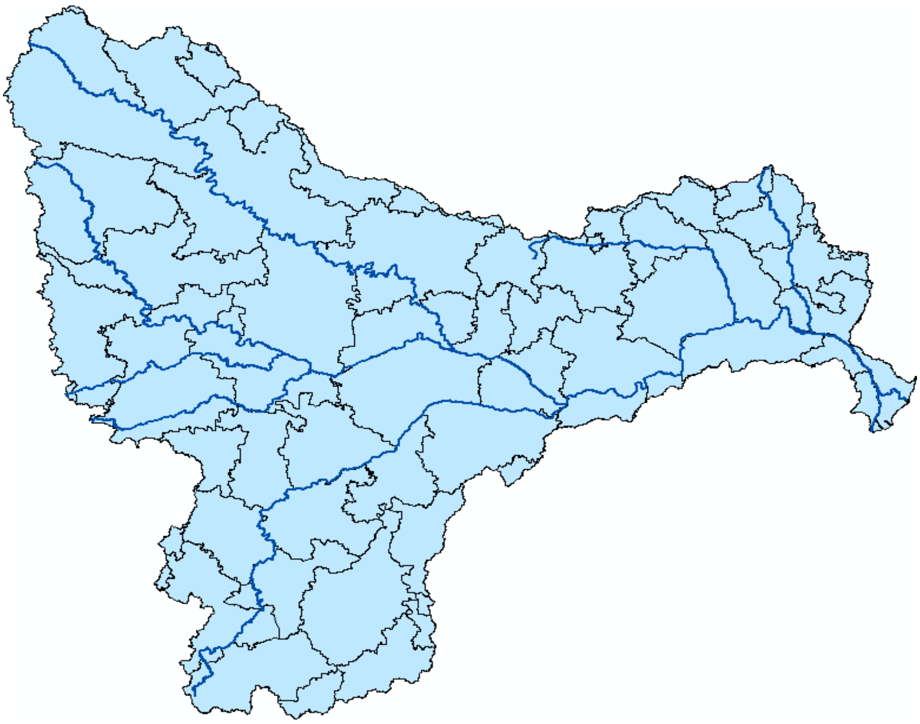
National River Conservation Directorate
Department of Water Resources, River Development & Ganga Rejuvenation
Ministry of Jal Shakti
Government of India

Pollution Source Mapping of Krishna River Basin



June 2026

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# Krishna River Basin Pollution Source Mapping Report
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## National River Conservation Directorate (NRCD)

The National River Conservation Directorate, functioning under the Department of Water Resources, River Development & Ganga Rejuvenation, and Ministry of Jal Shakti providing financial assistance to the State Government for conservation of rivers under the Centrally Sponsored Schemes of 'National River Conservation Plan (NRCP)'. National River Conservation Plan to the State Governments/ local bodies to set up infrastructure for pollution abatement of rivers in identified polluted river stretches based on proposals received from the State Governments/ local bodies.

www.nrcd.nic.in

## Centres for Krishna River Basin Management Studies (cKrishna)

The Centres for Krishna River Basin Management Studies (cKrishna) is a Brain Trust dedicated to River Science and River Basin Management. Established in 2024 by NIT Warangal and NITK Surathkal, under the supervision of cGanga at IIT Kanpur, the center serves as a knowledge wing of the National River Conservation Directorate (NRCD). cKrishna is committed to restoring and conserving the Krishna River and its resources through the collation of information and knowledge, research and development, planning, monitoring, education, advocacy, and stakeholder engagement.

www.ckrishna.org

## Centre for Ganga River Basin Management and Studies (cGanga)

cGanga is a think tank formed under the aegis of NMCG, and one of its stated objectives is to make India a world leader in river and water science. The Centre is headquartered at IIT Kanpur and has representation from most leading science and technological institutes of the country. cGanga's mandate is to serve as think-tank in implementation and dynamic evolution of Ganga River Basin Management Plan (GRBMP) prepared by the Consortium of 7 IITs. In addition to this, it is also responsible for introducing new technologies, innovations, and solutions into India.

www.cganga.org

## Acknowledgment

This report is a comprehensive outcome of the project jointly executed by NIT Warangal (Lead Institute) and NITK Surathkal (Fellow Institute) under the supervision of cGanga at IIT Kanpur. It was submitted to the National River Conservation Directorate (NRCD) in 2025. We gratefully acknowledge the individuals who provided information and photographs for this report.

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PREFACE

In an era of unprecedented environmental change, understanding our rivers and their ecosystems has never been more critical. This report aims to provide a comprehensive overview of our rivers, highlighting their importance, current health, and the challenges they face. As we explore the various facets of river systems, we aim to equip readers with the knowledge necessary to appreciate and protect these vital waterways.

Throughout the following pages, you will find an in-depth analysis of the principles and practices that support healthy river ecosystems. Our team of experts has meticulously compiled data, case studies, and testimonials to illustrate the significant impact of rivers on both natural environments and human communities. By sharing these insights, we hope to inspire and empower our readers to engage in river conservation efforts.

This report is not merely a collection of statistics and theories; it is a call to action. We urge all stakeholders to recognize the value of our rivers and to take proactive steps to ensure their preservation. Whether you are an environmental professional, a policy maker, or simply someone who cares about our planet, this guide is designed to support you in your efforts to protect our rivers.

We extend our heartfelt gratitude to the numerous contributors who have generously shared their stories and expertise. Their invaluable input has enriched this report, making it a beacon of knowledge and a practical resource for all who read it. It is our hope that this report will serve as a catalyst for positive environmental action, fostering a culture of stewardship that benefits both current and future generations.

As you delve into this overview of our rivers, we invite you to embrace the opportunities and challenges that lie ahead. Together, we can ensure that our rivers continue to thrive and sustain life for generations to come.

Centers for Krishna River Basin Management Studies (cKrishna)

NIT Warangal and NITK, Surathkal

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1. Introduction

The Krishna River Basin is one of the most important river basins in India, supporting diverse ecological systems, agricultural activities, industries, urban settlements, and livelihoods across the states of Maharashtra, Karnataka, Telangana, and Andhra Pradesh. Rapid population growth, urbanization, industrial expansion, and intensive agricultural practices within the basin have significantly increased pressure on water resources and environmental quality. The various forms of pollution such as domestic sewage, industrial effluents, agricultural runoff, solid waste, hazardous waste, biomedical waste, plastic waste, and construction & demolition waste have emerged as major concerns affecting the health of the river system.

Pollution within the river basin not only deteriorates surface water and groundwater quality but also threatens aquatic ecosystems, public health, irrigation suitability, and the long-term sustainability of basin resources. Industrial clusters, urban wastewater discharge, improper waste management practices contribute substantially to the pollution load entering the river and its tributaries. In several regions, inadequate wastewater treatment infrastructure and poor environmental monitoring further aggravate the problem.

In this context, the Pollution Source Map of the Krishna River Basin has been developed to identify and analyze the major pollution-generating activities across different sub-basins and districts. The study integrates data from multiple government agencies, environmental reports, pollution control boards, and geo-spatial analysis to support river basin planning and pollution abatement strategies. The report provides a comprehensive assessment of pollution sources, industrial clusters, wastewater generation, waste management status, and environmental stress zones within the basin. It also highlights spatial variations in pollution intensity and identifies critical hotspots requiring immediate attention and sustainable management interventions.

2. Monitoring stations in Krishna River Basin

The Krishna River Basin comprises diverse hydrological, geological, climatic, and land-use conditions that strongly influence both surface water and groundwater quality across the basin. The river system includes several major tributaries such as the Bhima, Tungabhadra, Panchaganga, Malaprabha, Bhadra, and Musi rivers, which contribute significantly to the hydrology and water quality characteristics of the basin. Variations in rainfall, geology, urbanization, agricultural activities, and industrial development across different regions result in considerable spatial variability in water quality conditions.

The present study utilizes secondary water quality data collected from national monitoring agencies for the assessment of both surface water and groundwater quality in the Krishna River Basin during 2019-2023. Surface water quality data were obtained from the Central Pollution Control Board (CPCB). The surface water monitoring network consists of stations located along the main course of the Krishna River and its major tributaries covering upstream, midstream, and downstream stretches. Monitoring stations are situated near urban centres, industrial regions, confluence points, reservoirs, bridges, and water abstraction locations to capture the influence of natural processes and anthropogenic activities on river water quality. Most of the surface water monitoring stations are monitored on a monthly basis for major physico-chemical and biological parameters.

2.1 Surface Water Quality Monitoring stations and Frequency

In this study, the surface water quality assessment in the Krishna River basin was carried out employing the data acquired from the Central Pollution Control Board (CPCB). Overall, 68 monitoring stations were used for the entire course of the river from source to mouth and important tributaries were also considered. Apart from the main river, the analysis included six significant tributaries: the Bhima River, Tungabhadra River, Panchganga River, Malaprabha River, Bhadra River, and Musi River. The monitoring stations along the Krishna River and its tributaries are illustrated in Figure 1.

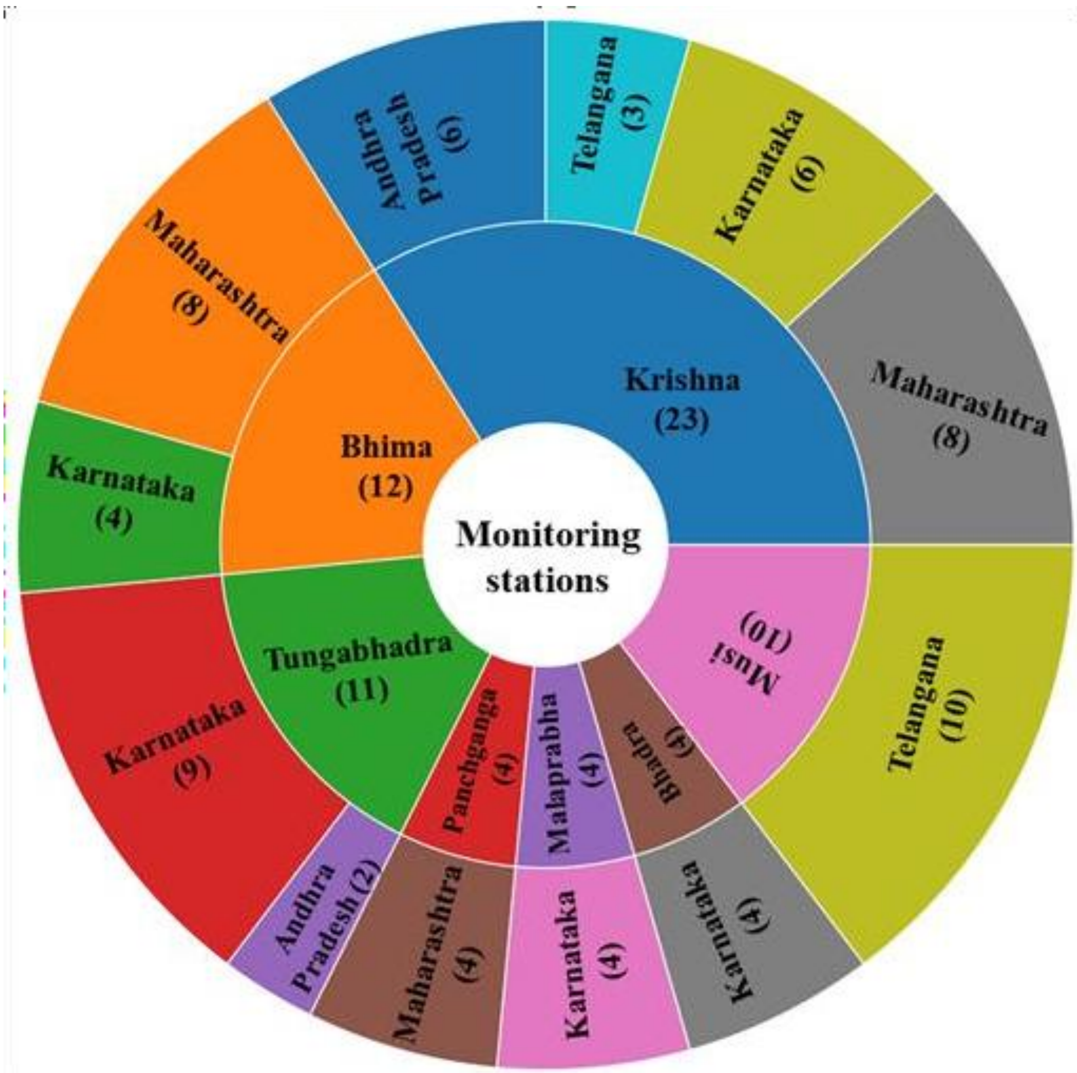

Figure 1: Monitoring stations of the Krishna River and its tributaries

Table 1: The monitoring stations along the Krishna River with coordinates

S.No	Station codes	Station names	States	Frequency	Latitude	Longitude
1	1153	Krishna River at Rajapur Weir, Village-Rajapur, Taluka-Shirol, District-Kolhapur.	Maharashtra	Monthly	16.6301	74.6639
2	36	Krishna at Krishna Bridge, Karad, Karad, Satara	Maharashtra	Monthly	17.2953	74.1888
3	37	Krishna at Gawali Gally,Miraj,Sangli	Maharashtra	Monthly	16.824	74.6495
4	1906	Krishna D/S of Islampur, Walwa, Sangli	Maharashtra	Monthly	17.0293	74.3801
5	1310	Krishna at Kurundwad, Shirol, Kolhapur	Maharashtra	Monthly	16.6814	74.5903
6	2190	Krishna River at Wai, Satara	Maharashtra	Monthly	17.9493	73.8913
7	2187	Krishna River at Kshetra Mahuli, Mahuli, Satara	Maharashtra	Monthly	17.6885	74.0633
8	2188	Krishna River at Krishna-Venna Sangam at Mahuli, Satara	Maharashtra	Monthly	17.6883	74.0633
9	1181	Krishna at D/S of Narayanpura Dam,	Karnataka	Monthly	16.2424	76.3707
10	1182	Krishna at U/S of Ugarkhurd Barrage,	Karnataka	Monthly	16.6409	74.8213
11	1889	Krishna-Ankali Bridge along Chikkodi Kagwad Road	Karnataka	Monthly	16.5575	74.6797
12	1170	Krishna at D/S of Devasagar Bdg.,	Karnataka	Monthly	16.3805	77.3627
13	1028	Krishna at Tintini Bridge,	Karnataka	Monthly	16.3692	76.6566
14	2781	Krishna at D/S of Alamatti Dam,	Karnataka	Monthly	16.3251	75.8999
15	1784	Krishna at Thangadi , Mahaboobnagar Dist.	Telangana	Monthly	16.4242	77.2789
16	1175	Krishna A/C with Tungabhadra, Sangameshwaram, Kunool	Andhra Pradesh	Monthly	16.0019	78.365
17	39	Krishna at Gadwal Bridge	Telangana	Monthly	16.3388	77.6102
18	1465	Krishna at Wadapally after Confl. with R. Musi(Shifted From 1220)	Telangana	Monthly	16.6947	79.6899
19	1786	Krishna at Vedadri, Kurnool	Andhra Pradesh	Monthly	16.8019	80.1296
20	1787	Krishna at Amaravati, Guntur	Andhra Pradesh	Monthly	16.5826	80.3435
21	25	Krishna at Vijaywada, Krishna	Andhra Pradesh	Monthly	16.4925	80.6408
22	3083	Krishna D/S of Srishailam, Kurnool	Andhra Pradesh	Monthly	16.0879	78.8902
23	1782	Krishna at Hamsaladeevi Puligadda aqueduct near Avanigadda(V), Krishna District	Andhra Pradesh	Monthly	16.0001	81.0791

Table 2: Monitoring Stations of the Bhima River with Coordinates.

S.no	Station codes	Station names	States	Frequency	Latitude	longitude
1	1189	Bhima at Pune U/S Vithalwadi, Haweli, Pune	Maharashtra	Monthly	18.481871	73.829569
2	2655	Bhima River at Koregaon Near Koregaon Bridge, Shirur,Pune	Maharashtra	Monthly	18.645719	74.056442
3	1190	Bhima at Pune, D/S Of Bundgarden, Yerwada, Haweli, Pune	Maharashtra	Monthly	18.54325	73.885036
4	1191	Bhima at Pargaon (After Confl.with Mula Mutha),Pargaon, Daund, Pune	Maharashtra	Monthly	18.560303	74.37332
5	1192	Bhima after Conf. with Daund, Daund, Pune	Maharashtra	Monthly	18.464553	74.583576
6	1188	Bhima at Narsingpur, (D/S Af.Confl.with R.Nira), Narsingpur, Malshiros, Solapur	Maharashtra	Monthly	17.985845	75.116249
7	28	Bhima at Takli, South Solapur, Solapur	Maharashtra	Monthly	17.703734	75.544604
8	1183	Bhima at D/S Of Road Bridge at Gangapur Village,	Karnataka	Monthly	17.179219	76.566603
9	1184	Bhima at Ferozabad Village (D/S),	Karnataka	Monthly	17.069328	76.794283
10	1167	Bhima at D/S of Bdg. Near Yadgir,	Karnataka	Monthly	16.7341	77.130744
11	1888	Bhima River at Confluence of Jewargi Town Sewage Disposal Point	Karnataka	Monthly	17.043481	76.814478
12	2656	Bhima River-Backwater of Ujani Dam near Raw water Pump House, Kumbargaon, Indapur, Pune	Maharashtra	Monthly	18.202061	75.088989

Table 3: Monitoring stations of the Tungabhadra River with coordinates.

S.no	Station codes	Station names	States	Frequency	Latitude	longitude
1	1189	Bhima at Pune U/S Vithalwadi, Haweli, Pune	Maharashtra	Monthly	18.481871	73.829569
2	2655	Bhima River at Koregaon Near Koregaon Bridge, Shirur,Pune	Maharashtra	Monthly	18.645719	74.056442
3	1190	Bhima at Pune, D/S Of Bundgarden, Yerwada, Haweli, Pune	Maharashtra	Monthly	18.54325	73.885036
4	1191	Bhima at Pargaon (After Confl.with Mula Mutha),Pargaon, Daund, Pune	Maharashtra	Monthly	18.560303	74.37332
5	1192	Bhima after Conf. with Daund, Daund, Pune	Maharashtra	Monthly	18.464553	74.583576
6	1188	Bhima at Narsingpur, (D/S Af.Confl.with R.Nira), Narsingpur, Malshiros, Solapur	Maharashtra	Monthly	17.985845	75.116249
7	28	Bhima at Takli, South Solapur, Solapur	Maharashtra	Monthly	17.703734	75.544604
8	1183	Bhima at D/S Of Road Bridge at Gangapur Village,	Karnataka	Monthly	17.179219	76.566603
9	1184	Bhima at Ferozabad Village (D/S),	Karnataka	Monthly	17.069328	76.794283
10	1167	Bhima at D/S of Bdg. Near Yadgir,	Karnataka	Monthly	16.7341	77.130744
11	1888	Bhima River at Confluence of Jewargi Town Sewage Disposal Point	Karnataka	Monthly	17.043481	76.814478
12	2656	Bhima River-Backwater of Ujani Dam near Raw water Pump House, Kumbargaon, Indapur, Pune	Maharashtra	Monthly	18.202061	75.088989

Table 4: Monitoring stations of the Panchganga River with coordinates.

S.no	Station codes	Station names	States	Frequency	Latitude	Longitude
1	1311	Panchaganga at Ichalkaranji, Shiradwad, Hatkanangale, Kohlapur	Maharashtra	Monthly	16.7462	74.4457
2	2163	Panchaganga River at Shirol near Shirol Intake Well, Kolhapur	Maharashtra	Monthly	16.7215	74.5948
3	1904	Panchaganga U/S of Kolhapur town, Balinga, Karvir, Kolhapur	Maharashtra	Monthly	16.6885	74.1695
4	1905	Panchaganga D/S of Kolhapur town, Uchegaon, Kolhapur	Maharashtra	Monthly	16.6955	74.275

Table 5: Monitoring stations of the Malaprabha River with coordinates.

S.no	Station codes	Station names	States	Frequency	Latitude	Longitude
1	1187	Malaprabha at D/S of Khanapur Village,	Karnataka	Monthly	15.6334	74.5103
2	1164	Malaprabha at Water Abstr. Pt. to Hubli, Dharwar	Karnataka	Monthly	15.798	75.1915
3	1186	Malaprabha at D/S of Aihole Town,	Karnataka	Monthly	16.0093	75.878
4	2764	Malaprabha at Badami Bridge,	Karnataka	Monthly	15.8757	75.7223

Table 6: Monitoring stations of the Bhadra River with coordinates.

S.no	Station codes	Station names	States	Frequency	Latitude	Longitude
1	1387	Bhadra at D/S of Bhadravathi,	Karnataka	Monthly	13.8323	75.7132
2	1169	Bhadra at D/S of Kiocl Road Bridge, near Holehunnur,	Karnataka	Monthly	13.9893	75.6837
3	2765	Bhadra At U/S Of Mpm,	Karnataka	Monthly	13.8126	75.7163
4	2771	Bhadra At U/S Of Kiocl,	Karnataka	Monthly	13.2128	75.2342

Table 7: Monitoring stations of the Musi River with coordinates.

S.no	Station codes	Station names	States	Frequency	Latitude	Longitude
1	4253	Musi Sample at Bapughat Sangam U/S of Musi	Telangana	Monthly	17.3718	78.4124
2	4656	River Musi at Moosarambagh Bridge, Hyderabad	Telangana	Monthly	17.3795	78.5168
3	2339	River Musi at Nagole, Rangareddy	Telangana	Monthly	17.3827	78.5578
4	4659	Outlet of Nalla Cheruvu, Peerajadiguda	Telangana	Monthly	17.3856	78.5611
5	4660	River Musi at Peerajadiguda	Telangana	Monthly	17.3831	78.639
6	1173	Musi D/S at Pratapsingaram, Hyderabad	Telangana	Monthly	17.3701	78.4698
7	4657	River Musi at Pillapalli	Telangana	Monthly	17.3852	78.7376
8	4254	River Musi Sample at Rudravelly Bridge	Telangana	Monthly	17.4068	78.7863
9	4658	River Musi at Valigonda Bridge, Nalgonda	Telangana	Monthly	17.151	79.5443
10	3082	Musi Reservoir at Kasaniguda, Nalgonda	Telangana	Monthly	17.2476	79.492

2.2 Ground Water Quality Monitoring Stations and Frequency

The monitoring frequency and number of sampling locations varied slightly between years depending on data availability and operational monitoring programs of CGWB. A total of 856 groundwater sampling points were considered for 2019, 89 for 2020, 112 for 2021, 1243 for 2022, and 1284 for 2023. The comparatively lower number of monitoring stations during 2020 and 2021 may be associated with limitations in field monitoring and data collection during that period, whereas a substantial increase in sampling coverage was observed during 2022 and 2023. The large spatial coverage of monitoring stations provides a comprehensive representation of groundwater quality conditions within the Krishna River Basin.

3. Surface Water Quality in Krishna River

The surface water quality of the Krishna River varies along its course and is influenced by urban runoff, agricultural activities, industrial discharges, and domestic wastewater. In many stretches, key water quality parameters such as pH, dissolved oxygen (DO), electrical conductivity (EC), and nutrient concentrations remain within acceptable limits, while some locations show signs of pollution due to sewage and industrial effluents.

Temperature: The temperature of the Krishna River showed good spatial and temporal variation, with the minimum and maximum being around 18.05°C and 32.50°C, respectively, during the study period. Station 2781, located downstream of Alamatti Dam, recorded the highest temperature of approximately 32.50°C in 2018, while Station 1181 consistently observed maximum temperatures of around 30°C during several years. These elevated temperatures may be attributed to shallow flow conditions, reduced shading, and increased solar radiation. In contrast, lower temperatures were observed at Stations 37 and 1465, which were recording approximately 18.05°C in 2023 and ranging between 19°C and 21°C. The relatively lower temperatures at these locations may be associated with groundwater upwelling and localized cooling effects. Overall, most monitoring stations exhibited temperature values between 24°C and 29°C, indicating moderate temporal variation across the study area. Slight fluctuations were observed among the years; however, no significant long-term increasing or decreasing trend was evident during the study period. The spatial and temporal variation of water temperature at different monitoring stations from 2018 to 2023 is represented in Figure 2.

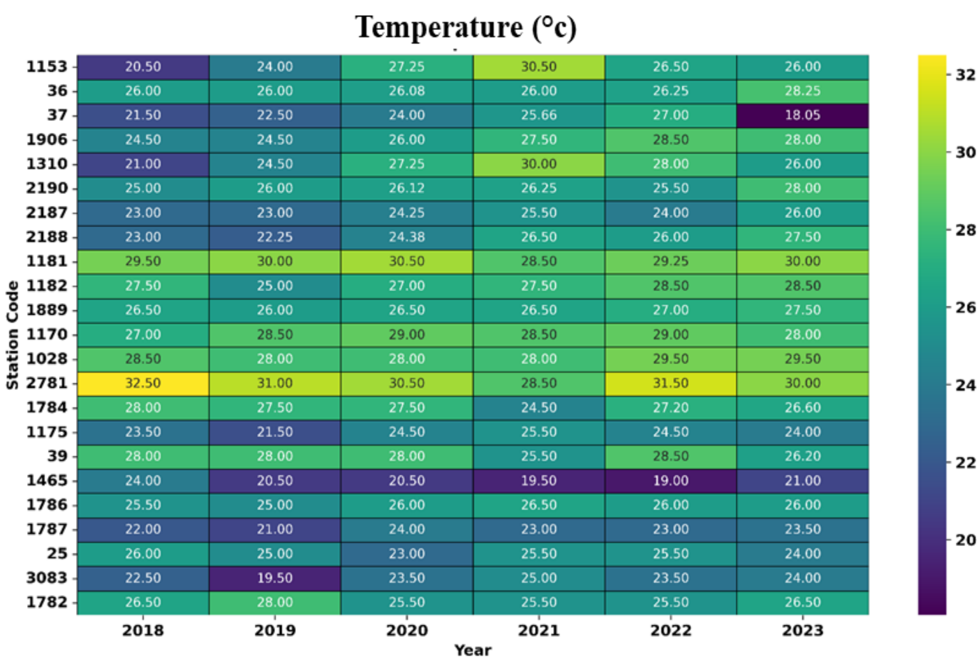

Figure 2: Spatial and temporal variation of temperature at different monitoring stations during 2018-2023

pH: The observed pH values ranged from approximately 7.15 to 8.50 during the study period, indicating slightly alkaline conditions across most monitoring locations. The highest pH values were observed at 1181 station (downstream of Narayanpura Dam, Karnataka) (approximately 8.50 in 2019) and 1170 (approximately 8.35 in 2023), which might be due to higher photosynthetic activity and the impact of agriculture runoff, which increases alkalinity. On the other hand, Station 1465 recorded the minimum pH value of 7.15 in 2019, whereas Stations 3083 and 1175 also exhibited lower pH levels during certain years of the study period. The lower pH values may be influenced by localized organic matter decomposition, inflow of slightly acidic runoff, and reduced buffering capacity. Overall, the pH values at all monitoring stations remained within the permissible limits prescribed by the Bureau of Indian Standards (BIS) and the designated best-use criteria defined by the Central Pollution Control Board (CPCB). The spatial and temporal variation of pH values at different monitoring stations from 2018 to 2023 is represented in Figure 3.

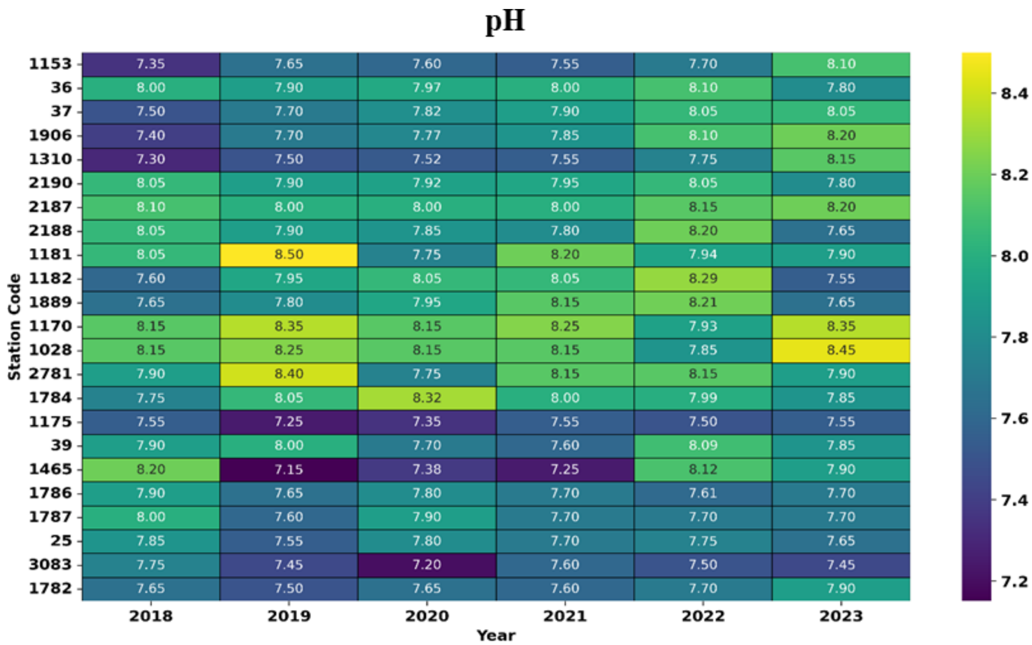

Figure 3: Spatial and temporal variation of pH at different monitoring stations during 2018-2023

Electrical conductivity (EC): Figure 4 illustrates the spatial and temporal variation of electrical conductivity (EC) at different monitoring stations from 2018 to 2023. EC showed high spatial variability from 300 to 1500 µmho/cm at the majority of stations, corresponding to a moderate ionic strength typical of river systems under agricultural and domestic wastewater influence. Nevertheless, very high conductivity values in the order of 30,000 µmho/cm were recorded for station 1906 in the year 2018. For station 1782 in the range of 17,000 to 32,000 µmho/cm for the duration of the study, which represent extreme ionic contamination and possibly from industrial aqueous discharges or salinity intrusion. In contrast, lower EC values were recorded at Stations 36 (range 220.5 and 1084 µmho/cm), 2187 (range from 393 to 517 µmho/cm), and 3083 (388.5-711 µmho/cm), reflecting comparatively better water quality conditions.

The monitoring frequency and number of sampling locations varied slightly between years depending on data availability and operational monitoring programs of CGWB. A total of 856 groundwater sampling points were considered for 2019, 89 for 2020, 112 for 2021, 1243 for 2022, and 1284 for 2023. The comparatively lower number of monitoring stations during 2020 and 2021 may be associated with limitations in field monitoring and data collection during that period, whereas a substantial increase in sampling coverage was observed during 2022 and 2023. The large spatial coverage of monitoring stations provides a comprehensive representation of groundwater quality conditions within the Krishna River Basin.

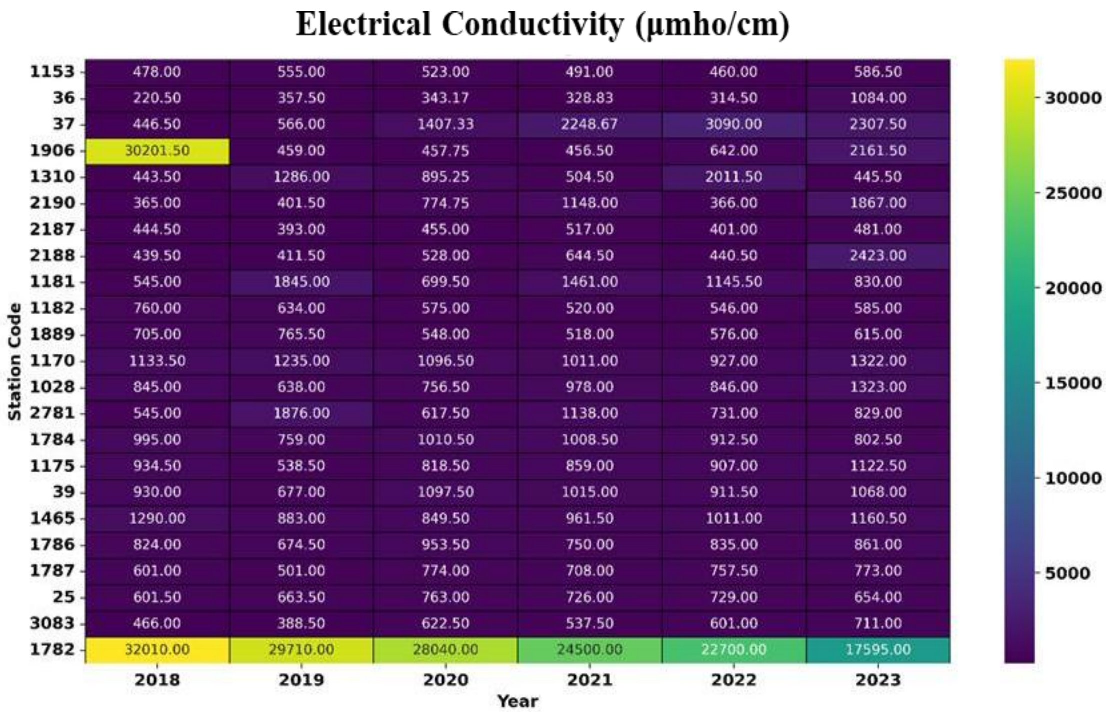

Figure 4: Spatial and temporal variation of pH at different monitoring stations during 2018-2023

Dissolved Oxygen (DO): The Dissolved Oxygen (DO) levels were observed in a healthy range (around 4-8.35 mg/L) throughout the study period, indicating that the river has a strong self-purification ability. The maximum DO were found at stations 1181 and 2781 about 8 mg/L which associated with higher flow turbulence, aeration, and lower organic pollution loads. Conversely, Station 1782 recorded the minimum DO concentration of 4.45 mg/L in 2020, whereas Stations 2190 and 36 consistently exhibited lower values during several years of the study period. Reduced DO concentrations may indicate higher organic matter decomposition, limited reaeration, and increased biological activity. The negative correlation between DO and BOD/coliform at a number of stations also supports the associations of organic pollution with oxygen usage. Although there were several highly organically-polluted readings, the stable DO at most of the sites also exemplifies the effect of reaeration and dilution in maintaining the environmental balance. The spatial and temporal variation of water DO at different monitoring stations from 2018 to 2023 is shown in Figure 5.

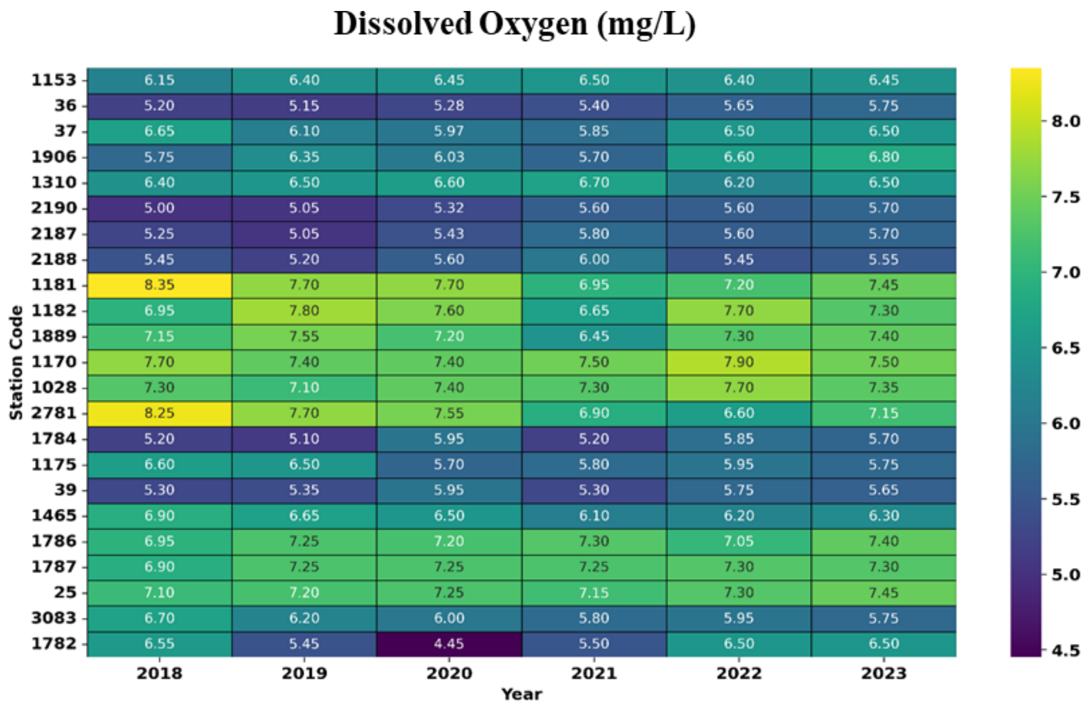

Figure 1: Spatial and temporal variation of dissolved oxygen at different monitoring stations during 2018-2023

Biochemical Oxygen Demand (BOD): The observed BOD values ranged from 1.10 mg/L to 33.25 mg/L throughout the study period. The highest BOD value of 33.25 mg/L was recorded at Station 1170 in 2019, followed by Station 1784 with 25.00 mg/L in 2018 and Station 1465 with 16.50 mg/L in 2018. These elevated BOD levels indicate higher organic pollution and increased microbial decomposition activity at these locations. In contrast, lower BOD values were observed at Stations 1787, 3083, and 25, where the values generally ranged between 1.10 mg/L and 2.65 mg/L, indicating comparatively better water quality conditions and lower organic contamination. Most monitoring stations exhibited BOD values between 1.5 mg/L and 5.0 mg/L during the study period. Overall, the results reveal noticeable spatial and temporal variations in BOD concentrations across the monitoring network, reflecting differences in organic load and anthropogenic influences in the study area. Figure 6 presents the spatial and temporal variation of biochemical oxygen demand (BOD) at different monitoring stations during 2018-2023.

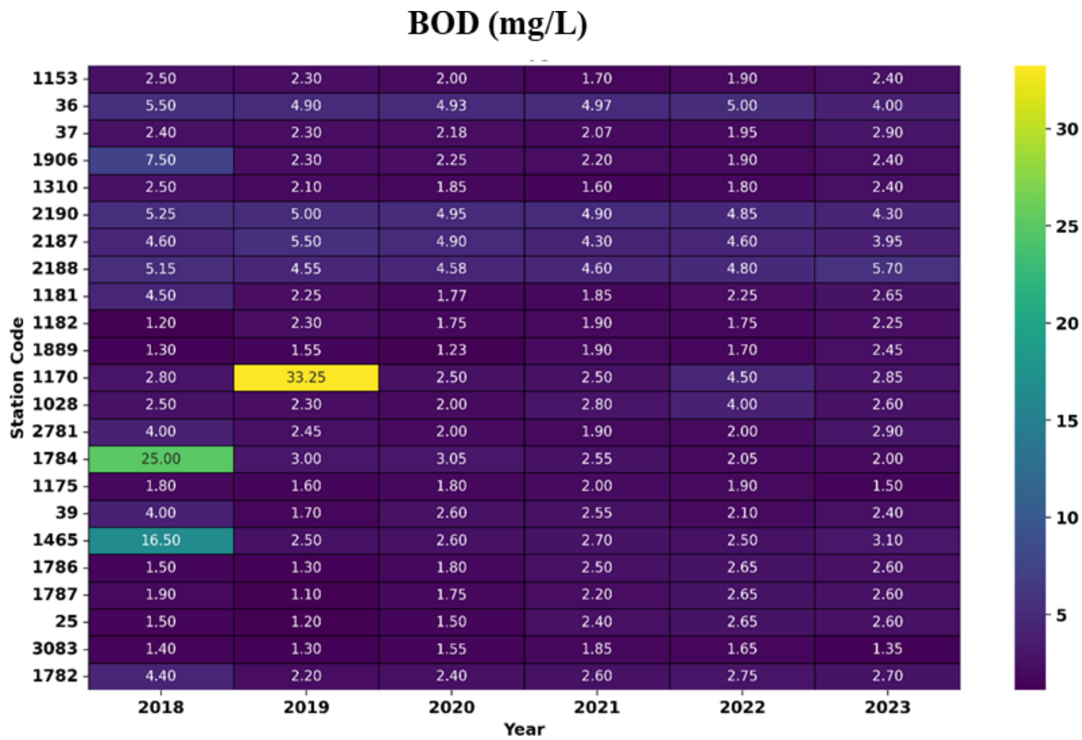

Figure 6: Spatial and temporal variation of biochemical oxygen demand at different monitoring stations during 2018-2023

3.1 Surface water quality in tributaries of Krishna River

The surface water quality of tributaries in the Krishna River Basin is influenced by land use, agricultural runoff, domestic sewage, and industrial activities. Water quality parameters such as pH, dissolved oxygen, electrical conductivity, and nutrient levels generally vary across tributaries and seasons. While many tributaries maintain moderate to good water quality, some stretches experience pollution due to wastewater discharge and anthropogenic pressures, affecting their ecological health.

Temperature: The temperature values across the Krishna River tributaries showed considerable spatial and temporal variation during 2018-2023. The Bhima River exhibited the widest fluctuation in temperature, ranging from about 24.5°C at station code 28 (Bhima at Takli, Solapur) during 2018-2019 to 35.0°C at station code 1188 in 2020, indicating significant thermal variation in downstream stretches. In the Tungabhadra River, temperature varied between 18.0°C and 31.5°C, with the highest value observed at station code 2776 (D/S of Gangawathi) in 2022, likely influenced by seasonal climatic conditions and reduced river discharge. The Panchaganga River recorded a maximum temperature of 33.0°C at station code 1311 in 2020 and a minimum of 23.5°C at station code 1904 in 2019, reflecting the impact of urban and industrial activities around Kolhapur.

The Malaprabha River maintained comparatively lower temperatures, with the highest value of 29.0°C recorded at station code 1164 during 2019-2020, while the lowest temperature of 18.5°C was observed at station code 1186 (D/S of Aihole Town) in 2020, associating with lower anthropogenic stress and better flow conditions. Similarly, the Bhadra River showed relatively stable thermal conditions, with the highest temperature of 29.0°C at station code 1387 in 2020 and the lowest value of 19.0°C at station code 2771 in 2019, likely due to dense vegetation cover, reservoir influence, and comparatively lesser pollution load.

In contrast, the Musi River consistently exhibited elevated temperatures, ranging from 27.4°C at station code 3082 (Kasaniguda Reservoir) in 2022 to 29.7°C at station code 4659 (Peerajadiguda) in 2019, reflecting strong urban and anthropogenic influences. Overall, the Bhima and Musi rivers experienced comparatively higher thermal stress, whereas the Malaprabha and Bhadra rivers maintained relatively stable thermal conditions.

pH: The pH of the Krishna River tributaries during 2018-2023 indicate predominantly neutral to slightly alkaline conditions, suggesting generally stable hydro-chemical behavior across the basin. In the Bhima River, pH values range from 7.35 to 8.50, with the highest value recorded at station code 1184 (Ferozabad Village, D/S) and the lowest at station code 1190 (Bundgarden, Pune), reflecting minor alkalinity influenced by urban sewage. The Tungabhadra River exhibits a relatively narrow pH range of 7.10 to 8.40, where the maximum occurs at station code 2776 (D/S of Gangawathi) and the minimum at station code 1785 (Manthralayam), indicating stable buffering capacity. In the Panchaganga River, pH varies between 7.10 and 8.10, with the highest at station code 2163 (Shirol) and lowest at station code 1905 (D/S of Kolhapur), suggesting slight anthropogenic influence near urban stretches. The Malaprabha River shows values ranging from 7.40 to 8.40, with maximum pH at station code 1186 (Aihole Town) and minimum at station code 1187 (Khanapur), indicating moderate alkalinity likely due to geological contributions. The Bhadra River maintains a comparatively narrower and slightly lower range of 6.80 to 7.80, with the highest at station code 1387 (Bhadravathi) and lowest at station code 2771, reflecting near-neutral conditions with minimal disturbance. In contrast, the Musi River exhibits pH values between 7.08 and 8.40, with the highest observed at station code 3082 (Kasaniguda Reservoir) and the lowest at station code 4254 (Rudravelly Bridge), indicating fluctuating conditions influenced by urban discharge yet remaining within permissible limits. Overall, the pH across all tributaries remains within the acceptable range (6.5-8.5), suggesting that despite localized anthropogenic pressures, the river system retains its natural buffering capacity without significant acidification or extreme alkalinity.

Electrical conductivity (EC): The analysis of Electrical Conductivity (EC) across the Krishna River tributaries indicates substantial spatial and temporal variability, reflecting differences in anthropogenic influence, geological characteristics, and flow conditions. In the Bhima River, EC values exhibit the highest variability among all tributaries, with a maximum recorded at station code 1188 (Narsingpur) reaching 5277 µmho/cm (2022) and a minimum at station code 1190 (Pune D/S Bundgarden) of approximately 470 µmho/cm (2019), indicative of strong pollution inputs and salinity build-up in downstream stretches. The Tungabhadra River shows moderate variability, with the highest EC at station code 1174 (Kurnool U/S) reaching 1529 µmho/cm (2023) and the lowest at station code 38 (Honnali Bridge) around 196 µmho/cm (2018), suggesting localized anthropogenic impacts downstream.

In the Panchaganga River, EC ranges from a minimum value of 138.5 µmho/cm at station code 1904 (2023) to a maximum of 1874.5 µmho/cm (2022) at the same station, indicating episodic pollution or discharge events. The Malaprabha River exhibits relatively high EC levels, with a maximum at station code 2764 (Badami Bridge) of 1288 µmho/cm (2023) and a minimum at station code 1187 (Khanapur) of around 194 µmho/cm (2019). In contrast, the Bhadra River maintains comparatively low EC values, with a maximum value of about 250 µmho/cm at station code 1387 (2018 and 2020) and a minimum value of around 83 µS/cm at station code 2771 (for both 2020 and 2021), indicating relatively better water quality.

The Musi River shows consistently high EC levels, reflecting severe urban and industrial influence, with the highest value at station code 3082 (Musi Reservoir) reaching 1844 µmho/cm (2019) and the lowest at station code 4253 (Bapughat) around 1178 µmho/cm (2023). Overall, the EC trends highlight that the Bhima and Musi rivers are significantly impacted by anthropogenic activities, while Bhadra remains relatively unpolluted, and other tributaries exhibit moderate variability.

Dissolved Oxygen (DO): The Bhima River shows pronounced fluctuations, with the lowest DO value of 3.5 mg/L recorded at station codes 1189 and 1190 in near Pune, indicating substantial organic pollution load, while the highest value of 16.3 mg/L at station code 2656 (Ujani backwater) represents an anomalous condition. Excluding this outlier, the Bhima River generally ranges between 3.5 and 9.1 mg/L, reflecting gradual downstream recovery. The Tungabhadra River maintains relatively stable DO levels, ranging from 4.1 mg/L (station code 29) to 7.7 mg/L (station code 1029), and indicative of moderate ecological conditions. Similarly, the Panchaganga River exhibits a narrow DO range of 5.0-6.7 mg/L (station codes of 1904 and 1311), suggesting balanced oxygen dynamics.

The Malaprabha River shows comparatively higher variability, with DO ranging from 5.0 mg/L to 9.0 mg/L (station code 1164), indicating generally good oxygen availability with episodic enhancement. The Bhadra River demonstrates consistently healthy conditions, with DO values between 5.6 mg/L (station code 1387) and 7.4 mg/L (station code 2765). In contrast, the Musi River exhibits critically depleted DO levels, with a minimum of 0.1 mg/L observed at station codes 4253 and 2339, reflecting near-anoxic conditions in stretches impacted by untreated urban discharge from Hyderabad, while downstream improvement is evident with a maximum DO of 6.8 mg/L at station code 3082. Overall, the DO regime highlights severe oxygen stress in highly urbanized tributaries, moderate conditions in regulated river stretches, and relatively healthy oxygen levels in less impacted sub-basins, emphasizing the role of wastewater inputs and dilution mechanisms in controlling riverine oxygen dynamics.

Biochemical Oxygen Demand (BOD): The Bhima River exhibits the widest fluctuation, with the highest BOD observed at station code 1189 (Pune U/S Vithalwadi) reaching 22.5 mg/L (2023), while the lowest occurs at station code 1167 (Yadgir) with values around 2.5 mg/L, resulting in a broad range from 2.5 to 22.5 mg/L, indicating severe organic pollution in upstream urban stretches and gradual improvement downstream. In the Tungabhadra River, BOD remains relatively moderate, with a peak of 11.0 mg/L at station code 2776 (D/S of Gangawathi, 2022) and a minimum value of about 1.8 mg/L at station code 1785 (Manthralayam), suggesting localized pollution events. The Panchaganga River shows episodic high BOD levels, particularly at station code 1905 (D/S of Kolhapur Town) with 11.0 mg/L (2018), while the lowest value of 1.6 mg/L occurs at station code 1904, indicative of urban discharge influence.

The Malaprabha River maintains relatively low BOD levels, with a maximum value of 3.0 mg/L at station code 1164 (2018) and a minimum value of 1.5 mg/L at station code 2764, resulting in a narrow range, reflecting comparatively better water quality. Similarly, the Bhadra River shows low organic pollution, with BOD ranging from about 1.3 mg/L at station code 2771 to around 4.9 mg/L at station code 1387. In stark contrast, the Musi River demonstrates critically high BOD levels, with the maximum recorded at station code 4656 (Moosarambagh Bridge, Hyderabad) reaching 40 mg/L (2019) and the minimum at station code 4254 (Rudravelly Bridge) around 3.2 mg/L, resulting in a very high range, clearly reflecting intense urban and industrial pollution. Overall, the analysis indicates that while tributaries like Bhadra and Malaprabha maintain relatively good water quality, the Bhima and especially the Musi rivers are heavily impacted by organic pollution, necessitating targeted management interventions.

4. Pollution Sources

Pollution Sources in a river basin refer to the various natural and human-induced activities that degrade the quality of surface water and groundwater within the basin area. Major sources include domestic sewage from urban settlements, industrial effluents, agricultural runoff containing fertilizers, pesticides and solid waste disposal near water bodies. Rapid urbanization and unregulated land-use changes further increase the inflow of pollutants into the basin system. These pollution sources negatively affect water quality, aquatic ecosystems, irrigation suitability and the overall sustainability of river basin resources.

4.1 Industrial Clusters

Industries play a significant role in the economic development of the Krishna River Basin, but they also contribute to environmental pollution, particularly affecting water resources. Based on the pollution potential as classified by the Central Pollution Control Board (CPCB), industries are categorized into Red, Orange, Green, and White categories. Red category industries are highly polluting and generate substantial quantities of effluents and hazardous wastes, while orange category industries have moderate pollution potential. Green category industries are less polluting with relatively lower environmental impact, whereas White category industries are considered non-polluting and do not generate significant emissions or effluents. The analysis of industrial data across the four states of the basin indicates that a considerable number of industries fall under the red and orange categories, especially in major industrial districts, highlighting potential pollution risks. In contrast, Green and White category industries have comparatively minimal impact on water quality. This classification helps in identifying pollution hotspots and emphasizes the need for effective monitoring, regulation, and adoption of cleaner technologies to protect the river ecosystem.

Upper Krishna Sub – basin: The distribution of polluting and non-polluting industries in the Upper Krishna Basin indicates a significant presence of industries across all CPCB categories, including Red, Orange, Green, and White. The analysis shows that orange and green category industries dominate the basin, reflecting a predominance of moderate to low pollution-generating activities. However, a considerable number of red category industries, particularly in districts such as Kolhapur, Satara, and Belagavi, indicate the presence of highly polluting industrial units that may contribute significantly to water quality degradation. Kolhapur district stands out with a notably high concentration of industries across all categories, making it a major industrial hub as well as a potential pollution hotspot within the basin. Similarly, districts like Sangli and Dharwad also show substantial numbers of orange and green industries, indicating moderate industrial activity with associated environmental impacts. In contrast, districts such as Vijayapura and Bagalkot exhibit relatively lower industrial intensity. Overall, the spatial distribution highlights that while non-polluting and less polluting industries (Green and White categories) form the majority, the concentration of red and orange category industries in key districts necessitates stringent monitoring and effective pollution control measures to protect the river ecosystem in the Upper Krishna Sub-Basin. The polluting and non-polluting industries in Upper Krishna Sub basin has been represented in figure 7 below.

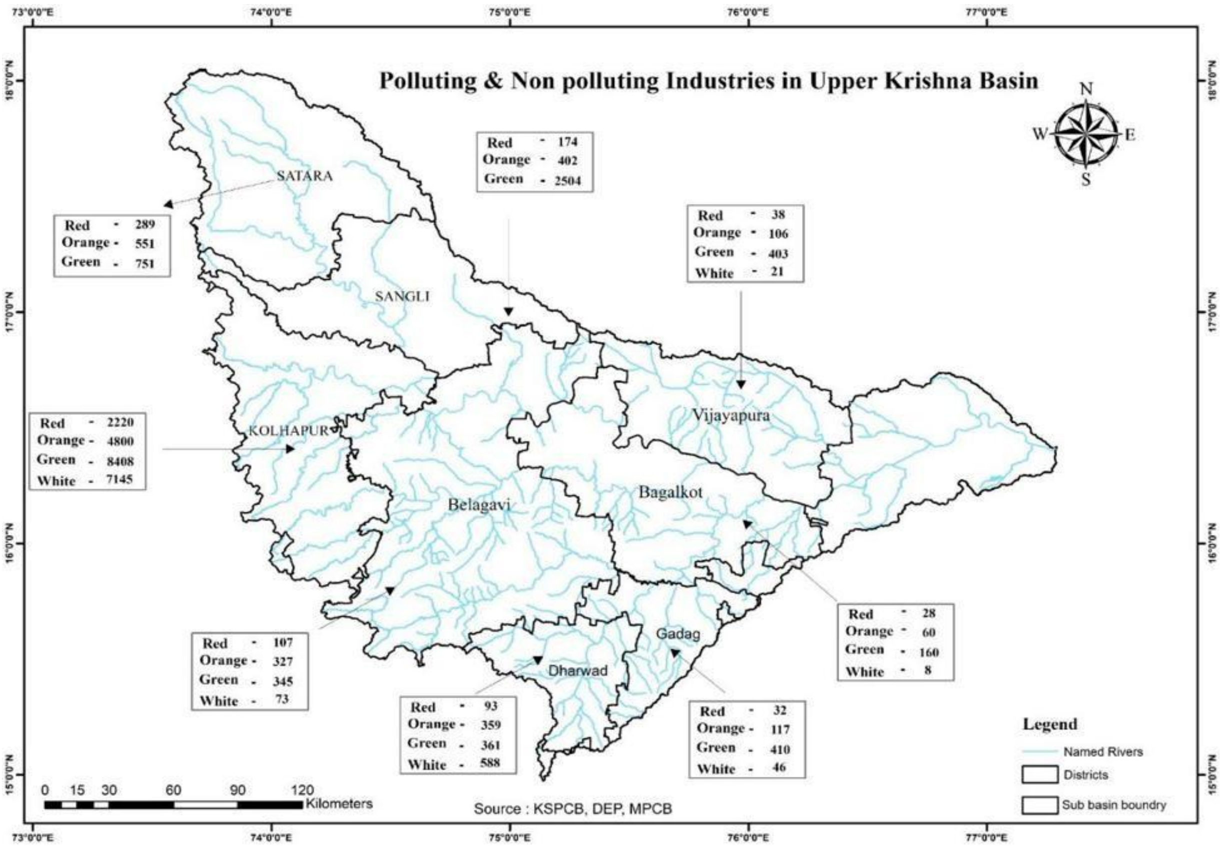

Figure 7: Polluting and Non – Polluting Industries in the districts of Upper Krishna Sub basin

Middle Krishan Sub- basin: The Middle Krishna Basin shows a varied distribution of industries across red, orange, green and white categories, with a noticeable dominance of orange category industries, indicating moderate pollution levels across the region. Prakasam district stands out with the highest industrial concentration reflecting significant heavy industrial activity. Ranga Reddy also shows a strong presence. While, Nalgonda records moderate to high industrialization. Mahabubnagar shows a dominance of red and orange categories. Importantly, Nagar Kurnool district has comparatively low industrial presence indicating limited industrial development. Northern parts like Raichur display a more balanced and environmentally favorable distribution indicating a higher presence of less-polluting sectors. Other districts such as Narayanpet, Jogulamba Gadwal and Wanaparthy also show relatively low industrial activity. Some areas like Kurnool and Nandyal have no available data. The polluting and non-polluting industries in Middle Krishna Sub basin has been represented in figure 8 below.

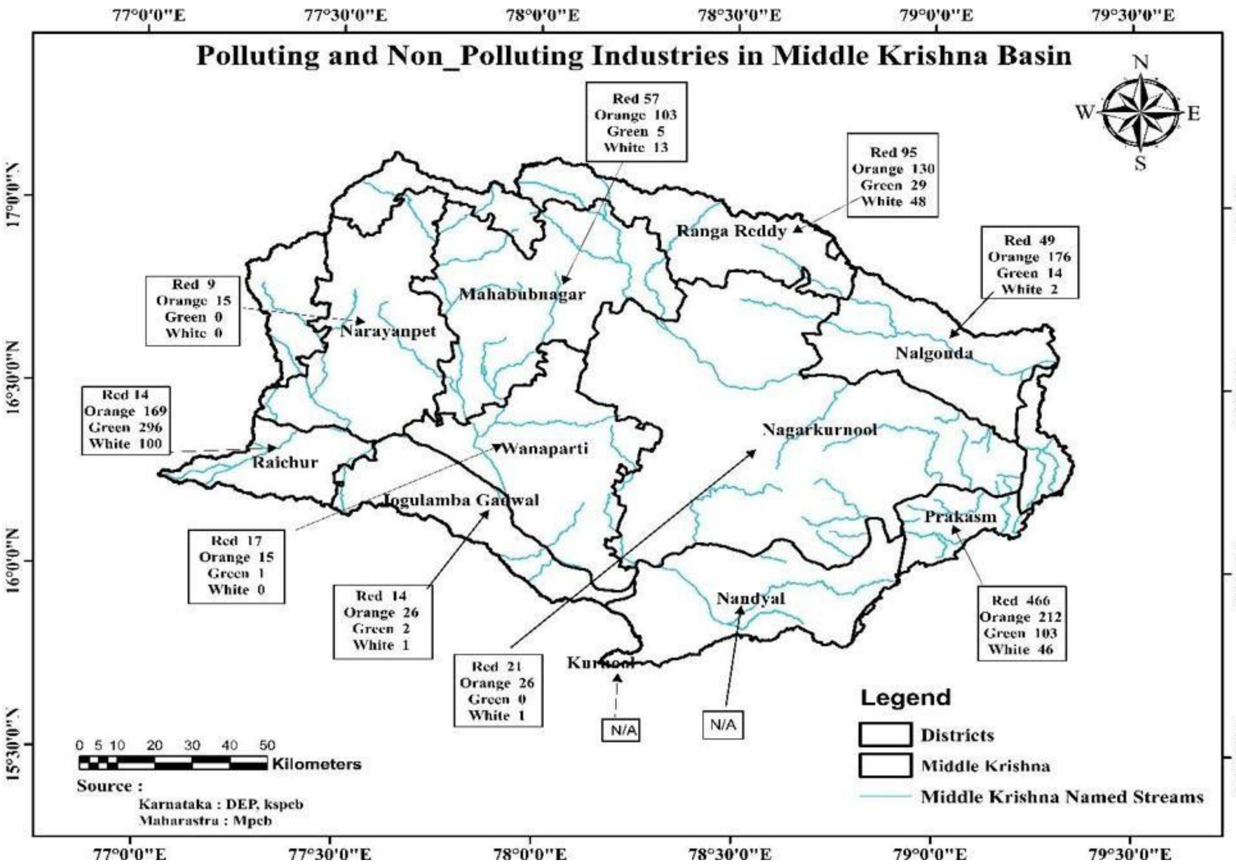

Figure 8: Polluting and Non – Polluting Industries in the districts of Middle Krishna Sub basin

Lower Krishna Sub – basin: The map of the Lower Krishna Basin shows an uneven distribution of polluting (Red, Orange) and non-polluting (Green, White) industries across districts. Very high industrial concentration is seen in Guntur and Krishna indicating major pollution loads. Khammam and Bhadradri Kothagudem shows contrasting patterns, with the latter having more green industries. Warangal and Hanumakonda also differ significantly in industrial composition. Moderate levels are observed in Nalgonda, Siddipet and Yadadri Bhuvanagiri. Lower industrial presence is seen in Hyderabad, Medchal–Malkajgiri. Some areas like Palnadu, Bapatla and NTR have no available data. Overall, Red and Orange industries dominate most districts, highlighting uneven industrial growth and potential environmental stress in the basin. The polluting and non-polluting industries in Lower Krishna Sub basin has been represented in figure 9 below.

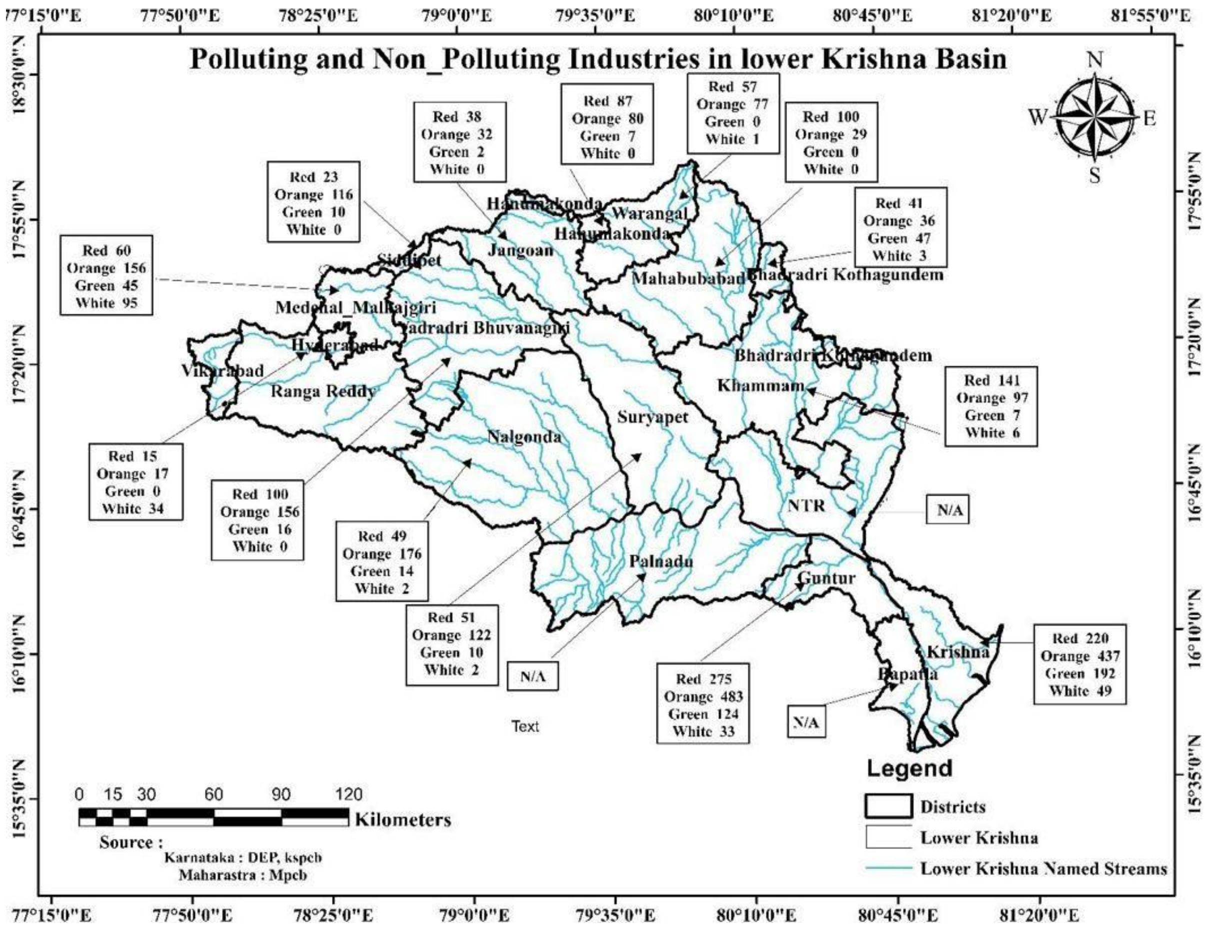

Figure 9: Polluting and Non – Polluting Industries in the districts of lower Krishna Sub basin

Upper Bhima Sub – basin: The distribution of polluting and non-polluting industries in the Upper Bhima Basin indicates a strong industrial presence across all CPCB categories, the analysis reveals that orange and green category industries dominate the basin, suggesting a prevalence of moderate to low pollution-generating activities. However, a substantial number of red category industries are also present, particularly in districts such as Pune and Solapur, indicating significant potential for environmental pollution. Pune district emerges as a major industrial hub with the highest concentration of industries across all categories, making it a key pollution hotspot within the basin. Solapur also shows considerable industrial activity, especially in the orange and green categories, contributing to cumulative pollution loads. Other districts such as Ahmednagar and Satara exhibit moderate industrial presence, while regions like Beed and Dharashiv have comparatively lower industrial intensity. Overall, while non-polluting and less polluting industries (Green and White categories) form the majority, the concentration of red and orange category industries in major districts highlights the need for stringent monitoring, effective effluent treatment, and sustainable industrial practices to safeguard water quality in the Upper Bhima Basin. The polluting and non-polluting industries in Upper Bhima Sub basin has been represented through Figure 10 below.

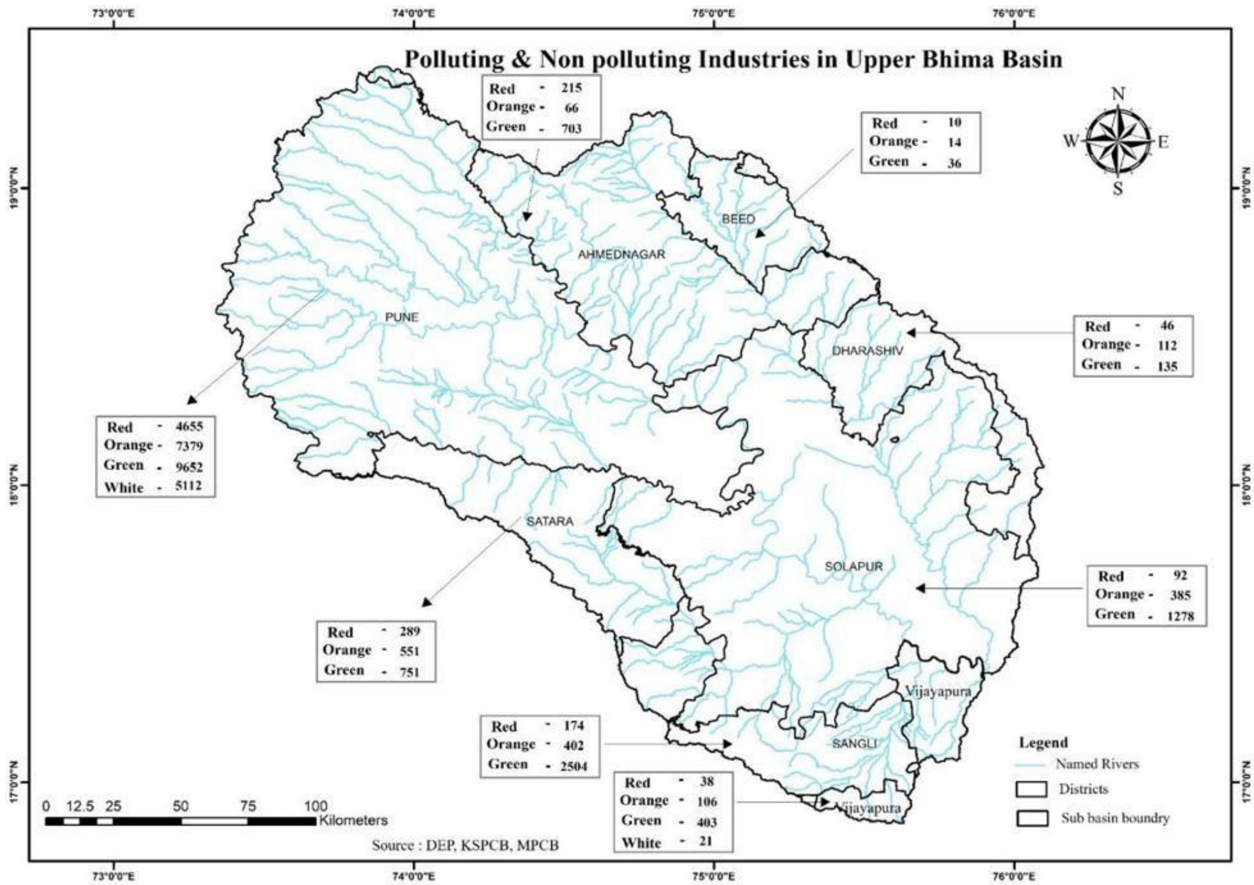

Figure 10: Polluting and Non – Polluting Industries in the districts of Upper Bhima Sub basin

Lower Bhima Sub – basin: The distribution of polluting and non-polluting industries in the Basin reflects a moderate level of industrial activity across districts. The analysis indicates that orange and green category industries dominate the basin, suggesting the prevalence of moderate to low pollution-generating activities. However, a notable presence of red category industries is observed in districts such as Solapur and Ranga Reddy, indicating potential environmental stress due to higher pollution loads. Solapur emerges as a key industrial district with a significant number of industries, particularly in the orange and green categories, making it an important contributor to cumulative pollution within the basin. Similarly, Ranga Reddy district shows a considerable concentration of red and orange category industries, highlighting it as a potential pollution hotspot. Other districts such as Bidar, Kalaburagi, and Yadgir exhibit moderate industrial presence, while areas like Vikarabad show relatively lower industrial intensity. The polluting and non-polluting industries in Lower Bhima Sub basin has been represented in figure 11 below.

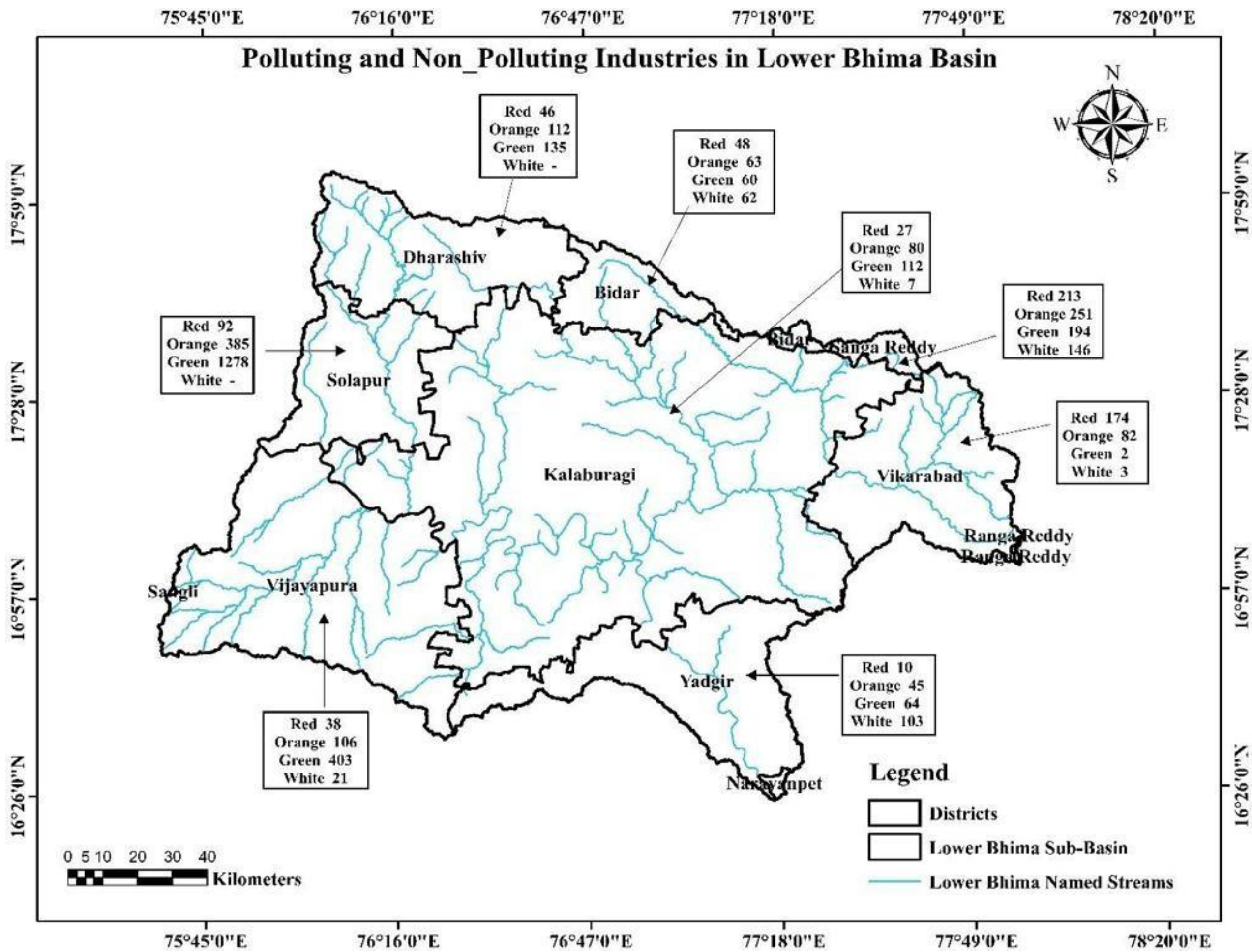

Figure 11: Polluting and Non – Polluting Industries in the districts of lower Bhima Sub basin

Upper Tungabhadra Sub – basin: The Upper Tungabhadra Basin shows a diverse distribution of industries across different pollution categories, with a dominance of green and orange industries, indicating a prevalence of less to moderately polluting activities. Districts such as Dharwad and Gadag exhibits a strong presence of green and white category industries, Shivamogga also demonstrates a notable inclination toward eco-friendly industrial development. In contrast, Ballari and Koppal show relatively higher concentrations of red and orange category industries, indicating the presence of more pollution-intensive activities. Davangere and Chitradurga display a balanced mix of all industry categories, suggesting moderate industrial development. Uttara Kannada and Haveri have comparatively lower industrial presence with a greater share of less-polluting industries. Chikkamagaluru has minimal industrial activity overall, while Vijayanagara has partly unavailable data. The polluting and non-polluting industries in Upper Tungabhadra Sub basin has been represented in figure 12 below.

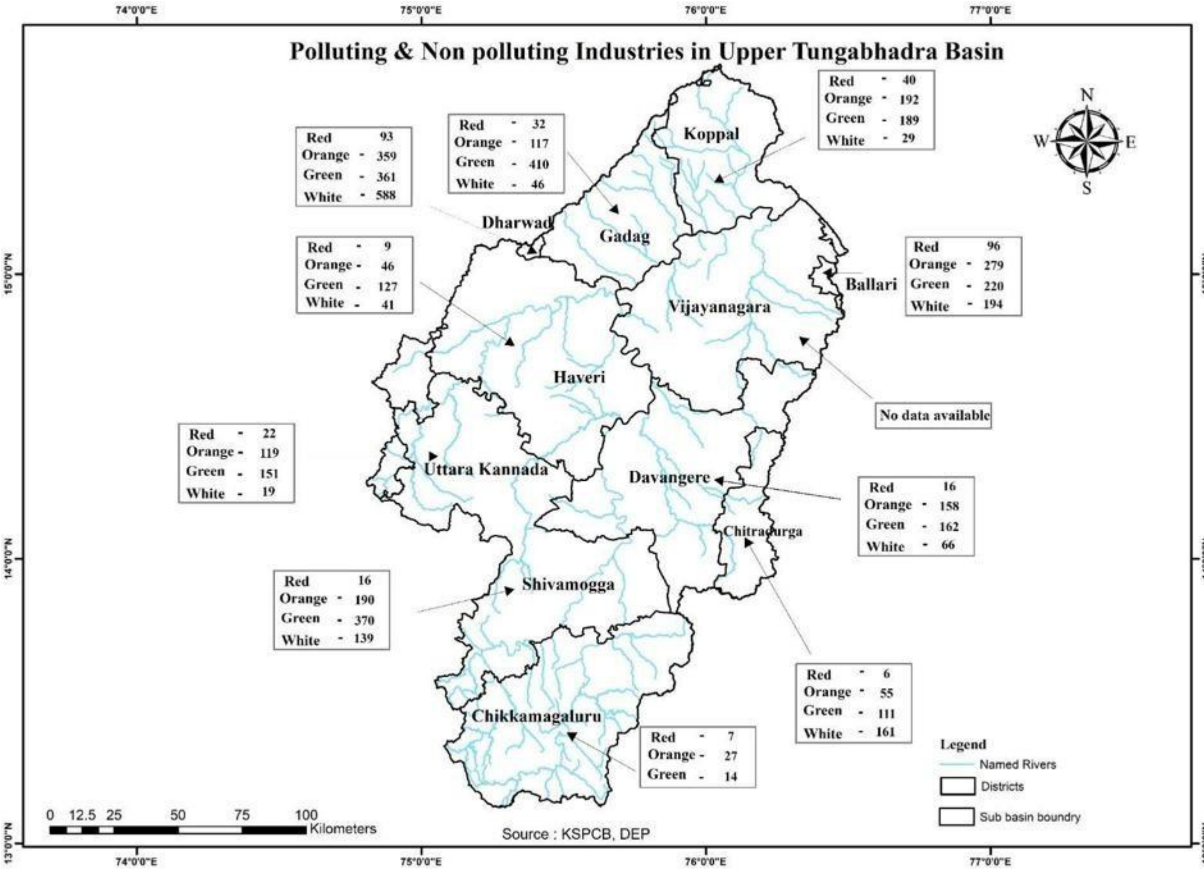

Figure 12: Polluting and Non – Polluting Industries in the districts of Upper Tungabhadra Sub basin

Lower Tungabhadra Sub – basin: The Lower Tungabhadra Basin exhibits a diverse distribution of industries categorized into red, orange, green, and white groups based on their pollution levels. Overall, orange and green category industries dominate the region, indicating a prevalence of moderate to low-pollution activities. However, certain districts such as Ananthapur and Kurnool show a high concentration of red category industries, reflecting significant heavy industrial activity and potential environmental concerns. In contrast, districts like Hassan and Tumakuru have a large number of green and white category industries, suggesting a shift toward more environmentally sustainable sectors. Bellari also shows a balanced industrial distribution across categories. Northern districts such as Raichur, Bagalkot, and Koppal display a balanced mix of all industry types, while districts like Chitradurga, Chikkamagaluru, Jogulamba Gadwal and Davangere indicates moderate industrial presence. Nandyal, Vijayanagara, and Sri Sathya Sai, where industrial data is partly unavailable or limited. The polluting and non-polluting industries in Lower Tungabhadra Sub basin has been represented in figure 13 below.

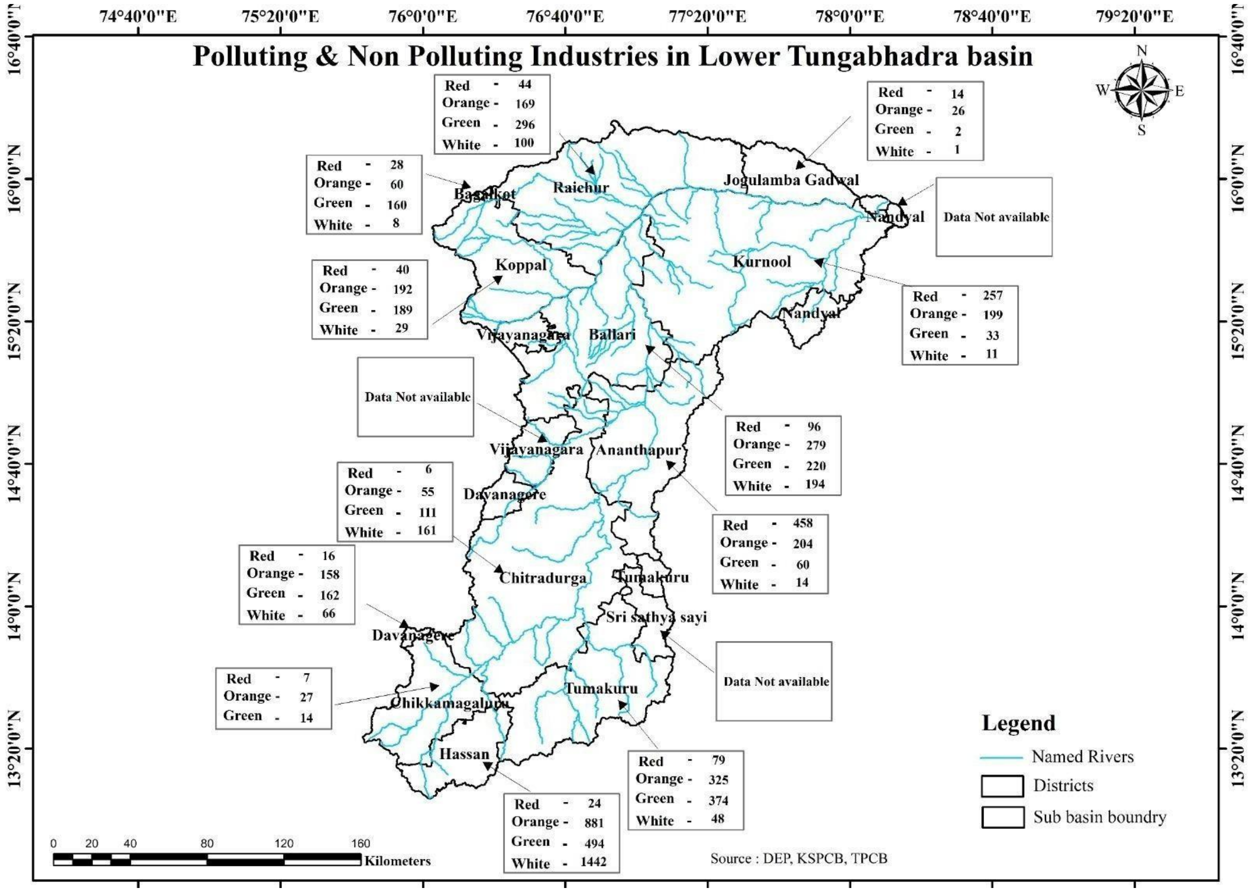

Figure 13: Polluting and Non – Polluting Industries in the districts of lower Tungabhadra Sub basin

4.2 Domestic Wastewater load

Domestic wastewater load is defined as the amount of wastewater and associated pollutants generated from household activities, including bathing, cooking, laundry, and sanitation. It is typically characterized by hydraulic flow and pollutant concentrations such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), and nutrients. The magnitude of the domestic wastewater load is influenced by factors such as population density, water consumption patterns, socioeconomic conditions, and lifestyle practices. Accurate assessment of wastewater load is essential for the effective design, operation, and optimization of wastewater collection, treatment, and disposal systems.

The quantity of Domestic Wastewater generated data has been collected from District Environment Plan (DEP) Reports-2016 and Maharashtra Pollution Control Boards (MPCB), Telangana and Andhra Pradesh Sewage Management Reports.

Upper Krishna Sub-basin: The quantity of domestic wastewater generated varies considerably among districts of Upper Krishna baisn, with Kolhapur producing the highest amount (231.9 MLD), followed by Satara (142.44 MLD) and Sangli (122.37 MLD). Moderate wastewater loads are observed in Belagavi, Dharwad, and Raichur, whereas Yadgir (0.45 MLD) and Raichur (7.54 MLD) contribute the least. Overall, the spatial distribution indicates that districts with larger populations and higher urbanization levels generate greater volumes of domestic wastewater. The quantity of Domestic Wastewater Generated in the districts of Upper Krishna Sub-basin is represented in figure 14 below.

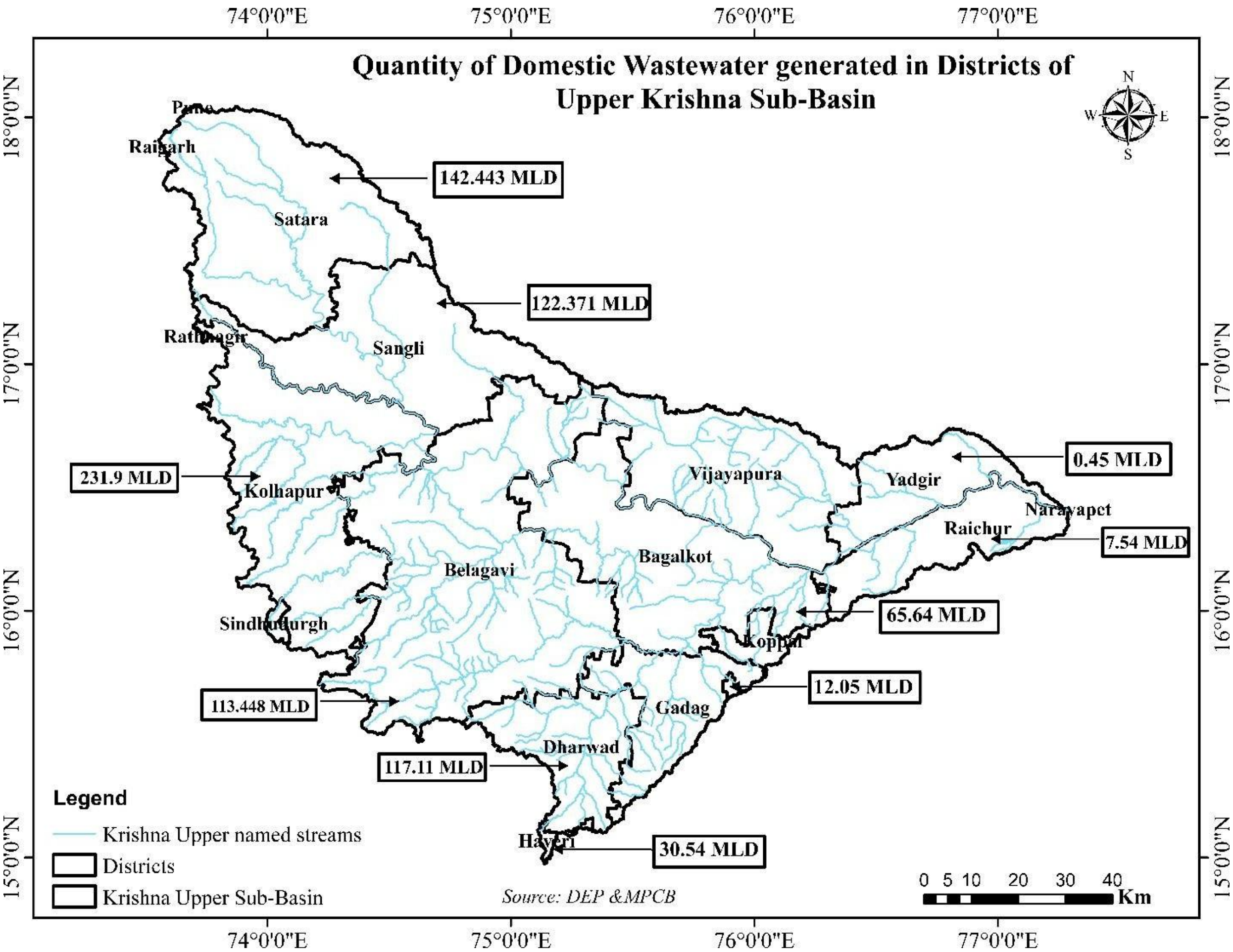

Figure 14: Quantity of Domestic Wastewater Generated in the districts of Upper Krishna Sub-basin

Middle Krishna Sub-basin: The quantity of domestic wastewater generated across the districts of the Middle Krishna Sub-Basin, showing notable spatial variation in wastewater production. Prakasam records the highest wastewater generation (73.39 MLD), followed by Palnadu (61.35 MLD) and Nalgonda (26.05 MLD), indicating relatively higher population and urban activity in these districts. Moderate wastewater loads are observed in Nandyal, and Raichur, while Yadgir (0.45 MLD) and NagarKurnool (1.9 MLD in a basin portion) contribute the least. Overall, the distribution highlights the influence of demographic and developmental factors on domestic wastewater generation within the basin. The quantity of Domestic Wastewater Generated in the districts of Middle Krishna Sub-basin is represented in figure 15 below.

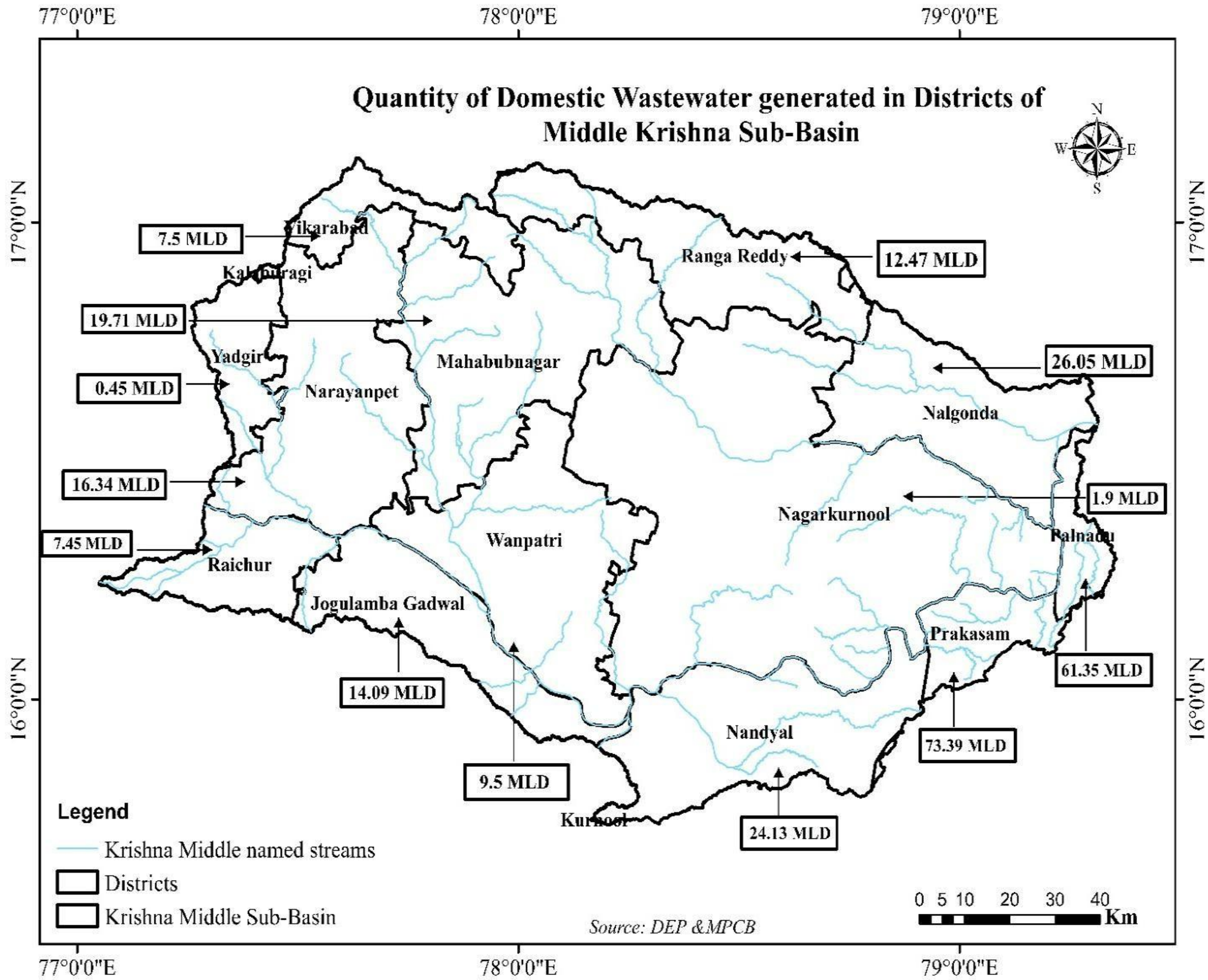

Figure 15: Quantity of Domestic Wastewater Generated in the districts of Middle Krishna Sub-basin

Lower Krishna Sub – basin: The spatial distribution of domestic wastewater generation across the districts of the Lower Krishna Sub-Basin, Hyderabad contributes the highest wastewater load (1950 MLD), significantly exceeding all other districts, followed by NTR (156.59 MLD), Guntur (148.95 MLD), and Warangal (144.84 MLD). Moderate wastewater generation is observed in Palnadu, Krishna, and Bhadradri Kothagudem districts, while Sangareddy, Jangaon, and Vikarabad record comparatively lower values. The quantity of Domestic Wastewater Generated in the districts of Lower Krishna Sub-basin is represented in figure 16 below.

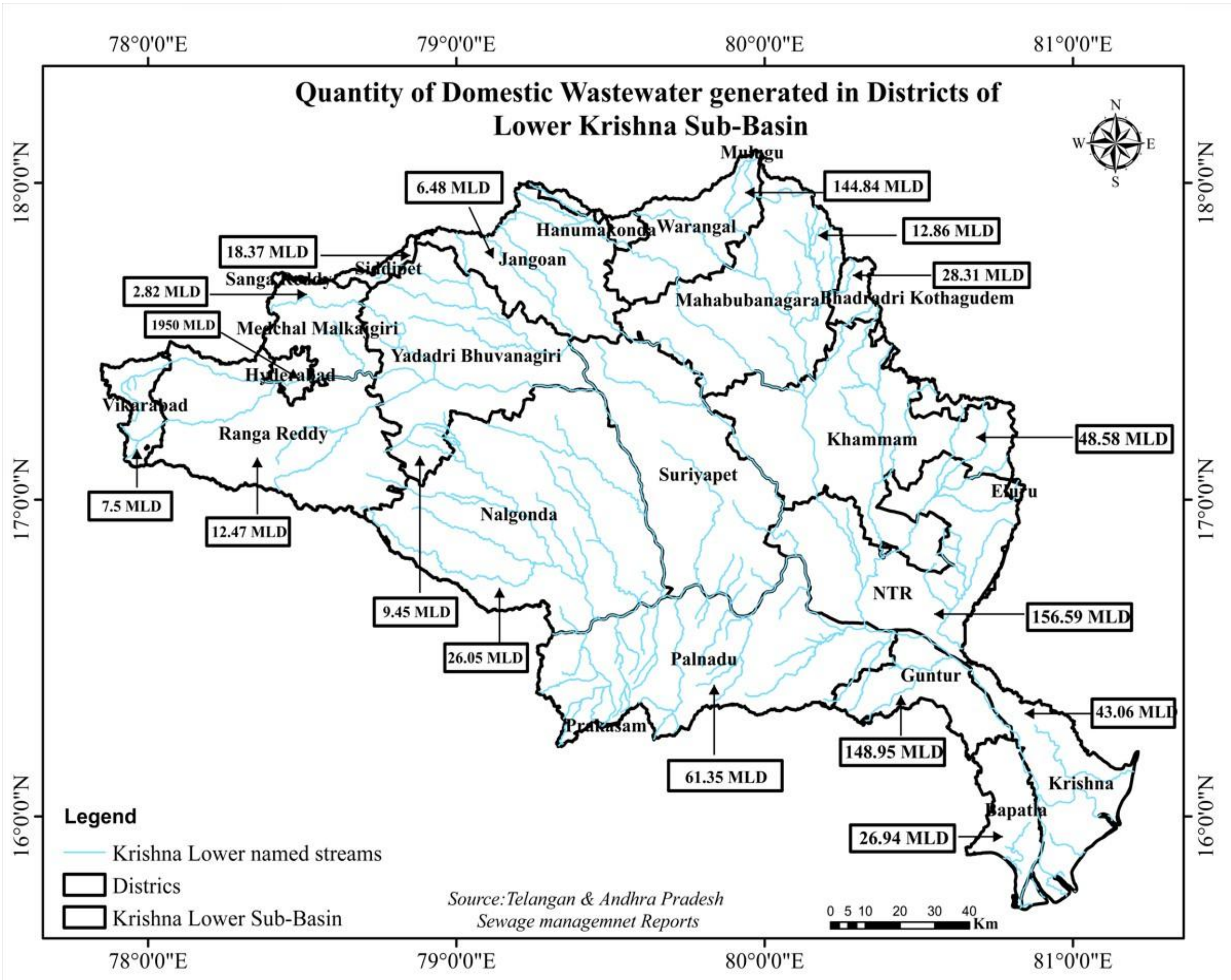

Figure 16: Quantity of Domestic Wastewater Generated in the districts of Lower Krishna Sub-basin

Upper Bhima Sub – basin: The quantity of domestic wastewater generated across districts within the Upper Bhima Sub-Basin. Pune records the highest wastewater generation (1475.65 MLD), far exceeding other districts, reflecting its large population and extensive urban development. Solapur (227.9 MLD), Satara (142.44 MLD), Sangli (122.37 MLD), and Belagavi (113.45 MLD) contribute moderate wastewater loads, while Vijayapura generates the lowest amount (36.81 MLD). Overall, the spatial pattern indicates that highly urbanized and densely populated districts are the major contributors to domestic wastewater generation in the basin. The quantity of Domestic Wastewater Generated in the districts of Upper Bhima Sub-basin is represented in figure 17 below.

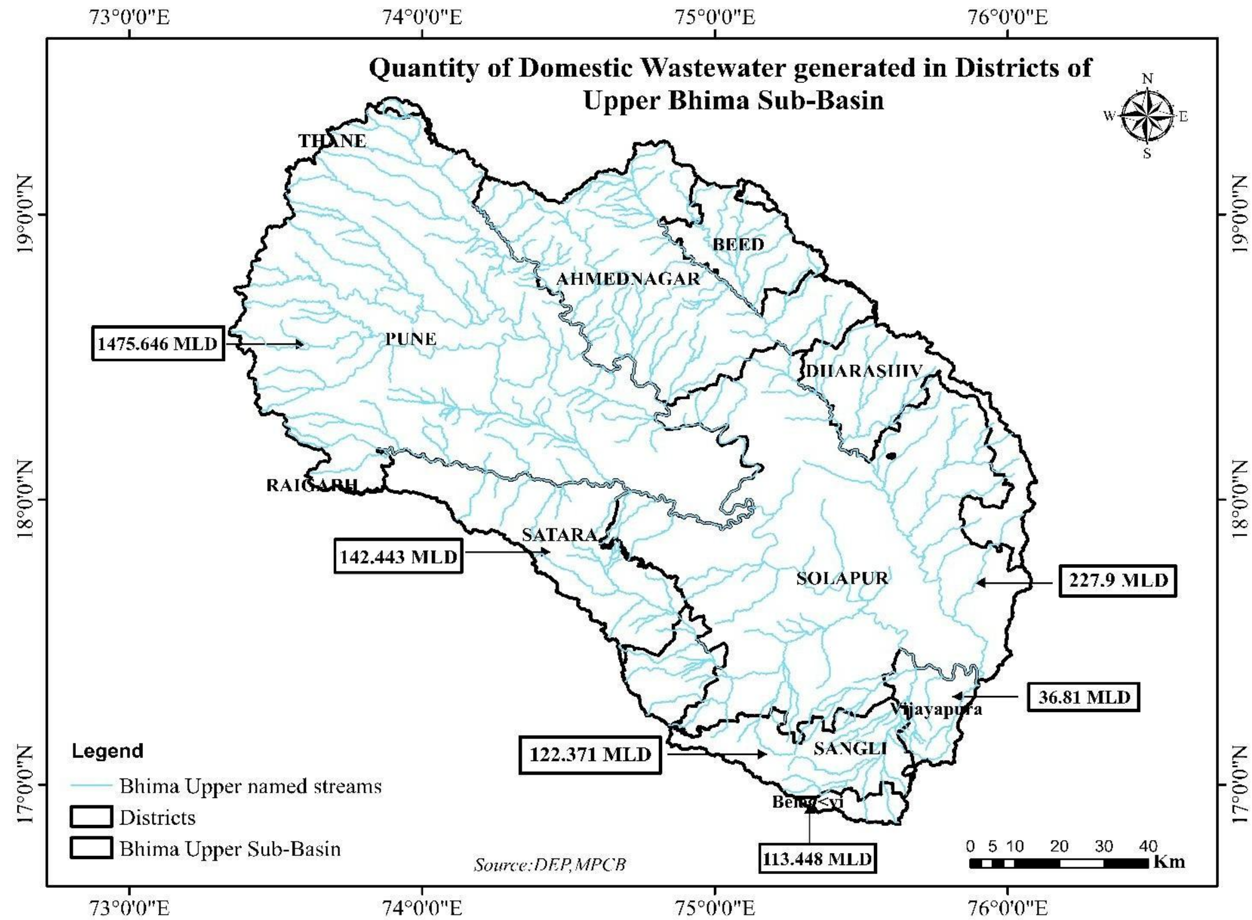

Figure 17: Quantity of Domestic Wastewater Generated in the districts of Upper Bhima Sub-basin

Lower Bhima Sub – basin: The quantity of domestic wastewater generated across districts within the Lower Bhima Sub-Basin. Solapur produces the highest wastewater volume (227.9 MLD), followed by Vijayapura (113.448 MLD) and Kalaburagi (103.206 MLD), indicating major urban and population centers. Moderate quantities are observed in Sangareddy (36.66 MLD) and Bidar (13.4 MLD), while Vikarabad (7.5 MLD) and Yadgir (0.45 MLD) generate comparatively low amounts. Overall, wastewater generation is unevenly distributed, with a few districts contributing the majority of the domestic wastewater load in the basin. The quantity of Domestic Wastewater Generated in the districts of Lower Bhima Sub-basin is represented in figure 18 below.

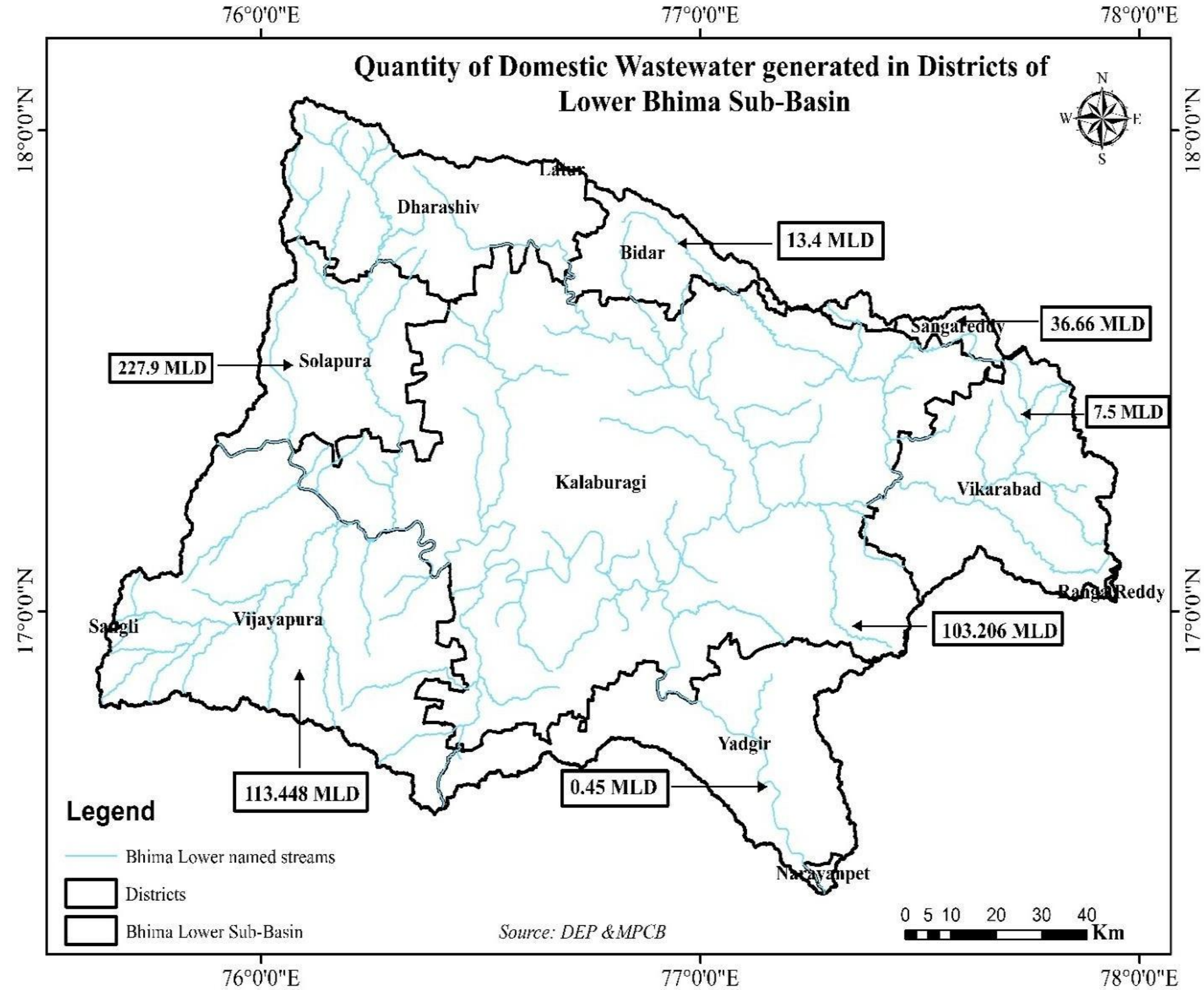

Figure 18: Quantity of Domestic Wastewater Generated in the districts of Lower Bhima Sub-basin

Upper Tungabhadra Sub–basin: Domestic wastewater generation in the Upper Tungabhadra Sub-Basin shows significant variation among districts. Shivamogga generates the highest amount of domestic wastewater (86.66 MLD), followed by Davanagere (62.74 MLD), while Uttara Kannada (33.73 MLD) and Haveri (30.54 MLD) contribute moderate volumes. Lower wastewater generation is observed in Chitradurga (15.2 MLD), Chikkamagaluru (12.56 MLD), and Koppal (12.05 MLD). Overall, wastewater generation varies considerably across the basin, reflecting differences in population density and urban development among the districts. The quantity of Domestic Wastewater Generated in the districts of Upper Tungabhadra Sub-basin is represented in figure 19 below.

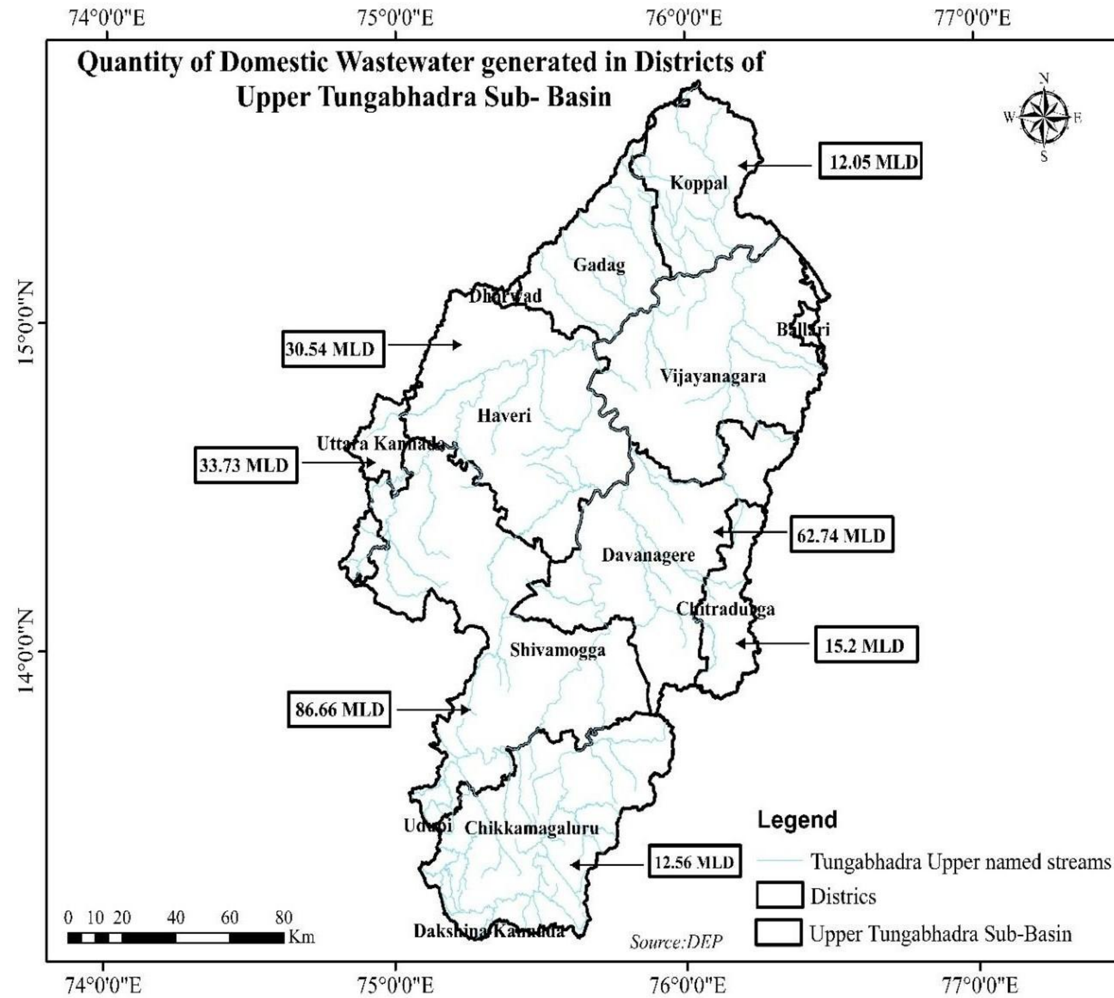

Figure 19: Quantity of Domestic Wastewater Generated in the districts of Upper Tungabhadra Sub-basin

Lower Tungabhadra Sub–basin: Domestic wastewater generation in the Lower Tungabhadra Sub-Basin varies considerably among the districts. Kurnool records the highest wastewater generation (134.16 MLD), followed by Ananthapuramu (90.72 MLD), Tumakuru (86.66 MLD), and Ballari (65.57 MLD), indicating major concentrations of domestic wastewater. Moderate contributions are observed from Davanagere (62.74 MLD) and Sri Sathya Sai (34.49 MLD), while Raichur (7.54 MLD), Koppal (12.05 MLD), Chikkamagaluru (12.5 MLD), and Chitradurga (15.2 MLD) generate relatively lower volumes. Overall, wastewater production is unevenly distributed across the basin, reflecting variations in population, urbanization, and domestic water consumption patterns. The quantity of Domestic Wastewater Generated in the districts of Lower Tungabhadra Sub-basin is represented in figure 20 below.

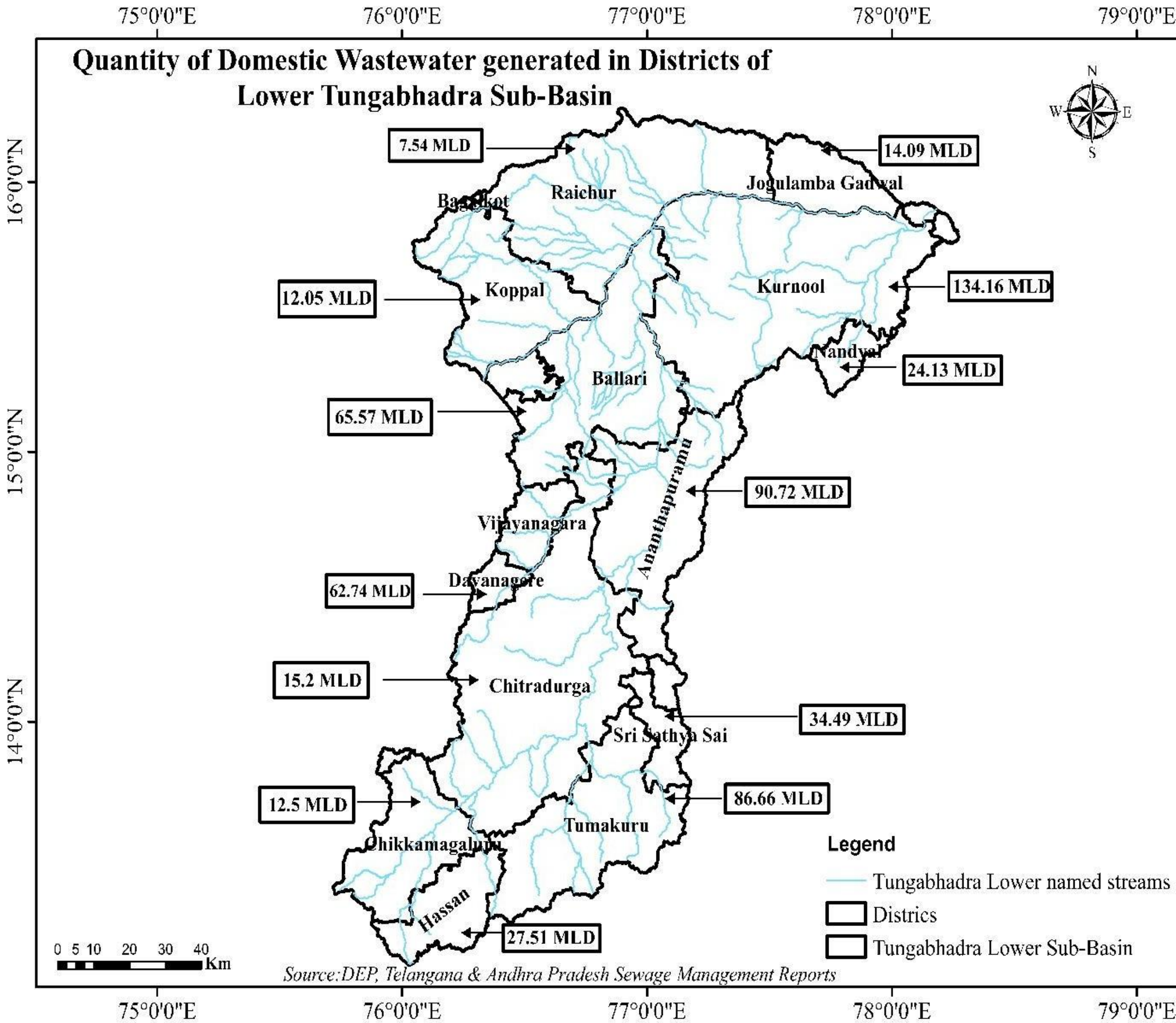

Figure 20: Quantity of Domestic Wastewater Generated in the districts of Lower Tungabhadra Sub-basin

4.3 Industrial Wastewater load

Wastewater generation is a key indicator for assessing the pressure exerted on water resources and the potential pollution load within the Krishna River Basin. It is primarily influenced by domestic, industrial, and commercial activities across urban and rural regions. In the present study, district-wise wastewater generation data has been compiled and further aggregated at the sub-basin level to understand the spatial distribution of wastewater across the basin. This approach helps in identifying critical regions contributing higher wastewater volumes and supports effective planning for treatment and management strategies.

Upper Krishna Sub-basin: The analysis of wastewater generation by Industries in the Upper Krishna sub-basin indicates a significant spatial variation across districts. Higher wastewater generation is observed in districts such as Pune (296 MLD) and Satara (275.97

MLD), reflecting the influence of urbanization and population density. Moderate contributions are noted from districts like Kolhapur (52.5 MLD) and Yadgiri (57.6 MLD), while districts such as Vijayapura (4.51 MLD), Sangli (9.3 MLD), and Dharwad (8.2 MLD) show comparatively lower wastewater generation. In Karnataka districts within the sub-basin, wastewater generation varies, with Bagalkot, Belagavi, and Gadag contributing moderate amounts, whereas Haveri and Koppal exhibit relatively lower values. Overall, the Upper Krishna sub-basin demonstrates a concentration of higher wastewater generation in upstream urbanized districts, indicating potential stress on river water quality and highlighting the need for efficient wastewater treatment infrastructure in these regions. The Wastewater generation in the districts of Upper Krishna Sub basin has been represented through Figure 21 below.

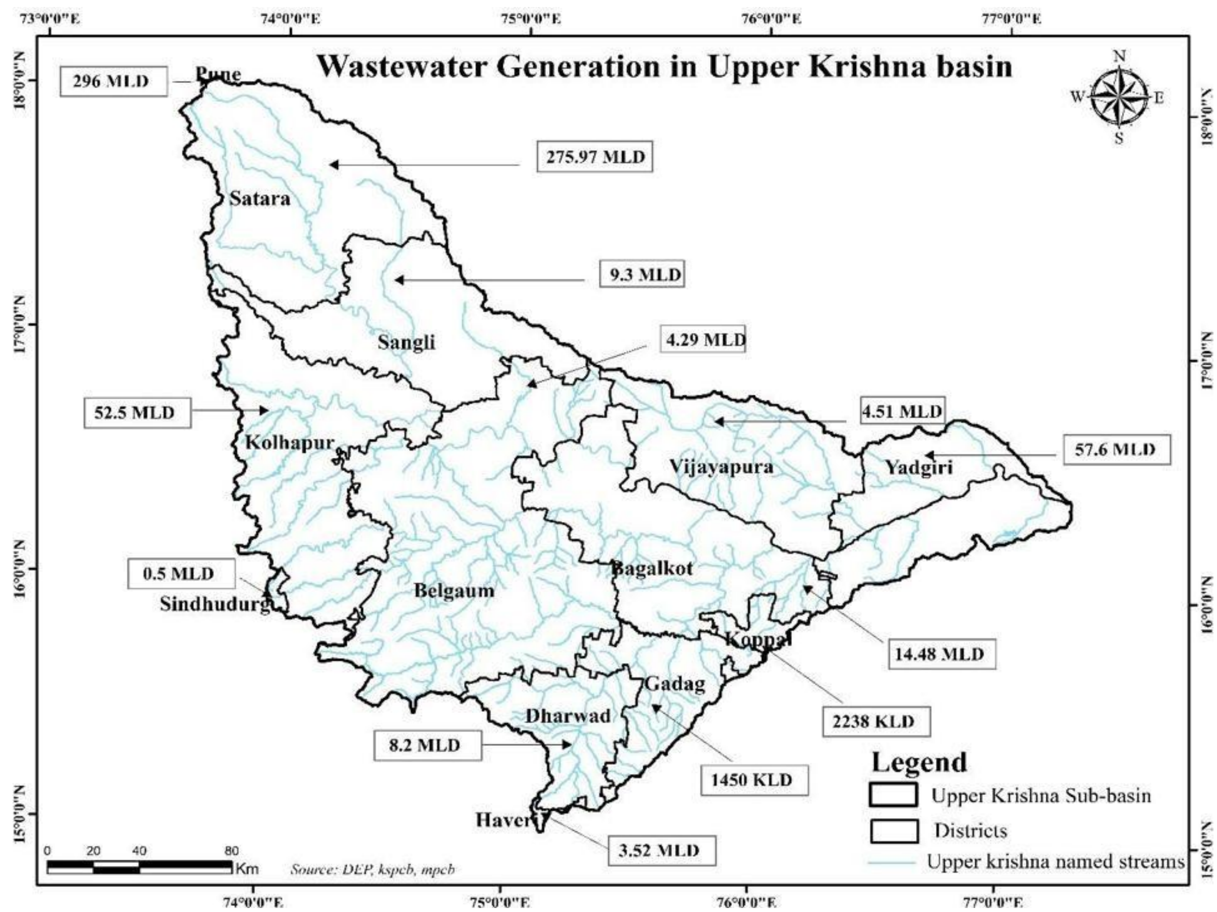

Figure 21: Wastewater Generation in the districts of Upper Krishna Sub basin

Middle Krishna Sub-basin: The map illustrating wastewater generation in the Middle Krishna Basin reveals noticeable spatial variation among different districts. Areas such as Nalgonda, Kurnool, and parts of the eastern region show relatively higher wastewater generation, which can be linked to increased urban settlements, agricultural activities, and local industrial influence. On the other hand, districts like Narayanpet, Wanaparthy, and Jogulamba Gadwal exhibit comparatively lower levels, reflecting limited urban and industrial development. Several parts of the basin, including Rangareddy, Mahabubnagar, and Prakasam, lack sufficient information, pointing to gaps in data availability and coverage. The Wastewater Generation in the Districts of Lower Bhima Sub basin is represented in figure 22 below.

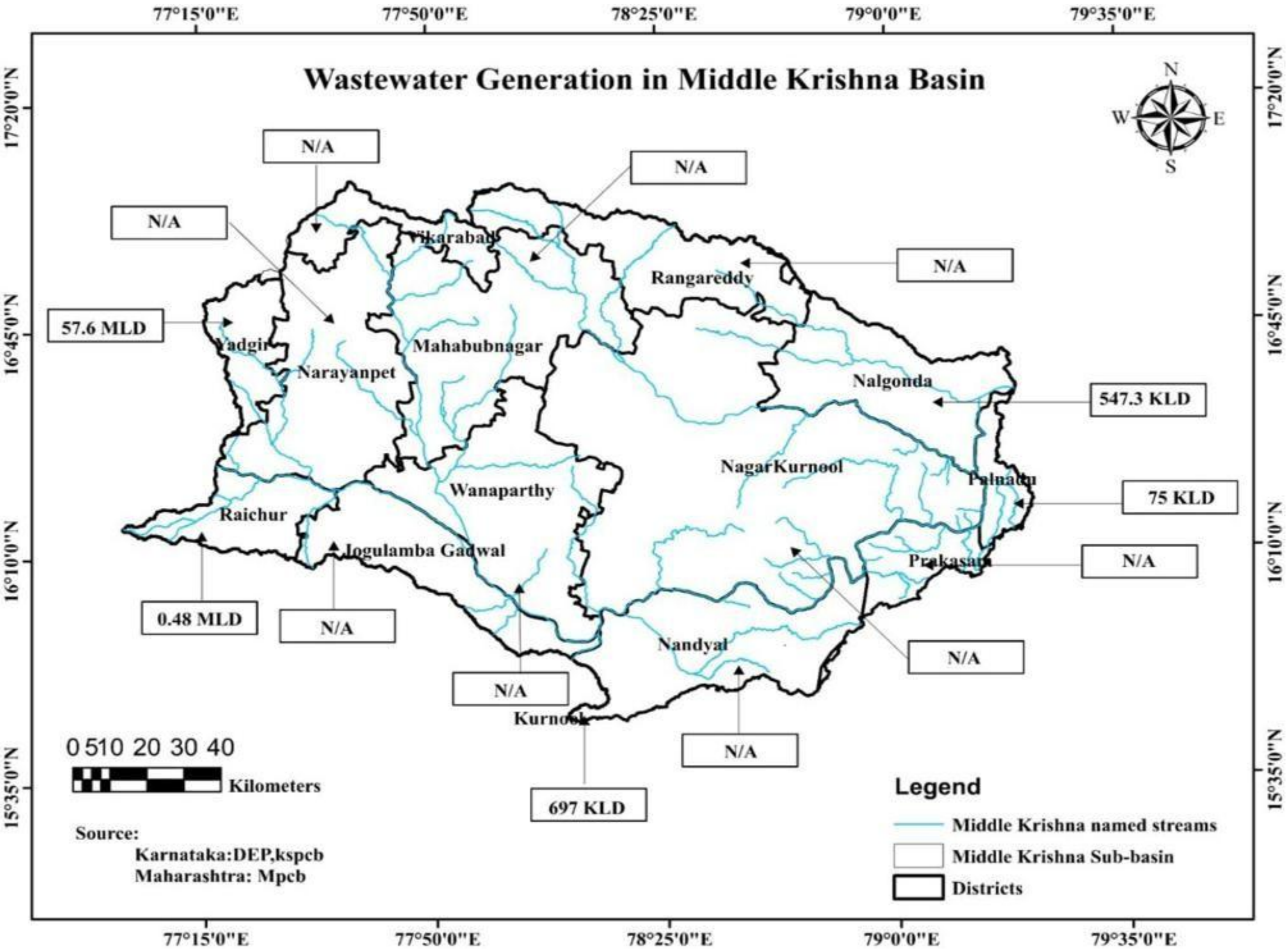

Figure 22: Wastewater Generation in the districts of Middle Krishna Sub basin

Lower Krishna Sub – basin: The map of wastewater generation in the Lower Krishna Basin covers several districts across Telangana and Andhra Pradesh, showing clear spatial variation. In Telangana, districts such as Vikarabad, Rangareddy, Medchal–Malkajgiri, Hyderabad, Yadadri Bhuvanagiri, Siddipet, Jangaon, Hanumakonda, Warangal, Mahabubabad, Bhadradri Kothagudem, Khammam, Suryapet and Nalgonda are included, many of which show either low generation or unavailable data, especially in the northern and western regions. In Andhra Pradesh, districts like Palnadu, NTR, Guntur, Bapatla and Krishna are part of the basin, with comparatively higher and more consistent wastewater generation observed toward the downstream coastal areas. Central districts such as Nalgonda and Suryapet show moderate contributions, acting as transition zones between low and high generation regions. The Wastewater Generation in the districts of Lower Krishna Sub basin is represented in figure 23 below.

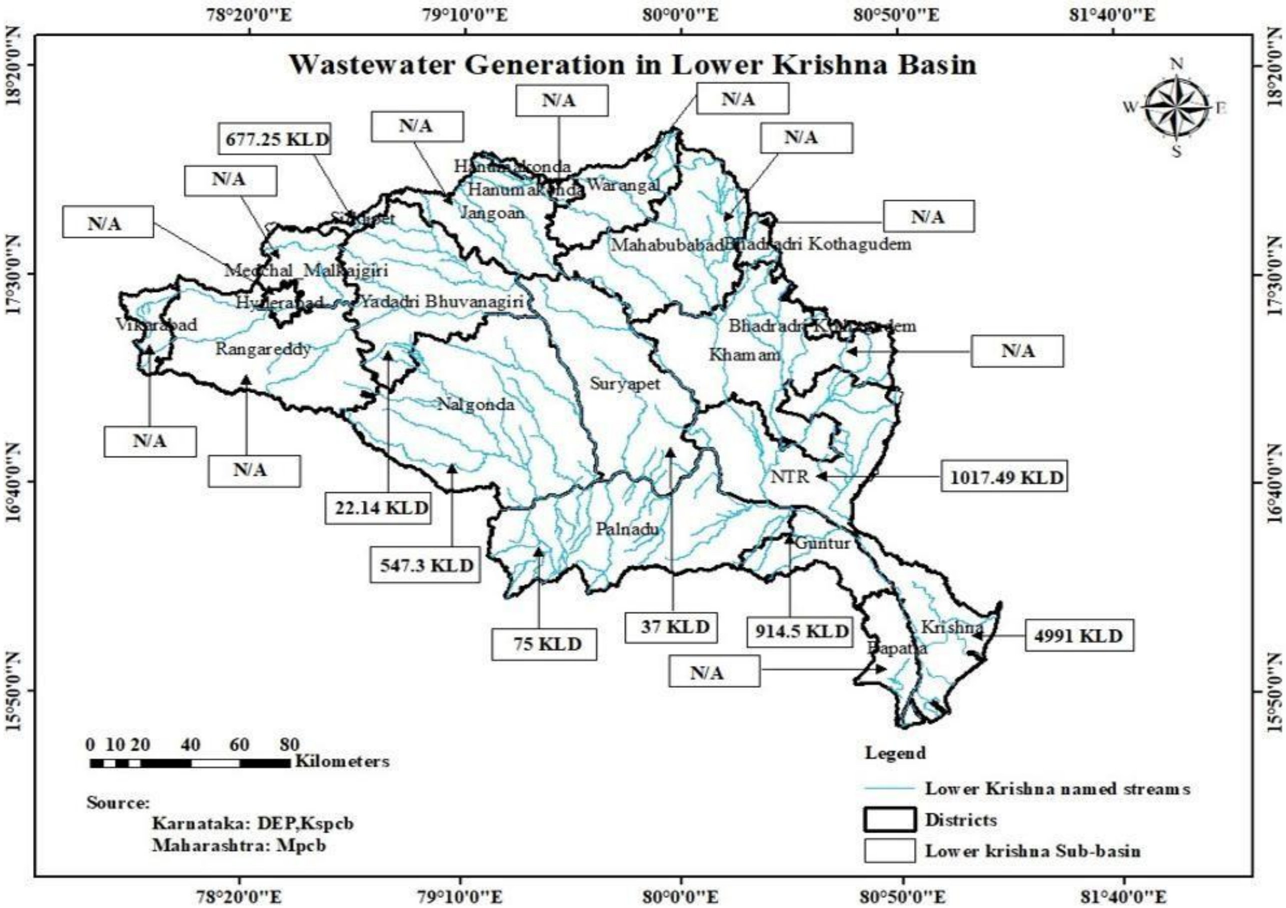

Figure 23: Waste Water Generation in the districts of upper Krishna Sub basin

Upper Bhima Sub – basin: Wastewater generation across the Upper Bhima basin shows considerable variation among districts, influenced by differences in population size, urbanization, and economic activities. Highly urbanized districts such as Pune and Satara contribute significantly higher volumes of wastewater due to intensive domestic, commercial, and industrial water usage. In contrast, districts like Solapur, Osmanabad, and Vijayapura generate comparatively lower amounts, reflecting lower urban concentration and limited industrial development. Intermediate levels in districts such as Ahmednagar and Beed indicate moderate water consumption patterns. The Wastewater Generation in the districts of Upper Bhima Sub basin is represented in figure 24 below.

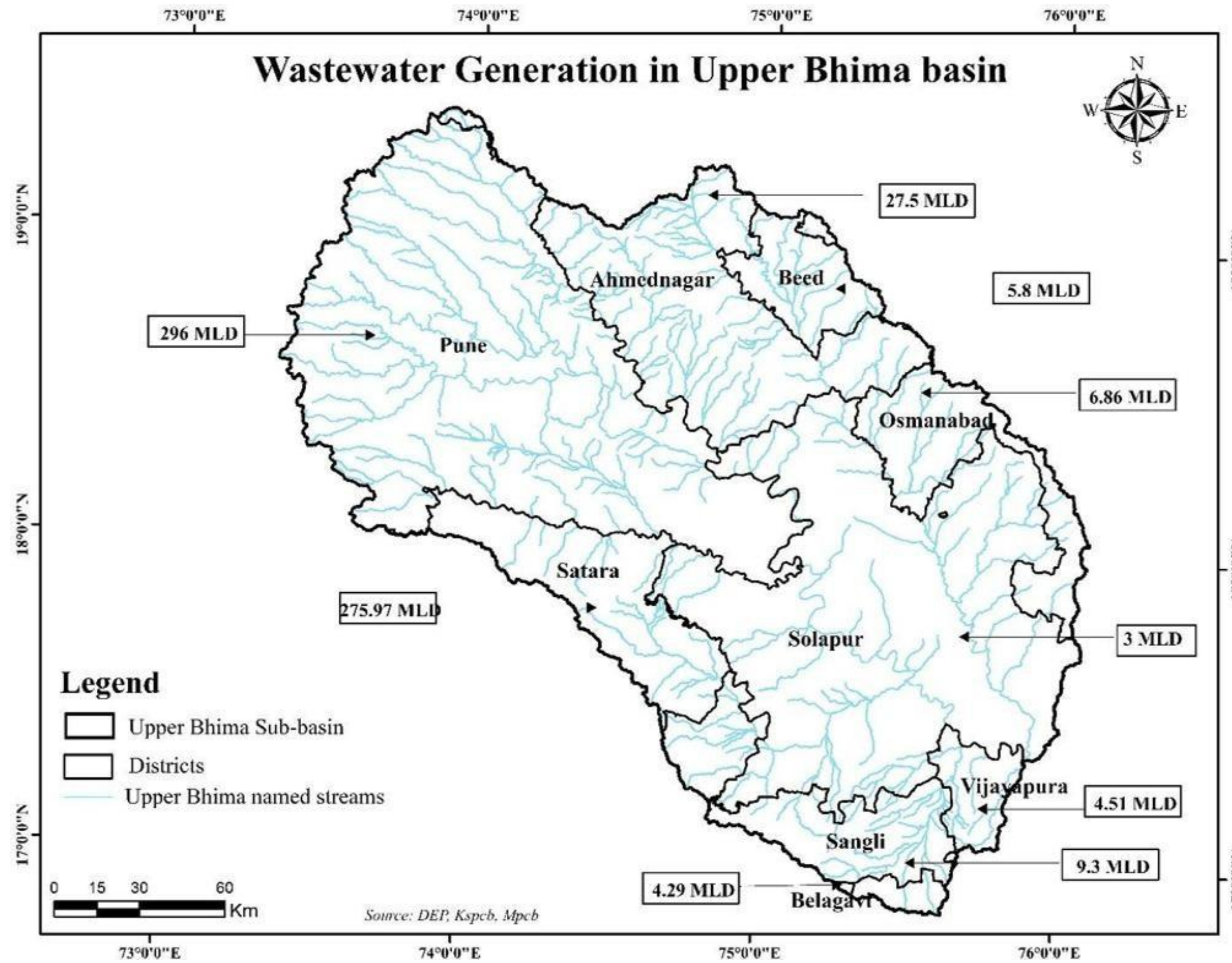

Figure 24: Waste Water Generation in the districts of upper Bhima Sub basin

Lower Bhima Sub – basin: The image depicts the variation in wastewater generation across different districts of the Lower Bhima basin. Some districts, like Yadgir and Bidar, record relatively higher wastewater volumes, which may be associated with greater domestic and industrial water use, while others such as Solapur and Vijayapura have lower outputs, possibly due to lower urbanization or fewer industrial operations. The presence of “N/A” in certain locations indicates a lack of available data, pointing to limitations in data collection and monitoring. The Wastewater Generation in the districts of Lower Bhima Sub basin is represented in figure 25 below.

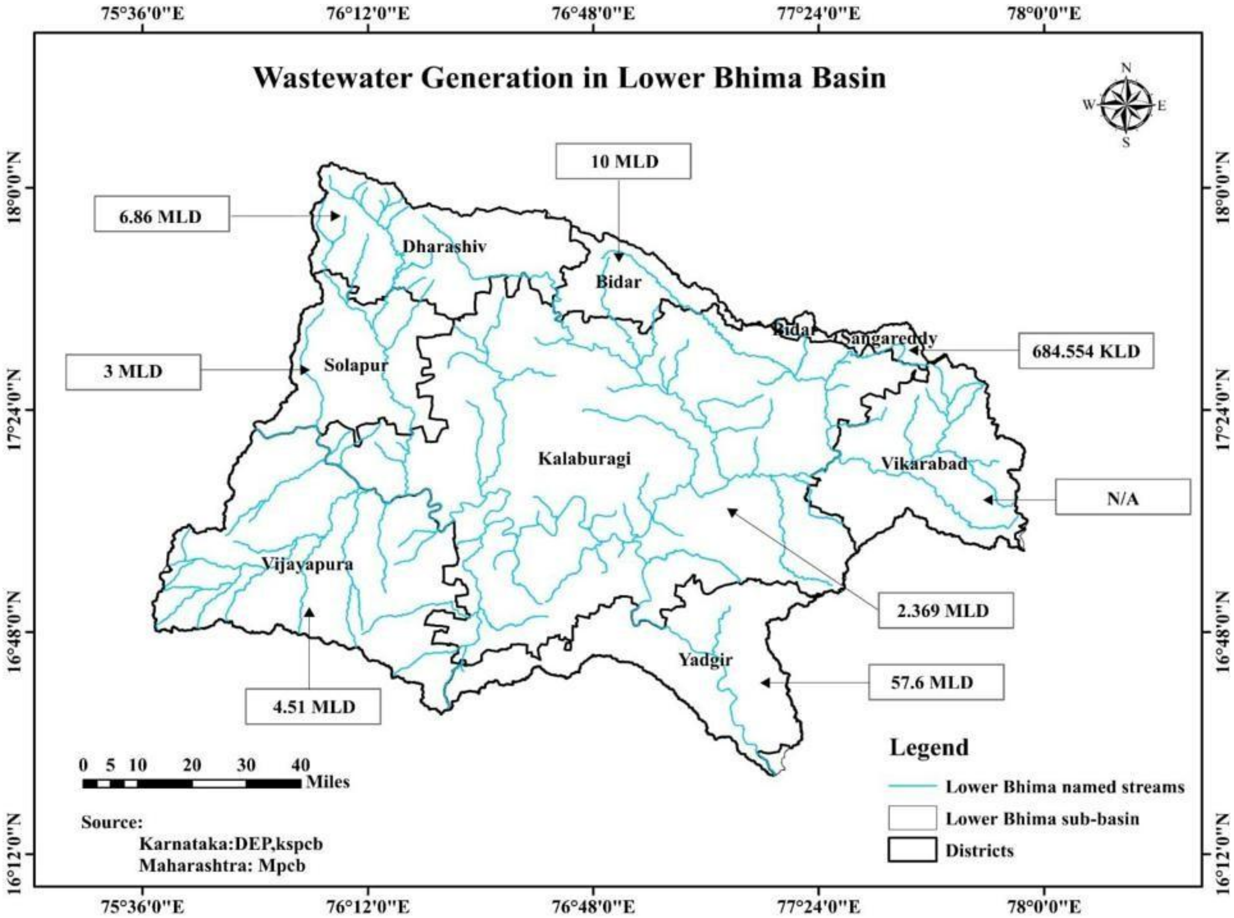

Figure 25: Waste Water Generation in the districts of Lower Bhima Sub basin

Upper Tungabhadra Sub – basin: The spatial distribution of wastewater generation in the Upper Tungabhadra basin across different district illustrates how the quantity of wastewater produced varies significantly from one district to another, reflecting differences in population density, level of urbanization, industrial activities, and water consumption patterns. Districts such as Dakshina Kannada and Chitradurga show comparatively higher wastewater generation, indicating more intensive domestic or industrial water use, while districts like Chikkamagaluru generate much lower amounts, suggesting either lower population density or limited industrialization. The presence of "no data available" in some areas highlights gaps in monitoring and data collection. Overall, the map emphasizes the uneven distribution of wastewater production within the basin and underscores the need for region-specific wastewater management strategies to ensure sustainable water resource planning and environmental protection. The Wastewater Generation in the districts of Upper Tungabhadra Sub basin is represented in figure 26 below.

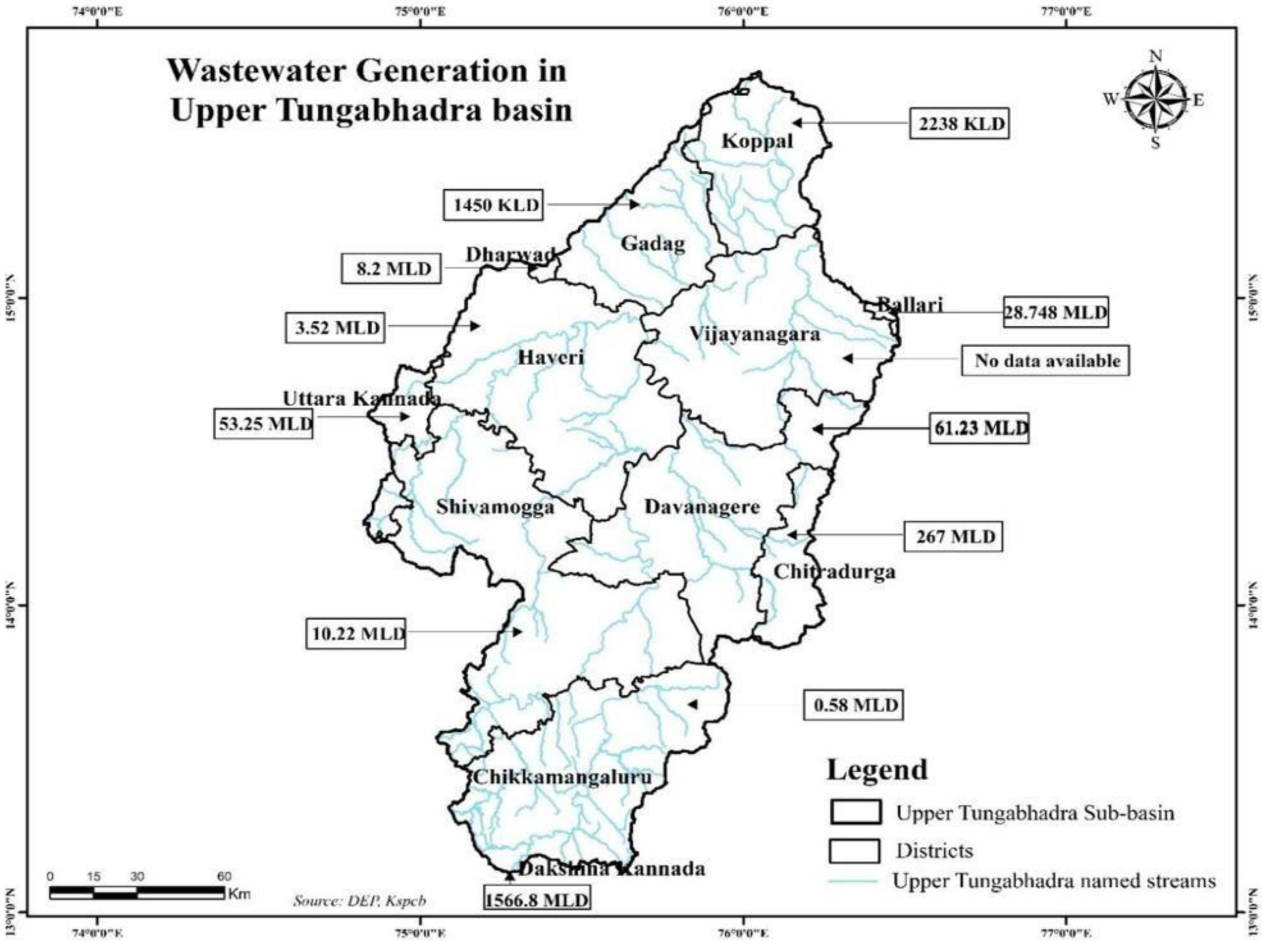

Figure 26: Waste Water Generation in the districts of Upper Tungabhadra Sub basin

Lower Tungabhadra Sub – basin: The map of wastewater generation in the Lower Tungabhadra Basin shows a varied spatial distribution across different districts. Certain districts such as Ballari, Kurnool, and Davanagere exhibit comparatively higher wastewater generation, indicating the influence of urbanization, industrial activities, and population concentration. In contrast, districts like Chikkamagaluru, Hassan, and Tumakuru show relatively lower levels, which may be due to lesser industrial development and lower population density. In some areas, including parts of Anantapur, Nandyal, and Sri Sathya Sai, information is not available, indicating inconsistencies in data coverage across the basin. The Wastewater Generation in the districts of Lower Tungabhadra Sub basin is represented in figure 27 below.

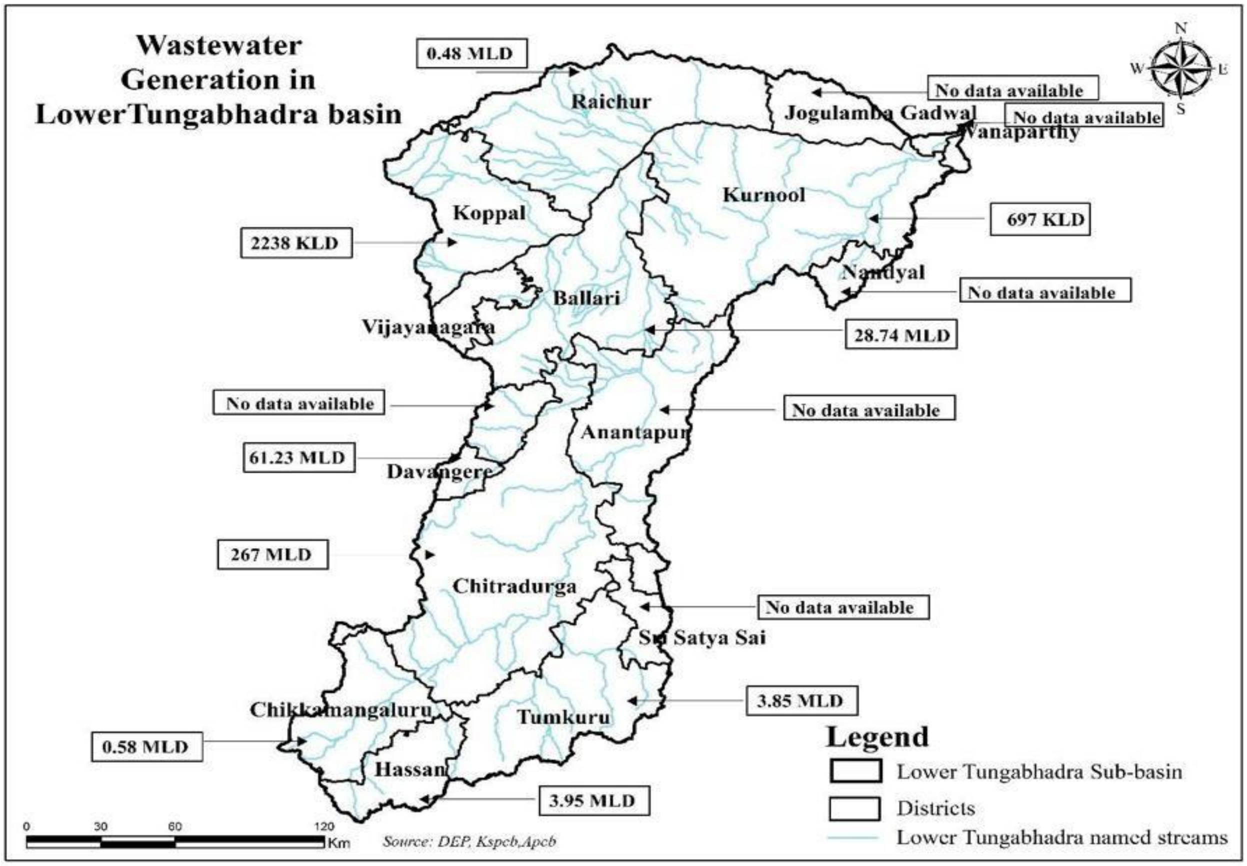

Figure 27: Waste Water Generation in the districts of Lower Tungabhadra Sub basin

5. Wastewater Treatment Facilities

Wastewater Treatment Facilities are specialized plants that clean used water from homes, industries, and businesses before it is released back into the environment or reused. These facilities remove pollutants, harmful microorganisms, and suspended solids through physical, chemical, and biological treatment processes. The treatment helps protect public health, aquatic ecosystems, and water resources from contamination. By treating wastewater effectively, these facilities play a vital role in environmental sustainability and water conservation.

5.1 Sewage Treatment Facilities

Sewage Treatment Facilities are plants designed to treat wastewater that comes primarily from households, including water from toilets, sinks, showers, and kitchens. These facilities remove solid waste, organic matter, harmful bacteria, and other contaminants through a series of treatment processes. The treated water is then safely discharged into rivers, lakes, or reused for certain purposes. Sewage treatment facilities help prevent water pollution, protect public health, and maintain a clean and sustainable environment.

5.2 Existing STPs and their Cumulative capacity

Existing STPs are sewage treatment facilities that have already been established and are available within a region or city. They may be either operational or temporarily inactive, depending on their condition and maintenance status. These plants are designed to collect and treat sewage to remove contaminants before the treated water is discharged or reused. Existing STPs form an essential part of wastewater management infrastructure, helping to reduce pollution and protect public health and the environment.

- **Existing STPs and their Cumulative capacity of Karnataka State**

The Existing STPs cumulative capacity data of districts of Karnataka State of KRB portion are been obtained from the Karnataka Economic Survey 2021-22 report. District-wise table of Karnataka state is presented in table 8 to illustrate the Existing STPs and their Cumulative capacity across the Krishna River basin.

Table 8: Existing STPs and their Cumulative capacity in Karnataka districts of KRB portion

Existing STPs in Karnataka State				
S.No	**District**	**No. of STPs**	**STPs capacity (MLD)**	**Cumulative Capacity of Existing STPs (MLD)**
1	Bagalkote	9	22.49	22.49
2	Ballari	6	58	80.49
3	Belagavi	4	7.7	88.19
4	Bidar	2	5	93.19
5	Bijapura	5	37.76	130.95
6	Chikkamagaluru	2	6.3	137.25
7	Chitradurga	1	5	142.25
8	Davanagere	6	55.8	198.05
9	Dharwad	9	41	239.05
10	Gadag	5	14.97	254.02
11	Hassan	6	25.3	279.32
12	Haveri	3	7.5	286.82
13	Kalaburgi	5	67.5	354.32
14	Koppal	1	14	368.32
15	Raichur	3	19.2	387.52
16	Shivamogga	6	24.4	411.92
17	Tumkur	4	22.5	434.42
18	Uttar Kannada	2	3	437.42
19	Vijayanagara	-	-	-
20	Yadgiri	1	0.64	438.06

- ### Existing STPs and their Cumulative capacity of Telangana State

The Existing STPs cumulative capacity data of districts of Telangana State of KRB portion are been obtained from the NGT Monthly Progress report. District-wise table of Telangana state is presented in table 9 to illustrate the Existing STPs and their Cumulative capacity across the Krishna River basin.

Table 9: Existing STPs and their Cumulative capacity in Telangana districts of KRB portion

Existing STPs in Telangana State				
Sl.No	**District**	**Location of STP'S**	**Capacity of Operational STP's in MLD**	**Cumulative Capacity of Operational STP's in MLD**
1	Hyderabad	Amberpet	339	339
		Attapur 1	51	390
		Attapur 2	23	413
		Miralam Tank 1	10	423
		Miralam Tank 2	5	428
		Saroor Nagar	2.5	430.5
		Langer House	1.2	431.7
		Noor Mohammad Kunta	4	435.7
		JVR Park, Nagarjuna Circle	0.5	436.2
		Peddacheruvu	17.5	453.7
		Fathenagar-I	133	586.7
		Necklace Road	20	606.7
		Krishnakanth Park,	0.5	607.2
		Pattigadda	30	637.2
		Amberpet	212.5	849.7
		Miralam Site-I	41.5	891.2
		Attapur-1	64	955.2
2	Medchal Malkajgiri	Nagole	172	172
		Nagole	320	492
		Nallacheruvu	30	522
		Nallacheruvu-I	86.5	608.5
		Pedda Cheruvu, Nacharam	10	618.5
		Patel Cheruvu, Nacharam	2.5	621
		Safilguda, Malkajgiri	0.6	621.6
		Safilguda	5.5	627.1
		Khajakunta, Metro, KKP	12	639.1
		Vennelagadda	10	649.1
		Mullakathuwa Cheruvu	25	674.1
		Shivalaynagar	14	688.1
		Rangadhamini Lake, KKP	5	693.1
		Amber Cheruvu, Pragatinagar	2.5	695.6
		Pragathinagar	15	710.6
		Nainoni Kunta	1.5	712.1
		Khajakunta	20	732.1
		Miyapur Patelcheruvu	7	739.1
3	Rangareddy	Durgam Cheruvu, SLP	5	5
		Durgam Cheruvu	7	12
		Khajaguda, Gachibowli	7	19
		Nanakramguda, Gachibowli	4.5	23.5
		Gopanapally, SLP	4.5	28
		Kokapet	15	43
		Nallagandla	7	50
		Palapitta Park	7	57
4	Sangareddy	Lingam Kunta, BHEL	30	30
5	Vikarabad	Chakali Gadda, Allampally	13	13
6	Siddipet	Thallagadda	11.5	11.5
		Chinthala Cheruvu	7.25	18.75
		Narsapur Cheruvu	11	29.75
		Rajareddy Pally	1.5	31.25
		Pidichedu Road	3.5	34.75
		Pandavula Chervu	0.5	35.25
		Pragnapur (By-Pass Road)	1.25	36.5
		Pullareddy cheruvu	10	46.5
		Ursugutta	5	51.5
7	Nagar Kurnool	Nagar Kurnool	2.3	2.3
8	Nalgonda	Nalgonda	17.16	17.16

- **Existing STPs and their Cumulative capacity of Andhra Pradesh State**

The Existing STPs cumulative capacity data of districts of Andhra Pradesh State of KRB portion are been obtained from the NGT Monthly Progress Report. District-wise table of Andhra Pradesh state is presented in table 10 to illustrate the Existing STPs and their Cumulative capacity across the Krishna River basin.

Table 10: Existing STPs and their Cumulative capacity in Andhra Pradesh districts of KRB portion

Existing STPs in AndraPradesh State						
SL.No	**District**	**Name of the ULB**	**Location of Operational STP's**	**No of STPs**	**Capacity of Operational STP's in MLD**	**Cumulative Capacity of Operational STP'S in MLD**
1	NTR	Vijayawada	Ajith Singh Nagar-1	1	40	40
			Ajith Singh Nagar-2	1	20	60
			Ramalingeswar Nagar-1	1	20	80
			Ramalingeswar Nagar-2	1	10	90
			Autonagar-1	1	10	100
			Autonagar-2	1	10	110
			Jakkampudi	1	20	130
2	Krishna	Kondapalli	Security Colony	1	0.8	130.8
			Security Colony	1	2	132.8
3	Guntur	Tadepalli	Mahanadu -1	1	0.2	133
			Mahanadu -2	1	0.2	133.2
		CRDA (Guntur)	Inavolu	1	0.8	134
			Nowluru	1	1.5	135.5
4	Palnadu	Narsaraopete	CPT Road	1	15.55	151.05
5	Prakasam	Ongole	Koppolu	1	15	166.05
		Kandukur	Uppucheruvu-1	1	1.4	167.45
6	Kurnool	Yemmiganuru	Soganur road	1	19.8	187.25
		Kurnool	Jammichettu	1	0.8	188.05
			Sankal Bagh	1	0.8	188.85
			Tungabhadra Pump House	1	0.8	189.65
			Jagannadhagattu	1	0.8	190.45
			Jagannadhagattu	1	1.6	192.05
		Adhoni	Siriguppa Road	1	0.2	192.25
7	Anathapur	Tadipatri	Gannevaripalle	1	3.5	195.75
			Gannevaripalle	1	8	203.75
8	Sri Satya Sai	Puttaparthy	Sai Nagar	1	0.5	204.25
			Gokulam	1	0.5	204.75
9	Nandyal	Nandyal	SRBC Colony	1	1.1	205.85
			SRBC Colony	1	1.2	207.05
		Allagadda	Chinthakuntla Village-III	1	0.2	207.25
10	Bapatla	Repalle	Repalle- II	1	0.9	208.15

- ## Existing STPs and their Cumulative capacity of Maharashtra State

The Existing STPs cumulative capacity data of districts of Maharashtra State of KRB portion are been obtained from the NGT Monthly Progress Report. District-wise table of Maharashtra state is presented in table 11 to illustrate the Existing STPs and their Cumulative capacity across the Krishna River basin.

Table 11: Existing STPs and their Cumulative capacity in Maharashtra districts of KRB portion

<table>
<tr><th colspan="6">Existing STPs in Maharashtra State</th></tr>
<tr><th>SL.No</th><th>District</th><th>Name of the Town</th><th>Location of STPs</th><th>Capacity of Operational STPs in MLD</th><th>Cumulative Capacity of Operational STPs in MLD</th></tr>
<tr><td rowspan="11">1</td><td rowspan="11">Pune</td><td rowspan="9">Pune Municipal corporation</td><td>Erandwane STP, S.No.3&4 Erandwane</td><td>50</td><td>50</td></tr>
<tr><td>Bopodi STP, S.No.2A, 2B, 2C, 2D &6 (P) Bopodi</td><td>18</td><td>68</td></tr>
<tr><td>Tanajiwadi S.No.24, Shivajinagar</td><td>17</td><td>85</td></tr>
<tr><td>Bhairoba STP, Final plot No.330 S.No.33A, 33B Koregaon Park</td><td>130</td><td>215</td></tr>
<tr><td>Mundhawa STP, S.No.2,3A,4 Mundhawa</td><td>45</td><td>260</td></tr>
<tr><td>Vithalwadi STP, S.No.20(P) Hingane</td><td>32</td><td>292</td></tr>
<tr><td>Baner STP, S.No.221 To 227 Baner</td><td>30</td><td>322</td></tr>
<tr><td>Kharadi STP, S.No.74, 75 Kharadi</td><td>40</td><td>362</td></tr>
<tr><td>New Naidu STP, S.No.439 To 444 Pune final Plot No. 98 Knndy Road</td><td>115</td><td>477</td></tr>
<tr><td>Pune Cantonment Board</td><td>900 Boottee Street, Pune</td><td>20</td><td>497</td></tr>
<tr><td>Dehu Nagarpanchayat, Dist. Pune</td><td>Dehu, Pune</td><td>3</td><td>500</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Kolhapur</td><td rowspan="3">Kolhapur Municipal Corporation, Kolhapur</td><td>Kolhapur Municipal Corporation STP (76 MLD)Kasaba Bavada, Kolhapur</td><td>76</td><td>576</td></tr>
<tr><td>Kolhapur Municipal Corporation STP (17 MLD)Dudhali, Kolhapur</td><td>17</td><td>593</td></tr>
<tr><td>4 MLD -Kasba Bavada</td><td>4</td><td>597</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Sangli</td><td rowspan="2">Sangli Municipal Corporation</td><td>STP at Miraj -9 MLD (Oxidation pond)</td><td>9</td><td>606</td></tr>
<tr><td>Hamumannagar STP 100 Footy road(Commising date - 23/7/2018)</td><td>23.5</td><td>629.5</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">Solapur</td><td rowspan="3">Solapur Municipal Corporation</td><td>Degaon STP</td><td>75</td><td>704.5</td></tr>
<tr><td>Kumathe STP</td><td>12.5</td><td>717</td></tr>
<tr><td>Pratap Nagar STP</td><td>15</td><td>732</td></tr>
<tr><td rowspan="7">5</td><td rowspan="7">Satara</td><td>Mahabaleshwar Municipal Counci</td><td>at Survey No.626, near Dhobi Ghat,At - Mahabaleshwar, Tal - Mahabaleshwar, Dist -Satara</td><td>1</td><td>733</td></tr>
<tr><td>Panchagani Municipal Council</td><td>Survey No. 83/2 near Siddharthnagar,At - Panchgani, Tal - Mahabaleshwar, Dist - Satara</td><td>0.65</td><td>733.65</td></tr>
<tr><td>Panchagani Municipal Council</td><td>Plot no. 497/4 & 5 near Shivajinagar,At - Panchgani, Tal - Mahabaleshwar, Dist - Satara</td><td>0.35</td><td>734</td></tr>
<tr><td>Panchagani Municipal Council</td><td>Hindu Crematorium,At - Panchgani, Tal - Mahabaleshwar, Dist -Satara</td><td>1.5</td><td>735.5</td></tr>
<tr><td>Karad Municipal Council</td><td>Bara Dabari, Karad, Tal -Karad, Dist - Satar</td><td>12.5</td><td>748</td></tr>
<tr><td>Malkapur Municipal Council</td><td>A/p -Malkapur Tal Karad Dist -Satara</td><td>5</td><td>753</td></tr>
<tr><td>Malkapur Municipal Council</td><td>A/p -Malkapur Tal Karad Dist -Satara</td><td>3</td><td>756</td></tr>
<tr><td>6</td><td>Ahmednagar</td><td>Shirdi Nagarpanchyat</td><td>Shirdi, Tal-- Rahata, Dist- Ahmednagar</td><td>16</td><td>772</td></tr>
</table>

5.3 STPs under Construction and their Cumulative capacity

- **STPs under Construction and their Cumulative capacity of Karnataka State**

The STPs under Construction and their cumulative capacity data of districts of Karnataka State of KRB portion are been obtained from the Karnataka Economic Survey 2021-22 report. District-wise table of Karnataka state is presented in table 12 to illustrate the STPs under Construction and their cumulative capacity across the Krishna River basin.

Table 12: STPs under Construction and their Cumulative capacity in Karnataka districts of KRB portion

Under Construction STPs in Karnataka State				
S.No	**District**	**No. of STPs**	**Capacity of STPs (MLD)**	**Cumulative Capacity of STPs Under Construction (MLD)**
1	Bagalkote	0	0	0
2	Ballari	4	13.15	13.15
3	Belagavi	4	76.8	89.95
4	Bidar	1	7	96.95
5	Bijapura	3	12.86	109.81
6	Chikkamagaluru	0	0	109.81
7	Chitradurga	1	3.3	113.11
8	Davanagere	0	0	113.11
9	Dharwad	0	0	113.11
10	Gadag	1	13.88	126.99
11	Hassan	0	0	126.99
12	Haveri	1	5	131.99
13	Kalaburgi	1	9	140.99
14	Koppal	0	0	140.99
15	Raichur	2	17.5	158.49
16	Shivamogga	0	0	158.49
17	Tumkur	5	38.68	197.17
18	Uttar Kannada	10	31.2	228.37
19	Vijayanagara	-	-	-
20	Yadgiri	0	0	228.37

- **STPs under Construction and their Cumulative capacity of Telangana State**

The STPs under Construction and their cumulative capacity data of districts of Telangana State of KRB portion are been obtained from the NGT Monthly Progress Report. District-wise table of Telangana state is presented in table 13 to illustrate the STPs under Construction and their cumulative capacity across the Krishna River basin.

Table 13: STPs under Construction and their Cumulative capacity in Telangana districts of KRB portion

STPs Under Construction in Telangana State				
Sl.No	**District**	**Location of STPs**	**Capacity of Under Construction STPs in MLD**	**Cumulative Capacity of Under Construction STPs in MLD**
1	Nagar Kurnool	Bus Depot Back side	3.2	3.2
2	Khammam	Dhamsalapuram	20	23.2
3	Suryapet	Nallacheruvu	10	33.2
4	Nalgonda	Arjalabavi	2.55	35.75

- **STPs under Construction and their Cumulative capacity of Andhra Pradesh State**

The STPs under Construction and their cumulative capacity data of districts of Andhra Pradesh State of KRB portion are been obtained from the NGT Monthly Progress Report. District-wise table of Andhra Pradesh state is presented in table 14 to illustrate the STPs under Construction and their cumulative capacity across the Krishna River basin.

Table 14: STPs under Construction and their Cumulative capacity in Andhra Pradesh districts of KRB portion

Under Construction STPs in Andrapradesh State					
SL.No	**District**	**Name of the ULB/Location**	**No of STPs**	**Capacity of Under Construction STPs in MLD**	**Cumulative Capacity of Under Construction STPs in MLD**
1	Krishna	Machilipatnam	1	5	5
		Gudivada	1	5	10
		Vuyyuru	1	0.9	10.9
			1	0.3	11.2
			1	0.1	11.3
2	Palnadu	Chilakaluripeta	1	5	16.3
		Piduguralla	1	5.9	22.2
			1	5.2	27.4
		Vinukonda	1	5.7	33.1
			1	5.5	38.6
			1	0.7	39.3
3	Sri Satya Sai	Dharmavaram	1	4	43.3
			1	4	47.3
		Hindupur	1	0.7	48
		Kadiri	1	14.9	62.9
		Madakasira	1	5	67.9
		Puttaparthi	1	0.25	68.15
4	Anathapur	Guntakal	1	8	76.15
			1	1.25	77.4
		Tadipatri I&II	1	2.75	80.15
		Gooty	1	3.6	83.75
			1	4.4	88.15
		Pamidi	1	0.7	88.85
		Raydurgam	1	0.6	89.45
5	Kurnool	Kurnool	1	10	99.45
			1	35	134.45
			1	0.4	134.85
		Adoni	1	5	139.85
6	NTR	Tiruvuru	1	0.24	140.09
			1	0.4	140.49
			1	0.4	140.89
		Jaggaiahpeta	1	1.6	142.49
7	Prakasam	Giddalur	1	6.1	148.59
		Kandukur	1	9.6	158.19
		Kanigiri	1	6	164.19
		Addanki	1	0.5	164.69
8	Bapatla	Bapatla	1	3	167.69
		Chirala	1	5	172.69
9	Nandyal	Allagadda	1	5	177.69
		Nandikotkur	1	5	182.69
10	Guntur	Guntur	1	10	192.69
		Guntur	1	20	212.69
		Guntur	1	42	254.69
		Guntur	1	28	282.69
		Guntur	1	23	305.69

- **STPs under Construction and their Cumulative capacity of Maharashtra State**

The STPs under Construction and their capacity data of districts of Maharashtra State of KRB portion are been obtained from the NGT Monthly Progress Report. District-wise table of Maharashtra state is presented in the following table to illustrate the Existing STPs and their Cumulative capacity across the Krishna River basin.

Table 15: STPs under Construction and their Cumulative capacity in Maharashtra districts of KRB portion

STPs Under Construction in Maharashtra State					
SL.No	**District**	**Name of the ULB**	**Location of Under Construction STPs**	**Capacity of Under Construction STPs in MLD**	**Cumulative Capacity of Under Construction STPs in MLD**
1	Pune	Total 11 + 1 = 12 STP under Jica Dr Naidu & other STPs in PMC.	Dr Naidu & other STPs in PMC.	403	403
		Phaltan Municipal Council	at Shivaji nagar	2.5	405.5
			Sheti Nalla	5.5	411
		Pimpri Chinchwa d Corporati on – PCMC.	Bopkhel	5	416
			Chikhali	12	428
			Pimple Nilakh	15	443
			Chikhali S.No. 1436 , Near	20	463
2	Sangli	Sangli Corporati on	Bedag Road	22.5	485.5
3	Satara	Panchgani Council	Godavali Area	0.6	486.1
		Wai Council	8/1, Songirwadi	6	492.1
		Satara Council	387A, Karanje	5.5	497.6
4	Solapur	Jalgaon Corporati on	Near River	63	560.6
		Solapur Corporati on	Desai Nagar (4th STP)	20	580.6
		Solapur Corporati on	Degaon (5th STP)	49	629.6
5	Kolhapur	Kolhapur Corporati on	Dudhali	6	635.6

6. Status of Solid Waste Generation

The Solid waste generation across districts within the Krishna River Basin region. Waste generation is classified into three categories: high (>400 MTD), medium (200–400 MTD), and low (<200 MTD), while some districts like Vijayanagara, Sri Satya Sai, Anantpur, Kurnool, Nandyal, Prakasam, Palnadu, NTR, Guntur, Bapatla, Krishna, Sangareddy and Hanumakonda have unavailable data. High waste generation is concentrated in districts such as Pune, Dharwad, and Bellari, indicating major urbanization and industrial activity. Most districts fall under the medium and low categories, showing moderate to limited municipal solid waste production. Several districts in Andhra Pradesh and surrounding regions show data gaps, highlighting the need for improved waste monitoring systems. Overall, the map reflects the uneven pattern of solid waste generation influenced by population density, urban growth, and economic development across the basin.

The Solid waste data has been collected from Karnataka Economic Survey reports, District Environment Plan Reports-2016 and State Pollution Control Boards datasets. The Solid waste generation in the districts of Krishna River basin is represented in the figure 28 below.

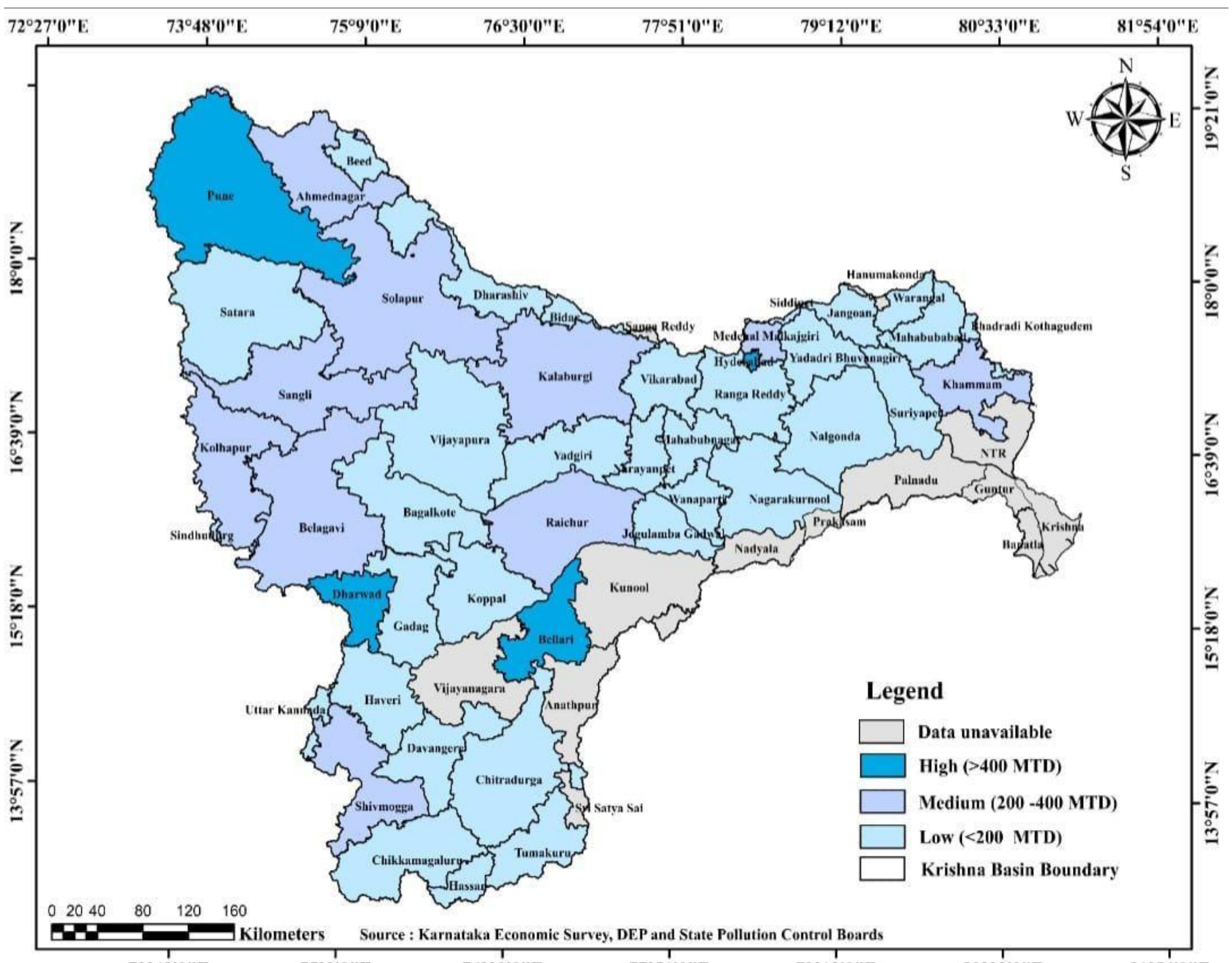

Figure 28: Solid Waste Generation in the districts of Krishna River basin

7. Status of Hazardous Waste

The hazardous waste generation of the Krishna River Basin indicates significant spatial variation in industrial waste production across the basin districts. High hazardous waste generation areas (>10,000 MT/annum) are concentrated in districts such as Pune, Solapur, Belagavi, Hyderabad, Ranga Reddy, Nalgonda, Kurnool, and Shivamogga, reflecting the presence of major industrial and urban centres. Medium waste generation districts are scattered across parts of Karnataka, Telangana, and Maharashtra, showing moderate industrial activities. Low hazardous waste generation is observed in several rural and less industrialized districts, particularly in the southern and interior regions of the basin. A few districts like Vijayanagara, Sri Satya Sai, Nandyal, Palnadu, NTR and Bapatla have unavailable data, indicating limitations in waste reporting or monitoring systems. Overall, the hazardous waste generation in the Krishna Basin is closely associated with industrial development and urban expansion.

The Hazardous waste data has been collected from District Environment Plan Reports-2016 and State Pollution Control Boards datasets. The Hazardous waste generation in the districts of Krishna River basin is represented in the figure 29 below.

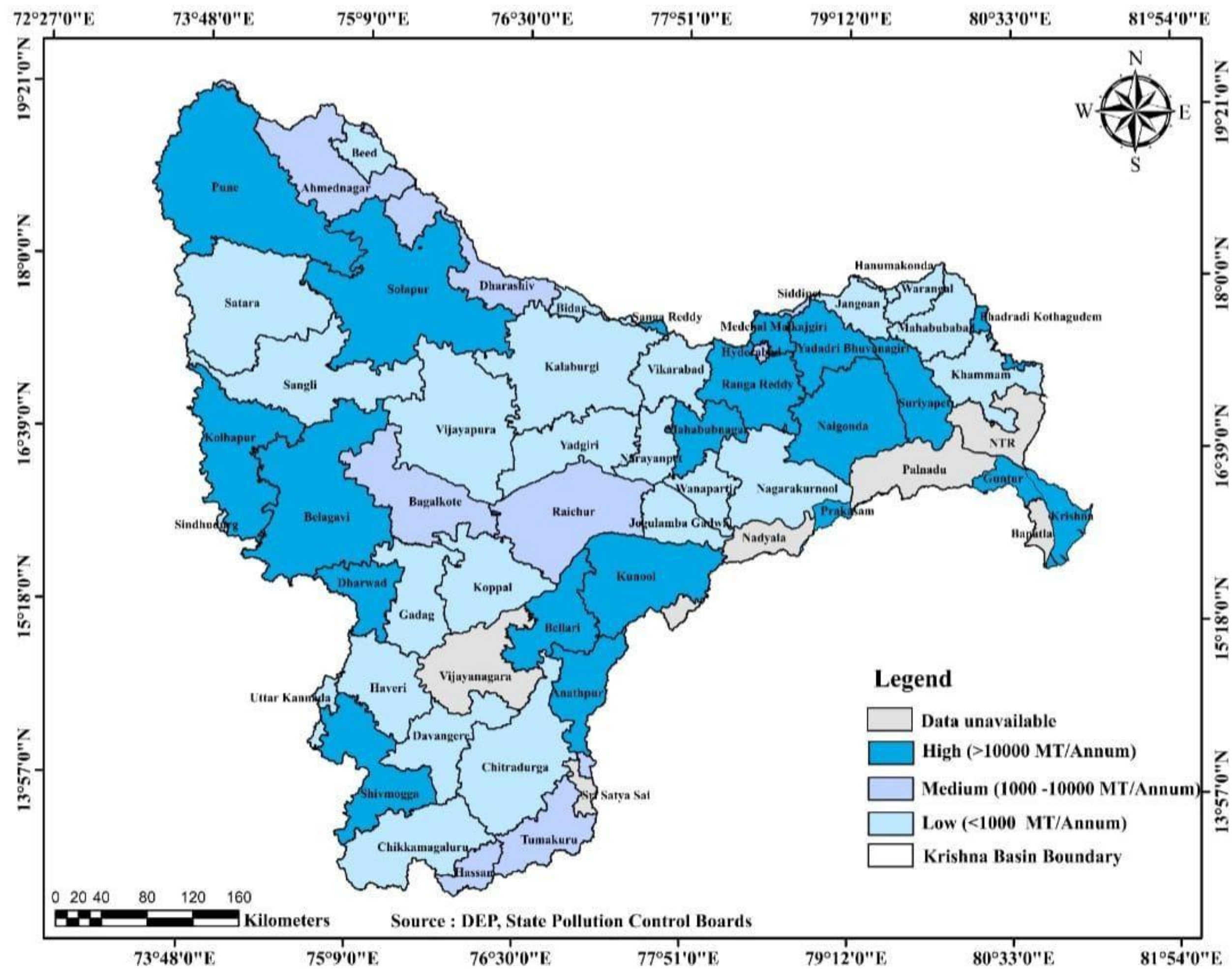

Figure 29: Hazardous Waste Generation in the districts of Krishna River basin

8. Status of Biomedical Waste

The Biomedical waste generation of the Krishna River Basin shows a varied spatial distribution of waste generation across different districts. High biomedical waste generation areas (>2000 kg/day) are mainly concentrated in urbanized and industrial districts such as Hyderabad, Ranga Reddy, Belagavi, Kolhapur, Raichur, Dharwad, and Shivamogga, indicating the presence of major healthcare facilities and higher population density. Medium waste generation districts are widely distributed across Maharashtra, Karnataka, Telangana, and Andhra Pradesh, reflecting moderate healthcare infrastructure. Low waste generation (<1000 kg/day) is observed in several rural and less urbanized districts, particularly in the southern and eastern parts of the basin. Some districts like Vijayanagara, SriSatyaSai, Nandyal, Palnadu, NTR, Pune, Beed and Bapatla shows unavailable data, indicating gaps in monitoring or reporting systems. Overall, the influence of urbanization and healthcare concentration on biomedical waste generation within the Krishna Basin.

The Biomedical waste data has been collected from District Environment Plan Reports-2016 and State Pollution Control Boards datasets. The Biomedical waste generation in the districts of Krishna River basin is represented in the figure 30 below.

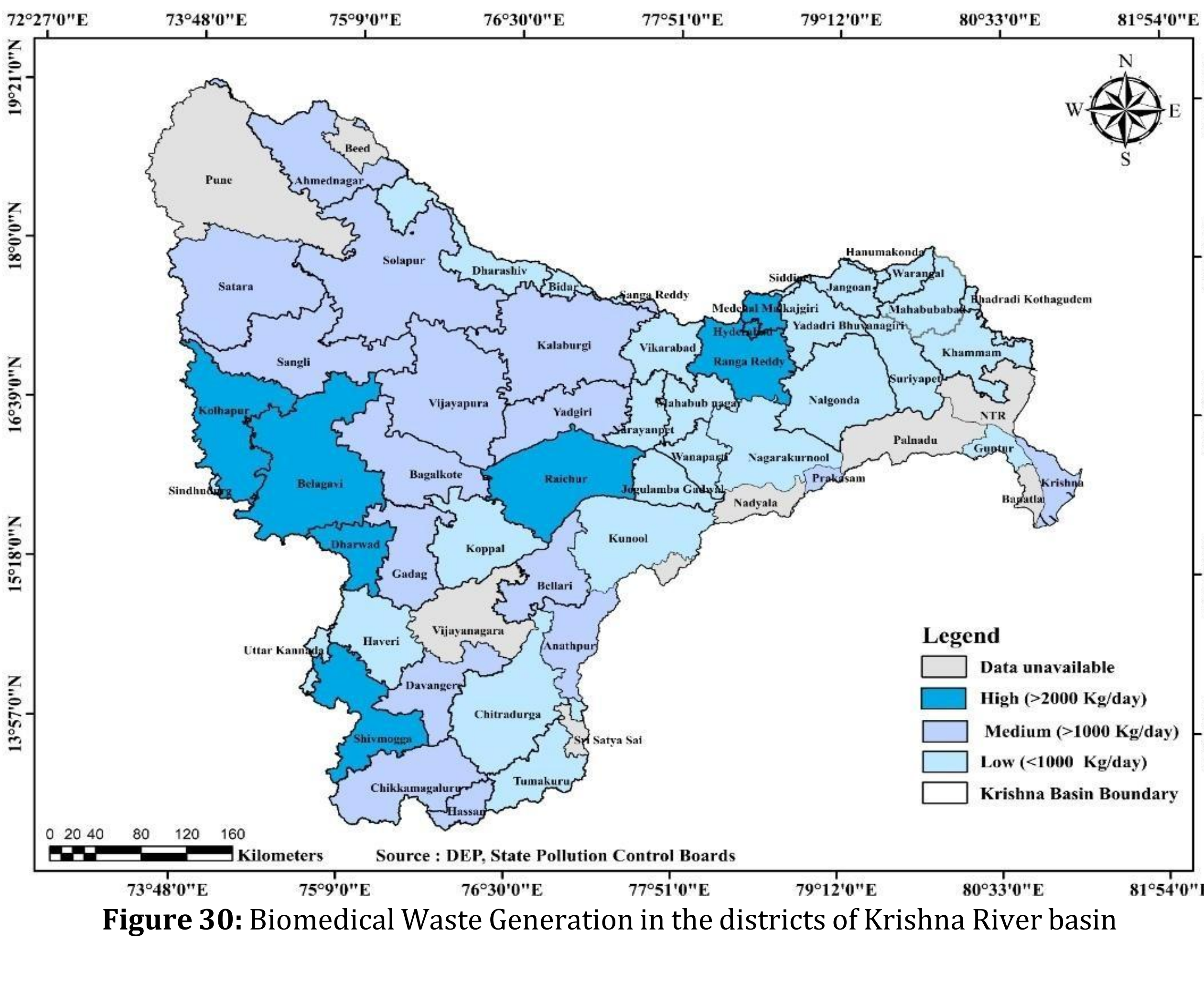

Figure 30: Biomedical Waste Generation in the districts of Krishna River basin

9. Status of Plastic Waste

The plastic waste generation of the Krishna River Basin shows distinct variations in waste generation across different districts. High plastic waste generation areas (>100 MTD) are mainly concentrated in districts such as Bidar, Davangere, Shivamogga, Chikkamagaluru, and Tumakuru, indicating higher urbanization, commercial activities, and consumption patterns. Medium plastic waste generation (10–100 MTD) is observed across several districts in Maharashtra, Karnataka, and Telangana, reflecting moderate levels of population density and industrial activity. Low plastic waste generation (<10 MTD) is dominant in many rural and less developed districts of the basin. Some districts like Vijayanagara, Ananthpur,Sri Satya Sai, Kurnool, Wanaparti, Nandyal, Prakasam, Sangareddy, Hanumakonda, Palnadu, Khammam, NTR, Guntur, Bapatla and Krishna shows unavailable data, suggesting gaps in monitoring or reporting mechanisms. Overall, the growing challenge of plastic waste management in urban and semi-urban regions of the Krishna River Basin.

The Plastic waste data has been collected from District Environment Plan Reports-2016 and State Pollution Control Boards datasets. The Plastic waste generation in the districts of Krishna River basin is represented in the figure 31 below.

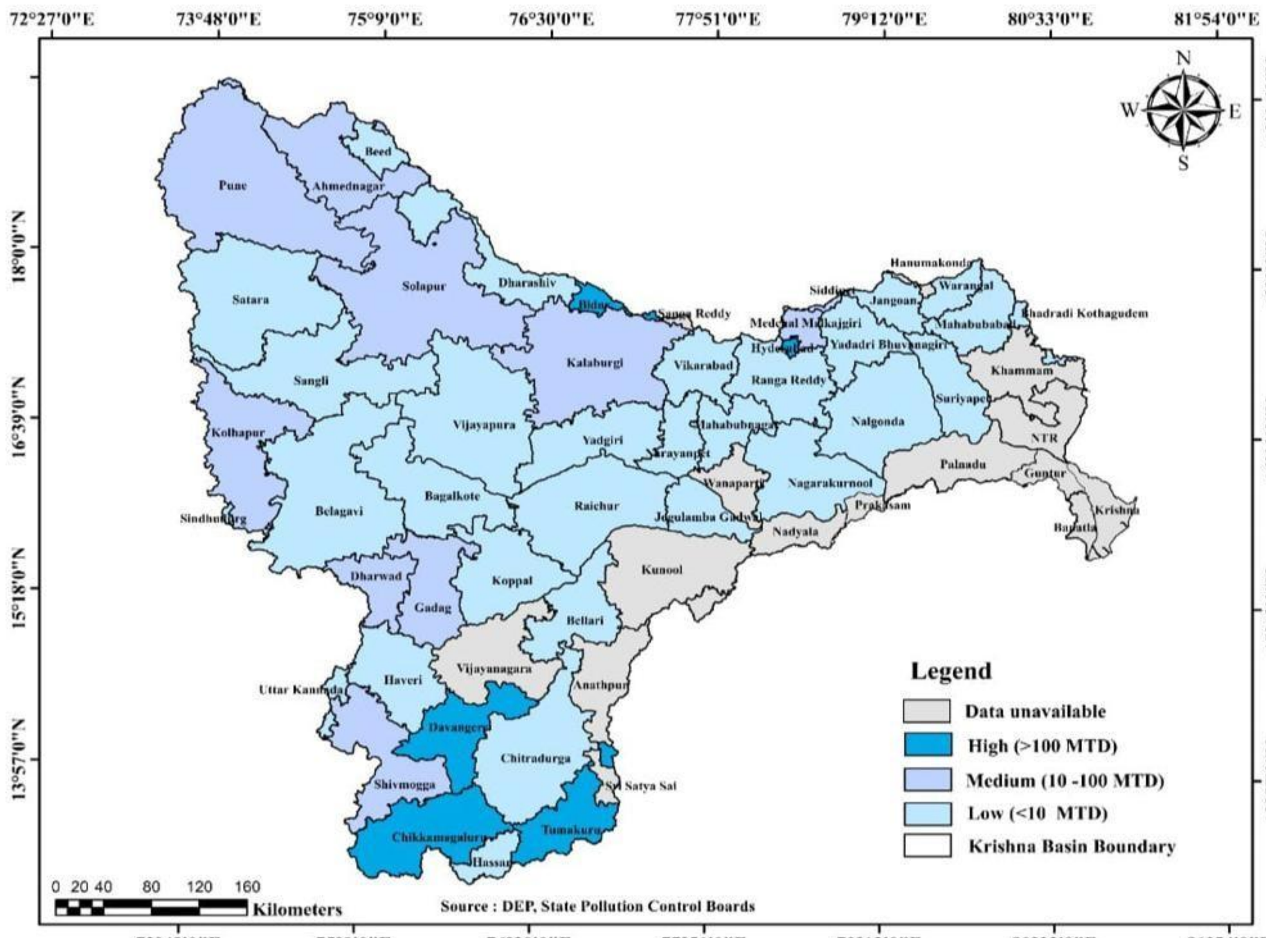

Figure 31: Plastic Waste Generation in the districts of Krishna River basin

10. Status of C&D Waste

The Construction and Demolition (C&D) waste generation pattern in the Krishna River Basin varies considerably across districts. High C&D waste generation (>100 TPD) is mainly observed in Ahmednagar and Sangli districts, indicating intensive urban expansion and infrastructure development activities. Medium waste generation (10–100 TPD) is recorded in districts such as Pune, Solapur, Kalaburagi, Belagavi, Bagalkote, Gadag, Davangere, Chitradurga, Bellari, Ananthapur, Shivamogga, Tumakuru, and Guntur, reflecting moderate levels of construction and urbanization. Low waste generation (<10 TPD) is found in districts including Satara, Vijayapura, Yadgiri, Koppal, Haveri, Chikkamagaluru, Hassan, Nalgonda, Suryapet, Wanaparthy, and Nagarkurnool, where urban growth is comparatively limited. Some districts Pune, Vijayanagara, Sri Satya Sai, Kurnool, Wanaparti, Nandyal, Prakasam, Palnadu, Khammam, NTR, Krishna, Sangareddy, Hanumakonda, Bapatla and Rangareddy shows unavailable data due to gaps in reporting and monitoring systems. Overall, the distribution highlights the close relationship between urban development and C&D waste generation in the Krishna River Basin.

The C&D waste data has been collected from Karnataka Economic Survey reports, District Environment Plan Reports-2016 and State Pollution Control Boards datasets. The C&D waste generation in the districts of Krishna River basin is represented in the figure 32 below.

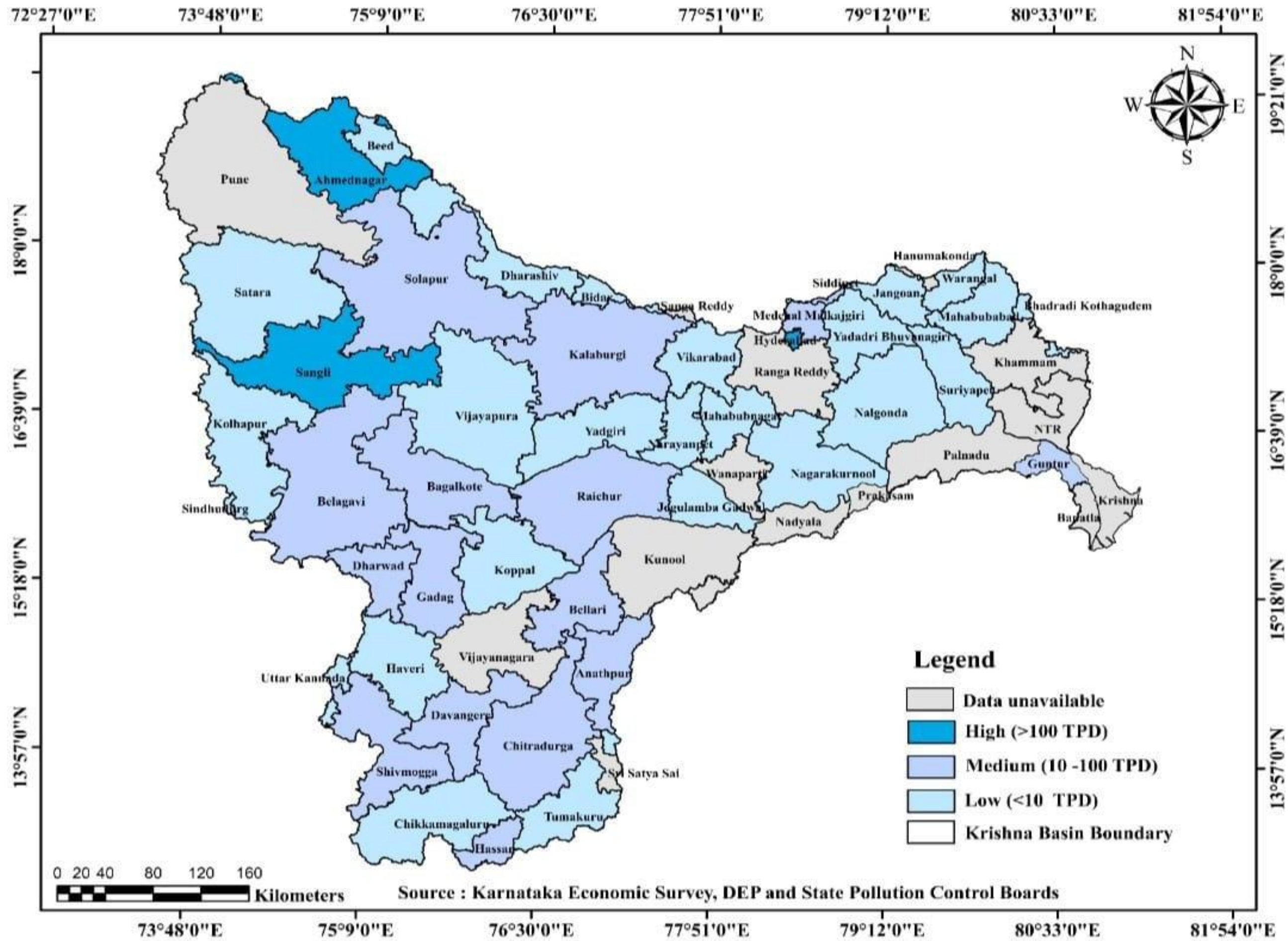

Figure 32: C&D Waste Generation in the districts of Krishna River basin

11. Conclusion and Role of Stakeholders

Conclusion: The present study identified major pollution sources in the Krishna River Basin and revealed significant spatial variations in water quality. The Bhima and Musi rivers emerged as the primary pollution hotspots, exhibiting elevated BOD and EC levels along with reduced DO concentrations due to untreated sewage, industrial effluents, and urban runoff. Among the tributaries, the Musi River showed the highest degree of pollution, while the Bhima River experienced considerable water quality degradation in urban and downstream stretches. The assessment of industrial pollution sources highlighted several industrial effluent hotspots across the basin. Districts such as Pune, Satara, Kolhapur, Solapur, Belagavi, Prakasam, Ranga Reddy, Guntur, Krishna, Kurnool, Ballari, and Ananthapur contain significant concentrations of red and orange category industries, indicating high pollution potential. Domestic wastewater generation analysis revealed that highly urbanized districts contribute the largest sewage loads to the basin. Hyderabad was identified as the dominant domestic wastewater hotspot, generating approximately 1950 MLD, followed by Pune

(1475.65 MLD), Solapur (227.9 MLD), Kolhapur (231.9 MLD), NTR, Guntur, Warangal, Kurnool, and Ananthapuramu. These urban centers exert substantial pressure on river water quality due to inadequate treatment and direct discharge of municipal wastewater into nearby water bodies. Industrial wastewater generation was highest in Pune (296 MLD) and Satara (275.97 MLD), indicating substantial industrial pollution pressure. These districts represent critical industrial pollution hotspots and require prioritized monitoring, effective effluent treatment, and stringent pollution control measures. Overall, the study indicates that domestic sewage, industrial effluents, and rapid urbanization are the major factors contributing to water quality degradation in the Krishna River Basin. Significant pollution hotspots were identified in the Bhima and Musi river systems and in highly industrialized districts such as Pune, Hyderabad, Kolhapur, Solapur, Prakasam, Ranga Reddy, Guntur, and Krishna. These highlights the need for improved wastewater treatment facilities, effective industrial effluent management, and strengthened environmental monitoring programs. The study also emphasizes the importance of implementing basin-scale pollution control measures to reduce pollutant loads and improve river health. Furthermore, the developed pollution source maps provide a valuable scientific basis for prioritizing management interventions and supporting sustainable water resource conservation within the basin.

Role of Stakeholders: Effective management of pollution in the Krishna River Basin requires the active participation of multiple stakeholders, including government agencies, pollution control boards, industries, local bodies, agricultural communities, and the public. Regulatory agencies should strengthen monitoring programs, enforce environmental regulations, and promote basin-wide water quality management strategies. Industries must adopt cleaner production technologies, ensure efficient effluent treatment, and comply with discharge standards to minimize environmental impacts. Urban local bodies should enhance sewage collection and treatment infrastructure to reduce the discharge of untreated domestic wastewater into river systems. Farmers can contribute by adopting sustainable agricultural practices that reduce nutrient and chemical runoff. Furthermore, community participation, public awareness programs, and inter-state coordination among basin stakeholders are essential for improving water quality, protecting aquatic ecosystems, and achieving sustainable management of the Krishna River Basin's water resources.

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