the Dutch, who built a Fort and a factory in the 17th Century AD. The most important aspect of interest at the place is the beach which is perhaps matchless for its beauty all along the east coast. It is a usual resort for sea bathers as it is free from dangerous depth and sharks. Nearer the sea and facing the flagstaff is a well equipped round bungalow which it is said was originally the Vizianagaram Raja's resort. The view of the seascape from the verandah of the bungalow is captivating. This place was an important port in the olden days. It has a light house and it is a minor port though it is seldom used now. Bheemunipatnam is undoubtedly a place of the holiday resort.

1.6.3.3. Dr.Y.S.Rajasekhara Reddy Central Park: It is also known as VMRDA city Central park. It is an urban park in the city of Visakhapatnam. The park is located at the heart of the city. It covers an area of 22 acres. It comes under the maintenance and operated by Visakhapatnam Metropolitan Region Development Authority.

1.6.3.4. Geo-Park (Erramatti Dibbalu): Erra Matti Dibbalu also called as Red Sand Hills, a notified National Geo-heritage Monument, is situated at the outskirts of Visakhapatnam city. It is located very near to the Bay of Bengal and is one of Visakhapatnam's many heritage sites.

1.6.3.5. Kailasagiri: Kailasagiri is a picturesque hill overlooking the sea is a natural gift with 350 AD. available has been developed into a lush green park that has a panoramic sea view with a serene atmosphere with water Sprinklers, Microwave Repeater Station, beautiful garden locations, and recent flower clock titanic view point making it outstanding tourist

spot. On the top of the hill, a giant statue of Sivaparvatulu which is recently illuminated, and Sanku Chakra and Namalu of Lord Venkateswara are established. Hitherto a road is being formed on the hill from Simhachalam gives much attraction to the pilgrims. Further, recently a beautiful rope way from Foot hill to the picturesque mountains has been erected for the benefit of pilgrims.

1.6.3.6. Kali Temple: Bhavatarani Charitable Trust has constructed the famous Kali Temple in 1984 on the Beach road. The Temple architecture is very unique. The uniqueness of Siva Temple is its Linga made of 10 kgs single stone called Rasalinga.

1.6.3.7. Kambalakonda Eco Tourism Spot: It is located at in an area of 71 sq.km out of which 0.8sq.km of sanctuary is is marked for community based eco tourism project. It is a forest located near Endada village, and 3 km far away from Visakhapatnam city. This extremely scenic region of the Eastern Ghats of India is a wonderful place to travel during the cooler months of the year.

1.6.3.8. KanakamahalakshmiAmmavari Temple: This temple lies about 4 km distance from the Visakhapatnam city. The temple is located in Burujupeta of Visakhapatnam city.

This temple is the presiding deity of Visakhapatnam locals.

1.6.3.9. Lumbini Park: Lumbini Park is located on the beautiful beach road with the Buddha Statue in the middle of the park and is gifted with idyllic sylvan hills on one side and the blue sea on the other is a great attraction to the tourist public. It is convenient location and near to famous tourist places like Kailasagiri and R.K.Beach.

1.6.3.10. Mudasarlova Park: Mudasarlova the name itself depicts is a valley formed by the natural hills is situated 10 km from Visakhapatnam. It has a lake that supplies drinking water to the city. The Municipal Corporation, Visakhapatnam has developed this into a beautiful park with different types of green plants and orchards are a beautiful picnic spot attracting a good number of tourists and the public.

1.6.3.11. Padmanabha Swamy Temple: Padmanatham lies 16 km Northwest of Bheemunipatnam on the left bank of the Gosthani. Padmanabham is known in the local history as the place where the Raja of Vizianagaram was slain in AD 1794 in the fight with the East India Company's troops and the spot is marked by a small memory erection. The Padmanabheswara Swamy temple of this place is one of the most important temples of the region. The presiding deity Padmanabha Swamy is said to be the lord who readily responds to the desires of his devotees. On the top of the hill which overlooks the place, is the shrine of

Padmanabha and the Kalyanostavam of the deity celebrated annually during March-April draws a congregation of the large number of devotees.

1.6.3.12. Ramanaidu film studio: A film city built top of Rishikonda hills serves an enticing bird's eye view of the Bay of Bengal at Visakhapatnam. On the beach road connecting Visakhapatnam to Bheemili, at a distance of 18 km from RK beach the Ramanaidu film studio is located at the top of a hill.

1.6.3.13. Ramakrishna Mission Beach: The Ramakrishna Mission Ashram beach is a beautiful spot for relaxation and pleasure is a natural beauty scene. There is an imposing Kali Temple near this beach. The aquarium here is an added attraction. The roaring sounds of the sea give enormous pleasure.

1.6.3.14. Rushikonda Beach: Rushikonda is 8 km away from Visakhapatnam with clean golden Beaches, is an ideal place for swimming and wind surfing in picturesque settings A.P. Tourism has 12 elegant cottages overlooking the beach for comfortable accommodation for tourists. Proposed to construct a swimming pool and also to introduce water sports are on the anvil.

1.6.3.15. Submarine Museum: Kurusura and originally decommissioned submarine is located on the sands of the R.K. Beach is developed into a museum. This project is jointly taken up by the NSDRC and Eastern Naval Command. The estimated cost is around 2.55 crore and it is the first of its kind in Asia and second in the world and is opened to the public.

1.6.3.16. Tenneti Park: It is also known as (Vuda Tenneti park), is an Urban park in the city of Visakhapatnam. It is situated on the Beach Road in Chinagadili village, it the first children's park, and one of the oldest parks in the city. It is located beside Sea Shore of Bay of Bengal.

1.6.3.17. Totlakonda Beach: Totlakonda beach is quite close to Bheemili beach and this beach gets its name from Totlakonda Budhist complex. It is a scenic beach located near the city of Visakhapatnam. The beach is known for its serene atmosphere and stunning views of the Bay of Bengal. Visitors can enjoy a range of water sports, such as swimming, sunbathing and boating.

1.6.3.18. ThotlakondaBuddist Site: The name Totlakonda has been derived from the presence of rock-cut-troughs hewn in the bed rock of various shapes, sizes with 4 to 8 steps in the hillock by which water has been drawn for drinking water purposes. Thotlakonda lies about 15 km from Visakhapatnam in beach road located 128 mts high above sea level. The archaeological excavations reveal antiquities like Maha stupa Viharas, Votive stupas, Chaitya Gruhas, pillared hall, congregation hails, tiles,

finials Buddapadas, Eppatra pieces, engraved with Brahmelipi recovered from the site of Mangamaripeta hill and reflects the Kalinga and Andhaka schools of Buddism.

1.6.3.19. TU-142 (Museum): It is located 5 km from Visakhapatnam city and 18 km from Visakhapatnam International Airport. The TU 142 Aircraft Museum is a preserved Tupolev Tu-142 located in Visakhapatnam. Built as part of Visakhapatnam tourism promotion, it was formally inaugurated by President of India Ram Nath Kovind in December 2017.

1.6.3.20. Varaha Lakshmi Narasimha Temple: It is a Hindu temple situated on the Simhachalam hill range, which is 300 meters above sea level in Visakhapatnam. It is dedicated to Lord Vishnu, who is worshipped there as Varaha Narasimha.

1.6.3.21. Visakha Museum: The Visakha Museum was opened in 1991 to preserve the house collections from the cultural and social heritage of the city of Visakhapatnam. Along with the museum have many models of planes, warships and submarines. The museum also houses the shell of a250-lb unexploded bomb dropped by Japanese during the World War II.

1.6.3.22. VMRDA Park, Kailasgiri: It is one of the prominent hill top park with panoramic sea view on the East Coast. The divine view from the hilltop accompanies devotional over toned as the Lord Shiva and Goddess Parvathi sits ever so peacefully as if at the Manasa Sarovar in the great Himalayas. one can view the entire city of Visakhapatnam from the top of this Eco-Rich hill. The hill park developed by VMRDA covers 380 acres of land with existing landscape gardens consisting rich flora and tropical trees.

1.6.3.23. Vuda Park: VUDA park established in a vast area has beautiful greenery and panoramic sea view had a dancing musical fountain sprinkling with colourful up and downs dancing along with the beat of the music, boating facility, and skating rink, has also facilities as pleasure rides on horses and camels which are very fond for children and a well-equipped gymnasium.

1.6.3.24. Water Fleet at Fishing Harbour: It is one such place that remains overcrowded all the time. Spread over an area of 26 hectares, it was opened in the year 1976 and is under the control of Visakhapatnam Port Trust. Here you can also enjoy a mix of sea, land and hill from a distance.

1.6.3.25. World Telugu Museum: It is also called Telugu Samskruthika Niketanam. It is located 8 km from Visakhapatnam. It was established with the goal of highlighting Telugu's historical significance and culture.

1.6.3.26. Yarada Beach: The Yarada Valley is surrounded by hills and the beach is an enchanting seashore with lovely rocks and the soft pebbles spread across the beach are fabulous with their exotic blend of golden sands and the lush green stretch of hills is a picturesque landscape for tourists.

1.6.3.27. Zoo Park VSP: Indira Gandhi Zoological Park is located amidst Seethakonda Reserve Forest covering an area of 625 acres in Visakhapatnam. It is surrounded by beautiful and scenic hills of Eastern Ghats on three sides and Bay of Bengal on the fourth side. It houses 843 number of animals like mammals, carnivores, lesser carnivores, ungulates, reptiles, birds and butterflies belonging to 123 species in natural ambiance.

(Source: http://en.m.wikipedia.org).

1.7 Drainage Pattern

1.7.1 Drainage

There are four rivers draining the district, viz. Gosthani, Naravagedda, Pedda Gedda and Borramma Gedda. They originate in the Eastern Ghats and after flowing through the district, finally joining Bay of Bengal. The drainage pattern is mainly sub-dendritic to dendritic type. The Meghadrigedda reservoir supplies around 8 million gallons/day of water to the needs of Visakhapatnam city for domestic and industrial purposes.

The Gostani River originates in the Ananthagiri forest area of Srungavarapukota near Borra caves. It flows towards south direction through Anandapuram mandal after entering Visakhapatnam district and joining to Bay of Bengal near Bheemunipatnam in Visakhapatnam district.

The Naravagedda originates from the Narava Reserved Forest and Nallakonda Reserved Forest, Sabbavaram mandal in Anakapalli district, passes through Pendurthi and Gajuwaka mandals in Visakhapatnam district. It finally joins Bay of Bengal at Visakhapatnam city.

The Pedda Gedda originates in the Tivva Konda, Anandapuram mandal in Visakhapatnam district and joining to Bay of Bengal near Dibbadipalem village, Bheemunipatnam mandal in Visakhapatnam district.

The Borramma Gedda originates in the Kannuru Konda, Marripalem village, Parawada mandal in Anakapalli district and joining to Bay of Bengal near Gangavaram in Visakhapatnam district. Figure-14 illustrates the drainage system, and the surface water bodies.

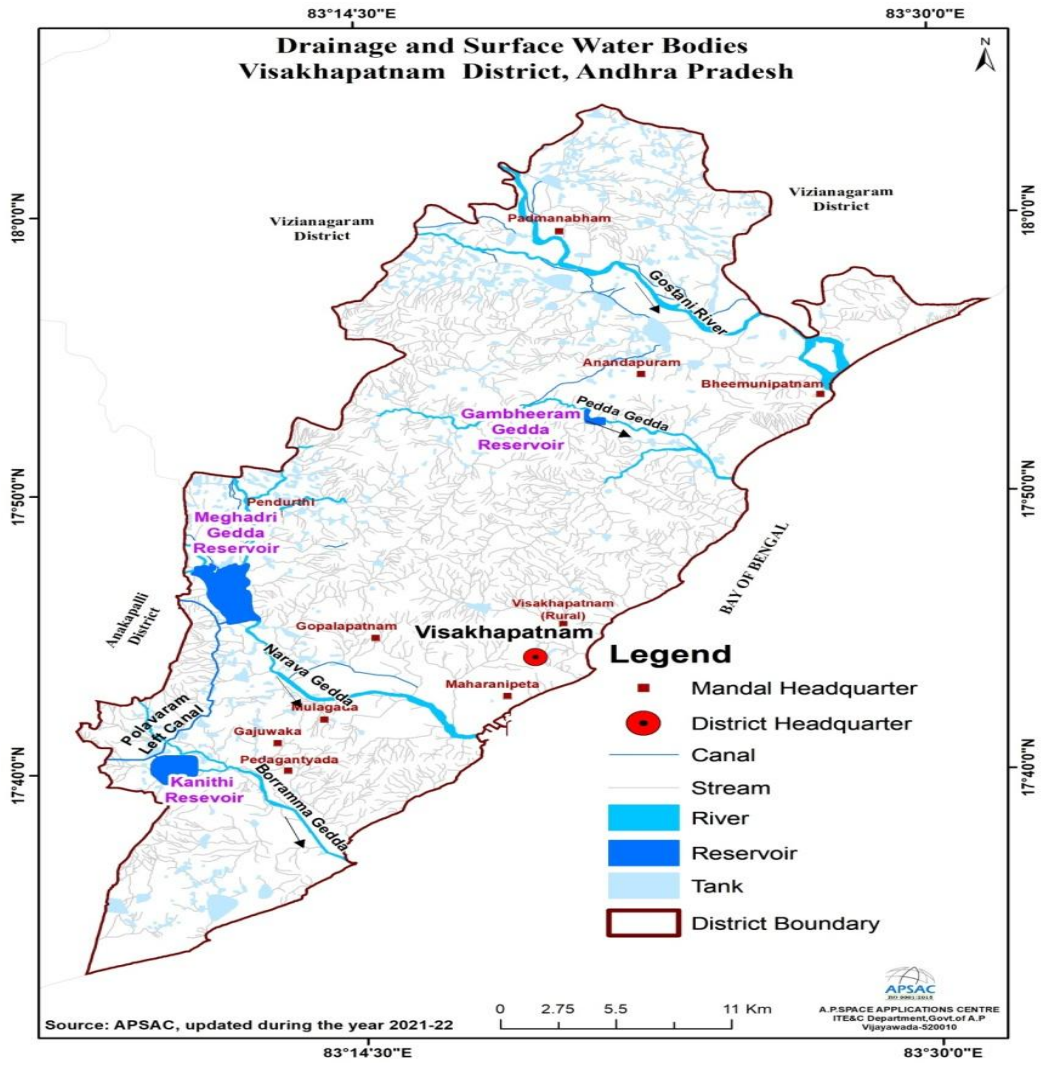

Figure - 14: Drainage Network and Surface Water Bodies of Visakhapatnam District

1.7.2 Geomorphology of the District:

Using IRS satellite data and GIS, a detailed geological, geomorphological, and structural map of Visakhapatnam District was generated following the guidelines of the Rajiv Gandhi National Drinking Water Mission (RGNDWM) on a 1:50,000 scale. The objective of this mapping was to delineate lithology, geomorphology, and structural characteristics of the area at a 1:50,000 scale and integrate this information to identify potential groundwater prospect zones and recommend suitable structures for groundwater recharge. Various hydrogeomorphic units were delineated, and appropriate recharge structures were proposed for villages affected by drinking water scarcity under this project. The description of the Geomorphology Map of Visakhapatnam District is shown in Figure 15.

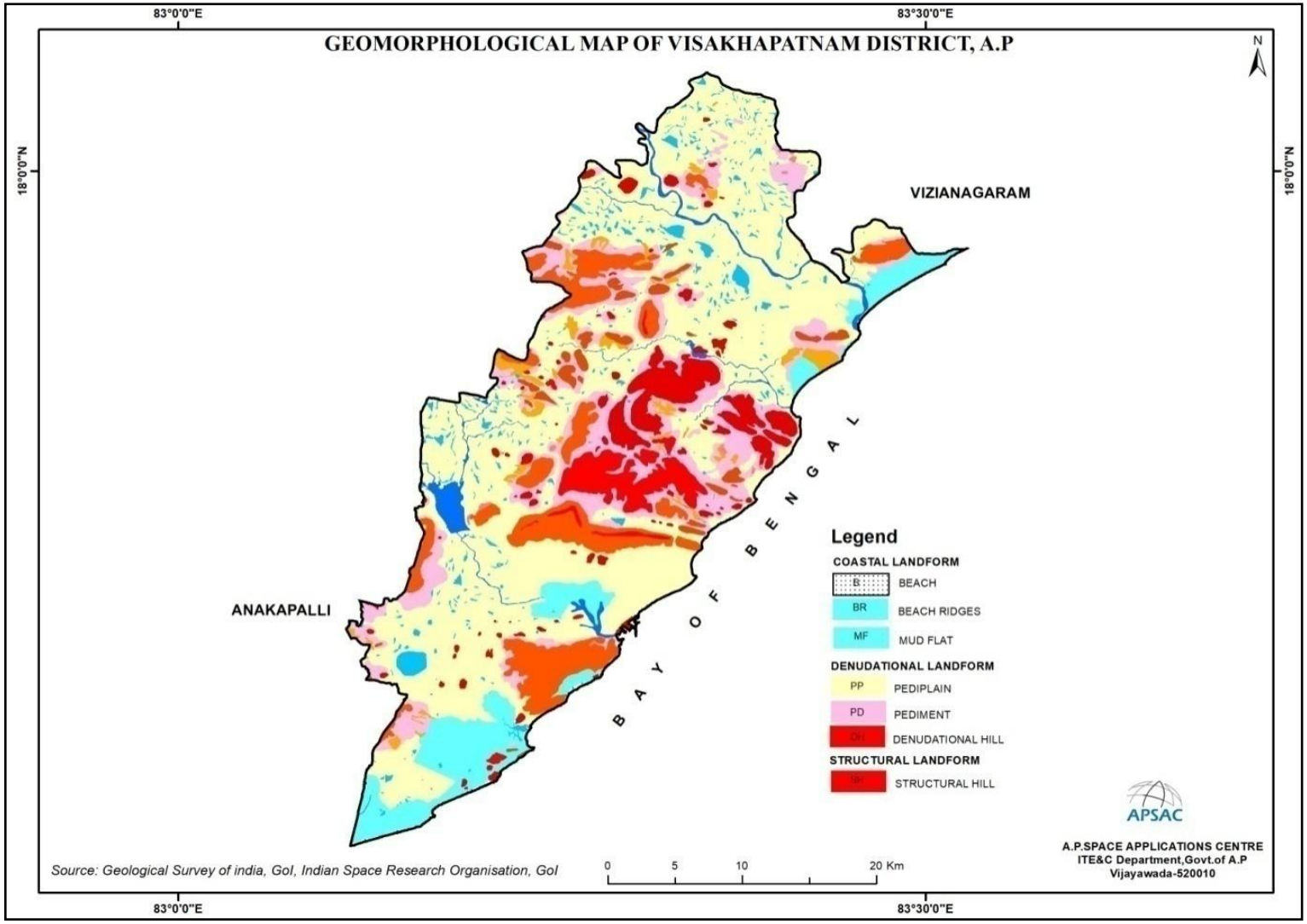

Figure 15: Geomorphology of Visakhapatnam District, Andhra Pradesh

1.7.3 Landforms of Fluvial origin

The term "Fluvial" is used in Earth science to refer to processes and landforms generated by running water. Like other geological processes, running water can either erode material from the earth's landscape or deposit layers of sediment. The resulting landforms can thus be classified as either erosional or depositional. The incredible power of running water in carving various erosional and depositional landforms is well known. Although the quantity of water in the stream may be small at certain times of the year, very large volumes of water move through the channel, forming an important component of the hydrological cycle. The fluvial dissection of the landscape consists of valleys and their included channel ways organized into a drainage network system. Drainage networks display many types of quantitative regularity that are useful in analyzing both fluvial systems and the terrains they dissect (NRSA, 2007).

1.7.3.1. Alluvial plain: A level or gently sloping tract, or a slightly undulating land surface produced by extensive deposition of alluvium, typically adjacent to a river that periodically overflows its banks. It may be situated on a floodplain, delta, or alluvial fan. This landform is predominantly observed in the southern part of the district

1.7.4 Landforms of Coastal Origin

Coasts are also the loci of a unique assemblage of erosion and depositional processes. The various landforms of coastal areas are almost exclusively the result of the action of ocean waves, which create some of the world's most spectacular erosional landforms. Where wave energy is reduced, depositional landforms like beaches are created. The source of energy for coastal erosion and sediment transport is wave action. A wave possesses potential energy as a result of its position above the wave trough and kinetic energy caused by the motion of the water within the wave. This wave energy is generated by the frictional effect of winds moving over the ocean surface. The higher the wind speed and the longer the fetch, or distance of open water across which the wind blows and waves travel, the larger the waves and the more energy they possess. Long open ocean waves or swells travel faster than short, locally generated sea waves. They also have longer wave periods, distinguishing them from short sea waves upon reaching the coast. Long swells, which have travelled hundreds of kilometres, may have wave periods of up to

20 seconds, while smaller sea waves have wave periods of 5 to 8 seconds. Where ocean depths are greater than the length of the waves, the wave motion does not extend to the ocean floor and therefore remains unaffected by it. As the ocean depth falls below half the wavelength, the bottom increasingly affects the wave motion. As the depth of water decreases, the wave height increases rapidly and the wavelength decreases rapidly. Thus, the wave becomes more peaked as it approaches the shore, finally curling over as a breaker and breaking on the shore. As the wave breaks, its potential energy is converted into kinetic energy, providing a large amount of energy for the wave to do work along the shoreline. Transportation by waves and currents is necessary to move rock particles eroded from one part of a coastline to a place of deposition elsewhere.

One of the most important transport mechanisms results from wave refraction. Since waves rarely break onto a shore at right angles, the upward movement of water onto the beach (swash) occurs at an oblique angle. However, the return of water (backwash) is at right angles to the beach, resulting in the net movement of beach material laterally. This movement is known as beach drift. The endless cycle of swash and backwash, and resulting beach drift, can be observed on all beaches. Frequently, backwash and rip currents cannot remove water from the shore zone as fast as it is piled up there by waves. As a result, there is a build-up of water that results in the lateral movement of water and sediment just offshore in a direction with the waves. The currents produced by the lateral movement of water are known as longshore currents. The movement of sediment is known as longshore drift, which is distinct from the beach drift described earlier, operating on land at the beach. The combined movement of sediment via longshore drift and beach drift is known as littoral drift. Tidal currents along coasts can also be effective in moving eroded material. While incoming and outgoing tides produce currents in opposite directions daily, the current in one direction is usually stronger than in the other, resulting in a net one-way transport of sediment. Longshore drift, longshore currents, and tidal currents in combination determine the net direction of sediment transport and areas of deposition. The use of multi-temporal satellite data can illustrate the dynamics of the coast (NRSA, 2007)

1.7.4.1. Beach: A gently sloping zone, typically with a concave profile, of unconsolidated material that extends landward from the low-water line to

the place where there is a definite change in material or physiographic form (such as a cliff) or to the line of permanent vegetation (usually at the effective limit of the highest storm waves).

1.7.4.2. Beach ridge: A low, essentially continuous mound of beach or beach and dune material (such as sand, gravel, or shingle) heaped up by the action of waves and currents on the backshore of a beach, extending beyond the present limit of storm waves or the reach of ordinary tides. They occur singly or as one of a series of approximately parallel deposits. The ridges are roughly parallel to the shoreline and represent successive positions of an advancing shoreline.

1.7.5 Landforms of Structural Origin

The landforms of structural origin are related to the structural aspects of the area. Most of the landforms under this class have a genesis related to the underlying structure. Structure plays an important role in reducing the resistance of rock, which manifests itself in different geomorphic forms. Some of the variations are minor, while others occur on a mega-scale. Mega-scale forms have a dramatic effect on the genesis of landforms, and hence mapping such forms indirectly indicates the structural setup of the area. Mega-scale structural features like faults and folds, depending on their type, play an important role in the genesis of structural landforms. The influence of geologic structures on the development and appearance of landscapes is prominent. This influence ranges from large features, which exert a dominant influence on the form of an entire landscape, to small features, which affect an individual landform and the geomorphic processes operating on it. The structural control could be active structures whose form is directly impressed on the modern landscape or ancient structural features whose influence on a modern landscape is primarily due to differential erosion (NRSA, 2007).

1.7.5.1. Structural Hills: Hills and valleys that originate due to tectonic processes and are highly dissected by drainage lines. This classification can be further categorized into high, moderate, and low dissection, depending on the density of joints and drainage. Mostly, this interpretation will be derived from planimetric satellite data, and the classification is highly subjective.

1.7.6 Landforms of denudational origins

The landforms of denudational origin are formed where the denudation process dominates over other processes. Most of the landforms resulting from this process are the combined effect of mechanical and chemical weathering. Denudation is the process of material removal by erosion and weathering, which has a direct influence on the relief of the area, especially in the reduction of relief to the base level. The agents involved are mostly water, ice, and wind. The major factors affecting denudation are geology, climate, tectonics, and anthropogenic effects. All rocks and minerals at or near the surface are subject to attack by physical and chemical processes. The effect of these processes is not uniform everywhere due to varying resistance to change in rocks. As a result, weathering and erosion yield some landforms with typical shapes and forms. Weathering is an essential part of the rock cycle, where the parent material or rock-weathered material is disaggregated to form smaller fragments, and some minerals are dissolved and removed by water agents. This removal of material is erosion and is accomplished by running water, wind, glaciers, etc. Weathering provides raw material for sedimentary rock and soil (NRSA, 2007)

1.7.6.1. Denudational Hill: It is a highly dissected hill that has had its structures obliterated.

1.7.6.2. Pediment: A broad, flat, or gently sloping erosion surface or plain of low relief, typically developed by sub aerial agents (including running water) in an arid or semiarid region at the base of an abrupt and receding mountain front or plateau escarpment. It is underlain by bedrock (occasionally by older alluvial deposits) that may be bare but more often partly mantled with a discontinuous veneer of alluvium derived from the upland masses and in transit across the surface.

1.7.6.3. Pediplain: An extensive, multi-concave, rock-cut erosion surface formed by the coalescence of two or more adjacent pediments and occasional desert domes, representing the result (the "peneplain") of the mature stage of the erosion cycle. They are further classified based on the thickness of weathering as shallow, moderate, and deep pediplains.

1.7.7 Structural Features of Visakhapatnam District

The district forms a part of the Eastern Ghats Mobile Belt, exposing all the characteristic litho units of the Eastern Ghat Supergroup, such as Khondalite, Charnockite, and Migmatite. Marine sediments of active beaches and tidal flats are seen in the narrow Coastal plain. The coastal plain south of Elamanchili is rocky and scarp, believed to be fault-controlled. The rocks along the coast bear impressions of sea-level fluctuations up to an elevation of 130m above mean sea level.

The structural grain of the litho units is defined by foliation, considered to have developed because of the first phase of folding, and uniformly shows parallelism with the primary layering wherever preserved. The strike of the foliation varies from Northeast - Southwest to Northwest - Southeast with moderate to steep dips. The rocks have been subjected to tight isoclinal folding with a regional trend of Northeast - Southwest. Faults and lineaments trending mostly northeast (NE) - southwest (SW) and northwest (NW) - southeast (SE) are seen in the area.

This area is covered with denudational hills ranging between 30 to 510m above mean sea level. Kailasa range and Yarada range are two important hill ranges. Kailasa hill range limits the Visakhapatnam city in the western boundary, whereas the Yarada range is located on the eastern side. These two ranges are separated from each other by a vast tidal basin, a few scattered hillocks, and portions of low land. The above-mentioned two hill ranges attain a maximum height of 506 and 356m respectively, extending nearly east to west, deviating from the general Northeast – Southwest trend of Eastern Ghats. These two hill ranges typically end their extremities into the sea as promontories. One such promontory formed by the Yarada range is Dolphin’s Nose, famous for its shape resembling a fish dolphin. The Structural Map of Visakhapatnam District is shown in Figure 16.

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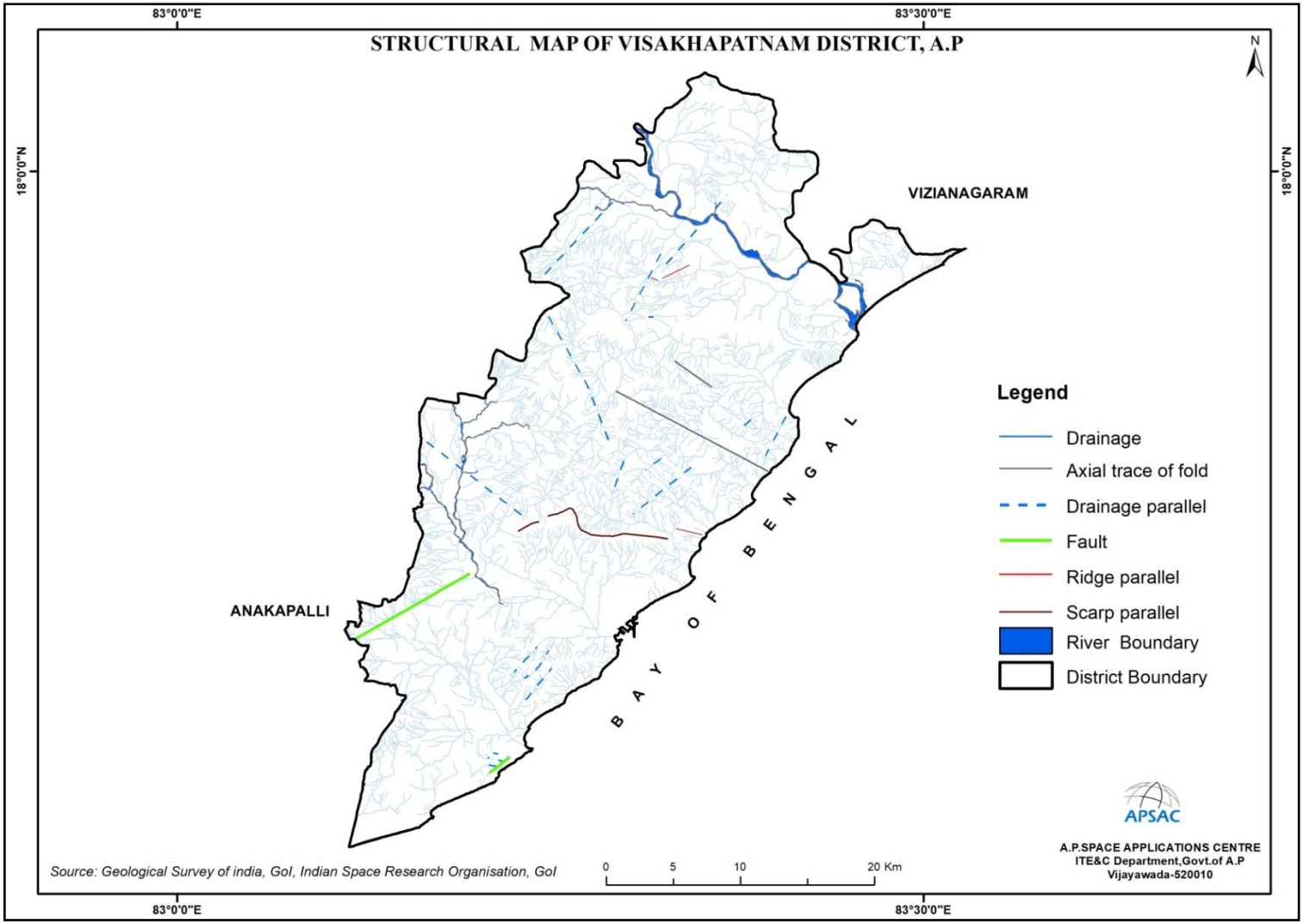


Figure-16: Structural Map of Visakhapatnam District, Andhra Pradesh

1.7.8 Ground Water Quality in the Visakhapatnam District

The groundwater quality laboratory analyzed physicochemical parameters such as Total Dissolved Solids, Total Hardness, Chlorides, Nitrate, pH, Fluoride, Iron, Alkalinity, and Sulphate using standard techniques. Groundwater quality samples were collected for two seasons, i.e., post-monsoon and pre-monsoon, from December 2017 to June 2019 by the Rural Water Supply and Sanitation Department (RWSS). These samples were compared with the Bureau of Indian Standards, 2015 Groundwater Quality standards, in terms of desirable, permissible, and non-potable classes. Blue, yellow, and red colors indicate pre-monsoon quality, while + and - symbols indicate post-monsoon quality for desirable, permissible, and non-potable classes, respectively.

From the analysis, it has been observed that groundwater is polluted in both pre-monsoon and post-monsoon seasons, with about 10% of the area falling under the non-potable category due to high concentrations of Nitrate, Total Dissolved Solids, and Fluoride. Further, approximately 75% of the area is in the potable category, while the remaining 15% is covered with hills and water bodies throughout the district. The occurrence and movement of groundwater in an area are governed by several factors, such as topography, lithology, geological structure, depth of weathering, extent of fractures, drainage pattern, and climate conditions, along with the interrelationship between these factors. The groundwater quality map of Visakhapatnam District is shown in Figure 17.

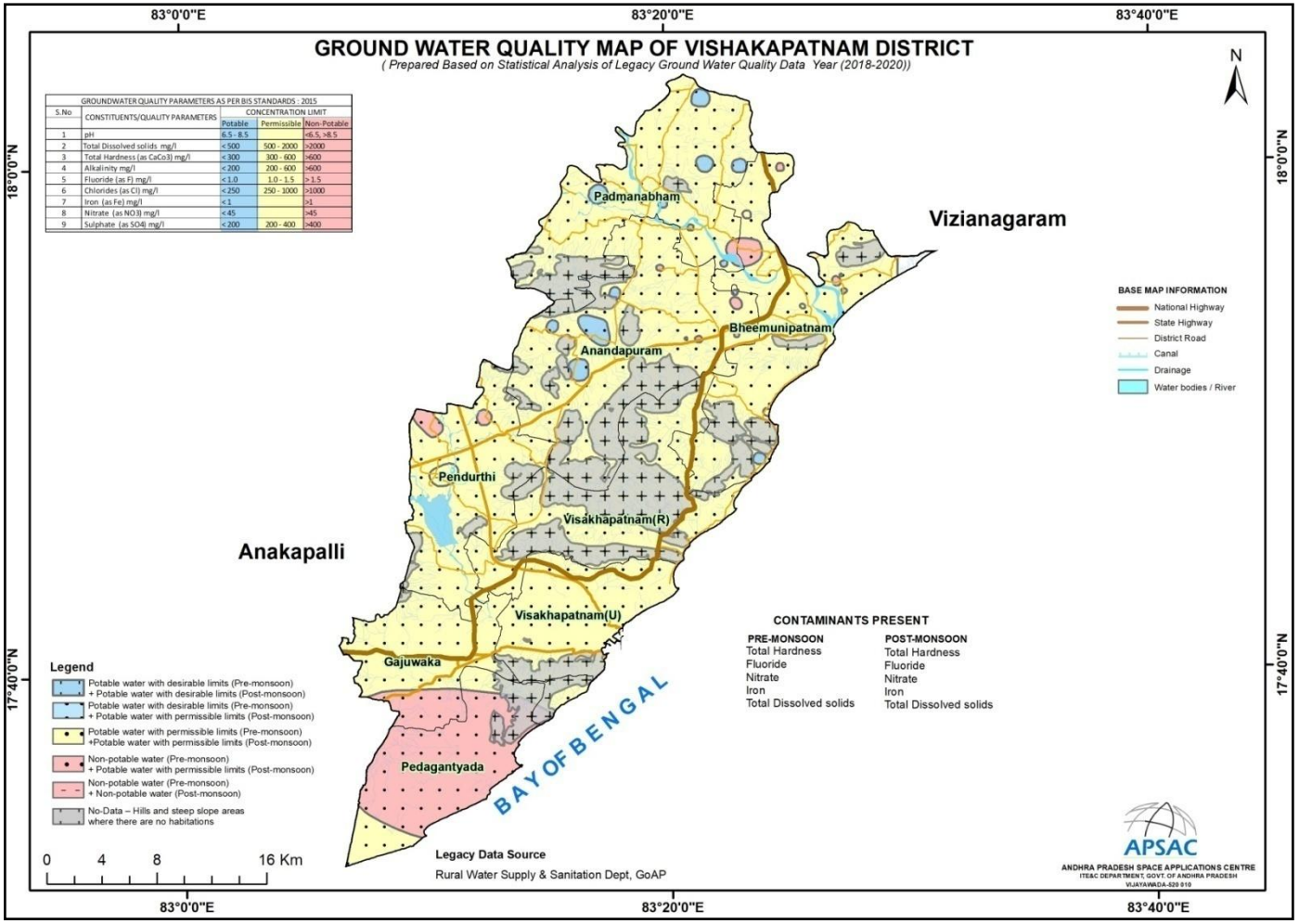


Figure-17: Ground Water Quality Map of Visakhapatnam District

Chapter – II Minor Minerals

2.1 Overview of Mining Activity

The following leases exist in this Visakhapatnam office jurisdiction. Mineral Regulatory, the important functioning of this office in these aspects are:-

i. Achievement of Targets of Mineral Revenue collections being fixed to this office annually
ii. Receiving and processing of the Mineral Concession Applications duly conducting the technical inspection, Survey and demarcation of the Mineral bearing applied areas
iii. Execution and Regulation of the operations of the Mining / Quarry leases in accordance with the Acts and Rules
iv. Issuing of dispatch permits duly collecting the Advance Royalty / Seig.fee from the lease holders on the minerals produced and intend to dispatch from their leased areas through online permit system
v. Controlling the illegal Mining / Quarrying and transportation by conducting the periodical inspections of the Mines and Quarries and also conducting the surprise vehicular checking and imposing the penalties
vi. Finalisation of Demand, Collection and Balance statements of the leases on annual basis

2.2 Geology of the District

Genaralized Litho-stratigraphic Succession of Andhra Pradesh

Geological Time (a)	(b)	Supergroup (c)	Group	Formation (d)
Holocene		-	-	Alluvium, river terraces, beach sands and soils
Pleistocene		-	-	Laterite and Gravel
Mio-Pilocene		-	-	Rajahmundry Fm.
Late Cretaceous Eocene		-	-	Deccan Trap with infra-and inter-trappeans
Lower Cretaceous	Gondwana	Upper Gondwana	Godavari Valley (Fluviatile)	Coastal Area (Fluvio-marine) Tirupati Fm.

to Upper Carboniferous			Chikiala Fm. Gangapur Fm.	(Vejendla Fm) Raghavapuram Fm. (Vemavaram), Kandukuru, SriperambadurFms)
		Lower Gondwana	Kota Fm. Maleri Fm.	Gollapalle Fm. (Satyavedu Fm.) Kamthi Fm. Barren Measures, Barakar Fm. Talchir Fm.

			Cuddapah Basin	**Pakhal Basin**
Sullavai Sandstone				
Middle to Upper Proterzoic (980-500 m.y)		Kurnool	Nandyala Shale Koilakuntla Limestone PanyamQuarzite Owk Shale Narji Limestone Banaganapalli Quartzite	Putnur Limestone Penganga Group Takalapalle Arkose
Middle Proterozoic (1600-1300 m.y.)	Cuddapah	Nallamalai Chitravathi Papaghni	**Srisailam Quartzite** Cumbum Fm. Mulug Group Bairankonda Quartzite Gandikota Quartzite Tadipatri Fm. Pulivendula Quartzite Mallampalli Group Vempalle Fm. Gulcheru Quartzite	**Alabaka Sandstone** Lankavaram Shale Pattipalle Quartzite Polavaram Fm. Jakaram Arkose Pandikunta Shale Gunjeda Dolomite Bayyaram Quartzite Bolapalle Fm.

EPARCHAEAN INTERVAL

Middle Proterozoic to Late Archean (2600-970 m.y)	Eastern Ghats	Charnockite	Charnockite with megacrystic k-feldspar charnockite
		Khondalites	Two pyrozene granulite / amphibolite Calc-silicate / granulite, Garnet-sillimanite-quartz-graphite gneiss (biotite-k-feldspar (Khondalite) Quartzite (gernet, sillimanite)
Late Archaean (2700 m.y)	Dharwar	Ramagiri-Penakacherla, Kolar, Kadiri, Gadwal-Narayanpet, Jonnagiri, VeligalluPeddavuru Schist Belts &W.Part of Nellore Belt.	Pyroclastic Rocks, local conglomerate / event conglomerate Metabasalt (Pillowed), Acid volcanics, minor and esite, dacite, rhyodacite, amphibolites, metaultramafics, minor quartzite, calcsilicates, phyllites, intrusives of basic rocks and granites, rare lamprophyres.
Middle Archaean (3100-2900 y.m)	Older Supracrustals (Sargur)	Eastern and Southern parts of Nellore.	High Grade schists include include garnet, staurolite, kyanite, sillimanite, cordierite (rarely sapphirine-kornuropine as in Karimnagar) Mica schists, calcilicate rocks, crystalline limestone (minor). BIF, fuchsite quartzite, hornblende granulite, amphibolite, migmatite streaky biotite gneiss.
Gneissic Complex			Banded Tonalite-Trondhjemite Gneiss.

Geologically, the State of Andhra Pradesh forms a part of peninsular India and is one of the most ancient land masses. The geological formations of Andhra Pradesh range from the oldest to the recent.

Sargur Supracrustals are the oldest rocks in Southern India, primarily occurring as enclaves within migmatitic gneiss formations. They are predominantly found in the eastern and southern parts of the Nellore schist belt. The lithology of Sargur consists mainly of garnet and staurolite schists, kyanite schists, Banded Iron Formations (BIFs), quartzites, granulites, and amphibolites. The gneissic complex comprises banded tonalite-trondhjemite gneiss, which forms the basement rock of the study area, along with migmatitic gneiss and biotite granite gneiss. TTGs (Tonalite-Trondhjemite-Granodiorite) are sodic, quartz-bearing granitic plutonic rocks, with plagioclase as the most common feldspar and K-feldspar ranging from subordinate to nearly absent.

The Dharwar rocks in Andhra Pradesh are exposed in the western part of the Nellore belt and in various other areas such as Anantapur, Ramagiri-Penakacherla, Kolar, Kadiri, Gadwal-Narayanpet, Jonnagiri, Veligallu Peddavuru Schist Belts, and the western part of the Nellore Belt. Lithologies mostly comprise metabasalt (pillowed), acid volcanics, minor and esite, dacite, rhyodacite, amphibolites, meta-ultramafics, minor quartzite, calcsilicates, phyllites, intrusives of basic rocks and granites, rare lamprophyres, as well as some pyroclastic rocks and local conglomerates, defining hiatus in stratigraphy observed in the study area. Rocks ranging from middle Proterozoic to late Archaean are exposed in the Eastern Ghats mobile belt, characterized by extremely high-grade metamorphism, falling under the granulite metamorphic facies. They predominantly include khondalites and charnockites. The metamorphic facies of rocks in the Eastern Ghats extends up to the granulite facies. Charnockite with megacrystic K-feldspar, Two-pyroxene granulite/amphibolite, calc-silicate/granulite, garnet-sillimanite-quartz-graphite gneiss (biotite-K-feldspar), and quartzite (garnet, sillimanite) are exposed in most of the state.

The Cuddapah Basin is a part of the Dharwar Craton and is the second-largest Purana basin in Peninsular India. It marks the profound Eparchaen unconformity in early literature. The formation of the Cuddapah Basin exposes rocks ranging from the late Proterozoic to the upper Proterozoic.

It is divided into four groups: Nallamalai, Chitravathi, Papaghni, and Kurnool. Papaghni comprises dolomite and limestones, Chitravathi comprises shale, dolomite, and quartzites, Nallamalai comprises shale, quartzites, and arkosic sandstones, and Kurnool comprises shales, quartzites, and limestones. The Cuddapah Basin is characterized by a rhythmic pattern of quartzite-shale-carbonates cycles. Uraniferous limestone is also reported from the Cuddapah Basin. Major exposures of Purana rock formations are found in Prakasam, Kurnool, Cuddapah, Chittoor, and Nellore. The Deccan Traps are found in the East and West Godavari districts, with exposures near Rajahmundry. Tertiary formations are found in the East and West Godavari and Visakhapatnam districts, while Quaternary sediments occur as thick blankets of alluvium in river valleys, deltas, and along the East coast.

The study area geologically belongs to the Precambrian age and is characterized by the occurrence of metasediments and intrusive meta-igneous bodies. Apart from metasediments, the area is also marked by the occurrence of recent sediments such as red sediments with calcium carbonate calcretes, dune sands, and beach sands with economically important black sand concentrations. All these rocks and sediments exhibit a variety of geomorphic features distributed from the deepest hinterland to near coastal plains.

The study area is characterized by the Eastern Ghats mobile belt. This area is covered with denudational hills ranging between 30 to 510 meters above mean sea level. The Kailasa range and Yarada range are two important hill ranges. The Kailasa hill range marks the western boundary of Visakhapatnam city, while the Yarada range is situated on the eastern side. These two ranges are separated by a vast tidal basin, scattered hillocks, and low-lying areas. The Kailasa and Yarada ranges reach maximum heights of 506 and 356 meters respectively, extending nearly east to west, thus deviating from the general northeast (NE)–southwest (SW) trend of the Eastern Ghats. They typically terminate into the sea as promontories, with one such prominent feature being the Dolphin’s Nose, formed by the Yarada range, famous for its resemblance to a dolphin.

Garnet–sillimanite–biotite gneisses (Khondalites), hypersthene granites (Charnockites), and quartzite are the chief rock types occurring as bedded, banded, and massive formations in the Visakhapatnam district. The area can be termed as an Archean high-grade metamorphic

migmatite complex of the Eastern Ghats mobile belt. The Eastern Ghats Super Group, comprising the Khondalite and Charnockite Groups, is exposed in the central part of the upland area. They consist of quartz, K-feldspar, garnet, sillimanite, and graphite, with or without corundum. The geological map and detailed legend with a stratigraphic sequence of the Visakhapatnam district are shown in Figure-18.

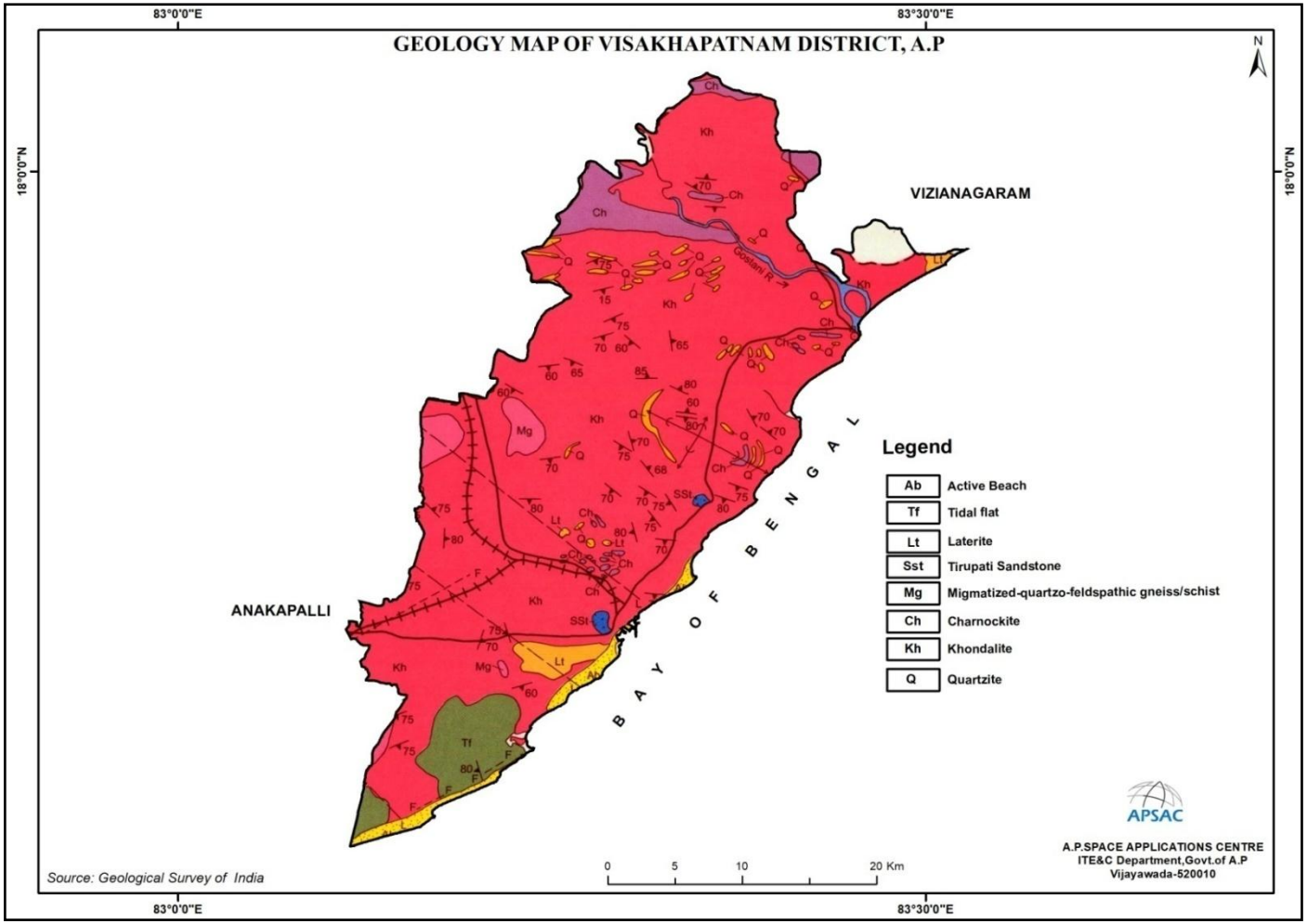
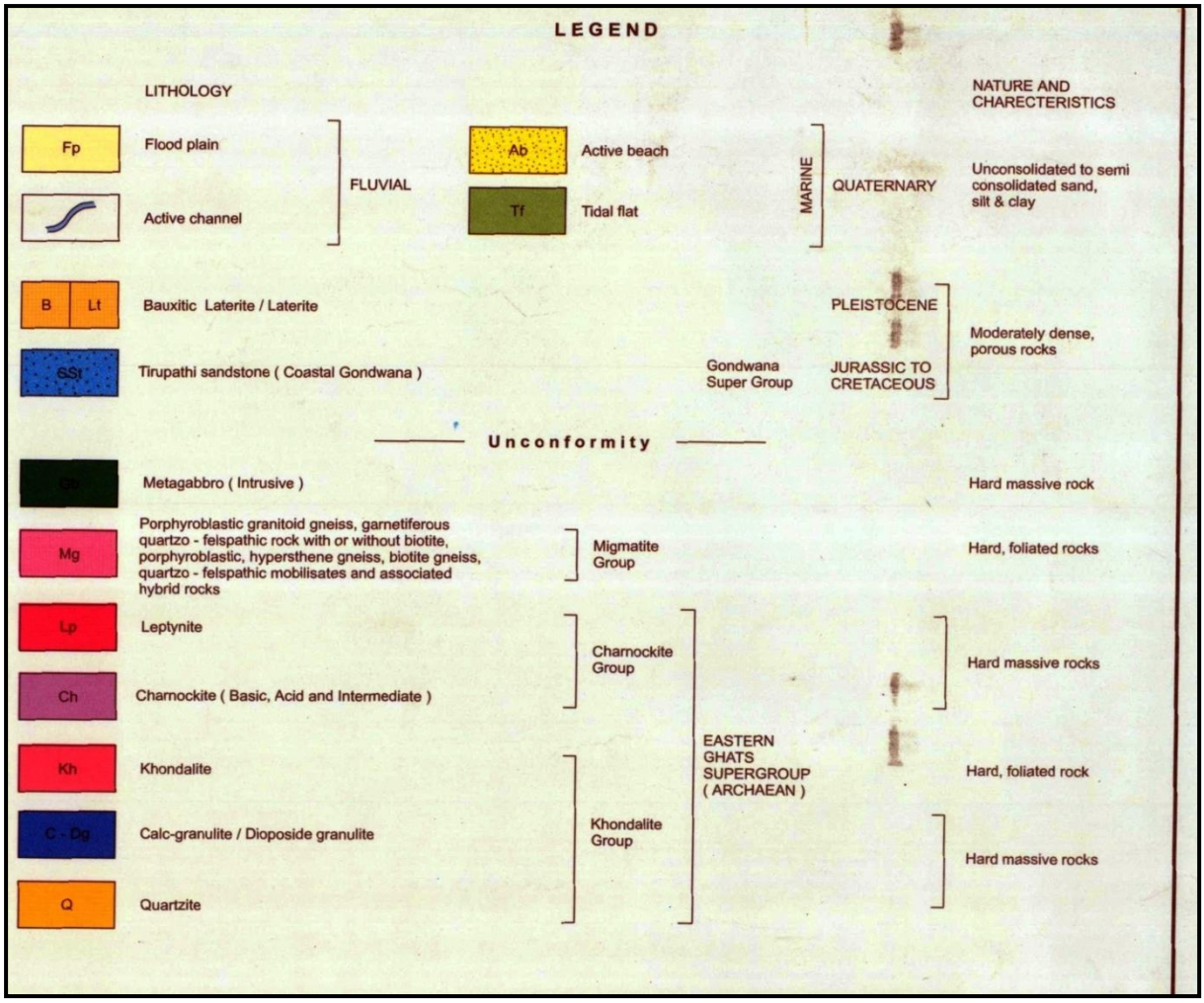


Figure 18: Geology of Visakhapatnam District, Andhra Pradesh (Source: GSI, 2000)



Detailed Legend with Stratigraphic Sequence of Visakhapatnam District

2.3 Minor Mineral Resources of Visakhapatnam District:

As per literature (GSI, 2000) the following minerals are *available in Anantapuramu District. (Data Source: Assistant Director of Mines and Geology, Visakhapatnam District, Andhra Pradesh).* A brief description of each mineral is as follows.

2.3.1. Building Stone: In Visakhapatnam district, building stone minerals are mainly used in the construction of foundations, walls, lintels, columns, arches, dams, retaining walls, harbors, lighthouses, barrages, piers, and abutments of bridges. The building stone mineral is available in Gandigundam, Jagannadhapuram, and Ramavaram villages in Anandapuram Mandal, Dakamarri village in Bheemunipatnam Mandal, Bhandevupuram, Krishnapuram, Pandrangi, Reddipalle Agraharam

villages in Padmanabham Mandal, Pedagantyada village in Pedagantyada Mandal, and Sowbhagya Rayapuram village in Pendurthi Mandal.

2.3.2. Road Metal: Road metals are mainly used in the construction or repair of roads or railways. These mainly occur in Pakeru, Ramavaram villages in Anandapuram Mandal, Bodamettapalem village in Bheemunipatnam Mandal, Bhandevupuram, Krishnapuram, Reddipalle Agraharam villages in Padmanabham Mandal, and Porlupalem village in Pendurthi Mandal of Visakhapatnam District.

2.3.3. Gravel: Gravel is mainly used for road construction, for mixing with asphalt, as construction fill, and in the production of construction materials like concrete blocks, bricks, and pipes. It is available in Gandigundam, Jagannadhapuram, and Ramavaram villages in Anandapuram Mandal, Dakamarri village in Bheemunipatnam Mandal, Bhandevupuram, Krishnapuram, Pandrangi, Reddipalle Agraharam villages in Padmanabham Mandal, Porlupalem, and Sowbhagya Rayapuram villages in Pendurthi Mandals of Visakhapatnam District.

2.3.4. Manufactured Sand: Manufactured sand is mainly used as a substitute for river sand for construction purposes, mostly in the production of concrete and mortar mix. It is available in Krishnapuram and Reddipalle Agraharam village in Padmanabham Mandal of Visakhapatnam District.

2.3.5. Rough Stone: Rough stones are mainly used in blacksmithing, engineering, and jewel crafting. They are available in Jagannadhapuram village in Anandapuram Mandal, Krishnapuram village in Padmanabham Mandal, Pedagantyada village in Pedagantyada Mandal, and Porlupalem village in Pendurthi Mandals of Visakhapatnam District.

2.3.6. Quartzite: Quartzite is also quarried for paving blocks, riprap, road metal (crushed stone), railroad ballast, and roofing granules. It is available in Jagannadhapuram village in Anandapuram Mandal. The mineral resources map of the Visakhapatnam district is shown in Figure 19.

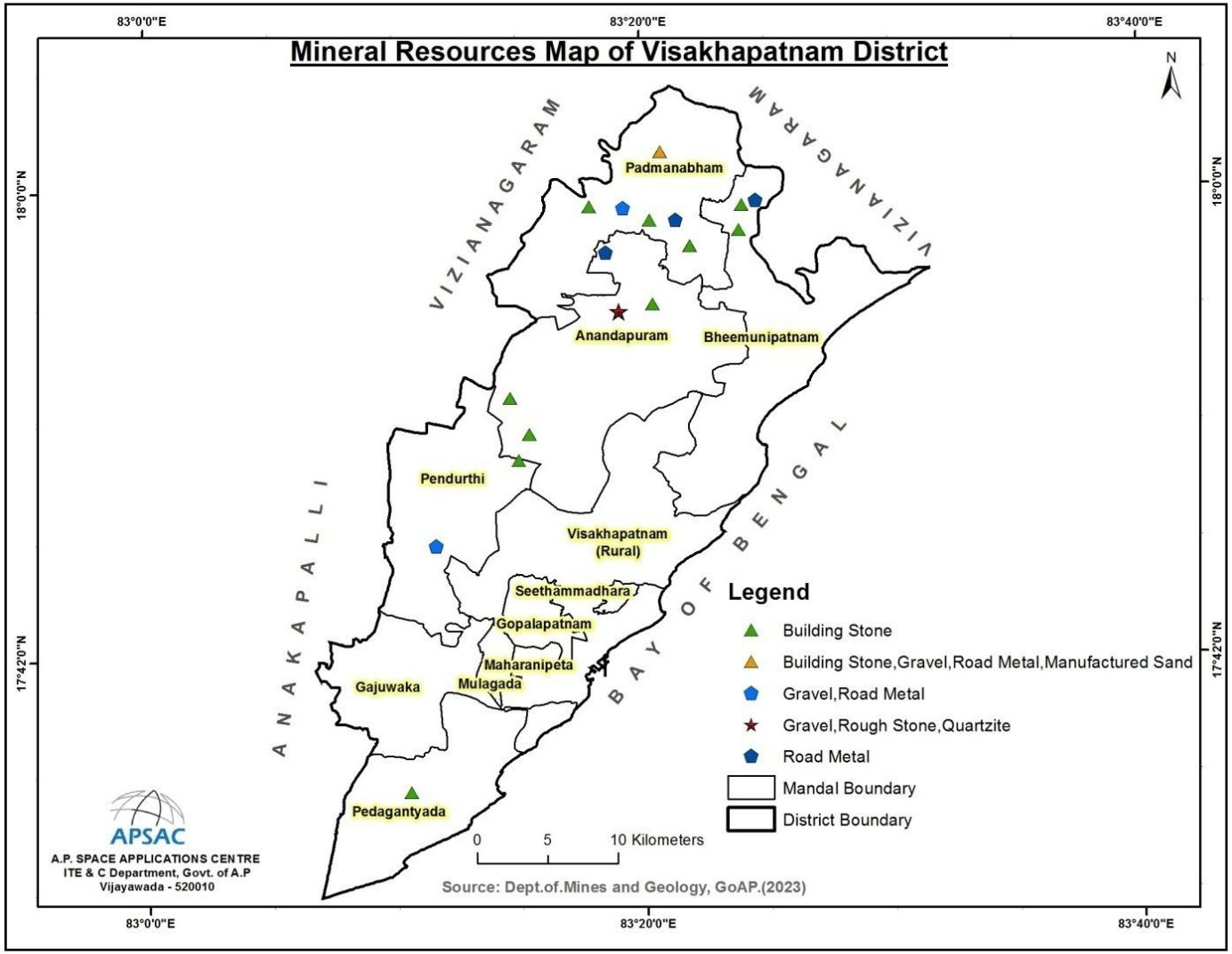


Figure-19: Mineral Resurce Map of Visakhapatnam District

Statement Showing the Details of Operative leases in the jurisdiction of District Mines and Geology Officer, Visakhapatnam in Table-14

Table 14 Details of Operative leases in the jurisdiction of District Mines and Geology Officer, Visakhapatnam

S.No	Lessee Name	Mineral	Lessee Id	GPS Coordinates		Mandal	Village	Extent	Survey No	Execution Date	Expiry Date	Remarks
				Latitude	Longitude							
1	Sri sowbagya quarry workers mutually aided labour contract cooperative society	Building Stone,Gravel	311070126	17-48-48.64970	83-15-02.67338	Pendurthi	Sowbhagya rayapuram	1	100	04-08-2007	03-08-2027	ACTIVE
				17-48-50.15169	83-15-03.32310							
				17-48-48.90690	83-15-06.45924							
				17-48-44.40093	83-15-04.51007							
2	sri siva ganesh mutually aidedcoperative society	Building Stone,Gravel	311070127	17-48-50.15169	83-15-03.32310	Pendurthi	Sowbhagya rayapuram	1	100	04-08-2007	03-08-2027	ACTIVE
				17-48-51.65368	83-15-03.97283							
				17-48-53.41286	83-15-08.40844							
				17-48-48.90690	83-15-06.45924							
3	G.Vijay Gopal	Building Stone,Gravel	311140129	17-48-57.12070	83-14-58.01947	Pendurthi	Sowbhagya rayapuram	4.37	100	19-05-2014	18-05-2024	ACTIVE
				17-48-55.56977	83-15-02.00058							
				17-48-43.63783	83-14-55.26215							
				17-48-46.35068	83-14-53.44009							
				17-48-53.82660	83-14-56.60215							
4	V.VISWESWARARAO	Building Stone,Gravel	311230508	17-46-80.80014	83-11-44.29031	Pendurthi	Porlupalem	3.31	75	30-01-2023	29-01-2033	ACTIVE
				17-46-60.85651	83-11-48.81756							
				17-46-70.46377	83-11-50.68703							
				17-46-11.54489	83-11-53.01511							
				17-46-13.51148	83-11-49.99963							
				17-46-12.95042	83-11-47.23405							
				17-46-10.12936	83-11-44.64942							
5	K.DIWAKAR	Gravel,Road Metal,Rough Stone	311170315	17-46-17.84284	83-12-04.13472	Pendurthi	Porlupalem	12.86	75	20-11-2017	28-11-2027	INACTIVE
				17-46-13.25283	83-12-08.94746							
				17-46-00.41529	83-11-57.66991							
				17-46-07.46377	83-11-50.68703							
				17-46-13.94401	83-11-56.20896							
				17-46-11.89926	83-11-58.85113							
6	P.Srinivasa Rao	Road Metal	311040005	17-57-47.44481	83-18-27.20790	Anandapuram	Pekeru	0.809	4	04-03-2004	03-03-2024	INACTIVE
				17-57-48.32338	83-18-30.42632							
				17-57-47.86417	83-18-30.68181							
				17-57-46.45272	83-18-30.97001							
				17-57-44.57559	83-18-28.30108							
				17-57-44.45992	83-18-28.02022							
7	V.V.R.Associates	Road Metal	311060003	17-57-48.64627	83-18-23.85797	Anandapuram	Pekeru	0.8	4	27-12-2006	26-12-2026	INACTIVE
				17-57-49.55978	83-18-25.04689							
				17-57-43.90713	83-18-26.67792							
				17-57-43.40706	83-18-25.46367							
				17-57-43.46880	83-18-25.13011							
8	V.V.R Associates	Road Metal	311070004	17-57-48.64627	83-18-23.85797	Anandapuram	Pekeru	1	4	27-10-2007	31-03-2024	INACTIVE
				17-57-49.55978	83-18-25.04689							

				17-57-43.90713	83-18-26.67792							
				17-57-43.40706	83-18-25.46367							
				17-57-43.46880	83-18-25.13011							
9	V.V.R. Associates	Road Metal	311100002	17-57-47.05239	83-18-25.77038	Anandapuram	Pekeru	0.4	4	30-04-2010	29-04-2025	INACTIVE
				17-57-47.44481	83-18-27.20790							
				17-57-44.45992	83-18-28.02022							
				17-57-43.90713	83-18-26.67792							
10	SRI M.RAMARAJU	Building Stone,Gravel	311180326	17-55-26.96029	83-19-09.57833	Anandapuram	Jagannadhapuram	4.86	1	18-05-2018	17-05-2028	ACTIVE
				17-55-27.28465	83-19-28.85129							
				17-55-24.46043	83-19-28.92802							
				17-55-24.11298	83-19-09.63335							
				17-55-37.63230	83-19-20.25151							
				17-55-39.20404	83-19-11.77308							
11	Sri M. Rama Raju	Gravel,Rough Stone,Quartzite	311180329	17-55-41.27567	83-19-28.12560	Anandapuram	Jagannadhapuram	22.5	1	30-06-2018	29-06-2038	ACTIVE
				17-55-37.63230	83-19-20.25151							
				17-55-39.20404	83-19-11.77308							
				17-55-42.42049	83-19-03.90987							
				17-55-38.86803	83-19-04.17931							
				17-55-37.04954	83-19-08.19566							
				17-55-26.96029	83-19-09.57833							
				17-55-27.28465	83-19-28.85129							
12	K SHANTHARAM	Gravel,Rough Stone	311230512	17-55-22.55572	83-19-07.60972	Anandapuram	Jagannadhapuram	10.268	1	06-05-2023	05-05-2033	ACTIVE
				17-55-25.16821	83-18-54.76381							
				17-55-30.25181	83-18-58.20801							
				17-55-31.09937	83-19-08.97068							
				17-55-26.87461	83-19-09.47993							
				17-55-26.86462	83-19-08.82012							
				17-55-24.06451	83-19-08.84991							
				17-55-24.17231	83-19-13.43491							
				17-55-19.62144	83-19-13.30224							
				17-55-19.61754	83-19-07.31844							
13	Sri Ravuri Mahesh	Building Stone,Gravel	311180331	17-53-07.94534	83-14-56.39977	Anandapuram	Gorinta	2	8	19-07-2018	18-07-2028	INACTIVE
				17-53-07.61146	83-14-58.44497							
				17-53-06.70490	83-15-00.23063							
				17-53-05.19917	83-15-01.23851							
				17-53-01.83318	83-14-53.04153							
14	Sri Karrothu Pydi Naidu	Building Stone,Gravel	311170286	17-54-52.25742	83-20-41.02317	Anandapuram	Chandaka	4.6	12	09-01-2017	08-01-2027	INACTIVE
				17-54-53.90049	83-20-49.22148							
				17-54-54.72082	83-20-50.66538							
				17-54-51.33734	83-20-51.87652							
				17-54-50.07507	83-20-50.23657							
				17-54-49.96893	83-20-49.42901							
				17-54-48.89433	83-20-46.50568							
				17-54-48.59608	83-20-42.91406							
				17-54-47.52845	83-20-40.24855							
				17-54-48.08540	83-20-38.09703							
				17-54-49.95466	83-20-39.34734							
15	Sri K Rama Mohan Reddy	Building Stone,Gravel,Road Metal	311180317	17-51-23.16	83-14-44.10	Anandapuram	Ramavaram	3	63	02-02-2018	01-02-2028	ACTIVE
				17-51-25.62	83-14-48.40							
				17-51-22.00	83-14-52.67							
				17-51-18.54	83-14-51.85							
				17-51-20.29	83-14-46.84							

16	A.Demudu Babu	Building Stone,Gravel	311080001	17-50-38.73012	83-15-08.48940	Anandapuram	Gandigundam	0.5	15	03-03-2008	03-03-2028	ACTIVE
				17-50-39.85267	83-15-11.02222							
				17-50-38.03875	83-15-11.77244							
				17-50-36.91627	83-15-09.23973							
17	Smt.S.Nagamani	Building Stone,Gravel,Road Metal,Manufactured Sand	311160254	17-59-42.05	83-21-5.44	Padmanabham	Reddipalle agrm.	1.5	295	08-06-2016	07-06-2026	INACTIVE
				17-59-45.15	83-21-7.14							
				17-59-42.41	83-21-12.65							
				17-59-40.61	83-21-11.54							
18	M/s. Vishupriya Granites	Building Stone,Gravel,Road Metal,Manufactured Sand	311160271	17-59-36.84437	83-21-18.54089	Padmanabham	Reddipalle agrm.	8	294 & 295	10-05-2016	09-05-2026	ACTIVE
				17-59-31.66742	83-21-23.21356							
				17-59-22.07665	83-21-28.63775							
				17-59-16.21787	83-21-33.80073							
				17-59-26.77484	83-21-17.39686							
19	Theegala Sesha Saila	Building Stone,Gravel,Road Metal,Manufactured Sand	311160272	17-59-53.58595	83-20-55.42005	Padmanabham	Reddipalle agrm.	9.5	293p & 295p	17-05-2016	16-05-2026	ACTIVE
				17-59-52.34668	83-21-02.65231							
				17-59-47.20532	83-21-06.27574							
				17-59-47.90543	83-21-07.95088							
				17-59-47.88754	83-21-08.74625							
				17-59-41.52357	83-21-05.17693							
				17-59-43.78530	83-20-55.70997							
20	M/s. Nagabhushanam & Co.,	Building Stone,Gravel,Road Metal,Manufactured Sand	311160273	17-59-39.65976	83-21-12.97785	Padmanabham	Reddipalle agrm.	5	294 &295	10-05-2016	09-05-2026	ACTIVE
				17-59-36.84437	83-21-18.54089							
				17-59-26.77483	83-21-17.39688							
				17-59-30.20433	83-21-12.06496							
21	Sri Surakasi Sankara Rao	Building Stone,Gravel,Road Metal,Manufactured Sand	311160288	17-59-58.81847	83-20-20.75385	Padmanabham	Reddipalle agrm.	6	293	29-12-2016	28-12-2026	INACTIVE
				17-59-56.30025	83-20-36.05344							
				17-59-55.84542	83-20-39.61088							
				17-59-48.69684	83-20-39.45521							
22	Sri G.V.V.Harivarma	Building Stone,Gravel,Road Metal,Manufactured Sand	311160291	17-59-43.78530	83-20-55.70997	Padmanabham	Reddipalle agrm.	10	2932,94,295	29-12-2016	28-12-2026	INACTIVE
				17-59-39.65976	83-21-12.97785							
				17-59-30.20433	83-21-12.06496							
				17-59-39.94203	83-20-55.84685							
				17-59-40.00276	83-20-55.80184							
23	Sri S.Venkateswarlu	Building Stone,Gravel,Road Metal,Manufactured Sand	311160292	17-59-55.84542	83-20-39.61088	Padmanabham	Reddipalle agrm.	5.59	293	29-12-2016	28-12-2026	ACTIVE
				17-59-54.92086	83-20-46.93047							
				17-59-44.95477	83-20-46.36839							
				17-59-48.69684	83-20-39.45521							
24	Sri G.Girish Varma	Building Stone,Gravel,Road Metal,Manufactured Sand	311160293	17-59-54.92086	83-20-46.93047	Padmanabham	Reddipalle agrm.	9.75	293	07-12-2016	06-12-2026	ACTIVE
				17-59-54.65040	83-20-49.60590							
				17-59-53.58595	83-20-55.42005							
				17-59-39.87508	83-20-55.75296							
				17-59-44.95477	83-20-46.36839							
25	SHAIK BASHA	Building Stone,Gravel,Road Metal	311200449	17-59-40.29123	83-18-10.93981	Padmanabham	Bhandevupuram	4.6	98	28-11-2020	27-11-2030	INACTIVE
				17-59-40.21992	83-18-14.33692							
				17-59-39.79641	83-18-15.47013							
				17-59-39.03893	83-18-17.54671							
				17-59-32.59572	83-18-18.35932							
				17-59-31.09774	83-18-12.44671							
				17-59-33.86633	83-18-11.99291							
26	Ferro Alloys Corporation LLtd	Quartz	312990077	17-59-58.95270	83-16-39.14912	Padmanabham	Thimmupuram	50.75	29	09-02-1999	31-03-2024	INACTIVE
				17-59-45.94907	83-16-43.29197							

				17-59-44.61239	83-16-40.09794							
				17-59-42.68949	83-16-34.60988							
				17-59-41.66877	83-16-29.42781							
				17-59-40.11344	83-16-26.43686							
				17-59-38.04777	83-16-18.83555							
				17-59-38.15261	83-16-10.87128							
				17-59-38.17671	83-16-09.04633							
				17-59-37.52530	83-16-08.83872							
				17-59-37.99296	83-16-07.30848							
				17-59-37.54125	83-16-05.80203							
				17-59-40.54720	83-16-05.34825							
				17-59-40.63467	83-16-05.88658							
				17-59-40.42118	83-16-06.25801							
				17-59-40.63365	83-16-07.59336							
				17-59-39.84760	83-16-09.47235							
				17-59-48.25600	83-16-13.31386							
				17-59-48.96347	83-16-11.62273							
				17-59-49.01438	83-16-11.65396							
				17-59-48.98368	83-16-12.05326							
				17-59-53.99731	83-16-14.79335							
				17-59-55.73786	83-16-15.66369							
				17-59-57.10064	83-16-16.05317							
				17-59-56.86055	83-16-16.83418							
				17-59-57.80946	83-16-17.43994							
				17-59-57.48285	83-16-18.11997							
				17-59-59.05468	83-16-19.35937							
				17-59-58.73617	83-16-20.25968							
				18-00-00.57779	83-16-22.08053							
				18-00-00.27949	83-16-22.20302							
				18-00-01.11678	83-16-24.42979							
				18-00-01.10955	83-16-25.21213							
				18-00-01.65375	83-16-27.35541							
27	M/s SVS MOOKAMBIKA CONSTRUCTIONS PRIVATE LIMITED	Building Stone,Gravel,Road Metal	311230517	17-59-52.84058	83-20-31.92502	Padmanabham	Krishnapuram	21	1	13-03-2023	12-03-2026	ACTIVE
				17-59-36.69844	83-21-02.01474							
				17-59-33.30395	83-21-00.17556							
				17-59-45.30408	83-20-25.84611							
28	M/s. Nagabhushanam & Co.,	Building Stone,Gravel,Road Metal,Manufactured Sand	311160226	17-59-04.81013	83-21-05.94828	Padmanabham	Krishnapuram	3.687	77	11-03-2016	10-03-2026	INACTIVE
				17-59-05.11579	83-21-06.67151							
				17-59-02.11034	83-21-08.55546							
				17-58-58.96157	83-21-09.40256							
				17-58-57.84501	83-21-05.94701							
				17-58-57.75748	83-21-01.98937							
				17-58-59.73037	83-20-57.62722							
				17-59-01.58102	83-20-58.49614							
				17-59-00.93789	83-21-05.44827							
29	VVR Crushers & Constructions	Road Metal	311040084	17-59-02.64453	83-20-51.68763	Padmanabham	Krishnapuram	1.72	74/3	04-03-2004	31-03-2024	ACTIVE
				17-59-01.96015	83-20-52.85997							
				17-58-58.84461	83-20-57.36940							
				17-58-57.13086	83-20-57.23983							
				17-58-57.65940	83-20-52.61657							
				17-58-59.54534	83-20-52.63353							

				17-59-00.00474	83-20-50.62553							
30	P.Ratnalatha	Building Stone,Gravel,Road Metal	311050083	17-59-26.45843	83-21-4.82659	Padmanabham	Krishnapuram	2.428	1	21-11-2005	20-11-2030	ACTIVE
				17-59-25.90082	83-21-6.78025							
				17-59-19.73483	83-21-6.98579							
				17-59-17.13267	83-21-16.10274							
				17-59-16.50954	83-21-15.90850							
				17-59-20.22683	83-21-2.88426							
31	Smt. R.S. Anuradha	Road Metal	311050085	17-59-05.29033	83-21-01.88828	Padmanabham	Krishnapuram	0.5	77	26-10-2005	25-10-2025	ACTIVE
				17-59-05.00956	83-21-04.26223							
				17-59-02.73783	83-21-03.96889							
				17-59-03.01861	83-21-01.59495							
32	P.Ratnalatha	Building Stone,Gravel,Road Metal,Rough Stone	311100119	**The DGPS Survey is under process**		Padmanabham	Krishnapuram	6.5	1	18-01-2010	31-03-2024	IN-ACTIVE
33	vvr Crushers and constructions	Building Stone,Gravel,Road Metal,Rough Stone	311110122	**The DGPS Survey is under process**		Padmanabham	Krishnapuram	17.5	1	10-05-2011	05-09-2026	IN-ACTIVE
34	Sanjana Granites	Gravel,Road Metal	311130082	17-59-20.22683	83-21-2.88426	Padmanabham	Krishnapuram	4.05	1	25-06-2013	24-06-2028	ACTIVE
				17-59-16.50954	83-21-15.90850							
				17-59-13.39378	83-21-14.93731							
				17-59-17.11105	83-21-1.91313							
35	P.Prameela	Building Stone,Road Metal	311100199	17-58-49.88881	83-21-43.56551	Padmanabham	Pandrangi	1.5	41	18-01-2010	31-03-2024	INACTIVE
				17-58-50.32898	83-21-50.3001							
				17-58-49.04186	83-21-50.17142							
				17-58-48.68770	83-21-46.6591							
				17-58-48.68529	83-21-46.85720							
				17-58-45.79121	83-21-44.28820							
				17-58-48.37723	83-21-44.31021							
				17-58-48.60021	83-21-43.67612							
36	SriNeelamsettyChinnayya	Building Stone,Gravel	311170302	17-58-39.63398	83-21-19.03068	Padmanabham	Pandrangi	2.85	53	02-05-2017	01-05-2027	INACTIVE
				17-58-41.65523	83-21-21.59591							
				17-58-38.62593	83-21-22.83005							
				17-58-37.87244	83-21-21.40246							
				17-58-36.75985	83-21-20.20076							
				17-58-28.50176	83-21-16.63473							
				17-58-30.47001	83-21-22.69372							
				17-49-12.81581	83-20-3638386							
38	M/s. Saptagiri Stone Crusher	Road Metal	311110025	18-00-32.91923	83-24-41.47561	Bheemunipatnam	Bodamettapalem	3.642	67	12-08-2011	11-08-2026	ACTIVE
				18-00-32.62672	83-24-43.01547							
				18-00-29.03365	83-24-44.48407							
				18-00-28.72128	83-24-43.87046							
				18-00-26.70543	83-24-45.24629							
				18-00-31.25387	83-24-54.05388							
				18-00-30.91751	83-24-53.77607							
				18-00-30.08265	83-24-54.33842							
				18-00-29.21913	83-24-53.02939							
				18-00-27.78817	83-24-51.62944							
				18-00-27.56763	83-24-51.18173							
				18-00-28.21176	83-24-49.90034							
				18-00-28.74651	83-24-49.90763							
				18-00-28.78848	83-24-49.53162							
				18-00-27.32633	83-24-48.02337							

				18-00-25.72404	83-24-47.65321							
				18-00-26.12794	83-24-46.66439							
				18-00-25.37219	83-24-45.82828							
				18-00-24.74281	83-24-44.44616							
				18-00-24.74271	83-24-42.83529							
				18-00-24.45688	83-24-41.10147							
				18-00-25.84581	83-24-40.26072							
39	M/s. Sampath Granites	Road Metal	311100026	18-00-32.70249	83-24-43.01554	Bheemunipatnam	Bodamettapalem	1.283	67	06-04-2010	05-04-2025	INACTIVE
				18-00-33.04082	83-24-45.14795							
				18-00-34.25041	83-24-47.91458							
				18-00-31.86725	83-24-49.24397							
				18-00-29.10961	83-24-44.48432							
40	M/s. Mahesh Constructions Corpration	Road Metal	311080023	18-00-34.17671	83-24-47.91448	Bheemunipatnam	Bodamettapalem	3.642	67	05-10-2008	04-10-2023	INACTIVE
				18-00-35.45316	83-24-51.06579							
				18-00-36.28299	83-24-51.22517							
				18-00-36.00210	83-24-51.84140							
				18-00-35.50270	83-24-52.67106							
				18-00-34.06378	83-24-52.43955							
				18-00-33.68072	83-24-53.05368							
				18-00-34.42845	83-24-54.41707							
				18-00-34.39711	83-24-55.06752							
				18-00-33.21508	83-24-54.73551							
				18-00-32.89539	83-24-55.40994							
				18-00-31.25387	83-24-54.05388							
				18-00-26.70543	83-24-45.24629							
				18-00-28.72128	83-24-43.87046							
				18-00-31.79124	83-24-49.24391							
41	BOTCHA NAIDU BABU	Road Metal	311220483	18-00-32.99613	83-24-41.47561	Bheemunipatnam	Bodamettapalem	1.24	67	04-01-2022	03-01-2032	ACTIVE
				18-00-25.92266	83-24-40.26073							
				18-00-26.82271	83-24-39.71861							
				18-00-26.89403	83-24-38.85144							
				18-00-27.27351	83-24-38.68013							
				18-00-27.53729	83-24-37.65232							
				18-00-29.00179	83-24-37.32911							
				18-00-29.47341	83-24-37.55846							
42	Sri Sariki Naga Raju	Building Stone,Gravel	311180324	18-00-50.32529	83-24-05.03748	Bheemunipatnam	Dakamarri	0.5	235	18-04-2018	17-04-2028	INACTIVE
				18-00-50.06290	83-24-07.05787							
				18-00-47.39230	83-24-06.76203							
				18-00-47.61751	83-24-04.73675							
43	S.Prakash	Building Stone	311070030	18-00-49.84276	83-24-08.74777	Bheemunipatnam	Dakamarri	0.5	235	14-11-2007	13-11-2027	INACTIVE
				18-00-49.67537	83-24-10.13000							
				18-00-46.80494	83-24-09.20155							
				18-00-48.03126	83-24-06.83281							
44	T RAMANA	Building Stone	311210470	18-00-47.28449	83-24-11.62757	Bheemunipatnam	Dakamarri	1.5	235	15-03-2021	14-03-2031	INACTIVE
				18-00-49.46119	83-24-11.47221							
				18-00-50.46466	83-24-19.56211							
				18-00-48.64345	83-24-19.21391							
				18-00-47.08441	83-24-11.63661							
45	S.SATYANARAYANA	Building Stone	311210471	18-00-49.67537	83-24-10.13001	Bheemunipatnam	Dakamarri	0.5	235	15-03-2021	14-03-2031	INACTIVE
				18-00-49.46119	83-24-11.47221							
				18-00-47.28449	83-24-11.62757							

				18-00-47.08441	83-24-11.63661							
				18-00-46.80494	83-24-09.20155							
46	Gangavaram Port Ltd	Building Stone,Rough Stone	311130164	17-37-57.22956	83-13-33.74202	Pedagantyada	Pedagantyada (u)	8.093	24	31-07-2013	31-03-2024	ACTIVE
				17-37-46.49284	83-13-46.77414							
				17-37-44.14398	83-13-39.75850							
				17-37-45.40580	83-13-36.08723							
				17-37-50.00666	83-13-32.53718							
47	Gangavaram Port Ltd	Rough Stone	311090157	17-38-18.68817	83-14-16.94426	Pedagantyada	Pedagantyada (u)	2.02	274	06-03-2009	05-03-2029	ACTIVE
				17-38-17.69710	83-14-18.33243							
				17-38-12.13051	83-14-13.48860							
				17-38-14.60034	83-14-09.86290							
48	R.S.Anuradha	Road Metal		17-59-07.61845	83-21-02.17993	Padmanabham	Krishnapuram	0.785	77	28.08.2023	27.08.2033	
				17-59-07.33934	83-21-04.54037							
				17-59-05.60173	83-21-06.06059							
				17-59-04.87956	83-21-05.94824							
				17-59-05.35966	83-21-01.88820							
49	VVR Assoicates	Road Metal, Building Stone		17-57-49.11	83-18-24.28	Anandapuram	Pekeru	0.878	4	15-07-2023	14-07-2038	
				17-57-46.90	83-18-25.72							
				17-57-49.37	83-18-29.76							
				17-57-50.20	83-18-28.92							
				17-57-50.15	83-18-25.93							
				17-57-49.78	83-18-24.89							
50	Smt. R.S. Anuradha	Road Metal	311110117	**The DGPS Survey is under process**		Padmanabham	Krishnapuram	0.5	77	11.01.2011	10.01.2021	renewal applied

Data Source: District of Mines and Geology,Visakhapatnam District, Andhra Pradesh

The Details of statement showing the letter of intent (LoI) in the district is showing in Table-14:

Table 15: Statement showing the list of the letter of intent (LoI) in the district

S.No.	District	Fresh / Renewal	Name of the LOI holder	Date of LOI Issue	LOI No.	Mineral	Extent	Sy. No.	Mandal	Village	AMP submitted (yes/ No)	If Yes, AMP Letter No.	If yes, Date of AMP submission	EC submitted (yes/ No)	If Yes, EC Order No.
1	Visakhapatnam	Fresh	M/s Nagabhushaam & Co, Mg.Ptr: Sri V. Nagabhushana Rao,	18/05/2018	1639/Q2V/2018	RM, BS, Gravel & Rock Sand	2.30 Ha & 2.70 Ha	98	Padmanabhapalem	Bhandevapuram	Yes	2174/MP-VSP/2018	17.01.2019	No	-
2	Visakhapatnam	Fresh	M/s. S.S.Associates	24/03/2018	899-2/Q1V/2017	RM & BS	3.50 Ha	41	Padmanabham	Kurapalli	Yes	2559/MP-VSP/2018	29.09.2018	No	-
3	Visakhapatnam	Fresh	Sri KVB.Simhachalam	20.08.2019	1942/Q1v/2019	Gravel	5.00Ha	258	Anandapuram	Gidijala	Yes	2520/MP-VSP/2019	18.09.2019	No	-
4	Visakhapatnam	Fresh	Sri Dukka Srinivas Rao,	26.07.2019	1943/Q1v/2019	Gravel	23.972 Ha	258	Anandapuram	Gidijala	Yes	2336/MP-VSP/2019	31.08.2019	No	-
5	Visakhapatnam	Fresh	Sri Y.Surya Vamsi,	22.08.2019	2458/Q1v/2019	Gravel& Rough Stone	10.00 Ha	1	Anandapuram	Jagannadhapuram	Yes	2480/MP-VSP/2019	29.08.2019	No	-
6	Visakhapatnam	Fresh	Sri D.Laxmana Rao,	27.08.2019	2486/Q1v/2019	Gravel& Rough Stone	9.99 Ha	1	Anandapuram	Jagannadhapuram	Yes	2504/MP-VSP/2019	17.09.2019	No	-
7	Visakhapatnam	Fresh	Sri D.Srinivasa Rao,	27.08.2019	2487/Q1v/2019	Gravel& Rough Stone	22.000Ha	1	Anandapuram	Jagannadhapuram	Yes	2506/MP-VSP/2019	31.08.2019	No	-
8	Visakhapatnam	Fresh	Sri.K.Rama Gopala Rao,	27.08.2019	2489/Q1v/2019	Gravel& Rough Stone	9.90Ha	1	Anandapuram	Jagannadhapuram	Yes	2505/MP-VSP/2019	31.08.2019	No	-
9	Visakhapatnam	Fresh	Sri Botcha Naidu Babu	17.04.2021	874-1/Q1V/2021	RM & BS	3.65 Ha.	67	Bheemunipatnam	Bodamettapalem	Yes	874-2/MP-VSP/2021	18.06.2021	No	-
10	Visakhapatnam	Fresh	Sri G.Kanaka Raju,	20.08.2020	2063/Q1V/2018	BS & Gravel	3.145 ha.	94	Sabbavaram	Erukunaidupalem	Yes	2063/MP-VSP/2020	24.08.2020	No	-
11	Visakhapatnam	Fresh	Sri L.Venkata Reddy,	04.02.2021	1839/Q1V/2020	RM & BS	0.5	1	Madugula	Sambuvanipalem	Yes	1100/MP-VSP/2021	11.06.2021	No	-
12	Visakhapatnam	Fresh	M/s Sri Lakshmi Narasimha Rocksand Industries Private Limited, Director: Sri Challa Venkata Ravi Babu	21.11.2023	2128/E-Auction/Visakhapatnam	RM, BS, Gravel	34.981	1	Padmanabham	Krishnapuram	No				

Data Source: District of Mines and Geology, Visakhapatnam District, Andhra Pradesh

2.4 Details of Royalty in last 3 years

The details of royalty collected in last 3 years in the district is shown in Table-16

Table 16 Details of Royalty in last 3 years

Royalty for 2022-23

S. No.	Mineral	Royalty (in Rs. Lakhs)	Consideration Amt. (in Rs. Lakhs)	DMF (In Rs. Lakhs)	MERIT (in Rs. Lakhs)
1	Building Stone	1.006	1.006	0.302	0.02
2	Gravel	136.548	136.548	40.964	2.731
3	Quartzite	37.845	37.845	11.354	0.757
4	Road Metal	132.473	132.473	39.742	2.649
5	Road Metal/Building Stone/Rough Stone	7.079	7.079	2.124	0.142
Total		**315**	**315**	**94**	**6**

Royalty for 2021-22

S. No.	Mineral	Royalty (in Rs. Lakhs)	Consideration Amt. (in Rs. Lakhs)	DMF (In Rs. Lakhs)	MERIT (in Rs. Lakhs)
1	Building Stone	44.883	22.4415	13.465	0.898
2	Gravel	397.521	198.7605	119.248	7.95
3	Ordinary	4.5	2.25	1.35	0.09

S. No.	Mineral	Royalty (in Rs. Lakhs)	Consideration Amt. (in Rs. Lakhs)	DMF (In Rs. Lakhs)	MERIT (in Rs. Lakhs)
	Earth				
4	Quartzite	21.69	10.845	6.507	0.434
5	Road Metal	28.523	14.2615	8.552	0.57
6	Road Metal/Building Stone/Rough Stone	124.934	62.467	37.48	2.499
7	Rough Stone	2.7	1.35	0.81	0.054
Total		**625**	**313**	**187**	**12**

Royalty for 2020-21

S. No.	Mineral	Royalty (in Rs. Lakhs)	DMF (In Rs. Lakhs)	MERIT (in Rs. Lakhs)
1	Building Stone	65.408	19.622	1.308
2	Gravel	310.162	93.048	6.203
3	Ordinary Earth	0.405	0.122	0.008
4	Quartz	1.08	0.324	0.022
5	Quartzite	6.75	2.025	0.135
6	Road Metal	66.969	20.091	1.339
7	Road Metal/Building Stone/Rough Stone	77.101	23.13	1.542

S. No.	Mineral	Royalty (in Rs. Lakhs)	DMF (In Rs. Lakhs)	MERIT (in Rs. Lakhs)
8	Rough Stone	9.585	2.876	0.192
Total		**537**	**161**	**11**

Data Source: District of Mines and Geology,Visakhapatnam District, Andhra Pradesh

2.5 Details of Production in last 3 years

The details of production in last 3 years in the district is shown in Table-17

Table 17 Details of Production in last 3 years

Production for 2022-23

S. No.	Mineral	Unit	Production
1	Building Stone	Cubic Meter	1078
2	Gravel	Cubic Meter	276403.66
3	Quartzite	MT	42050
4	Road Metal	Cubic Meter	147149
5	Road Metal/Building Stone/Rough Stone	Cubic Meter	7866

Production for 2021-22

S. No.	Mineral	Unit	Production
1	Building Stone	Cubic Meter	49861
2	Gravel	Cubic Meter	870130
3	Ordinary Earth	Cubic Meter	9986

4	Quartzite	MT	24100
5	Road Metal	Cubic Meter	31679
6	Road Metal/Building Stone/Rough Stone	Cubic Meter	138112
7	Rough Stone	Cubic Meter	3000

Production for 2020-21

S. No.	Mineral	Unit	Production (in MT)
1	Building Stone	Cubic Meter	52446.185
2	Gravel	Cubic Meter	667886.92
3	Ordinary Earth	Cubic Meter	900
4	Quartz	MT	999
5	Quartzite	MT	7500
6	Road Metal	Cubic Meter	74326
7	Road Metal/Building Stone/Rough Stone	Cubic Meter	68223.756
8	Rough Stone	Cubic Meter	10650

Data Source: District of Mines and Geology,Visakhapatnam District, Andhra Pradesh

2.6 Impact on environment

The extraction and utilization of minor minerals have become integral to our modern way of life, fueling infrastructure development, construction, and various industries. However, the impact of these activities on the environment cannot be underestimated. Minor minerals, which include granite, road metal,

gravel, clay, and more, play a significant role in shaping the natural landscape and ecosystems. The various environmental consequences associated with the extraction and use of minor minerals are:

i. **Habitat Destruction:** The mining of minor minerals often entails the removal of topsoil and vegetation, leading to habitat destruction. This can disrupt ecosystems, displace wildlife, and threaten the survival of numerous species. Loss of biodiversity is a significant concern in regions with extensive mining operations.

ii. **Land Degradation:** Mining activities can lead to land degradation, including soil erosion and compaction. This not only reduces the land's fertility but also affects its ability to support agriculture and vegetation growth. Moreover, land degradation can contribute to increased vulnerability to natural disasters like floods.

iii. **Water Pollution:** Mining operations can contaminate nearby water bodies through the discharge of sediments, chemicals, and heavy metals. This pollution can have detrimental effects on aquatic life, disrupt local hydrology, and compromise the quality of water available for human consumption.

iv. **Air Quality:** Dust emissions from mining sites can deteriorate air quality in surrounding areas. The fine particles and pollutants released during excavation and transportation of minor minerals can pose health risks to both workers and nearby communities.

v. **Regulatory Challenges:** Enforcing regulations and monitoring mining activities in remote or unregulated areas can be challenging, allowing illegal and unsustainable practices to persist.

The extraction and utilization of minor minerals are essential for economic development, but they come at a cost to the environment. Recognizing the environmental impacts of these activities is crucial for sustainable resource management.

2.7 Remedial Measures

The provisions of Rule 12 (1) and Rule 12 (5) and of Andhra Pradesh Minor Mineral Concession Rules, 1966 allows the State Government to issue the Letters of Intent with the stipulated conditions to submit Approved Mining Plan (AMP), Environment Clearance (EC) and Consent for Establishment (CFE) for grant of lease.

Mine Plan stipulates the maximum permissible annual production of the mineral from the designated lease area and also includes estimated quantum of solid waste generation and its method of disposal, etc. Based on the Approved Mine Plan projections, Environment Management Plan shall be prepared and SEIAA makes the decision to grant the EC based on the EMP.

Leaseholders commit to all the remedial measures in the Mining Plan and the State Environment Impact Assessment Authority (SEIAA) ensures the remedial measures are being adhered to during the tenure of the Environmental Clearance.

Leaseholders in the district have adopted various remedial measures to mitigate the impact of mining on the environment. These measures aim to reduce the environmental footprint of mining operations and address the associated challenges. Some common practices include:

i. **Environmental Impact Assessments (EIAs):** Leaseholders conduct comprehensive EIAs to evaluate the potential environmental consequences of mining projects. They shall use this information to develop mitigation strategies.

ii. **Reclamation and Rehabilitation:** Leaseholders work to restore mined areas by recontouring landscapes, replanting native vegetation, and stabilizing soils to promote ecosystem recovery.

iii. **Water Management:** Proper management of water resources is crucial. Leaseholders use techniques like sedimentation ponds, water recycling, and water treatment

facilities to minimize water pollution and ensure responsible water use.

The following preventive measures are being followed for minimizing adverse effects on water regime:

- Small Gully checks, gully check dams, silt settling tanks, silt traps, etc. shall be constructed.
- Along all discharge points leaving the mining lease, into the surrounding area, suitable number of filter walls of sufficient lengths shall be erected across the flow, at intervals, all along the length to prevent suspended solids entering the surrounding streams/ drains/ water courses, to confine the discharge water quality to the permissible limits.
- Regular monitoring may be carried out and further remedial steps as may be necessary may be taken.

iv. **Waste Management:** Effective management of mining waste, such as tailings and slag, involves containment in secure facilities to prevent soil and water contamination. Advances in waste disposal technologies are also being explored.

Steps being followed for effective waste management:

- Implementation of practices to minimize waste generation at the source. This involves optimizing extraction techniques, reducing overburden removal, and improving resource utilization.
- Encouraging recycling and reuse of waste materials wherever possible within the mining operation.
- Selection of an appropriate disposal methods based on waste characteristics and environmental considerations. Common methods include land filling, controlled dumping, and backfilling.
- Treatment of contaminated water and effluents using appropriate technologies before discharge.

v. **Afforestation:** Leaseholders carry out a year-wise afforestation plan for the initial years with detailed costing of each plant, its maintenance per piece, etc.

While these measures represent positive steps toward mitigating environmental impact, it's important to note that the effectiveness of these practices can vary widely depending on factors such as the location, scale, and specific mineral being mined. Continuous improvement and adaptation are essential in the mining industry's ongoing efforts

2.8 Reclamation Measures

As per Rule 7A (ii) of Andhra Pradesh Minor Mineral Concession Rules, 1966, Mine Closure Plan shall be submitted by the leaseholder before 6 months of expiry of the lease in the proforma as prescribed by the Director. The Deputy Director concerned shall approve the mine closure plan and ensure compliance of conditions of the approved mine closure plan before expiry of the lease period.

Financial assurance of Rs.50,000/-(Rupees Fifty Thousand) for the quarry lease granted below five(5) hectares and Rs.10,000/- (Rupees Ten Thousand) per Hectare or part thereof for the quarry lease granted five (5) hectares and above, shall be submitted in the form of deposit. If the leaseholder does not reclaimate the area as mentioned in the Mine Closure Plan, the deposit shall be forfeited, and the Department of Mines & Geology ensure the proper implementation of the Mine Closure Plan.

2.9 Risk Assessment & Disaster Management Plan

Leaseholders conduct comprehensive risk assessment, prepare a model disaster management plan and submit in the Mining Plan.

The leaseholders maintain and arrange following resources at the mine site:

a) Firefighting equipment

b) Ambulance services with location

c) List of volunteer organizations

d) List of Civil, Police and other authorities to be informed in case of an accident

e) Last of mobile crane operators (Government, Public Sector, and Private Sector).

f) List of mines, contacts, facility available nearby

g) List of first aiders and contacts.

h) List of Officers of DGMS to be informed in case of serious accidents Concerned DGMS officers concerned is displayed at the mine head.

The leaseholders shall monitor the total execution of the disaster management plan. The resources of all departments including men and material are being promptly made available. They are also conducting regular mock rehearsals with their staff to update the risk register and accordingly, disaster management plan

2.9.1. Mineral Regulatory:

The important functioning of District Mines and geology Officer, Visakhapatnam are:-

1. Achievement of Targets of Mineral Revenue collections being fixed to this office annually

2. Receiving and processing of the Mineral Concession Applications duly conducting the Technical inspection, Survey and demarcation of the Mineral bearing applied areas

3. Execution and Regulation of the operations of the Mining / Quarry leases in accordance with the Acts and Rules

4. Issuing of dispatch permits duly collecting the Advance Royalty / Seig.fee from the lease holders on the minerals produced and intend to dispatch from their leased areas through online permit system

5. Controlling the illegal Mining / Quarrying and transportation by conducting the periodical inspections of the Mines and Quarries and also conducting the surprise vehicular checking and imposing the penalties

6. Finalisation of Demand, Collection and Balance statements of the leases on annual basis

2.10 Plantation & Green Belt Development

Leaseholders are complying with the plantation and green belt development programmes as committed in their Mining Plans.

CHAPTER III: SAND

3.1 Sand Mineral Resources of the Visakhapatnam District

3.1.1 General Sand Mineral Details Visakhapatnam District

(Prepared as per Sustainable Sand Mining Management Guidelines 2016 and 2020)

Table 18 Details of Production of Sand in Last three years in the District

Year	Production (In MTs)	Revenue Generated (in Rs)
2020-21	---	---
2021-22	0	0
2022-23	0	0

Data Source: District Mines and Geology Officer, Visakhapatnam District

3.1.2 River Basins in Visakhapatnam District

Visakhapatnam district is covered all minor rivers are directly joined to the Bay of Bengal. The Gosthani, Naravagedda, Madhuravada minor drainages, Anakapalli minor drainages and partially Minor drainage between Gosthani & Champavathi are the minor basins covered in the district. These 05 minor-basins are further divided into 25 sub-basins subsequently divided into 96 cascades and the total number of tanks of the district is 846. The catchment area of each basin is delineated using the boundaries from master plan records and updated by super imposing on Survey of India toposheet (1:50K). The sub basins are suitably subdivided into cascades based on local drainage conditions. The Hydrological units of Visakhapatnam District is shown in Table-19 and Figure-20, Drainage system with description of main rivers is shown in Table-20, Salient features and altitudes origin of rivers is shown in Table-21 and rivers lengths of Visakhapatnam District is shown in Table-22.

Table 19 Hydrological units of Visakhapatnam District

S.No	Major Basin	Minor Basin	Catchment Area (Sq.km)	No of. Sub Basins	No of. Cascades	No of. Tanks
1	Anakapalli minor drainages	Anakapalli minor drainages	170.67	5	14	131
2	Gosthani	Gosthani	283.98	1	29	339
3	Madhuravada minor drainages	Madhuravada minor drainages	272.02	4	27	146
4	Minor drainage between Gosthani & Champavathi	Minor drainage between Gosthani & Champavathi	11.49	5	1	2
5	Naravagedda	Naravagedda	253.44	10	25	228
Total			**991.59**	**25**	**96**	**846**

Data source: APSAC, Vijayawada

Table 20 Drainage System with Description of main rivers

S.No	Name of the Minor Basin	Area Drained (Sq.Km)	% of Area Drained in the District
1	Madhuravada Minor Drainages	271.62	27.34
2	Anakapalli	170.98	17.21
3	Gosthani	293.80	29.58
4	Champavathi	2.99	0.30
5	Naravagedda	254.00	25.57

Data source: APSAC, Vijayawada

Table 21 Salient Features of Important Rivers in Visakhapatnam District

S. No	Name of the River	Place of Origin	Altitude at Origin (m)
1	Gosthani	Eastern Ghats, Ananthagiri hills, Borra Caves of Alluri Sitharama Raju dsitrict	1,278
2	Naravagedda	Narava RF and Nallakonda RF, Sabbavaram mandal in Anakapalli district	463
3	MeghadriGedda	Kothavalasa mandal in Vizianagaram district	359
4	Pedda Gedda	Tivva Konda, Anandapuram mandal in Visakhapatnam district	381
5	Borramma Gedda	Kannuru Konda, Marripalem village, Parawada mandal in Anakapalli district	291

Data source: APSAC, Vijayawada

Table 22 River Lengths in Visakhapatnam District

S. No	Name of the Major Basin	Name of the Minor Basin	Name of the River	River Length in Km
1	Gosthani	Gosthani	Gostani River	80.79
2	Madhuravada Minor Drainages	Madhuravada Minor Drainages	Marikavalasa Gedda	6.13
3			Pedda Gedda	21.67
4	Narvagedda	Narvagedda	Meghadri Gedda	12.19
5			Narvagedda	17.12
			Total	**137.89**

Data source: APSAC, Vijayawada

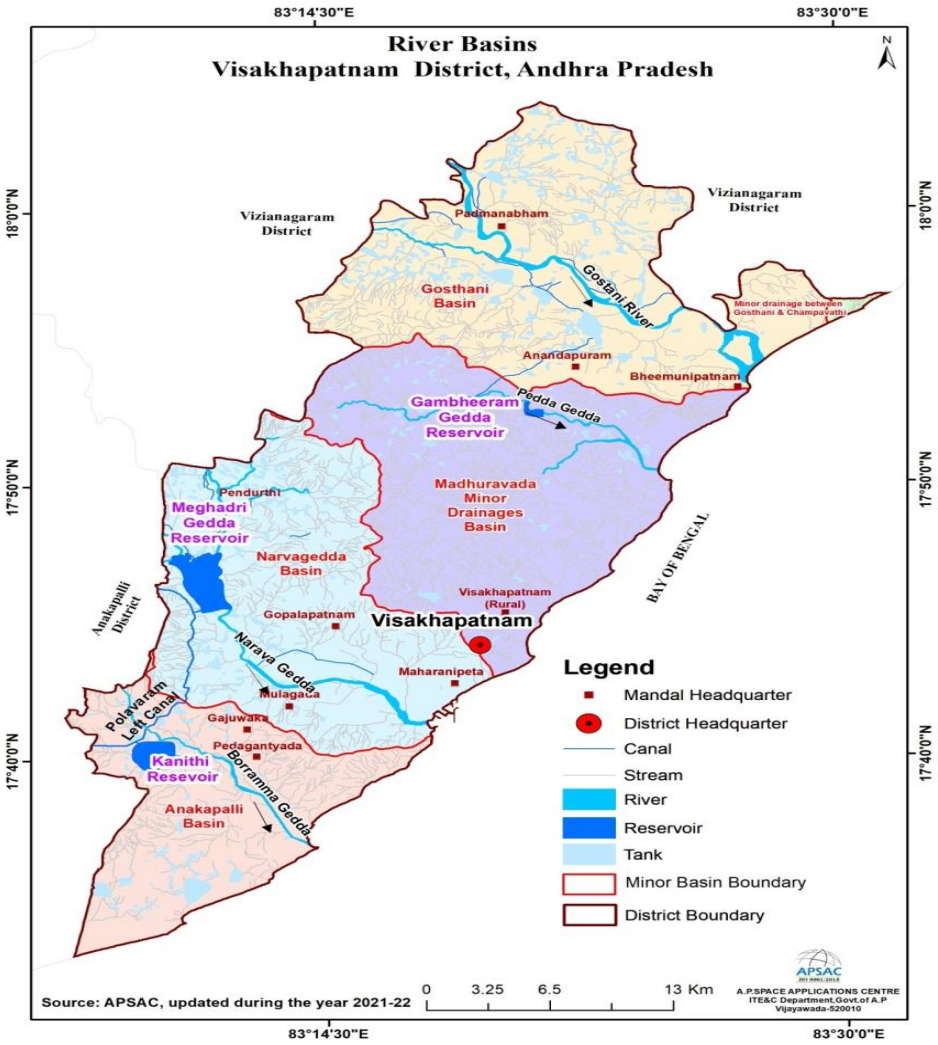


Figure-20: *Major and Minor River basin boundaries in Visakhapatnam District*

3.1.3 Process of Deposition of Sediments in the Rivers of the District

Sediment transport is a natural process, and many have argued that the point of rivers is to move sediment downstream. However, with land use changes, e.g., deforestation and construction; agricultural practices; and development activities, an accelerated erosion rates is ubiquitous. Sediment in the water column reduces transparency and can be deposited downstream and exacerbate flooding. Three principal sources of sediment are the following:

Sediment transport is the movement of organic and inorganic particles by water. In general, the greater the flow, the more sediment that will be conveyed. Water flow can be strong enough to suspend particles in the water column as they move downstream, or simply push them along the bottom of a waterway. Transported sediment may include mineral matter, chemicals and pollutants, and organic material. Another name for sediment transport is sediment load. The total load includes all particles moving as bedload, suspended load, and wash load.

3.1.3.1. Bedload

As the name suggests, this element of sediment movement consists of loose, granular particles at the sediment-water interface (such as a stream bed or tidal flat). Air or water that moves across the bed will being to move grains if the flow velocity is great enough to overcome the force of gravity and any resistance at grain contacts. This is the **threshold velocity (**Figure-21).

The bedload contains two main components:

- the **traction load**, or traction carpet, and
- the **saltation loads**.

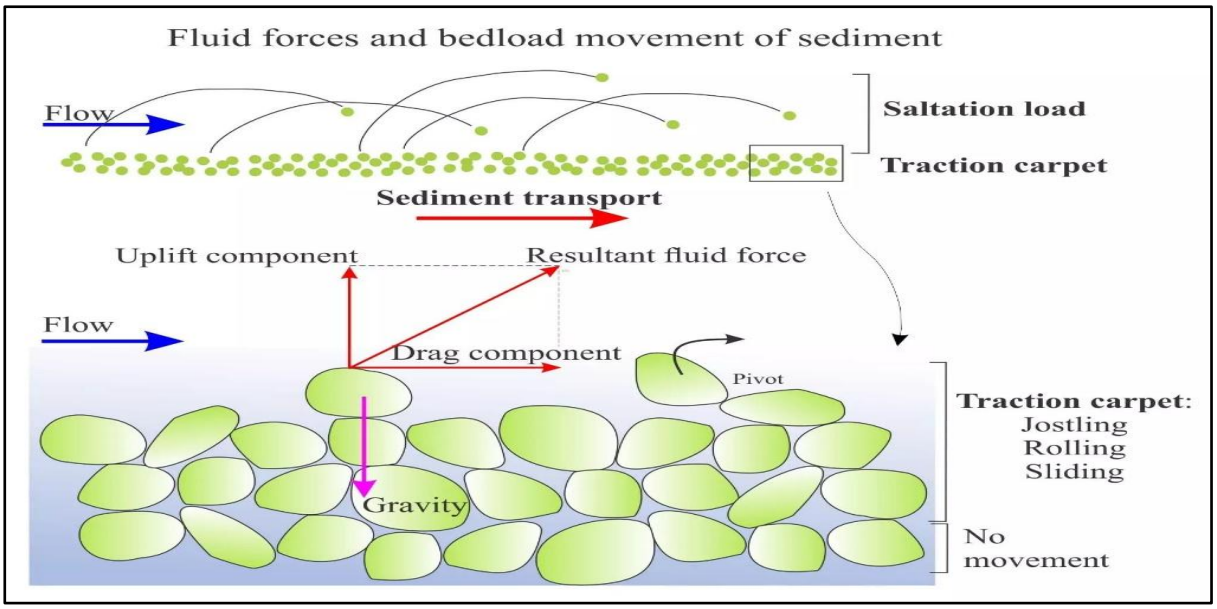


Figure-21: Bedload Movement of Sediment

The various components of force involved in initiation of grain movement are shown above. Here, fluid flowing over a sediment bed produces shear stresses that can be resolved into a component of drag (parallel to the bed) and a lift component normal to the bed. At the threshold velocity when the resultant fluid force on grains is greater than gravity, grains begin to roll, slide and jostle along the bed like a moving carpet – the **traction carpet**.

3.1.3.2. Suspended Load Most natural flows in rivers, shallow marine settings and air are turbulent. Even at low-flow velocities, the speed and trajectories of flow can vary considerably – witness the eddies and boils in seemingly tranquil streams. Very fine particulate sediment (particularly clays) can be kept in suspension for long periods by turbulence; the stresses generated by turbulent flow balance or overcome the gravitational force acting on the particles.

If turbulence decreases significantly, for example when a river empties into a lake, then most particles will gradually settle to the sediment bed. The rate at which a particle settles out of suspension is called the **settling velocity**, where the force of gravity (downwards) exceeds the combined effects of upward-directed **buoyancy forces** acting on a grain and the drag on a particle caused by **fluid (viscous) resistance**. Thus, the rate of settling depends on the size, shape and density of particles, and the viscosity of the fluid. In general, settling through air is much more rapid than through water.

Both bedload and suspension load are important processes in the generation of sedimentary structures. In particular, bedload transport of loose sand is the critical process for growth of bedforms and their internal cross-stratification (crossbedding). The description of **bedforms** (crossbeds) and the flow conditions (**flow regime**) under which they form have been described in other posts (Figure-22).

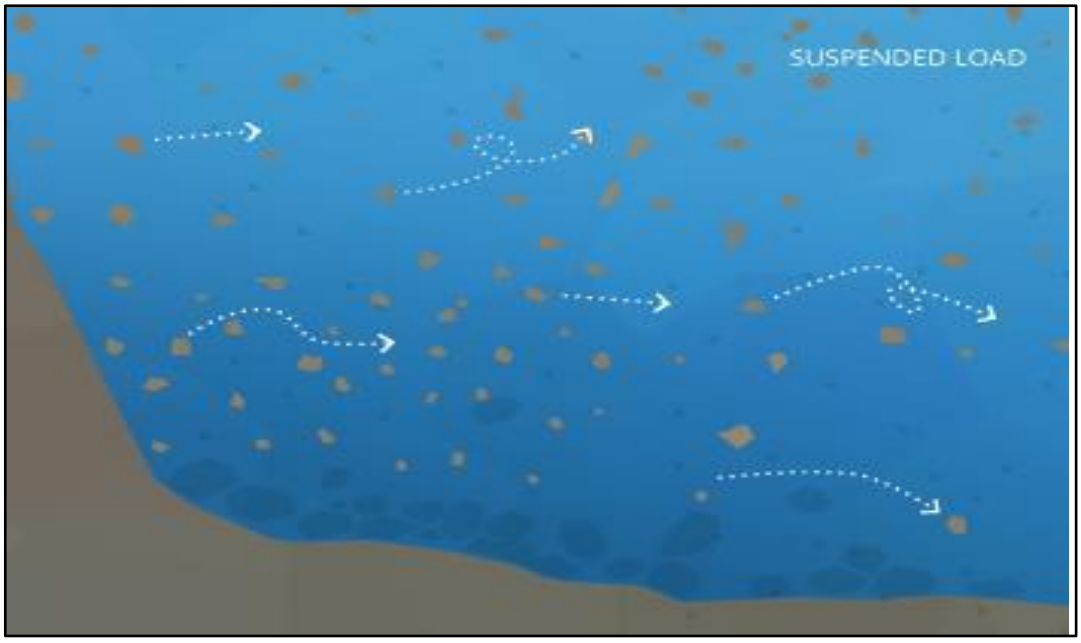


Figure-22: Sediment Load

3.1.3.3. Wash Load

The wash load is the portion of sediment that will remain suspended even when there is no water flow. The wash load is a subset of the suspended load. This load is comprised of the finest suspended sediment (typically less than 0.00195 mm in diameter). The wash load is differentiated from the suspended load because it will not settle to the bottom of a waterway during a low or no flow period. Instead, these particles remain in permanent suspension as they are small enough to bounce off water molecules and stay afloat. However, during flow periods, the wash load and suspended load are indistinguishable. Turbidity in lakes and slow-moving rivers is typically due the wash load 8. When the flow rate increases (increasing the suspended load and overall sediment transport), turbidity also increases. While turbidity cannot be used to estimate sediment transport, it can approximate suspended sediment concentrations at a specific location (Figure-23).

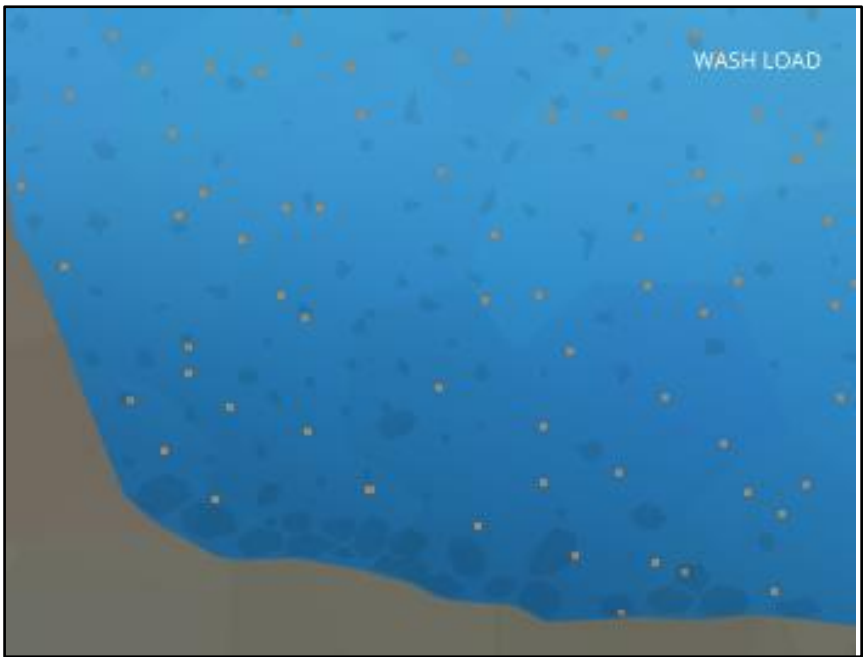


Figure-23: Wash Load

3.1.3.4. Settleable Solids

The suspended particles that fall to the bottom of a water body are called settleable solids. As they are found in riverbeds and streambeds, these settled solids are also known as bedded sediment. The size of settleable solids will vary by water system – in high flow areas, larger, gravel-sized sediment will settle out first. Finer particles, including silt and clay, can be carried all the way out to an estuary or delta (Figure-24).

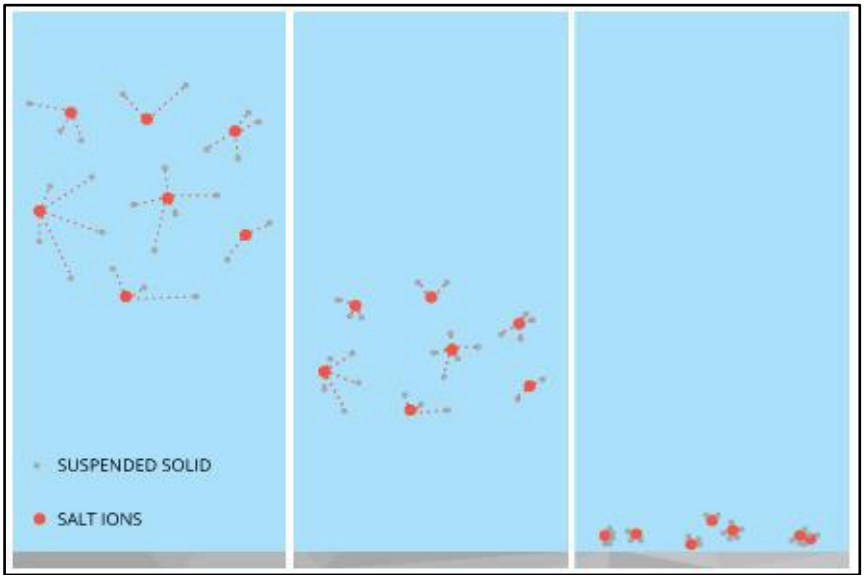


Figure-24: Settleable Solids

3.1.3.5. Sediment Deposition

Sediment is necessary to the development of aquatic ecosystems through nutrient replenishment and the creation of benthic habitat and spawning areas. These benefits occur due to sediment deposition – when suspended particles settle down to the bottom of a body of water. This settling often occurs when water flow slows down or stops and heavy particles can no longer be supported by the bed turbulence. Sediment deposition can be found anywhere in a water system, from high mountain streams, to rivers, lakes, deltas and floodplains. However, it should be noted that while sediment is important for aquatic habitat growth, it can cause environmental issues if the deposition rates are too high, or too low. Sediment transportation and Deposition depends upon various factors like Slope of the Area, Annual Rainfall, Lithology, flow intensity of River, Geomorphology, Soil, Geology and Land use.

In sediment transport a distinction is generally made between fine and coarse sediment, because the transport mechanisms differ. Coarse sediment (grain size >63 μm) tends to be characterised by particles that remain separate and are chemically inert; fine sediments (<63 μm) on the other hand tend to come together as flocculated populations (flocs) and have the tendency to attract organic material and contaminants to their surface. A great deal has been researched and written about the break up and flocculation of these primary particles under turbulence and subsequent settling (e.g., Uncles et al., 2010). These differences imply important variations in the rate of transport and settling characteristics for the same flow conditions for different sediments. The nature of the physical environment also has an important bearing on this, in that fine sediment tend to be found in sheltered environments (shallow, enclosed estuarine systems), while beaches on open coasts are characterised by coarser materials. This reflects the energy of the water in which the particles become suspended and their subsequent fate.

Rates of transport of material are generally expressed in terms of a flux, as kg/s for example, where this figure is generally obtained by considering the product of the flow rate (in m^3/s) and the concentration of material in suspension (kg/m^3). This does not necessarily imply a requirement for the material to be suspended; it is equally possible to express a bed load using the same units, for example, but it does imply that to obtain an estimate of the sediment flux it is necessary to know both the concentration and the flow rate over a given cross section. Both these quantities can be measured and there are a variety of techniques

available to do this, using insitu collection or sampling, in situ optical or acoustic methods, or remote sensing from aircraft or satellites (Uncles and Mitchell, 2017) (Figure-25).

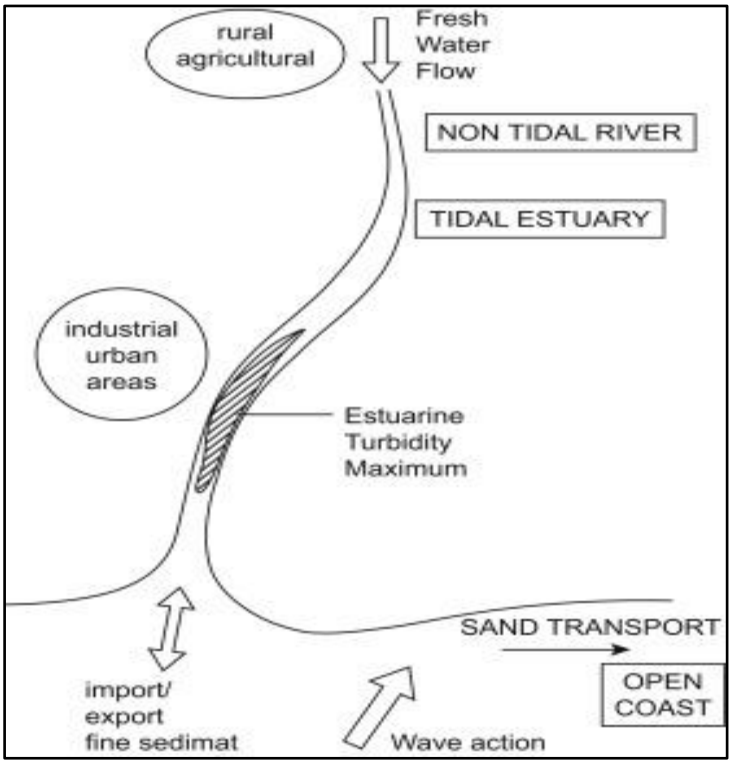


Figure-25: Sediment Deposition Process

Process of Deposition of Sediments in the Rivers of the District Sand is deposited because of the following reasons: (a) Floods: The surface or strip of relatively smooth land adjacent to a river channel constructed (or in the process of being constructed) by the present river in its existing regimen and covered with water when the river overflows its banks at times of high water. It is built of alluvium carried by the river during floods and deposited in the sluggish water beyond the influence of the swiftest current (b) Valley fill: The unconsolidated sediment deposited by any agent so as to fill or partly fill a valley.

3.1.4 Replenishment Study

All the rivers in Visakhapatnam district are of 3rd Order streams. The Sand extraction in Visakhapatnam District shall be as per Rule 23(1) (a) of AP Water Land and Tree Rules, 2004 where the transportation of sand shall be by means of bullock carts/ Tractors for the local use.

In case, if the sand deposition exceeds 5,000 Cu.Min a part of the stretch, then manual mining shall be permitted after obtaining Statutory

Clearances. the District Collector shall put in place proper administrative mechanism for enforcement of WALTA regulations in extraction and transportation of sand in I, II & III order streams.

Sand extraction is permitted for commercial usage in sand reaches of III Order streams having sand deposition of more than 5,000 cum, after obtaining AMP, EC, CFE & CFO (G.O. Ms. No. 2, PR&RD Dept, dated 06.01.2022).

3.1.5 Details of Sand Mining Leases:

There is no sand bearing rivers flowing in the district.

Name of the river	List of Mandals
NIL	

Proposed potential Sand Mining Leases in Visakhapatnam district shown in Table-23.

Table 23 The detail of Potential Sand Mining Leases

Reach Name	Quantity (in MTs)	Remarks
Nil	Nil	Nil

Data Source: District Mines and Geology Officer, Visakhapatnam District, Andhra Pradesh

3.1.6 Details of De-Siltation Location: (Lakes/Ponds/Dams etc.)

The detail of potential of de-siltation location in Visakhapatnam District is shown in Table-24.

Table 24 List of Potential De-Siltation Location: (Lakes/Ponds/Dams etc.) (Existing and proposed)

De-siltation Points	Quantity (in MTs)	Remarks
NIL		

Data Source: District Mines and Geology Officer, Visakhapatnam District, Andhra Pradesh

3.1.7 Details of Patta Lands in the District:

The details of Patta Lands in the Visakhapatanam district are shown in Table-25.

Table 25 Details of Patta Lands.

Owner	Sy. No.	Area (Ha)	District	Tehsil	Village	Total Reserve (MT)	Total Mineral to be mined (MT)	Existing/ Proposed
Nil								

Data Source: District Mines and Geology Officer, Visakhapatnam District, Andhra Pradesh

3.1.8 Details of M-Sand Plants in the District:

The details list of Manufacturing Sand in Visakhapatnam district shown in Table-26.

Table 26 Shown Details of Details of M-Sand Plants

Plant Name	Owner	District	Tehsil	Village	Geo-location	Quantity Tonnes/Annum
NIL						

Data Source: District Mines and Geology Officer, Visakhapatnam District, Andhra Pradesh

3.1.9 Details of Cluster of Sand Mining Leases

The area of Cluster of Mining Leases in Visakhapatnam jurisdiction is shown in Table-27.

Table 27 Details Cluster of Mining Leases in Visakhapatnam District

Sl.No	Name of the Cluster	Location (Latitude and Longitude)	Extent (in Ha)	Total No. of Mining Leases in the Cluster	No.of Leases working	Extent of the working leases (in Ha)
NIL						

Data Source: District Mines and Geology Officer, Visakhapatnam District, Andhra Pradesh

3.1.10 Details of Contiguous Clusters

The area of Contiguous Cluster of Sand Reaches in Visakhapatnam jurisdiction is shown in Table-28.

Table 28 Details of Contiguous Cluster of Sand Reaches in Visakhapatnam District

Sl.No	Name of the Cluster	Location (Latitude and Longitude)	Extent (in Ha)	Total No. of Mining Leases in the Cluster	No.of Leases working	Extent of the working leases (in Ha)
NIL						

Data Source: District Mines and Geology Officer, Visakhapatnam District, Andhra Pradesh

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