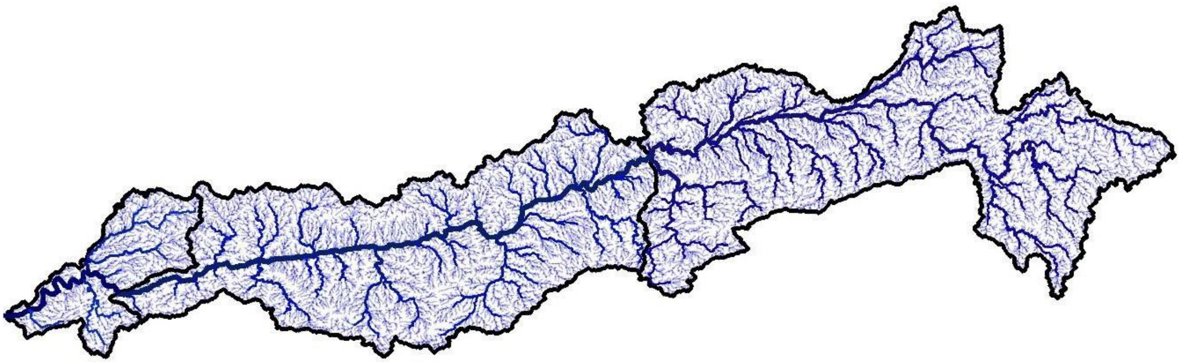
**National River Conservation Directorate**
Ministry of Jal Shakti, Department of Water Resources,
River Development & Ganga Rejuvenation
Government of India

# Pollution Source Mapping for Narmada River Basin



**September 2025**

# Pollution Source Mapping for Narmada River Basin

## National River Conservation Directorate (NRCD)

The National River Conservation Directorate, functioning under the Department of Water Resources, River Development & Ganga Rejuvenation, and the Ministry of Jal Shakti, provides financial assistance to the State Government for the 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 Narmada River Basin Management and Studies (cNarmada)

The Centre for Narmada River Basin Management and Studies (cNarmada) is a Brain Trust dedicated to River Science and River Basin Management. Established in 2024 by IIT Gandhinagar and IIT Indore, under the supervision of cGanga at IIT Kanpur, the centre serves as a knowledge wing of the National River Conservation Directorate (NRCD). cNarmada is committed to restoring and conserving the Narmada River and its resources through the collation of information and knowledge, research and development, planning, monitoring, education, advocacy, and stakeholder engagement.
**www.cnarmada.org**

## Centres 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 a think-tank in the implementation and dynamic evolution of the 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 IIT Gandhinagar (Lead Institute) and IIT Indore (Fellow Institute) under the supervision of cGanga at IIT Kanpur. It was submitted to the National River Conservation Directorate (NRCD) in 2024. We gratefully acknowledge the individuals who provided information and photographs for this report.


## Disclaimer

This report is a preliminary version prepared as part of the ongoing Condition Assessment and Management Plan (CAMP) project. The analyses, interpretations and data presented in the report are subject to further validation and revision. Certain datasets or assessments may contain provisional or incomplete information, which will be updated and refined in the final version of the report after comprehensive review and verification.

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# PREFACE

The Narmada River Basin, often referred to as the lifeline of central India, sustains millions of people, ecosystems, and economic activities. With rapid urbanization, industrial growth, and increasing demands on natural resources, the basin faces significant challenges related to pollution, wastewater management, and waste generation.

This report has been prepared to provide a comprehensive assessment of the current status of water quality and pollution sources across the upper and middle stretches of the basin. It brings together data from monitoring stations, evaluates industrial and domestic wastewater loads, and reviews the performance of sewage treatment plants (STPs) and other treatment facilities. Special focus has been given to various categories of waste — including solid, hazardous, biomedical, plastic, construction & demolition (C&D), and e-waste to understand their generation patterns.

The objective of this document is to support informed decision-making for policymakers, administrators, researchers, and stakeholders engaged in river basin management. It aims to strengthen ongoing initiatives such as the Swachh Bharat Mission, Smart Cities Mission, and Nirmal Dhara, while contributing to the broader goals of sustainable development and ecological preservation.

We extend our sincere gratitude to the government agencies, research institutions, project staff, and individuals whose contributions of data and insights made this assessment possible.

It is our hope that this report inspires informed dialogue and coordinated action, contributing to the restoration and long-term sustainability of the Narmada River Basin for both ecological health and socio-economic development.

**Centre for Narmada River Basin**
**Management and Studies (cNarmada)**
**IIT Gandhinagar, IIT Indore**

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## Abbreviations and Acronyms

| Abbreviation | Full Form |
|---|---|
| AMC | Ankleshwar Municipal Corporation |
| BOD | Biochemical Oxygen Demand |
| BMW | Biomedical Waste |
| C&D / C&D Waste | Construction and Demolition Waste |
| CBWTF | Common Biomedical Waste Treatment Facility |
| CETP | Common Effluent Treatment Plant |
| COD | Chemical Oxygen Demand |
| CPCB | Central Pollution Control Board |
| DG | Diesel Generator |
| DO | Dissolved Oxygen |
| EC | Environmental Clearance |
| EPR | Extended Producer Responsibility |
| F.C. | Fecal Coliforms |
| FSS | Floating Suspended Solids |
| GEMS | Global Environmental Monitoring System |
| GIDC | Gujarat Industrial Development Corporation |
| GPCB | Gujarat Pollution Control Board |
| GP | Gram Panchayat |
| GPS | Global Positioning System |
| GWSSB | Gujarat Water Supply and Sewerage Board |
| HP | Horse Power |
| KLD | Kilo Litres per Day |
| lpcd | Litres per Capita per Day |
| MLD | Million Litres per Day |
| MPPCB | Madhya Pradesh Pollution Control Board |
| MRF | Material Recovery Facility |
| MSW | Municipal Solid Waste |
| MT | Metric Tonne |
| NGO | Non-Governmental Organization |
| NGT | National Green Tribunal |
| NMCG | National Mission for Clean Ganga |
| NRCD | National River Conservation Directorate |
| NRCP | National River Conservation Plan |
| NP3 / NP4 | Reinforced Concrete Pipe Class (used for sewer lines) |
| pH | Potential of Hydrogen |
| PLC | Programmable Logic Controller |
| PM | Particulate Matter |
| RAS | Return Activated Sludge |

| **Abbreviation** | **Full Form** |
|---|---|
| RCC | Reinforced Cement Concrete |
| SAS / WAS | Surplus / Waste Activated Sludge |
| SBM | Swachh Bharat Mission |
| SCADA | Supervisory Control and Data Acquisition |
| SEZ | Special Economic Zone |
| SBR | Sequential Batch Reactor |
| SLF | Secured Landfill Facility |
| STP | Sewage Treatment Plant |
| SWR | Soil, Waste, and Rainwater (Pipeline Type) |
| TDS | Total Dissolved Solids |
| TPD | Tonnes per Day |
| TSS | Total Suspended Solids |
| TSDF | Treatment, Storage, and Disposal Facility |
| UV | Ultraviolet |
| WHO | World Health Organization |
| XGN | Extended Green Node (GPCB Online Waste Management Portal) |

# 1 Introduction

The Narmada River is among the most prominent rivers in India. Stretching over 1,312 kilometers from Amarkantak in Madhya Pradesh to the Arabian Sea at the Gulf of Khambhat 88°48′10.46″ east **(Fig. 1).** With a basin area of about 98,786 sq. km, It is the ninth-largest river basin in the country and sustains millions of people through agriculture, drinking water supply, industry, and fisheries. The basin spreads across Madhya Pradesh, Gujarat, Maharashtra, and Chhattisgarh, with the Vindhya, Satpura, and Maikala ranges forming its natural boundaries. It is divided into three parts: the Upper Basin, characterized by forests and hilly terrain; the Middle Basin, which is agriculturally fertile; and the Lower Basin (**Fig. 1**), which lies primarily in Gujarat and supports both fertile plains and dense industrial settlements.

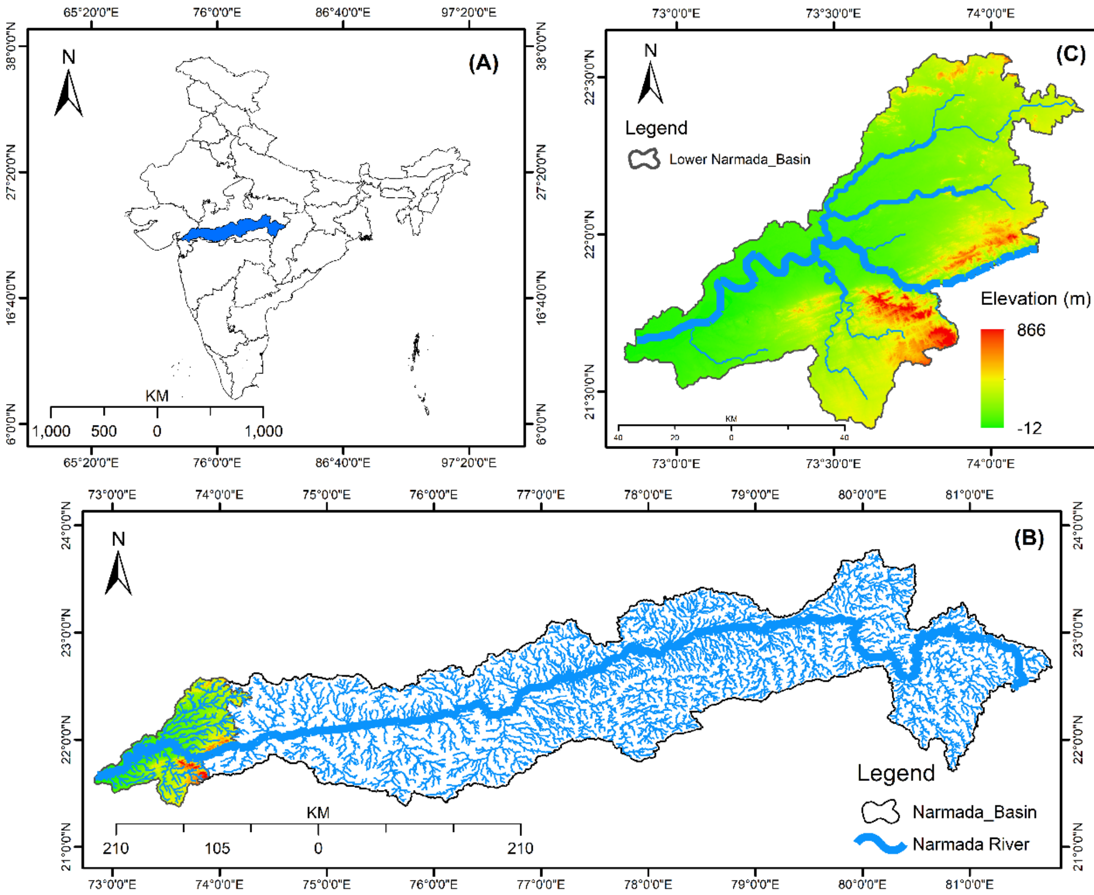


***Figure 1:*** *Location Map of Lower Narmada Basin*

However, rapid urbanization, industrialization, and population growth have increasingly exerted pressure on the river's water quality and ecological health. The discharge of untreated domestic sewage, **industrial effluents**, and the mismanagement of **solid waste, hazardous waste, biomedical waste, plastics, construction & demolition (C&D) waste, and e-waste** have emerged as major contributors to pollution in the basin. These wastes, when disposed of improperly, introduce pollutants such as organic matter, nutrients, heavy metals, persistent organic pollutants, plastics, and other non-biodegradable materials into the river system.

In order to assess the current status of pollution in the Narmada River Basin, secondary data from multiple government agencies have been compiled and analyzed. These include the Madhya Pradesh Pollution Control Board (MPPCB), the Central Pollution Control Board (CPCB), the Ministry of MSME, records from the National Green Tribunal (NGT), the Government of Madhya Pradesh, and other relevant agencies.

By integrating secondary datasets from regulatory agencies, this report aims to provide insights into the presence and concentration of key pollutants and trends in water quality parameters. The study evaluates key pollutants such as domestic and industrial wastewater, solid and hazardous waste, biomedical and plastic waste, and e-waste, while also mapping existing and under-construction sewage treatment facilities is also there.

This basin-wide data provides crucial insights into the spatial distribution of pollution, helping identify priority areas where interventions are urgently needed to protect the river's ecological and social functions.

## 1.1 Monitoring Stations, Locations, and Water Quality

### 1.1.1 Upper Basin

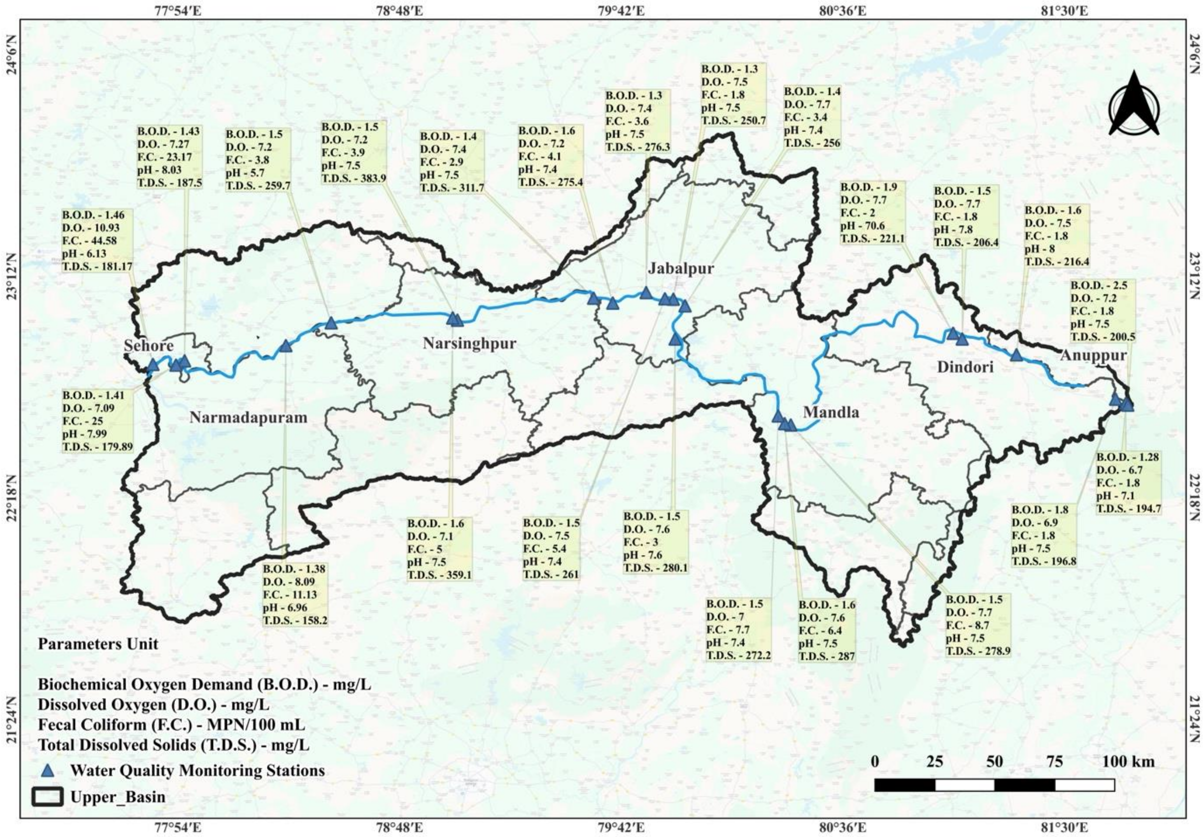


***Figure 2 Spatial distribution of water quality index parameters at monitoring stations along the Narmada Upper Basin***

**Source: Locations are digitized using Google Maps after taking reference from locations from MPPCB Narmada Water Quality Report 2024-25, and Data is taken from Narmada River monitoring Report 2025, MPPCB*

The Map shown in **Fig. 2** provides a spatial overview of water quality in the Narmada Upper Basin, using data from Madhya Pradesh Pollution Control Board (MPPCB) water quality monitoring stations distributed throughout the basin. The map summarizes key water quality indicators at each station: Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Fecal Coliform (FC), pH, and Total Dissolved Solids (TDS). BOD values generally range from 1.3 to 2.5 mg/L, DO fluctuates from around 6.4 to 8.9 mg/L, and TDS varies widely from about 179 to 383 mg/L. Higher BOD and FC values are observed closer to urban centers like Jabalpur and Narmadapuram, suggesting increased organic and fecal contamination in these segments, likely due to inputs from municipal sewage and anthropogenic activities.

Upstream Stations or forested regions, such as near Mandla and Anuppur, typically exhibit lower BOD and higher DO, reflecting less impacted stretches.

**Table 1** provides the standard limits of the parameters suggested by different agencies as a guideline for the users to ensure the water quality for direct and indirect uses. The MPPCB water quality monitoring stations, district-wise, in the upper basin are listed in **Table 2**.

***Table 1:*** *Water Quality Parameters Standard Limits*

| Parameter | Requirement (Acceptable Limit) | Permissible Limit in Absence of Alternate Source | Unit | Agency |
|---|---|---|---|---|
| TDS | 500 | 2000 | mg/L | BIS IS 10500: 2012 |
| pH | 6.5-8.5 | - | | BIS IS 10500: 2013 |
| DO | 6 or more | - | mg/L | CPCB |
| BOD | 3 or less | - | mg/L | CPCB |
| F. Coliform | 0 | - | MPN/100 | WHO |

***Table 2:*** *List of MPPCB Monitoring Stations in Upper Basin*

| S.No. | District | City/ Town | Name of Monitoring Station | B.O.D | Dissolved Oxygen | Fecal Coliform | pH | TDS |
|---|---|---|---|---|---|---|---|---|
| 1 | Anuppur | Amarkantak | Narmada River at Amarkantak origin point, Dist. Anuppur | 1.28 | 6.7 | 1.8 | 7.1 | 194.7 |
| 2 | Anuppur | Amarkantak | Narmada River at Puskar Dam, Amarkantak | 2.5 | 7.2 | 1.8 | 7.5 | 200.5 |
| 3 | Anuppur | Amarkantak | Narmada River at Kapildhara | 1.8 | 6.9 | 1.8 | 7.5 | 196.8 |
| 4 | Dindori | Dindori | Narmada River at Chandanghat near Road Bridge, Dist. Dindori | 1.6 | 7.5 | 1.8 | 8 | 216.4 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5 | Dindori | Dindori | Narmada River at Dindori Up Stream | 1.5 | 7.7 | 1.8 | 7.8 | 206.4 |
| 6 | Dindori | Dindori | Narmada River at Dindori Down Stream | 1.9 | 7.7 | 2 | 70. 6 | 221.1 |
| 7 | Mandla | Mandla | Narmada River near Shamshanghat, Mandla | 1.5 | 7.7 | 8.7 | 7.5 | 278.9 |
| 8 | Mandla | Mandla | Narmada River near Road Bridge, Mandla | 1.6 | 7.6 | 6.4 | 7.5 | 287 |
| 9 | Mandla | Mandla | Narmada River at Bhairav Temple, Shhastradhar, Mandla | 1.5 | 7 | 7.7 | 7.4 | 272.2 |
| 10 | Jabalpur | Jabalpur | Narmada River near Road Bridge (Down Stream of Bargi Dam), Jabalpur | 1.5 | 7.6 | 3 | 7.6 | 280.1 |
| 11 | Jabalpur | Jabalpur | Narmada River at Jamtara, near Railway Bridge | 1.4 | 7.7 | 3.4 | 7.4 | 256 |
| 12 | Jabalpur | Lalpur | Narmada River near Water Supply Intake Point, Lalpur | 1.3 | 7.5 | 1.8 | 7.5 | 250.7 |
| 13 | Jabalpur | Jabalpur | Narmada River at Tilwaraghat | 1.5 | 7.5 | 5.4 | 7.4 | 261 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 14 | Jabalpur | Jabalpur | Narmada River at Panchwatighat, Bheraghat | 1.3 | 7.4 | 3.6 | 7.5 | 276.3 |
| 15 | Jabalpur | Jabalpur | Narmada River at Sarswastighat after mixing Bawanganga River | 1.6 | 7.2 | 4.1 | 7.4 | 275.4 |
| 16 | Jabalpur | Jabalpur | Narmada near Road Bridge at Jhansinghat, Jabalpur | 1.4 | 7.4 | 2.9 | 7.5 | 311.7 |
| 17 | Narsinghpur | Narsinghpur | Narmada N.H.44 near Road Bridge at Barman, Jabalpur | 1.5 | 7.2 | 3.9 | 7.5 | 383.9 |
| 18 | Narsinghpur | Narsinghpur | Narmada Barmanghat, 100 mts D/s Mainghat | 1.6 | 7.1 | 5 | 7.5 | 359.1 |
| 19 | Narsinghpur | Narsinghpur | Narmada S.H.44 near Road Bridge, Jhilkoli, Narsinghpur | 1.5 | 7.2 | 3.8 | 5.7 | 259.7 |
| 20 | Narmadapuram | Sandia | Narmada River near Road Bridge, Sandia, Narmadapuram | 1.38 | 8.09 | 11.13 | 6.96 | 158.2 |
| 21 | Sehore | Jait | Narmada River at Up Stream of | 1.43 | 7.27 | 23.17 | 8.03 | 187.5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Village Jait, Sehore | | | | | |
| 22 | Sehore | Jait | Narmada River at Down Stream of Village Jait, Sehore | 1.41 | 7.09 | 25 | 7.99 | 179.89 |
| 23 | Sehore | Sehore | Narmada River at Shahaganj Guest House, Sehore | 1.46 | 10.93 | 44.58 | 6.13 | 181.17 |

**Source: MPPCB Narmada Water Quality Report 2024-25*

### 1.1.2 Middle Basin

The Map shown in **Fig. 3** offers an integrated snapshot of water quality in the Narmada Middle Basin using various monitoring stations along the river. Each station reports Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Fecal Coliform (FC), pH, and Total Dissolved Solids (TDS). Most BOD values remain below 2 mg/L, signaling moderate organic pollution. DO levels generally range from approximately 7 to 8 mg/L, which is favorable for aquatic life. FC bacteria counts and TDS indicate localized contamination and mineral load, revealing spatial variability along the river. Stations near urban centers like Sehore and Narmadapuram tend to have higher BOD and FC values, pointing to significant organic and microbial pollution inputs from population and development pressures. In Khandwa, Dhar BOD stays low, and DO remains relatively high, suggesting healthier river stretches with fewer anthropogenic disturbances. The data-rich, spatial view allows officials to pinpoint critical pollution hotspots and tailor water quality interventions. Prioritizing sanitation projects and continuous monitoring in high BOD/FC areas will improve river health for communities and ecosystems across the Narmada Middle Basin. The MPPCB water quality monitoring stations district-wise wise in the middle basin are listed in **Table 3**.

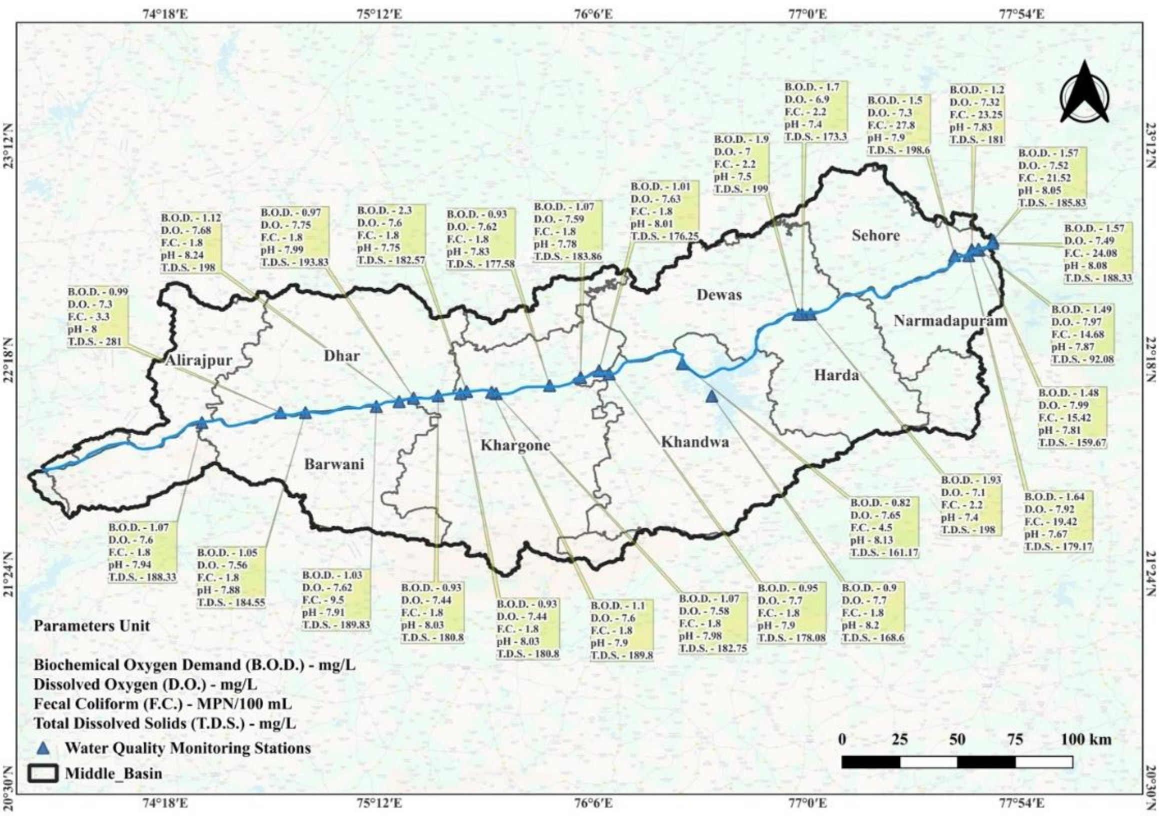


***Figure 3 Spatial distribution of water quality index parameters at monitoring stations along the Narmada Middle Basin***

**Source: Locations are digitized using Google Maps after taking reference from locations from MPPCB Narmada Water Quality Report 2024-25, and Data is taken from Narmada River monitoring Report 2025, MPPCB*

***Table 3***: *List of MPPCB Monitoring Stations in Middle Basin*

| S.No | District | City/Town | Name of Monitoring Station | B.O.D | Dissolved Oxygen | Fecal Coliform | pH | TDS |
|---|---|---|---|---|---|---|---|---|
| 1 | Sehore | Sehore | Narmada Up Stream before Confluence of River Tawa near Bandrabhan, Sehore | 1.57 | 7.52 | 21.52 | 8.1 | 185.8 |
| 2 | Sehore | Ramnagar | Narmada Down Stream after Confluence of River Tawa, Ramnagar | 1.57 | 7.49 | 24.08 | 8.1 | 188.3 |
| 3 | Sehore | Budhni | Narmada Budhnighat, Budhni | 1.2 | 7.32 | 23.25 | 7.8 | 181 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4 | Narmada puram | Narmadapu ram | Narmada Korighat, Hoshangabad | 1.48 | 7.99 | 15.42 | 7.8 | 159.7 |
| 5 | Narmada puram | Narmadapu ram | Narmada Sethanighat, Hoshangabad | 1.49 | 7.97 | 14.68 | 7.9 | 92.08 |
| 6 | Narmada puram | Narmadapu ram | Narmada River 100 m downstream after SPM Nalla | 1.64 | 7.92 | 19.42 | 7.7 | 179.2 |
| 7 | Sehore | Budhni | Narmada at the Down Stream of Textile Unit, Village Holipura, Budhni | 1.5 | 7.3 | 27.8 | 7.9 | 198.6 |
| 8 | Dewas | Nemawar | Narmada at before Confluence of River Jamner, Village Nemawar | 1.93 | 7.1 | 2.2 | 7.4 | 198 |
| 9 | Dewas | Nemawar | Narmada at Water Supply Intake Point, Nemawar | 1.7 | 6.9 | 2.2 | 7.4 | 173.3 |
| 10 | Dewas | Nemawar | Narmada 500 m Down Stream near Jain Mandir, Village Nemawar | 1.9 | 7 | 2.2 | 7.5 | 199 |
| 11 | Khandwa | Hanuwantia | Narmada at Hanuwantia, Dist. Khandwa | 0.9 | 7.7 | 1.8 | 8.2 | 168.6 |
| 12 | Khandwa | Punasa | Narmada River at Punasa Dam | 0.82 | 7.65 | 4.5 | 8.1 | 161.2 |
| 13 | Khandwa | Omkareshw ar | Narmada at Up Stream, Omkareshwar Dam | 0.95 | 7.7 | 1.8 | 7.9 | 178.1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 14 | Khandwa | Omkareshwar | Narmada at Omkareshwar Down Stream | 1.01 | 7.63 | 1.8 | 8 | 176.3 |
| 15 | Khargone | Barwaha | Narmada, Barwaha near Mortakka Bridge | 1.07 | 7.59 | 1.8 | 7.8 | 183.9 |
| 16 | Khargone | Dhareshwar | Narmada River at Dhareshwar | 0.93 | 7.62 | 1.8 | 7.8 | 177.6 |
| 17 | Khargone | Jallod | Narmada near Water Supply Intake, Jallod | 1.07 | 7.58 | 1.8 | 8 | 182.8 |
| 18 | Khargone | Mandleshwar | Narmada River at Mandleshwar Down Stream | 1.1 | 7.6 | 1.8 | 7.9 | 189.8 |
| 19 | Khargone | Maheshwar | Narmada River at Maheshwar Down Stream | 2.3 | 7.6 | 1.8 | 7.8 | 182.6 |
| 20 | Khargone | Maheshwar | Narmada River at Shahastradhara (Jalkoti) | 0.93 | 7.44 | 1.8 | 8 | 180.8 |
| 21 | Dhar | Dhar | Narmada at Khalghat | 0.93 | 7.44 | 1.8 | 8 | 180.8 |
| 22 | Dhar | Dharampuri | Narmada at Dharampuri | 0.97 | 7.75 | 1.8 | 8 | 193.8 |
| 23 | Dhar | Dharampuri | Narmada River at Dharampuri Down Stream | 1.12 | 7.68 | 1.8 | 8.2 | 198 |
| 24 | Barwani | Barwani | Narmada River at Semalda Up Stream of Barwani | 1.03 | 7.62 | 9.5 | 7.9 | 189.8 |
| 25 | Barwani | Barwani | Narmada River at Rajghat, Barwani | 1.05 | 7.56 | 1.8 | 7.9 | 184.6 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 26 | Dhar | Nisarpur | Narmada River at Koteshwar, Nisarpur, Dhar | 0.99 | 7.3 | 3.3 | 8 | 281 |
| 27 | Alirajpur | Kakrana | Narmada River at Kakrana | 1.07 | 7.6 | 1.8 | 7.9 | 188.3 |

**Source: MPPCB Narmada Water Quality Report 2024-25*

### 1.1.3 Lower Basin

In the Lower Basin, GPCB monitors water quality monthly at Garudeshwar, Panetha, Zadeshwar, and Zanor. Garudeshwar is under the GEMS project, while the others,Panetha, Zadeshwar, and Zanor, are under MINARS. However, yearly monitoring data is presently available for Chandod and Navagam Station **Fig. 4** shows monitoring station of the Lower Narmada Basin. **Fig. 5** shows that Pollution intensity at the upstream of lower Narmada (Garudeshwar and Panetha) is low to moderate, but at the downstream of lower Narmada (Zanor & Zadeshwar) is high to very high.

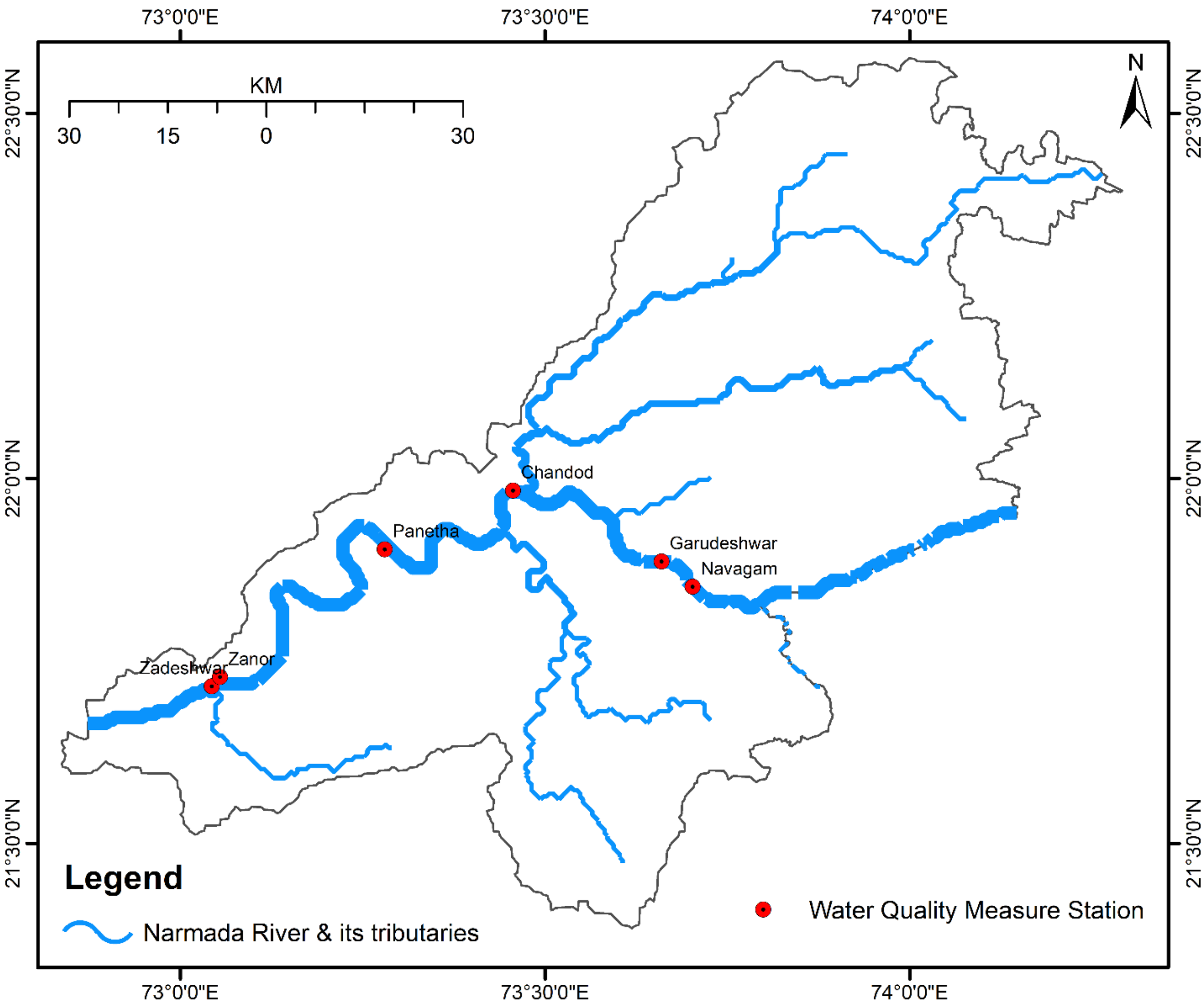


***Figure 4 Water quality monitoring stations in Lower Basin***
*Source: GPCB Water quality report of Narmada river*

Rural areas have no regular monitoring stations, but localized drains and septic discharges influence nearby tributaries.

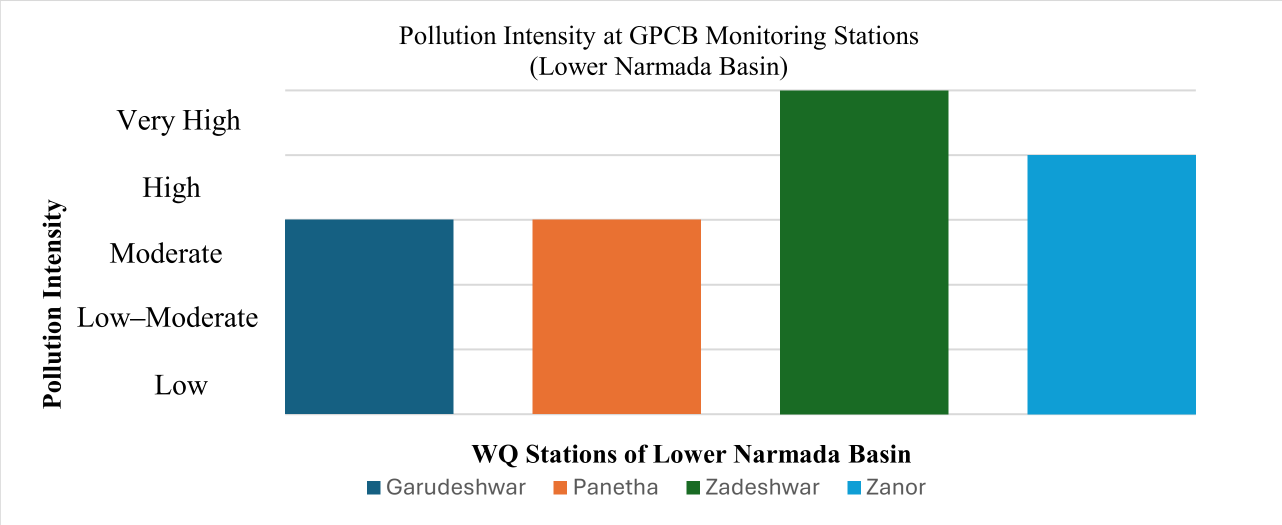


***Figure 5 Pollution Intensity at GPCB Monitoring Stations, Lower Narmada Basin***
*Source: GPCB Water quality report of Narmada river*

***Table 4 Pollution Intensity at GPCB Monitoring Stations, Lower Narmada Basin***

| Station | Pollution Intensity | Key findings |
|---|---|---|
| Garudeshwar | Moderate | Water quality impacted by upstream releases and seasonal variations. |
| Panetha | Moderate | Moderate quality, affected by sewage inflows. |
| Zanor | High | Heavily influenced by urban discharges and industrial load. |
| Zadeshwar | Very High | Downstream stretch often reflects cumulative pollution. |

*Source: GPCB Water quality report of Narmada river*

# 2 Pollution Sources

## 2.1 Industrial Clusters

### 2.1.1 Upper Basin

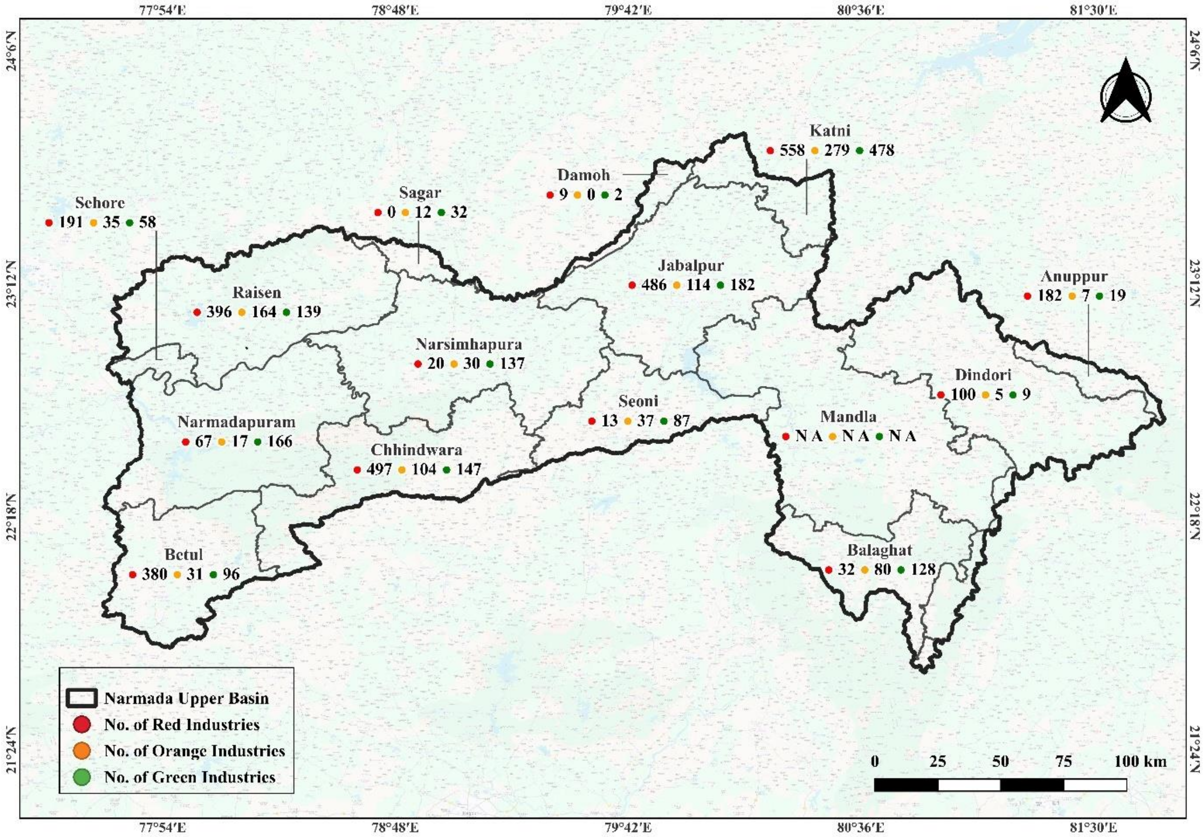


***Figure 6 Upper Narmada River Basin District-wise Distribution of Red, Orange, and Green Category Industries***

**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

The industrial ecosystem of the Upper Narmada River basin, shown in **Fig. 6**, demonstrates substantial district-level heterogeneity in the number and type of industrial units, as classified by the Central Pollution Control Board in Red, Orange, and Green categories. Katni emerges as the most industrialized district in the basin, registering 558 red, 279 orange, and 478 green industries, reflecting a broad and intense industrial base with likely significant environmental pressures. This is closely followed by Jabalpur and Chhindwara, with Jabalpur housing 486 red, 114 orange, and 182 green units, while Chhindwara has 497 red, 104 orange, and 147 green units. Raisen and Betul are notable for their high figures as well, evidencing considerable manufacturing and processing activities distributed across their territories.

In contrast, districts such as Sehore, Anuppur, Balaghat, and Narsimhapur, while still actively industrial, have lower absolute numbers, with green-category industries often outnumbering orange and red, suggesting either a prevalence of less polluting enterprises or a strategic shift toward environmentally friendly industrial practices. Districts such as Sagar and Damoh present a minimal red industry and a clear dominance of less hazardous (green and orange) sectors, indicating localized efforts or structural economic factors favoring lower-impact industry. Mandla stands out, showing no available data or negligible industrial activity across all three categories, potentially due to ecological prioritization, stricter land-use regulations, or reporting gaps.

This spatial variation underscores the dynamic nature of industrial development within the Upper Narmada Basin. Some districts serve as primary industrial corridors, potentially contributing heavily to both economic growth and cumulative pollution loads, while others remain less industrialized, either because of policy, infrastructure, or geography. These patterns are critical for regional planning, permitting targeted regulatory measures and resource allocation to manage and mitigate industrial pollution, especially in high-concentration red category zones. The basin-wide industrial profile highlights the necessity for context-sensitive interventions to balance economic advancement with sustainable water and environmental stewardship in the Narmada region.

### 2.1.2 Middle Basin

The Narmada Middle Basin exhibits a diverse industrial profile, with pronounced variation across its constituent districts in terms of both the quantity and environmental categorization of industrial units. The Map shown in **Fig. 7**. Indore stands out as the foremost industrial hub within the basin, hosting 276 red, 473 orange, and a remarkable 941 green category industries. This reflects both significant economic activity and a progressive shift towards less polluting, green industries. Dhar also demonstrates substantial industrial density, with 351 red, 270 orange, and 734 green industries, highlighting its role in the region's manufacturing and processing sectors.

Several districts, including Raisen, Betul, Chhota Udepur, and Dewas, display considerable numbers of red and orange industries, suggesting a strong presence of high and moderate pollution potential activities, balanced by notable green category establishments. Alirajpur and Jhabua, by contrast, have modest totals, with a predominance of green industries relative to their red and orange counterparts, indicating either an orientation towards environmentally conscious enterprises or limited large-scale industry.

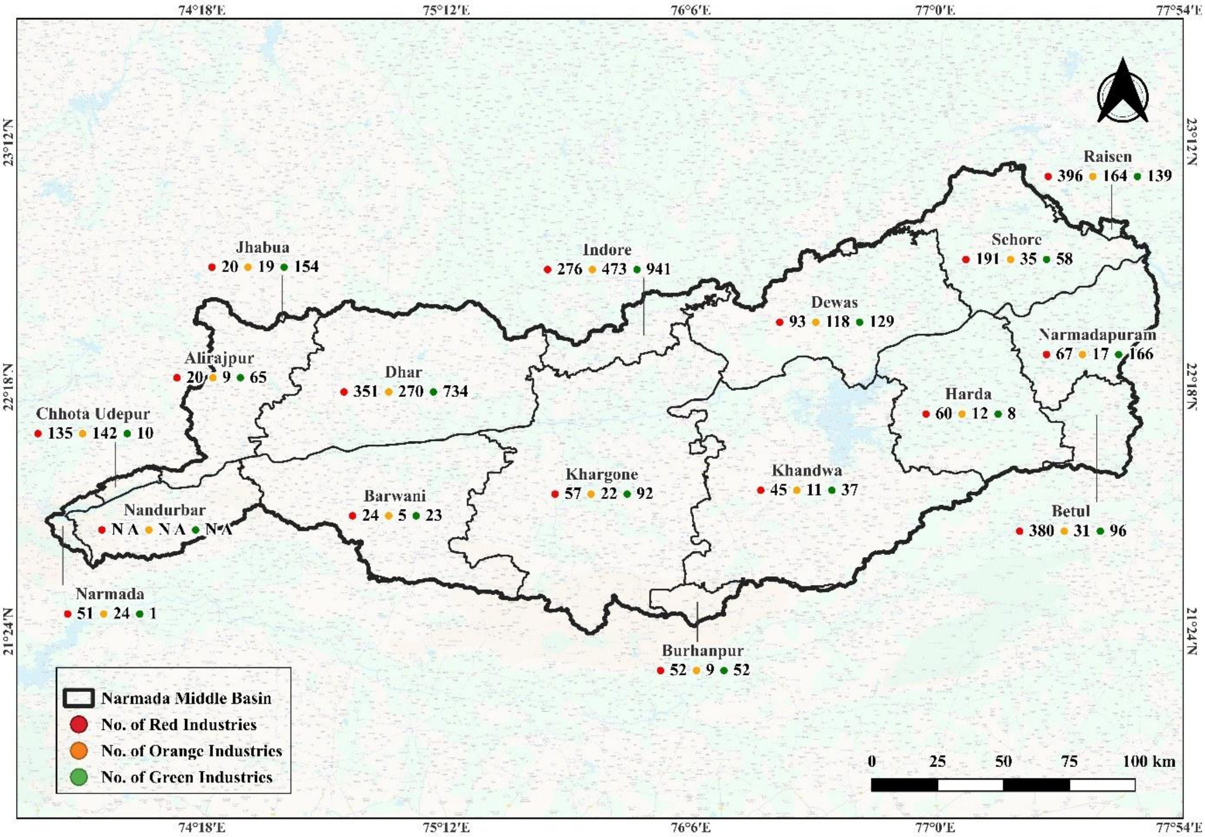


***Figure 7 Middle Narmada River Basin District-wise Distribution of Red, Orange, and Green Category Industries***

**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

Some districts, such as Nandurbar, exhibit negligible or unavailable data for all three categories, potentially pointing to gaps in reporting, the absence of significant industrial operations, or preferential policies favoring low-impact development. Across Harda, Khargone, Burhanpur, and other districts, the trend of green industries outnumbering red and orange ones persists, signifying efforts towards sustainable industrialization.

This spatial and categorical differentiation underscores the varied environmental and economic landscape of the Narmada Middle Basin. Districts with high concentrations of red-category units may be subject to greater regulatory focus and pollution mitigation requirements, while areas favoring green industries illustrate a move towards cleaner, sustainable development. The observed distribution of industry types is instrumental for planning targeted interventions, resource prioritization, and fostering environmentally responsible growth across the basin.

### 2.1.3 Lower Basin

The Lower Basin is Gujarat's suitable industrial zone. A total of 13 GIDC estates are counted in the lower basin that host diverse sectors like chemicals, textiles, pharmaceuticals, and agroprocessing industries, as shown in **Fig. 8** and **Table 5** shows different industrial clusters in Lower Narmada basin, which lies in Gujarat.

***Table 5 Different Industrial Clusters in the Lower Narmada Basin***

| **Industrial Cluster** | **Area (Hectares)** | **Key Industries** |
|---|---|---|
| Bharuch | 83.5 | Chemical plants, textile mills, long-staple cotton, dairy products, and others. |
| Ankleshwar | 1600 | Chemicals, pesticides, pharmaceuticals, bulk drugs, petroleum products, engineering, textiles, plastics, rubber, packaging. |
| Rajpipla | 9.5 | Textile, agro-food industries, chemicals, cold storage, hotels, herbal pharmaceuticals. |
| Chhota Udepur | Not specified | Small- to medium-scale industries involved in varied manufacturing. |

*Source:- Gidc at a glance*

The Bharuch–Ankleshwar area has 1,804 red, 550 orange, and 226 green industries. The main clusters are Ankleshwar with chemical and pharma units, Panoli with chemical and textile industries, Vilayat with chemical and pulp & paper units, and Dahej with petrochemical, chemical, and pharma industries. In Narmada District, which includes Rajpipla and Kevadiya, there are 51 red, 24 orange, and 1 green industries, mostly textile and agro-based. Chhota Udepur has 135 red, 142 orange, and 10 green industries, but only 5 of them discharge wastewater.

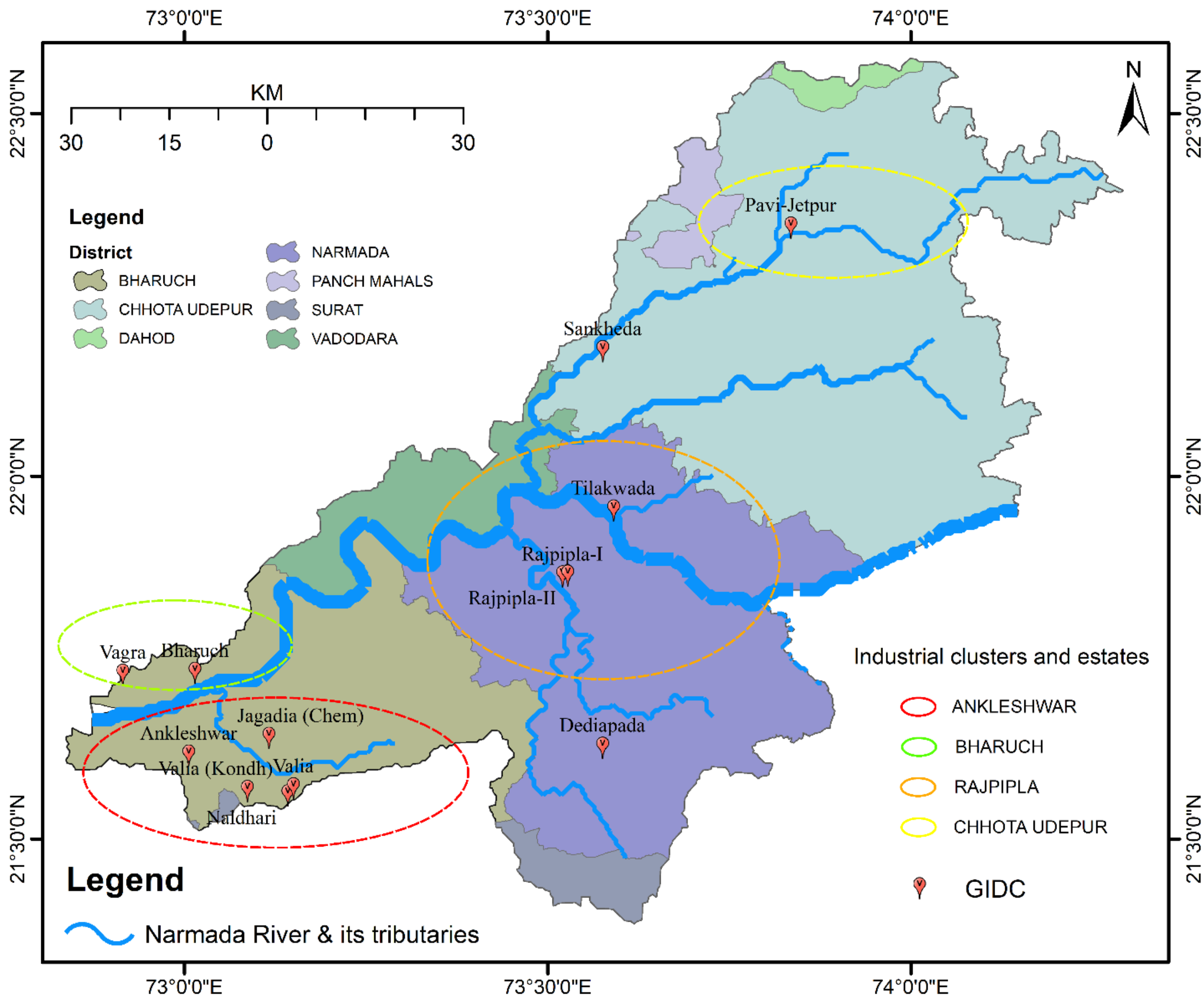


***Figure 8 Different Industrial Clusters in the Lower Narmada Basin***

*Source:- Gidc at a glance*

## 2.2 Domestic Wastewater Load

### 2.2.1 Upper Basin

The Map shown in **Fig. 9** illustrates the spatial distribution of domestic sewage generation across districts within the Narmada Upper Basin region of Madhya Pradesh, India, highlighting significant disparities in sewage loads among various administrative zones. The map uses a color gradient to depict the magnitude of domestic sewage generation in Million Liters Per Day (MLD) for each district, with darker shades representing higher sewage loads and lighter shades indicating comparatively lower contributions.

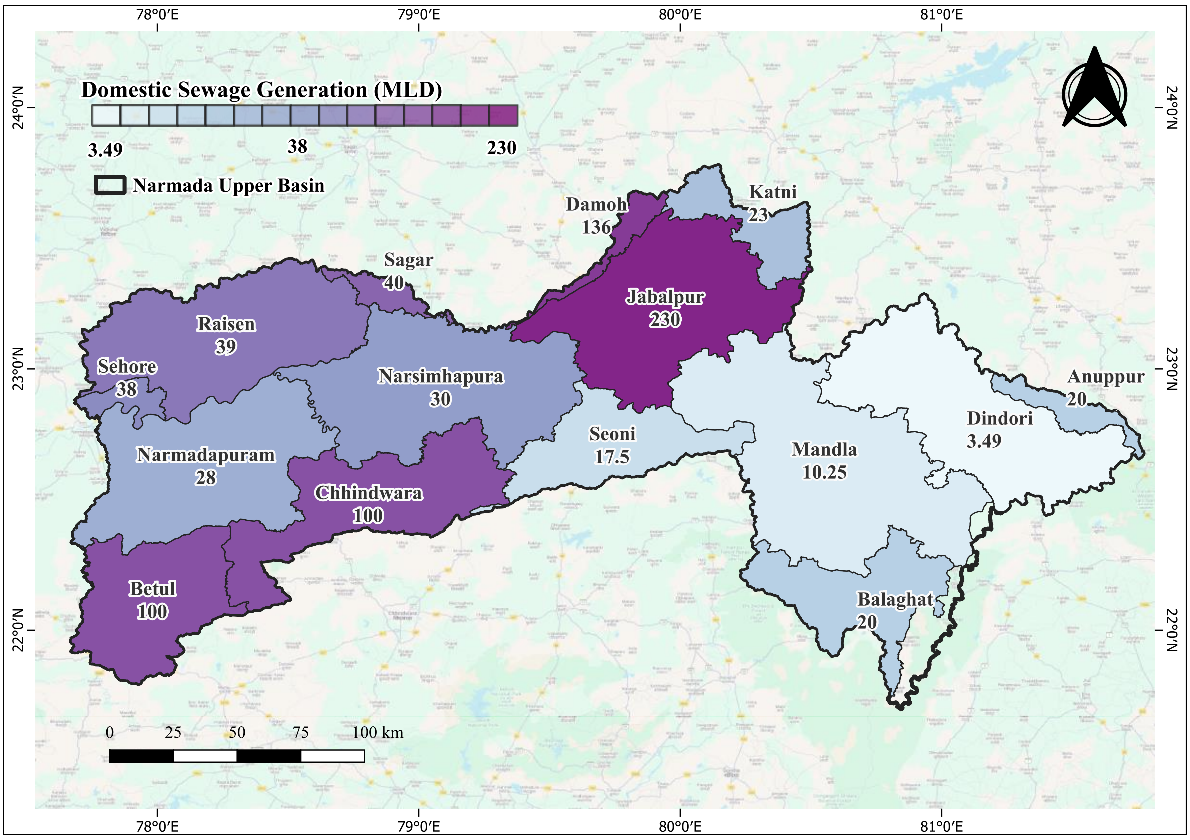


***Figure 9 District-wise Domestic Sewage Generation (MLD) in Narmada Upper Basin***
**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

Jabalpur emerges as the district with the highest generation of domestic sewage at 230 MLD, signifying its urban dominance and relatively large population base. Other key urban centers, such as Betul, Chhindwara, and Damoh, also show elevated sewage outputs of 100 MLD and 136 MLD, respectively, indicating their roles as regional urban and commercial hubs.

Districts such as Seoni (17.5 MLD), Mandla (10.25 MLD), Dindori (3.49 MLD), and Anuppur (20 MLD) are characterized by lighter shades, signifying their relatively low domestic sewage generation rates. These patterns generally reflect smaller population concentrations, lower urbanization levels, and possibly different water usage behaviors. Central districts like Raisen (39 MLD), Sagar (40 MLD), and Narsimhapura (30 MLD) register moderate values, indicative of balanced urban-rural characteristics. A clear correlation is observed between urbanization, population density, and sewage load; districts with major urban centers such as Jabalpur, Betul, and Chhindwara considerably outpace their rural or semi-urban counterparts. This highlights the vital need for robust sewage management and treatment infrastructure in these high-load zones to prevent environmental and public health risks. Conversely, districts with lower MLD values may prioritize decentralized wastewater management and pollution prevention strategies suitable for smaller population clusters.

### 2.2.2 Middle Basin

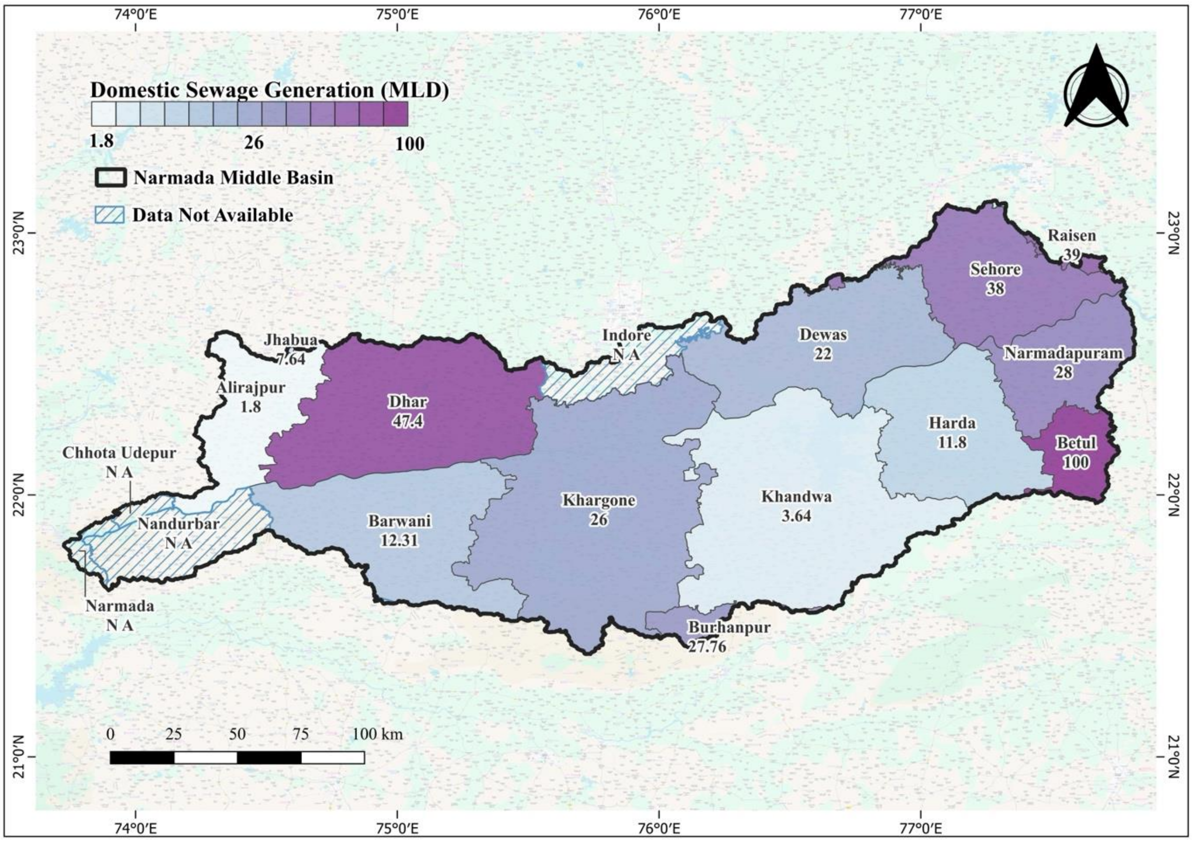


***Figure 10 District-wise Domestic Sewage Generation (MLD) in Narmada Middle Basin***

**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

The Map shown in **Fig. 10** illustrates the spatial distribution of domestic sewage generation, measured in Million Liters Per Day (MLD), across the districts falling within the Middle Narmada Basin. The basin boundary is clearly demarcated, and regions with unavailable data are represented using hatched shading. The values reveal significant inter-district variability, reflecting differences in population density, urbanization, and developmental patterns. Among the districts, Betul (100 MLD) emerges as the highest contributor of sewage, followed by Dhar (47.4 MLD), both of which are highlighted in darker purple to denote their considerable wastewater burden. Moderate contributors include Sehore (38 MLD), Raisen (39 MLD), Narmadapuram (28 MLD), Burhanpur (27.76 MLD), and Khargone (26 MLD), reflecting semi-urban settlements and growing towns with intermediate levels of wastewater generation. Districts with relatively low sewage output include Khandwa (3.64 MLD), Alirajpur (1.8 MLD), and Harda (11.8 MLD), typically representing smaller urban centers or predominantly rural populations. Certain districts, notably Indore, Nandurbar, and Narmada, are marked as "Data Not Available," which is a critical limitation given Indore's prominence as a major urban hub within the basin. Spatially, the western districts such as Alirajpur, Jhabua, and Barwani show relatively low sewage generation, consistent with their lower population density, whereas the central and eastern parts, including Dhar, Betul, Raisen, Sehore, and Narmadapuram, emerge as major sewage contributors, reflecting higher urban influence. The southern belt, comprising Burhanpur, Khandwa, and Harda, shows mixed patterns, with Burhanpur producing comparatively higher sewage than its neighboring districts. These observations highlight the urgent need for robust wastewater treatment infrastructure in high-generation districts like Betul and Dhar, while moderate-load areas could benefit from decentralized treatment solutions appropriate for semi-urban contexts. The absence of reliable data for Indore underscores a major research and planning gap, and comprehensive, continuous monitoring remains essential for developing effective sewage management strategies to safeguard the water quality of the Narmada River and its tributaries.

### 2.2.3 Lower Basin

Domestic wastewater depends on sewerage coverage, household connections, and pumping drain capacity. The situation differs across towns as given in **Fig. 11**.

Rajpipla city has a partial sewer network with a mix of combined and separate systems. However, some regions still discharge untreated wastewater into drains, which previously flowed into the Karjan River. Presently, wastewater is treated for gardening, road cleaning, and maintenance activities. The city generates 4.5 MLD of wastewater, handled by a 5.5 MLD. SBR-based sewage treatment plant (STP) is operational since 2024.

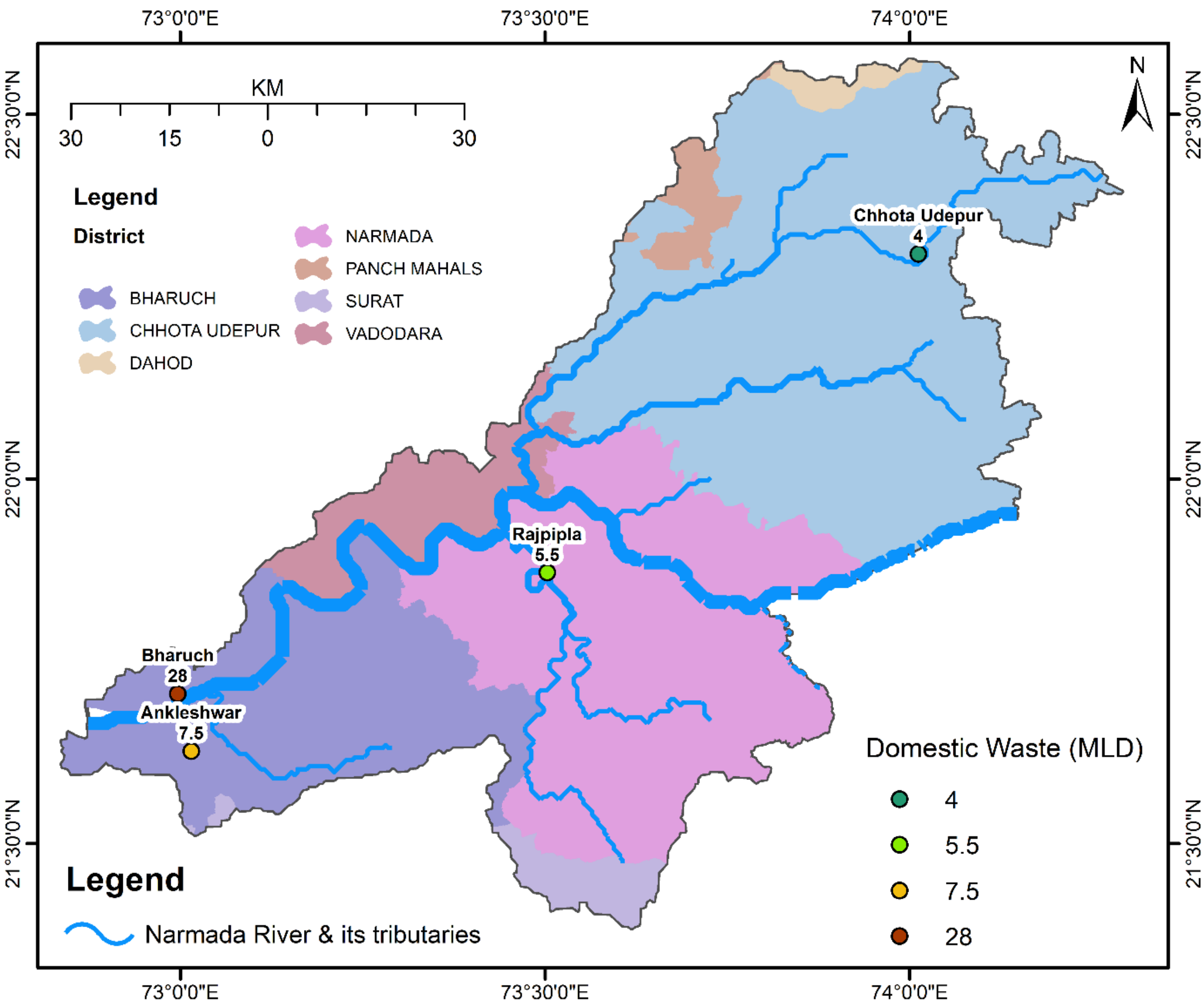


***Figure 11*** *Domestic Wastewater Generated City in Lower Narmada Basin*
*Source: Gujarat Pollution Control Board (GPCB).. District Environmental Plans (DEPs)*

Ankleshwar city generates sewage around 7.5MLD. And STP of 14MLD is under construction with a 146km length drainage network. Chhota Udepur city generates around 4 MLD of sewage, which is completely treated by a 5MLD STP. There is no discharge of untreated sewage into lakes or rivers. Bharuch city is organized into five sewerage zones, with a total sewage generation estimated at 28 MLD. Rural regions mostly rely on on-site sanitation systems such as septic tanks and leaching pits. The coverage of individual household latrines has seen improvement under the Swachh Bharat Mission, although piped sewer networks remain uncommon.

## 2.3 Industrial Wastewater Load

### 2.3.1 Upper Basin

The Map shown in **Fig. 12** displays the district-wise distribution of industrial sewage generation within the Narmada Upper Basin of Madhya Pradesh, India, emphasizing the substantial variations in industrial wastewater output across the region. The map employs a color spectrum ranging from light yellow to deep red to represent industrial sewage generation in Million Liters Per Day (MLD). Darker shades indicate districts with higher industrial sewage loads, while lighter shades reflect lower outputs. Narsimhapura stands out with an exceptionally high value of 1006 MLD, signifying it as a major industrial center in the basin. Chhindwara (46.33 MLD) and Betul (51.99 MLD) also show significantly elevated levels, corresponding to the presence of numerous industrial facilities and activities.Contrasting the industrial heavyweights, districts such as Mandla (0.9 MLD), Katni (0.14 MLD), and Dindori (0 MLD) demonstrate minimal or negligible industrial sewage generation, mirroring their limited industrialization and predominance of agriculture or rural livelihoods. Other areas like Sagar (15.3 MLD), Sehore (22 MLD), and Narmadapuram (25 MLD) register moderate output, indicative of localized industrial clusters or small-scale manufacturing units. The spatial concentration of industrial sewage generation follows industrialization patterns within the basin. Districts with high industrial activity, especially Narsimhapura, Betul, and Chhindwara, require robust strategies for industrial effluent treatment and regulatory oversight to mitigate environmental pollution risks. The absence or low levels of industrial sewage in certain districts like Damoh, Mandla, and Dindori hint at their potential suitability for conservation-driven initiatives and lower pollution management needs.

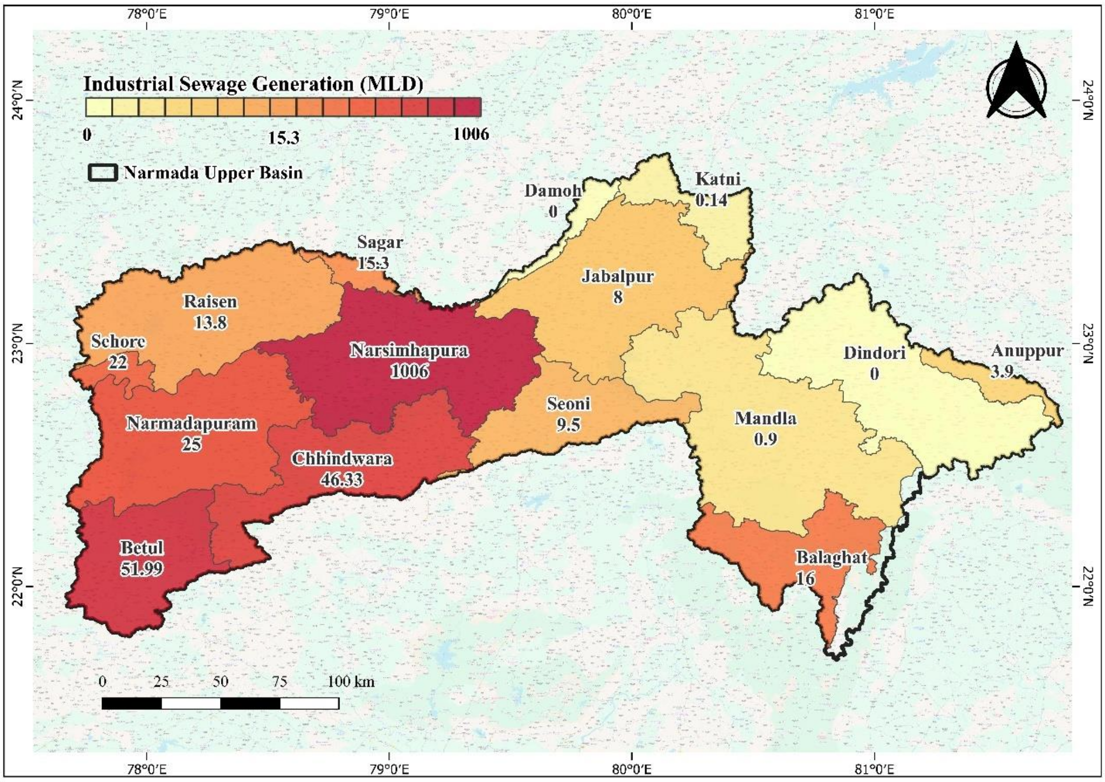


***Figure 12 District-wise Industrial Sewage Generation (MLD) in Narmada Middle Basin***

**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

## 2.3.2 Middle Basin

The Map shown in **Fig. 13** illustrates industrial sewage generation (in MLD, Million Liters per Day) across various districts of the Narmada Middle Basin, categorizing regions according to the volume of sewage generated. Highest emissions are observed in Betul (51.99 MLD), followed by Khandwa (39.96 MLD) and Narmadapuram (25 MLD), while some regions like Harda (0.11 MLD) and Jhabua (0.72 MLD) show minimal contributions.

Betul leads with the highest recorded value of 51.99 MLD, marking it as a critical point source for industrial effluent within the basin. Districts such as Khandwa (39.96 MLD), Narmadapuram (25 MLD), Khargone and Shajapur (22 MLD each), and Dhar (18.6 MLD) also demonstrate significant industrial sewage contributions. Harda (0.11 MLD), Jhabua (0.72 MLD), and Burhanpur (1.07 MLD) represent districts with notably lower industrial sewage outputs, indicating limited industrial activity or effective waste management. Industrial sewage data is not available for certain districts, including Indore, Alirajpur, Nandurbar, and Chhota Udepur, which are indicated with shaded regions on the map.

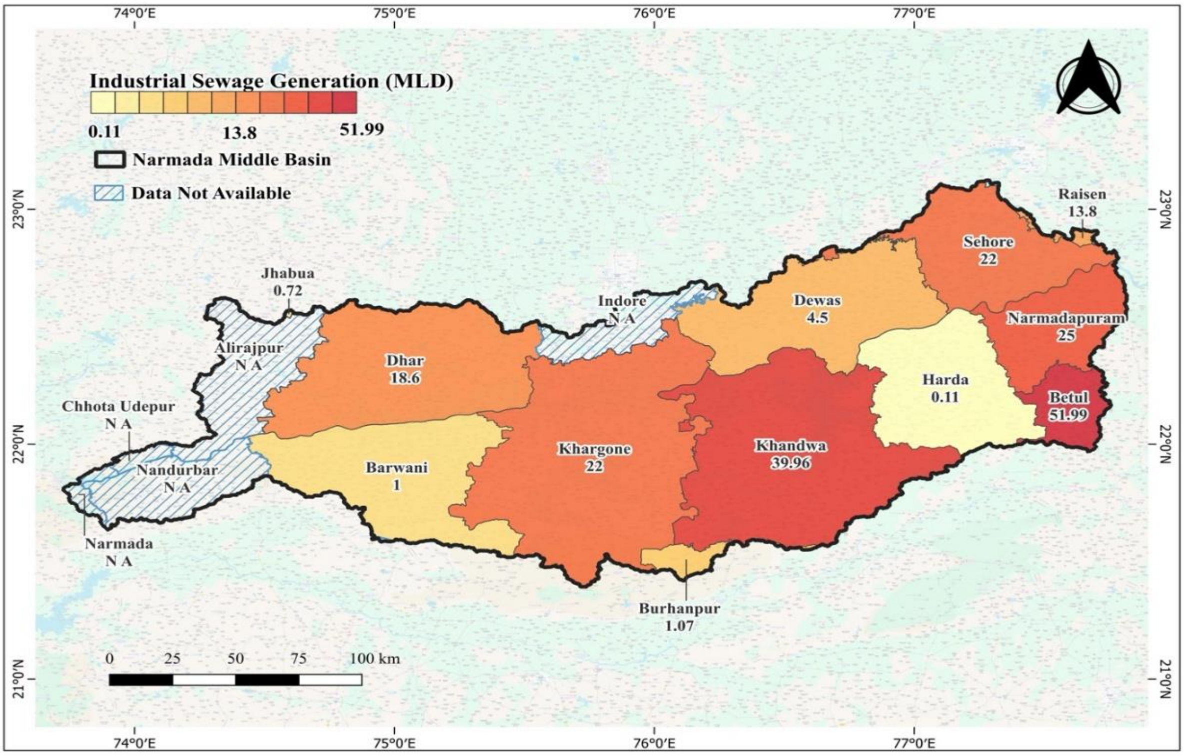


***Figure 13 District-wise Industrial Sewage Generation (MLD) in Narmada Middle Basin***

**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

### 2.3.3 Lower Basin

Industrial wastewater is a major pollution source in lower basin, especially in Bharuch and Ankleshwar. The basin hosts chemical, pharmaceutical, textile, pulp & paper, and petrochemical units generating over 230 MLD of wastewater daily. Smaller districts Chhota Udepur (0.10805MLD), Rajpipla (2.456MLD) have few industries and negligible wastewater which is shown in **Fig. 14**.

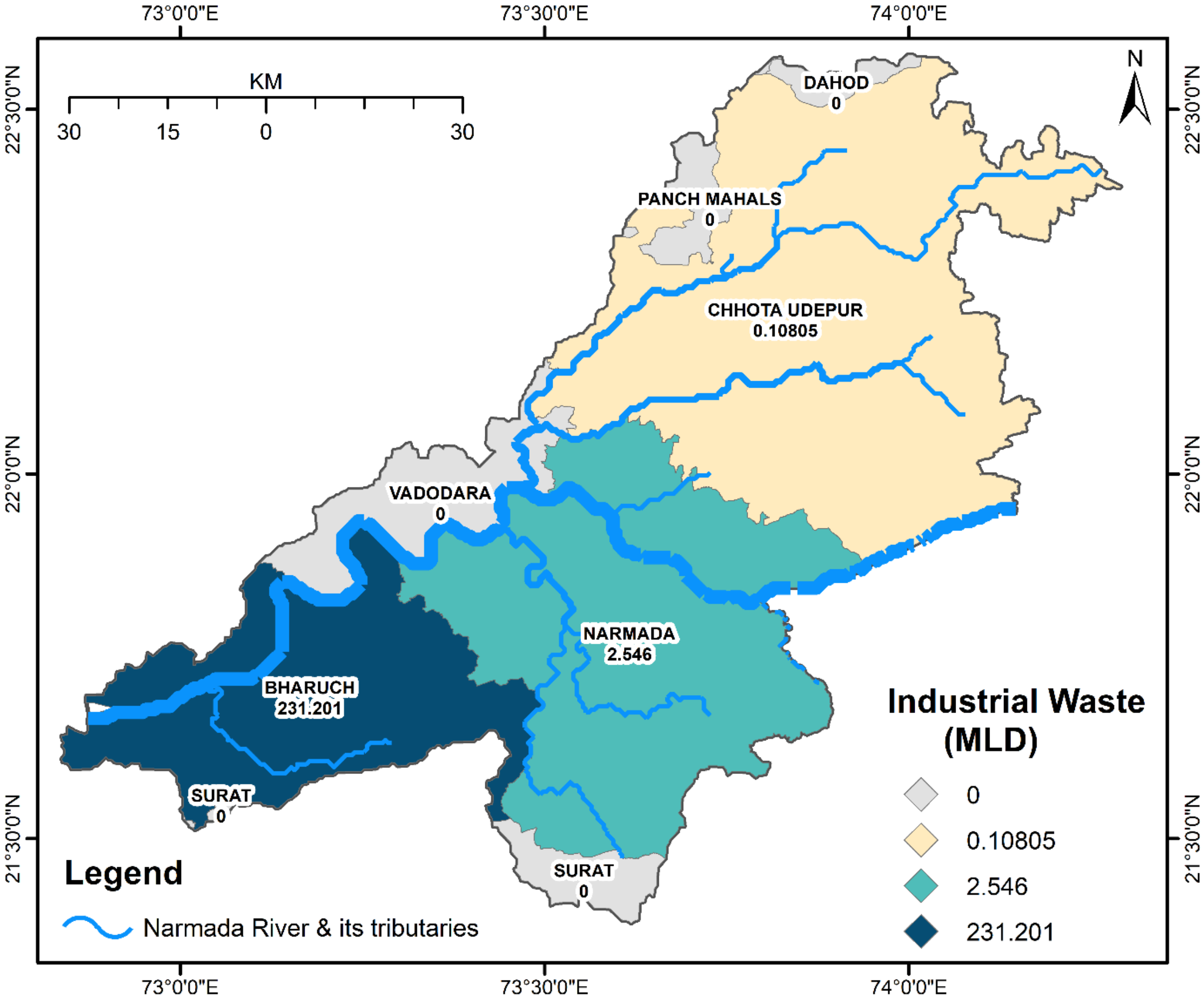


***Figure 14 District-wise Industrial Wastewater Load in Lower Narmada Basin***

*Source: Gujarat Pollution Control Board (GPCB).. District Environmental Plans (DEPs)*

In Chhota Udepur, industries generate about 0.108 MLD of wastewater. It is treated inside the industrial area, and none is released into the river. In Rajpipla, around 2.546 MLD of wastewater is produced. It is also treated within the premises, and no untreated water goes to the river. In the Bharuch–Ankleshwar area, the total industrial wastewater is about 231.201 MLD, with 104.414 MLD from Ankleshwar and 126.787 MLD from Bharuch. About 41.962 MLD is treated within industries and then discharged to drains or rivers, while the rest is treated in common effluent treatment plants (CETPs).

# 3 Wastewater Treatment Facilities

## 3.1 Sewage Treatment Plants (STPs)

### 3.1.1 Upper Basin

#### 3.1.1.1 Operational STPs

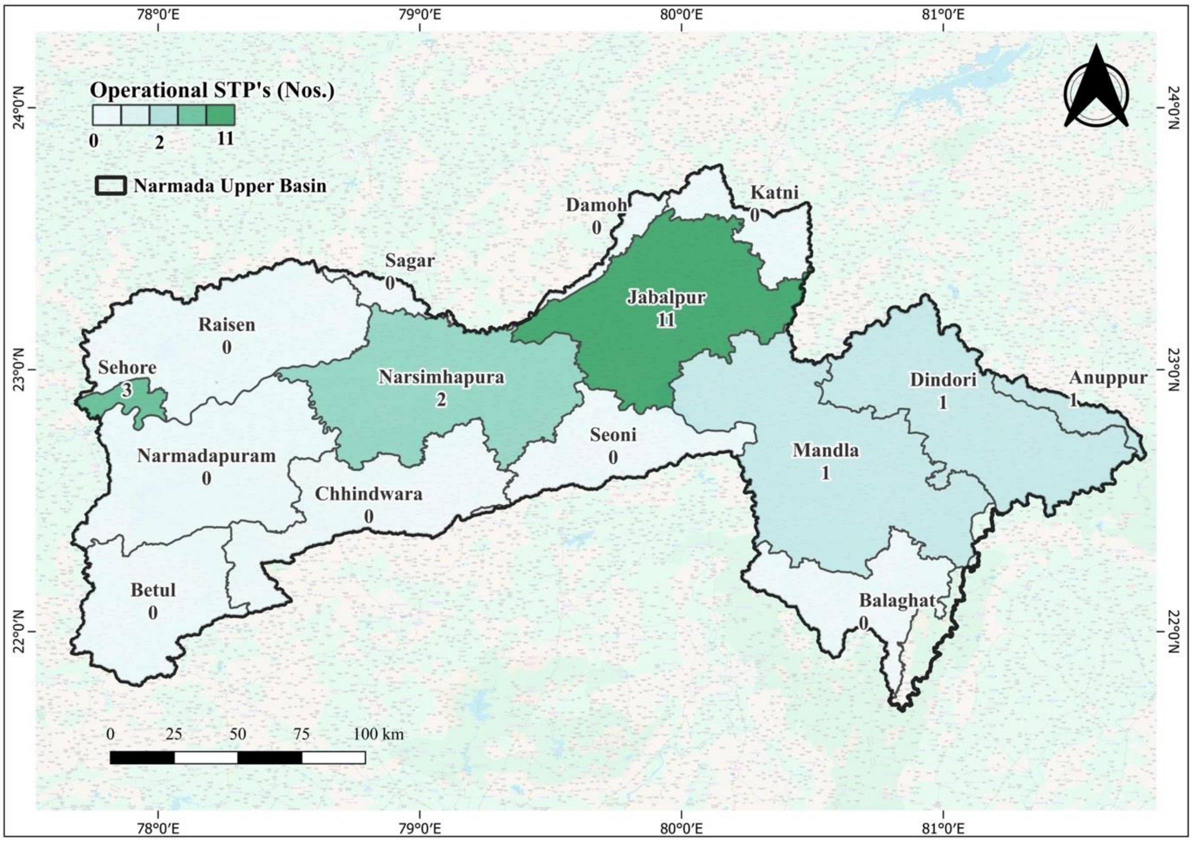


***Figure 15 Number of Operational STPs per district in Narmada Upper Basin***

**Source: Government of Madhya Pradesh. (2024). Action taken report in OA No. 606 of 2018 (Compliance of MSW Management Rules, 2016, and other environmental issues). National Green Tribunal.*

The Map shown in **Fig. 15** provides a district-wise overview of the number of operational Sewage Treatment Plants (STPs) in the Narmada Upper Basin, Madhya Pradesh, highlighting regions with established sewage management infrastructures.

Jabalpur is the clear hotspot, hosting 11 operational STPs, the highest number in the basin. This significant concentration underscores Jabalpur's central role in regional wastewater treatment, likely reflecting a combination of large urban population, industrial presence, and strong administrative prioritization of sanitation efforts. Sehore (3 STPs) and Narsimhapura (2 STPs) form secondary hotspots. Their multiple operational facilities enable more decentralized, reliable sewage management, benefiting local communities with improved environmental and public health conditions. Districts such as Mandla (1 STP) and Dindori (1 STP) have begun to establish sewage treatment capacity but lag in coverage. Anuppur (1 STP) and Balaghat (no number shown, presumed to be 0 or 1) show minimal STP infrastructure. The majority of districts including Narmadapuram, Betul, Raisen, Damoh, Katni, Chhindwara, Sagar, Seoni, and Balaghat currently have no operational STPs, indicated by the lightest map shades. These regions face ongoing challenges of untreated sewage, with risks of river pollution and health impacts.

The map highlights the need for targeted expansion of STP facilities in districts with either no or only one operational plant. Strengthening sewage infrastructure not only protects water quality in the Narmada Basin but also promotes sustainable urban growth, disease reduction, and ecological restoration.

### 3.1.1.2 STPs Under Construction

The Map shown in **Fig. 16** illustrates the spatial distribution of under-construction Sewage Treatment Plants (STPs) across various districts of the Narmada Upper Basin. Districts such as Jabalpur, Mandla, Betul, and Sehore have the highest number of under-constructions STPs (2 each), highlighting their prioritization in wastewater treatment infrastructure. These areas are likely critical nodes for managing wastewater due to higher population densities or strategic river stretches. Districts including Raisen, Narmadapuram, Narsimhapur, Chhindwara, and Seoni each have 1 STP under construction, reflecting moderate investment in wastewater management infrastructure. Some districts, such as Dindori, Anuppur, Katni, and Damoh, currently show 0 STPs under construction, indicating either limited sewage management needs or projects still in the planning phase. This visualization is important for environmental planning and water quality management as it demonstrates ongoing efforts to strengthen sewage treatment infrastructure in the upper catchment of the Narmada River, which plays a crucial role in reducing pollution loads and enhancing river health.

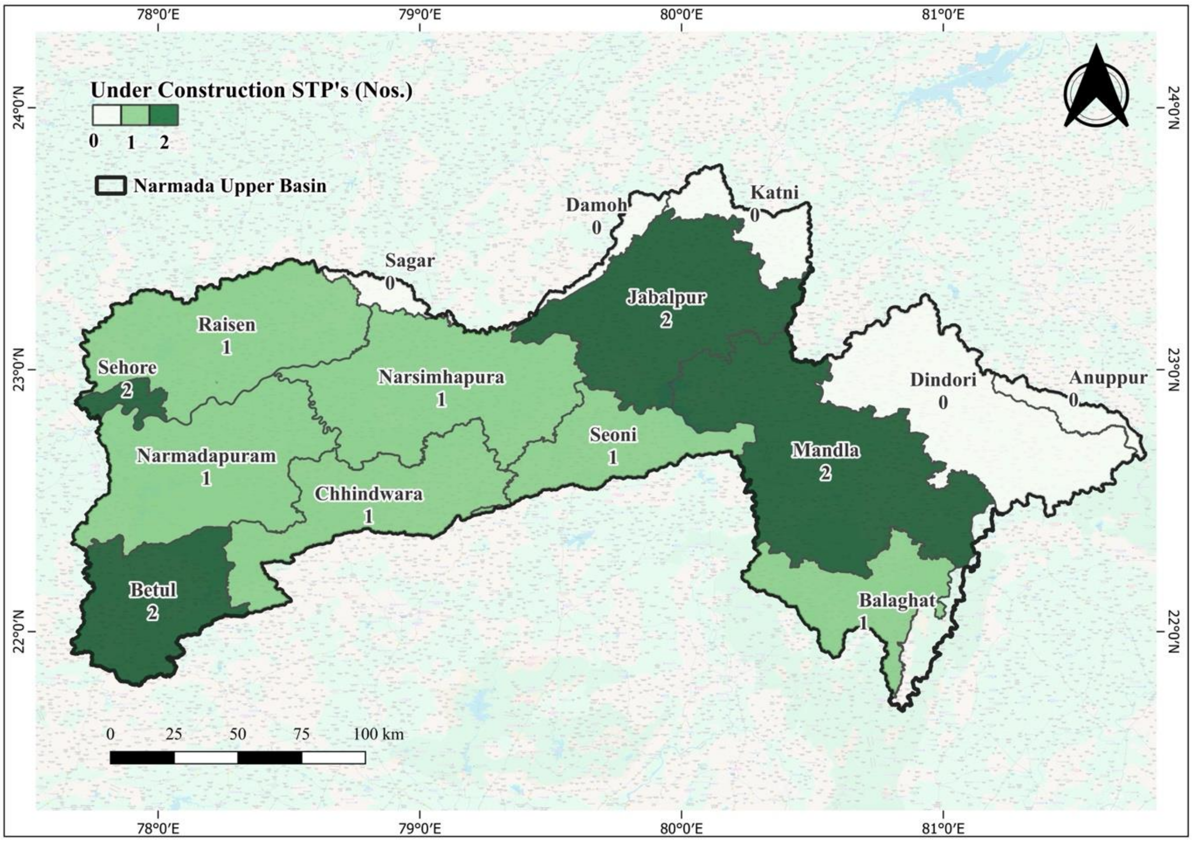


***Figure 16 Number of Under Construction STPs per district in Narmada Upper Basin***

**Source: Government of Madhya Pradesh. (2024). Action taken report in OA No. 606 of 2018 (Compliance of MSW Management Rules, 2016 and other environmental issues). National Green Tribunal.*

### 3.1.1.3 Cumulative Capacity of Operational STPs

The Map shown in **Fig. 17** highlights operational sewage treatment across the Narmada Upper Basin districts in Madhya Pradesh, providing a clear spatial picture of where sewage is actively treated and where gaps persist.

The city of Jabalpur is the dominant hotspot, with an impressive operational STP capacity of 154.15 MLD, by far the largest in the basin. Mandla (17.6 MLD) and Sehore (15.28 MLD) form secondary hotspots, each showing substantial investment in functional sewage treatment infrastructure. These blue-shaded operational clusters represent centers where urban populations benefit from active wastewater cleansing, reduced river pollution, and improved public health outcomes. Narsimhapura (9 MLD), Dindori (3.85 MLD), and Anuppur (1.2 MLD) constitute smaller but notable hotspots. These districts are making tangible progress towards modern sanitation, directly benefiting both their local environments and downstream quality in the Narmada system. In contrast, districts such as Narmadapuram, Betul, Raisen, Damoh, Katni, Chhindwara, Sagar, Seoni, and Balaghat currently lack operational STPs and appear as coldspots on the map. These areas face ongoing challenges regarding untreated sewage, with higher risk of waterborne diseases and pollution in natural water bodies. Addressing these gaps is vital for equitable water management across the Narmada basin.

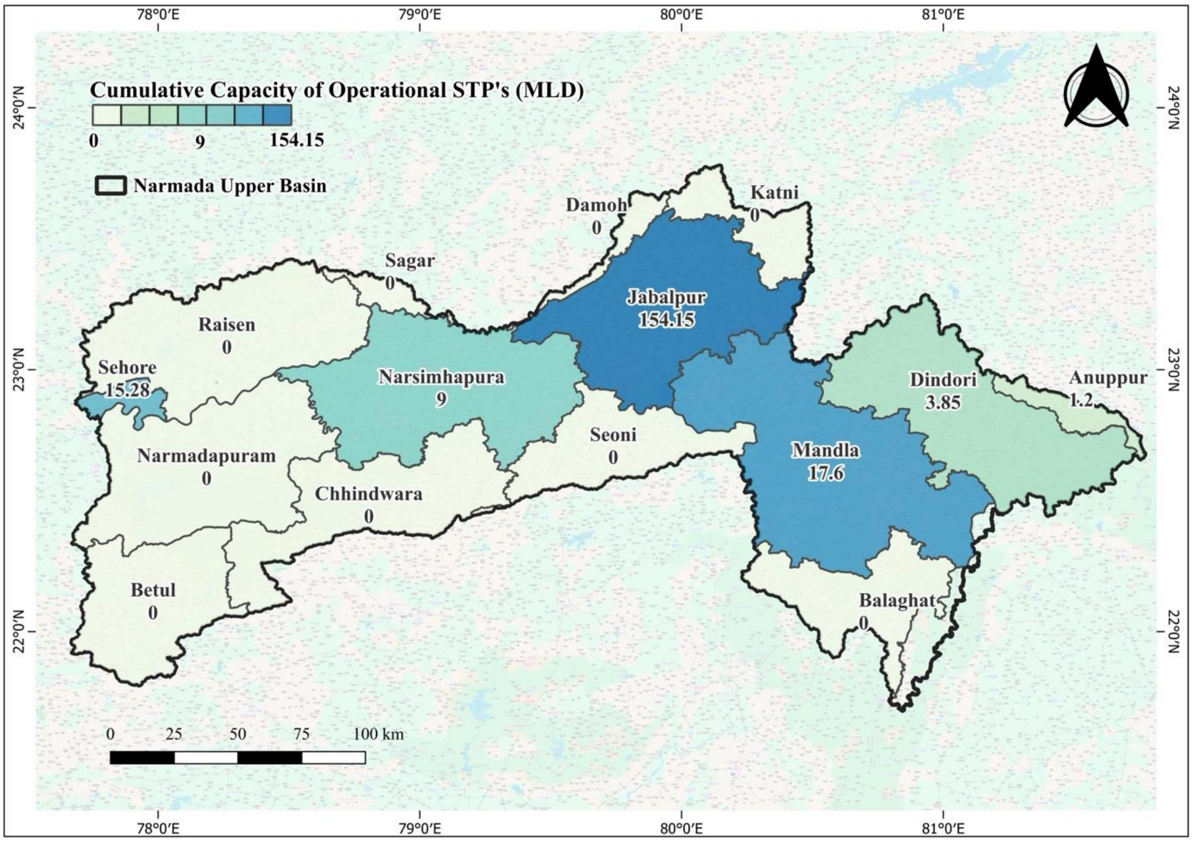


***Figure 17 District-wise cumulative capacity (MLD) of Operational STPs in Narmada Upper Basin***

**Source: Government of Madhya Pradesh. (2024). Action taken report in OA No. 606 of 2018 (Compliance of MSW Management Rules, 2016 and other environmental issues). National Green Tribunal.*

### 3.1.1.4 Cumulative Capacity of Under-Construction STPs in Upper Basin

The Map shown in **Fig. 18** depicts the cumulative capacity of under-construction Sewage Treatment Plants (STPs) across districts in the Narmada Upper Basin, Madhya Pradesh, India, measured in Million Liters per Day (MLD), providing insight into the spatial progress of wastewater infrastructure development.

Narmadapuram is the leading district for ongoing STP infrastructure, with a cumulative under-construction capacity of 21 MLD, the highest on the map. Mandla (9.5 MLD) and Jabalpur (8.8 MLD) are also significant contributors, marked by darker green. These districts are proactively expanding their wastewater management capabilities, which aligns with both high sewage generation volumes and priority for stricter pollution control to preserve basin water quality.

Sehore (5.2 MLD), Chhindwara (3 MLD), Raisen (2.7 MLD), and Balaghat (1.5 MLD) sit within the moderate range. These areas are investing consistently in STP capacity, supporting balanced urban development, and enhancing regional resilience against untreated sewage discharge. Betul, Narsimhapura, and Seoni each have 1 MLD under construction, representing initial steps to upgrade sanitation infrastructure. Several districts Damoh, Katni, Sagar, Dindori, and Anuppur report zero under-construction STP capacity at present, indicated by the lightest shades. The lack of new projects in these areas may reflect lower sewage loads, budgetary constraints, or a need for greater prioritization in future planning cycles.

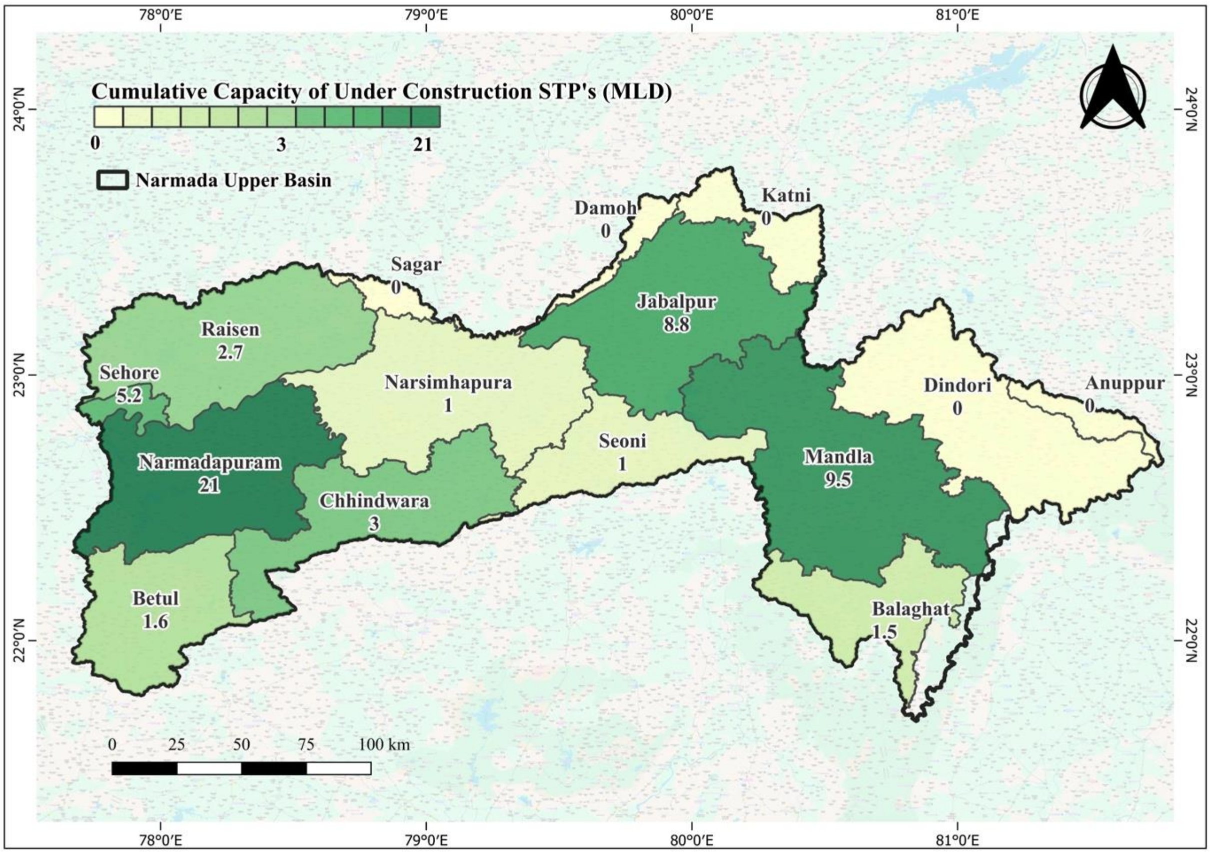


***Figure 18 District-wise cumulative capacity (MLD) of Under Construction STPs in Narmada Upper Basin***

**Source: Government of Madhya Pradesh. (2024). Action taken report in OA No. 606 of 2018 (Compliance of MSW Management Rules, 2016 and other environmental issues). National Green Tribunal.*

Narmadapuram, Mandla, and Jabalpur are key districts with robust STP capacity under construction, forming the backbone of future wastewater management in the basin. Moderate investment zones such as Sehore, Chhindwara, Raisen, Betul, Balaghat, Narsimhapura, and Seoni reveal transitional progress toward improved sanitation coverage. Districts with zero capacity underway (Damoh, Katni, Sagar, Dindori, and Anuppur) need renewed focus in infrastructure planning, especially as urbanization accelerates. The map offers strategic regional intelligence for optimizing STP project rollout and tuning basin-level sustainability objectives.

### 3.1.2 Middle Basin

#### 3.1.2.1 Operational STPs in Middle Basin

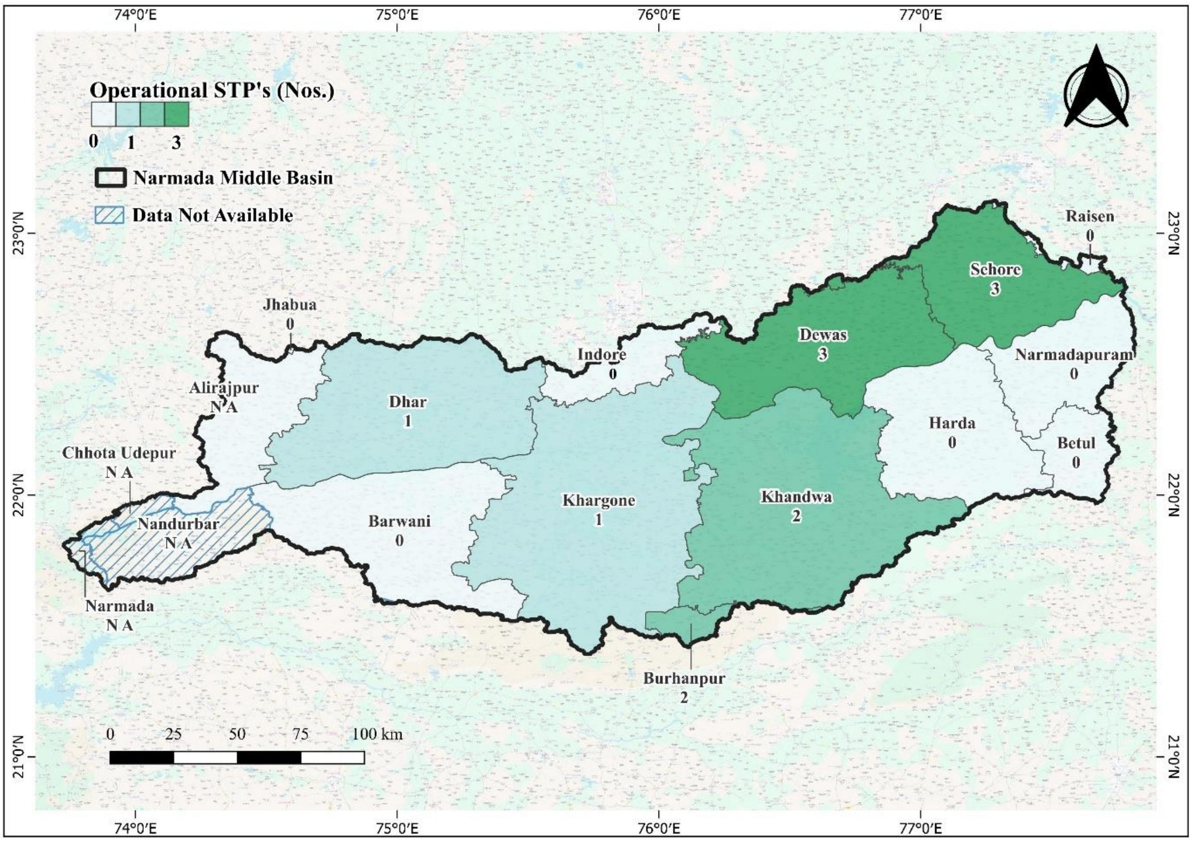


***Figure 19 District-wise Operational STPs in Narmada Middle Basin***

**Source: Government of Madhya Pradesh. (2024). Action taken report in OA No. 606 of 2018 (Compliance of MSW Management Rules, 2016 and other environmental issues). National Green Tribunal.*

The Map shown in **Fig. 19** displays the distribution of operational Sewage Treatment Plants (STPs) by number across the districts of the Narmada Upper Basin. It highlights areas of significant infrastructure development and points out regions needing future attention. Jabalpur is the principal hotspot, housing 11 operational STPs, the highest number among all districts in the basin. This strong infrastructure reflects an advanced stage of urban sanitation management, supporting Jabalpur's ability to process large sewage volumes from both residential and industrial sources. Jabalpur's leadership sets an example for regional urban centers regarding the expansion of wastewater treatment facilities. Sehore (3 STPs) and

Narsimhapura (2 STPs) are notable secondary hotspots. Their increased number of plants suggests growing urban populations and progressive local governance with a focus on sustainable waste management. Many districts, including Narmadapuram, Betul, Raisen, Damoh, Katni, Chhindwara, Sagar, Seoni, and Balaghat, lack operational STPs altogether, or only have a single plant (such as Mandla, Dindori, and Anuppur). These light-shaded zones represent underserved regions where sewage treatment infrastructure is either nascent or absent, exposing local populations and waterways to greater health and pollution risks.

Jabalpur is the chief operational hotspot for STPs, setting the infrastructural standard for the Narmada Upper Basin. Sehore and Narsimhapura are emerging secondary clusters showing forward momentum in sewage management. Many districts require focused policy, planning, and investment to bridge large infrastructure gaps and promote sustainable sanitation outcomes across the basin.

### 3.1.2.2 Under Construction STPs in Middle Basin

The Map shown in **Fig. 20** shows the distribution of under-construction Sewage Treatment Plants (STPs) by number across the districts of the Narmada Middle Basin. It highlights zones of present infrastructure growth and regions that require prioritization for future sewage management. Barwani and Khargone each have 4 under-construction STPs, emerging as the core hotspots for upcoming sewage treatment capacity in the basin. This active expansion reflects strong recognition of sanitation needs, the pressure of rapid urbanization, and responsive district-level planning to manage future wastewater loads. Dhar and Alirajpur each feature 2 plants under construction, signifying moderate levels of imminent infrastructure development. Sehore also joins the group of moderately active districts with 2 new facilities underway, positioning it for improved management of urban and peri-urban sewage. Several districts, including Raisen, Narmadapuram, Betul, and Burhanpur, report just 1 STP under construction, reflecting initial steps toward improved sewage treatment but leaving considerable coverage gaps. Many districts, such as Dewas, Harda, Khandwa, Indore, and others, have no current projects, as portrayed by the lightest coloration, indicating significant vulnerability to unmanaged wastewater issues as populations grow.

Several territorial units, namely Nandurbar, Narmada, and Chhota Udepur, are shown with crosshatch shading, representing areas where data is not available. These pose challenges for monitoring and infrastructure planning, and transparency improvements are needed.

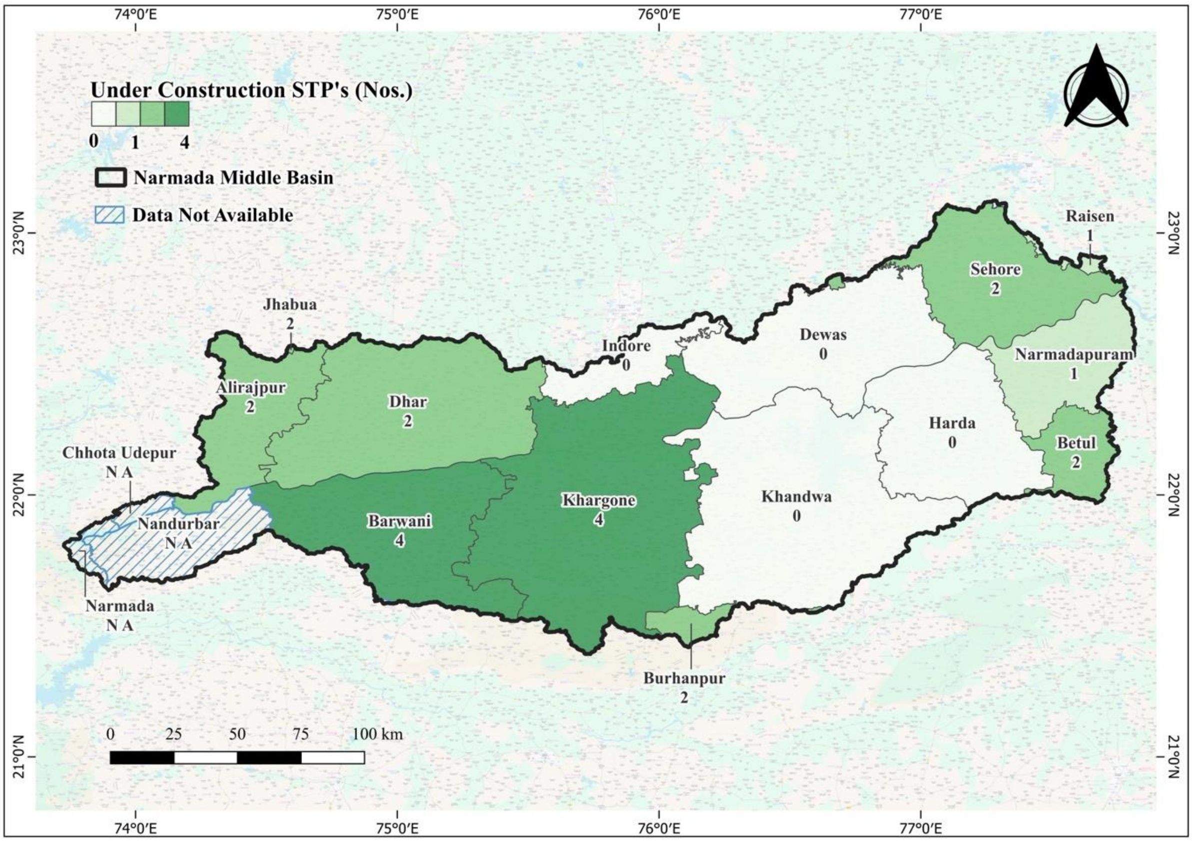


***Figure 20 District-wise Under-Construction STPs in Narmada Middle Basin***

**Source: Government of Madhya Pradesh. (2024). Action taken report in OA No. 606 of 2018 (Compliance of MSW Management Rules, 2016, and other environmental issues). National Green Tribunal.*

### 3.1.2.3 Cumulative Capacity of Operational STPs in Middle Basin

The Map shown in **Fig. 21** illustrates the cumulative capacity of operational sewage treatment plants (STPs) across the districts of the Narmada Middle Basin, expressed in Million Liters per Day (MLD). It highlights which regions are already equipped to treat large amounts of sewage, and which continue to face infrastructure gaps.

Dewas (38 MLD) and Burhanpur (24 MLD) are the leading hotspots, shown with the darkest blue, indicating strong operational infrastructure for sewage treatment. These districts are well-positioned to manage urban and industrial sewage flows, offering significant protection to local water bodies and helping maintain sanitation standards for growing populations. Khandwa (17.95 MLD) and Khargone (17.6 MLD) also represent notable operational strengths, with considerable treatment capacities. Sehore (15.28 MLD) and Dhar (12 MLD) reinforce this emerging belt of sewage management readiness throughout the middle basin. Districts like Narsimhapura (not labeled, presumed moderate or minimal), along with lower-capacity districts such as Alirajpur (not labeled) and Indore (not labeled), tend to have less capacity but show progress in operational deployments, as reflected in lighter blue hues. Consistent investment and scaling in these areas will help address cumulative sanitation needs.

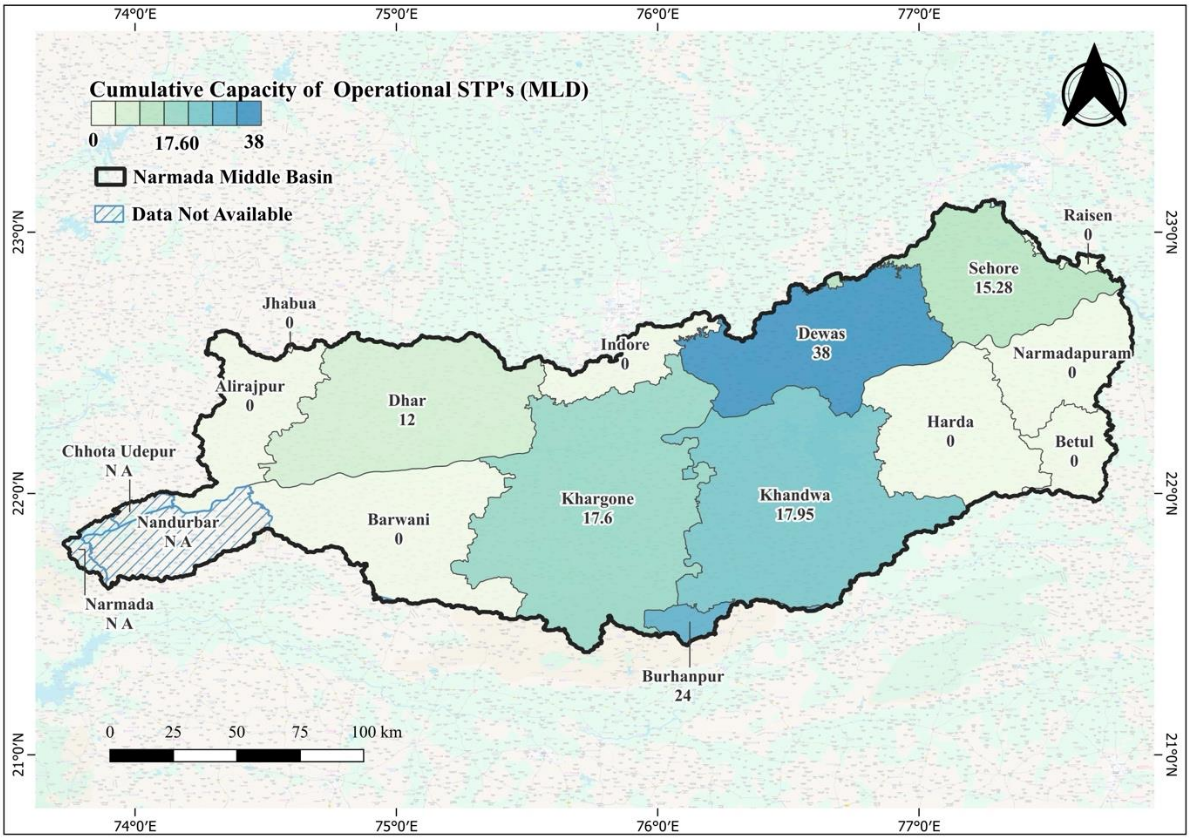


*Figure 21 District-wise cumulative capacity (MLD) of Operational STPs in Narmada Middle Basin*

**Source: Government of Madhya Pradesh. (2024). Action taken report in OA No. 606 of 2018 (Compliance of MSW Management Rules, 2016 and other environmental issues). National Green Tribunal.*

Several districts, such as Harda, Narmadapuram, Betul, Raisen, and Barwani, record zero operational STP capacity, highlighted in the lightest coloration. Chhota Udepur, Nandurbar, and Narmada are marked as data not available, which flags a transparency and monitoring gap. These regions are the most vulnerable to risks from untreated wastewater—public health hazards, environmental contamination, and long-term river degradation.

### 3.1.2.4 Cumulative Capacity of Under-Construction STPs in the Middle Basin

The Map shown in **Fig. 22** presents the cumulative capacity of under-construction Sewage Treatment Plants (STPs) across districts in the Narmada Middle Basin, measured in Million Liters per Day (MLD). It reveals which districts are rapidly upgrading their wastewater treatment infrastructure and which areas are yet to expand their capacity.

Narmadapuram (21 MLD), Barwani (20 MLD), Khargone (16 MLD), Dhar (11 MLD), Jhabua (8 MLD), and Alirajpur (4 MLD) emerge as key hotspots for ongoing STP development, illustrated by dark green shades. These districts are showing strong progress, signaling recognition of wastewater management needs and commitment to clean river basin practices. Significant under-construction capacity in these areas will enhance future sewage treatment coverage, reduce environmental pollution, and improve public health. Sehore (5 MLD), Raisen (3 MLD), Burhanpur (2 MLD), and Betul (1 MLD) demonstrate moderate investments in new STP capacity. These ongoing expansions will help support growing urban populations and prevent the escalation of untreated wastewater problems.

Several districts, including Indore, Dewas, Harda, and Khandwa, currently show zero under-construction STP capacity, indicated by the lightest coloring. Additionally, Nandurbar, Chhota Udepur, and Narmada have striped shading to denote that data is not available. These gaps may reflect delays in infrastructure planning, lower urbanization, or reporting limitations, but they represent priority areas for future intervention and improved monitoring.

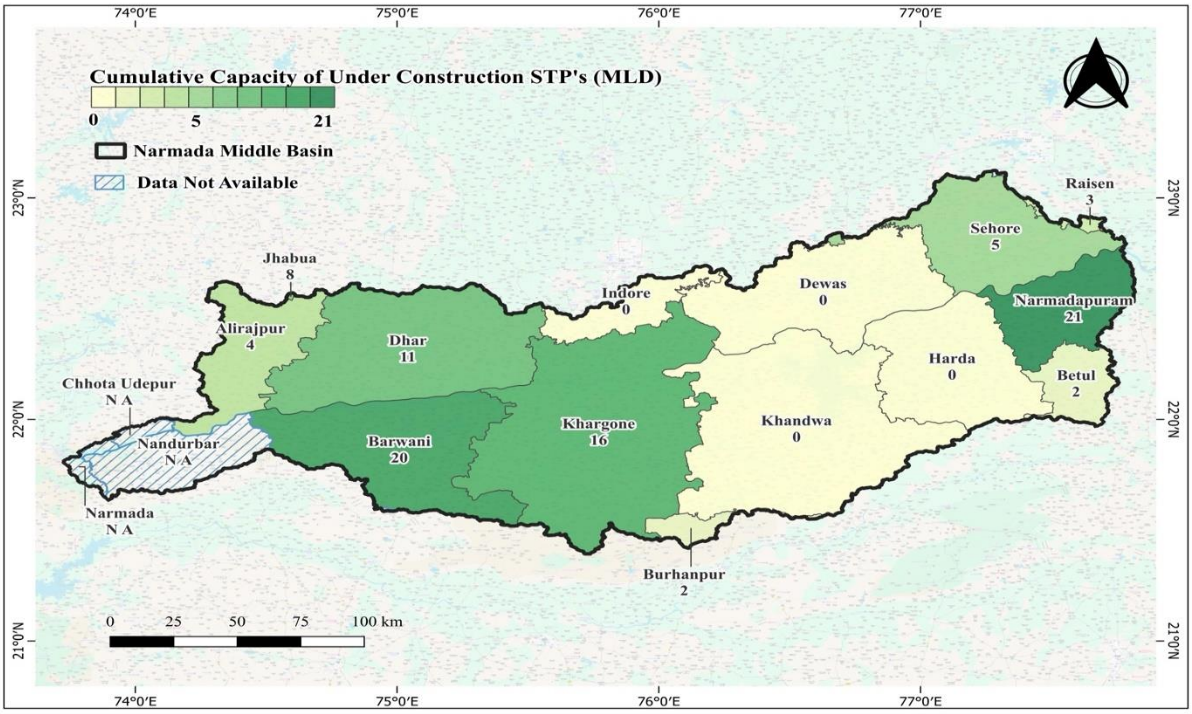


***Figure 22 District-wise cumulative capacity (MLD) of under-construction STPs in Narmada Middle Basin***

**Source: Government of Madhya Pradesh. (2024). Action taken report in OA No. 606 of 2018 (Compliance of MSW Management Rules, 2016 and other environmental issues). National Green Tribunal.*

### 3.1.3 Lower Basin

The Lower Narmada basin has a mix of municipal and institutional STPs serving towns, industrial areas, and tourist facilities, as shown in the map of **Fig. 23**. Rajpipla has a sewage treatment plant (STP) with a capacity of 5.5 million litres per day(MLD). In Ankleshwar, a larger STP with a capacity of 14 MLD is under construction. Chhota Udepur has a plant of 5 MLD. Bharuch has the biggest plant with a capacity of 29.3 MLD(**Table 6**).

***Table 6 Sewage Generation & STP Capacity of City in Lower Narmada Basin***

| Town/Area | Sewage Generated | STP Capacity | Current Status |
|---|---|---|---|
| Rajpipla | 4.5 MLD | 5.5 MLD | Operational |
| Ankleshwar | 7.5 MLD | 14 MLD | Under Construction |
| Chhota Udepur | 4.0 MLD | 5.0 MLD | Operational |
| Bharuch | 28 MLD | 29.3 MLD | Operational |

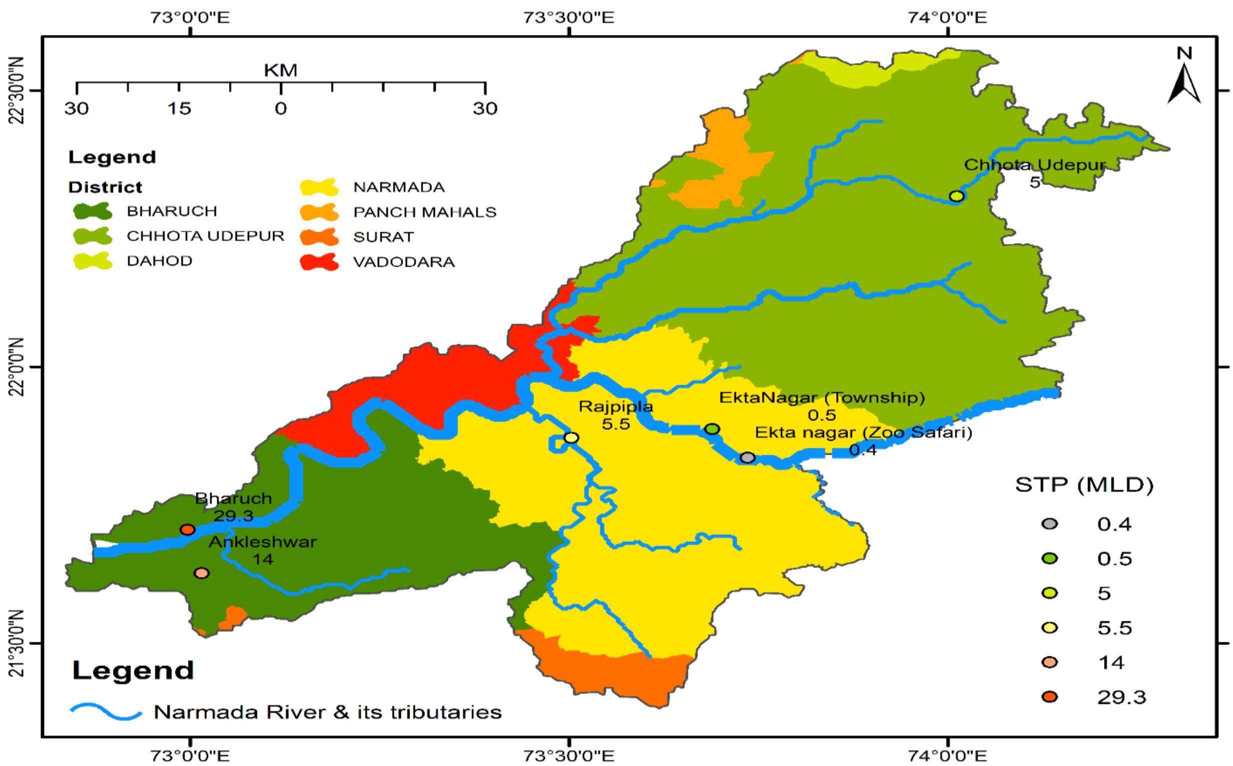


***Figure 23 Distribution of sewage treatment facilities in Lower Narmada Basin***

*Source: Gujarat Pollution Control Board (GPCB).. District Environmental Plans (DEPs)*

# 4 Status of Solid Waste Generation in the Basin

## 4.1 Upper Basin

### 4.1.1 Solid Waste Generation in Upper Basin

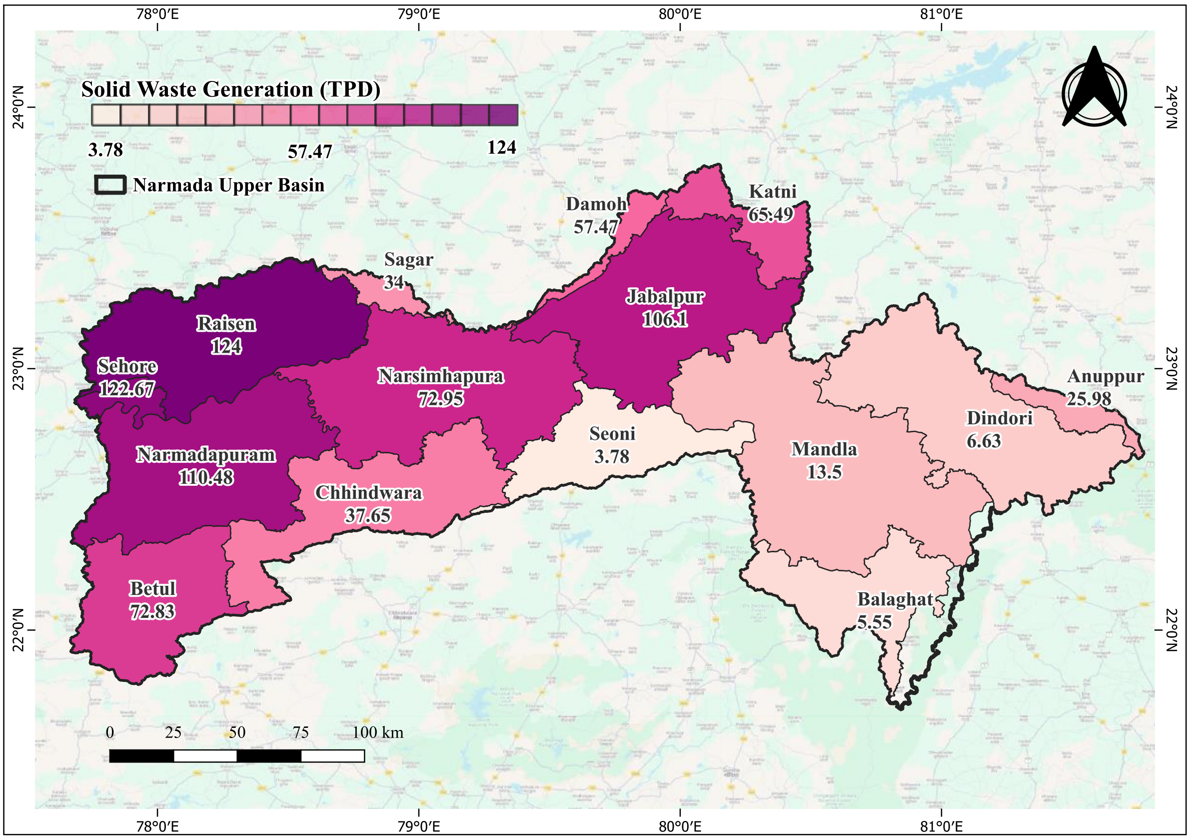


***Figure 24 District-wise Solid Waste Generation (TPD) in the Narmada Upper Basin***

**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

The Map shown in **Fig. 24** identifies solid waste generation hotspots across districts in the Narmada Upper Basin, Madhya Pradesh, India, with a spatial focus on regions exhibiting high daily waste production, measured in Tons Per Day (TPD). The districts of Jabalpur (106.1 TPD), Sehore (122.67 TPD), Raisen (124 TPD), and Narmadapuram (110.48 TPD) emerge prominently as solid waste generation hotspots, represented by the deepest shades on the map. These urbanized zones indicate substantial solid waste management needs driven by dense populations, commercial activity, and rapid urban growth. Strategic intervention in these districts is critical for containing environmental pollution, promoting effective municipal waste management systems, and preventing the proliferation of legacy dumpsites.

Districts such as Katni (65.49 TPD), Damoh (57.47 TPD), Betul (72.83 TPD), and Narsimhapura (72.95 TPD) present moderate solid waste loads, serving as secondary hotspot zones. These areas require scaled localized solutions—such as waste segregation, decentralized composting, and robust collection infrastructure to reduce landfill dependence and address mounting daily waste volumes.

In contrast, districts like Seoni (3.78 TPD), Mandla (13.5 TPD), Balaghat (5.55 TPD), Dindori (6.63 TPD), and Anuppur (25.98 TPD) register lower values and are displayed in lighter tones. These peripheral regions, while presenting relatively modest waste management challenges, can benefit from early adoption of best practices, community engagement, and innovations in decentralized waste processing to prevent future escalation as populations grow.

## 4.2 Middle Basin

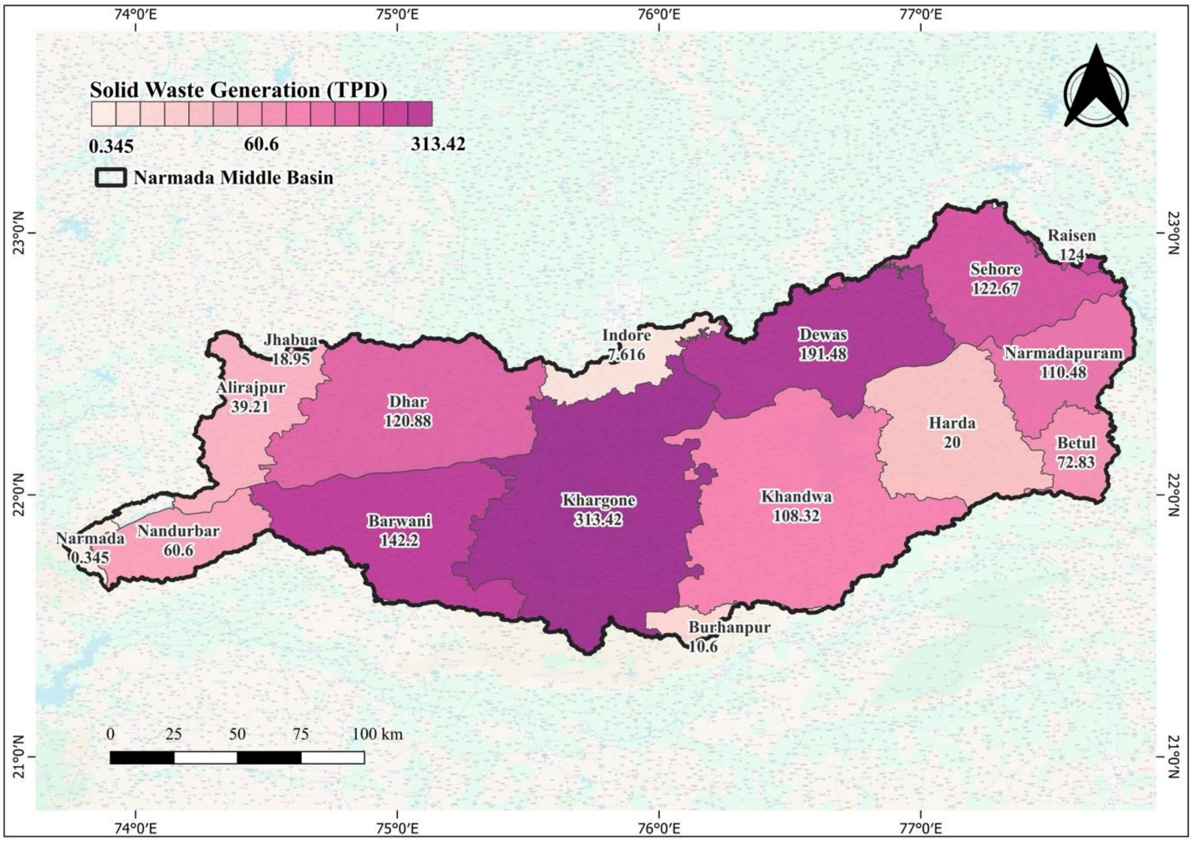


***Figure 25 District-wise Solid Waste Generation (TPD) in the Narmada Middle Basin***
**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2021,2025). District Environmental Plans (DEPs)*

The Map shown in **Fig. 25** visualizes daily solid waste generation (TPD) for each district in the Narmada Middle Basin, showcasing hotspot regions where municipal and commercial activities generate the most waste. Khargone (313.42 TPD), Barwani (142.5 TPD), Dewas (191.48 TPD), and Sehore (122.67 TPD) are the principal hotspots, marked in the deepest purple. These districts have thriving urban centers, diverse economic activities, and large populations—leading to massive daily solid waste production. They urgently require advanced waste management systems such as modern landfill sites, segregation facilities, composting units, and public awareness campaigns about recycling and reduction. Narmadapuram (110.48 TPD), Khandwa (108.32 TPD), Dhar (120.88 TPD), Raisen (124 TPD), Betul (72.83 TPD), Burhanpur (10.6 TPD), Indore (76.16 TPD), and Alirajpur (39.21 TPD) show moderate waste generation. Their lighter shading signals steady urban expansion and emerging commercial hubs. These districts can benefit from scaling up decentralized waste management approaches, promoting structured door-to-door collection, and building community partnerships for sustainable waste practices. Districts such as Harda (20 TPD), Jhabua (18.95 TPD), Nandurbar (60.6 TPD), and Narmada (0.345 TPD) have the lowest daily generation rates. Rural or semi-rural characteristics explain their minimal loads. Nonetheless, foundational interventions in waste reduction, composting, and public education will help them prepare for future growth and avoid waste accumulation problems.

## 4.3 **Lower Basin**

The Lower Narmada area in Gujarat includes parts of six districts: Bharuch, Narmada, Vadodara, Chhota Udepur, Panchmahal, and Surat. Fewer people live in towns here compared to the middle and upper Narmada basin. Gujarat produces about 9,800–10,800 tonnes of waste every day, but towns in Lower Narmada contribute only a small part. The largest solid waste genareted towns in the Lower Narmada Basin are Bharuch, Ankleshwar, and Rajpipla, as represented in **Fig. 26**. Most other areas are small towns or villages, generating much less waste.

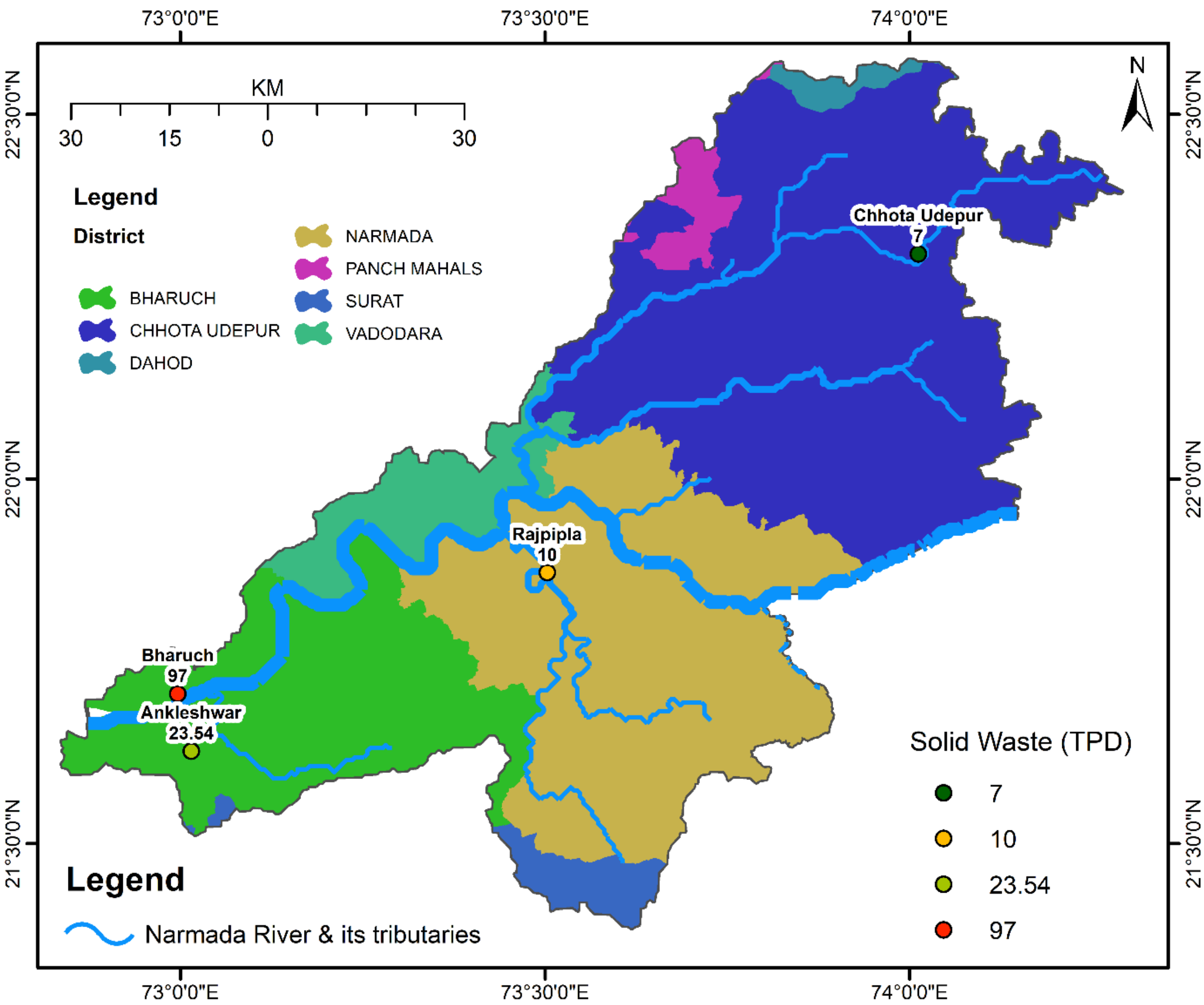


***Figure 26 Solid Waste Generated City in Lower Narmada Basin***

*Source: Gujarat Pollution Control Board (GPCB).. District Environmental Plans (DEPs)*

Chhota Udepur generates about 4 tons of waste per day from 7 wards and 11,945 households with a population of 25,787. It is a small town and needs better waste management. Rajpipla produces 10 tons per day from 7 wards and 10,185 households with a population of 34,845, which is higher than Chhota Udepur. The rural area of Narmada district produces only 0.345 tons per day from 222 gram panchayats, 1,37,814 households, and a population of 6,69,231, but it is still important to manage. Bharuch generates 97 tons per day from 11 wards and 53,092 households with a population of 1,87,793, so it needs a strong waste management plan. Ankleshwar produces 23.54 tons per day from 9 wards and 22,223 households with a population of 81,922 and has fully urban waste.

# 5 Status of Hazardous Waste Generation in the Basin

## 5.1 Upper Basin

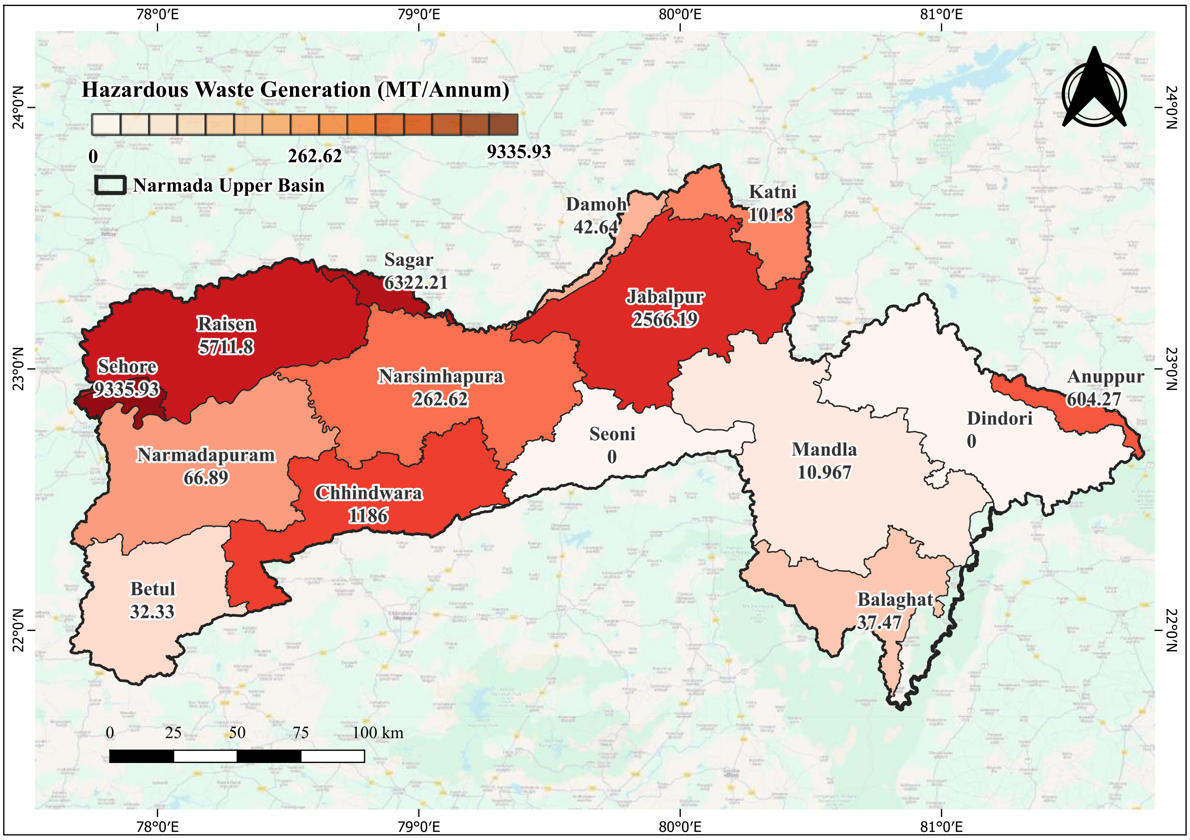


***Figure 27 District-wise Hazardous Waste Generation (MT/Annum) in the Narmada Upper Basin***
**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

The Map shown in **Fig. 27** highlights the hazardous waste generation hotspots across the districts of the Narmada Upper Basin, Madhya Pradesh, India, with particular focus on areas producing the highest annual tonnage (MT/Annum) of hazardous waste. Sehore district stands out as the most significant hazardous waste hotspot, generating a massive 9335.93 MT per annum, followed by Sagar (6322.21 MT/annum), Raisen (5711.8 MT/annum), and Jabalpur (2566.19 MT/annum). The darkest map shades pinpoint these zones, indicating extensive industrial activity and waste-intensive processes, likely due to the presence of large-scale manufacturing, processing, or specialized waste-handling facilities. Several other districts Chhindwara (1186 MT/annum), Anuppur (604.27 MT/annum), Katni (101.18 MT/annum), and Narsimhapura (262.62 MT/annum) register moderate yet non-trivial quantities of hazardous waste. These districts, found in intermediate shades, are essential focal points for regulatory intervention, infrastructure upgrades, and pollution surveillance to ensure containment and safe disposal of hazardous materials. Districts such as Mandla (10.967 MT/annum), Balaghat (37.47

MT/annum), Damoh (42.64 MT/annum), and Narmadapuram (66.89 MT/annum) display lower hazardous waste volumes, while some, notably Dindori and Seoni, report negligible or zero generation. These zones pose less immediate risk but must maintain vigilant environmental monitoring and preparedness as local industrialization patterns evolve.

## 5.2 Middle Basin

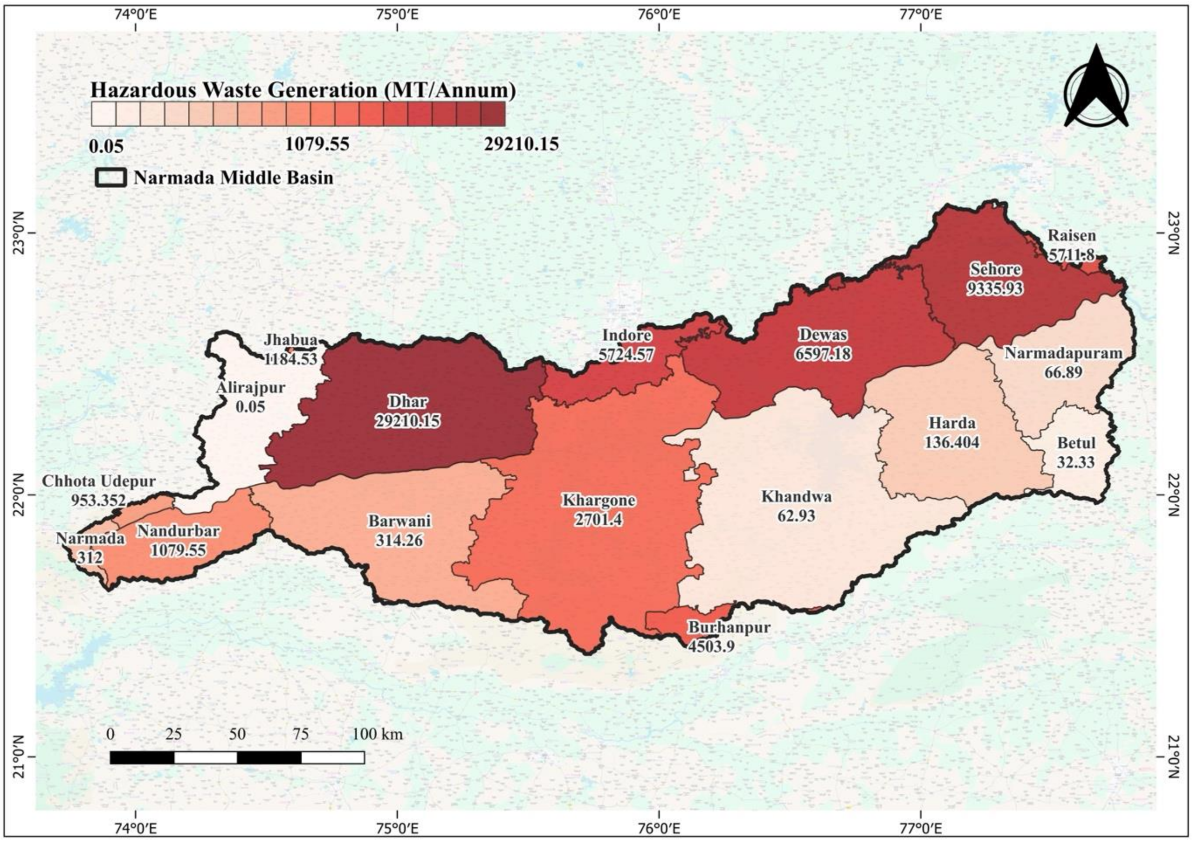


***Figure 28 District-wise Hazardous Waste Generation (MT/Annum) in the Narmada Middle Basin***
**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

The Map shown in **Fig. 28** visualizes hazardous waste generation (in MT/annum) across the districts of the Narmada Middle Basin, spotlighting key industrial and pollution hotspots.Dhar emerges as the most critical hotspot, generating a staggering 29,210.15 MT of hazardous waste annually. Sehore (9,335.93 MT), Indore (5,724.57 MT), Dewas (6,597.18 MT), and Burhanpur (4,503.9 MT) also stand out with some of the highest figures. These dark-shaded districts are major industrial and urban centers, where intense manufacturing and processing activities create substantial volumes of hazardous by-products. The high concentration of such waste underscores the urgent need for robust waste management, strict regulatory oversight, and the adoption of best practices to reduce risks to people and the environment. Additional districts generating notable hazardous waste include Khargone (2,701.4 MT), Jhabua (1,184.53 MT), Barwani (314.26 MT), Nandurbar (1,079.55 MT), and Chhota Udepur (953.352 MT). While not as extreme as the primary hotspots, these areas still require vigilant waste monitoring, better treatment infrastructure, and continuous public health safeguarding. Some districts, such as Betul (32.33 MT), Khandwa (62.93 MT), Harda (136.404 MT), and Narmadapuram (66.89 MT), produce much smaller quantities, visualized in the lightest shades. Although their contribution to hazardous waste loads is comparatively minor, proactive management measures are still important for future-proofing these regions against the risks associated with industrialization and pollution.

## 5.3 Lower Basin

Bharuch district is one of the largest hazardous waste generators in Gujarat, as shown in **Fig.29** 2,380 industries are producing 12,53,485 MT/year of hazardous waste. Out of this, 1,04,525 MT/year is incinerable, 5,92,019 MT/year is landfillable, and 5,56,941 MT/year is recyclable or usable. The district has 3 TSDFs and 6 SLFs. No contaminated sites have been identified.

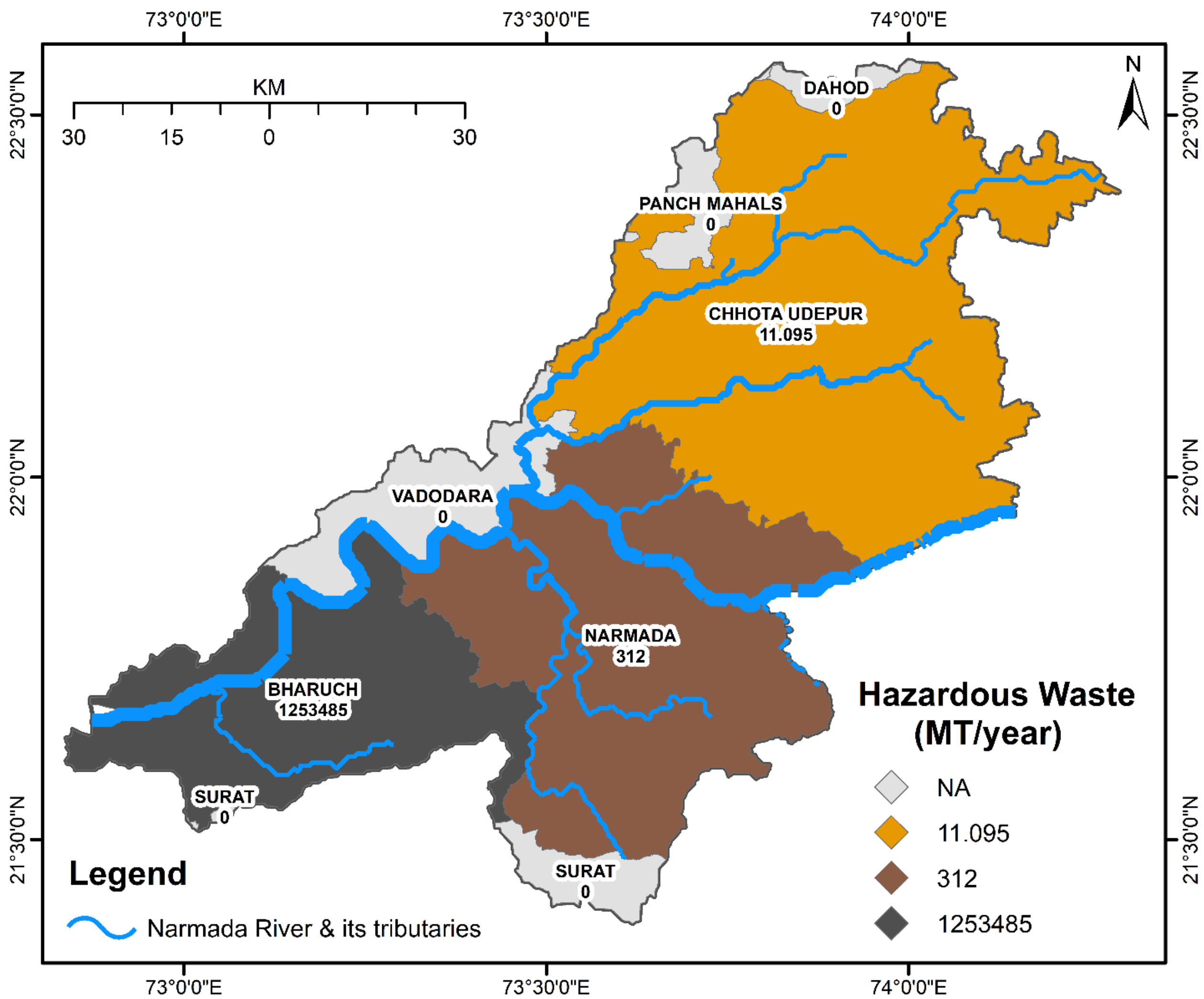

*Figure 29 District-wise hazardous waste Load in Lower Narmada Basin*

*Source: Gujarat Pollution Control Board (GPCB).. District Environmental Plans (DEPs)*

Ankleshwar is a major industrial hub. Ankleshwar contributes a large share of hazardous waste. Industries keep their own storage areas and send waste to TSDFs using the GPCB online system (XGN). Workers receive regular training, and compliance monitoring ensures proper disposal. In the Narmada district, 18 industries are generating 312 MT/year of hazardous waste. Out of this, 269.70 MT/year is incinerable and 42.303 MT/year is landfillable. There is no recyclable fraction. No TSDF exists in the district, so all waste is sent to other districts. A proposed MRF will handle domestic hazardous waste, and worker training will also be completed by then. Chhota Udepur district has 19 industries producing about 11.095 MT/year of hazardous waste. Of this, 0.11 MT/year is incinerable, 14.51 MT/year is landfillable, and 953.352 MT/year is recyclable or usable. No TSDF exists in the district, but industries are connected to state-level facilities via XGN. No contaminated sites have been reported.

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# 6 Status of Biomedical Waste Generation in the Basin

## 6.1 Upper Basin

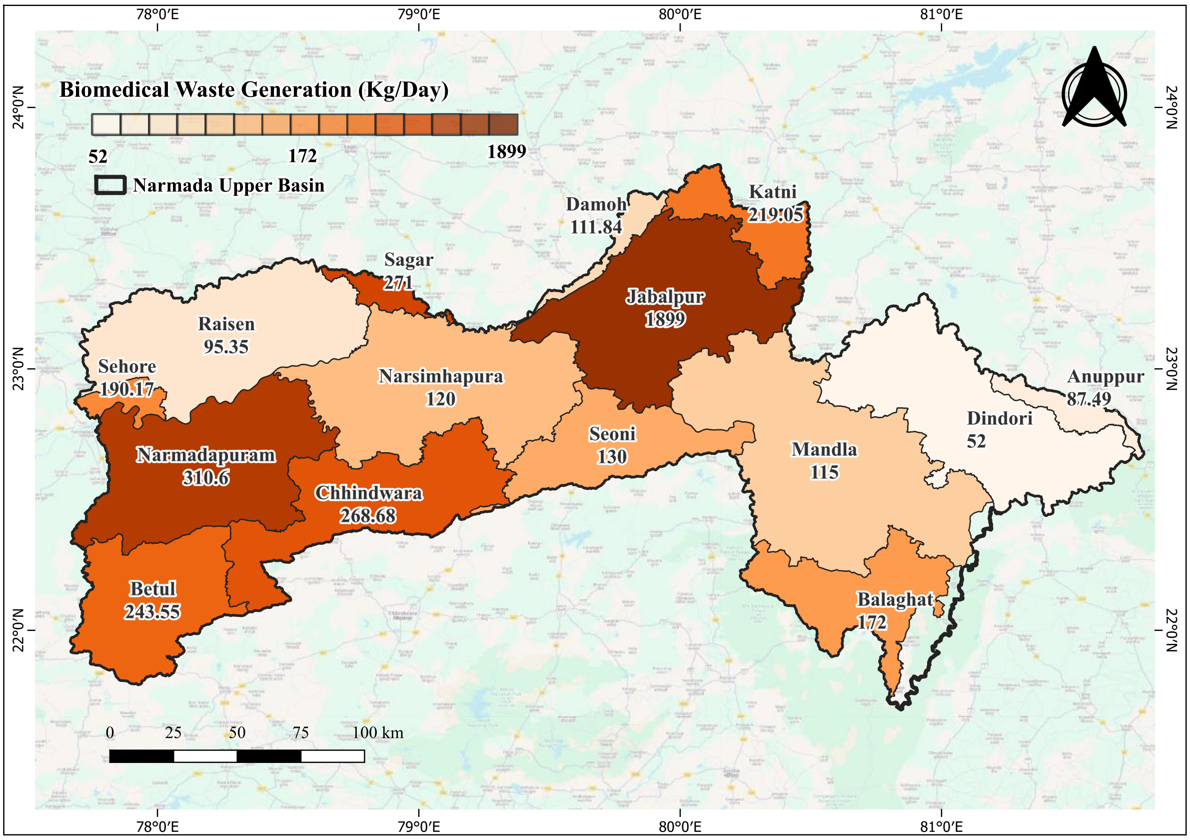


***Figure 30 District-wise Biomedical Waste Generation (Kg/Day) in the Narmada - Upper Basin***
**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

The Map shown in **Fig. 30** represents the spatial distribution of biomedical waste generation across districts in the Narmada Upper Basin, Madhya Pradesh, India, measured in kilograms per day (Kg/Day), highlighting regions of heightened biomedical waste burden linked to urban centers and healthcare facilities. Jabalpur (1899 Kg/Day) and Katni (2190.53 Kg/Day) are depicted as the most critical hotspots for biomedical waste generation, signaled by the darkest shades on the map. These districts harbor major urban centers, regional hospitals, and healthcare infrastructure, necessitating advanced biomedical waste segregation, treatment, and disposal systems to mitigate public health and environmental risks. Districts such as Narmadapuram (310.6 Kg/Day), Chhindwara (268.68 Kg/Day), Betul (243.55 Kg/Day), Sagar (271 Kg/Day), and Sehore (190.17 Kg/Day) also generate considerable quantities of biomedical waste. While not at the extreme scale of Jabalpur or Katni, these areas represent significant secondary clusters requiring robust collection, incineration, and safe containment practices. The remaining districts—including Raisen (95.35 Kg/Day), Damoh (111.84

Kg/Day), Seoni (130 Kg/Day), Narsimhapura (120 Kg/Day), Mandla (115 Kg/Day), Balaghat (172 Kg/Day), Anuppur (87.49 Kg/Day), and Dindori (52 Kg/Day)—display moderate to low biomedical waste loads. In these territories, strengthening decentralized waste management, staff training, and compliance monitoring can prevent future escalations as healthcare demand grows.

## 6.2 Middle Basin

The Map shown in **Fig. 31** represents daily biomedical waste generation (Kg/Day) across the districts of the Narmada Middle Basin, highlighting regions where management and containment of medical waste are especially crucial. Khargone (368.97 kg/day), Nandurbar (553 kg/day), and Jhabua (207.3 kg/day) are the most prominent hotspots for biomedical waste production, illustrated with the darkest orange on the map. These districts likely feature significant healthcare infrastructure, including hospitals and clinics, and serve as central nodes for medical services in the region. This necessitates robust biomedical waste management facilities to prevent environmental and public health hazards associated with improperly handled infectious and hazardous medical materials. Khandwa (297.47 kg/day), Dewas (273.33 kg/day), Burhanpur (260.62 kg/day), Narmadapuram (310.6 kg/day), Betul (243.55 kg/day), Dhar (201.1 kg/day), Barwani (184.59 kg/day), Alirajpur (190 kg/day), Sehore (190.17 kg/day), and Indore (29 kg/day) all contribute substantially to the biomedical waste load. While not as extreme as the primary hotspots, these districts require consistent attention with waste segregation, timely collection, and secure treatment systems. Districts such as Chhota Udepur (0.25 kg/day), Harda (85 kg/day), and Raisen (95.35 kg/day) produce lower quantities, shown in the lightest shades. Although risk intensity is lower, the presence of any untreated biomedical waste can still pose health and ecological risks, suggesting a need for foundational waste management frameworks and periodic monitoring.

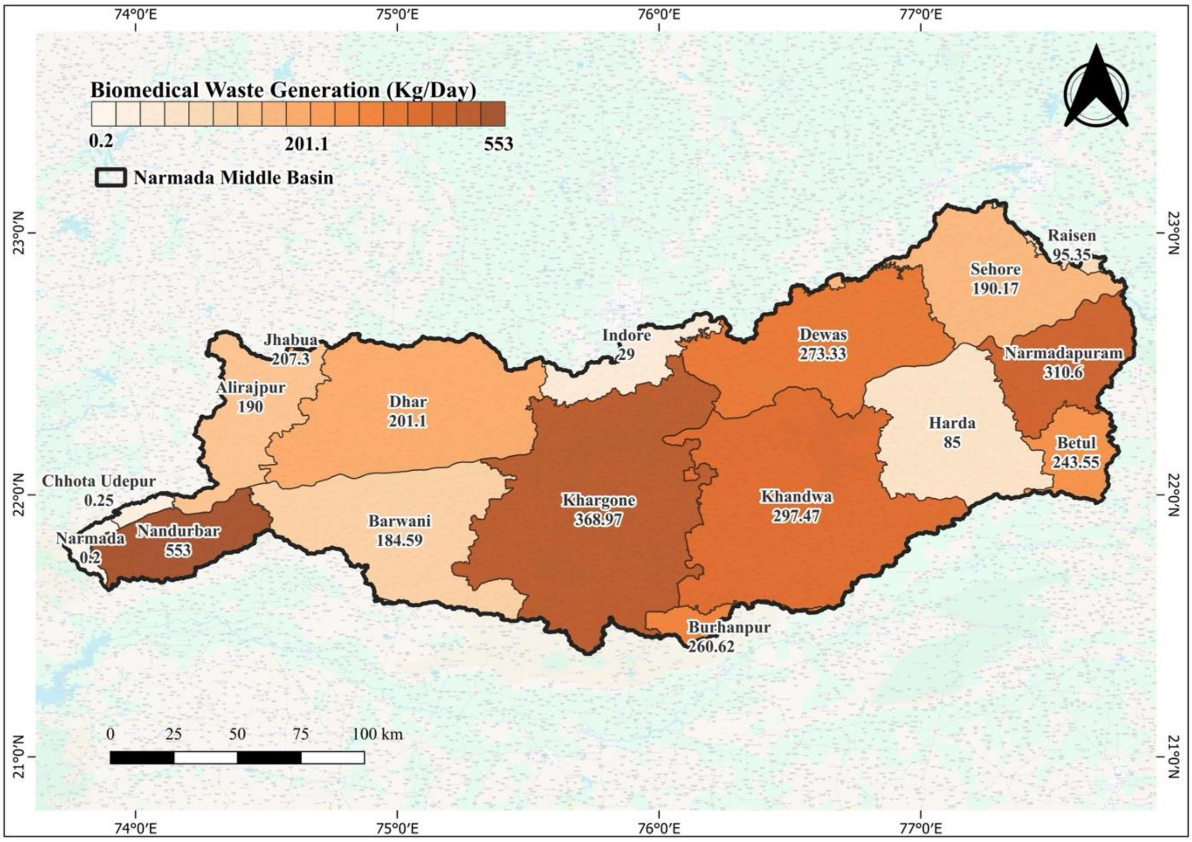


***Figure 31 District-wise Biomedical Waste Generation (Kg/Day) in the Narmada Middle Basin***

**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

Khargone, Nandurbar, and Jhabua are critical hotspots, demanding prioritized and sophisticated biomedical waste management solutions. Secondary hotspots must maintain steady increases in capacity and coverage as healthcare services expand. Peripheral regions should initiate best practices and ongoing monitoring to prevent risk escalation and safeguard local communities. The spatial analysis enables targeted actions for improved human and environmental safety across the Narmada Middle Basin. This map illustrates biomedical waste generation in the districts of the Narmada Middle Basin, with daily loads (in kg/day) visualized to highlight key hotspots where health infrastructure and population density drive substantial medical waste production.

## 6.3 Lower Basin

Biomedical waste management in Bharuch district is well-organized, as shown in **Fig. 32**. The district has 292-bedded and 688 non-bedded healthcare facilities, totaling 827 authorized units. The Globe Bio Care CBWTF in Ankleshwar serves the entire district. It has an incinerator with 100 kg/hr capacity, an autoclave of 50 kg/hr, and a shredder of 50 kg/hr. About 27,200 kg/day of biomedical waste is generated in the district and fully treated. While treatment capacity is sufficient, barcoding is not yet implemented, though GPS tracking is installed in trucks. Awareness and training programs for healthcare staff are ongoing. Currently, wastewater from healthcare facilities is discharged into municipal drains, but a proposed STP in Ankleshwar is expected to treat this wastewater by December 2022.

There is no CBWTF in the Narmada district, so waste is sent to Globe Bio Care in Bharuch. About 200 kg/day of biomedical waste is generated and treated daily. Tracking is poor, with only 10% barcode coverage. Government facilities will implement barcoding by December 2023. Training and awareness are conducted regularly. Wastewater is managed via septic tanks, with improvements planned by December 2023.

Chhota Udepur district has 98-bedded and 142 non-bedded facilities, of which 195 are authorized. About 250 kg/day of biomedical waste is generated and sent to Samvedana BMW Incinerator at Halol, where all waste is scientifically treated. Barcoding has been implemented, but regular staff training and monitoring are needed.

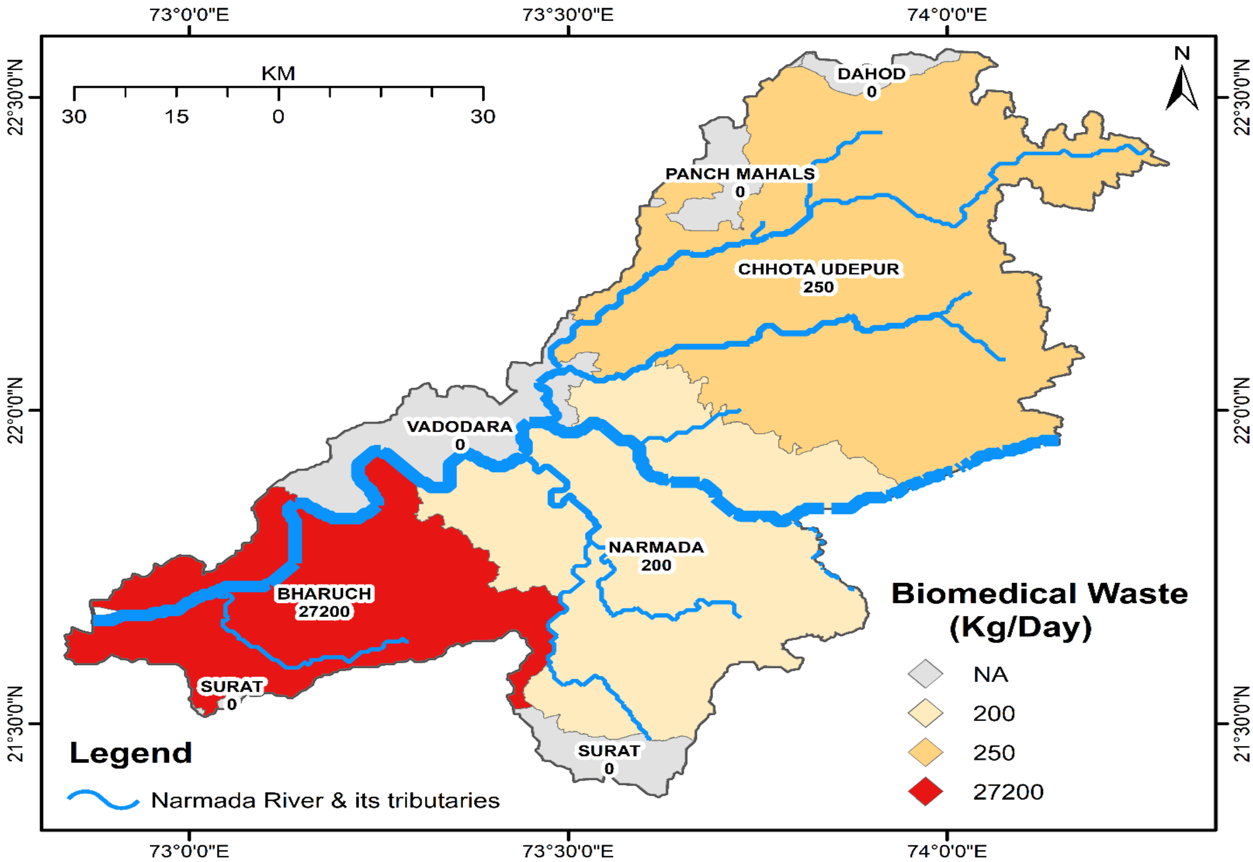


*Figure 32 District-wise Biomedical Waste Load in Lower Narmada Basin*

*Source: Gujarat Pollution Control Board (GPCB).. District Environmental Plans (DEPs)*

# 7 Status of Plastic Waste Generation in the Basin

## 7.1 Upper Basin

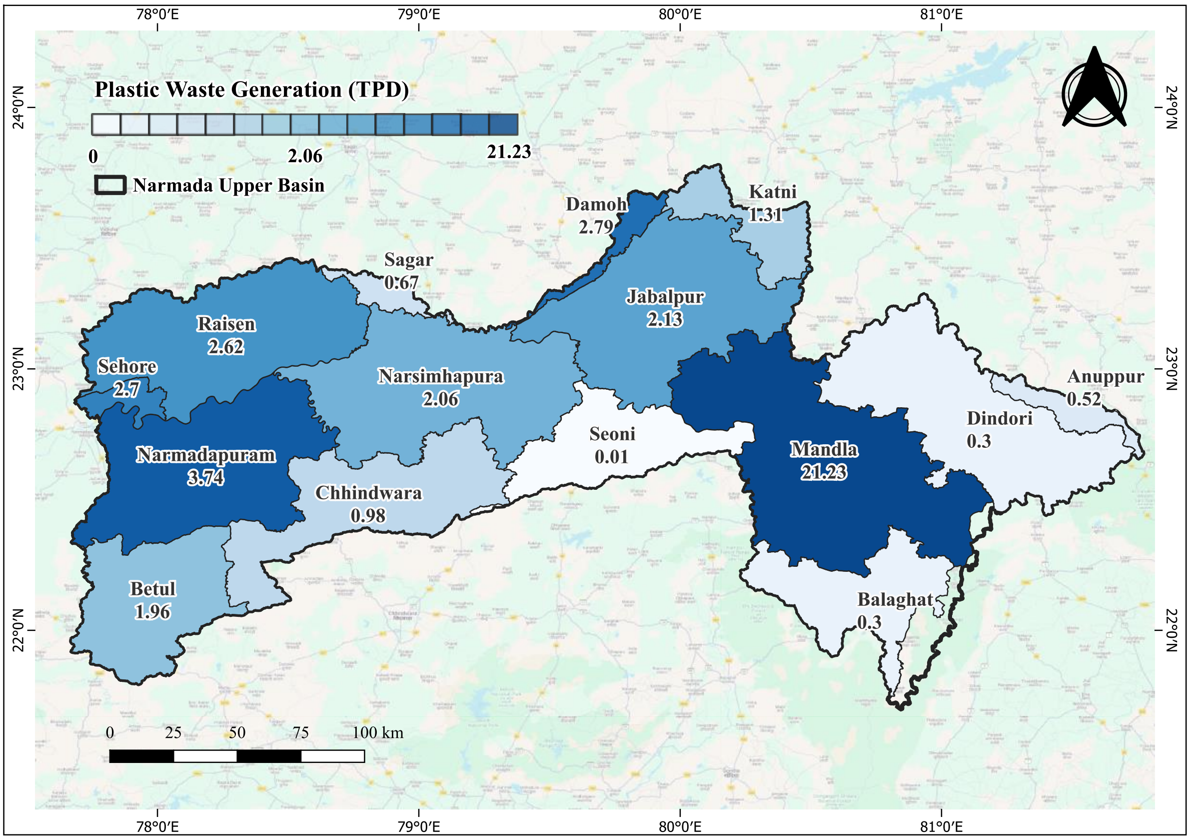


***Figure 33 District-wise Plastic Waste Generation (TPD) in the Narmada Upper Basin***
**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

The Map shown in **Fig. 33** visualizes plastic waste generation across districts in the Narmada Upper Basin, Madhya Pradesh, India, measured in Tons Per Day (TPD), offering insight into the regions facing the most significant plastic waste management pressures.

Mandla district emerges as the dominant hotspot, generating 21.23 TPD of plastic waste marked by the darkest blue shade on the map. This exceptionally high figure suggests concentrated urban activity, prevalent market networks, and substantial consumer usage of plastic products, revealing an urgent need for targeted interventions in plastic collection, recycling, and reduction initiatives. Narmadapuram (3.74 TPD), Sehore (2.7 TPD), Damoh (2.79 TPD), Raisen (2.62 TPD), Jabalpur (2.13 TPD), Narsimhapura (2.06 TPD), and Betul (1.96 TPD) form a secondary ring of moderate plastic waste generators. These districts foster both urban and peri-urban settlements, indicating growing plastic use associated with commercial activities and changing lifestyles. Focused awareness campaigns, improved segregation infrastructure, and extended producer responsibility (EPR) mechanisms are essential here. Other districts demonstrate comparatively minimal plastic waste output Katni (1.31 TPD), Chhindwara (0.98 TPD), Sagar (0.67 TPD), Anuppur (0.52 TPD), Dindori (0.3 TPD), Balaghat (0.3 TPD), and Seoni (0.01 TPD). These areas, painted in lighter shades, support limited urbanization and industrialization, but should still integrate preventive measures and scalable recycling infrastructure to address incremental rises as development proceeds. Mapping plastic waste hotspots aids regional authorities, municipal bodies, and community organizations in tailoring solutions. It prioritizes Mandla for immediate action, with secondary districts poised for scalable pilot programs. Participatory approaches such as public-private partnerships (PPP), waste pickers' empowerment, and implementation of plastic alternatives can amplify region-specific impact.

## 7.2 Middle Basin

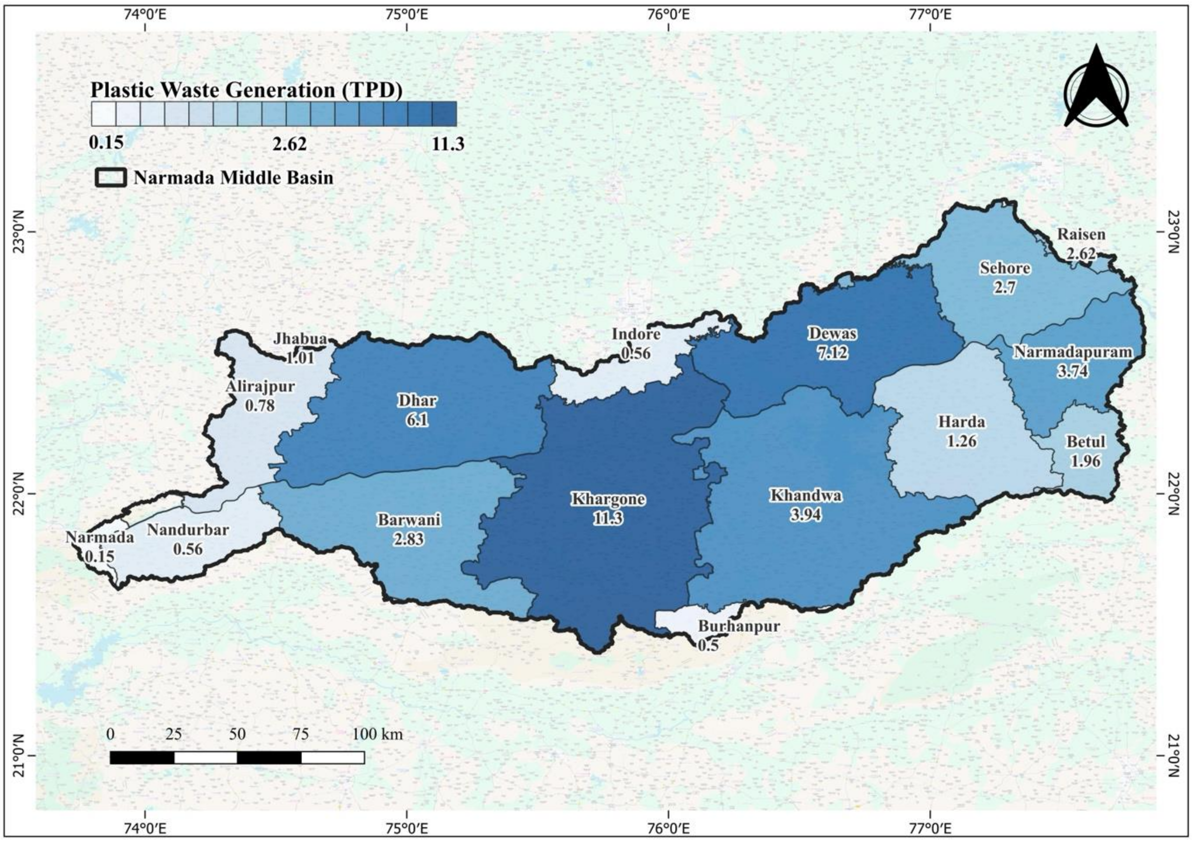


***Figure 34 District-wise Plastic Waste Generation (TPD) in the Narmada Middle Basin***

**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

The Map shown in **Fig. 34** depicts the generation of plastic waste (in Tons Per Day) across the districts of the Narmada Middle Basin, highlighting areas with significant plastic pollution challenges and variation in plastic consumption patterns. Khargone (11.3 TPD) and Dewas (7.12 TPD) are the most pronounced plastic waste generation hotspots, indicated with the darkest blue shade. These districts have robust marketplaces, expanding urbanization, and high rates of packaged consumption, all contributing to larger volumes of discarded plastic. Addressing these loads requires investment in plastic collection systems, large-scale material recovery facilities, and public awareness drives targeting reduction and recycling. Dhar (6.1 TPD), Narmadapuram (3.74 TPD), Barwani (2.83 TPD), Khandwa (3.94 TPD), Raisen (2.62 TPD), Sehore (2.7 TPD), Betul (1.96 TPD), and Harda (1.26 TPD) generate moderate quantities. These areas reflect a blend of urban-rural transition and require a proactive approach strengthening door-to-door plastic collection, promoting alternatives, and supporting decentralized recycling initiatives. Burhanpur (0.5 TPD), Indore (0.56 TPD), Nandurbar (0.56 TPD), Alirajpur (0.78 TPD), Jhabua (1.01 TPD), and Narmada (0.15 TPD) fall in the lowest range, shown in the lightest blue. Their lower levels suggest a dominant rural character or effective waste minimization, but they should prioritize early adoption of anti-littering campaigns and small-scale recycling programs to prevent future accumulation.

## 7.3 Lower Basin

Plastic waste generation in Bharuch district is high, as shown in **Fig. 35**, and management faces many challenges.

Bharuch Nagarpalika generates about 7 TPD of plastic waste. Panchayats together produce 480 kg/day, and gram panchayats produce 11 kg/day. Door-to-door collection in panchayats is only 74%, leaving gaps, while in nagarpalikas, collection exists but needs improvement. Organized collection at transfer points or material recovery facilities (MRFs) is partially operational at the panchayat level. Bharuch has started developing such facilities.

Ankleshwar Nagarpalika generates about 3 TPD of plastic waste. Door-to-door collection of dry waste, including plastics, has begun but is not yet 100% complete. Segregation and organized collection at transfer points are under development. Ankleshwar currently does not have a plastic waste collection centre, but one will be set up once land is allocated, targeted for December 2022. Currently, collected plastic waste is sent directly to the dump site. Awareness and education programs are at an early stage but will be continuous, implemented by the Nagarpalika, District Education Office, and Special Taskforce Committee. Facilities for disposal and recycling are available.

Rajpipla Nagarpalika generates about 2 TPD of plastic waste. At the block and taluka level, 150 kg/day is generated, and Gram Panchayats across 5 tehsils and 222 Gram Panchayats also generate 150 kg/day. Door-to-door collection of dry waste is 0% in villages, but town coverage is full. Only about 50% of plastic waste is collected at the village level. Gaps exist in collection, segregation, availability of centers, and awareness. Plans include building compost pits, segregation sheds, and collection centers at the block level in collaboration with the Statue of Unity authority by March 2024.

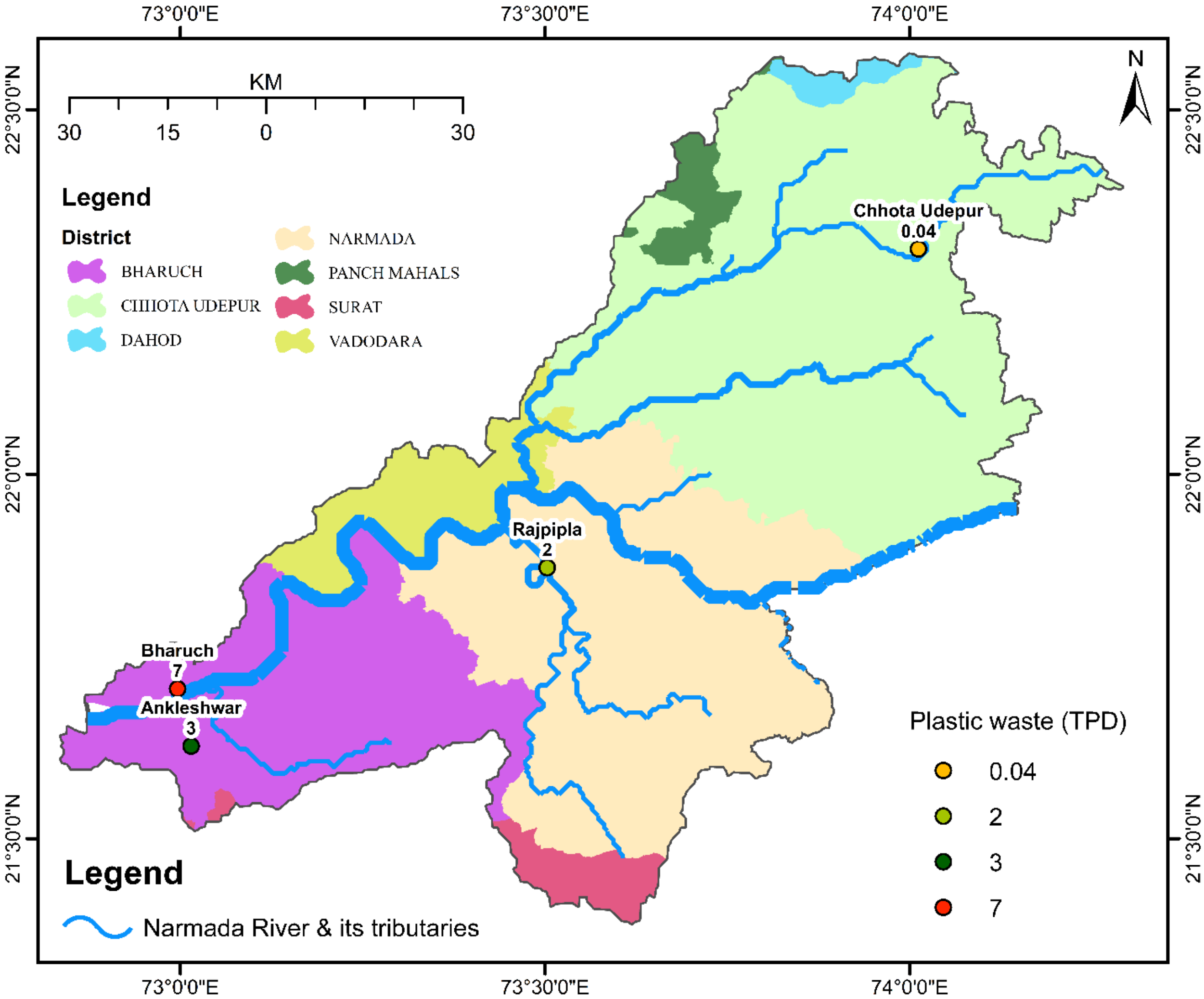


***Figure 35 Plastic Waste Generated City in the Lower Narmada Basin***

*Source: Gujarat Pollution Control Board (GPCB).. District Environmental Plans (DEPs)*

Chhota Udepur generates about 0.040 TPD of plastic waste, mostly from municipal areas, with Chhota Udepur town as the main contributor. Door-to-door collection is not fully operational, and organized collection at transfer points or MRFs is limited. Plastic waste collection centers are insufficient, and public awareness is low. Plans focus on achieving 100% door-to-door collection, establishing MRFs, and linking with recyclers and cement plants for co-processing..

# 8 Status of C&D Waste Generation in the Basin

## 8.1 Upper Basin

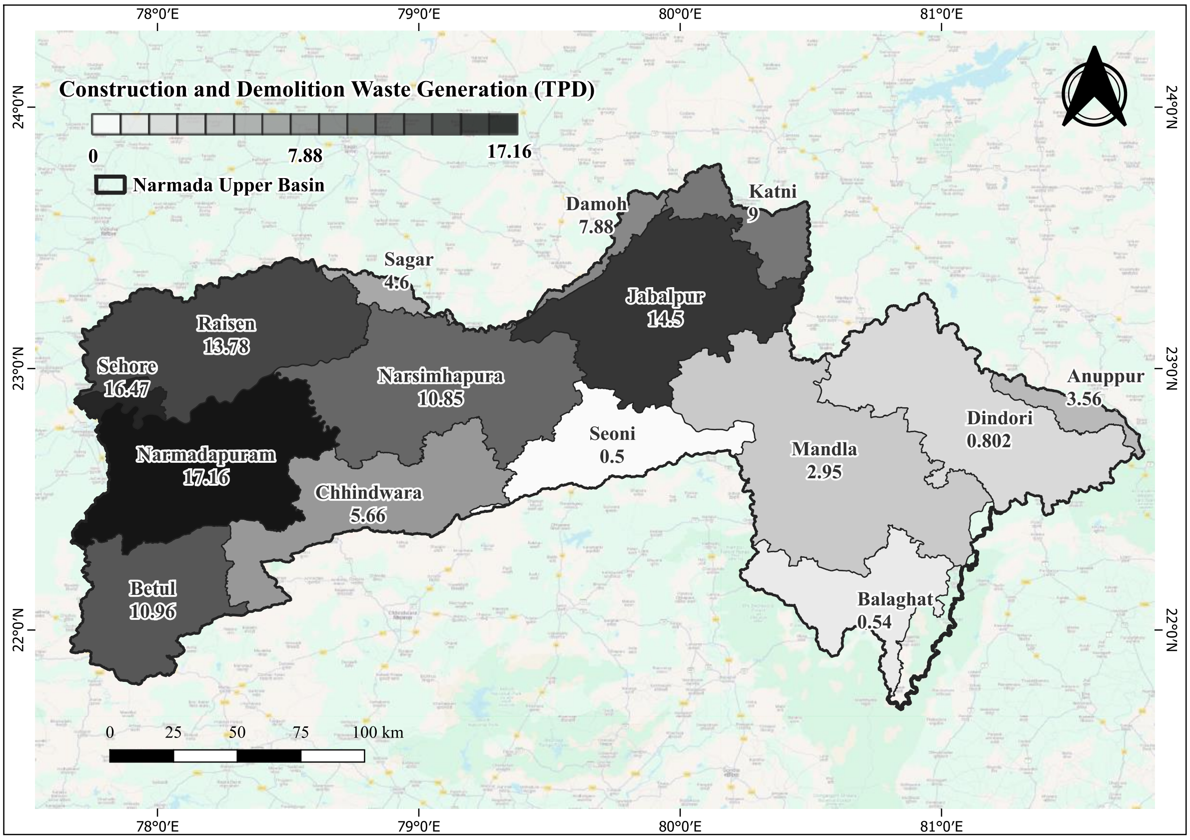


***Figure 36 District-wise Construction and Demolition Waste Generation (TPD) in the Narmada Upper Basin, highlighting major and minor hotspots.***

**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

The Map shown in **Fig. 36** depicts the spatial distribution of construction and demolition (C&D) waste generation across the districts of the Narmada Upper Basin, Madhya Pradesh, India, with waste quantities expressed in Tons Per Day (TPD). The varying shades of gray illustrate the intensity of C&D waste generation, allowing identification of key hotspots. The western and central districts stand out as hotspots for C&D waste, with Narmadapuram (17.16 TPD), Sehore (16.47 TPD), Betul (10.96 TPD), Raisen (13.78 TPD), and Jabalpur (14.5 TPD) displaying the darkest tones on the map. These areas are marked by robust urban expansion, infrastructural activities, and significant real estate or industrial development. Such high levels of C&D waste require sustainable construction practices, efficient debris removal systems, and dedicated recycling facilities to reduce landfill pressure and support circular economy ambitions. Katni (9 TPD), Damoh (7.88 TPD), Narsimhapura (10.85 TPD), and Chhindwara

(5.66 TPD) form a secondary band of moderate waste generation, representing zones with advancing urbanization and incremental construction projects. These districts can benefit from targeted awareness programs on C&D waste minimization and incentivized recycling schemes. A majority of the eastern and southern districts, including Anuppur (3.56 TPD), Dindori (0.802 TPD), Balaghat (0.54 TPD), Mandla (2.95 TPD), and Seoni (0.5 TPD), are characterized by lighter shades, indicating low daily generation of C&D waste. These areas exhibit relatively limited construction activity, likely due to smaller urban footprints and less intensive infrastructure development.

## 8.2 Middle Basin

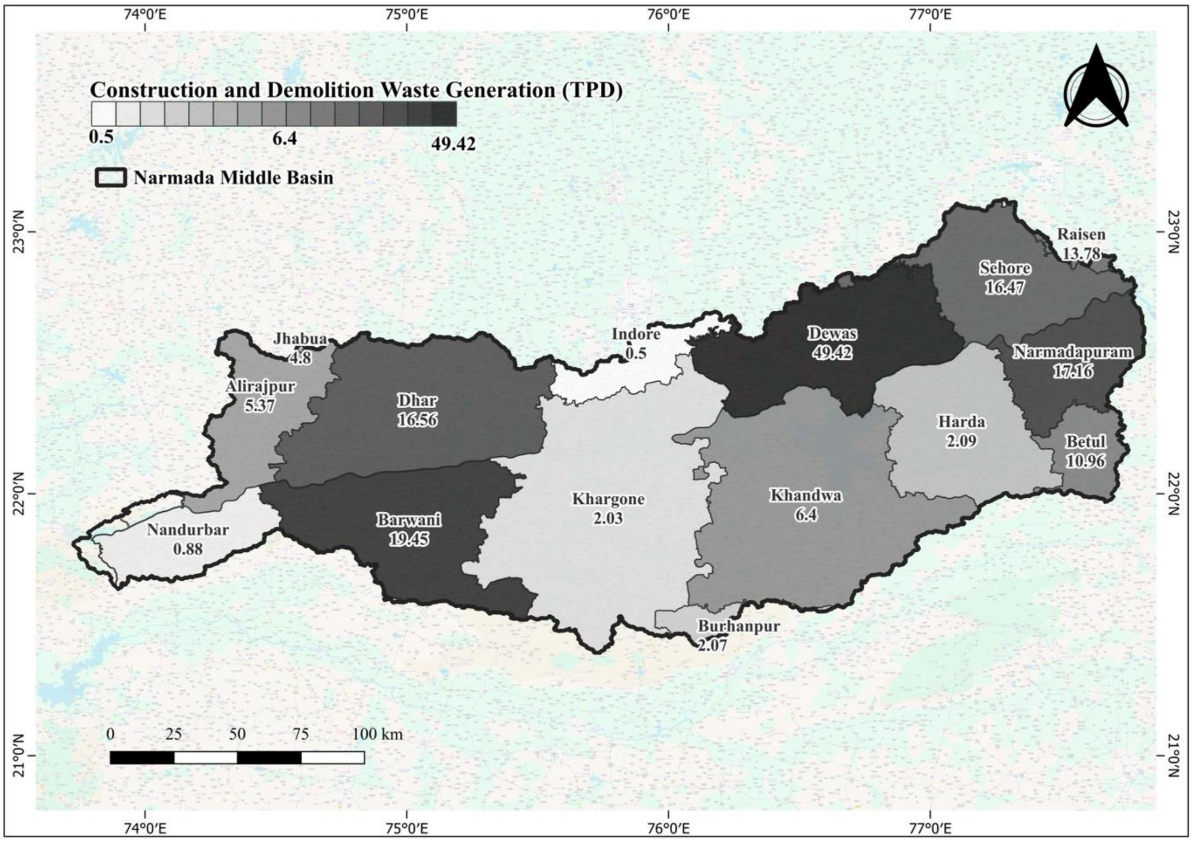


***Figure 37 District-wise Construction and Demolition Waste Generation (TPD) in the Narmada Middle Basin, highlighting major and minor hotspots.***

**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

The Map shown in **Fig. 37** presents construction and demolition (C&D) waste generation across districts in the Narmada Middle Basin, quantified in tons per day (TPD). The distribution is visually represented in shades of gray, highlighting regions with higher and lower waste generation. Dewas district is the top contributor, generating 49.42 TPD, indicating significant construction and demolition activities.  Large volumes are also generated in Barwani (19.45

TPD), Sehore (16.47 TPD), Dhar (16.56 TPD), Narmadapuram (12.16 TPD), Raisen (13.78 TPD), and Betul (10.96 TPD), identifying these areas as construction hotspots within the basin. Districts like Khandwa (6.4 TPD), Alirajpur (5.37 TPD), Jhabua (4.8 TPD), Khargone (2.03 TPD), Harda (2.09 TPD), Burhanpur (2.07 TPD), Nandurbar (0.88 TPD), and Indore (0.5 TPD) represent zones with less intense C&D activity. The gradient from light to dark gray efficiently communicates areas of waste generation concern, aiding in prioritization for management interventions.

## 8.3 Lower Basin

Bharuch district produces a large amount of C&D waste, as shown in **Fig. 38**. Bharuch city generates around 5 TPD of C&D Waste. There is no recycling facility yet, but a project report has been prepared to build one at Saykha GIDC. C&D waste is already being used in road pavements, with full implementation planned by June 2024. Ankleshwar produces about 0.5 TPD of C&D waste. There is no recycling facility or designated deposition site. Waste is collected using vans, and some is used for road filling and landfilling. Awareness programs are conducted regularly. Rajpipla generates around 0.5 TPD of C&D waste. No recycling facilities or deposition points exist yet. Plans include identifying sites by December 2022, introducing user fees, and controlling bulk waste generation. Recycled C&D waste is not yet used, but maybe in the future, and awareness activities are planned. Chhota Udepur produces about 0.5 TPD of C&D waste. Recycling facilities exist, but separate collection and deposition points are not well established. Plans focus on creating common deposition points, using recycled waste for paving and rural roads, and awareness campaigns for contractors and communities.

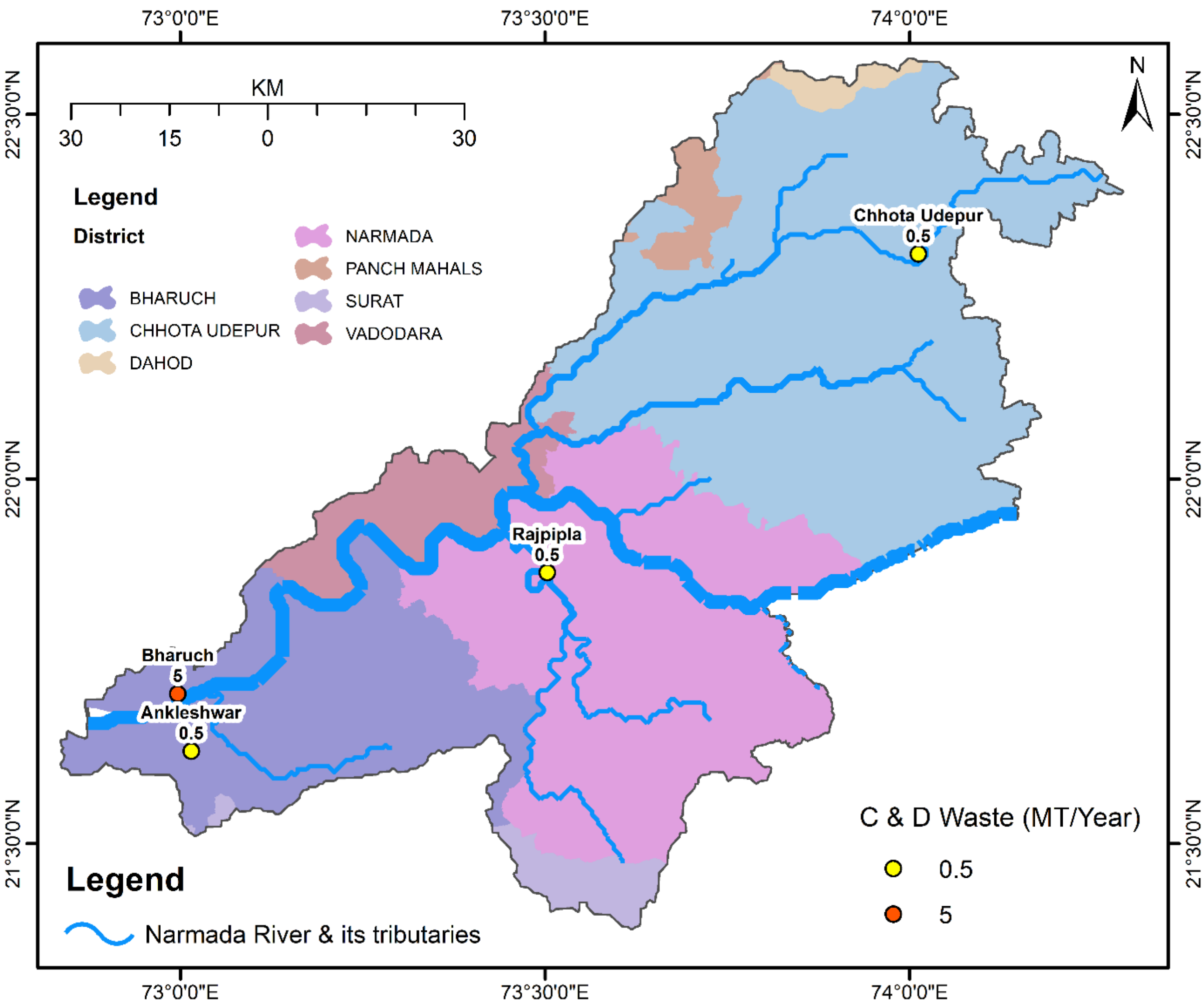


***Figure 38 C&D Waste Generated City in the Lower Narmada Basin***

*Source: Gujarat Pollution Control Board (GPCB).. District Environmental Plans (DEPs)*

# 9 E-Waste

## 9.1 Upper Basin

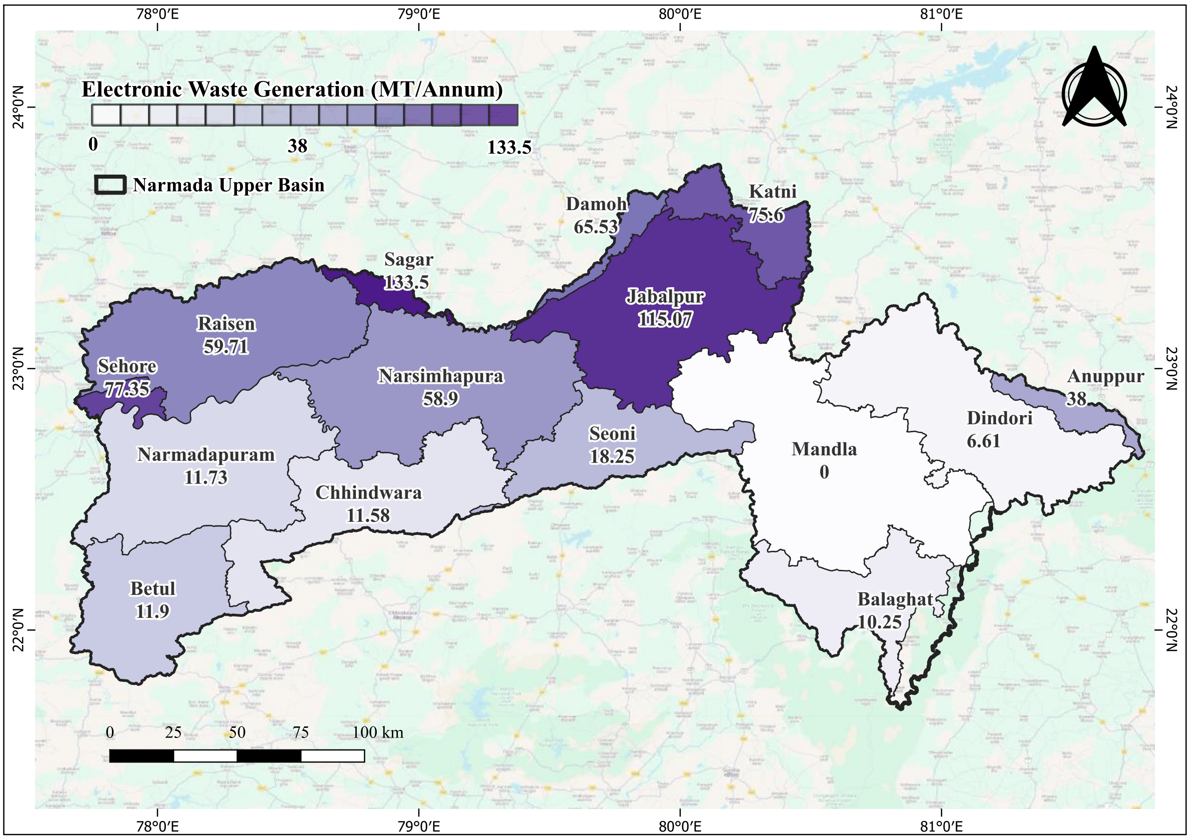


***Figure 39 District-wise Electronic Waste Generation (MT/Annum) in the Narmada Upper Basin, highlighting hotspots and data gaps***

**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

The Map shown in **Fig. 39** offers a detailed view of electronic waste (e-waste) generation across the districts of the Narmada Upper Basin, Madhya Pradesh, India, quantified in metric tons per annum (MT/annum) and visualized by district hotspot intensity. The highest concentrations of e-waste appear in Sagar (133.5 MT/annum), Jabalpur (115.07 MT/annum), Katni (75.6 MT/annum), Sehore (77.35 MT/annum), and Damoh (65.53 MT/annum), highlighted in the darkest colors. These districts reflect urbanization patterns, higher population density, and greater penetration of electronics, underscoring the urgent need for dedicated e-waste collection facilities, formal recycling systems, and public awareness campaigns about safe disposal practices. Raisen (59.71 MT/annum), Narsimhapura (58.9 MT/annum), Chhindwara (11.58 MT/annum), Betul (11.9 MT/annum), and Seoni (18.25 MT/annum) fall into the moderate generation category. While their outputs are not as high as principal hotspots, progressive localization of e-waste recycling infrastructure, repair initiatives, and effective involvement of informal waste pickers can prevent environmental contamination and health hazards from improper e-waste disposal. Several districts, including Balaghat (10.25 MT/annum), Narmadapuram (11.73 MT/annum), Anuppur (38 MT/annum), and Dindori (6.61 MT/annum), contribute much less e-waste, shown in lighter colors. Mandla reports 0 MT/annum, possibly due to low urbanization and minimal electronic usage. These districts can scale best practices as digital inclusion rises, focusing early on collection, refurbishment, and community sensitization measures.

Sagar, Jabalpur, Katni, Sehore, and Damoh function as e-waste generation hotspots and merit the highest priority for infrastructure provisioning and digital waste management policy. Moderate generators, including Raisen, Narsimhapura, Chhindwara, Betul, and Seoni, require scalable, community-led e-waste handling solutions. Low-output districts benefit from early engagement and inclusivity in e-waste planning, preparing them for future growth as electronic access expands. The map represents spatial intelligence for prioritizing investment and interventions around e-waste sustainability in the Narmada Upper Basin.

## 9.2 Middle Basin

The Map shown in **Fig. 40** displays district-wise annual electronic waste (e-waste) generation across the Narmada Middle Basin, identifying major urban and semi-urban hotspots. Indore dominates e-waste generation with 51,115.53 MT/year, far surpassing all other districts, and is followed by Dewas (89.92 MT), Sehore (77.35 MT), Jhabua (66.62 MT), and Raisen (59.71 MT). These areas are heavily urbanized, with high rates of digital device consumption and disposal. Such massive figures pose urgent environmental management challenges, highlighting the need for formal collection centers, specialized processing units, and strict regulation to prevent informal or unsafe recycling. Barwani (77.2 MT), Alirajpur (41.7 MT), Burhanpur (43.4 MT), and Nandurbar (41.7 MT) represent districts in transition, where increasing adoption of electronics is rapidly enlarging e-waste streams. Public awareness campaigns and the establishment of take-back programs could arrest the growth of unsafe handling practices and boost the recovery of valuable materials. Districts such as Betul (11.9 MT), Narmadapuram (11.73 MT), Khandwa (18.73 MT), Khargone (21.6 MT), Dhar (28.56 MT), and Harda (33 MT) have comparatively lower e-waste generation rates

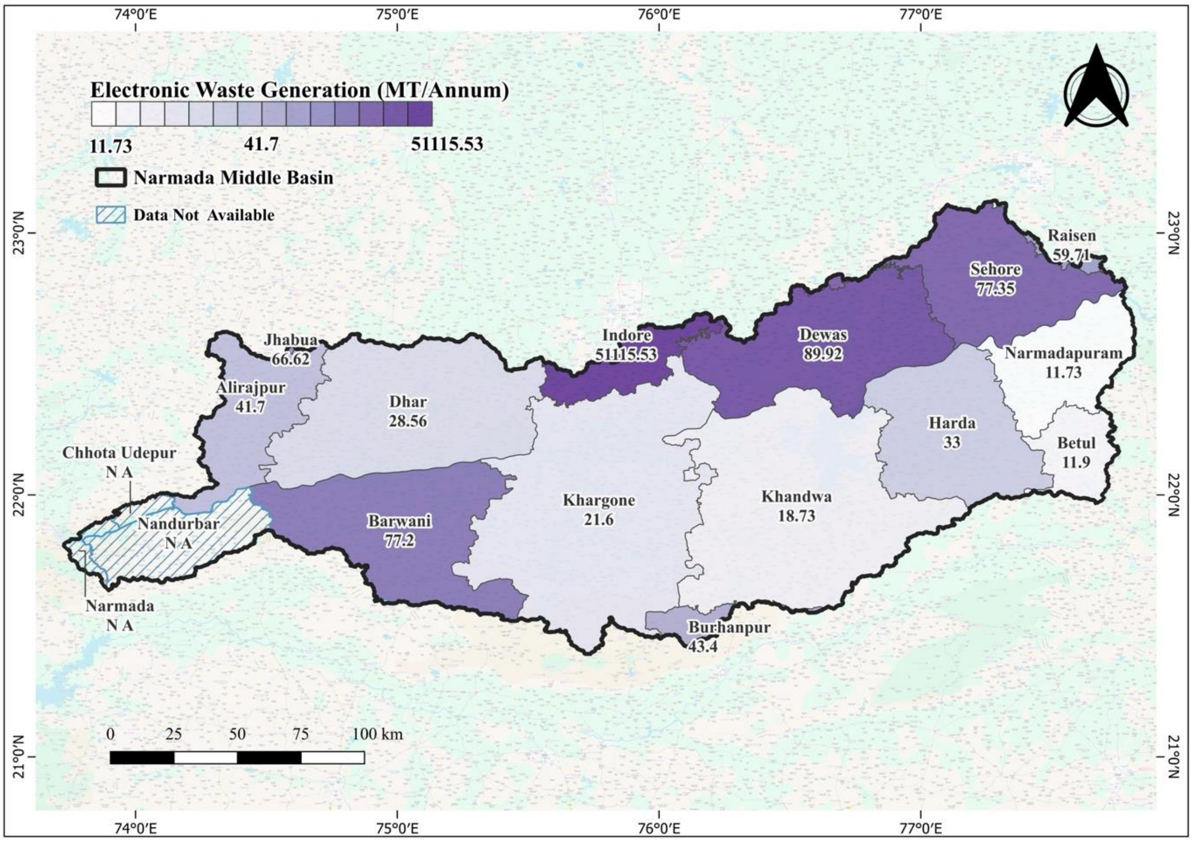


***Figure 40 District-wise Electronic Waste Generation (MT/Annum) in the Narmada Middle Basin, highlighting hotspots and data gaps.***

**Source: Madhya Pradesh Pollution Control Board (MPPCB). (2025). District Environmental Plans (DEPs)*

Indore is by far the largest e-waste hotspot, Dewas, Sehore, Jhabua, Raisen, and Barwani are key secondary hotspots where investments in management infrastructure are crucial. Ramp-up in emerging and low-load districts by education and system-building is needed to address the issue before it scales up. Regional policies should prioritize collection, recycling, and pollution control, ensuring responsible e-waste management for human and environmental health.

## 9.3 Lower Basin

E-waste management in the lower Narmada basin is weak, as shown in **Fig. 41**. In Bharuch, around 4,480 MT of e-waste is produced each year. There are no collection centers or authorized recyclers. Plans are in place to set up collection points, make an inventory, and run awareness programs starting in December 2022.

In the Narmada district, E-waste quantity of E-waste has not yet been measured. There are no collection centers or recyclers. Collection points were made in August 2022, linked with recyclers, and awareness campaigns will involve different stakeholders.

In Chhota Udepur, no official e-waste inventory exists, and there are no collection centers or recyclers. The plan includes making an inventory, establishing collection centers at municipal and block levels, linking with nearby recyclers, and raising public awareness to stop informal dismantling.

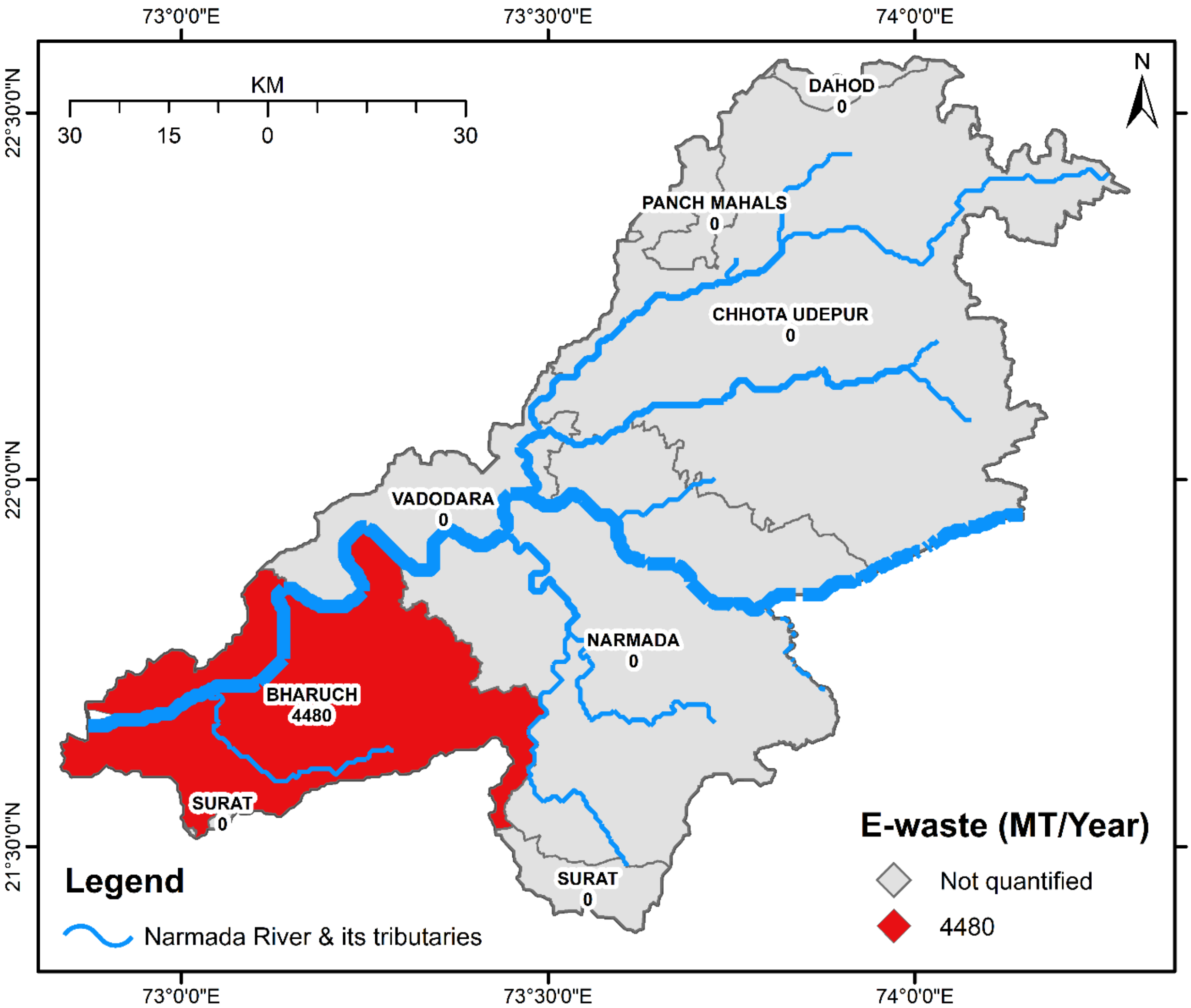


***Figure 41 District-wise E-waste Load in Lower Narmada Basin***

**Source: Gujarat Pollution Control Board (GPCB).. District Environmental Plans (DEPs)*

# 10 Summary and Conclusions

The pollution load mapping of the Narmada River Basin highlights significant pressures from domestic sewage, industrial effluents, solid waste, hazardous waste, biomedical waste, plastic waste, and e-waste across both the Upper and Middle Basins. While urban centers such as Jabalpur, Sehore, and Narmadapuram exhibit high Biochemical Oxygen Demand (BOD) and fecal coliform counts, reflecting untreated sewage discharge. Jabalpur leads in domestic sewage generation, while Narsimhapur and Betul are major industrial effluent contributors, yet many districts lack adequate sewage treatment plants, resulting in direct wastewater inflows into the river. Solid waste hotspots include Jabalpur, Raisen, and Khargone, whereas hazardous waste is concentrated in Sehore, Sagar, Dhar, and Indore. Biomedical waste generation peaks in Jabalpur, Katni, and Khargone, with plastic waste highest in Mandla, Khargone, and Dewas, while Indore dominates e-waste generation. The findings emphasize the urgent need for strengthening wastewater treatment infrastructure, enforcing pollution control in industrial zones, and promoting sustainable waste management practices to safeguard the ecological and public health integrity of the Narmada River Basin.

The pollution profile of the Lower Narmada Basin presents a clear picture of contrasting pressures between industrial hubs, urban centers, and rural areas. Industrialization is the most dominant factor, with Bharuch and Ankleshwar collectively discharging over 230 MLD of wastewater from chemical, pharmaceutical, and petrochemical units. While Common Effluent Treatment Plants (CETPs) and in-house treatment facilities exist, about 42 MLD of treated effluent continues to enter rivers and drains, posing ecological risks. Smaller industrial centers like Rajpipla and Chhota Udepur generate limited effluents, which are mostly treated within premises.

Domestic sewage adds another layer of pressure. Bharuch town alone produces nearly 30 MLD of sewage, followed by Ankleshwar, Rajpipla, and Chhota Udepur. Most towns are now equipped with modern STPs, but gaps in sewerage coverage and bypassing during peak flows remain challenges. In contrast, rural settlements rely on septic tanks, leaching pits, and open drains. Though the rural volumes are smaller, the absence of monitoring and scientific treatment creates localized contamination, especially near tributaries.

Solid waste management shows a similar pattern. Bharuch and Ankleshwar contribute large quantities of municipal waste, while smaller towns like Rajpipla and Chhota Udepur generate less. Rural Narmada produces only about 0.3 TPD of waste, but due to poor segregation and collection, even this small load leads to scattered pollution. Hazardous waste generation is overwhelmingly concentrated in Bharuch and Ankleshwar, while Narmada and Chhota Udepur contribute negligible amounts. Biomedical waste is generally well managed through Common Biomedical Waste Treatment Facilities (CBWTFs), though rural health centers still depend on neighboring districts for treatment.

Plastic waste, construction and demolition (C&D) waste, and e-waste remain underdeveloped areas of management. Bharuch produces the highest quantities, but rural Panchayats also contribute significant amounts of unsegregated plastic waste, which lacks proper collection and recycling systems. C&D waste recycling is in its infancy, with most waste used informally for filling. E-waste management is the weakest link, with inventories and collection points still in planning stages across most towns and rural areas.

***Table 7 Pollution Hotspot Matrix, Lower Narmada Basin***

| District / Area | Hotspot Locations | Major Sources | Pollution Intensity | Key Observations |
|---|---|---|---|---|
| Bharuch | Zadeshwar, Dahej, Vilayat, Bharuch town | Industrial effluents, urban sewage, hazardous waste, plastic | Very High | >126 MLD industrial wastewater, ~30 MLD sewage, 97 TPD solid waste; 12.5 lakh MT hazardous waste/year |
| Ankleshwar | Ankleshwar GIDC, Panoli GIDC | Chemical & pharma industries, CETP discharges, municipal sewage | Very High | >104 MLD industrial effluent, 7.5 MLD sewage, 23.5 TPD solid waste; high hazardous waste load |
| Rajpipla (Narmada) | Rajpipla town, Kevadiya (tourism hub) | Domestic sewage, small textile & agro-industries, plastic waste | Moderate | 5.5 MLD sewage (STP exists), ~10 TPD solid waste, ~2.5 MLD industrial wastewater; rural Panchayats generate ~0.3 TPD scattered waste |
| Chhota Udepur | Chhota Udepur town, small clusters | Domestic sewage, small industries, poor solid waste management | Low–Moderate | 4 MLD sewage, 5 MLD STP, ~4 TPD solid waste, ~0.1 MLD industrial wastewater; scattered plastic waste |
| Rural Basin | Villages along | Untreated | Diffuse & | No centralized STPs; ~0.3 |

| | | | | |
|---|---|---|---|---|
| (Narmada & Bharuch GPs) | tributaries and drains | household wastewater, septic tank effluent, scattered solid/plastic waste | Low | TPD rural solid waste; ~150–480 kg/day rural plastic waste not collected properly |

Pollution Hotspots in the Lower Narmada Basin are concentrated in Bharuch and Ankleshwar, where a dense cluster of industries, urban sewage, and hazardous waste disposal create significant stress on the river. Zadeshwar and Zanor monitoring stations downstream of these hubs consistently record poor water quality, reflecting cumulative impacts. Rajpipla and Chhota Udepur represent secondary hotspots, where domestic sewage and poor solid waste management contribute localized contamination, though at a smaller scale. Rural Panchayats, while less polluting in absolute terms, form diffuse hotspots due to untreated wastewater and scattered solid/plastic waste entering drains and tributaries.

In conclusion, the Lower Narmada Basin exhibits a dual pollution scenario (*Table 7)*. On one side, Bharuch and Ankleshwar face acute challenges from industrial effluents, hazardous waste, and urban sewage. On the other, smaller towns and rural areas generate relatively low pollution but struggle with inadequate infrastructure for sewage treatment, waste segregation, and monitoring. Addressing pollution in this region requires an integrated management strategy that strengthens industrial compliance, expands urban STPs, introduces rural sanitation systems, and develops systematic waste collection and recycling facilities for plastic, C&D, and e-waste. Without such coordinated interventions, the cumulative pressures threaten to compromise the ecological health of the Narmada River in Gujarat.

Policy measures should focus on extending monitoring to unrecorded stations. improving CETP efficiency, expanding decentralized rural sanitation, and accelerating EPR-based systems for plastic and e-waste. A coordinated basin-level management framework is essential to safeguard the ecological health of the Lower Narmada.

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