International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Digitalization of Information on Sewage Treatment Facilities implemented under NGT in Mandya District

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ABSTRACT
The National Green Tribunal (NGT), a pivotal force in environmental protection, has identified 351 polluted river stretches across all states in India. These polluted locations are categorized into priority classes based on Biochemical Oxygen Demand (BOD) concentration. Understanding and addressing these identified polluted river stretches is crucial for restoring water quality and implementing appropriate action plans to mitigate pollution. In Karnataka, implementing agencies are creating infrastructure to prevent pollution of the river stretches as per the instructions of the Honorable National Green Tribunal. The current study, a significant contribution to the NGT's efforts, is focused on digitizing information about sewage treatment plants in the Mandya district using the QGIS software application. QGIS, a professional application built on Open-Source Software (FOSS) principles, is pivotal in digitizing assets by providing a platform for effectively managing spatial data, empowering us to make informed decisions. It is designed for viewing, editing, creating, evaluating, and publishing geospatial information. With its unique ability to address environmental challenges, this powerful tool is being utilized in the current study to digitize information about sewage treatment plants in the Mandya district, demonstrating the hopeful role of technology in addressing environmental challenges.

KEYWORDS: Digitalization; GIS; Sewage Treatment Plant; Mandya District; NGT

1. INTRODUCTION

The National Green Tribunal (NGT), established on 18 October 2010 under the National Green Tribunal Act of 2010, plays a crucial role in protecting and conserving the environment. In 2018, it identified 351 polluted river stretches across 28 States and 3 Union Territories based on the exceedance of the BOD river water quality criteria limit. As shown in Figure 1, this identification is a significant step in addressing the urgent need to restore water quality and mitigate pollution.

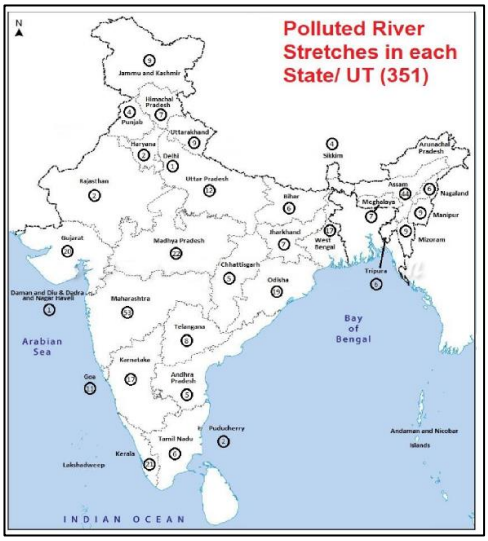


Figure 1: Polluted River Stretches as identified by NGT
(Source: NWMP)

The NGT has identified 17 river-polluted stretches in Karnataka and has instructed the government to prevent pollution by implementing underground drainage (UGD) systems in towns and cities along these stretches. The Urban Development Department and the Karnataka Urban Water Supply and Drainage Board (KUWSDB) are undertaking sewerage projects to achieve this objective. Regular inspections and meetings at the government level are being conducted to watch the progress of these projects. The authorities also continuously monitor information about sewage treatment plants (STPs) in these stretches to ensure their effectiveness and compliance with regulations. Information about the status, performance, and adequacy of various STPs in Karnataka must be integrated into a digital platform to streamline monitoring. In Mandya District, the NGT has identified three polluted stretches of River Cauvery as indicated in Table 1.

Table 1: Polluted Stretch of Cauvery River in Mandya District

Location of the Monitoring station	Priority class	Latitude	Longitude
1. Cauvery River at Sri Rangapattana, D/S of Road Bridge	**IV** (Monitoring locations having BOD between 6-10 mg/l.)	12.423705	76.693672
2. Cauvery at KRS Dam, Balamurikshetra		12.425291	76.57265
3. Cauvery at Satyagala Bridge		12.25531	77.163515

Figure 1: Polluted River Stretches as identified by NGT
(Source: NWMP)

The primary cause of pollution in the Cauvery River is the expansion of urban local bodies (ULBs) into new areas without proper underground drainage (UGD) systems, leading to untreated sewage being discharged into the river. Furthermore, the existing STPs do not meet the required discharge standards set by the NGT.

Digitizing information related to NGT projects is not just a necessity, but a crucial step for the government's review and monitoring process. The most suitable approach for this is using GIS applications to share and publish geospatial data as maps, online services, or print maps in various file formats. This digitalization of infrastructure projects in Mandya District will establish a central repository of information

that can be easily accessed and viewed as required, significantly enhancing the efficiency of the review and monitoring process.

2. LITERATURE REVIEW

The current study focuses on digitalizing information about the polluted Cauvery River stretch in Mandya District, sewage treatment plants in Mandya District, and asset mapping of Srirangapatna STP using QGIS. Several pieces of literature were reviewed throughout the study to obtain necessary guidance. GIS applications are extensive, and the tools available can help analyze and provide feasible solutions. It is a valuable tool for managing spatial data, covering its collection, storage, and processing.

In urban planning, GIS offers a distinct approach to comprehending spatial development and design and analyzing and modelling various processes and connections within a given area, thereby aiding in planning based on sustainable development principles (Xhafa & Kosovrasti, 2015).

GIS applications have been successfully used in the site suitability analysis for Sewage Treatment Plants, which provides several alternatives for siting sewage treatment plants based on well-defined spatial criteria (Agrawal et al., 2019).

GIS has become an essential tool for creating spatial distribution maps, which are valuable in various fields, including environmental engineering. For example, using GIS, it is possible to estimate water quality parameters at an unknown location based on known values, which can help assess the water quality of a specific area. Spatial distribution maps display the variation in concentrations of different chemical parameters. The spatial analyst module in GIS software uses the inverse distance weighted (IDW) raster interpolation technique to create these spatial distribution maps (DeepChand et al., 2022).

GIS is a powerful tool that can significantly reduce conflicts among conflicting interest parties by providing more and better information. GIS, a computer-based spatial analysis method applied to solid waste management, enables decision-makers to make better judgments by combining alternatives and preferences (Asefa et al., 2022).

GIS applications also aid in disaster management. Combining GIS and ML techniques helps identify the relationship between historical landslide points and conditioning elements, simplifying landslide prediction. In their research, Amen et al. (2022), explain that flood-vulnerable areas can be identified using remote sensing and geospatial methodology.

Integrating spatial and non-spatial databases in the Web-GIS highlights the GIS system's ability to effectively incorporate facility and space management and deliver information. According to Bahri et al. (2020), a sound facility management system can help institutions optimize space and asset utilization, ultimately leading to cost-efficient solutions in the long term.

The GIS application for monitoring environmental pollution has been developed by researchers using the open-source software Quantum GIS. Web-based GIS has several advantages, including being easy to operate, easily accessible and able to present data (spatial and non-spatial) in real-time. GIS is utilized in this study, combined with the decision-making system, using the Spatial Decision Support System (SDSS) criteria. The technology of web-based GIS is used in the application development of monitoring environmental pollution due to its being easily accessible and straightforward to operate by users from various professions and educational backgrounds (Anna et al., 2019).

GIS tools for land records management would be highly beneficial in India, where land issues are prevalent (Dhote et al., 2017). These tools can help solve infrastructure development hurdles and land acquisition problems and minimize duplication of land by providing people with proper records using GIS technology.

An example is the "DISHANK" application developed by the Karnataka Geographical Information System (KGIS), which is a valuable tool for accessing information about land survey numbers and records in the state. It aims to simplify the process of obtaining land-related information as per the Karnataka GIS mission.

According to research by Akbari et al. (2021), designing and implementing an environmental alerting and monitoring system using GIS applications is necessary. This system can provide essential information to make effective decisions, such as imposing traffic limitations, warning vulnerable individuals about hazardous times and locations, and ensuring public health and safety.

3. METHODOLOGY

The study involves Digitalizing the river Cauvery in Mandya District, mapping the polluted stretch, geo-mapping the STPs of Mandya District, and creating an asset map of the Srirangapatna STP. The methodology consisted of 6 stages, as indicated in Figure 2.

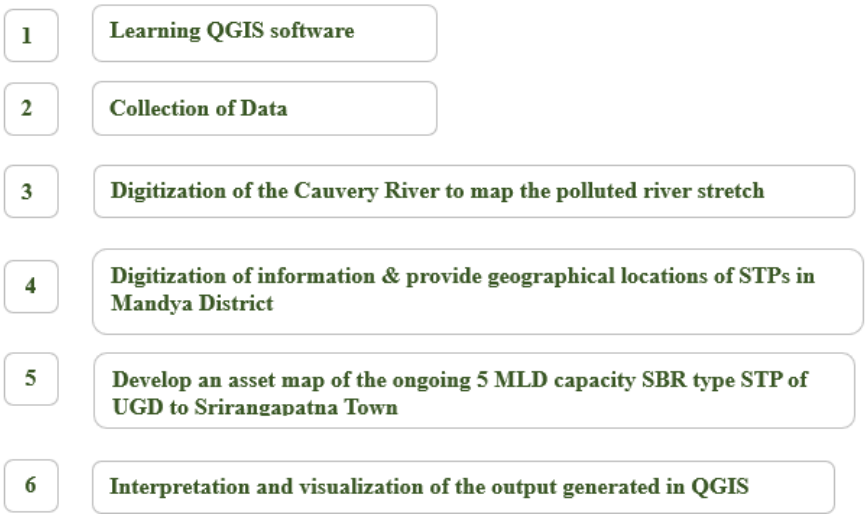


Figure 2: Methodology of Study

3.1 Data and Sources of Data

Primary data, namely photographs of the polluted locations and Sewage Treatment Plants, was obtained from the project sites. Supporting information was collected and collated from various sources such as the Karnataka State Pollution Control Board (KSPCB), Karnataka Urban Water Supply and Drainage Board (KUWSDB), KGIS website, DMA website and research papers.

4. THE STUDY

Mandya district is an administrative district in southern Karnataka, India. Its current population is about 18.5 lakhs. The district comprises seven taluks: Mandya, Maddur, Malavalli, Srirangapatna, Nagamangala, Krishnaraj Pete, and Pandavapura, as shown in Figure 3.

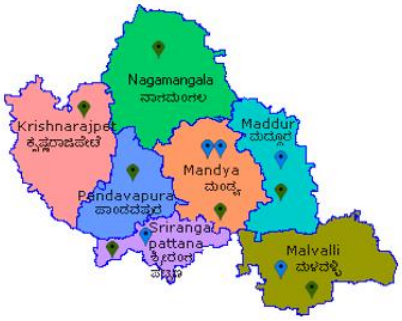


Figure 3: Mandya District Map
(Source: kfcsc.kar.nic.in)

The River Cauvery flows through the district for about 62 kilometres and is a significant water supply and irrigation source.

The current study involves digitalizing information on sewage treatment facilities, including creating a database with details of polluted stretches of the Cauvery River and STPs and developing an asset map for the ongoing SBR-type STP of the UGD to Srirangapatna Town under NGT projects.

The River Cauvery in Mandya District has been digitalized to locate the polluted river stretch and analyze the distribution of the critical parameters. As identified by NGT, the area of the polluted stretch of the Cauvery River is from Srirangapatna under the bridge along the Bengaluru-Mysuru Highway up to the Satyagala bridge. Topographic sheets of the Mandya district were downloaded from the Survey of India website, and the flow of the Cauvery River was digitalized based on the geo-referenced topographic sheets, as shown in Figure 4.

Figure 4: Digitalized image of Cauvery River with Geo-referenced Topographic sheets of Mandya District

Table 2 presents the average values of critical parameters such as Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Total Coliform, and Faecal Coliform for 2018 to 2024.

Table 2: Average values of critical parameters of the polluted river stretch

River Stretch	Month of the year	Station no.	Monitoring station / location	Lat Long Details	DO (mg/l)	BOD (mg/l)	FC (MPN/100 ml)	TC (MPN/100 ml)
Ranganatittu to Satyagala bridge	2018	1	D/S of road bridge at Srirangapatna	12.423705 76.693672	7	2	274	1301
	2019				7	3	767	2467
	2020				7	2	505	1600
	2021				-	-	-	-
	2022				6	3	196	1373
	2023				6	3	208	1767
	2024				6	5	273	2300
	2018	2	At Ranganathittu	12.425022 76.653544	7	2	287	1263
	2019				7	2	344	1458
	2020				7	2	390	1500
	2021				-	-	-	-
	2022				7	2	175	1245
	2023				7	2	140	1333
	2024				6	3	170	1467
	2018	3	At Sathyagala Bridge	12.25531 77.163515	7	1	197	1041
	2019				7	2	254	1202
	2020				7	2	322	1110
	2021				-	-	-	-
	2022				6	2	144	1175
	2023				7	2	160	1355
	2024				7	2	118	1233

It can be seen that the values of most parameters have remained consistent over the past five years. However, there has been a slight variation in the values of BOD and Total Coliforms. The total Coliform count exceeds the standards set by the CPCB for discharge into water bodies, which is 1000 MPN/ 100 ml. Plate 1 presents graphs indicating the variation in average values of the said critical parameters.

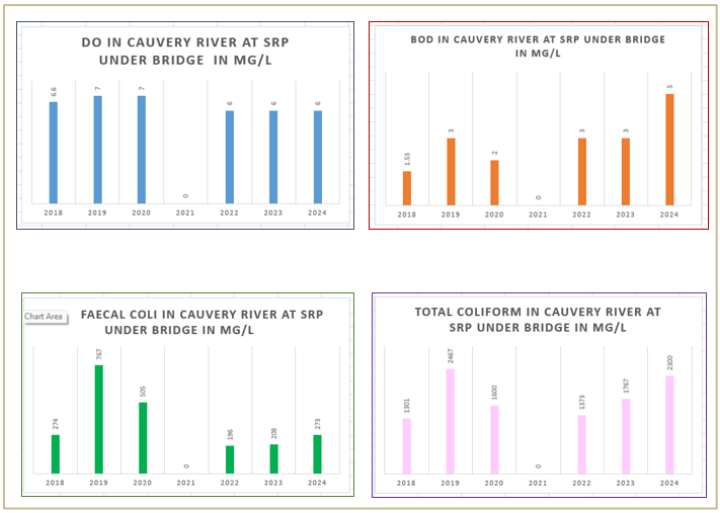


Plate 1: Variation in critical parameters

Another objective of the current project is to digitalize the Sewage Treatment Plants (STPs) of Mandya District. Shapefiles of India, Karnataka State, Mandya district, Taluks, and Towns were downloaded from the KGIS website. The city of Mandya and other towns in the Mandya district were digitalized using Google Satellite Imagery as a reference to capture recent developments. A digitalized image of Mandya City is indicated in Figure 5.

Figure 5: Digitalized image of Mandya City

The Digitization Process included identifying and marking the locations of Sewage Treatment Plants (STPs) in Mandya District on Google Maps. Later, the STPs in Mandya City and six other towns were mapped using GIS polygon tools.

The last objective of the project is to create an asset map of the ongoing STP work with a capacity of 5 MLD under the Srirangapatna UGD scheme. The CAD file was converted to "jpg" to trace the components of the STP using various tools into separate layers. The 'jpg' illustration was geo-referenced in GIS using satellite image coordinates from Google Earth. The SBR tank coordinates were matched to the layout

diagram in Figure 6. Digitalization of the civil and electro-mechanical components of the STP is carried out in distinct layers, with attributes created for each component's dimensions.

Figure 6: Geo-referencing image of the STP components on the satellite image of the STP location.

5. RESULTS AND DISCUSSIONS

Based on the study's findings, polluted areas along the 62 km stretch of the Cauvery River in Mandya District have been mapped. Digitalizing STPs in the Mandya District and creating an asset map of the 5 MLD capacity STP of Srirangapatna UGD System using QGIS has been done.

Figure 7 shows vector images of the latest water quality parameters (Dec-23) for BOD, DO, Faecal Coliform, and Total Coliform for the polluted river stretch. The reason Total coliforms exceed the limits of CPCB is the development of new areas in the towns that are not included in the comprehensive UGD system and sewage being left to the natural valleys/storm water drains.

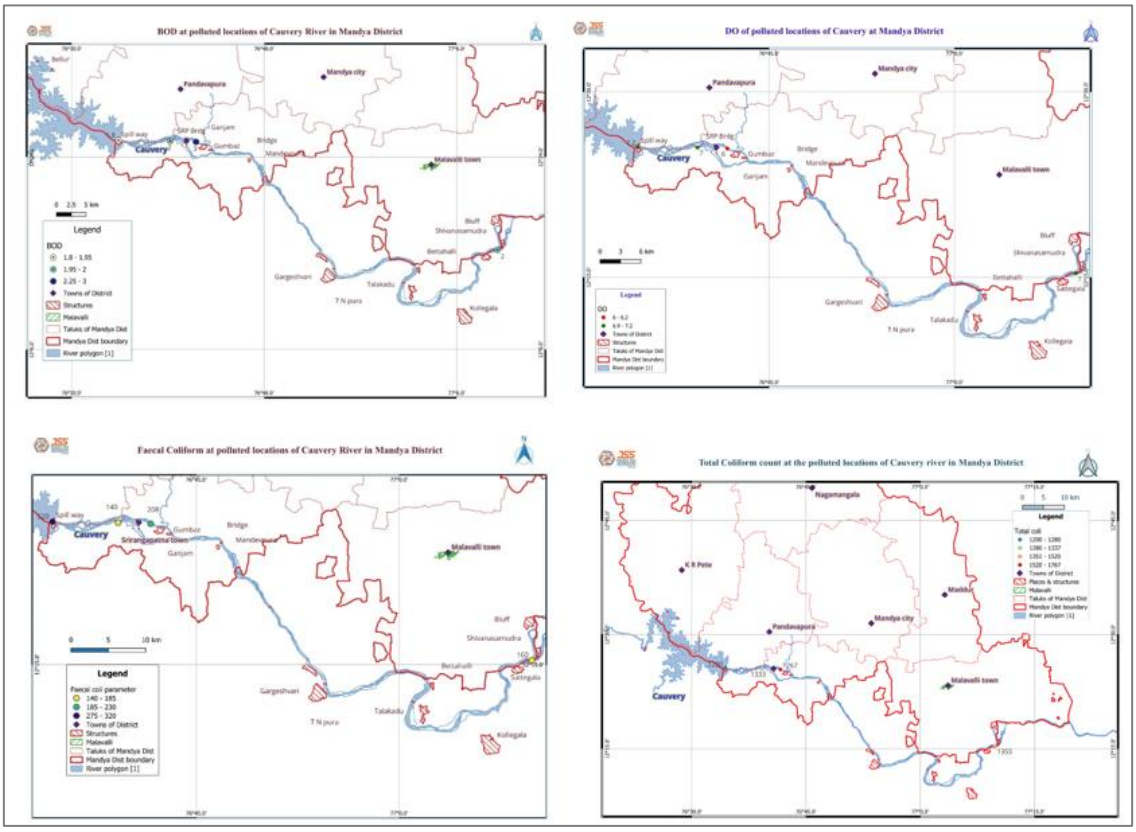


Figure 7: Vector images indicating the critical parameters of the polluted Cauvery River Stretch.

Figure 8 illustrates the distribution pattern of BOD, DO, Faecal coliforms, and Total Coliforms for the polluted Cauvery River stretch in Mandya District from December 2023 to the present.

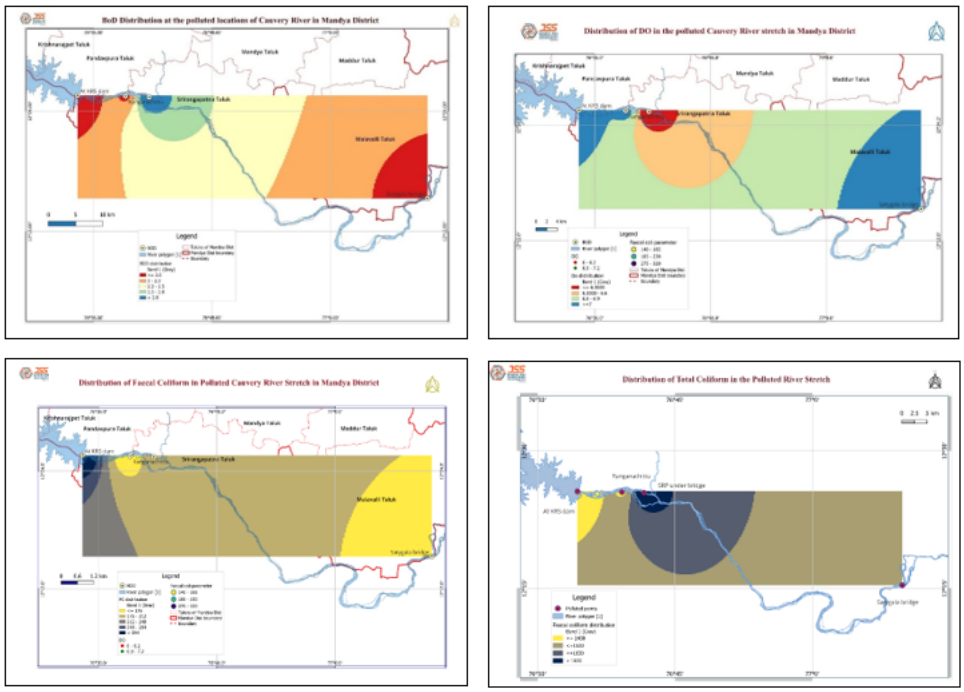
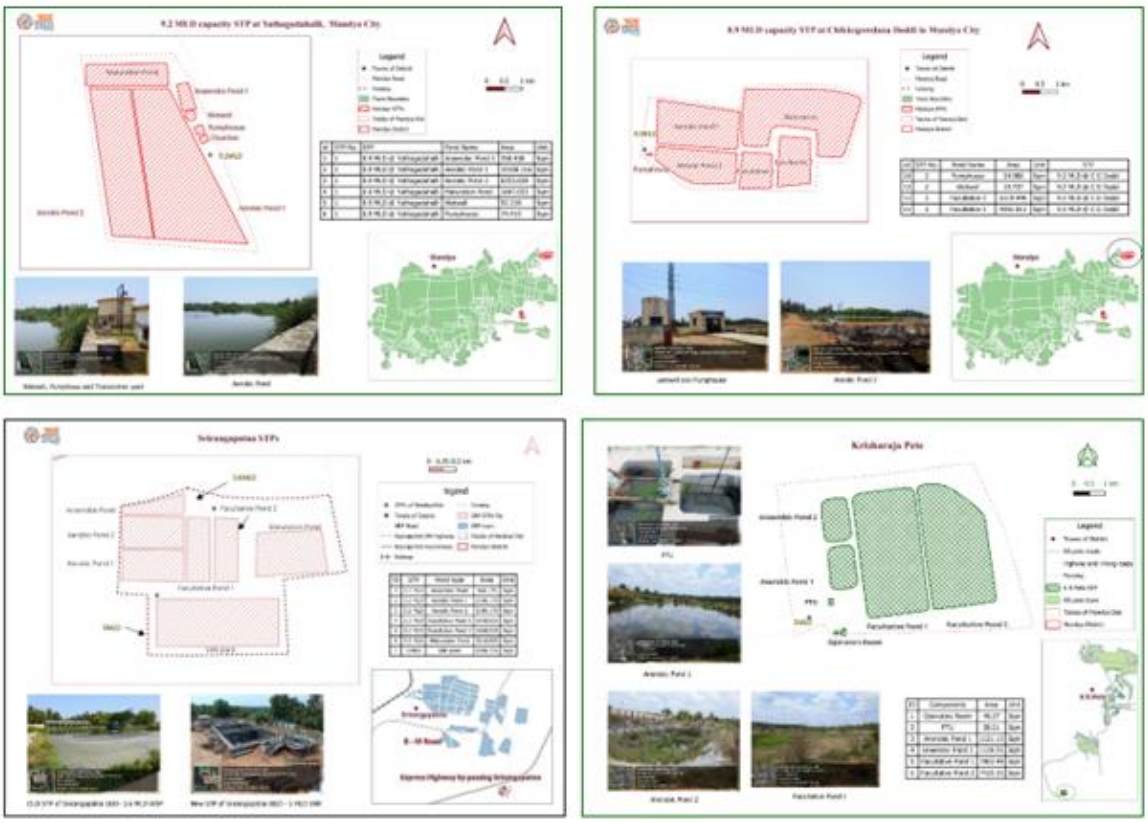


Figure 8: Distribution of patterns of critical pollutants at 4 locations in Cauvery River (Dec 23) using "Inverse Distance to Power" tool of GIS.

Figure 9 illustrates the digitalization of the STPs in Mandya City and five towns of Mandya District, except Pandavapura town, where the STP is yet to be constructed.



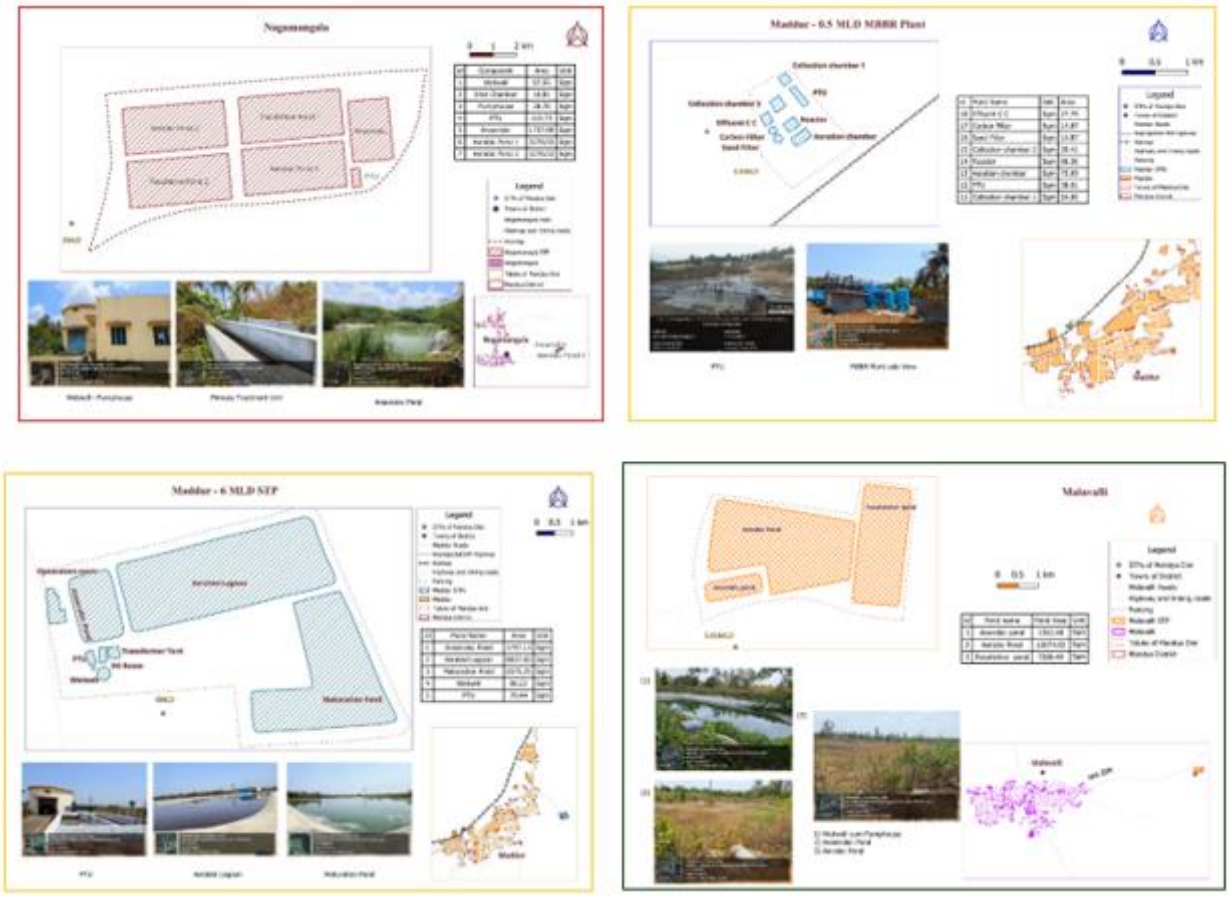


Figure 9: Layouts indicating the digitalized information of STPs in Mandya District

The 5.0 MLD capacity sewage treatment plant of SBR technology of the Srirangapatna UGD system, including relevant information about the various civil and electro-mechanical components, has been digitalized using the QGIS application. Figure 10 indicates the general layout of the STP generated.

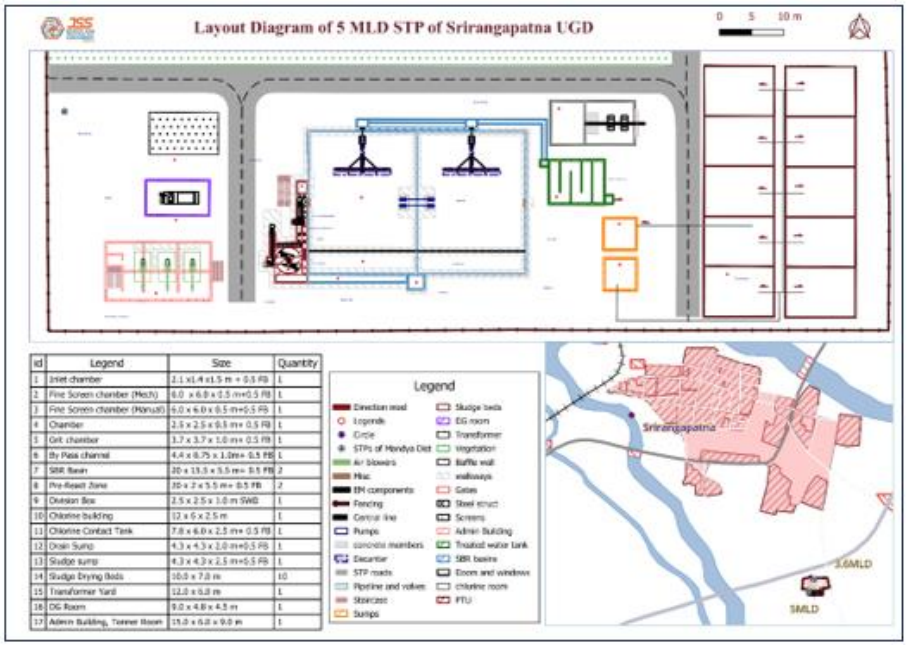


Figure 10: Layout showing Digitized 5 MLD capacity SBR type STP

Layouts have been created indicating the hydraulic and structural details, inventories, design considerations, standards, and other general and miscellaneous information on every component of STP. The PTU and SBR tank layouts are illustrated in Figures 11 and 12.

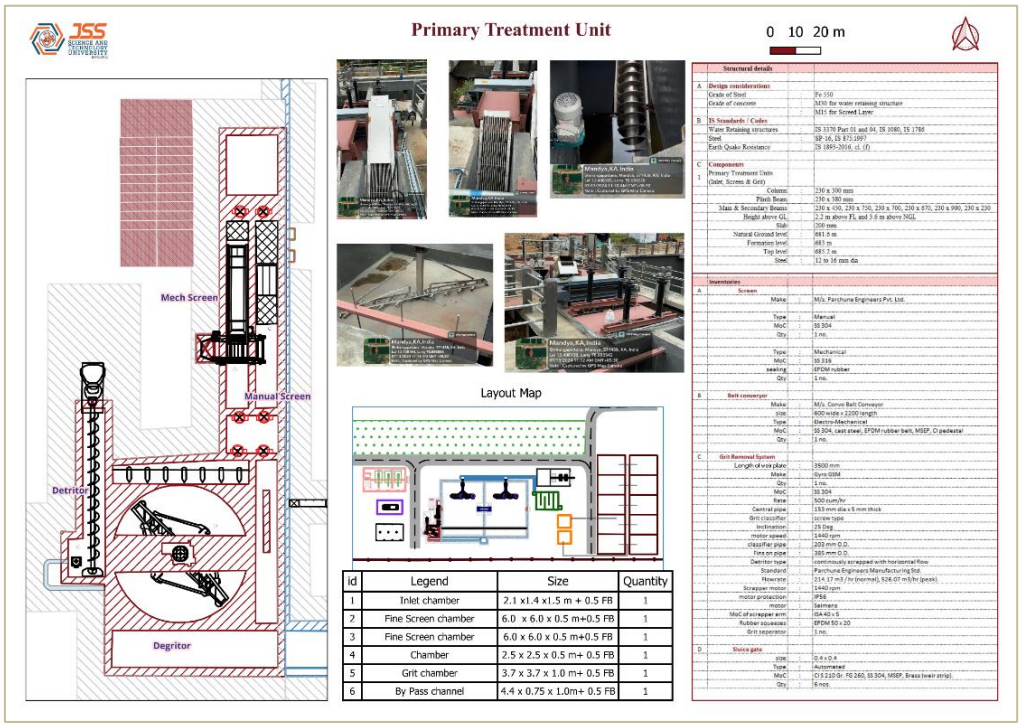


Figure 11: Layout showing the Primary Treatment Unit of STP

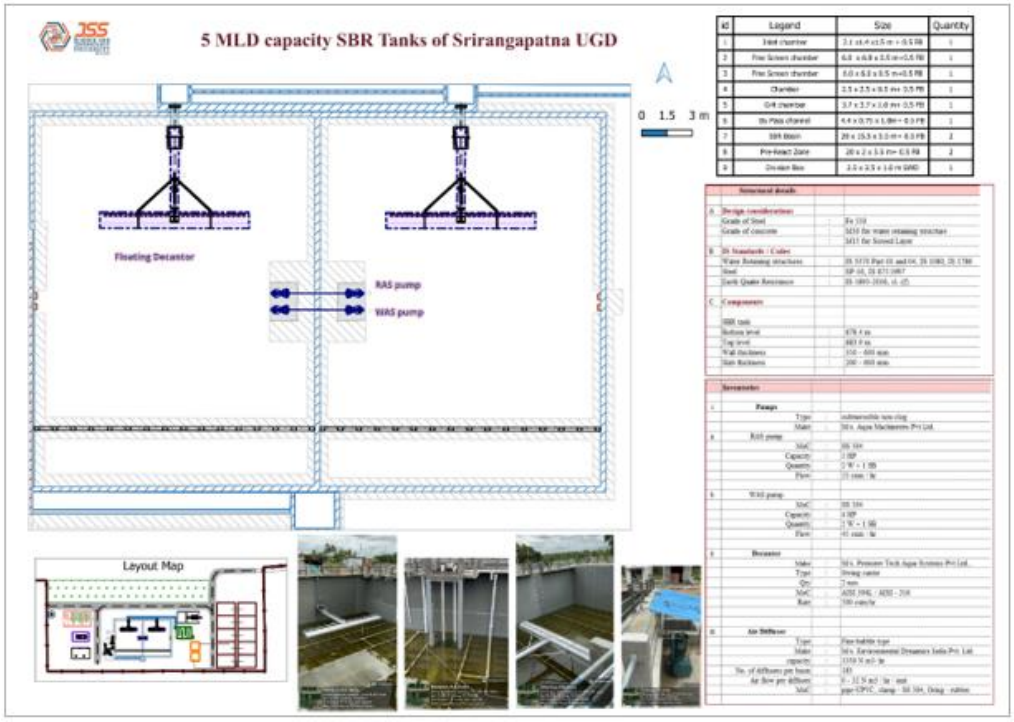


Figure 12: Layout showing the Sequential Batch Reactor of STP

6. CONCLUSION

An analysis was conducted on the polluted stretch of the Cauvery River in the Mandya District, as identified by the NGT, from 2018 to 2023. Using QGIS, Interpolated distance-weighted (IDW) maps were created to display the spatial distribution of various parameters. These maps help identify the potential zones of river water quality. The Digitalized information on STPs using QGIS benefits asset facility condition monitoring. Digitalizing the SBR-type STP of Srirangapatna 's UGD System using QGIS provides geospatial data and hydraulic and structural information of the components and electro-mechanical equipment.

Thus, integrating GIS technology in the engineering sector, especially in civil and environmental engineering, offers various benefits that can lead to improved project outcomes, cost savings, environment monitoring, resource management, and enhanced decision-making capabilities to effectively manage multiple infrastructure assets and projects.

Many government organizations under the Urban Development Department and District Municipal Administration of Karnataka lack a single repository of digitalized information containing their assets and infrastructure on the GIS platform. This project aims to provide guidelines for creating a repository that will be highly valuable to these organizations and enhance efficiency and scalability. Making this information available in real-time to all stakeholders on the official website will help achieve this purpose effectively.

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