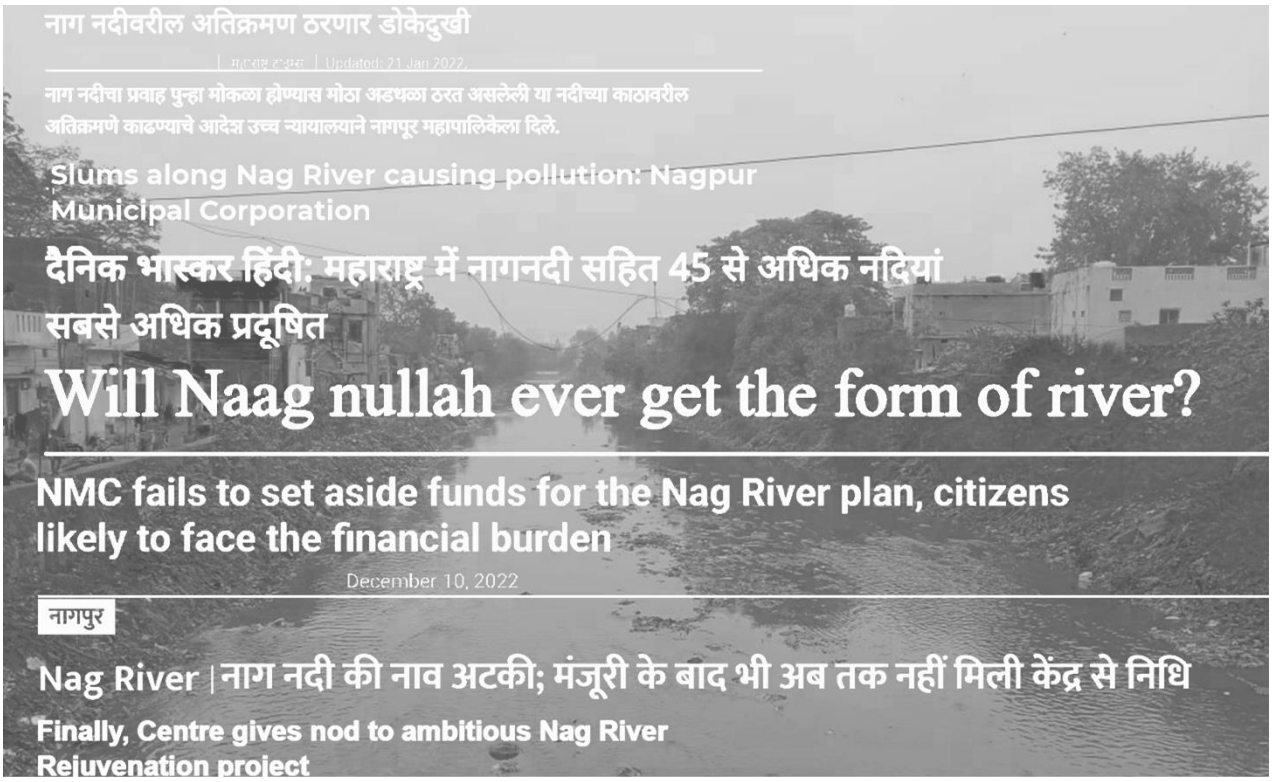
Application of Spatial Planning Techniques to Restore an Urban River:

Case of Nag River Nagpur



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I, ***Chaitanya Ananat Joshi***, the author of the DRP report titled ***"Rethinking River-centric Micro-Planning Approach Along With Rejuvenation of Freshwater Ecosystem: A Case of Nag River, Nagpur",*** hereby declare that this is an independent work of mine, carried out towards partial fulfilment of the requirements for the award of Masters Degree at Faculty of Planning, CEPT University, Ahmedabad. This work has not been submitted to any other institution for the award of any Degree/Diploma.

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Certificate

This is to certify that the DRP report titled "**Rethinking Restoration of Polluted Water Stretch using Spatial Planning Techniques: A Case of Nag River, Nagpur**" has been submitted by ***Mr. Chaitanya Anant Joshi*** towards partial fulfillment of the requirements for the award of a Master's Degree. This is bonafide work of the student and has not been submitted to any other university for award of any Degree.

Signature of Program Chair **Signature of Guide**

Date: 12 May, 2023

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Chaitanya Joshi

Executive Summary

Due to exponential rise of pollution unprecedented urbanization which occurred during 20th century, which was triggered by industrialization, pollution of waterbodies is one of the extremely irreversible actions. With 1.1% of the total volume of water available on earth as a freshwater in the forms of surface water bodies, the coming centuries is going to face a huge challenge in meeting the needs of rising population as well as ensuring that the waterbodies are clean and healthy. Various anthropogenic activities are responsible for pollution of river water throughout its basin starting from the origin throughout its stretch through various rural and urban transects. Out of all the transects along the path of river, urban river is the most vulnerable stretch of entire basin. Urban rivers are defined as "those rivers that have been folded into the process of urbanization, whether flowing through urban centers or not" (NIUA,2020) and are vulnerable to the rising rate of urbanization in Indian cities. Naturally, the rate at which urban rivers are getting contaminated due to human-centric activities is a very serious concern that needs immediate attention.

With more than 241 cities location along the river stretch in India, with poor strategies to maintain healthy and livable rivers, may result in serious problem to the urban pollution. Discussion on 'urban river' and their vulnerable conditions naturally points towards either greenfield or brownfield areas of intervention in the cities. Since urban rivers in context of greenfield development still have some less complexities compared to the brownfield ones, where the intervention in the existing urban fabric is challenging. Therefore, the project titled "Rethinking River-centric Micro-planning approach Along with Rejuvenation of Freshwater Ecosystem" aims to -

"Recreate the symbiotic relationship of Nag River with citizens to create a thriving ecosystem. The key focus area includes providing strategies for reducing pollution levels by restoring Nag River through nature-based solutions, not limiting to identifying key strategies for promoting homogeneous river-centric planned development using micro-planning tools and rethinking the river as an urban asset to generate economy using the bottom-to-top mechanism."

Originating from the Ambazari Lake, Nag River flows through the heart of Nagpur City with an overall length of 17 km. Several attempts were made to clean Nag River at various times which started fro0m 2013, where CPCB listed Nag River as one of the 47 most polluted rivers contaminated by influx of sewage and industrial waste. This increase in river pollution has a direct link to the degree at which urbanization has taken place in Nagpur. With past planning efforts neglecting the idea to preserve the existing blue network within the urban area has led to critical condition of river. Since Nag River is contaminated throughout its stretch, the increase in pollution from the river is contaminating the dams and sub-basin which exist downstream. Apart from pollution, unlike all other rivers some of the major characteristics which makes Nag River as the most suitable example as a case study to target specifically to rethink various solutions to improve condition of urban river (Nag River) in brownfield settings in Nagpur are-

- **Nag River and its context -** Unlike most of the rivers, which are predominated by similar kinds of urban character throughout the stretch, Nag River passes through the Old City area, which is organically developed along the river, followed by the Nag River on other hand is a part of upcoming neighbourhoods which are upcoming greenfield development in the city. The river flows through all varying densities and land uses throughout its stretch.
- **Varying width and depth of River for shorter stretches -** The river's width varies from 6 m wide to 42 m wide similarly, the river's depth from the road surface varies from 2 m to 4.5 m in depth. This large variation along a shorter stretch of the river makes it infeasible to implement the generic spatial strategy in one go.
- **Non-perineal nature of the river and condition of the floodplain -** The River is a part of the water overflow from Ambazari Lake. Like all other cases, the river’s source lies away from the urban context. Being a smaller tributary and due to rising growth in the upstream direction towards the source of Ambazari is also a unique setting. Moreover, the study conducted in the assessment of lakes in Nagpur shows significant pollution in Ambazari Lake due to heavy encroachment in its catchment area.

Overall, the study is based on various secondary data sources from various government and non-governmental agencies, research papers, and newspaper articles, as well as based on observations based on primary surveys and interaction with various

stakeholders. Since the study on urban rivers is multidisciplinary, more importance was given to deriving inferences from the pre-existing research works on similar lines in various fields of hydrology, ecology, and water resources from past years. As a result, more time was utilized in connecting the dots and deriving valuable inferences and actualizing the stories and narratives recorded during the primary survey and interaction with the people. This approach provided a considerable amount of time for framing relevant recommendations.

Starting with the most important objective to investigate the Nag River and its relation to the urban context of Nagpur. in both spatial and temporal way followed by primary survey. The research is based on various secondary sources in case of water quality assessment, assessment of municipal finance, review of past planning efforts by statutory bodies, assessment of existing development control regulations for regulating activities and restoring river stretches. Based on LULC and FCC maps it was identified that the condition of river is pre-existing and no drastic change in areas in vicinity of Nag River is observed. Assessment of surface water and groundwater using secondary data available from research articles highlighted the poor condition of Nag River stretches in Old City area of Nagpur because of which there is high chances of groundwater contamination due to infiltration of untreated wastewater.

The second set of objectives deals with the assessment of the existing situation of the Nag River and adjacent neighborhood. A primary survey was done throughout the 17 km stretch of Nag River along with urban neighborhoods on either side of the river. The entire stretch of the urban river was divided into seven parts based on various urban characteristics and qualitative aspects, which were classified under three major transects (developed new city area, CBD, and Old City Area and Urban Fringes) to understand the nature of the problem. Based on parameters like predominant land use, age of buildings, built character, and redevelopment potential, the vulnerability matrix was created to understand the areas which require immediate interventions.

The successive section of research deals with assessment of Urban River Management Plan Framework. With the given set of objectives which requires contribution of various institutions, the second part deals with understanding the institutional

framework and identifying missing links which was followed by the stakeholder's consultation. The section therefore summarizes the poor institutional framework and expertise to undertake actions based on urban river management plan guidelines. Throughout the research, the study conducted successfully investigates the relevance of hypothesis that the lack of availability of land for urban utilities and poor land management practices is the fundamental reason for degrading quality of urban rivers. This gap finds an opportunity as a urban practitioner to investigate the various methods of innovations where urban regeneration and riverfront restoration can be mutually dealt with in context of brownfield urban areas.

As a concluding part of the research project the set of recommendations. The first set of recommendations directly addresses the key problems identified from inferences and analysis conducted, where recommendation based on exploring the possibilities of micro-planning tools along with identifying possible options for land value capture methods to self-finance river restoration and urban regeneration along the river stretch. Secondly recommendation to identify the potential of TDR as a tool for compensation in case of restoration of lost streams during urban regeneration as a concept is mentioned. Apart from this the directed research project also suggests recommendations to improve institutional, financial and administrative aspects which are prevalent in the case of Nag River. Throughout the research the idea was to put forth a non-infrastructural, self-financed, bottom-to-top, and implementable method to deal with polluted river stretches.
The overall recommendations can be summarized in the phrase given below as

*"**Creating** Land Availability for Urban Utilities, **Capturing** Induced Land Value and **Compensating** the Land for Restoring River Ecosystem – The 3C's Approach to Restore Polluted River Stretch in context of Brownfields area of the cities."*

Abstract

Urban rivers are defined as "those rivers that have been folded into the process of urbanization, whether flowing through urban centres" (NIUA,2020) and are vulnerable to the rising rate of urbanization in Indian cities. With two-thirds of the entire stretch flowing through the Old City and the CBD area, the case of Nag River rejuvenation is a challenge. Nagpur's Old city fabric within the vicinity of Nag River provides an opportunity to look at the rejuvenating river with an altogether unique approach thus the project aims to specifically identify the potential of spatial planning techniques to rethink river restoration and urban regeneration in context of brownfield areas of the city.

Based on various secondary data sources from various government and non-governmental agencies, research papers, and newspaper articles, as well as based on observations based on primary surveys and interaction with various stakeholders the study tries to achieve the aims and objectives. The research project focusses on assessment of Nag River with its urban context in both spatial and temporal way followed by primary survey to investigate existing condition of river. Various secondary sources in case of water quality assessment, assessment of municipal finance, review of DCR and past planning efforts along with collection of LULC and FCC data to study the urban morphology. All these parameters were studied in both spatial as well as temporal manner which leads to the strong argument that the poor condition of Nag River is due to complete negligence on various parameters making Nag River a sewer drain flowing through the heart of the city.

Throughout the research the idea was to put forth a non-infrastructural, self-financed, bottom-to-top, and implementable method to deal with polluted river stretches which can be summarized below.

*"**Creating** Land Availability for Urban Utilities, **Capturing** Induced Land Value and **Compensating** the Land for Restoring River Ecosystem – The 3C's Approach to Restore Polluted River Stretch in context of Brownfields area of the cities."*

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List of Abbreviation

BOD – Biological Oxidation Demand

CDP – City Development Plan

CGWB – Central Ground Water Board

CPCB – Central Pollution Control Board

COD – Chemical Oxidation Demand

DCR – Development Control Regulation

FCC – False Colour Composite

GoM – Government of Maharashtra

GTPUDA Act - Gujarat Town Planning and Urban Development Authority's Act

JICA – Japan International Corporation Agency

LAP – Local Area Plan

LULC – Land Use Land Cover

LVC – Land Value Capture

MIDC – Maharashtra Industrial Development Corporation

MPCB – Maharashtra Pollution Control Board

MRTP Act – Maharashtra Regional and Town planning Act 1966

MSRTC – Maharashtra State Road Transport Corporation

NEERI – National Environmental Engineering and Research Institute, Nagpur

NIT – Nagpur Improvement Trust

NMA – Nagpur Metropolitan Region

NMRDA – Nagpur Metropolitan Area Development Authority

NMC – Nagpur Municipal Corporation

NSBB & LUP – National Bureau of Soil Survey and Land Use Planning

RRSC – Regional Remote Sensing Centre

TP Scheme – Town planning scheme

UDCPR – Unified Development Control and Promotional Regulations

UDPFI – Urban Development Planning Formulation and Implementation Guidelines

VHC – Vidarbha Heritage Committee

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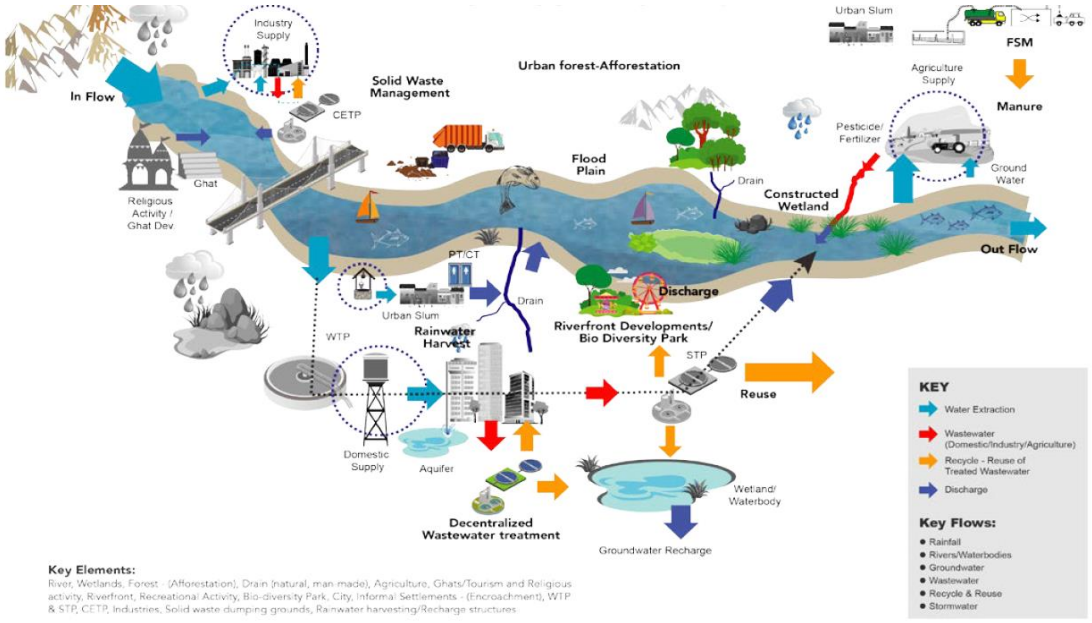
1 BACKGROUND

1.1 Role of Rivers in the Development of Human Civilization

Historically, River Nile and River Indus were among the first waterbodies which recorded the rise of human civilizations, which signifies the prima-facia requirement of availability of freshwater for subsistence. Over the period, throughout the world, river valleys became densely populated areas due to their suitability for human habitation, cultivation, and a major means of transport and communication for trade. A similar trend is also observed along the major river basins in India, where most of the urban centers started emerging along Indo-Gangetic Plains, making India's most populous regions River basins in India are of prime geographical importance as they cover an area of approximately 24 lakh sq. km. which includes 8 major and 12 minor river basins throughout the subcontinent (Fig.1). With respect to the urbanization observed along the river basins, **in India, 42 out of 53 metropolitan cities in India are river centric. Moreover, 293 out of 504 Class I cities are river towns** (Bhonde, 2019). The river body has the potential to serve all the necessary desired functions for human subsistence hence river as a source of freshwater is a part of the existing urban network, which is assumed to be functioning in a desired way.



Source: Urban River Management Plan, 2019

Figure 1: Desired functioning of the river in an urban context

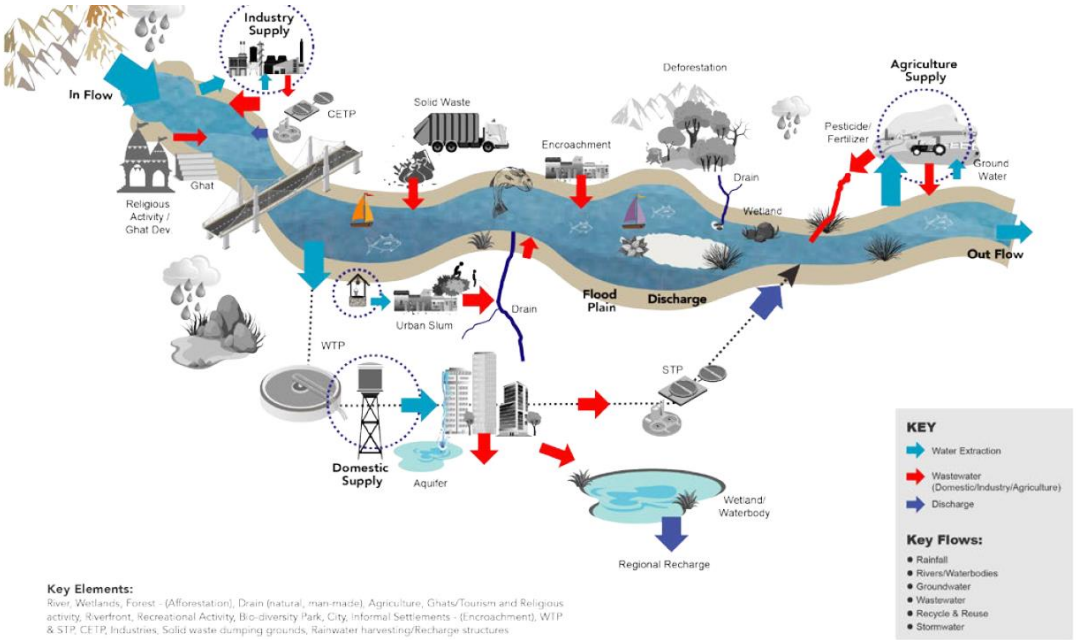
1.2 Urban River: The Most Vulnerable Stretch of River Ecosystem

'River basin' is defined as an area drained by a river and all its tributaries. Throughout its journey river flows through various transects of rural, peri-urban, and urban areas. **'Urban river'** on the other hand is a specific stretch of river that is flowing through urban areas, and thus can also be referred to as a subset of the entire river basin. Defining 'urban river' upfront is very important because of two major reasons-

Firstly **'urban river'** is considered one of the most vulnerable stretches of the river body because of the river's exposure to maximum human intervention due to urbanization as compared to rivers in rural or peri-urban contexts. Major issues leading to the degrading condition of urban rivers vary in quality and scale, unlike peri-urban areas where either deforestation, loss of riparian cover or pollution due to agriculture prevails. Urban development is a major cause of land use transformations, degradation of the water quality of rivers, increased flooding, and disturbance in the natural river basin ecology (Shukla, Shire, and Gedam). Some of the most prevailing issues faced by urban rivers include -

- Encroachments along the floodplain
- Alterations in the hydrology due to increasing imperviousness of the catchment area i.e., modifications in the aquatic ecosystem.
- Varying sources of water pollution which include, the discharge of untreated sewage and effluent from small- and large-scale industries.

Secondly, the urban river in India is a part of an existing urban fabric which indicated the nature of interventions undertaken as a part of brownfield developments. Unlike greenfield developments, it is difficult to form a consensus among stakeholders and prepare a development model which will fix the existing working of the urban environment so that it improves the quality of life as well as components of blue-green infrastructure in the city. The changing urban dynamics, therefore, have impacted 'urban rivers' critically especially after the post-independence period when unprecedented development of urban areas remained uncontrolled to preserve and maintain the natural ecosystems of urban rivers.



Source: Urban River Management Plan, 2019

Figure 2: The existing condition of rivers in an urban context

1.3 Increasing in Polluted River Stretches Across India: A Brief of Central Pollution Control Board (CPCB) Report 2022

As per the report of the Central Pollution Control Board (CPCB) 2022, a total of 311 polluted river stretches have been identified. Further, the report indicates that about 46 river stretches are classified under Priority I, and 16 river stretches are classified as Priority II, which has remained unchanged with respect to the study conducted by CPCB in 2018. (Fig. 1-3) Though the number of polluted river stretches has dropped from 352 to 311 in three years, the study highlights no change in rivers belonging to the priority I and priority II lists[1]. Some of the major sources of pollution include the dumping of untreated sewage, domestic water, and effluent from industries into rivers, which is generic to all the categories of rivers. This indicates that further stringent actions must be undertaken to reduce organic pollution from various resources (The Hindu, 2022).

[1] As per the CPCB, the criteria for identifying the pollution river stretches (PRS) as mentioned in CBCB Report 2022, classifies PRS in five categories –

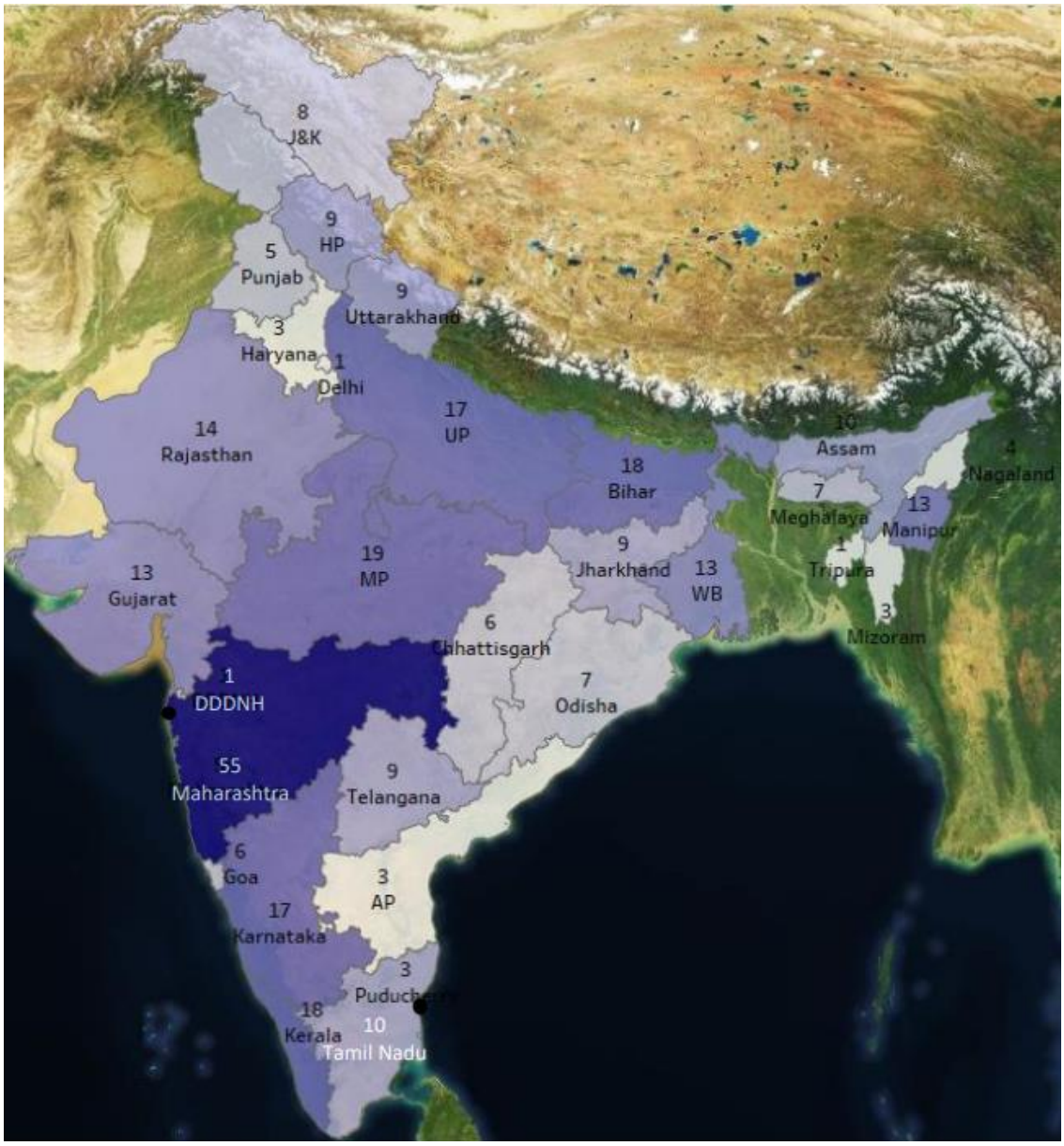
Priority I - Monitoring locations exceeding BOD concentration of 30.0 mg/ L

Priority II - Monitoring locations exceeding BOD concentration of 20-30.0 mg/ L.

Priority III - Monitoring locations exceeding BOD concentration of 10-20.0 mg/ L.

Priority IV - Monitoring locations exceeding BOD concentration of 6-10.0 mg/ L.

Priority V - Monitoring locations exceeding BOD concentration of 3-6.0 mg/ L.



Source: CPCB Report 2022

Figure 3: India's most polluted river stretches as per CPCB Report 2022

1.4 Key Hypotheses and Research Question

Statement 1 - "Urban rivers are considered in isolation from their urban setting."

Rejuvenating the urban river projects has been seen to have isolated the river from its adjacent neighborhoods. In the case of urban settings, the context of urban rivers holds equal importance as it provides character-specific interventions. Moreover, this also results in a mismatch with the proposed development envisioned for neighboring areas.

Statement 2 - "River restoration approach lacks consensus building among stakeholders."

Intervention in urban areas which are already developed, the past efforts of restoration were not welcoming from the side of stakeholders/owners. This highlights the need to carry out a project where it is essential to provide solutions having a bottom-to-top approach. This will ensure the smooth running of the project in a periodic manner.

Statement 3 - "River restoration being capital intensive aspect and strategic micro-planning approach to restoring rivers along with neighboring urban context can make projects more viable and successful."

Most of the projects implemented so far only considered urban rivers as a part of generating an economy using recreation spaces. To generate income, infrastructure needs to be created, where the cost of development must be bear by government authority. This highlights an opportunity to rethink another mechanism where the urban river will be considered an 'asset' to the city. The above-mentioned key hypotheses lead to following research statement as follows -

"Rethinking river restoration projects along with existing urban context to create opportunities for restoring the freshwater ecosystem using ecologically sensitive methods, exploring the potential of a river-centric economy, and creating a holistic framework of consensus building among stakeholders using a micro-planning approach."

1.5 Summary

The above section, in brief, highlights the key concerns that, over the years, the condition of rivers has been degrading primarily due to various anthropogenic activities which lead to pollution. Rivers comprise 1.1% of the total water volume available on earth and are the only source of freshwater after glaciers. With increasing dependency on freshwater resources and untapped pollution, the degrading condition of urban rivers is a very serious concern. The central research question, therefore, targets the various key issues associated with river restoration in an urban context.

Rethinking restoration of polluted water stretch using spatial planning techniques: A Case of Nag River, Nagpur

2 AIMS, OBJECTIVES, AND RESEARCH METHODOLOGY

From the previous section, we got a brief overview of the existing condition of urban rivers. Even though the river is one of the major sources of freshwater, which is available in plenty and is expected to have high demand as the population increases, ignoring the poor condition of the river will directly impact the health and liveability of the areas in the vicinity of the polluted rivers. With more than 50% of the country's total population expected to be living in urban areas, the challenges in river restoration and preserving them from additional contamination is a very ambitious task. On the other hand, if not taken seriously, the urban river stretches may impact the health and liveability of many populations in the cities and metropolitan areas.

2.1 Aim

Observing these key implications, the following research tries to address the subject with the aim mentioned below -

"To recreate the symbiotic relationship of Nag River with citizens to create a thriving ecosystem. The key focus area includes providing strategies for reducing pollution levels by restoring Nag River through nature-based solutions, not limiting to identifying key strategies for promoting homogeneous river-centric planned development using micro-planning tools and rethinking the river as an urban asset to generate economy using the bottom-to-top mechanism."

2.2 Objectives

As part of the idea, the project looks at all the mentioned concerns as a key opportunity to conserve Nag River, considering the ecological, social-cultural, environmental, and economic direction of interventions. The following are the key objectives of the project.

- ***To understand the relationship of the river (Nag River) with respect to the city's context (Nagpur) over the period in a spatial and temporal way.***

  The above objective can be characterized through various aspects covering the spatiotemporal aspects –

- Understanding the historical background and urban morphology over past decades and its relation to the Nag River and its existing Conditions.
- Review of past planning efforts, including examining the statutory plans, Development Control Regulations (DCR), and critical review of major projects related to pollution abetment.
- Review of Municipal Finance over the past few years to understand the financial capacity to undertake major infrastructure projects.
- Understanding the changing condition of surface water and groundwater using secondary data along a given stretch to understand the rising vulnerability during the past decade.

- ***To assess the existing condition of the urban neighborhood in the context of Nag River to identify various issues, opportunities, and existing conditions of the river and its surrounding urban context.***

  The major aspect covered under this objective is to understand the character of the urban river throughout the stretch of 17 km starting from the source. Based on observations, the outcomes will help delineate the key areas and priority of the river stretch selected for immediate intervention.

- ***To review the Urban River Management Plan (URMP) Framework identifying the roles of various key stakeholders subjected to river restoration.***

  As per the general objectives mentioned in URMP Framework for urban rivers, this section will critically examine the best-fit objectives and key areas of intervention in understanding the context of Nag River. Based on the analysis of spatial and temporal aspects, the section will examine the performance of the rivers based on qualitative guidelines with respect to each objective. Further, the objectives based on the stakeholder's consultation try to identify their role and responsibilities and find the missing links in planning and practice.

- ***Detailing recommendations and redefining a new spatial planning approach to river rejuvenation specific to Nag River's context.***

  The concluding part will be based on identifying key problems and finding possible solutions related to the micro-planning approach and land value capture specific to the Nag River's context. The section also highlights relevant examples as case studies related to the proposed interventions.

2.3 Scope of Research Project

The research attempts to rethink river restoration through a spatial planning approach where the major focus will be based on how micro-planning tools and various fiscal tools can be explored. The research project has the following scopes based on the mentioned aims and objectives –

- ***Identifying the missing links in the existing structure of river restoration projects and finding areas where spatial planning tools can provide appropriate solutions.***

  As an urban planning professional, there is a wide range of opportunities that have not been experimented with in the Indian context which can fill the gap to make river restoration successful when concepts like sponge cities or making room for rivers are academically debated but not implemented in practice. Urban Planning as a discipline can help to go beyond boundaries and rethink river restoration from the perspective of both planning and practice.

- ***The study helps in investigating the various alternatives that two-tier and three-tier cities have in case they have polluted river stretch within the urban limit.***

  This research attempts to explore a new paradigm in the case of fiscal tools and the use of land value capture methods to make river restoration self-financing and reduce the dependency of smaller cities on Central Grants.

- ***Restoration of the polluted river stretch along with urban regeneration in the Old City area is not being experimented with in the Indian context successfully.***

  Considering various experiments and successful implementations in the large-scale projects of river restoration on an urban scale in Singapore (Singapore River), in London (Thames River in Canary Wharf and King's Cross) these are some of the most ambitious projects undertaken with dual objectives to restore riverfront along with urban redevelopment. In the case of India, due to various land management practices and the organic structure of the old city, there is a

huge opportunity to explore and implement similar case studies in Indian context.

2.4 Limitations of Research Project

Directed Research Project being an academic exercise, has some major constraints in the amount of work produced, limited time and resources, etc. The following are the key limitations of the research project –

As an academic exercise, the research focuses more on spatial aspects considering suggestions of various above disciplines. The project does not aim to directly involve each expert domain.

Since river restoration is a multi-disciplinary subject involving experts apart from the discipline of urban planning from various backgrounds, which include hydrologists, environmentalists, botanists, etc,. whose inputs are essential for making the project technically sound.

Context-specific directed research project with a key focus on Nag River and Nagpur

The research is based on the context-specific case of the Nag River. As a result, the inferences and recommendations of the study therefore may not be relevant to the other urban rivers.

Use of secondary sources to make the study more comprehensive and compiled.

The research project tries to cover various domains directly or indirectly associated with the topic. Considering the limited amount of time and resources available, in most cases, considerable use of secondary sources of data in the form of research papers, newspaper articles and various statutory and non-statutory reports was used covering various perspectives and connect dots. There is a chance of errors arising from the adopted datasets from various research articles, which need to be neglected.

2.5 Research Methodology

Objectives listed above are covered in successive chapters. Research methodology which includes the brief listing of key aspects that are covered in the given objective, sources from where the data is acquired, nature of data set and its selected time frame based on the requirement of research and how the various tools and methods were used to derive objectives is discussed here –

Objective 1 –

Understand the relationship of the river (Nag River) with respect to the city's context (Nagpur) over the period in a spatial and temporal way.

This objective intends to identify the urbanization during past decades especially in context of Nag River. Based on the listed sub-objectives various data sources were used to meet the above objective –

***Understanding urban morphology over past decades* –** Various secondary sources in the form of statutory reports were studies to understand the spatial development of Nagpur over centuries. Apart from that it was essential to study the changing pattern of land uses and growth of Nagpur in past decades from 2000-2020 to understand the nature of development in context to Nag River. In this case data from various research papers in which LULC and FCC classification was made were studies and used as a source to derive various inferences. Considering the limited time for research project and area of focus rather than getting involved into LULC classifications, secondary sources with GIS and Remote Sensing analysis available for the required time was used.

***Review of past planning efforts* –** To understand the various statutory measures undertaken from post-independence period to the present stage, it was essential to review past planning efforts. Data available from various government websites about recent development, newspaper articles from 2000-2020 and statutory reports were major source of secondary information to derive at various conclusion related to this objective.

***Review of Municipal Finance* –** This objective covers the study of municipal finance statements of Nagpur Municipal Corporation to understand the capital expenditure for

river rejuvenation during the past five FY from 2016-2020. Open-source data available on official websites were used to derive inferences and to understand the income-expenditure trend.

Assessment of changing degree of contamination in groundwater and surface water resources in Nagpur Region **-** This objective is associated with a quantitative study of change in various technical parameters like BOD, COD and DO level to understand the degree of contamination of both surface water resources and groundwater resources (which include datasets collected across Nag River and Pili River for deriving comparative inferences.

Assessment of the condition of surface water is based on two temporal aspects. The first is based on season variation (during pre-monsoon and post-monsoon) to understand the contamination level based on the flow in the river. Based on various locations along Nag River (from 2000-2020) to investigate the areas with high degrees of pollution and whether any change in the quality of Nag River has been recorded in the past decade. Data in both cases was adopted from past research in the case of Nag River. Considering the scope of research and the limitation of time, secondary data was preferred for deriving various inferences.

Similarly, to understand the impacts of contaminated freshwater on groundwater resources (if any) in the context of the Nagpur Region, various reports by government advisory agencies were reviewed. Maps of post-monsoon and pre-monsoon depth of groundwater and availability of groundwater in the Nagpur Region were taken from the annual reports published by Central Groundwater Board (CGWB). On the other hand, data on necessary qualitative parameters like alkalinity, chloride level, BOD, and COD was adopted from relevant research papers. In all the cases where the data was derived from secondary sources, it was ensured that it matched the approach of this directed research project.

Objective 2

Assessment of the existing condition of Nag River and the urban neighborhood in its proximity

The objectives intend to conduct an existing situation study based on the primary survey to understand the ground reality of adjacent urban neighborhoods around Nag River. A

primary survey was done throughout the 17 km stretch of Nag River along with urban neighborhoods on either side of the river. The entire stretch of the urban river was divided into seven parts based on various urban characteristics and qualitative aspects, which were classified under three major transects (developed new city area, CBD, and Old City Area and Urban Fringes) to understand the nature of the problem. Based on parameters like predominant land use, age of buildings, built character, and redevelopment potential, the vulnerability matrix was created to understand the areas which require immediate interventions.

Objective 3

review of the Urban River Management Plan (URMP) Framework identifying the roles of various key stakeholders subjected to river restoration.

Based on the inferences derived from the primary survey and review of various secondary data and analyses, a critical overview of the URMP objectives is done. Further, based on the stakeholder consultation conducted through online and offline questionnaire interviews, various stakeholders' views were recorded to understand the existing gaps in roles and responsibilities. Key stakeholders that were interviewed included journalists, environmentalists, town planning officers, academicians, botanists, and various other experts related to the domain of river conservation and pollution abetment. The agenda was to indicate the reason for the existing gap between planning and practice in case of implementation of the Urban River Management Plan in Indian cities (specifically in case of Nag River, Nagpur)

Objective 4

Detailing recommendations and redefining a new spatial planning approach to river rejuvenation

The section includes highlights key problems that need to be addressed, which was echoed throughout the study. Based on the relevant case studies, key recommendations specific to spatial planning were detailed. Recommendations were classified into three classes based on the highlighted issues based on spatial hierarchy (district, regional, and city level recommendations as well as recommendations for improving administration, financial and institutional framework.

Overall, the study is based on various secondary data sources from various government and non-governmental agencies, research papers, and newspaper articles, as well as based on observations based on primary surveys and interaction with various stakeholders. Since the study on urban rivers is multidisciplinary, more importance was given to deriving inferences from the pre-existing research works on similar lines in various fields of hydrology, ecology, and water resources from past years. As a result, more time was utilized in connecting the dots and deriving valuable inferences and actualizing the stories and narratives recorded during the primary survey and interaction with the people. This approach provided a considerable amount of time for framing relevant recommendations.

3 LITERATURE REVIEW

3.1 River Restoration: Background

The growth of the urban population and the pressure of urbanization are the prime reasons for degrading riverfront areas with poor water quality, limited access, and rising encroachment in river floodplains. Such problems are not confined to a particular geographical location but are common to all the urban centers in the world, and India is no exception (RCUP Guidelines, 2021). The term *'that can fill the gap to make river restoration successful when concepts like sponge cities or making room for rivers are academically debated'* river restoration, therefore, is defined as -

"Assisting the recovery of ecological structure and function in a degraded river ecosystem both planning and practice perspectives elements and re-establishing the processes necessary to support the natural ecosystem and to improve the ecosystem services it provides" (WWF and GIWP, 2016)

3.2 Global Perspectives on River Restoration and Conservation: United Nations Sustainable Development Goals (SDGs)

Sustainable Development Goals (SDGs) were the most significant outcome of the '2030 Agenda of Sustainable Development adopted by United Nations Member States in 2015. All the listed 17 SDGs aimed to create a paradigm shift in the existing global scenario through various necessary actions to targets by 2030. With respect to the conservation of waterbodies (which includes rivers) following are the SDGs that align their targets to meet the river restoration –

- **SDG 6 Water and Sanitation:** Aiming primarily to achieve clean drinking water and basic sanitation needs by the end of 2030, one of the sub-targets associated with achieving SDG 6 titled **'Protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes'** is directly linked to the river restoration and preservation.
- **SDG 11 Sustainable Communities and Cities:** Under the sub-target of **'protecting cultural and natural heritage'** points out that the river is a symbol

of cultural and natural heritage, which can help improve socio-cultural gaps in cities to deliver sustainable communities.

- **SDG 12 Responsible Consumption and Production –** SDG 12 indirectly highlights the need for determining actions for river protection through its sub-target sustainable management and use of natural resources.
- **SDG 15 Life on Land** – Highlights the importance of conserving terrestrial and freshwater ecosystems in context to river bodies.
- **SDG 13 Climate Action –** Refers to the socio-cultural role of healthy rivers as a part of the urban ecosystem to allow community interaction during resilience.

Source: Author

Figure 4: Sustainable Development Goals Associated with river restoration.

3.3 Efforts of Worldwide River Restoration

River restoration in urban areas worldwide is a developing domain that started in the later 20th century (WWF and GIWP, 2016) as a reaction to the depleting condition of rivers primarily due to the dumping of industrial and household waste into rivers. The genesis of river restoration started with the Clean Water Act of 1972 in the United States (USEPA) followed by the European Union, where the restoration of the Rhine was undertaken. Worldwide actions of river restoration can be summarized below –

- **United States:** As mentioned earlier, the river restoration initiative was an outcome of the Clean Water Act of 1972, where the major reason was increasing industrial pollution. The Act did not mention river restoration but focused on improving water quality. restoration of the aquatic ecosystem, which is of economic, cultural, and spiritual importance, started in 1992. Restoration includes riparian and upland activities like reconnecting floodplains and adding aquatic life to the streams. Most of the investment was made to uplift the fisheries' resources. To summarize, river restoration evolved in the United States as a four staged process. Some prominent examples of river restoration are Columbia River Basin, the Florida Everglades, Missouri, and Mississippi. For most projects, the river restoration was based on recreating structural attributes that include engineering-based solutions. It was assumed that the ecosystem function would follow.

- **South Korea:** The degradation of the river ecosystem started during the 1960s due to industrialization and urbanization. Prominent practice in Korea is channelizing the water, which has a long-term impact on river patterns. Water quality in Water quality issues and flow diversions have profoundly altered river ecosystems in South Korea. South Korea's first restoration project was the Han River Project which was undertaken from 1982-86 and involved the development of riparian parks along floodplains in Seoul. The extent to which river restoration should focus primarily on beautifying rivers and increasing their human amenity (i.e., park rivers) versus returning rivers to being functional ecosystems (creating ecological rivers) remains a point of ongoing debate in South Korea. In recent practice, South Korea has two different models of

riverfront restoration named the Amenity Restoration Model and the Ecosystem Restoration Model.

Source: https://www.koreatimes.co.kr/www/opinion/2023/01/715_311119.html

Figure 5: Hun River aerial view Now (2018) and Then (1984)

(Note: Initially, during the early interventions of river restoration, various methods involving engineering proposals were identified. Further, after 2010 the restoration of lakes, canals, and waterbodies in Seoul started to happen by identifying the biodiversity and focusing more on ecological practices)

- **Europe:** River Restoration initiatives started in Europe during the 1980s. The initial interventions focused more on investment to treat wastewater to reduce domestic water flow into rivers rather than by following ecological and bio-engineering methods. The restoration was undertaken as a part of the Urban Wastewater Treatment (UWWT) Directive initiating heavy investments in wastewater treatment in 1991, including Habitat directives in the Early 21st century. The ecological status of a water body is assessed in relation to its hydrological characteristics, chemical characteristics, and biological life. Later years of restoration identify ecologically sensitive interventions focusing on the

habitation of multiple species as a part of the projects. A prominent example of river restoration is the Restoration of the River Thames in London. Due to industrial and anthropogenic activities, the river was declared **'biologically dead'** in 1957. The restoration initiative resulted from a million-pound investment which resulted in the cleanest river ecosystem supporting the widest biodiversity.

- **Australia:** Agriculture fertilizers were the major reason for poor river conditions in Australia. This was prominently observed in the Murray-Darling Basin, where the algal bloom was observed due to the use of nutritious pesticides in farming along the riverbanks in 1980-the 90s. As a result of the degrading condition of river basins, this was also a growing threat to the Great Barrier Reef. To mitigate this, The Reef Water Quality Protection Plan was drafted to reduce the sedimentation and load of fertilizers. Apart from this, as a part of the local government's initiative, Australia also practices riparian plantation and re-establishing instream habitat for smaller catchment basins.

Source: http://graphics.straitstimes.com/STI/STIMEDIA/2015/slider/microsite/index.html#sg-rvr

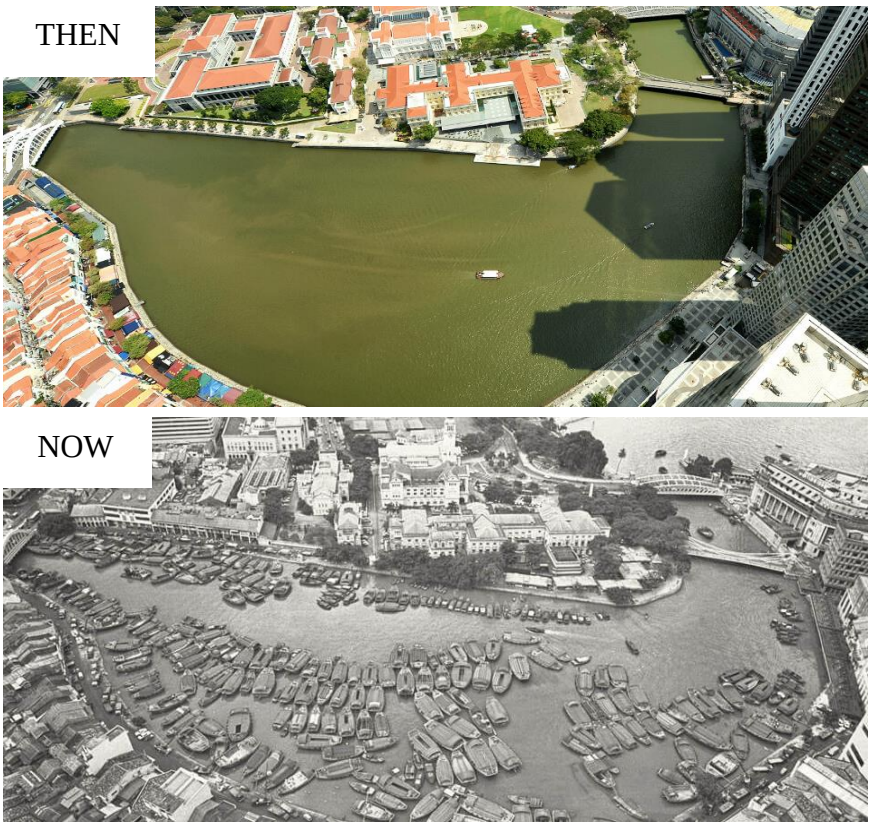
Figure 6: River Thames aerial view Now (2018) and Then (the 1960s)

The approach to river restoration considerably shifted over the period, where only restoration work involved mitigating point sources of pollution primarily through wastewater treatment. Over time, initiatives were undertaken to improve land use practices and rehabilitate degraded parts of the riparian zone and upper catchment.

- **Singapore:** During the post-independence period, the Singapore River became heavily polluted, which resulted in the government officially commencing a large-scale, 10-year project to clean up the Singapore River in 1977 (along with the Kallang basin), with the goal of bringing thriving aquatic life back to the river. The major source of pollution was domestic waste which included pig and duck farms, squatters, street hawkers, and vegetable wholesale activities, from which garbage, sewage, and other waste were dumped directly into the river, which was decommissioned with the high political will to restore the river. The efforts led to a clean river with aquatic life, setting an outstanding example of clean and aesthetically pleasing waterways. Subsequently**, a clean river allowed for intensive business and residential redevelopment along the waterfront, which is now a major tourist attraction in Singapore.**

- **China:** River management initiatives in China date back 5000 years during the early civilization period. Early engineering-based initiatives included concreting of riverbeds, construction of embankments and dams, and prevention of floods along river basins, but it resulted in ecological degradation of the freshwater ecosystem. The restoration approach to improving the river ecosystem remains elusive till the end of the 20th century. In the early 21st century, the Chinese Government initiated river restoration programs targeted restoration of rivers with the primary objective of restoration of riparian vegetation, river management from the landscape ecology perspective, and water quality restoration through water pollution control. In China, different methods are used to restore rivers depending on the catchment area and river basins. For major river basins river management plan is the most common initiative with the objective of ecological conservation and improving the socio-

economic value of the urban areas; for rivers with smaller catchment, techniques like landscaping or riparian management are preferred. A prominent example of river restoration in China is the Hei River, with a catchment area of 30,000 sq. km.



Source:http://graphics.straitstimes.com/STI/STIMEDIA/2015/slider/microsite/index.html#sg-rvr

Figure 7: Singapore River aerial view Now (2018) and Then (1960s)

The following inferences can be derived from the above-mentioned river restoration efforts worldwide. Almost every country identified the need for legislature during the end of the 20th century, which indicates that the earlier efforts at river restoration lacked the potential objective and vision necessary to restore river basins in urban areas.

- This can be concluded from the above examples that throughout the world, the scenario of river restoration remains the same, which is generic to their approach and objectives. Hence it can be concluded that the domain of river restoration will take considerable time to have specific context-based interventions.
- All the prime examples of successful river restoration projects result from large capital investments. This can be a matter of concern for polluted urban rivers in

developing nations, including India, where it is difficult to avail large investments from urban local bodies.

- Few emerging examples of locally based solutions for river restoration are seen in the case of Australia and Europe, which again highlights the need for localized objectives for reimagining river restoration.
- A shift from engineering-based intervention to focusing more on ecological health using nature-based solutions is being experimented with worldwide context.
- Nevertheless, the examples indicate that both the technical-based solutions must be integrated with ecological innovative solutions like riparian plantation, multi-habitat creation, etc., which may gain effective results.

3.4 Policies and Programs of the Government of India

3.4.1 Brief

Like the Global Guidelines and Targets with respect to restoring river ecosystem, most of the attempts were also made post-independence identifying the necessity of national-level guidelines and legislatures to navigate the prospect of river rejuvenation and abetment of rising issues of pollution. Further, under the banner of flagship projects, several attempts were made to improve the existing condition. The following section reviews the attempts undertaken at the national level regarding legislature, policy, programs, and projects.

3.4.2 Review of Legislature and Policy Framework for River Restoration

In India the legislative attempts to conserve water body date back to the enactment of the River Conservancy Act (Madras Act IV of 1884) which specifically focused on regulating the use of land within riverbanks rather than river restoration. Some of the legislative initiatives that govern the river restoration initiatives in India are mentioned in brief below –

- **The Water (Pollution and Control) Act 1974**

  Water quality management in India is performed under the provision of the Water Pollution Control Act of 1974 along with the Water Pollution Cess Act of 1977. The basic objective of this Act is to maintain and restore rivers' wholesomeness by preventing and controlling pollution. The Act was responsible for setting up of

Central Pollution Control Board (CPCB) and State Pollution Control Boards of respective states but does not specifically mention action for polluted rivers. Unfortunately, **the Act and the institutional system under it have been a complete failure. 37 years since the system was put in place, there is not a single successful example of the functioning of the State PCB or a single case where one can say that a river has been cleaned up due to the efforts under this Act.** (Philippe, Paranjape, Thakkar, Joy, Wani & Ramesh, 2012).

- **Environment Protection Act 1986**

  Environmental Protection Act 1986 (EPA, 1986) resulted from the Stockholm Convention 1972 whose broad agenda was to improve the human environment. EPA, 1986 empowers the Ministry of Environment, Forest and Climate Change (MoEF & CC) to plan execute and conduct nationwide flagship programs. The primary agenda of the Act is to mandate environmental quality standards, particularly those concerning the emission or discharge of environmental pollutants. Pollution abetment of rivers, monitoring discharges into water bodies, and river rejuvenation can be undertaken under this Act.

  Various central-level authorities like the National Ganga River Conservation Authority in 2009 (later converted into National Ganga Council in 2016) u/s 3 of EPA, 1986 was formed for the abetment of pollution and Rejuvenation of the Ganga basin (MoEF, 2009). National Ganga Council is therefore chiefly responsible for executing the 'Namami Gange Mission' a key flagship program under the Ministry of Jal Shakti, Govt. of India. (MoWR, 2016)

- **Maharashtra Water Resources Regulatory Authority Act (2005)**

  The Act established Maharashtra Water Resource Regulatory Authority foe the purpose of regulating water resources in the state, sustainable and equitable allocation and utilization of water resources and to fix rates of water for irrigation, drinking and other purposes. The said act also had a power to determine the priority of equitable distribution of water available at the water resource project, sub-basin, and river basin levels during periods of scarcity.

- **National Water Policy 1987, 2002 & 2012**

National Water Policy (NWP) was drafted to govern the planning and development of water resources and their optimum utilization. After its adoption in 1987, the policy was revised in 2002 and later in 2012. Some of the key parameters focusing on the quality of river water and its restoration are as follows –

- **Perspective for Water Resource Planning:** NWP 1987 & 2002 indicates the national perspective of the policy whereas revision of NWP 2012 comprises an integrated approach from top to bottom which includes states and local governments.
- **Flood Management**: In addition to the emphasis on non-structural measures for flood mitigation (which includes floodplain zoning, flood management, and forecasting) in 1987 and 2002, greater emphasis is given to the rehabilitation of natural drainage systems**.**
- **Flow of rivers:** The Water Policy of 1987 does not specifically highlight river restoration and planning whereas it mentions the preservation of ecological balance. While in 2002, NWP stated that the minimum flow should be ensured in perennial streams for maintaining ecology and social considerations. Further, the latest revision of the policy in 2012 clearly sets directives to keep a set of areas along the river basin for ecological needs ensuring that the proportional high and low flow releases correspond in time close to the natural flow regime. (Drishti IAS, 2019)

Apart from the above-mentioned legislative frameworks, **The Wildlife (Protection) Act 1972, Forest Conservation Act 1980, and The Electricity Act 2003** address the river as a resource and its conservation in physical aspects.

Thus, the legislative framework in India does not specifically highlights river restoration as a key agenda. Still, it is identified that several major flagship programs can be undertaken due to the robust EPA 1986. Moreover, **all the Acts have conservation and protection measures for river basin, the term 'urban river'** still indicates that the urban freshwater bodies are being treated as a part of river basins which generalizes the measures undertaken for rivers in urban, peri-urban, and rural areas.

3.4.3 Key Flagship Programs Related to River Rejuvenation: Critical Overview

Namami Gange Program (1.0 & 2.0) is an Integrated Conservation Mission, approved by the Ministry of Jalshakti, Govt. of India as a flagship project with an agenda of **twin objectives of effective abatement of pollution and conservation and rejuvenation of the National River Ganga. (Drishti, 2021). The program is implemented by the National Mission for Clean Ganga (NMCG), an implementation wing of the National Ganga Council. The key objectives of the Namami Gange Mission are –**

- Providing sewage treatment infrastructure
- Riverfront development
- Promoting afforestation and biodiversity
- Monitoring industrial effluent

Namami Gange Mission 2.0 (2021-26), along with the completion of existing projects as a part of NGM 1.0, the focus is also being given to the revival of small rivers and wetlands. (Drishti, 2022). Launching the program bridges the gap between guidelines and projects to restore polluted river basins. Though the program focuses on restoring major polluted river stretches in the Ganga basin efforts were made to provide a framework of policies and guidelines to restore urban rivers. Some of the recent guidelines as an outcome of the Namami Gange Program includes

- River-centric Urban Planning Guidelines 2014
- Urban River Management Plan 2019
- Strategic Guidelines for Making River Sensitive Master Plans 2021

Source: Author

Figure 8: Various guidelines for strategizing actions for urban rivers in India

Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0 -

AMRUT 2.0 is a centrally funded flagship program under the Ministry of Housing and Urban Affairs (MoHUA) and succession to AMRUT 1.0 which was launched in 2014 with agenda of basic infrastructure, in the selected cities and towns, in the sectors of water supply; sewerage and septage management; storm water drainage; green spaces and parks; and non-motorized urban transport.(V. Murugaiah, R. Shashidhar, V. Ramkrishna, 2018). Along similar lines AMRUT 2.0 is launched with an agenda of 'Aatmanirbhar Bharat' and to provide 100% coverage to nearly 4700s ULBs. One of the key objectives is the rejuvenation of water bodies to augment water enhance amenity value and development of green spaces with the following sub-targets -

- Rejuvenation of wetlands, and water bodies by desilting, strengthening the embankments, and stone packing
- Diverting the polluting drains to treatment plants
- Harvesting the rainwater through storm water drains into the water body (which is not receiving sewage/ effluent)
- Strengthening/ rejuvenation of the aquifers/ community wells
- Creation/ strengthening of stormwater drains around the water body.
- Provision of STP to treat inflow into a water body.
- Development of community green spaces linked to a clean water body.

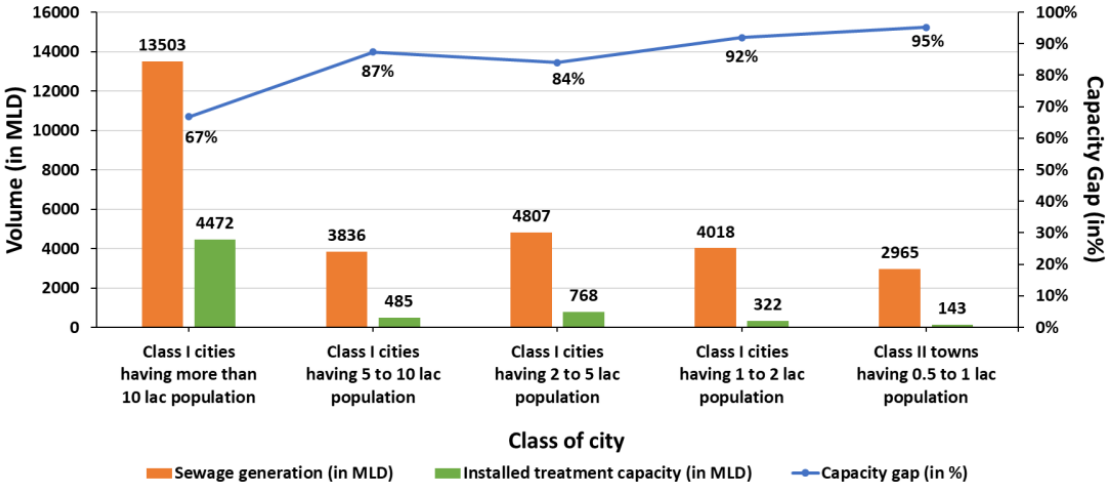
Compared to AMRUT 1.0 the successive timeline under AMRUT 2.0 indicates direct action to be undertaken for the abetment of river pollution and wastewater treatment. Identifying the fact that massive investment in urban infrastructure is required, the centrally funded program provides financial assistance to ULBs, but it still questions the financial capacity of building urban local bodies.

3.4.3.3. Swatchh Bharat Mission 2.0

Swatch Bharat Mission 2.0 (Urban) is the succession of Swatchh Bharati Mission (SBM-U) after achieving an agenda of Open Defection Free (ODF) ULBs by 2021. SBM-U 2.0 envisions making all cities 'Garbage Free' and ensuring grey and black water management in all cities other than those covered under AMRUT, making all urban local bodies as ODF+ and those with a population of less than 1 lakh as ODF++, thereby achieving the vision of safe sanitation in urban areas. The Mission will focus on source segregation of solid waste, utilizing the principles of the 3Rs (reduce, reuse,

recycle), scientific processing of all types of municipal solid waste, and remediation of legacy dumpsites for effective solid waste management. The outlay of SBM-U 2.0 is around ₹1.41 lakh crore. (PIB, Sept. 2021). The program also focuses on the treatment and reuse of wastewater which is indirectly related to the idea of promoting a healthy river ecosystem.

The flagship attempts justify the attempts made in the past decade highlighting the financial capacity required to improve the urban infrastructure scenario in India. With the rapidly rising urban population, there is a widening gap of supply and demand in the case of delivering basic sanitation facilities. Though major flagship programs like Swatchh Bharat Mission are aiming to improve the poor condition of urban sanitary practices in India, the high percentage of untreated flowing in an urban river indicates the poor existing state of wastewater treatment. As per the 2011 Census, Class I and Class II cities are estimated to have wastewater.



Source: Urban Wastewater Scenario in India, NITI Aayog, 2022.

Figure 9: Wastewater generation and treatment water capacity gap in Indian cities as per CPCB 2022

capacity as 29,129 MLD. It is expected to be 33,212 MLD at the current time considering the decadal growth of 30% (Fig. 7). Compared to this the existing capacity of sewage treatment is only 6,190 MLD. There is still a 79% (22,939 MLD) capacity gap between sewage generation and existing sewage treatment capacity. Another 1742.6 MLD wastewater treatment capacity is being planned or built. Even with this added to the current capacity, there is still a sewage treatment capacity shortfall of

21,196 MLD, equivalent to 73%. (NITI Aayog, 2022). Thus, this number clearly highlights the lack of treatment facilities for wastewater and sewage, and its widening

S.No.	STP Status	2014		2020	
		Number of STPs	Capacity (MLD)	Number of STPs	Capacity (MLD)
1	Operational	522	18883	1093	26869
2	Non-Operational	79	1237	102	1406
3	Under construction	145	2528	274	3566
4	Proposed	70	628	162	4827
	Total Installed (1+2+3)	**746**	**22648**	**1469**	**31841**
	Total Treatment (1+2+3+4)	**816**	**23276**	**1631**	**36668**
Data Source: CPCB. (2021)					

Source: Urban Wastewater Scenario in India, NITI Aayog, 2022.

Figure 10: Comparative status of STPs with respect to number and capacity for years 2014 and 2020

demand-supply gap is the key reason for pollution in river bodies. This estimates to be around USD 840 billion in urban infrastructure and municipal services in the 15 years till 2036 (in 2020 prices), equivalent to 1.18% of the estimated Gross Domestic Product (GDP) over this period. (Athar S. White R. & Goyal H. 2022). Hence an increasing gap of supply and demand for urban infrastructure seems to require a huge capital investment in future decades.

3.4.4 Major Examples of River Restoration in India

The major projects undertaken at the city level are the outcomes of the major policies and programs. The first proposal for developing the riverfront was presented in 1961 by the prominent citizens of the city. French architect Bernard Kohn proposed an ecological valley in the Sabarmati basin that stretched from the Dharoj Dam Gulf of Cambay in the 1960s. The construction started in 2005, and finally, it was completed in 2012. On similar lines various cities made several attempts to restore riverfronts using riverfront development as a tool. A few examples are listed below here –

Ahmedabad Municipal Corporation – Ahmedabad Municipal Corporation initiated the project by establishing a Sabarmati Riverfront Development Corporation Limited a special purpose vehicle (SPV) for the execution of the project in 1997. 11.5 km

riverfront was built reclaiming the land Though the riverfront development achieved one of its objectives over the years to make the river pollution free and create a recreational space for the city, the project encountered several delays due to concerns regarding water level, flooding, rehabilitation of displaced slum dwellers and the opposition from the activists involved with slum rehabilitation and problems in getting financial assistance to bear the cost of the project. Over the years though Sabarmati riverfront development is symbolic of how a natural river, not perennial but dependent on the monsoon, has been turned into an infrastructure project with an emphasis on commercial and recreational aspects rather than on ecological conservation. (Desai, 2022)

Pune – Pune Municipal Corporation (PMC) proposed a riverfront development project for pollution abetment along a 44 km stretch of Mula-Muth River predominantly comprising of channelizing and converting the rivers into canals by constructing 30- 40 Ft. high concrete or stone walls (Embankments) along both the banks. The project is identified to further narrow down the rivers by constructing embankments to create more land by reclaiming the riverbed or the flood plains. Reduction in the width of the river would reduce its cross-sectional area necessary for the uninterrupted flow of water. Consequently, whenever water is released from the dam, that flow will get less space to flow in the riverbed leading to the steep rise in flood levels inundating large areas of the city. As a result of these impacts local stakeholders' activities were involved in protests for 100 days.

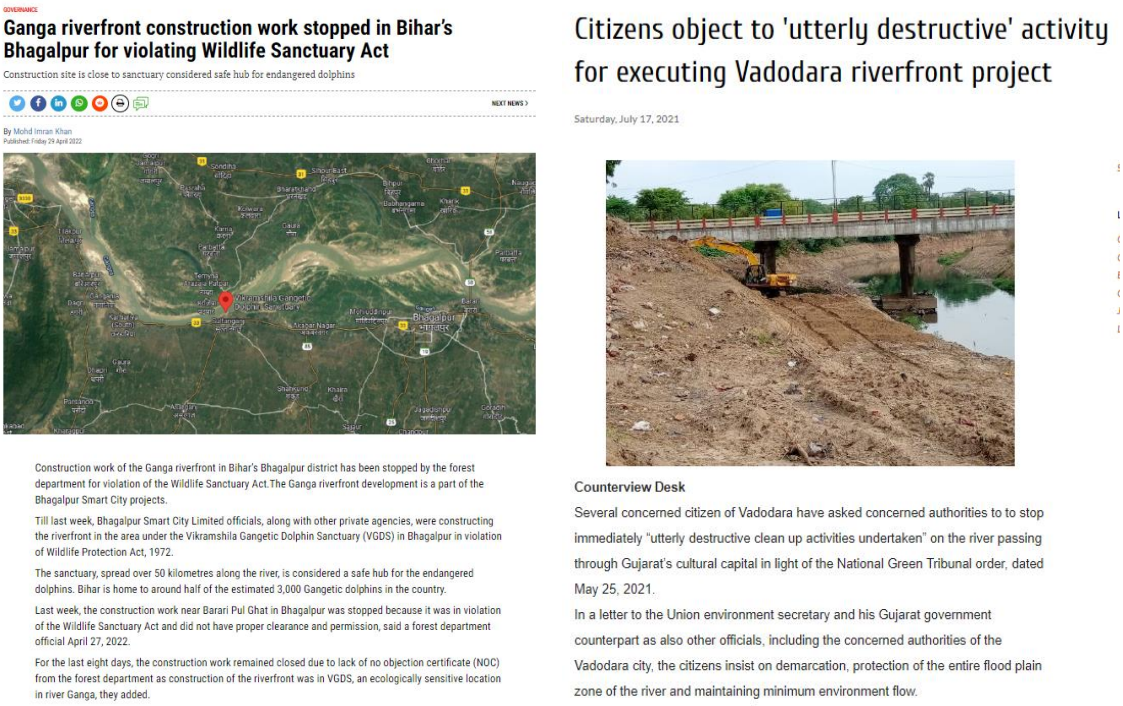
Vadodara – Vadodara Municipal Corporation (VMC) initiated the development of the riverfront along the banks of the Vishwamitri River in 2008. The most crucial objective of the project was to ensure the issue of flooding in the city is taken care of. The project The major concern was regarding the concretization of riverbeds and many other environmental concerns which will impact the river ecosystem. As a result, National Green Tribunal ordered a complete stay on the riverfront proposal in 2021.

Kota- The state government is in the process of making Kota city a tourist attraction where a 'Chambal River Front View' will be developed. But developing the Riverfront on the sides of the Chambal River ghats has now courted controversy. According to

activists, roads are being widened in the Walled City of Kota after razing old buildings of historical importance.

Bhagalpur – The riverfront development in Bhagalpur along the river Ganga is a part of the Bharaglpur Smart City project. The construction work was stopped by forest officials for violation of The Wildlife Protection Act 1972. The construction was without prior permission and officials were constructing the riverfront in the area under the Vikramshila Gangetic Dolphin Sanctuary (VGDS) in Bhagalpur.

Jaipur – Daryawati Riverfront Development was completed by Jaipur Development Authority (JDA) with a project cost of 1600 Crore. As the project remained unattended even after three years of completion, the encroachments are increasing inside and outside the boundary of the riverbank.



GOVERNANCE

Ganga riverfront construction work stopped in Bihar's Bhagalpur for violating Wildlife Sanctuary Act

Construction site is close to sanctuary considered safe hub for endangered dolphins

NEXT NEWS >

By Mohd Imran Khan
Published: Friday 29 April 2022

Construction work of the Ganga riverfront in Bihar's Bhagalpur district has been stopped by the forest department for violation of the Wildlife Sanctuary Act.The Ganga riverfront development is a part of the Bhagalpur Smart City projects.

Till last week, Bhagalpur Smart City Limited officials, along with other private agencies, were constructing the riverfront in the area under the Vikramshila Gangetic Dolphin Sanctuary (VGDS) in Bhagalpur in violation of Wildlife Protection Act, 1972.

The sanctuary, spread over 50 kilometres along the river, is considered a safe hub for the endangered dolphins. Bihar is home to around half of the estimated 3,000 Gangetic dolphins in the country.

Last week, the construction work near Barari Pul Ghat in Bhagalpur was stopped because it was in violation of the Wildlife Sanctuary Act and did not have proper clearance and permission, said a forest department official April 27, 2022.

For the last eight days, the construction work remained closed due to lack of no objection certificate (NOC) from the forest department as construction of the riverfront was in VGDS, an ecologically sensitive location in river Ganga, they added.

Citizens object to 'utterly destructive' activity for executing Vadodara riverfront project

Saturday, July 17, 2021

Counterview Desk

Several concerned citizen of Vadodara have asked concerned authorities to to stop immediately "utterly destructive clean up activities undertaken" on the river passing through Gujarat's cultural capital in light of the National Green Tribunal order, dated May 25, 2021.

In a letter to the Union environment secretary and his Gujarat government counterpart as also other officials, including the concerned authorities of the Vadodara city, the citizens insist on demarcation, protection of the entire flood plain zone of the river and maintaining minimum environment flow.

Source: SANDRP, 2022

Figure 11: Existing status of riverfront projects in Bhagalpur and Vadodara

Hyderabad - The Telangana government has shelved the Musi Rejuvenation and Beautification Project despite spending crores on the much-publicized venture and annually paying Rs 3.15 crore as salary to employees of Musi Riverfront Development Corp Ltd (MRDCL) for six years. en conceived in 2006, successive governments ignored it. Finally, MRDCL was constituted on March 25, 2017, after repeated

complaints of pollution by residents living alongside the Musi. The government allocated to the corporation Rs 377.35 crore in 2017-18, but it spent only Rs 0.32 crore. Though the allocation remained the same in the subsequent years, MRDCL spent Rs 2.8 crore in 2018-19 and similar meagre amounts in the subsequent financial years too. Moreover, cities like Madurai, Bilaspur, and Jammu are facing the common issue of protests from stakeholders and violation of ecological norms as a part of riverfront development. Contemporary riverfront developments in India are facing the daunting task of achieving a balance between the dichotomous idea of local vs. global.

Urban development projects, including riverfront developments in India, are generally undertaken by the local government agencies, following a top-down approach, whereas planning and design proposals are prepared by the agencies themselves or by professional consultants without the involvement of stakeholders resulting in poor acceptance of proposals and implementation by the agencies or private contractors. This exposes missing links which need to be mended according to a new approach in the current planning process. By incorporating the needs and interests of all stakeholders in the planning process, as suggested above, the gap between the aims and objectives of the plan for riverfront development and their delivery to the users can be bridged. The final plan would be socially responsive, economically viable, and environmentally sustainable. (Vriddhi. V, 2017). Apart from this, there are several other cases of Indian urban contexts in which there is no initiation of an attempt to restore the river, which is discussed below –

3.4.5 Condition of River in Major Urban Cities in India

- **Mula Mutha River Pune:** Mula Mutha River, Pune: Mula Mutha River is an East flowing river from Western Ghats. The river covers a path of 22 km throughout Pune's urban area. Over time, as the city expanded, uncontrolled sewage and industrial waste degraded water quality. As per MPCB Report in 2018, the river was mentioned as the second most polluted river in Maharashtra. (Manivanan R. & Jagtap S.S.) As per the MPCB Report 2018-19, Mula Mutha contains 332.08 mg/l faecal coliform. Similarly, the river has a BOD level of 12.43 mg/l whereas the COD level is 42 mg/l which is far more than the expected level of 3mg/l and 2.41 mg/l (MPCB, 2018-19).

- **Mithi River, Mumbai:** Originating at Powai, Mithi River is the convergence of water discharges from Powai and Vihar lakes. Considered as one of the most polluted rivers in Maharashtra, the entire 18 km stretch of the Mithi River is highly contaminated with pollution and sewage dumping. The river is treated as an open Nalla by nearby small and medium-scale industries and illegal tenements. As of 2018, the BOD level falls under priority I i.e., 95mg/l (MPCB, 2019). The river also vulnerable to flooding in the monsoon due to heavy rains and poor management of stormwater. Stretch along Dharavi, one of the largest slums in the world is the most polluted stretch throughout.

- **Nag River Nagpur:** Nag River is a part of the Kanha-Pench River system originating from Ambazari Lake and flows through urban areas of Nagpur for a stretch of 17 km. It is identified that the river receives fresh water only at the time of monsoon and rest of the year it carries untreated sewage and industrial effluent across the city. Nag River is responsible for polluting the Ghoiskurd dam built on the Wainganga River downstream, therefore, pollutes the entire major river basin of the Wainganga River. due to high organic load in terms of TSS: 20-600mg/L, COD 62-1880 mg/L and BOD 12- 315mg/l. (ESR Nagpur, 2019-20)

- **Musi River, Hyderabad:** The Musi River is part of the Krishna River basin and is associated with an ancient irrigation system comprising a large wetland system. It joins the Krishna River after flowing through Hyderabad. The pharma and chemical industries in south and west Hyderabad, which discharge pollutants into the city river, are major sources of river pollution. As a result, Musi River was declared the most polluted river in Telangana by National Green Tribunal (NGT) in 2022 (Kashyap, 2022). Maximum BOD, DO and faecal coliform sampled from the river stretch is 18mg/L, 0.3 mg/L, and 1600 mpn/100 ml respectively.

Apart from other major examples, most urban rivers face the serious threat of degraded freshwater ecosystems, encroachments in floodplains, and disposal of untreated sewage. A few other examples include the Ulhas River in Dombivli, River Ganga stretch in Kanpur, and River Yamuna stretch in Delhi. Among all the examples

mentioned below, dumping of sewage and untreated domestic waste is the common source of river contamination.

Note: Apart from all other locations, Mithi river along its stretch near Dharavi is found to be highly polluted due to untreated waste from slums. Situation during the flood worsen as the polluted water finds its way on streets and neighbourhood's leading to heavy contamination during monsoon. .

Note: Encroached floodplains along the River Nag are the major source of sewage released into river water.

Figure 12: Polluted River Stretch (from top to bottom) of Mithi River, Mula-Mutha River, Nag River, and Musa River respectively

3.5 Summary

The major objective of the literature study was to understand the actions and programs that are undertaken at both national and international level to understand the approach in dealing with issues of river restoration. There is a paradigm shift in the approach that is seen in worldwide actions of river restorations whereas in India, the river restoration is still highly based on engineering solution. As mentioned in most of the key flagship projects under Central Government maximum capital expenditure is done to river rejuvenation using engineering-based system where in most of the cases is violating the environment in context of rivers. Considering such a huge capital expenditure every year on improving river quality is a serious financial drain. As a result, there is an immediate need to understand the practices of various countries other way round and to understand the fundamentals adopted in river restoration and conservation practices.

4 NAG RIVER AND ITS RELATION TO THE GROWTH OF NAGPUR CITY

Nagpur the name of the city is associated with the Nag River along which city developed during the past centuries. Like all other cities Nagpur is also closely related to the Nag River. It is important to understand the largest picture of city to get an overview of the city in general terms. The following section initially starts with city's narrative and development in past decades and later based on various secondary studies, various aspects of Nag River in relation to the city are studied in detail. The rationale is to understand the setting of Nag River through chronological development of city and later getting into technical discussions focussing on Nag River and its condition.

4.1 Nagpur's Urbanization over the period from past centuries

4.1.1. Introduction

Nagpur with respect to population (As per Census 2011) is the 13th largest city in India and third largest in area and population after Mumbai and Pune in Maharashtra State. It is the major commercial and political center of the Vidarbha Region. The city has derived its name from the Nag clan which were pre-historic natives of this place who resided along the Nag River. The city has a 24 million population (As per Census 2011) with an average density of 11304 people/ sq. km. and a spatial extent of 217.65 sq. km. The city is divided into 136 wards among 10 administrative zones (Figure 13).

Zone	Zone Number	Area (sq. km)	Population	Population Density	Percentage Population
East	1	59.53	665,103	11,172	28
West	2	42.24	334,635	7,923	14
North	3	43.09	398,667	9,251	17
South	4	64.52	662,110	10,262	27
Central	5	11.43	337,487	29,519	14
	Total	**220.82**	**2,398,000**	**68,127**	**100**

Source: Kotharkar & Sarda, 2019

Table 1: Zone-wise population density of Nagpur City

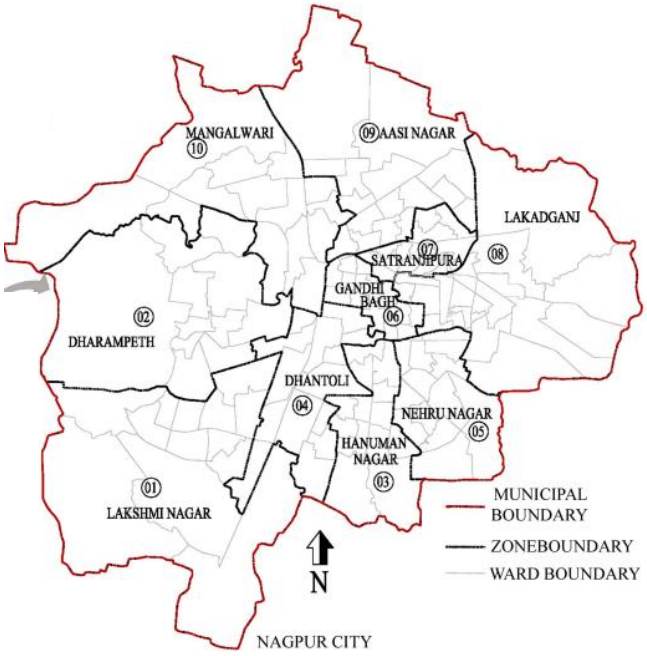
Year	1971	1981	1991	2001	2011
Spatial Extent	------	21756	21756	21756	21756
Population	864,488	1,219,461	1,650,751	2,051,946	2,405,665
Gross Population Density	40	56	76	94	111
Developed Area (in hac.)	7047	8425	9794	12481	13609
Developed Area density	123	145	169	164	178

Source: Draft Regional Plan, NMR (2012-32)

Table 2: Spatial Expansion of City from 1970 to 2010

4.1.2 Administrative Set-up

Nagpur Municipal Corporation (NMC) is the urban local body governing the functioning of Nagpur City set up under Maharashtra Municipal Corporation Act 1949, which became functioning in March 1951. Nagpur is an important urban center in the Vidarbha region, the Winter Capital of Maharashtra Legislative Assembly, the largest



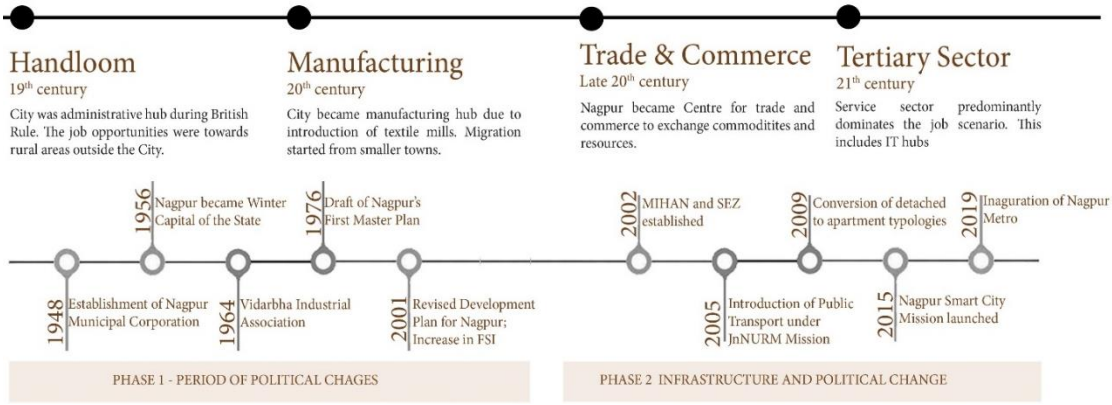
Source: Kotharkar, 2017

Figure 13: Nagpur Municipal Corporation jurisdiction showing zones and ward boundaries.

urban center in the district in terms of population, area, and the district headquarters. NMC governs the city area of about 227.38 sq. km and is divided into 136 administrative wards classified into 10 administrative zones (Figure 1). Further, Nagpur Improvement Trust (NIT, constituted as per the Nagpur Improvement Trust Act, 1936, is a non-elected body responsible for urban development and infrastructure within the city limits and for the development of new areas outside the city, apart from these Nagpur Metropolitan Regional Development Authority which is constituted under Maharashtra Metropolitan Area Development Authority Act 2016. NIT is entrusted as the Special Planning Authority for Nagpur Metropolitan Area.

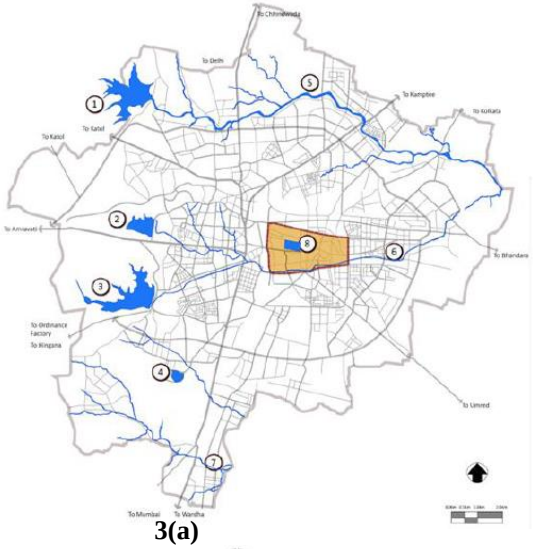
4.1.3 Chronological Development from Past to Present (17th - 21st Century)

Nagpur city's foundation was laid by the Gond King of Deogad, Bakht Buland Shah, in the year 1703. Chand Sultan, the successor to Bakht Buland Shah, constructed a three-mile-long wall around his city by the Nag River. In 1837, Nagpur became the capital of Bhonsle's Kingdom where it became the economic and cultural center of the Maratha territory. The city was annexed in 1817 by the British after the defeat of Appasaheb Bhonsle in the Battle of Sitabuldi. The city, during the British period, established textile mills outthrowing the existing cottage and handloom industry which was set up during Bhonsle's rule. Consciousness for planned city development was raised by Sir Patrick Geddes, who visited the city in 1915. (NMRDA, 2016). Identifying the location advantage and economic growth, Nagpur became the headquarter of Central Provinces and Berar under British Rule till 1956, when Nagpur became part of Maharashtra State as per the State Reorganization Act 1956.



Source: Author

Figure 14: Predominant economic sector and major events after post-independence in Nagpur City



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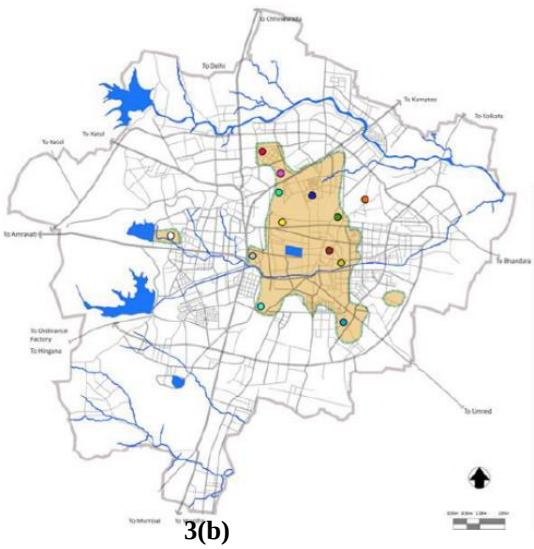

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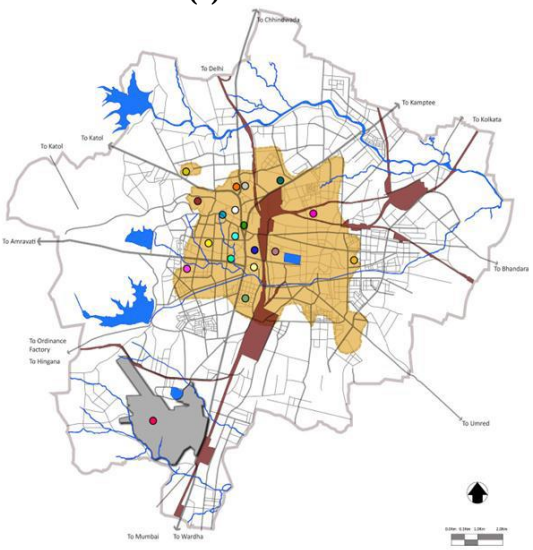

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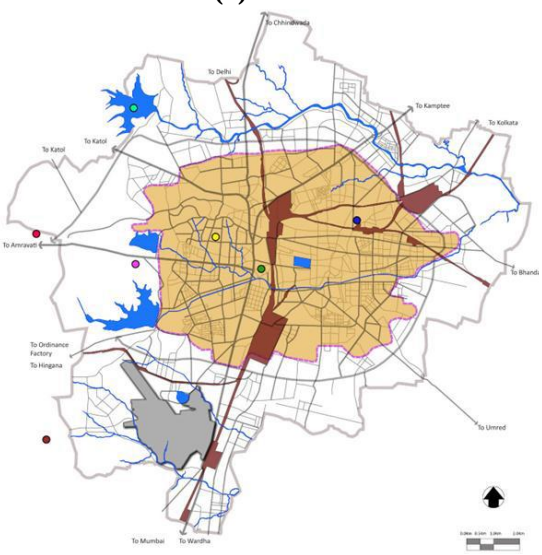

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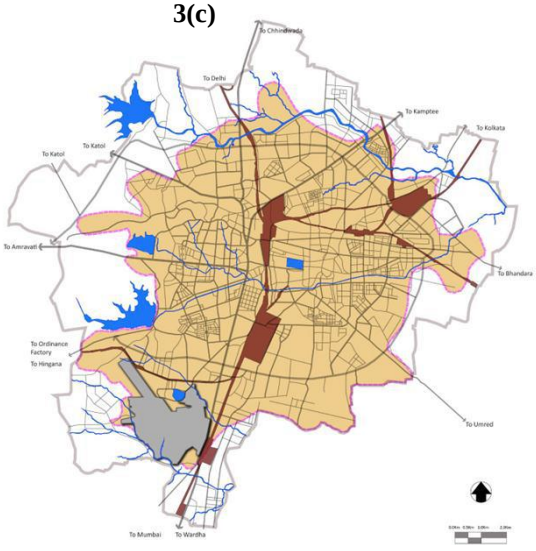

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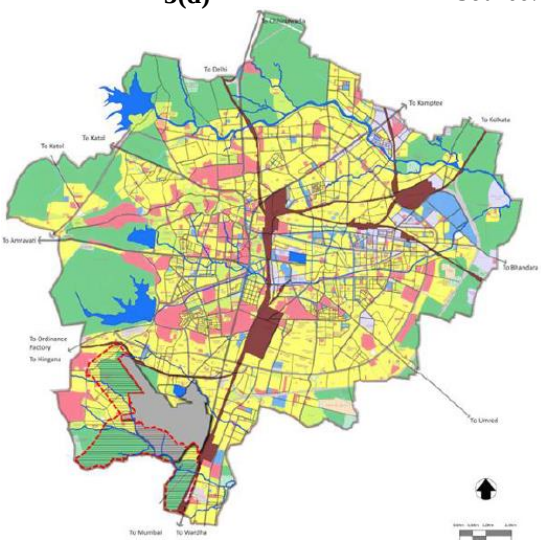


3(f)

Figure 15: Predominant economic sector and major events after post-independence in Nagpur City

(Note: **Fig. 3(a) The highlighted area indicates the territory of the Gond Ruler Buland Bhakt Shah the founder of Nagpur City**. Presently the area is known as Mahal which has highest population density compared to other areas of the city.

Fig. 3(b) Expansion of Nagpur under Bhonsle's Rule during 18th century (1743-1854). The city expanded towards North and South of the Old City Area with establishment of various commodity markets.

Fig. 3(c) Expansion of Nagpur under British Rule (1854-1947). Sitabuldi Fort near Old City are becoming the administrative centre. Establishment of textile mills started in the city.

Fig. 3(d) Post-independence expansion of Nagpur (1946-1976). MIDC Hingna towards East of the Old City developed as Industrial centre. Sitabuldi and Civil Lines continued to be retail market and administrative area respectively.

Fig. 3(e) Expansion (1976-2000) Regularization of unauthorized layouts under Gunthewari Act led to the expansion of the city during this period.

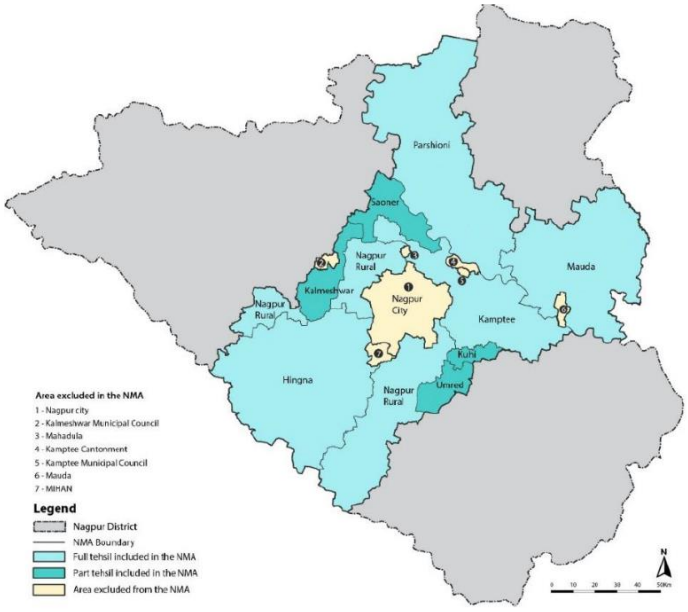
Fig. 3(f) Expansion (2000-2020) indicates the revised sanctioned proposed land use plan for Nagpur showing distribution of land use along with expansion of the city).

The exponential growth of the city radially outwards in all directions from the Old City area is seen from 1947-2000 due to increased migration and a high population growth rate. With changing administrative and political scenarios over a period, the city has experienced a change in dominating the economic sector with initial dependency on the cottage and handloom industry to manufacturing and textile mills in British Rule. During the post-independence period, the city is dominated by the tertiary sector of the economy.

4.1.4 Regional Context and Setting

The sanctioned Nagpur Metropolitan Area (NMA) consists of 721 villages outside city limits with a total area of 3567.37 sq. km. *(Fig. 3).* NMA comprises the predominant established industrial area of MIDC and MIHAN along with regional sub-centers like Butibori, Hingna, Umred and Kalmeshwar. Identifying the opportunities of jobs generated by these areas, the city is connected to all the major sub-centers using Metro Rail. As a result of this, the future scenario identifies the concentration of the population near urban fringes where job centers are located. Thus, the majority of growth will mainly occur close to employment centers – MIHAN, Butibori, Hingna and areas located close to the city within the Outer Ring Road; and along main transportation

corridors – Wardha Road (NH-7), Amravati Road and Bhandara Road (NH-6). (NMRDA, 2016).

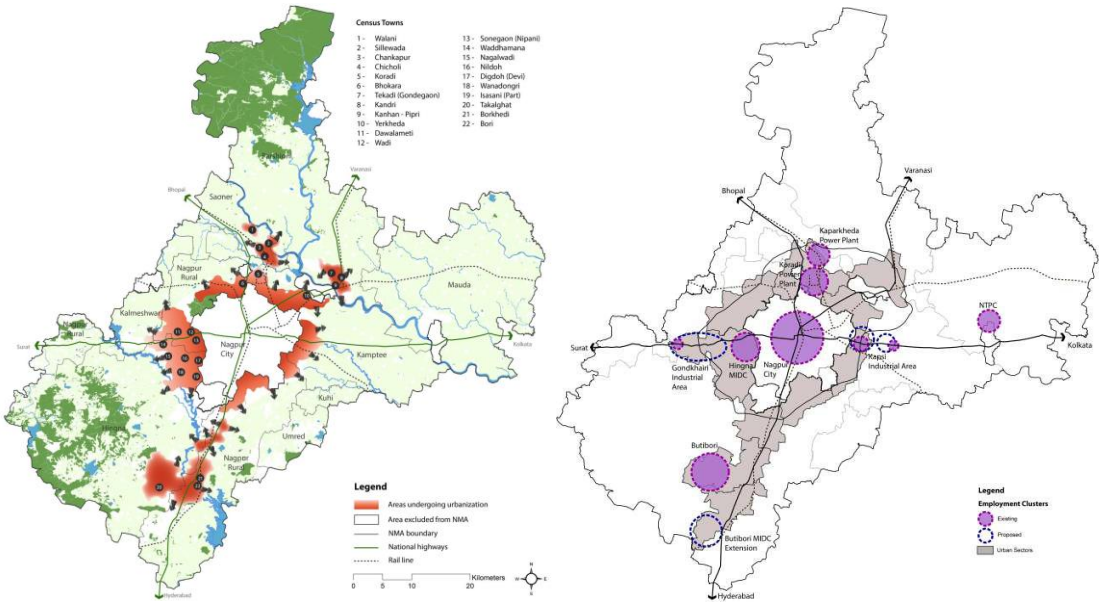


Tehsil under NMA	Area (in sq. km)
Parshioni	762.25
Hingna	641.07
Nagpur (Rural)	393.52
Mauda	815.19
Kamptee	617.24
Saoner (Part)	125.10
Kalmeshwar (Part)	103.10
Umred (Part)	75.10
Kuhi (Part)	34.80
Total	**3567.37**

Source: Draft Regional Plan, NMR (2012-32)

Figure 16: Present jurisdiction and percentage of the area of tehsils of Nagpur Metropolitan Area (NMA)

Over the years these above-mentioned urban corridors and some of the emerging Census Towns are experiencing urbanization at a rapid rate resulting in urban sprawl. Other than proximity to job centres, the availability of land in surplus at a cheap rate is also a key factor for sprawling city (Fig. 3). The data on non-agriculture permissions



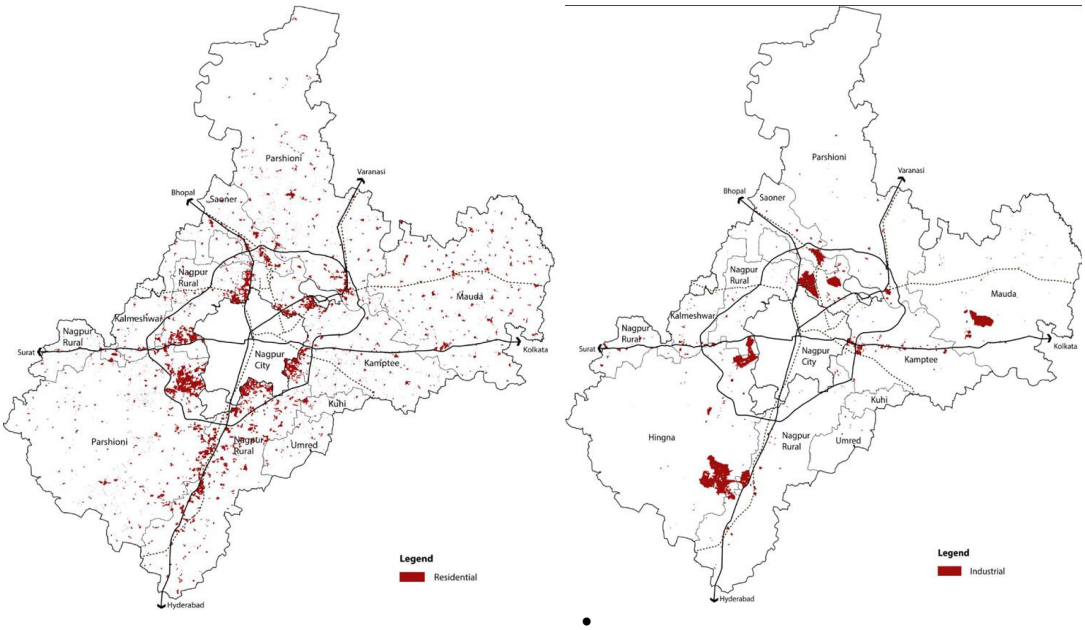
Source: Draft Regional Plan, NMR (2012-32)

Figure 17: Map showing areas undergoing rapid urbanization and emerging sub-centers in the NMA area.

granted in the past decade indicate that large tracts of agricultural land is rapidly converted to urban uses (NMRDA, 2016). The recent development of MIHAN has spawned several residential and commercial projects south of the city on NH-7. Sparse growth is also observed towards the north-east between the City and Kamptee town. Construction of the Outer Ring Road (ORR) has aided the prospects for new developments to be located on all sides of the city. The presence of upcoming residential clusters (Fig. 5) concentrated in the areas of industrial activities indicates the city's spatial transformation from a monocentric city to a polycentric city (Kotharkar, 2015).

Some of the key points identified addressing the key growth areas expected to rise in the future are mentioned here –

- **Residential development -** Observed along NH-7 running north (Bokhara village north of Nagpur city) - south (along Butibori industrial area) and NH-6 running east-west (significant towards the western side than to the east) of the city. Emerging residential clusters are also observed along SH-255 near the Hingna MIDC area and SH-9.
- **Industrial development -** The total industrial use constitutes an area of 61.37 km2 covering about 1.72 percent of the NMA with most of the land under the MIDC areas of Butibori and Hingna. Apart from the MIDC areas, a few



Source: Draft Regional Plan, NMR (2012-32)

Figure 18: Spatial of growth of residential and industrial pockets over past years in NMA

industrial uses have been observed towards the south along the NH-6 on the eastern side of the city in the direction of Kolkatta especially the Kapsi (Kh) village.

4.1.5 Spatial Changes in past years (2000-2020)

Land Use Land Cover classification along with Land Surface Temperature data indicates are used to highlight the changes in land cover over past decades. This indicates the key areas where significant development has taken place. Moreover, LULC helps to identify the degree of encroachment taking place in the city along water bodies. Following are the key points that can be highlighted from the satellite images

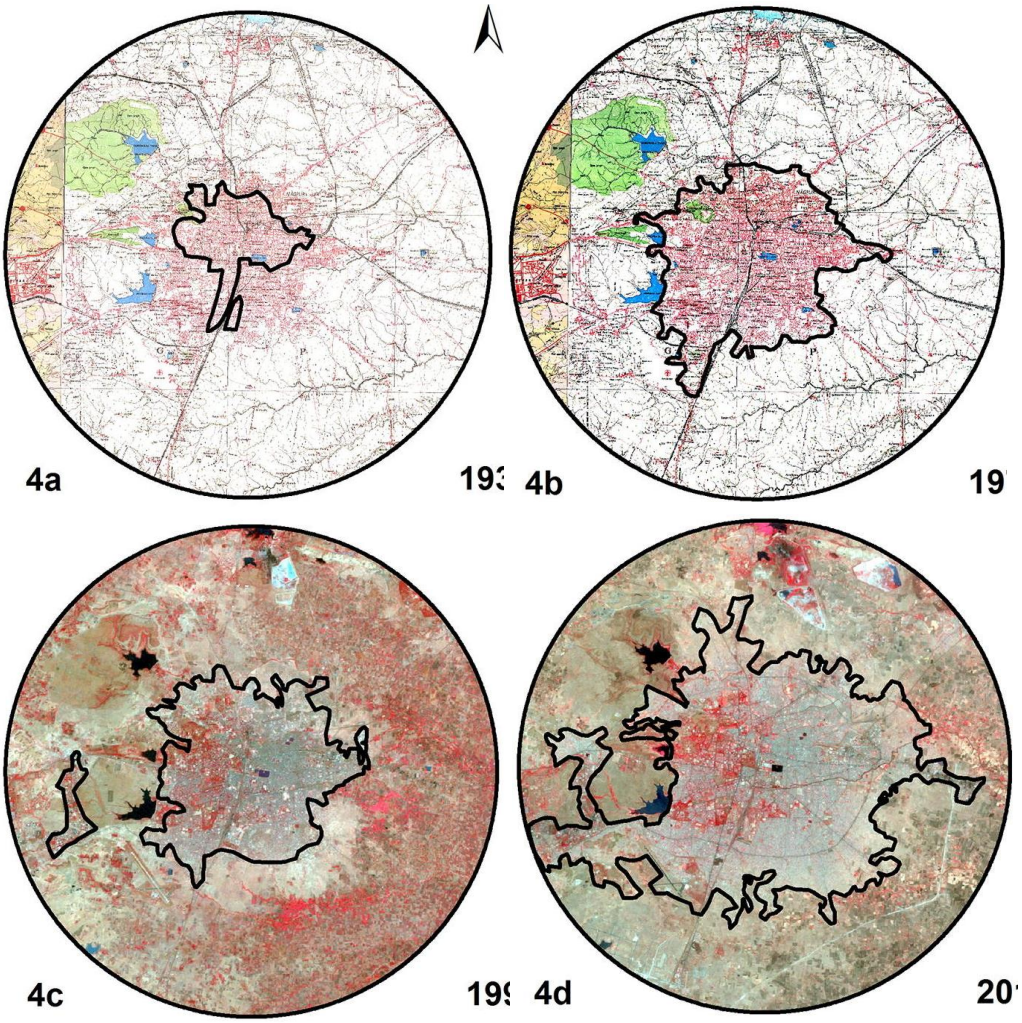
- From 2000-20 the change in LULC mainly occurred between two classes of built-up and vegetation. The built-up area increased by about 26.62 % (59.46 sq. km) of the total area, vegetation decreased by 15.93 % (35.58 sq. km), barren land also decreased by 10.88% (24.32 sq. km), and water bodies increased by 0.19 % (0.43 sq. km) of the total study area. (Kumar & Upadhyay, 2022)

LULC Classes	2010		2020		Change from 2000-2020	
	Area	Percentage	Area	Percentage	Area	Percentage
Barren	80.266	38.09	39.560	18.77	40.706	-19.32
Built-up	56.541	26.83	19.143	44.20	37.398	17.37
Forest	14.94	7.09	13.342	6.33	1.598	-0.76
Water Body	3.619	1.72	3.26	1.55	0.350	-0.17
Agriculture	55.345	26.27	61.422	29.15	26.195	2.88
Total	**210.72**	**100**	**210.72**	**100**	**100**	**0**

Source: Kumar A. Upadhayay A. Nagarkar S. Reddy M. & Kumar R. & Singh A. 2022

Table 3: Distribution of various land use land cover classes and percentage change over decade (2010-2020)

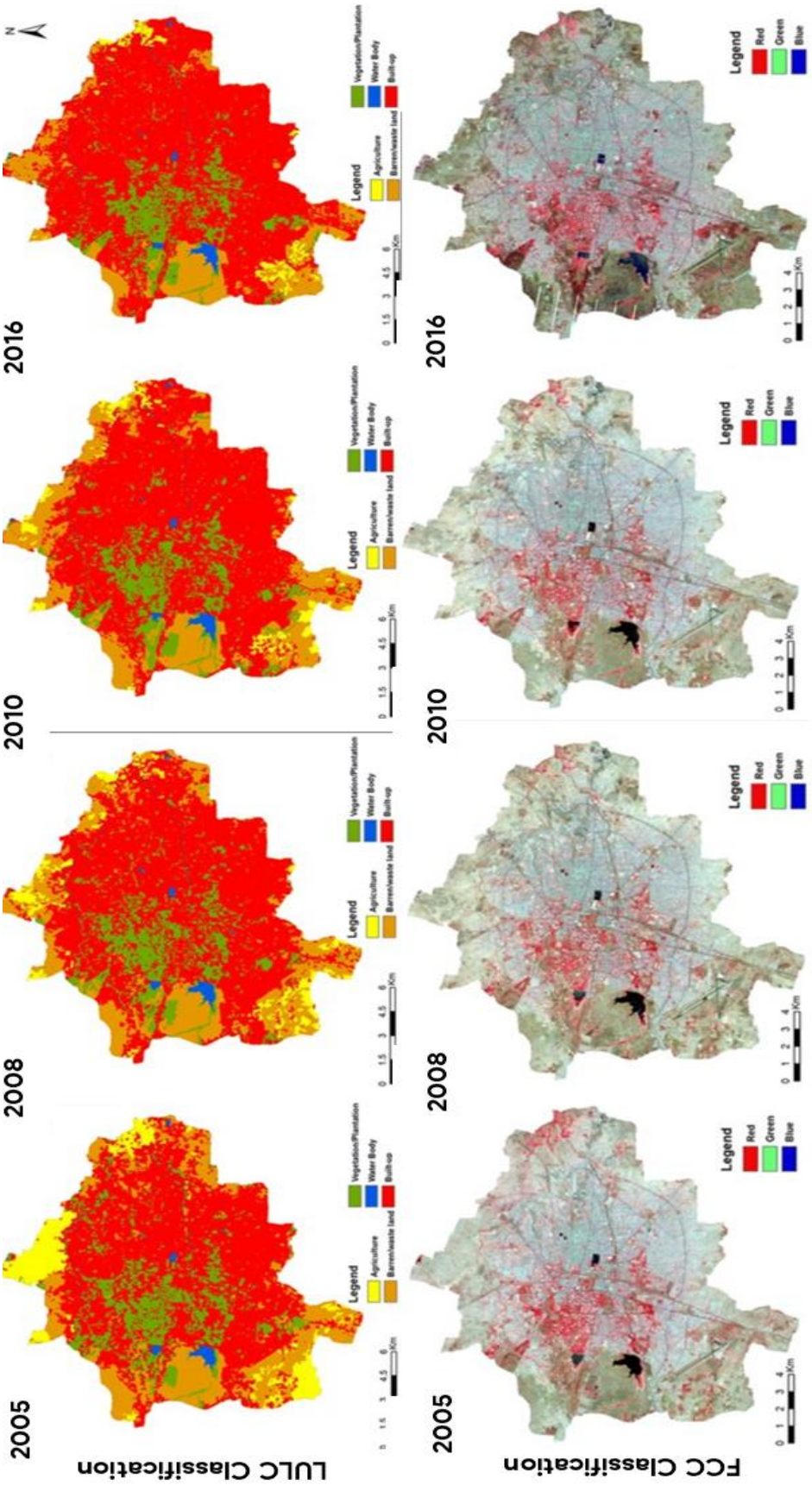
- The land use matrix reveals that from 2000 to 2020, about 30.14 km2 area of barren land is changed to a built-up region, 6.29 sq. km of the area to vegetation, and 0.01 sq. km area is converted to water bodies (Table 3). About 11.33 sq. km area of vegetation is converted to barren, 31.65 sq. km area is converted to build-up and 0.5 sq. km area to water bodies; about 0.01 km2 area of water bodies is converted to built-up and 0.13 sq. km area to vegetation (Table 3).



Source:

Figure 19: Images showing the rising sprawl of Nagpur over the past decades.

Both LULC and False Colour Composite data show the trend of urbanization. All the temporal variations show the urban fringes are more vulnerable to the land cover change from vacant land to build-up. This indicates that there is not enough significant change observed in the city center which was already densely populated. Therefore, the urbanization trend in the past decades highlights no relation to the increasing built-up in proximity to Nag River. Similarly, no significant development is seen in the

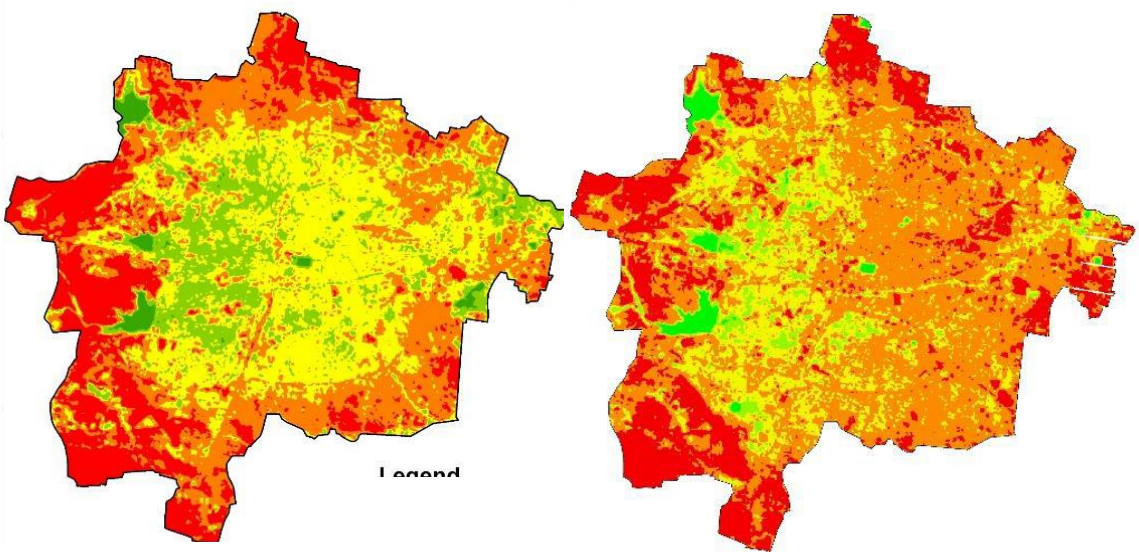


Source:

Figure 20: LULC and FCC classifications from 2005 to 2016

Note: Images here shows the increasing built-up over a period in LULC classification. Similarly red areas in False Color Composite indicates the change in vacant land for various use including built over a period. A significant transformation and rise in built cover is seen getting replaced by other land cover

upstream of Nag River but as the temporal change is seen in the Eastern part where Ambazari Lake is located, there is a possibility that the catchment of Ambazari is impacted over a period due to LULC change. Moreover, a similar trend is shown using land surface temperature analysis *(Fig. 8)* which highlights the similar result of change in considerable amount of land cover from vacant land to build up in urban fringes.



Source: Khan & Das, 2021

Figure 21: Distribution of various land use land cover classes and percentage change over decade (2010-2020)

LST shows that both barren land and built-up land cover classes have the highest temperature in the study area ranging from 42.6 – 46 degree and 38.48- 43.02 degrees respectively during the period 2000-2020 (Khan & Das, 2021). This rise in temperature is due to replacing natural vegetation with artificial surfaces including concrete showing a significant increase in built-up coverage over the past decades (Table 4).

LULC Classes	Temperature 2000	Temperature 2020	Change (2000-2020) in degrees
Barren	42.6	46.48	+3.88
Built-up	38.48	43.02	+4.54
Waterbody	27.45	30.75	+2.99
Vegetation	33.88	41.87	+3.3

Source: Khan & Das, 2021

Table 4: Table showing variation in percentage based on LST analysis.

4.1.6 Recent city-wide development (2016-21)

With the increasing population and considering spatial growth over the years, Nagpur is transforming in various spheres like administration, urban infrastructure, municipal finance etc. Some of the recent developments which are expected to impact city-wide development in upcoming years are as follows -

- **Administrative sphere:** To improve the efficiency of the functioning of NMC within municipal limits of the city and NMRDA outside city limits in the Metropolitan region, the abolition of Nagpur Improvement Trust is expected in the coming years. The abolition will lead to the distribution of assets among NMC and NMRDA. This step will ensure defining of the roles of the administrative bodies. The process was started in 2014 while as per the recent development, a petition to High Court was filed against the failure of the State Government to abolish NIT in 2019. *(TOI Nov. 12, 2019)*
- **Urban Development Projects:** Nagpur Metro Rail Phase II will follow the extension of four main corridors which were developed as per Phase I. The 43.8 km Phase-II shall extend to Kanhan in the North, Butibori MIDC in the South, Transport Nagar (Kapsi) in the East, and Hingna in the West with 32 stations planned over the entire route. As per the recent development, Maharashtra Cabinet has approved the revised project of Metro Phase II. *(Swarajya, Feb. 9, 2023)*. Similarly, the Union Cabinet has approved the Nag River Pollution Abetment Project which was pending for the past two decades to improve the condition of the polluted Nag River and increase city-wide sewer coverage. *(Nagpur Today, Dec. 9, 2022)*
- **Improvement in Municipal Finance Accounting System:** Nagpur Municipal Corporation from the coming financial year (2023-24) is going to adopt a real-time financial accounting system. Action is undertaken to abolish the cash-based, old manual tally-based system. The new system will help to provide real-time income-expenditure data and plan future municipal budgets. *(TOI, Feb 10, 2023)*

The later sections in the coming chapters highlight the critical aspects with respect to all the upcoming development and their impacts in detail along with specific impacts on Nag River and its context.

4.1.7 Summary

Throughout the section, the core point of discussion is the significant development happening outside the city limits. LULC and LST data validate that very few areas indicate a change in LULC cover over the past decades whereas no changes are seen within core city areas. In proximity to major water bodies including Nag River also there is no sign of significant encroachment or increase in built-up. But with the high degree of development occurring along the urban fringes can have a significant impact on the catchment of lakes within their proximity including Ambazari which forms the source of the Nag River flowing through the city. Hence urban sprawl during past decades may not be the reason of the contaminated condition of Nag River. There is no significant change in the Nag River's context if we look at past trends although the city is expanding.

4.2 Past Planning Efforts (Identifying the statutory planning efforts in case of Nagpur and Nag River)

The first effort towards the development of city infrastructure was seen in 1869 when the establishment of Nagpur Municipal Committee for the development of the town of an area of 3.8 sq. km. Further in 1937, the establishment of Nagpur Improvement Trust (NIT) was done, and it was given the status of Town Development Authority to undertake executive works regarding the development of Nagpur city. The first master plan was prepared in 1946 by NIT, which focused on various aspects like the issues of financial policy, development control, zoning regulations, etc. but it was not sanctioned and not implemented. Serious efforts toward the preparation of statutory plans started with the formation of the Nagpur Municipal Corporation (NMC) in 1951 followed by the enactment of the Maharashtra Regional and Town Planning Act in 1966. The statutory provision identifies the preparation of the two-level plan viz. Regional Plan at the regional level and Development Plan at the city level.

4.2.1 Development Plan

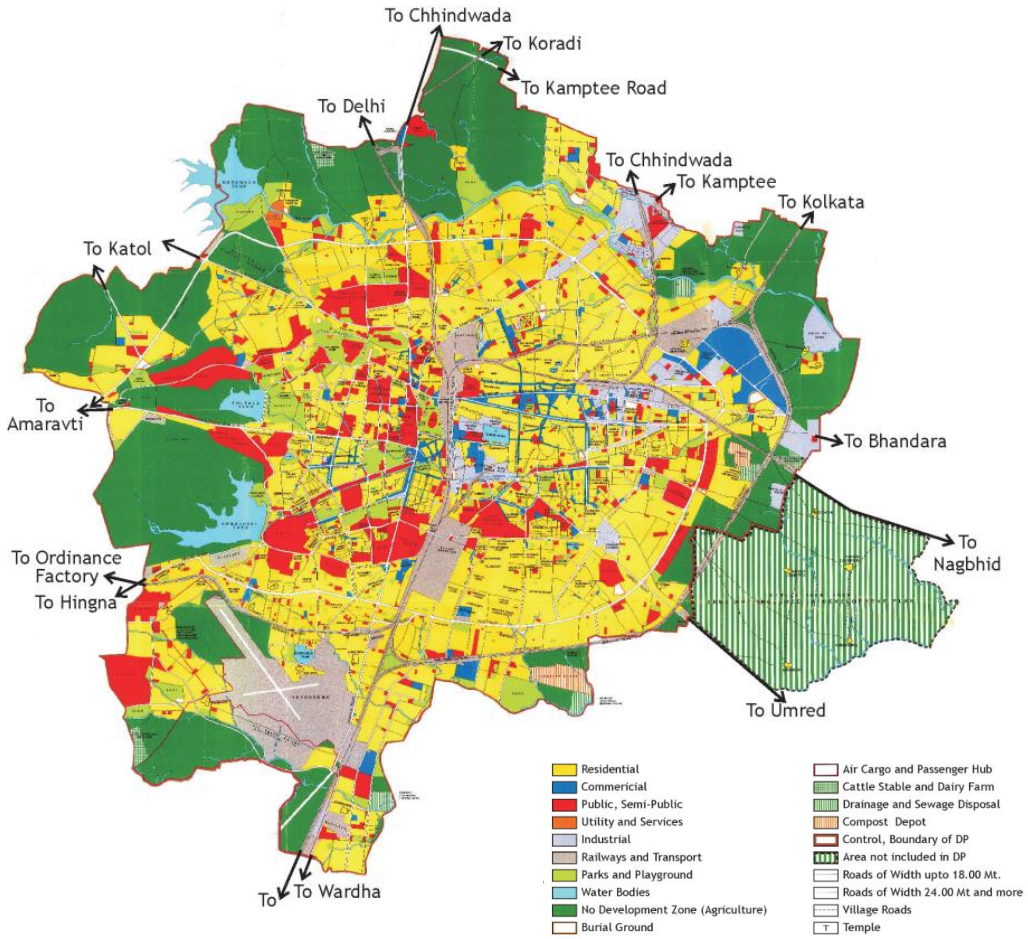
The statutory plan of the city is prepared in 1971 and was sanctioned in 1976. Further, the development plan was revised in 1986 which was sanctioned in 2000 and is currently under implementation. The following are the key aspects of the existing revised development plan 1986-2011.

Major Land Use	Area (in hac)	% Total
Residential	3500	16.08
Commercial	185	0.85
Industrial	225	1.08
Public Purpose	2000	9.19
Public Utility	100	0.47
Roads	555	2.55
Railway	440	2.08
Airport	525	2.42
Open and Garden	150	0.69
Developable Vacant Land	660	3.03
Total Developable Area	8340	38.40
Agriculture	8000	36.78
Forest	225	1.03
Water Tank	456	2.09
River / Nalla	380	1.74
Non-developable Land	4355	20.02

Source: Kotharkar R.

Table 7: Landuse Distribution as per Development Plan 2000–2011 of Nagpur

- As of 2014, Out of the total area of 21,756 hectares available within the Municipal Corporation limits, only 8340 hectares (38%) were notified for development.



Source: NMRDA

Figure 22: Sanctioned proposed land use plan for Nagpur city.

- About 38% of the land was kept under agriculture and forest cover and 4% was under nallahs (rivulets) and water bodies. As per Urban Development Plans Formulation and Implementation (UDPFI) guidelines, the land use distribution of developed land (as proposed in the Development Plan) conforms to the guidelines in the case of residential usage.
- Presently, much of the agricultural green belt is encroached upon and developed as built-up residential sprawl. The city has large agricultural land, forest cover, and institutional open spaces which compensates for the deficit of land under parks and gardens (recreational spaces) which is only 2%.
- Almost 660 Ha (i.e., approximately 8%) of developable vacant land is still available within the NMC administrative limits that may be used.

4.2.2 Regional Planning

The foundation of Regional Planning started delineating Nagpur Metropolitan Region constituted by GoM in 1967 which covered a total area of 1520 sq. km. and included Municipal Corporation limits (with an area of 217.53 km2), 1 Cantonment Board of Kamptee (15.10 km2) and 2 Municipal Towns of Kamptee and Kalmeshwar along with 262 villages. The following are the major characteristics of the previously sanctioned regional plans for the Nagpur Metropolitan Area.

Regional Plan 1971-1991 – A Regional Planning Board was constituted for the preparation of a long-term perspective plan that was sanctioned in 1976. The vision and major objective of the plan were to identify the potential areas to decongest the town and identify suitable industrial regions within proximity of the city. In this period, MIDC acquired 750-hectare land to revamp the industrial area and developed proper road and water infrastructure. Following were the key focus area of sanctioned plan –

- **Envisioned and Proposed growth centres –** Kanha-Pimpri towards North of Old City and Hingna towards East of Old City boundary.
- **Regional Connectivity –** Proposal of the Northern part of Ring Road connecting the city centre to regional centres.
- **Recreational and Green Areas –** Afforestation at the catchment area of Ambazari and Gorewada lakes and proposal of natural buffers to promote biodiversity.
- **River Rejuvenation -** Proposed recreational centres at the confluence of Kanhan and Pench river, the Koradi-area around Koradi temple, and Wana lake.

Since Nag River was a part of the Municipal city limits, the proposal for any recreational centres was out of the scope of the Regional Plan, yet we see that certain efforts were made to improve the condition of urban green at the regional level along existing lakes was proposed. During the horizon period, the Regional Planning failed unified implementation, resulting in its eventual neglect. land acquisition delayed the development of the industrial growth centre and was not able to meet the vision to decongest the city centre.

Regional Plan 1991-2011

Improving the backlog of the past regional plan 1971-1991 was taken as the key objective of the 1991-2011 Regional Plan. Identifying the implication of the problem of the cities to their outgrowths and hinterlands, the vision of the plan was to plan for a much larger area where the region was viewed as a part of the urban agglomeration of various municipalities, nagar palika, and various villages in the proximity of villages. Regional Planning Board was constituted in 1992 and the Plan was sanctioned in 2000 which is still in force. The following are the key aspects of the existing regional plan.

- **Holistic Economic and Spatial Planning of Region -** The key idea was to improve coordination among smaller developing urban and regional centres with a key focus on economic planning along with spatial planning.
- **Proposed Growth Centres –** Hingna towards East and Buti-bori towards South-west of Nagpur City for industrial use. Various hierarchies of growth centres were identified viz. regional metropolitan growth centre, regional growth centre, growth centre, sub-regional growth centre, and central villages.

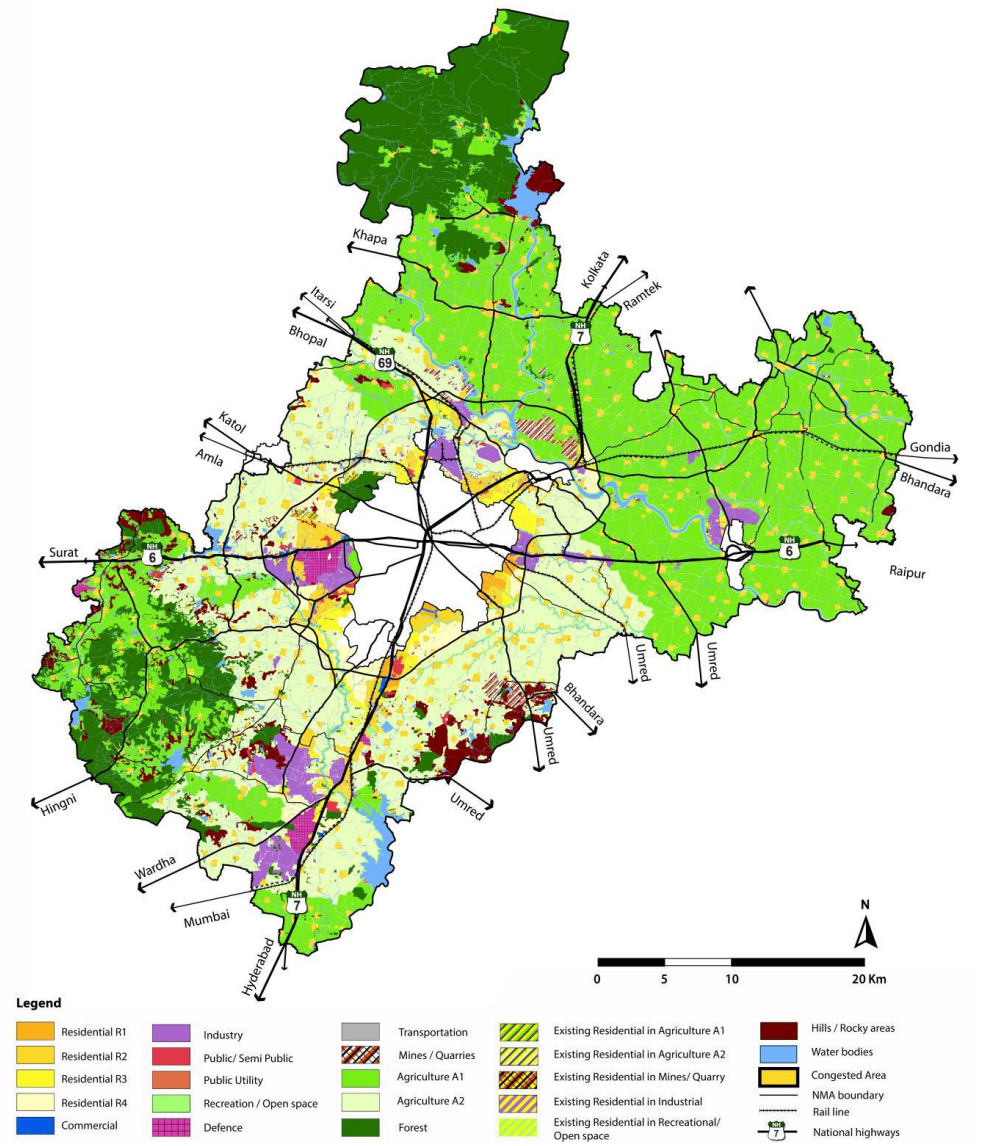
Proposed Nagpur Metropolitan Area Development Plan 2012-32

The key vision of the proposed regional plan was to provide a platform for healthy economic growth across the cross-section of the urban-rural transect. This vision encompasses three major working areas viz. economic growth, environmental and natural resource stewardship, and development and integration of urban systems. The following are the key points of the proposed regional plan –

- **Integration of land use and transportation-** Preparation of a structured plan to facilitate intensity-based development outside city limits and promotion of public transport using multi-modal integration.
- **Provision of social amenities –** This focuses on providing social infrastructure facilities to outgrowth and rural areas to have a homogeneous distribution of amenities in the region.
- **Water resource management –** Reuse treated wastewater from sewage treatment plants in thermal power plants in the vicinity to reduce the usage of fresh water in industries.
- **Housing and job markets –** promoting mixed-used development along

potential growth nodes to reduce travel distance and improve quality of life.

- **Open Spaces and Natural Resource Management –** Provision of regional biodiversity parks and open spaces, protecting ecologically sensitive areas through buffer areas of 100 m across major rivers (Kahna and Pench) and 50 m buffer for minor rivers (Nag and Pili).



Source: Regional Plan for Nagpur Metropolitan Region, NMRDA

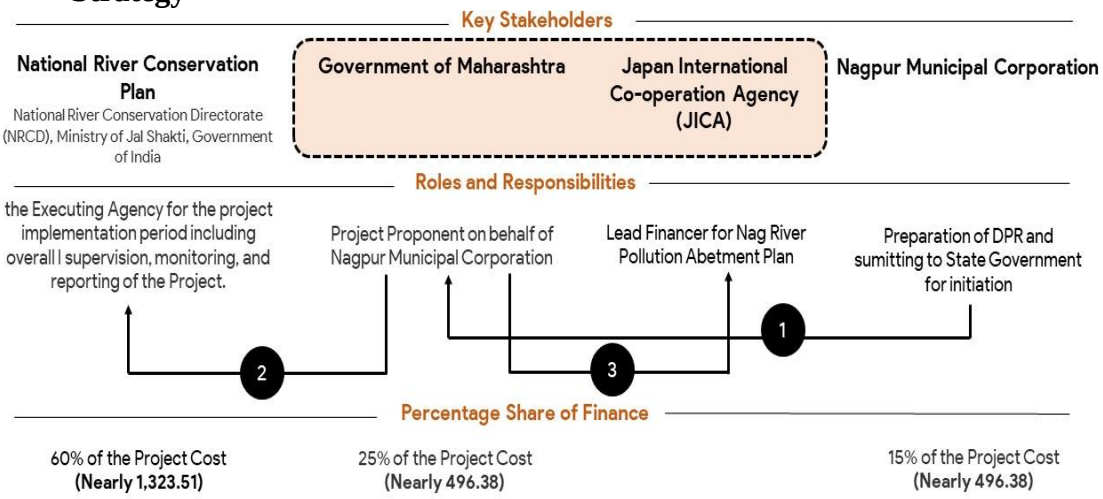
Figure 23: Proposed Regional Plan for Nagpur Metropolitan Area 2012-32 by NMRDA

4.2.3 Efforts of Planning and Project Implementation for Nag River Pollution Abetment -

The early signs of contamination of Nag River throughout its entire stretch were identified in 2000 during a study conducted by the National Environmental Engineering and Research Institute (NEERI) identified more than 70% of the sewage from

residential households is dumped without treatment in Nag River. In 2000 Vidarbha Heritage Committee proposed State Government to provide heritage status to Nag River which was repealed in 2001. The ideation of the Nag River Pollution Abetment Project was done in 2010 when the Bombay High Court asked NMC to take necessary actions to improve the condition of Nag River and take steps to reduce pollution. Followed by this Maharashtra Pollution Control Board (MPCB) identified 107 polluted stretches of rivers in the state in which the water of Nag River and Pili River was declared unfit for household activities. Detail project proposal with a project cost of 2117.54 was proposed in 2014 and was asked to be revised by National River Conservation Directorate. Over the decades' delay of the project due to various reasons degraded the quality of water in Nag River which increased the cost of the project from 1476.96 Cr. in 2002 followed by 2117.54 Cr. in 2021 and later 1925 Cr. sanctioned for Nag River Pollution Abetment Plan.

4.2.4 Status of Nag River Pollution Abetment Plan and Project Implementation Strategy -



Source: Author

Figure 24: Proposed project implementation framwwork for Nag River Pollution Abetment Project

The foundation stone of Nag River Pollution Abetment Plan was laid in December 2022 with the objective to rejuvenate the river and reduce sewage pollution. The project will e executed, monitored, and supervised by the National River Conservation Directorate (Ministry of Jalshakti, GoI). Other stakeholders include Nagpur Municipal Corporation (NMC) for the preparation of the Detail Project Proposal which will be submitted to the

Government of Maharashtra (GoM). Japan International Co-operation Agency (JICA) will act as a lead financer of the project which has gone into agreement with GoM. The project cost will be initiated by Central Government, State Government, and NMC each contributing share of 60%, 25%, and 15% respectively. The key objective of the project includes the –

- Proposed riverfront development so that the entire stretch of 17 km.
- Relocation of 35 encroached settlements to facilitate the development of amusement parks and other tourist facilities on the banks of Nag River.
- Prevent and reduce the pollution of rivers in the catchment area of Nag and its subsidiary Pili River.
- The construction of sewerage treatment plants and public sanitary facilities would be taken up.

4.2.5 Summary

The above section highlights various aspects of statutory planning efforts associated with respect to the conservation of river flood plains and regulating the development along the urban context next to the river. With respect to the examples of sanctioned Master Plan Delhi or Regulations for Singapore City developed by the Singapore Redevelopment Authority (discussed in successive chapters), the past planning efforts completely neglected the steps undertaken to improve the quality of urban waterbodies. The development over the past century highlights the drastic increase in development along the catchment of various sources of the river (Ambazari and Gorewada Lake) flowing in the city (Nag and Pili River) the regional plan failed to implement various regional level projects to conserve and protect the catchment from getting depleted. Similarly in case of proposed City Development Plan, there is no provision for buffer which is common practice to prevent floodplains from getting encroached, is going to impact river along various greenfield stretches. Though the timeline of Nag River Pollution Abetment Project was a direct result of reports by various organizations like NEERI and MPCB the recommendations of these agencies are not reflected in the statutory master plans. Therefore, it can be clearly seen that the past planning efforts failed miserably to protect and improve condition of river.

Similarly in case of Nag River’s project formulation and implementation, the major

cause of delay is seen due to lack of proper funding and poor capacity of NMC to undertake project. With limited financial powers the project was solely dependent on grants by various agencies which is seen as a major cause of delay degrading the condition of river further down the years. This will be discussed in later sections where municipal finance assessment of NMC is done to understand the nature of problem.

4.3 Review of Statutory Development Control Regulations –

Statutory development control regulations are necessary for mandating the planning decisions that are taken as a part of statutory planning exercise. As per the latest notification the sanctioned development plan for the city as per MRTP Act 1966 must follow the Unified Development Control and Promotional Regulations (UDCPR). Prior to 2018, like all other cities with the sanctioned development plan, the cities had their respective development control regulations (DCRs). It is important to critically analyze and review the changes made with respect to protecting the river and the various regulations associated with it.

4.3.1 Development Control Regulations of Nagpur City (applicable till 2020) –

The latest change was made as of the 2018 draft notification by Nagpur Improvement Trust based on certain modifications which were before the enactment of UDCPR were considered for defining planning and building norms for Nagpur City. Following are key aspects considering the control of development along waterbodies and lakes –

- **Recreational open spaces in the green belt –** Development is permitted excluding the 15 m width of the riverbank and 9 m along the nala provided such recreational space is sizable.
- **Permissible Land uses in the proposed Green Belt Zone –** The permissible land uses includes agriculture, tree plantation, gardens, public park, landscaping, recreational open space riverfront, development of pedestrian pathways, jogging tracks, cycle tracks, boat clubs, etc.
- **Marginal distance and nature of development near river/ nalla-** The marginal distance of 15 m for the major river, 9 m for minor river/ nalla, and 4.5 m. from the dividing line between the green belt zone and the other developable zone. Moreover, FSI will be granted for the surrendered area. Minimum 100 trees per hectare on the remaining area after the surrender.

4.3.2 Unified Development Control Regulation for Nagpur City (applicable from 2020)

The sanctioned UDCPR u/s section 37(1AA) and 20(4) of MRTP Act 1966, was issued in 2020 which diluted all the existing DCRs of cities with sanctioned development plans to have a unified code for planning and building development throughout the state. Considering the above-discussed parameters, very few changes are observed to regulate development along water bodies. As per the latest notification sanctioned by the Department of Urban Development, Govt. of Maharashtra in 2022, there are no critical changes were made with respect to regulating permissible land uses in the proposed green zone as well as the marginal distance to be left for undertaking development along river/nalla. Following key changes compared to the previous DCR for Nagpur City were made in UDCPR which includes regulations to be Nagpur City is mentioned below –

- **Recreational open spaces in the green belt –** Development is allowed excluding 15 m. width along the riverbank and 6 m along nala, provided such recreational space is sizable.
- **Development of cycle track along river/nalla -** Out of 6 m marginal width of land 3 m of land will be utilized for a cycle track. Out of the entire land parcel, 35% of the surrendered land will be availed for FSI compensation.

4.3.3 Critical Overview –

In the past DCR for Nagpur City and UDCPR for Maharashtra state, both planning regulations have similar outcomes to regulate development along river bodies. Since the river and waterbodies are getting encroached upon, and pollution is increasing due to various anthropogenic activities, there is no revision of activities promoted under permissible land uses in the green belt proposed in the sanctioned master plan. Moreover, though the latest DCR mentions permissible activities along the proposed green zone, under the revised sanctioned development plan of Nagpur City, the proposed land use plan does not have any green belt proposed along the river in greenfield regions under city limits. In both the efforts of preparation of development control regulations, there is a lack of incentives for private stakeholders which have their land within proximity to rivers so that both the development and conservation of waterbodies can be undertaken simultaneously. Regulation of marginal distance from the river does not consider the existing condition of cities where strict buffer regulations

are infeasible to regulate due to the dominance of private ownership with no detailed provision for compensation with respect to the land under the green belt is considered. Hence the sanctioned UDCR with respect to the mandating regulations to promote river conservation made a very generic effort for river rejuvenation in cities including Nagpur.

4.4 Status and Condition of Surface Water Resources in Nagpur Metropolitan Region

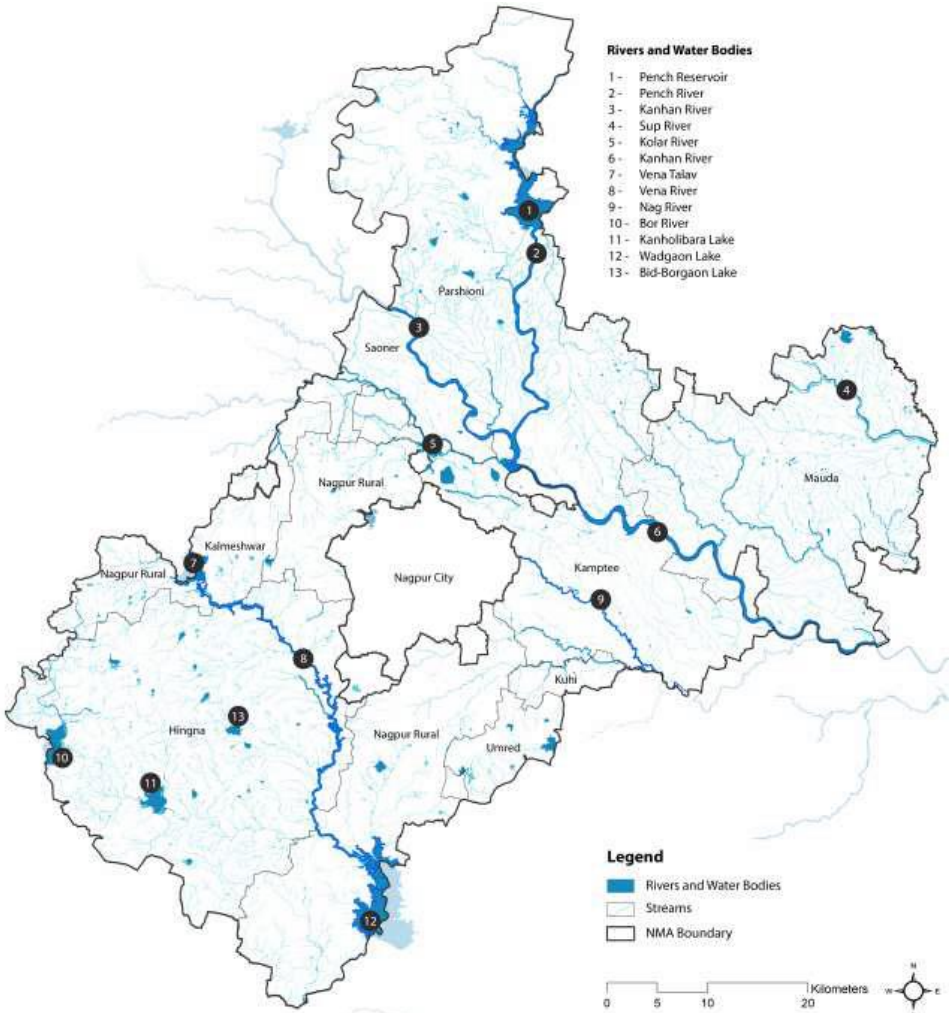
It is essential to identify the major areas which have a high degree of contamination along the stretch of Nag River because of two prime reasons. The first is the degree of pollution will determine the various aspects of detailing the project in later sections and the second is to address the river pollution in more quantitative aspects based the past studies.

4.4.1 Surface Water Resources in vicinity of Nagpur City

Out of the total Metropolitan Area of 3567.67 sq. km. the total area under the surface water accounts for 228.53 sq. km. (6.41%) of the total area. (NMRDA, 2015) This includes the area of water bodies in NMC jurisdiction which is 3.80 sq. km as well. Two of the three major rivers in the NMA which include the Pench and Kanhan rivers flow south in the northern part of the NMA.

Nagpur city gets raw water from three different surface sources, viz., Gorewada Tank, Kanhan River, and Pench canal. The sources have been developed over a period. The maximum amount of water is drawn from Pench schemes and Kanhan at present. Pench is a reservoir. (Fig. 5). The major surface water resources include -

- **Two Rivers -** The Nag and Pili rivers cut across the city and are 15.73 km and 12.11 km in length, respectively.
- **Twelve Lakes -** Gorewada, Futala, Ambazari, Sonegaon, Sakkardara, Gandhisagar, Lendi Talao, Naik Talao, Dob Talao, Sanjay Nagar Khadan, and Pardi) cover an area of about 3.13 sq km.
- **5 Nulla -** Chamar Nallah, Shakti Nagar Nallah, Hudkeshwar Nallah, Swawalabmi Nagar Nallah, and Sahakar Nagar Nallah.



Source: NMRDA Regional Plan 2012-32

Figure 25: River and water bodies along with major watersheds in NMR

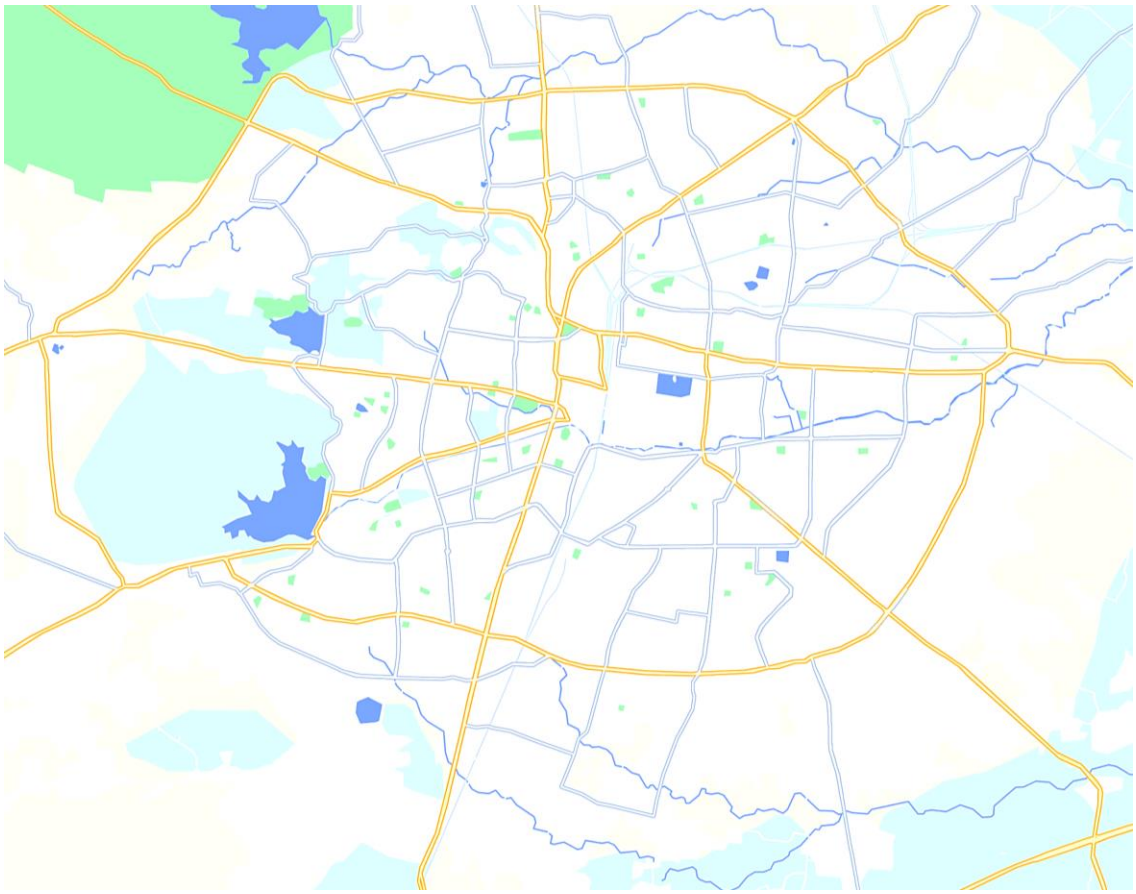
4.4.2 Major Drainage Pattern in Nagpur Metropolitan Region

Nag River originates from Ambazari Lake which is situated upstream of Nagpur City. The name of the city Nagpur is said to be derived from the Nag River which passes through the Old City area (Mahal). The total length of Nag River flowing throughout the city is 17 km along which the width of the river varies from 12 – 40 m and depth varies from 2-4.5 m. The total length of Nag River till it meets Kanhan River outside the city limit is 70 km. There are three tributaries of Nag River which are –

- **Pili River** originates from Gorewada Lake located North-west boundary of the city and flows East-West joining Nag River outside the eastern boundary of Nagpur city.
- **Futala Nalla** originates from Telankhedi Lake located on the west of the city**. It flows to the north of Nag River and joins near Sangam.**

- **Pora River-** originates from Sonegaon lake towards the west to south-east outside the city limits which drains into Kanhan River.

The major characteristic of the entire existing drainage pattern is that all these rivers originate within the city limits and flow through the developed part of the city because of which all these rivers are highly vulnerable to anthropogenic activities leading to pollution of water bodies. (Fig. 2) Pollution of these water bodies especially Nag River is affecting the quality of the Ghoiskhurd Dam located across the Wainganga River which is a Major Watershed of Nag River (MPCB, 2011).



Source: Google Earth

Figure 26: Nag River, Pili River, and Futala Nalla flow through developed city areas.

4.4.3 River Water Quality Assessment: Nag River and Pili River (2010-11)

Assessment of the Water Quality of the river during summer and monsoon months was carried out by Maharashtra Pollution Control Board (MPCB) as a part of the Nag River Basic Action Plan in 2010-11. The following study was undertaken based on the data obtained from 7 station points at various waterbodies in different seasons highlighting

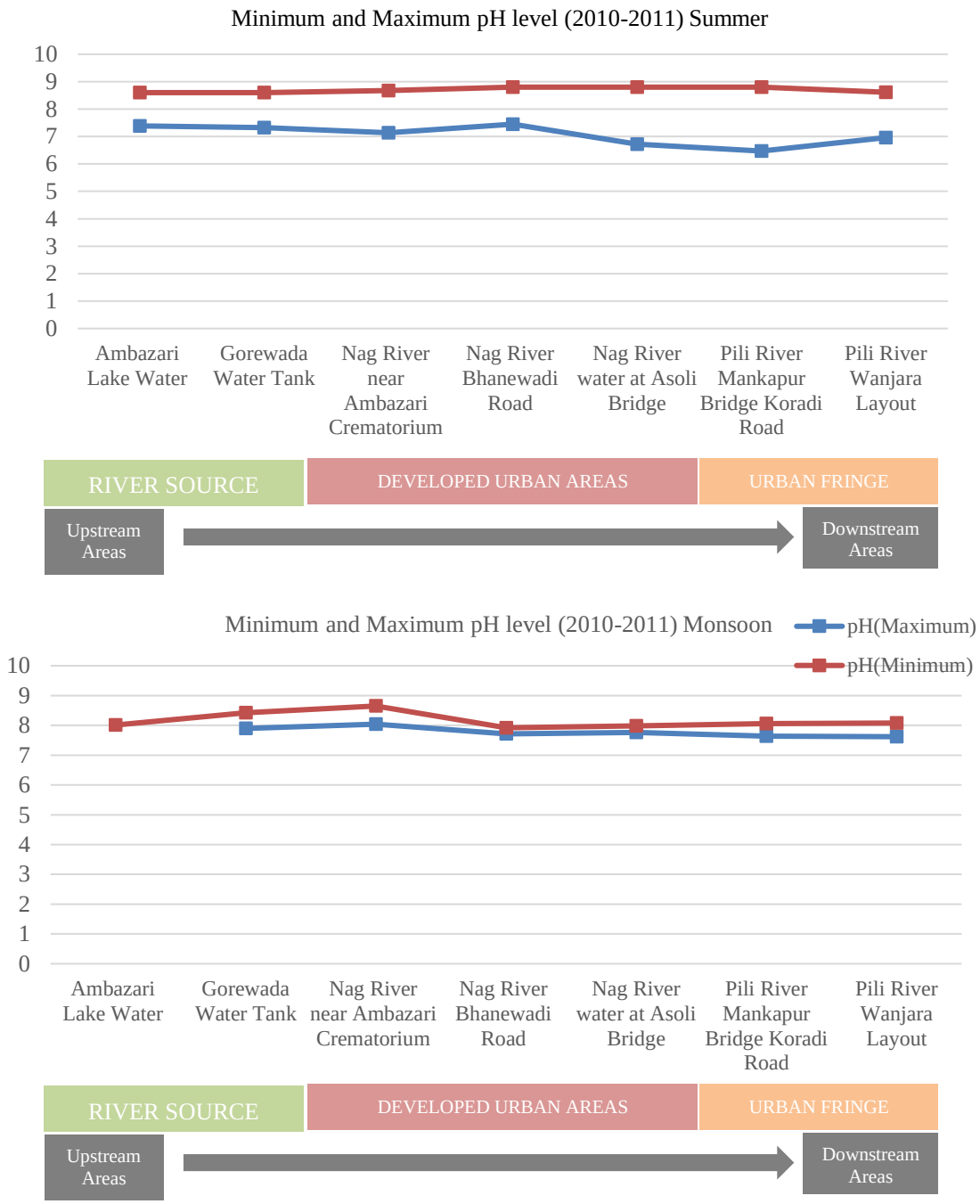
the vulnerability of waterbodies in Nagpur City and its metropolitan region. The samples are collected at various locations along Nag River at Ambazari Lake, Ambazari Crematorium, Nag River (Asoli Bridge), and Nag River at Bhanewadi. Similarly, samples along Pili River are collected near Mankapur Bridge and Wanjara Layout. (Fig.27).

Source: MPCB, 2011

Figure 27: Sample stations along various location on Nag River and Pili River (MPCB 2011)

- **Minimum and Maximum pH level in Summer and Winter –**

The graph highlights the recorded pH in summer is considerably shifted towards less than 7 indicating two of the samples collected along Nag River at Mankapur and Asoli Bridge downstream at 11.7 km and 14.5 km from the source respectively. Compared to that no drastic variation during the summer is observed in Pili River. Similar results are obtained in monsoon where slightly different result in pH is obtained since the flow of the river is high during monsoon and no such significant variation is seen in recorded readings of Nag and Pili River. In case of Nag River where the source of water is overflow from Nag River, in summer the river completely dries up with untreated wastewater flowing through the river. The contamination of samples therefore is high in summer. In post-monsoon the flow of monsoon is restored and as a result pH samples shows a lesser values.

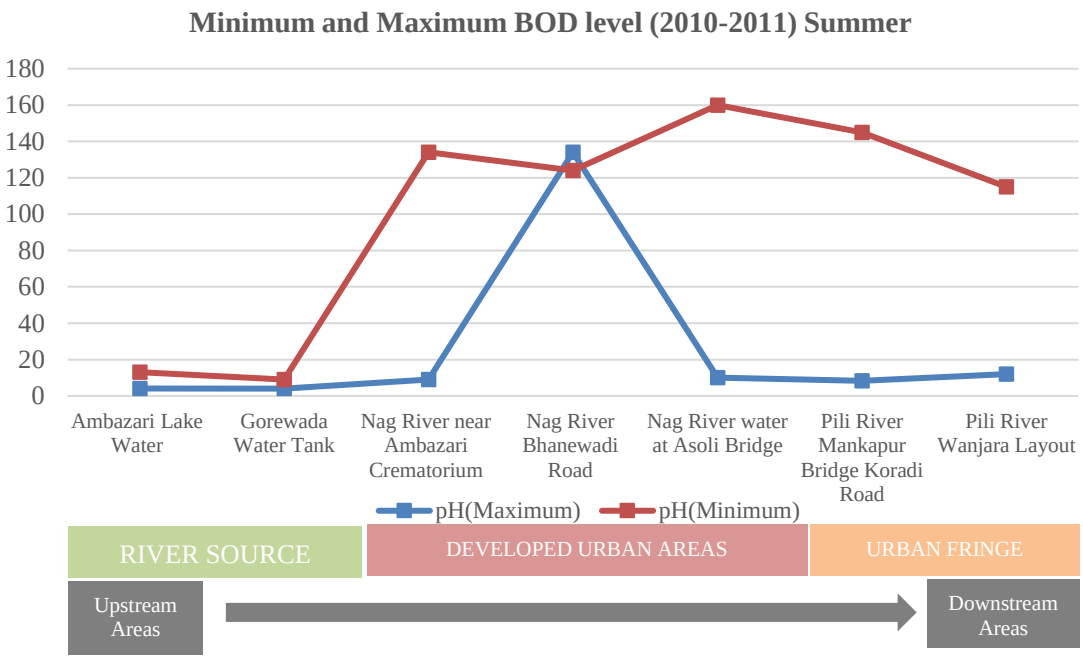


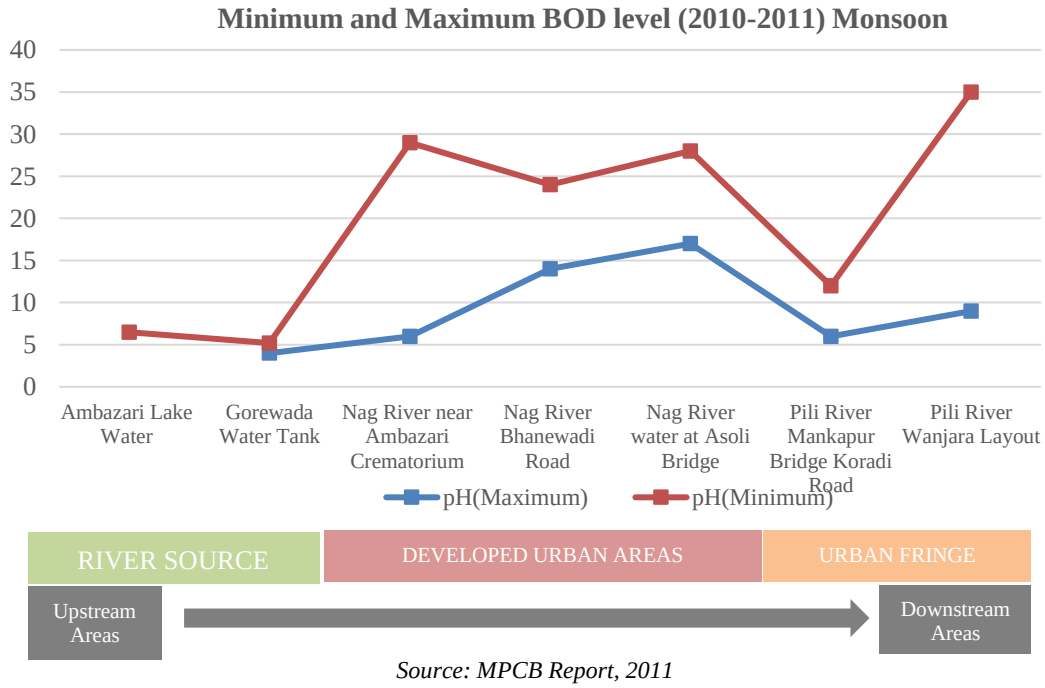
Source: MPCB, 2011

Figure 28: Variation of pH in summer and monsoon at sample stations along Nag and Pili River

- **Minimum and Maximum Biological Oxygen Demand (BOD) level in Summer and Winter-** The higher BOD indicates a high degree of pollutants in the water body. The study identified areas downstream near city limits have BOD of more than 100 mg/l compared to other locations at Pili River where 10-20 mg/l of BOD is recorded both in monsoon and summer. The primary

reason for contamination is the direct effluent of industrial wastewater located near Bhanewadi near Nag River.



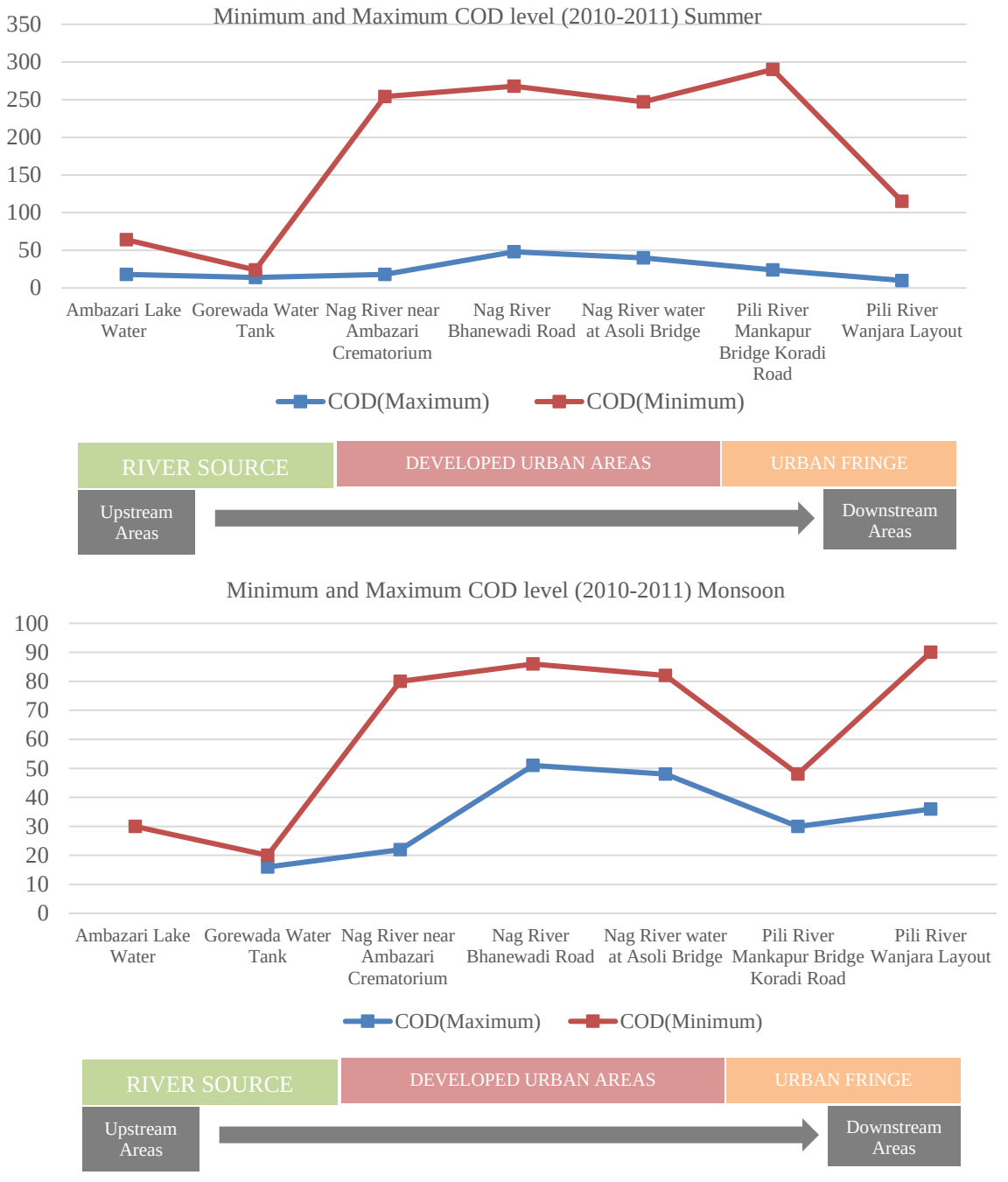


Source: MPCB Report, 2011

Figure 29: Variation of BOD in summer and monsoon at sample stations along Nag and Pili River

- **Minimum and Maximum Chemical Oxygen Demand (COD) level in Summer and Winter –** A similar trend of comparatively higher COD is identified in samples collected from Nag River along urban fringes near Bhanewadi, and Arsoli Bridge. The slight COD recorded at the Ambazari

Lake sample indicates the source of Nag River is itself polluted to a certain extent which needs immediate attention. The sample at Pili River near Wanjara Layout also shows 35 mg/l of COD. But the data shows high contamination in areas that are located near the outskirts along both rivers.



Source: MPCB, 2011

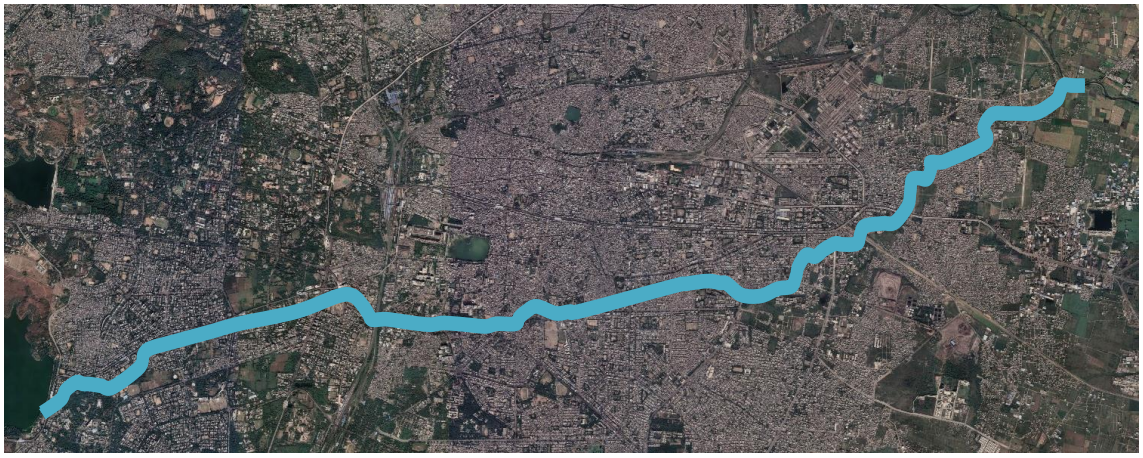
Figure 30: Variation of COD in summer and monsoon at sample stations along Nag and Pili River

The collection of data from the various sample points located on Nag River and Pili River can be summarized below –

- The major reason Nag River is more polluted is due to its path and various activities leading to pollution throughout the stretch, especially along the Nag River stretch lying near city limits. The recorded data shows poor infrastructure facilities and enforcement of statutory laws for wastewater treatment from industries and households.
- As there is a slight content of BOD and COD recorded at the sources of both Nag River and Pili River, it highlights the need for interventions to be undertaken to improve the quality of water in both Gorewada and Ambazari Lake. This can possibly be undertaken as a part of a restoration of lakes and waterbodies at the regional level.
- Higher degree of contamination is recorded in waterbodies in summer and monsoon (although the stormwater dilutes the waste content resulting in lesser readings compared to the summer season) indicating the continuous dumping of water in rivers is observed.

4.4.4 Condition of Nag River (Quantitive Study) over Past Decades (2000-2020)

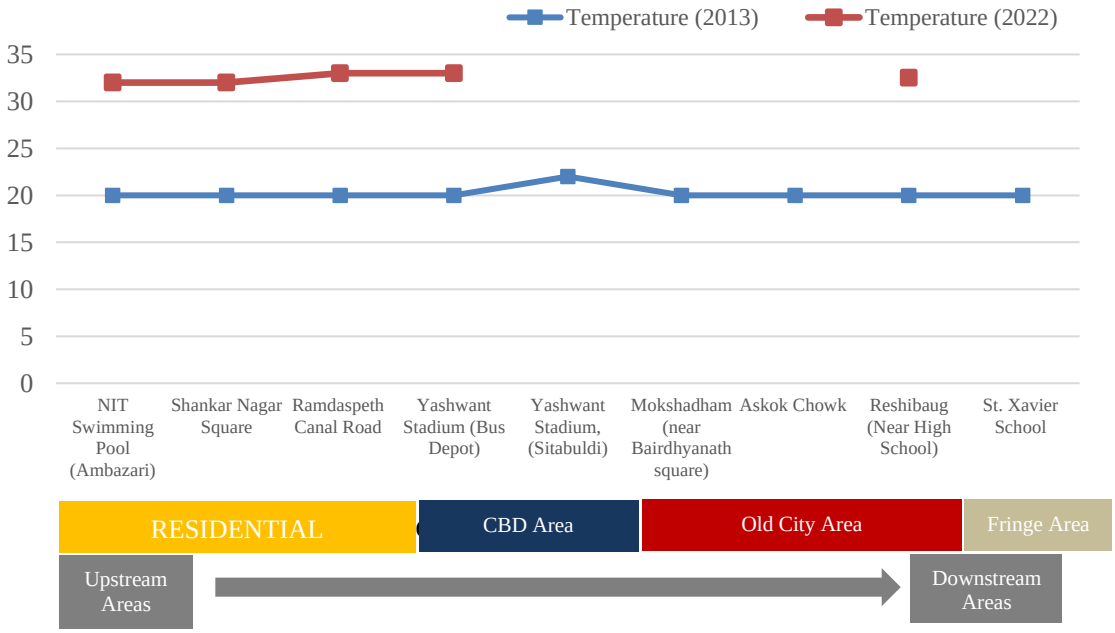
From the above assessment it is evident that compared to all other stretches of Pili and Nag River, the latter is highly contaminated. Over the past few years, the collection of data and assessment of sample points collected at various locations along Nag River



Source: Paul and Rasekar

Figure 31: Satellite Image showing the location of sample points for assessment of increasing pollution from 2013-2021

- **Variation in temperature of the water body at various location (2013 & 2022)** Water temperature impacts the various quality parameters and gives an idea of discharges that are dumped into water bodies. The temperature of water collected through samples at different locations indicates the increasing rate at



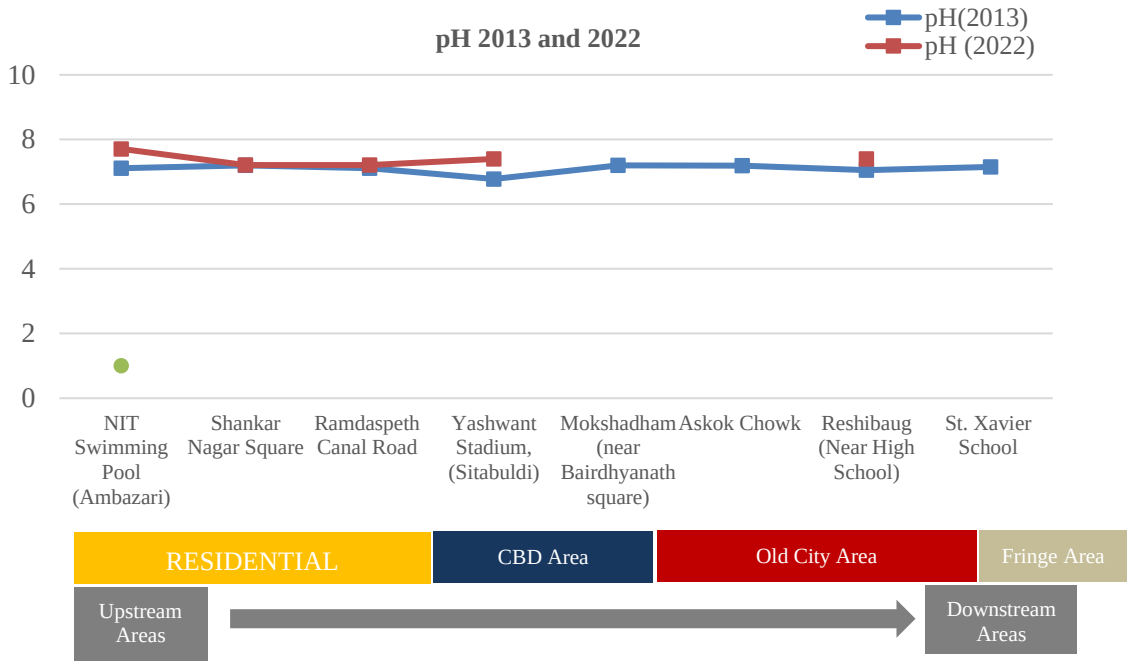
Source: Paul and Rasekar

Figure 32: Variation of temperature in 2013 and 2022 at sample stations along Nag River

in temperature over a span of a decade. No such drastic variation is seen in reading from the samples collected in 2013 and 2022. The present condition with an average temperature of 20 degrees throughout the collection points is very high for the survival of the freshwater ecosystem. (Figure 58)

- **Variation in pH (2013 to 2022)**

From the past decades, the samples indicate the increase in overall pH level by a very slight margin where most of the readings obtained are within a range of 7-8 pH. An increase in pH at Yeshwant Stadium and near the NIT swimming pool (near crematorium) can be the result of increased discharge of wastewater. Though the 6-8.5 pH range is adequate for the pH of water bodies other parameters need to be checked to identify the quality of water and its relevant usage with respect to it (MPCB). The above data also highlights the aerial observation indicating that hardly any drastic change in the urban character along the riverbanks throughout the stretch is observed.

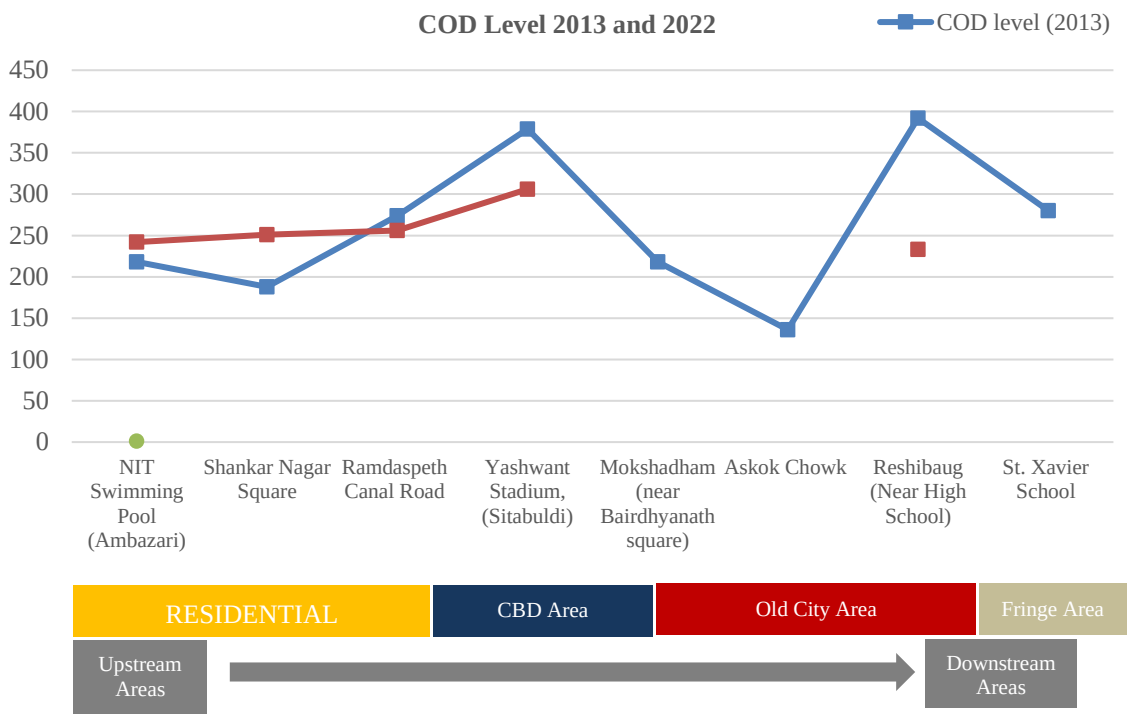


Source: Paul and Rasekar

Figure 33: Variation of pH in 2013 and 2022 at sample stations along Nag River

- **Variation of COD from the past decade (2013 to 2022)**

  COD indicates the amount of oxygen required for breaking down organic matter through chemical oxidation. Drastic variation in the data collected in 2013 can be seen where the COD level is recorded highest at Yeshwant Stadium (near Sitabuldi) i.e. 380 mg/l. Similarly, other sample locations lie between a range of 200 – 350 mg/l which indicates a serious level of contamination. The permissible limit as per guidelines 75-100 mg/l is fit for domestic use except drinking (CPCB) which clearly indicates that throughout the stretch the river water cannot be used for any domestic purposes. In the case of the sample obtained in 2022, an increase in COD level at each location can be seen. The data correlates with the primary where the areas with a high degree of encroachments like Old City area and CBD or areas with huge variations in activities along the river have poor conditions of water due to dumping of wastewater. As a result, the 2013 sample at Ashom Nagar has relatively lesser activities along the river stretch compared to Yeshwant Stadium and Sitabuldi which is a part of the CBD.

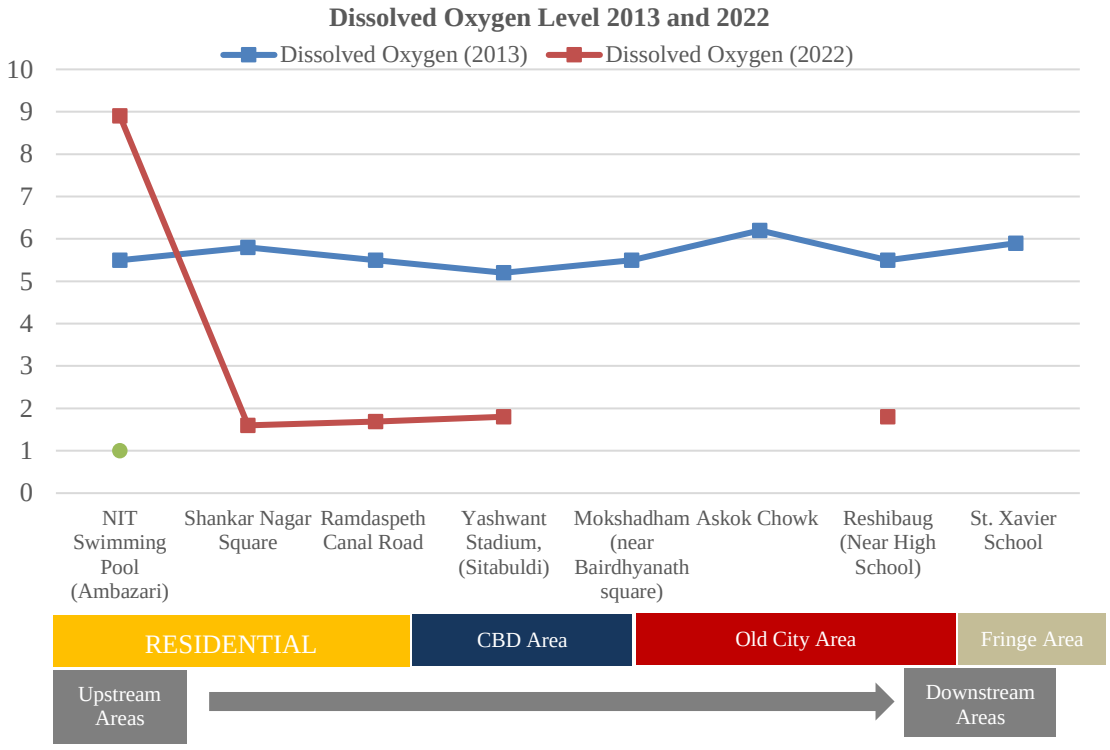


Source: Paul and Rasekar

Figure 34: Variation of COD level (2013 and 2022) at sample stations along Nag River

- **Variation of Dissolved Oxygen (DO) level from the past decade (2013 to 2022)**

  A level of DO indicates the health of rivers to foster aquatic life. The amount of dissolved oxygen depends on the temperature of the water, where an increase in temperature decreases the ability of water to carry dissolved oxygen. This indicates that the sample data which indicates an increase in temperature by 4-6 degrees in the past decade should correlate with the amount of DO at present along various locations in Nag River. A similar trend is observed (Fig. 61) where a drastic difference in change in DO is observed over past years. As per the CPCB standards, healthy river water should have 6 mg/l or more of DO for domestic usage (CPCB) which indicates that the entire stretch has poor content of dissolved oxygen as a result of which directly impacts the freshwater ecosystem.



Source: Paul and Rasekar

Figure 35: Variation of dissolved oxygen (DO) level in 2013 and 2022 at sample stations along Nag River

- **Presence of Faecal coliform and colour of water along Nag River stretch –** Faecal coliform indicates the presence of untreated sewage in waterbody. With the increase in faecal coliform content increases the BOD, COD and reduces the DO content of the waterbody. The secondary study (Paul and Rasekar, 2022) qualitatively identified the presence of faecal coliform. Throughout the entire stretch the presence of faecal coliform was observed which highlights the presence of untreated sewage directly dumped without being treated in Nag River. This also related to the condition of both the banks of Nag River where primary survey captures various activities like sewage outlets from neighborhoods and heavy encroachments in flood plain which correlated with the secondary data and inferences draw from it. The colour of water ranges from greenish-to-greenish blue to grey depending on the nature of activities along the banks of Nag River.

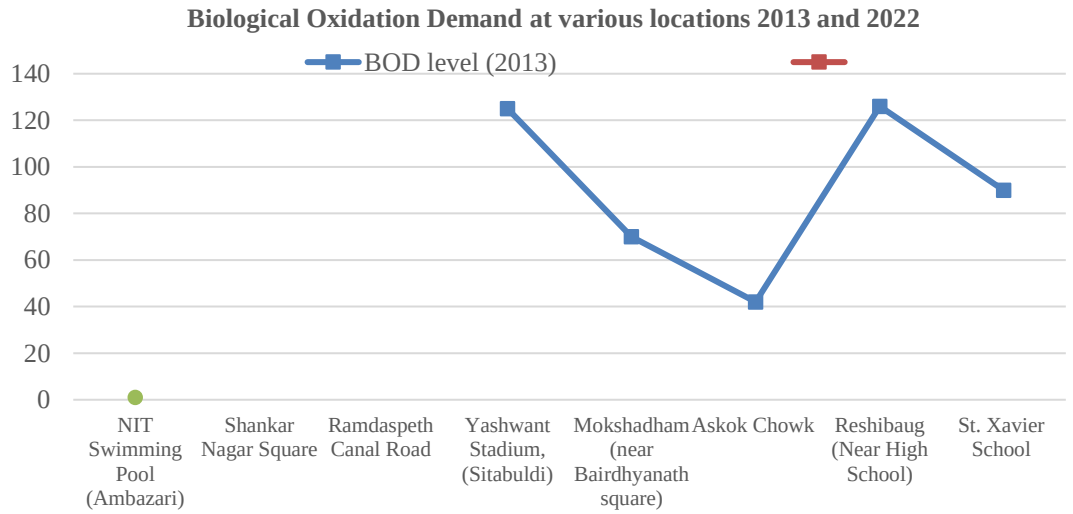
NIT Pool (Ambazari)	Shankar Nagar Square	Ramdas Peth Canal Road	Yash want Stadium, (Sitabuldi)	Moksha Dham	Askok Chowk	Reshibaug (Near High School)	St. Xavier School
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Greenish	Greenish-Blue	Grey	Greenish-GRey	Grey	Grey	Grey	Greenish-Blue

Source: MPCB, 2011

Table 6: Presence of Fecal Coliform and Colour of Water at collection samples across Nag River

- **Biological Oxidation Demand**

  BOD indicates the amount of oxygen required for the decomposition of organic matter by biological processes. Increased BOD in the water body indicates high contamination of waterbodies with organic and fecal matter. Since most of the data is across various locations was not obtained. Since very fewer data along the river stretch is gathered (Paul and Rasekar, 2022) based on the secondary data it is difficult to conclude and relate variation in BOD with other quantitative parameters.



Source: Paul & Rasekar, 2022

Figure 36: Variation of BOD level in 2013 and 2022 at sample stations along Nag River

4.4.5 Summary

The section summarizes the environmental degradation of the Nag River in the past decades based on various parameters like pH, BOD, and COD. The following points can be summarized from the above secondary data –

- Untreated discharge throughout the stretch from various stretch locations in the proximity of the river renders poor quality where the samples indicate river water is unsafe for domestic use to the high presence of fecal coliform (basically due to untreated sewage).
- The secondary data across various stretches along the Nag River correlates with the poor urban context along the Nag River stretch. This indicates that there is a very strong relation to the poor urban context (heavy encroachment and non-regulated activities along flood plains and poor infrastructure facilities)

The poor condition of surface water also impacts the groundwater reserve in the form of aquifers and nearby waterbodies due to the infiltration of waste content. The successive section indicates the condition of groundwater and its availability and based on a secondary study highlights the impact of polluted Nag River on groundwater sources.

4.5 Status and Condition of Groundwater Resources in Nagpur Metropolitan Region

4.5.1 Groundwater Resources and Availability in NMR

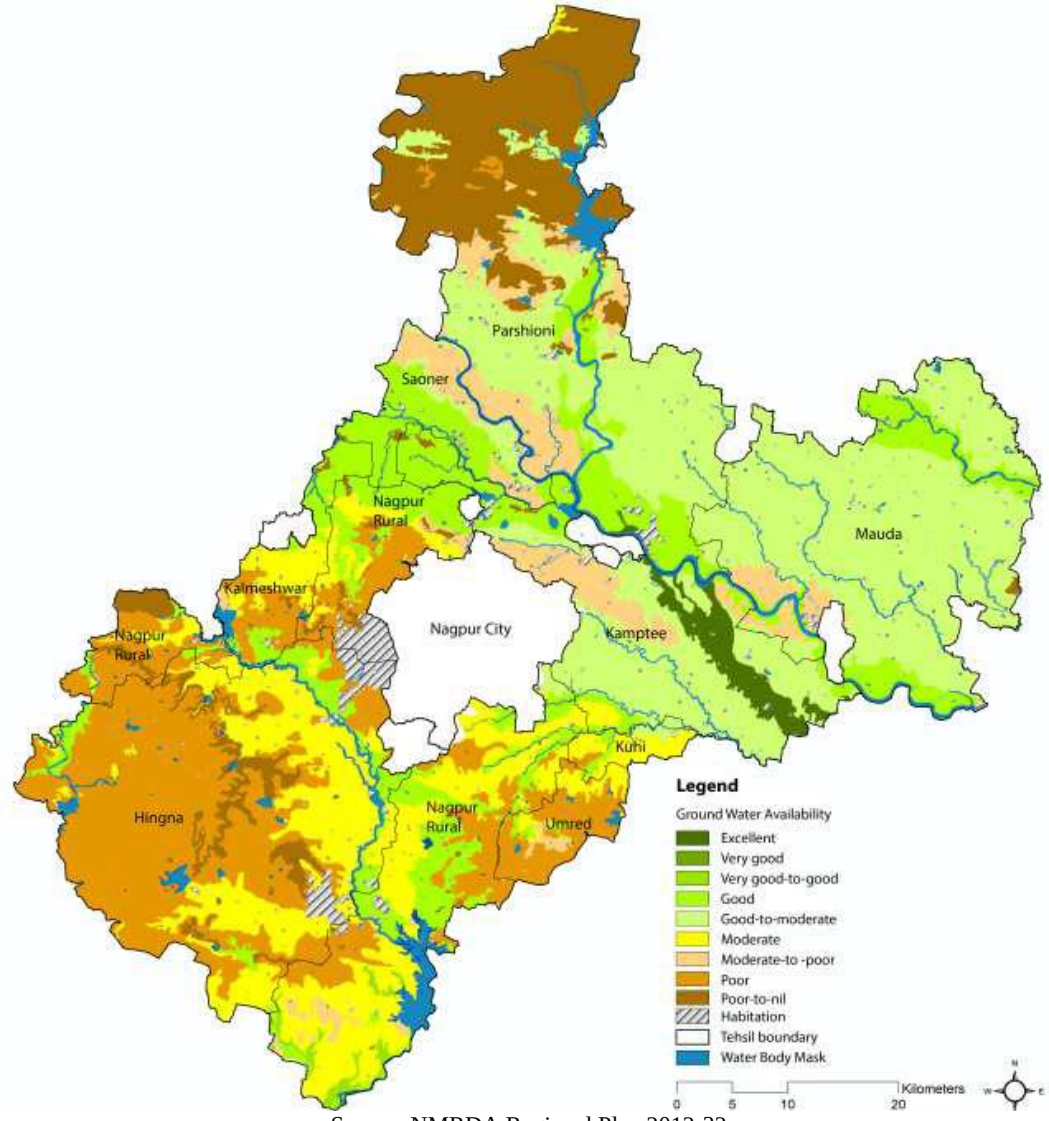
Groundwater resources refer to the shallow and deep aquifer resources harnessed using various methods like borewells, tube wells or traditional wells. As per the assessment conducted by Central Ground Water Board (CGWB) and Groundwater Survey and Development Agency (GSDA) indicates that the availability of groundwater in the area near Hingna and Western Nagpur limits is very poor. (Fig.62). Interestingly the development in the past decade has tremendously increased along this region in Nagpur Metropolitan Area. The total annual groundwater recharge in the Nagpur District was 1102.27 million cubic meters (MCM) with a natural discharge of 60.38 MCM, thus the net annual groundwater availability came out to be 1041.89 MCM as estimated in 2004. (NMA, 2016). The total gross draft for all uses was estimated at 452.95 MCM. (CGWB, 2011) The overall stage of groundwater development for the district is 43.47 percent with all tehsils under NMA belonging to the "Safe" category. As per the assessment, six tehsils of the NMA i.e., Hingna, Mauda, Umred, Kalmeshwar, Kuhi, and Kamptee, have medium to high yield potential and, Parshioni and Saoner tehsils have low to high yield potential. (NMA, 2016).

Assessment of groundwater and its quality condition plays a huge role in irrigation and domestic usage for the city and metropolitan region. With contamination of surface water sources (Nag River and Pili River), there is a high possibility of contamination of shallow aquifers within proximity of these rivers. Water table depth variation in various seasons shows considerable variation in average depth (Table 9).

Sr. No.	Season	Water table depth (in meters)
1.	Winter	7.6-10.7
2.	Summer	13.7-18.3
3.	Monsoon	6.1 – 7.6
4.	Post-monsoon	6.1-7.6

Source: NMRDA Regional Plan 2012-32

Table 7: Variation of the water table during various seasons in NMA



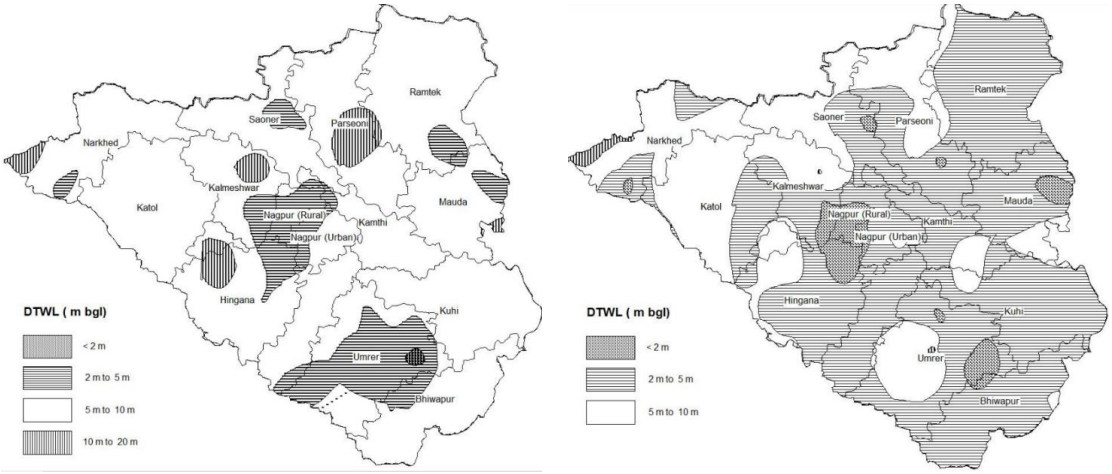
Source: NMRDA Regional Plan 2012-32

Figure 37: Map showing groundwater availability in Nagpur Metropolitan Region

Nagpur district is mainly occupied by two main river basins, Wainganga & Wardha. Wainganga Basin has 40 watersheds & Wardha Basin has 14 watersheds; thus, the district has a total of 54 watersheds. As per the 6th Groundwater assessment WRJ-2 & WRJ-4 of the Wardha basin are overexploited and WGKK-2 of the Wainganga basin is critical The watersheds WR-29 & WRJ-1 of the Wardha basin are semi-critical. The annual groundwater recharge of the district is 104189.02 ham, while the gross annual draft is 45295.28 ham, and the groundwater available is 49979.16 ham. (CGWB, 2013).

4.5.2 Depth of Water Table in Pre-monsoon and Post-monsoon period

The depth to water levels in the district during May 2011 ranged between 0.08 (Umrer) and 15.59 (Sathnaovi) m bgl. Depth to water levels during pre-monsoon (May 2011) (Fig. 63). Shallow water levels within 10 m bgl are seen in the almost entire district. Water levels in the range of 10-20 m bgl are observed in parts of Kamleshwar, Hingna, Narkhed, Paraseoni talukas as isolated patches. (CGWB, 2013) Similarly, in the case of post-monsoon (in November 2011), the depth of the water table varies between 0.60 m bgl (Umrer) and 10.60 m bgl (Manegaon Tek) (Fig. 63). In the entire district the water levels are shallow within 10 m bgl. Water levels of 2-5 m bgl are the most dominant range occupying major parts of Ramtek, Mouda, Kuhi and Bhiwapur talukas.



Water levels of less than 2 m bgl. are observed in isolated patches i.e., parts of Narkhed, Nagpur, Umrer and Mouda Talukas. (CGWB, 2013).

Source: CGWB, 2013

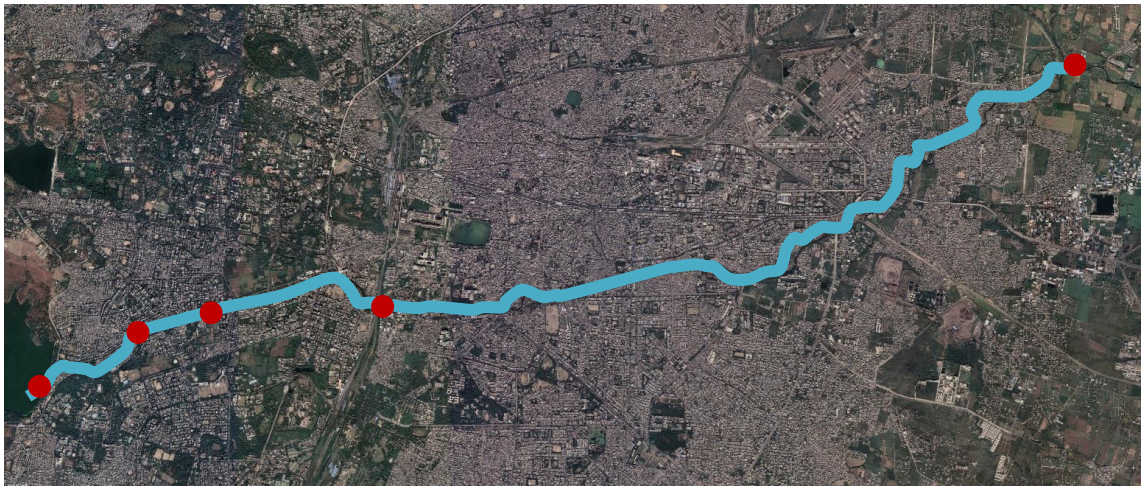
Figure 38: Nagpur District variation in depth of groundwater during pre-monsoon and post-monsoon period

The above map clearly explains the nature of the availability of groundwater. Though the numbers are based on the study conducted in 2011, the spatial distribution throughout the district gives a partial glimpse of the existing situation of groundwater availability in Nagpur district. The following section identifies the quality of groundwater along the stretch of Nag River to examine the impact of surface water contamination on the shallow and deep aquifer.

4.5.3 Quality of Groundwater Assessment within the Context of Nag River

Based on the secondary source the following section attempts to identify the impact of polluted water of Nag River on groundwater sources within proximity to the river. The

assessment is therefore based on the selection of five sampling locations viz. Subhash Nagar (S1), Daga Layout (S2), Shankar Nagar (S3), Panchasheel Square (S4), and Pardi (S5) in the proximity of 100 m from the Nag River from various groundwater sources. The samples were collected in summer, winter and monsoon to assess the alkalinity,



pH, BOD, COD, and chloride level based on the standard procedures laid down in Indian Standards of Drinking Water -Specifications (BIS 10500: 1991) &(BIS: 2296-1982) (Ansari & Khandeshwar, 2014).

Sampling Location	**Source of Collection**	**Distance from Nag River**
Subhash Nagar (S1)	Well	96
Daga Layout (S2)	Handpump	82
Shankar Nagar (S3)	Well	95
Panchasheel Square (S4)	Well	91
Pardi (S5)	Well	83

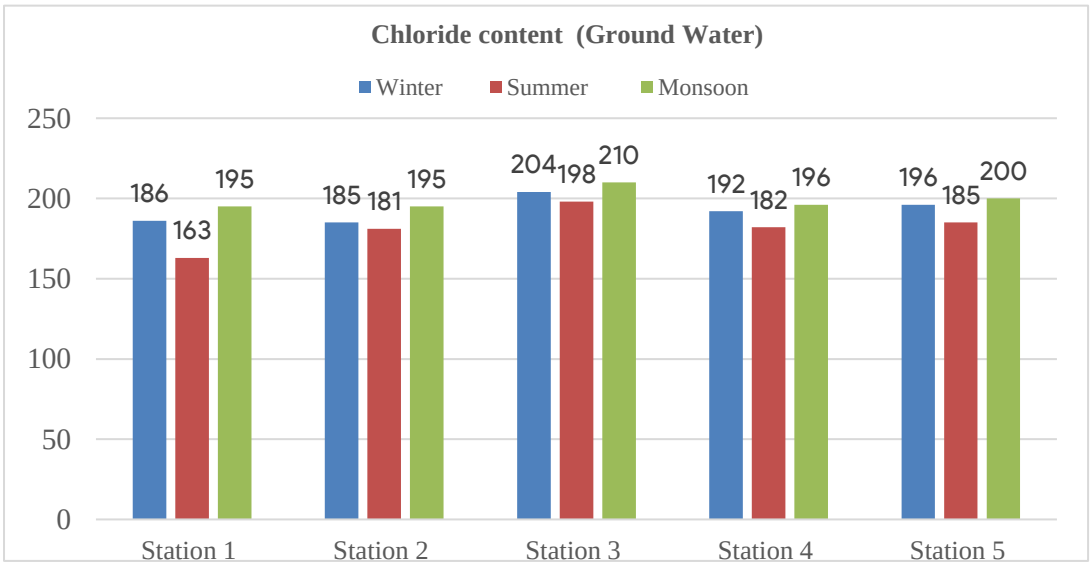
Source: Ansari & Khandeshwar, 2014

Figure 38: Table showing the location of sampling points for groundwater quality assessment.

- **Chloride content in groundwater samples**

  Chloride ends up in groundwater aquifers because of leaching occurring when the water flows down the streams and finally infiltrates into groundwater. The data obtained from sample points indicate that the chloride content is in the range of 150-200 mg/l. The desirable and permissible chloride content as prescribed by CGWB is within a range of 250 mg/l and 1000 mg/l respectively indicating that the chloride content is normally in the collected samples in the

vicinity of Nag River. the presence of high chloride content indicates salty groundwater.

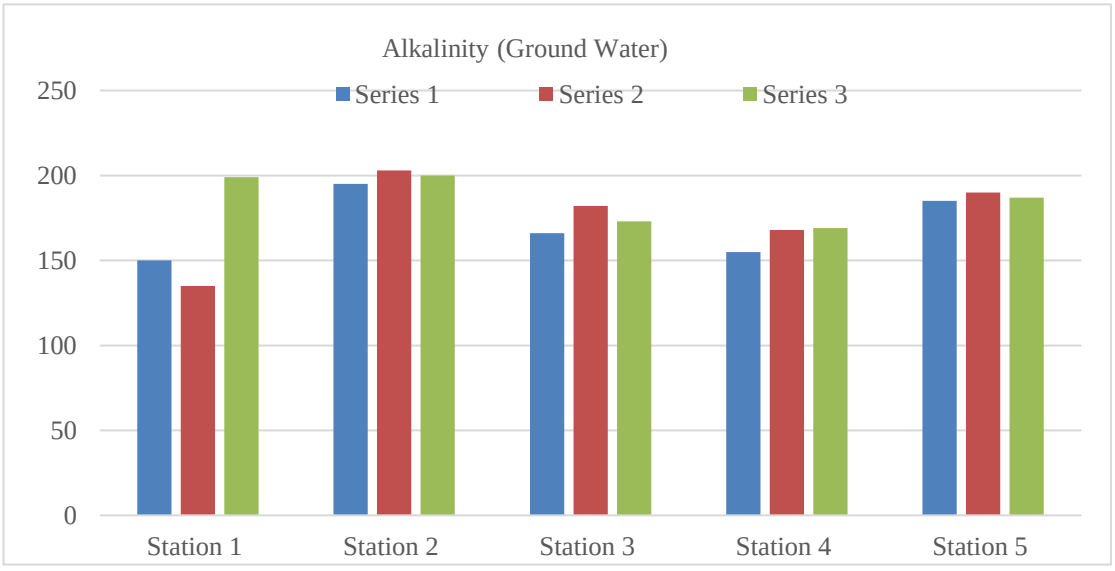


Source: Ansari & Khandeshwar, 2014

Figure 39: Chloride content from groundwater source obtained from station points near Nag River

- **Alkalinity content in groundwater samples**

  The alkaline content is due to the presence of carbonate and bicarbonate which indicates the degree of hardness of the water. The collected samples show the alkalinity content ranging from 130 – 200 mg/l. As per the CGWB standards, the desired and permissible alkaline limit in groundwater for domestic use is 200 mg/l and 600 mg/l respectively (CGWB, 2022) indicating that the degree of hardness is normal in the samples from the sources near Nag River.

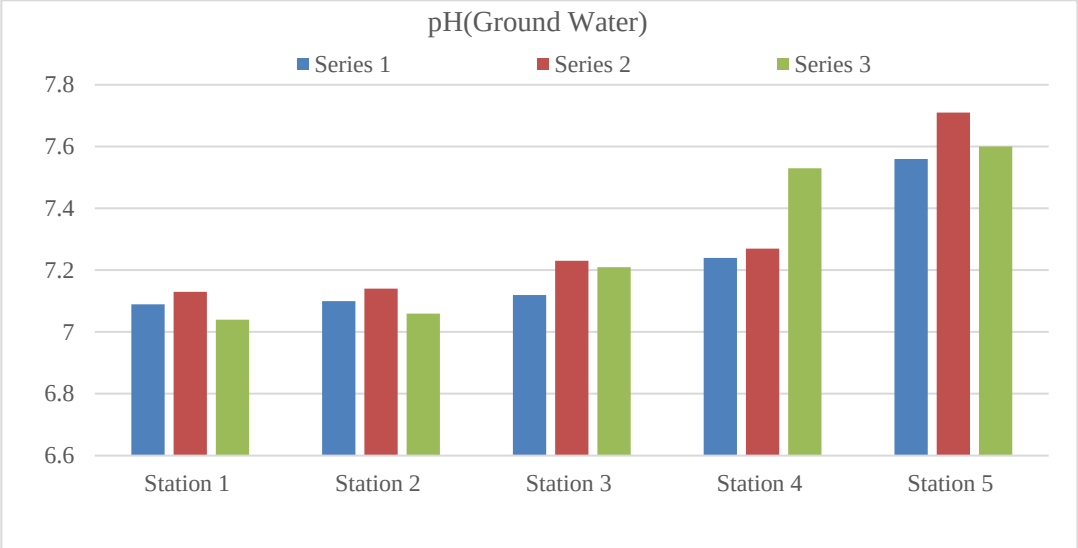


Source: Ansari & Khandeshwar, 2013

Figure 40: Alkaline content from groundwater source obtained from station points near Nag River

- **The pH of groundwater samples –**

  As per Indian Standards of Drinking Water -Specifications (BIS 10500: 1991) the range of pH desirable is between 6.5-8. It can be clearly seen that there is an increase in pH value at all the stations post-monsoon. All the collected samples that are collected have a range of pH varying from 7-7.75 which is within a prescribed limit as per standards.

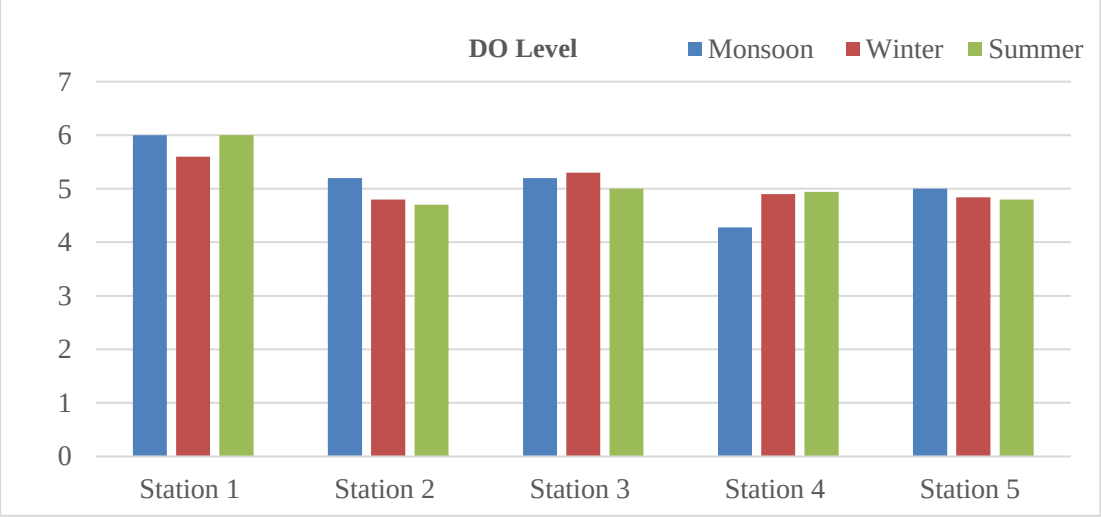


Source: Ansari & Khandeshwar, 2014

Figure 41: pH from groundwater sources obtained from station points near Nag River

- **Dissolved Oxygen level in the groundwater samples**

  The permissible standard for DO level for potable groundwater is 6.5-8.0 mg/l. Based on the samples collected all five stations have recorded dissolved oxygen levels in the range of 4.5-6.0 mg/l. Except for Station 1, all the other stations



Source: Ansari & Khandeshwar, 2014

Figure 42: DO content from groundwater sources obtained from station points near Nag River

indicate all DO levels from monsoon to summer it is due to an increase in the temperature of water resulting in low oxygen carrying capacity. The samples collected below the permissible range of DO require are all located in Old City Area (Station 2, Station 3, and Station 4)

4.5.4 Groundwater Related Issues and Challenges in Nagpur Metropolitan Region

Though the numbers and data as per the assessment of groundwater availability by CGWB is a decade old it highlights some of the key things –

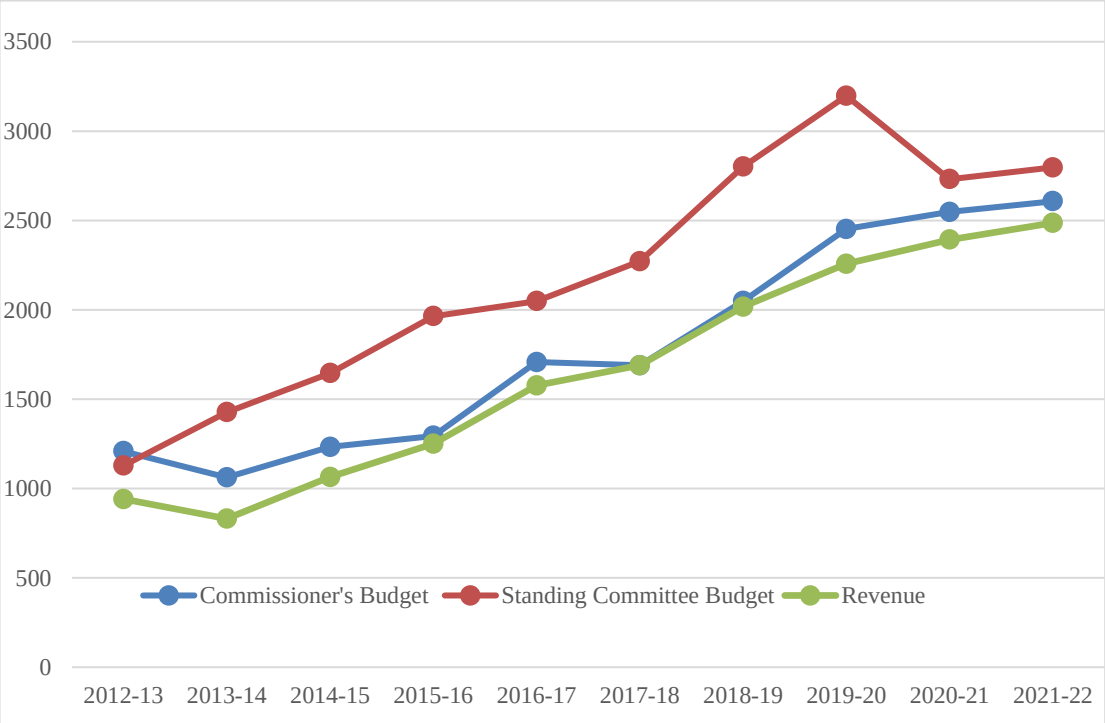
- With poor stormwater infrastructure and polluted surface water sources, there is a huge stress on the groundwater aquifer. With no efforts undertaken at the regional level as well as at the city level for the recharge of groundwater, it is expected that at present there is a huge stress on the groundwater resources. This shows the direct implication of poor quality of surface water resources.
- The report published in 2013 as per CPCB also indicates the presence of a high concentration of nitrates in groundwater samples collected from eastern and southern parts of Nagpur City which is an endpoint of municipal and domestic waste discharge of Nag River (Ansari & Khandeshwar, 2014). Indiscriminate discharge without hydrogeological considerations is leading to increased nitrate content which is an alarming sign to act for pollution abetment in Nag River.
- The alkalinity, chloride content, and pH values are well within the permissible limit as per the standards. Hence there seems to be no immediate threat but an increase in all the quality parameters levels during post-monsoon indicates the presence of acid rain which can be the possible cause of increasing values.

The above-mentioned key aspects highlight that contamination of surface water resources has a direct impact on the quality of groundwater which is long-lasting as well as irreversible. Over the years the depleting groundwater source degrading groundwater quality indicates the special actions to be undertaken to recharge shallow aquifers as well as surface water quality.

4.6 Assessment of Income-Expenditure Statements in Past Years: Review of Municipal Finance of Nagpur City

4.6.1 Rising of Municipal Finance Dependency on

As part of the 74th Constitutional Amendment Act, although the power to make decisions vests in the hands of urban local bodies, the dependency on finance majorly vests on the financial grants and various other assistances by higher tier of governments. While cities are expected to act as engines of growth in the coming decades, municipal finances in India remain underdeveloped (ICRIER, 2019). Like all other urban local bodies, where octroi was the major share of revenue income, after the abolition of



Source: Times of India, March 2022

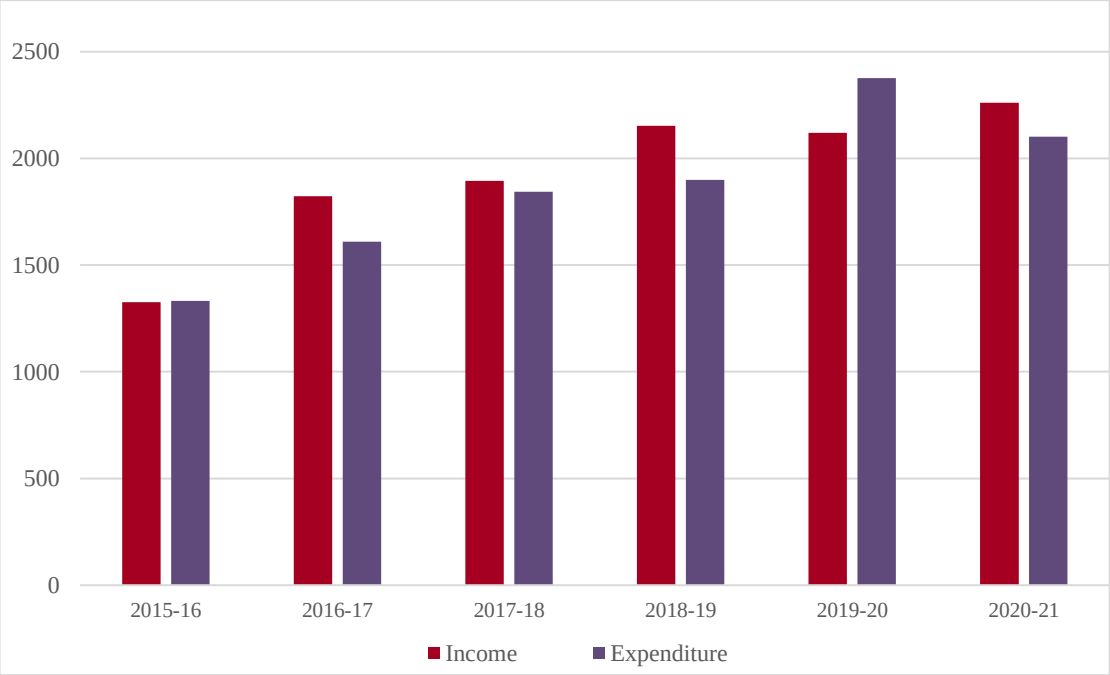
Figure 43: The gap between the approved budget and revenue for the past 10 fiscal years of NMC.

octroi, property tax has become the highest source of revenue income for local bodies. This has significantly impacted the fiscal income- expenditure records of urban local bodies including the fiscal accounts of NMC. Over the last 10 years, the constant gap between the proposed budget and revenue highlights the constant dependency on grants for capital expenditure (Fig. 1). With the Nag River Pollution Abetment Plan being

undertaken by National River With 15% of the financial contribution required from NMC for the Nag River Pollution Abetment Project under National River Conservation additional income capacity necessary to contribute a 15% share to the Nag River Pollution Abetment project.

4.6.2 Income Expenditure Statement (2016-2020)

Over the last six years from 2015-16 to 2020-21, income-expenditure values are at par with each other indicating the working of the Municipal Corporation with its full capacity to utilize the maximum allotted funds for the respective fiscal year. This highlights the business-as-usual scenario where the grants (capital and tied grants) and primary sources of revenue (property tax) were utilized to meet the expenditure (both



Source: Nagpur Municipal Corporation

Figure 44: Income-Expenditure record of NMC for past fiscal years (2015-16 to 2020-21)

capital and revenue) for successive years. The constant ratio of net income to net expenditure clearly indicates that no additional sources of revenue were created in subsequent years. Further, the similar the rend over the consecutive years also highlights the poor capacity of an urban local body to undertake mega-infrastructure projects which includes the Nag River Pollution Abetment program as well, which is being executed by the National River Conservation Directorate (Ministry of Jalshakti, Govt. of India). With the involvement of a central agency in the execution of the city-level project, mobilization of funds and decision-making is likely to take larger time.

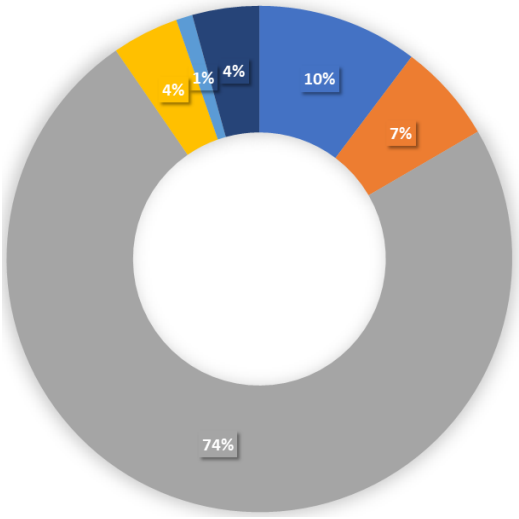
4.6.3 Expenditure on Public Health and Sanitation

The above graph indicates the increase in the net budgetary value of NMC during the last five years from 1325.82 Cr. in 2015-16 to 2260.85 Cr. in 2020-21. which essentially increased the overall expenditure in various heads including both capital and revenue expenditure in public health and sanitation. The following yearly statistics critically identify the expenditure of public health in the past four years –

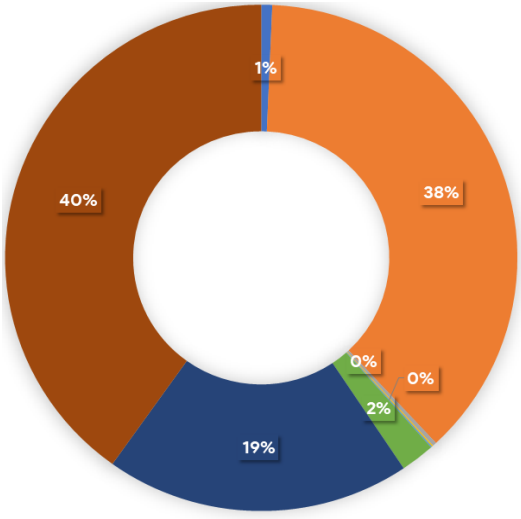
- **Financial Year 2020-21 –** Out of 2101.10 Cr. of the total expenditure, 20% (418.98 Cr) of the total expenditure was allotted to public health and sanitation works. Further, the major share of the allotted budget is expended under the establishment of road cleaning 168.15 Cr. (40%) and contingencies 103.20 (24%). The major sanitation works like the sewerage and STP allotted 0.33 Cr. (0.3%), and repairs of latrines are 0.36 Cr. (0.3%). Whereas the rest of the funds are allotted to miscellaneous usages like repair and establishment of ghats etc.
- **Financial year 2019-20 –** About 15.59% (370.59 Cr.) out of 2376.02 Cr. of the total annual expenditure was allotted to public health and sanitation works. Out of 370.59 Cr. of allotted funds, major expenditure was done under the establishment of road cleaning which accounts for 31.62% (117.28 Cr.) followed by repairs of latrines and roads 33.24% (123.20 Cr.) Major sanitation works like establishments of sewage and STP and capital expenditure works cost 0.47 Cr. (less than 1%) and 29.31 Cr. (7%) respectively.
- **Financial year 2018-19 –** During the 2018-19 fiscal year expenditure under the health and sanitation works includes 298.36 Cr. (15%) out of the total fiscal expenditure of 1899.16 Cr. Major expenditure heads establishment of road cleaning, repairs of road and latrines, and contingencies account for 104.49 Cr. (34%) and 105.05 Cr. (35.20%) respectively. Major sanitation works like Capital expenditure 11.20Cr. (3.7%), establishment of sewerage and STP 0.36 Cr. (Less than 1%) which is even less than 10% of the total expenditure.
- **Financial year 2017-18 –** Out of total expenditure of 1843.95 Cr. total expenditure under health and sanitation was 327.45 Cr. which is the highest among all the expenditures in the past four-year income-expenditure statements. Compared to the earlier expenditure heads, capital expenditure accounted for 24.73 Cr. (13%) which is the highest from the past four fiscal years. Like all the

successive financial year's major expenditure heads were the establishment of road cleaning and repair of latrines**.** Moreover, less than 10% of the total expenditure was done on sewerage establishments and STP.

Major Expenditure heads (2017-18)

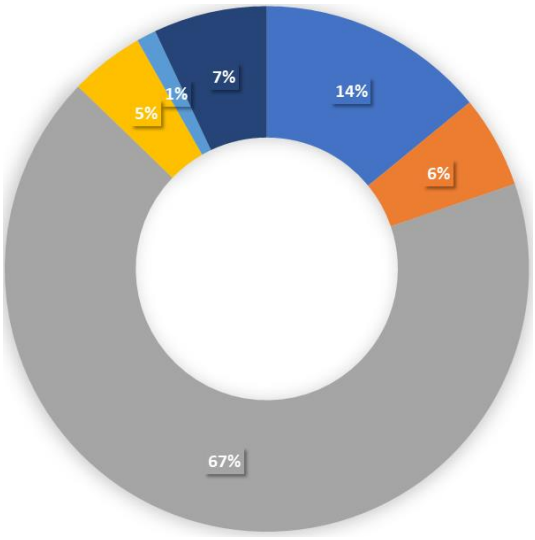


Public health and sanitation (2017-18)

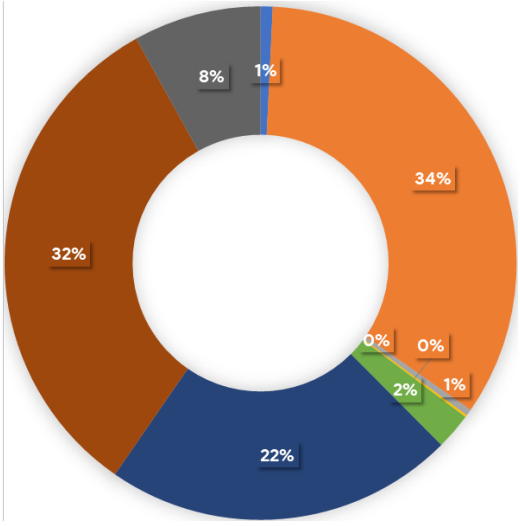


Total fiscal expenditure (2017-18) -
Total expenditure under health and sanitation sub-head (2017-18) -

Major Expenditure heads (2018-19)



Public health and sanitation (2018-19)



Total fiscal expenditure (2018-19) -

Total expenditure under health and sanitation sub-head (2018-19) -

Review of City's Financial Expenditure on Public Health

The following major highlights can be derived from the past four fiscal years mentioned below –

- It is evident that the capital expenditure under the public health and sanitation domain is less than 1-5% which is about 10 Cr. to 13 Cr. indicating that no major projects for the improvement of the sewerage network and treatment of waste were undertaken during the past four years.
- Capital expenditure during fiscal years indicates very less or no new area was laid to improve the coverage of existing sewerage infrastructure. This eventually impacted the condition of Nag River which is dumped with untreated sewage from nearby residential areas.
- Expenditure under the sub-head of the establishment of sewage and STP works over the past four fiscal years was found to be 01 Cr. to 0.5 Cr. which does not justify the strategy to reduce the percentage of untreated sewage by NMC.
- Most of the expenditure cost is associated with the establishment of road cleaning and repair of latrines which is not parred with the allotment of funds for capital expenditure and establishment of sewerage and STP which are essentially required to reduce the untreated waste in the city.

4.7 Summary of spatial and temporal changes over past decades with respect to Nag River –

Based on various aspects discussed above there are considerable changes that are observed that resulted in the poor condition of Nag River from time to time. The spatiotemporal study based on physical, financial, past planning efforts, and historical background indicates that all the aspects have actively or passively degraded the condition of river water. On the other hand, the impact of degraded surface water resources on the degrading condition of groundwater over the past years shows the implication that poor river water can have on other existing natural resources. The study clearly highlights that the poor condition of Nag River is a cumulative result of actions that have resulted in neglecting the river as a part of the city. The successive chapters will stress the existing condition of Nag River and its neighbors evaluating its existing condition.

5. EXISTING SITUATION STUDY OF NAG RIVER AND URBAN CONTEXT

5.1 Introduction

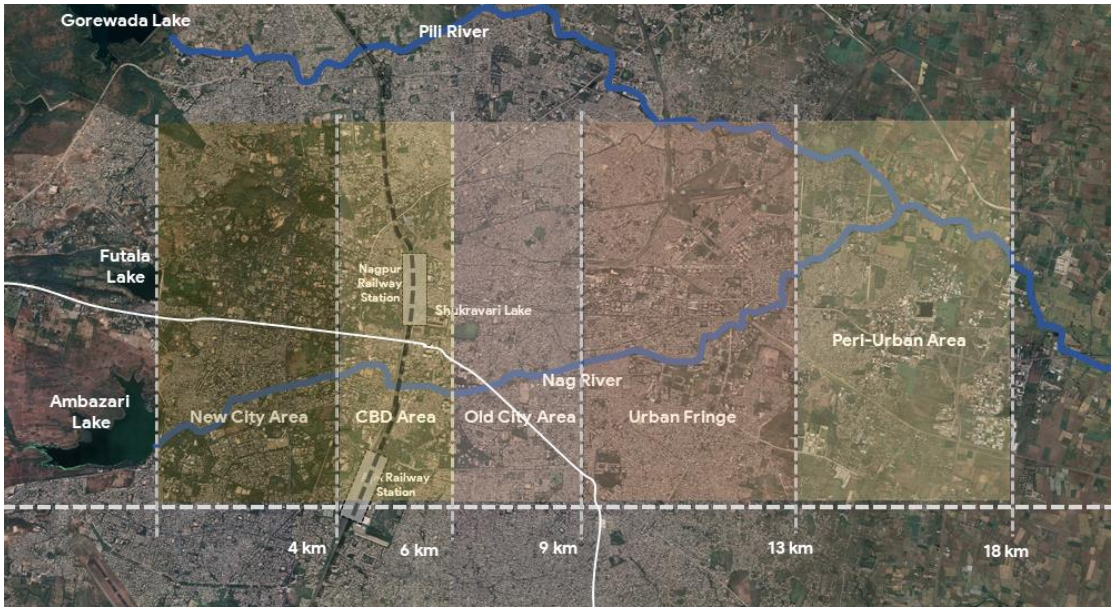
From the previous chapters based on Nagpur's urban sprawl, it can be clearly seen that there is no significant change in the city areas except urban fringes. This indicates that though the city is expanding outward the context of Nag River which is seen today and the degree of encroachments resulting in poor condition of river is decades old with no change in context of the river. It is essential to understand the nature of context throughout the stretch where river flows and what are major characteristic features of urban context in vicinity of the river. A detailed primary survey was done based on observations made in the field to understand the context. Since the city has expanded outwards in all directions over the centuries as the development happened, Nag River flows through the heart of the city and flows through various urban contexts established over a period. As a result, there is a dynamic change observed in the river's context.

LULC Classification	Area under different land uses in city zones					
	East	West	North	South	Central	Total
Forest	0.9	6.78	5.38	4.59	2.09	19.74
Open Land	13.72	14.78	8.63	12.13	0.25	49.51
Cultivation	13.53	3.88	8.93	9.51	1	36.85
Plantation	2.95	4.41	3.63	6.55	1.27	18.82
Habitation	28.13	10.85	15.39	31.49	6.57	92.42
Waterbody	0.31	1.53	1.13	0.25	0.26	3.48
Green space	17.38	15.07	17.94	20.65	4.36	75.41
TOTAL	**59.53**	**42.24**	**43.09**	**64.52**	**11.43**	**220.82**

Source: Author

Table 8: Area of different land uses in city zones

The following set of parameters were identified and observed to detail critical points throughout the stretch of river starting from Ambazari Lake upstream in the East to the Wathoda Layout to the Western end of the NMC boundary.



Source: Author

Figure 46: Imagery showing flowing of Nag River through various urban contexts of Nagpur.

A. Understanding urban context and existing neighborhoods along river – Five major parameters were observed during primary survey along the stretch of the river -

- Predominant Existing Land Use
- Age of Building
- Built Form and Density
- Consumed FSI
- Land Value and Development Potential

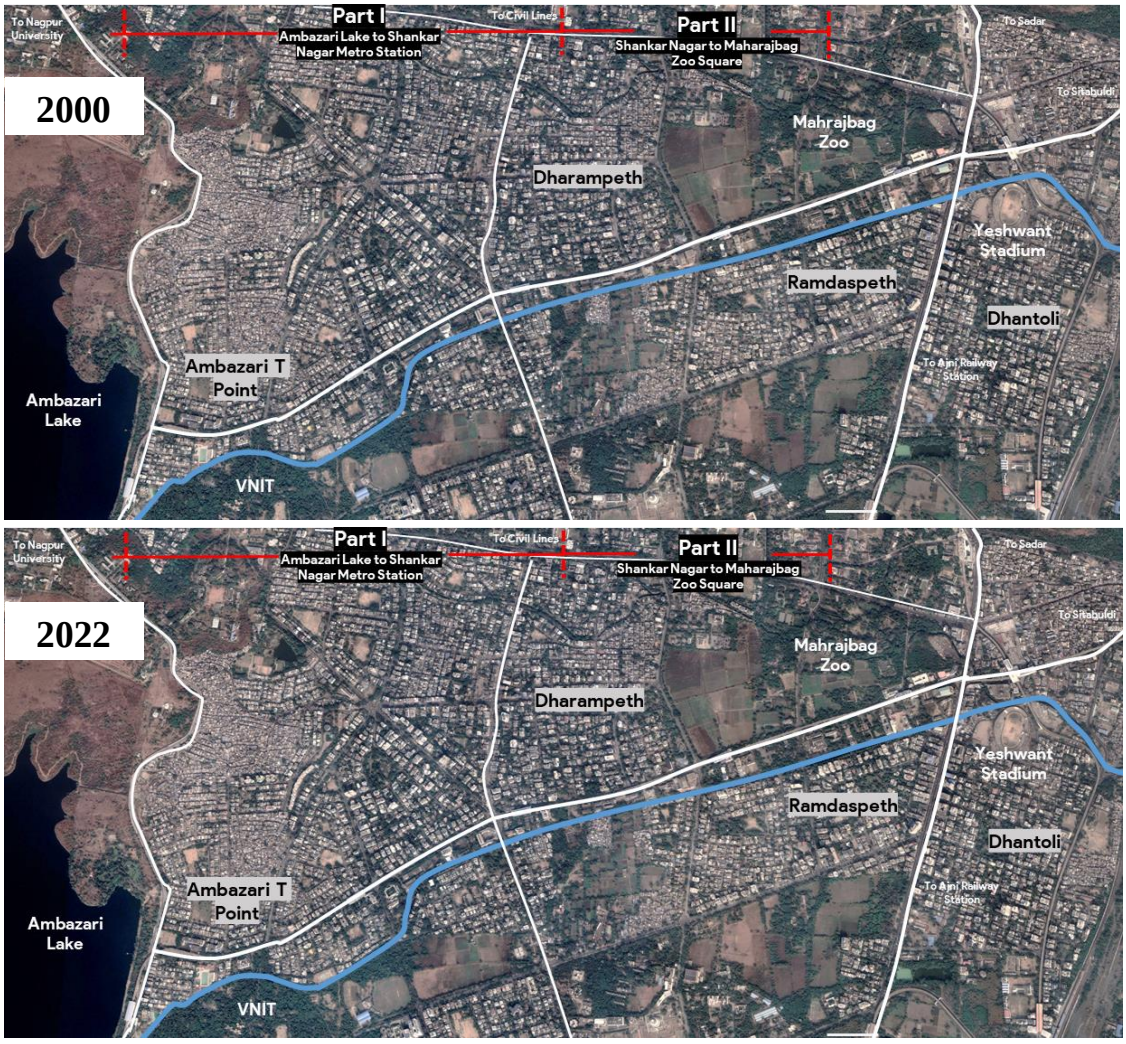
B. Condition of River – This was observed considering following qualitative factors to understand the changing qualitative aspect related to the health of the Nag River.

- Degree of encroachment
- Accessibility and connectivity along riverbanks
- Edge conditions
- Nature of Pollution

The 17 km stretch of Nag River based on the primary survey and observations is classified into eight parts distributed in three major sections throughout the urban context.

5.2 Transect I – Origin to Nag River (Ambazari) to Dhantoli

The area emerged during post-independence period in 1970s for providing residential land for increasing migration resulting in planned residential layouts. During the past two decades 2000-2020 within proximity of 200-400 m there is no drastic development since there were hardly any vacant land available for development. Moreover, the area from riverbank to 300 m wide on either side is undergoing a rapid redevelopment primarily because of poor condition of buildings and rising housing demand.



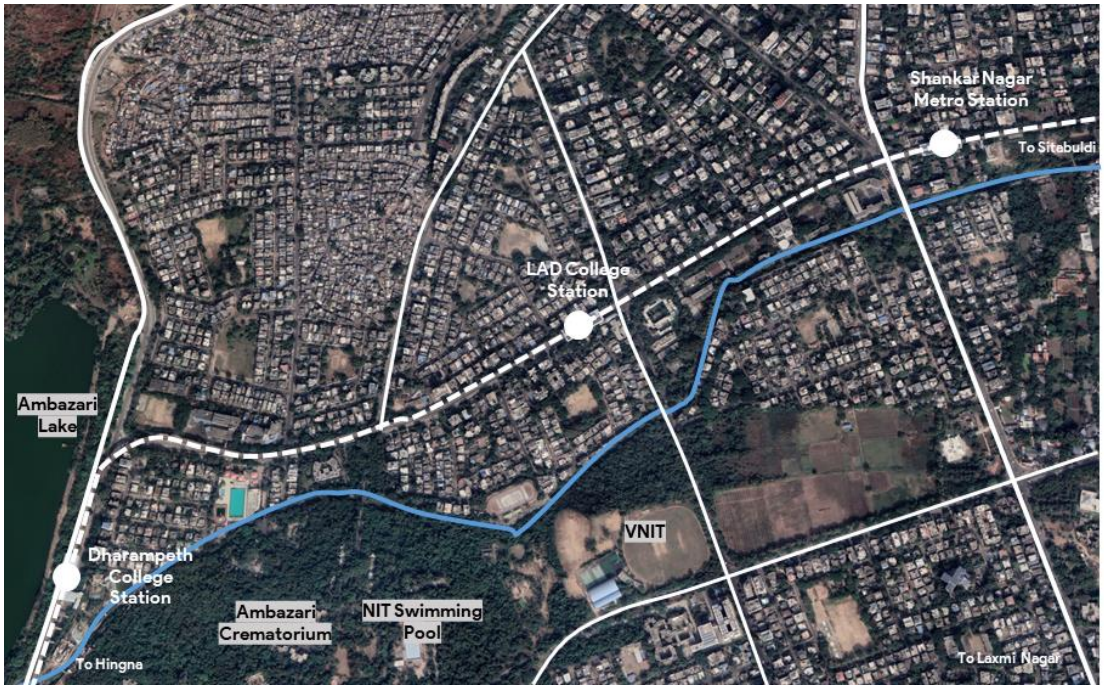
Source: Primary survey

Figure 47: Aerial imagery showing the recent development in urban context of Nag River 2000 & 2022

5.2.1 Part I (Ambazari Lake to Shankar Nagar near Saraswati School

This part of the transect is characterized by predominantly residential land use on either side of the Nag River covering the length of (0-1.6 km) starting from the source. Rapid redevelopment of independent detached housing units to apartment typologies is seen

throughout the stretch. This is primarily to capture real estate demand in the proximity. This development is expected to trigger in vicinity of Nag River in upcoming decades due to incentive FSI maximum upto 4.0 as per UDCPR 2022 since the area is within the proximity of Metro route. The area has average consumption of 1.2 FSI due to low rise low density urban character and plot sizes ranging from 70-120 sq. m



Source: Google Imagery

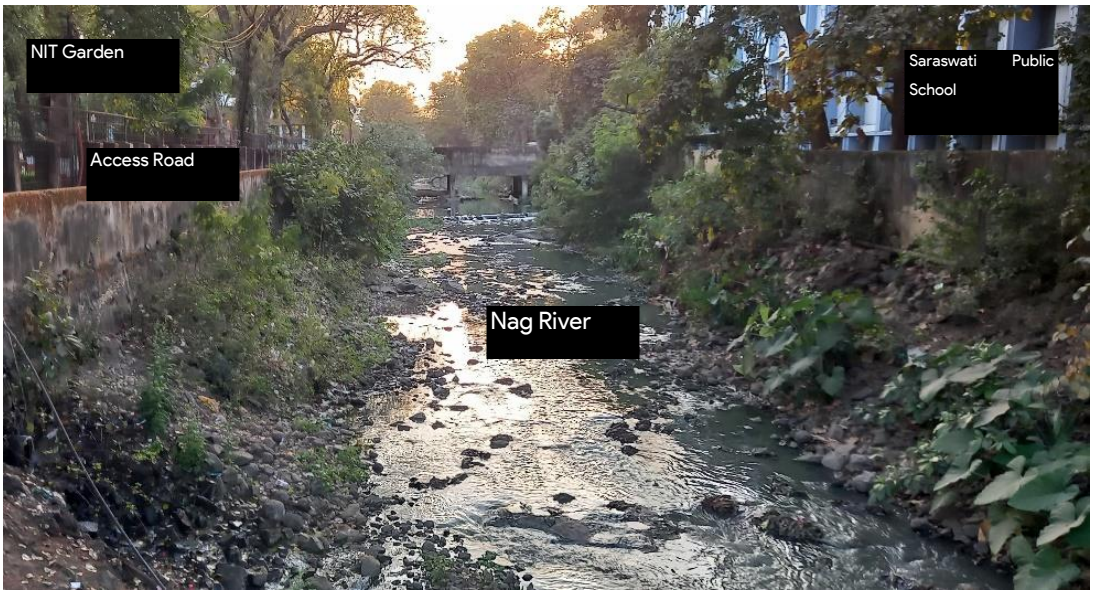
Figure 48: Satelite image showing stretch of Nag River 0-1.6 km

Note: Upcoming redevelopment undertaken by individual plot owners is replacing detached typologies with apartments.

Source: Google Imagery

Figure 49: Existing Urban Character within proximity of Nag River 0-1.6 km stretc

The river has no buffer and construction of buildings is observed right next to the edge of the river throughout the stretch. As mentioned in the assessment of water quality (Chapter 3) the primary reason of pollution is dumping untreated sewage. According to the primary survey there is not provision of septic tank or sewer lines throughout the river stretch. Larger parcel of land belonging to public ownership which includes community parks (NIT), skating ground (NIT), Ambazari Crematorium (NMC) which also encroaches the Nag River.



Source: Author

Figure 50: Image showing condition of Nag River 0-1.6 km stretch.

Note: No on-site or off-site sewage system is found in the residential and institutional units along the Nag River. Direct disposal of untreated sewage is seen. Small pockets of landfill collection near the stream are identified leading to clogging of sewer at specific points.

5.2.3 Part II Shankar Nagar Square (Saraswati High School) to Ramdaspeth

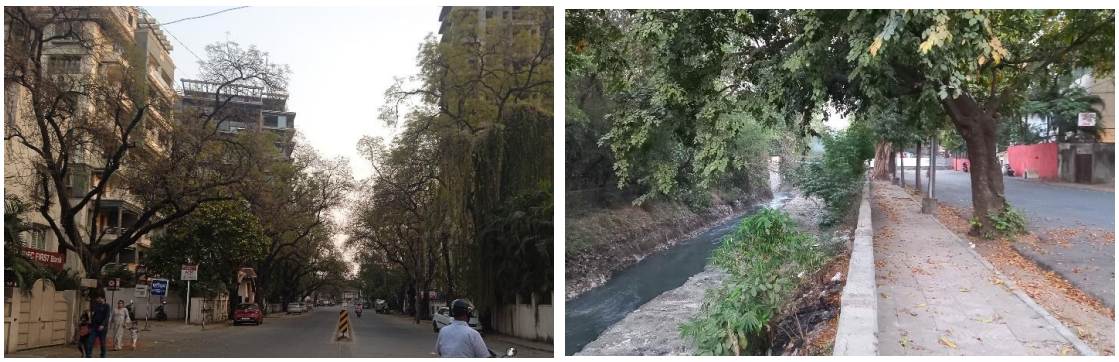
A stretch of 1.6 -3.0 km of Nag River lies between the predominant residential area Shankar Nagar and Ramdaspeth. The river runs parallel within proximity to the metro alignment surrounded by institutions on one bank and other banks having residential apartment typologies. The gradual transition of G+1 residential bungalows with G+6 apartment buildings can be seen along the urban neighborhood towards Ramdaspeth. The stretch is dominated by high residential property prices and high demand for floor space due to its effective connectivity to the CBD area adjacent to Ramdaspeth and another residential area of southwest Nagpur. As a result, the average consumption of FSI is 2.4 with maximum plots ranging from 90 -200 sq. m. Since the past decades have

already developed, the potential for a large parcel of area undergoing redevelopment is very less. The transformation of existing land use in the vicinity of the neighborhoods connected to Nag River is transformed into mixed-use typologies.

Source: Primary Survey

Figure 51: Image showing stretch of Nag River from Shankar Nagar to Ramdaspeth

(Note: Upcoming high-rise mixed used typologies which is an impact of existing CBD in the vicinity of the area)



Source: Primary Survey

Figure 52: Image showing stretch of Nag River from Shankar Nagar to Ramdaspeth

Poor edge condition is found throughout the stretch. Since the river is polluted throughout the stretch most of the river stretches have dead walls to hide open drains from access roads. The stream length varies from 4-6 m depending on the flow of water during seasons and depth varies from 1.5-2.5 m below road level. Though most of the new apartment buildings are connected to the sewer drain, certain slum clusters and institutions directly dump untreated wastewater into Nag River. Poor connectivity on

either side of the bank is seen throughout the stretch. The area undergoes flash floods due to heavy water drain during monsoon every year in areas that are highly encroached on the riverbanks. The nature of pollution and degree of contamination both increases along the river stretch as the river flows from predominantly residential typologies to mixed-used typologies towards CBD.

Source: Primary Survey

Figure 53: Image showing existing slums near Nag River at Ramdaspeth

(**Note:** The pocket of unauthorized slums lying along the edge of the river body with direct disposal of waste into the river. Many of such areas also experiences flash floods during monsoon when heavy storm water drains through the river)

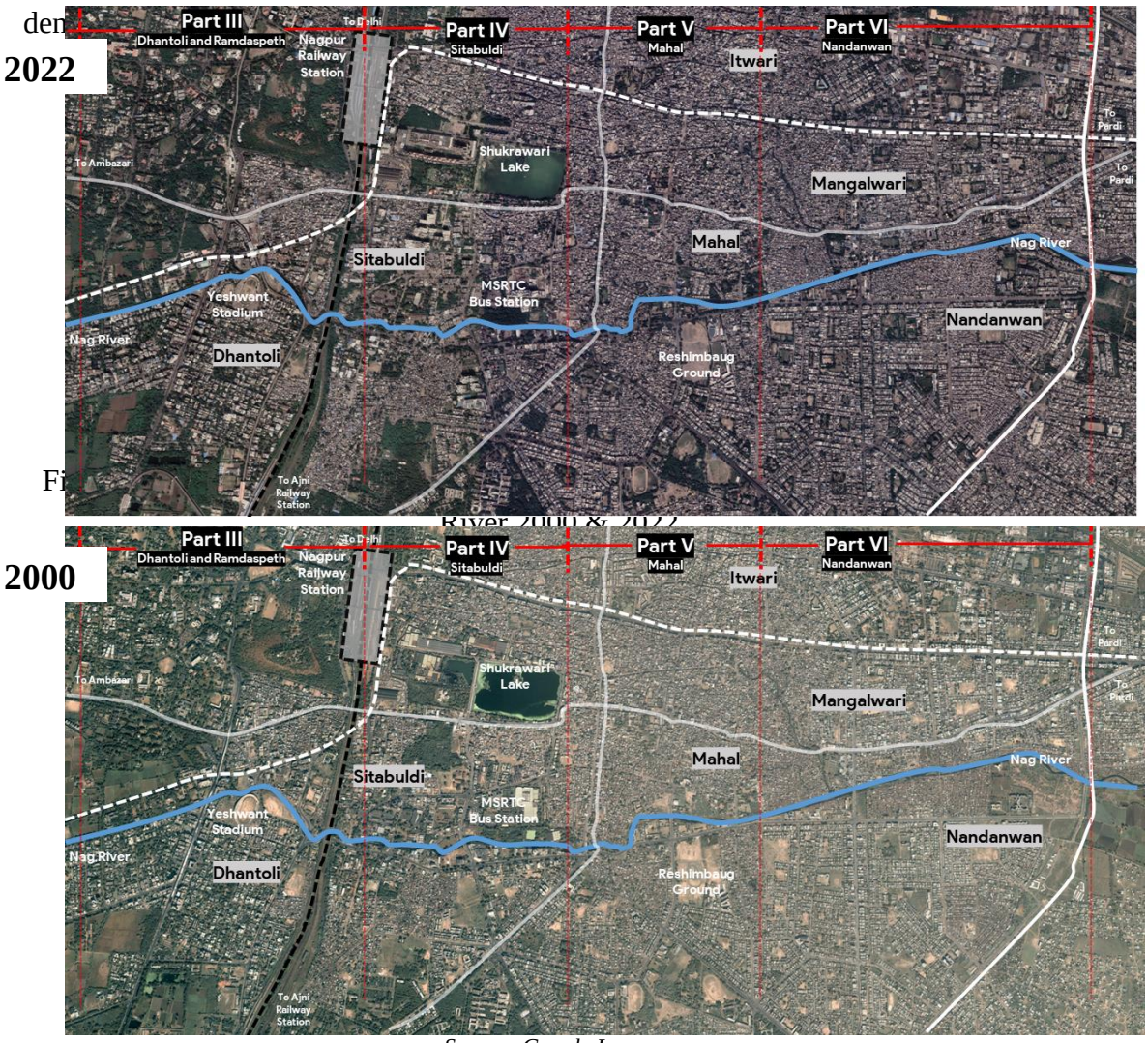
5.3 Section II Dhantoli – Sitabuldi – Mahal and Nanadanwan Area

This section comprises of 5.4 km stretch of river flowing through CBD area of Nagpur City followed by Old City area, wholesale commercial markets (Mahal and Mangalwari and finally through Nandanwan which consists of residential plotted layouts. Over the decades there is no drastic change that can be seen in case of new built up due to less availability of vacant land and high property values**.**

5.3.1 Part III Dhantoli CBD

Stretch of 3.0 – 4.6 km of Nag River flows through CBD area characterized by commercial mixed used typologies. This section has planned plotted development towards the Western part separated by Railway track and Eastern part which belongs to Sitabuldi which is historic retail market with organic growth. The area has high built

den



Fi River 2000 & 2022

Source: Google Imagery

Figure 54: Aerial imagery showing the recent development in urban context of Nag River 2000 & 2022

Various anthropogenic activities along the river stretch further degrades the condition of River. As per the past studies the samples collected shows high level of fecal as well as industrial contamination which is a result of direct dumping of wastewater coming from micro-scale industries in the nearby neighborhoods. Increase in pollution over the decade also resulted in lack of plant species. The stretch of the river varies from 6-15 m wide whereas the depth varies with 1.5-3.5 m. The stretch of river is subjected to heavy encroachment leaving no boundary for buffer for river like all other stretches. Both sides of the rivers have poor connectivity leading to dead ends which are primarily used for landfills at various locations in neighborhood next to the riverbank.

Source: Primary Survey

Figure 55: Satellite image showing stretch of river along CBD area of Nagpur.

Source: Primary Survey

Figure 56: Existing Urban Character along Nag River at Sitabuldi

Source: Primary Survey

Figure 57: Image showing poor water quality of Nag River near Yeshwant Stadium

(**Note:** Lack of streamlined flow throughout the drain due to the dumping of solid waste is frequently seen throughout the CBD area. With outlets of toilets directly opening into Nag Nala, flooding condition results in the choking of community and private toilets during monsoon).

5.3.2 Part IV Sitabuldi, Cotton Market Area till MSRTC Bus Depot, Ganeshpeth Old City Area

This part covers 1.5 km stretch of Nag River flowing though Old City Area with low-rise high-density character. The area is an extension of the CBD characterized by mixed land use typologies. Along the stretch there are various vacant, dilapidated, and unused land parcel which are used as dumping sites. Large parcels of institutional lands with poor built character are found along the bank of the river. The area has high potential for undergoing redevelopment with high demand for commercial retail and non-retail development which are not used to its optimum potential since most of them belong to public ownership.

Source: Primary Survey

Figure 58: Nag River stretch along Cotton Market and MSRTC Bus Depot
(Note: Regional Bus Terminal with formal and informal activities along the streets. Small cluster of unnotified slums within proximity of CBD market area).

The constantly varying river section throughout the course is observed ranging from 6 m wide to 32 m wide. A significant portion of the river dries during summer making it open sewer drain. With no buffer between the river and the built form along the river. The poor accessibility of riverbank along the residential neighbourhood characterized by dead ends, landfills and poor edge condition are prevalent like all other stretches as

discussed above. With multiple anthropogenic activities along the river stretch, the river stretch also carries high level of pollutants.

Source: Primary Survey

Figure 59: Images showing urban character of neighborhood along Nag River at Cotton Market

Source: Primary Survey

Figure 60: Condition of Nag River dried up during spring near Old City area of Nagpur.

(**Note:** Multiple anthropogenic activities polluting the river are seen especially small-scale household industries. The constantly varying river section from 6 m wide to 32 m wide).

5.3.3 Part V Old City Area (Mahal) and Chitvinispura

As a part of the Old City area (Mahal), the neighborhoods of Shukrawar, Chitvinispura and Tulsibagh are one of the densely populated neighborhoods of Nagpur City. Since the area is historically evolved over a period some of the prominent characteristics of this area include organic streets, compact built units and low-rise high-density built character. Considering the population density in the given neighborhood, the per capita floor space is relatively less due to poor structural conditions of buildings and no

redevelopment over a period leading to poor use of land. Compact urban fabric with varying street sections ranging from 4.5 – 10.5 m wide throughout the neighborhoods yeilds no scope for infrastructure improvement to meet rising needs. Since most of the areas have FSI consumption higher than the proposed FSI after undergoing redevelopment based on the development control regulation does not provide adequate floor space on a given space of parcel. As a result of this, though the area has strong potential for undergoing redevelopment, the incentives fail to initiate the redevelopment works that were essential to be undertaken due to rising needs and housing demand.

Source: Primary Survey

Figure 61: Satellite image showing stretch of Nag River with its near Mahal

(Note: Large units with poor structural condition high potential for redevelopment

Source: Primary Survey

Figure 62: Old City neighborhoods and street character along Nag River

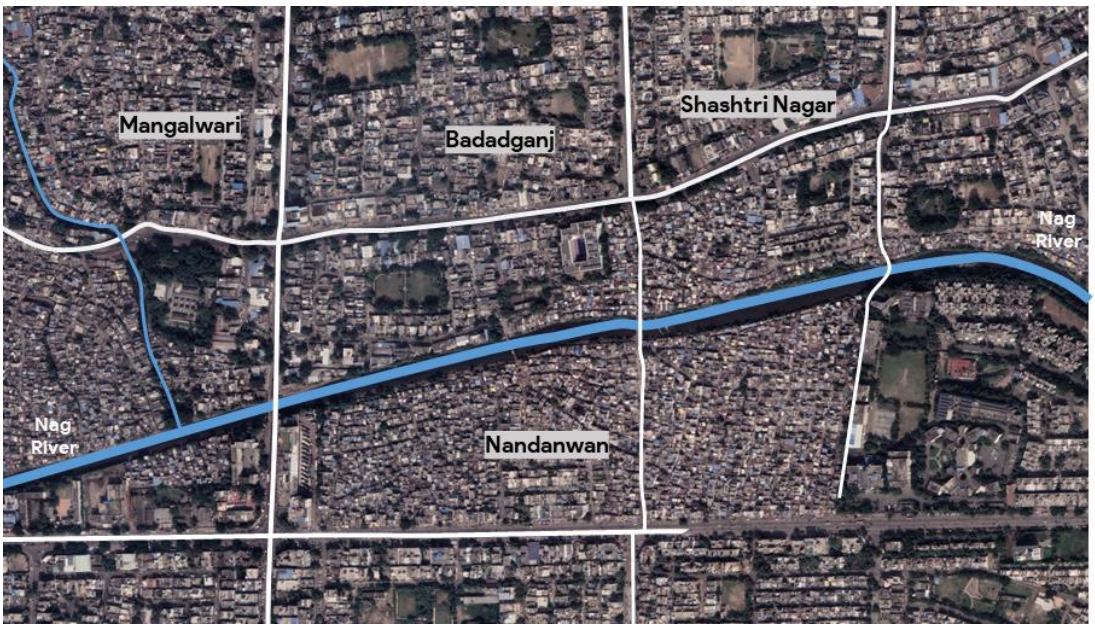
Source: Primary Survey

Figure 63: Encroachment along Nag River and poor edge condition along the banks

Note: Sewage outlets directly open to river untreated increasing the contamination rate downstream.

5.3.4 Part V Old City Area (Mahal) and Chitvinispura

This stretch of 12-14 km of Nag River on either side has predominantly residential land use with high density housing on either side of the river. Planned residential layouts with varying residential typologies due to variation in plot sizes 60-200 sq. m. The land prices are lesser compared to the old city area resulting in larger construction projects



Source: Primary Survey

Figure 64: Satellite image showing stretch of Nag River near Nandanwan

including some high-rise apartments. Mixed residential typologies like high-rise apartment and low-rise high density planned layout throughout the stretch of river. The average consumed FSI is 1.6 considerably higher compared to other areas due to the predominance of high-rise residential apartments.

Source: Primary Survey

Figure 65: Images showing the gated communities and recent development along the neighborhoods of Nag River.

.(**Note:** High rise residential apartment typologies are predominantly constructed overlooking poor river health)

Heavy encroachments lead to poor edge condition. Most of the river stretch has dead wall and embankment constructed to reduce the impact of backflow during monsoon. Sewage from residential layouts is major source of pollution followed by construction debris. Since the area lies downstream this stretch has widest river section of about 32 m – 40 m wide because of two major reasons. The first is as the area is located downstream the water carrying capacity is reached peak near this point. The degree of pollution content and BOD (30-110 mg/l) and COD level (40-150 mg/l) indicate poor health of river and unsuitable for growth of local flora and river ecosystem. (NMC, 2019). The area has high concentration of unauthorized slums on either side of the bank. Condition of lack of flow during summer is seen to impacting the groundwater quality in the region. As the untreated waste from sewage and industries settles near the basin due to lack of flow in summer season indicates chances of infiltration of contaminants causing this issue.

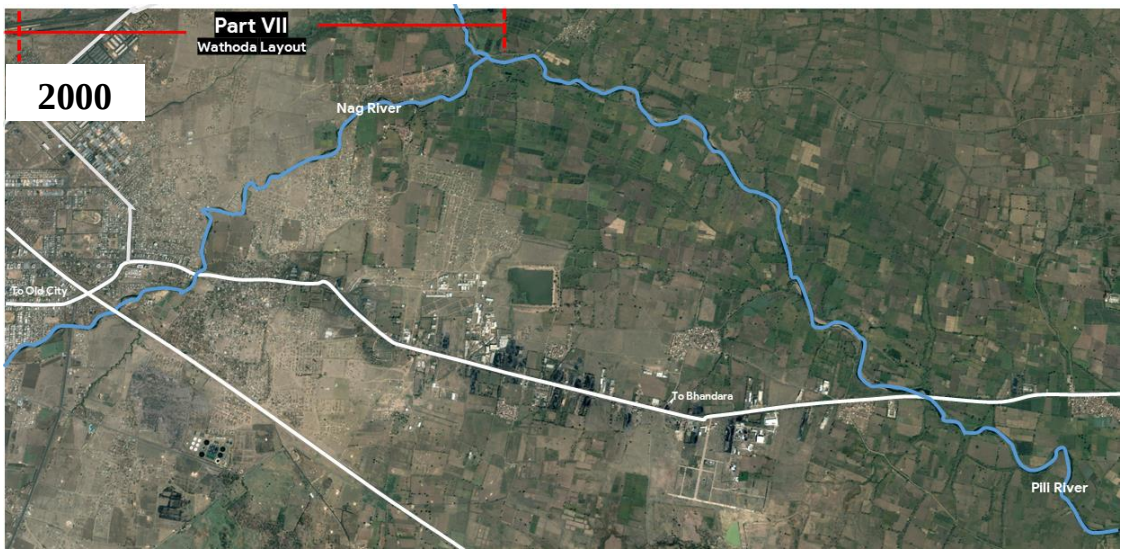
Source: Primary Survey

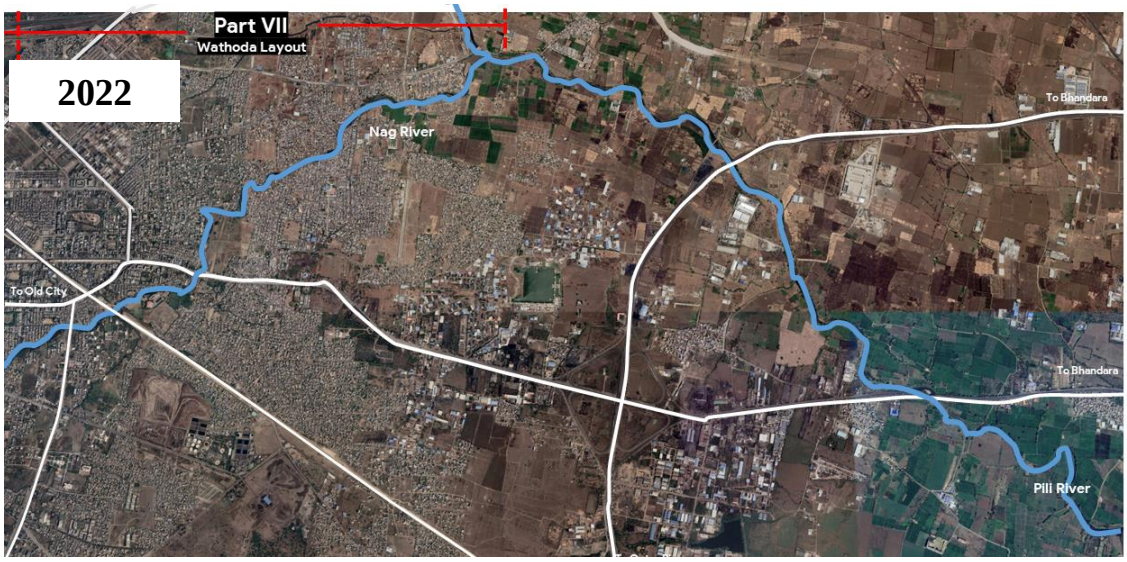
Figure 66: Poor connectivity of either banks along the neighborhoods of Nag River

Note: Throughout the river section accessibility to both the parts of the river is poor though there are crossings at possible locations.

5.4 Transect III – Urban Transect

This section of transect is characterized by increased urban sprawl from 2000-2022. Linear development along major regional corridors along these transect are sanctioned as planned layouts by NMC. The increased urban sprawl continues to encroach river throughout the stretch due to uncontrolled urban sprawl. This rapid development also resulted in poor laying of sewerage infrastructure which therefore makes Nag River as vulnerable to areas located upstream.





Source: Primary Survey

Figure 67: Urban sprawl during in past decades (2000-2022) along Nag River

5.3.4 Part VII - St Xavier's High School to Wathoda Layout (14.5-17 km)

Rapidly urbanized area along this transect is due to sanctioned residential layouts by NMC. The neighborhoods located in the vicinity of river are predominantly detached residential typologies with plot sizes ranging from 54-60 sq. m resulting in low-rise high-density development in clusters. with average FSI consumption of 1.2. This stretch is primarily due to lower land

Source: Primary Survey

Figure 68: Satellite image showing stretch of Nag River along Wathoda Layout

(**Note:** The development is the result of urban sprawl from past two decades. Proposed metro is likely to boost the connectivity to the city centre. The area has planned layout with poor lay of infrastructure including sewage).

prices compared to other residential neighborhoods. Improved connectivity through rapid rail transit is expected to increase the built density along the TOD corridor due to development incentives.

Source: Author

Figure 69: Existing Urban Character along urban fringes near Wathoda Layout

Poor edge condition and encroachment right at the riverbanks is resulting in the natural flow the of river and the dumping of debris and construction materials the into river channel. The lack of proper sewerage network which is a result of rapid urban growth with poor infrastructure planning adds to the pollution downstream.

Source: Primary Survey

Figure 70: Image showing upcoming high-rise development along river bank

Note: Construction activities adjacent to the river is resulting in dumping of demolished waste into river. Floodplains are heavily encroached throughout the stretch of river in old city characterized by dumping of untreated sewage directly into the river.

5.5 Summary

Following are the major key points that are highlighted from the existing condition of Nag River

- **Vulnerability of River due to rapidly changing urban character –** Since the river cannot be looked in isolation to the existing urban environment, specific solutions based on the interventions along urban transect will be a key strategy to improve quality of river pollution, having green buffers and promoting freshwater ecosystem.
- **Source of Pollution remains primarily same –** The primary source of pollution throughout the Nag River is untreated sewage from residential neighborhoods within the proximity of river which is a due to poor sewerage infrastructure.
- **Influence of TOD and UDCPR regulations for redevelopment –** The entire transect is likely to get influenced by TOD and changes in urban regulations. These statutory factors will also play a key role in defining the character of urban areas along the river stretch which will impact the Nag River.
- **Old City Area (Mahal) and polluted River Stretch –** One of the key issues along the entire river stretch is dealing with the polluted river stretch of Nag River in Old City Areas. Old City area Mahal is identified to have highest population density with high degree of encroachment along with high contamination compared to other regions.

In the case of Nag River, throughout the stretch though anthropogenic activities remain the same but there is a drastic change in urban character along the stretch. Starting from the new city-planned neighborhoods which are 40-50 years old to the old city area which is likely to have organic development to upcoming development near to NMC boundary due to urban sprawl, Nag River flows through a dynamically changing urban environment. As a result of which the Nag River Rejuvenation and Pollution Abetment highly depend on the transect in which intervention is being carried out.

Note: Recently the surface around the natural drain channel is being concretized removing the natural green cover to create a social gathering space which is an encroachment within river flood plain increasing the complexity upstream.

Small pockets of landfill collection near the stream are identified leading to clogging of sewer at specific points.

Poor edge conditions adjacent to the river without any buffer making the river a dumping ground for solid waste resulting in foul smell in the vicinity.

Source: Author

Figure 71: Images showing the existing condition of Nag River and various activities along the stretch.

In the case of Nag River, throughout the stretch though anthropogenic activities remain the same but there is a drastic change in urban character along the stretch. Starting from the new city-planned neighborhoods which are 40-50 years old to the old city area which is likely to have organic development to upcoming development near to NMC boundary due to urban sprawl, Nag River flows through a dynamically changing urban environment. As a result of which the Nag River Rejuvenation and Pollution Abetment highly depend on the transect in which intervention is being carried out.

Rethinking restoration of polluted water stretch using spatial planning techniques: A Case of Nag River, Nagpur

6 ASSESMENT OF URBAN RIVER MANAGEMENT PLAN FRAMEWORK AND ITS IMPLEMENTATION IN CONTEXT OF NAG RIVER

6.1 Background

The study so far identified some of the key aspects of the existing situation of Nag River and the impact of various subjects and activities over a period. Similarly, the stakeholder's consultation validated and highlighted the perspective of various groups that are directly or indirectly associated specifically with Nag River as well as experts who are directly linked to the field of river rejuvenation and pollution abetment before to this literature review highlighted some of the key aspects of the existing efforts from the global to the local level. It identified the fundamental gap between the expected outcome from projects related to improving the condition of the river, legislative hindrances, poor implementation mechanisms, and lack of a holistic approach to solving the problems. The literature review highlights the highly top-down infrastructure-driven approach of river rejuvenation funded by high capital investment, which is one of the major gaps which do exist in existing guidelines and frameworks associated with improving the condition of rivers. The section here summarizes critical aspects to derive an outcome of the study. The following part of the study focuses on identifying key areas of interventions based on field study and various inferences drawn so far.

6.2 Unique Aspect of Nag River: From Finding and Analysis

Based on the finding and analysis of the study so far, some of the unique aspects of Nag River identified throughout its urban stretch are mentioned below. This infers the need for creating a unique approach in providing possible interventions for river rejuvenation and abetment of pollution.

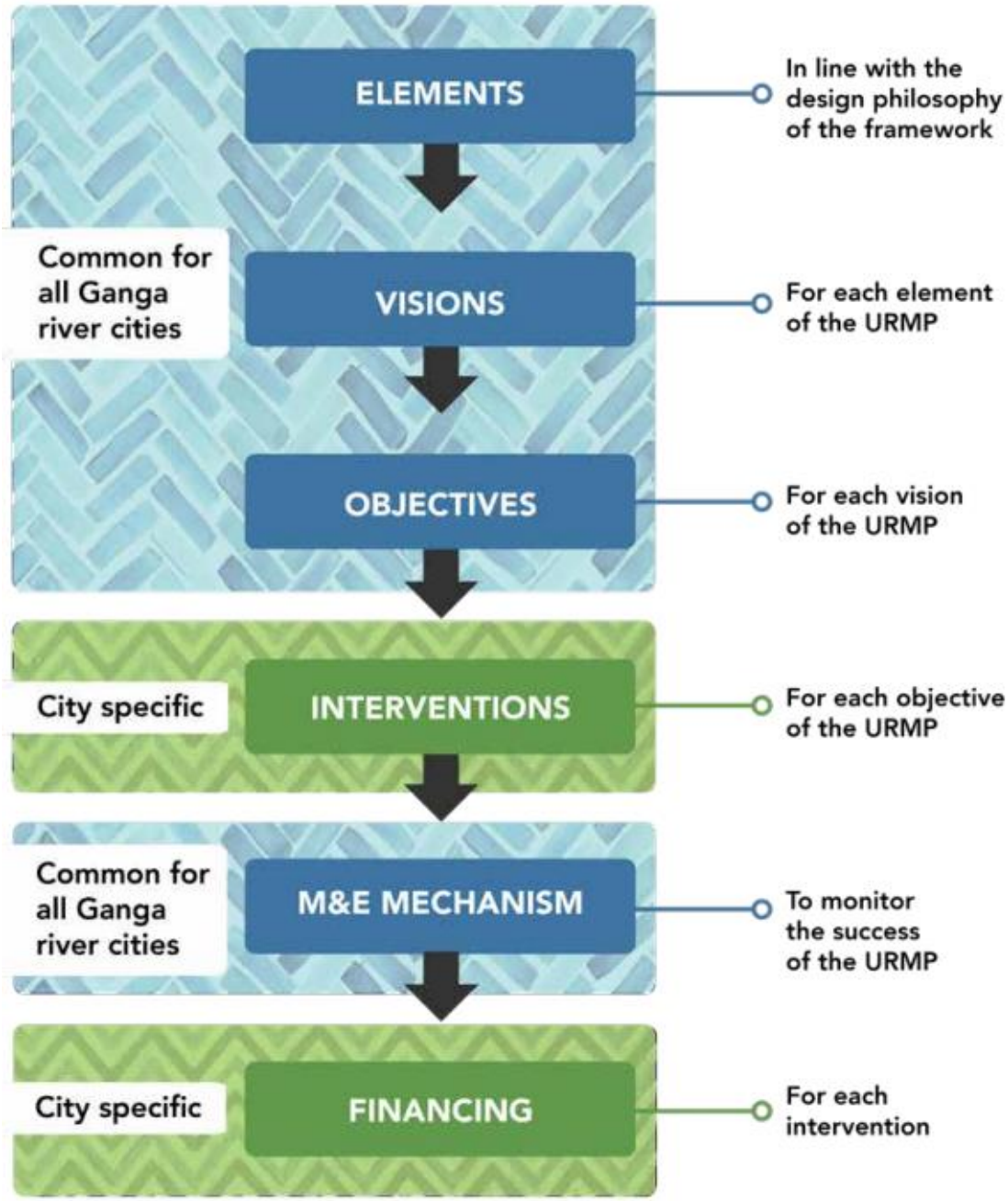
- **Nag River and its context -** Unlike most of the rivers, which are predominated by similar kinds of urban character throughout the stretch, Nag River is a unique example that passes through all major areas of the city and is identified as a part of urban morphology. The river passes through the Old City area, which is organically developed along the river, followed by the Nag River on other hand is a part of upcoming neighbourhoods which are upcoming greenfield development

in the city. The river flows through all varying densities and land uses throughout its stretch.

- **Varying width and depth of River for shorter stretches -** The river's width varies from 6 m wide to 42 m wide similarly, the river's depth from the road surface varies from 2 m to 4.5 m in depth. This large variation along a shorter stretch of the river makes it infeasible to implement the generic spatial strategy in one go.
- **Non-perineal nature of the river and condition of the floodplain -** The River is a part of the water overflow from Ambazari Lake. Like all other cases, the river's source lies away from the urban context. Being a smaller tributary and due to rising growth in the upstream direction towards the source of Ambazari is also a unique setting. Moreover, the study conducted in the assessment of lakes in Nagpur shows significant pollution in Ambazari Lake due to heavy encroachment in its catchment area.

6.3 Urban River Management Plan: A Brief Outline

The URMP is being developed by the National Mission for Clean Ganga (NMCG), which serves as the implementation arm of the National Council for Rejuvenation, Protection, and Management of River Ganga (after the dissolution of the National Ganga River Basin Authority), under the Ministry of Jal Shakti. The URMP framework is based on the holistic approach to improving the quality of polluted urban stretches based on the generic objectives based on environmental, economic, and social aspects to rejuvenate riverfronts. The conceptual layout of the URMP is divided into two distinct parts, including both generic actions identified as common to all the urban areas. At the same time, some aspects are left for context-specific interventions. The former generic aspects include elements, vision, and objectives, which are generic in nature. In contrast, the specific part of URMP includes interventions and financial mechanisms that cities can undertake based on their own capacities. Aligning the timeline of URMP with the statutory development plan (or master plan) is the first step toward its on-ground implementation. The river management plan will further, highlights short-term and long-term interventions that must be undertaken to achieve objectives. The Urban River Management Framework is widely used for restoring River Ganga under the Namami Gange Program. As per the latest updates, Ayodhya and Aurangabad are prepared along the lines of this framework.



Source: *NIUA, 2018*

Figure 72: Conceptual framework of urban river management framework

(Note: An illustration above indicates the structure flow of the urban river management framework. The components illustrated with blue boxes are generic components of URMP, whereas the city-specific aspects (interventions and financing methods are highlighted with green background. The idea of having city-specific components in the framework ensures innovative and locally feasible solutions and financial mechanisms for implementation of the management plan)

6.4 Rationale, Scope of Intervention, and Critics Based on URMP's Objectives with Respect to Nag River's Contact: A Review

Urban River Management Plan is a generic framework that forms the structure to intervene and rejuvenate urban rivers. As mentioned in the above section, the URMP is based on objectives characterized into three major domains, viz. environmental, economic, and social, to ensure the holistic intervention in river rejuvenations, this generic approach in terms of Nagpur's context of Nag River.

Source: *NIUA, 2018*

Figure 73: Objectives of urban river management plan guidelines

Based on the analysis so far, the following section discusses the critics based on objectives given in URMP mentioned below -

- **Regulating Land use in floodplains**

  The objective signifies the importance of delineating the floodplain and permitting certain activities and land uses that do not hamper or degrade the condition of the river. Thus, the objective can be achieved by implementing regulations using statutory plans law enforcement, awareness building, and relocation of activities to reduce encroachments. Considering the present condition of Nag River, where it passes through developed areas of the city, it is infeasible to regulate regulations. Further, the existing statutory laws do not have any mechanism for areas to undergo urban redevelopment. In the case of Nagpur, the statutory plan does not regulate any buffer to protect activities in the floodplains in greenfield areas along the river. This calls for action and devises a mechanism where urban

redevelopment can be initiated using statutory means to improve the city's greenfield and brownfield areas along the river.

- **Keeping the river free from pollution.** The major directive under this objective ensures the treatment of wastewater before disposal downstream to avoid contamination. The possible interventions based on the framework detail out improvement of coverage of the sewage network either using centralized or decentralized means. The present condition of Nag River indicates a lack of capital infrastructure for setting up sewage treatment facilities and improving sewer coverage. With no vacant parcel of land reserved for public utilities, it is very difficult to set up decentralized treatment units to cater to untreated waste running directly into the river. The major reason for decreasing capital investment in sanitation infrastructure is due to the high dependency on central ad-hoc grants with poor revenue-generating capacity of NMC. Hence in the case of Nagpur, it is essential to rethink the financial sources so that constant capital investment can be achieved. Similarly, in the case of greenfield areas, the infrastructure coverage failed to catch up with the already high occupancy in the outskirts due to poor land prices.

- **Rejuvenating waterbodies and wetlands in the city and creating a riparian buffer-** Improving wetlands and rejuvenating nearby waterbodies helps to reduce the burden on rivers and helps recharge groundwater. This intends to create a wetland ecosystem within proximity of the river, which will help to create a holistic environment for animal and plant species. Like all other conditions of urban rivers, Nag River highly encroaches with no space for wetland development along the river. This results in a heavy flow of stormwater during monsoon, resulting in flood-like situations in the areas which are highly encroached. In both the cases of greenfield and brownfield development, creating river zone or riparian buffers using statutory regulations will ensure the improvement of the condition of the river, but on the other hand, the prescribed buffers will require huge land to be undertaken in the public domain. As most of the urban land parcels belong to private ownership, the buffer regulation is likely to create landlock scenario reducing the valuable land available for development. The rationale for providing

the width of the riparian buffer of 12-15 m (NIUA, 2019) needs to be rethought based on the context.

- **Adoption of methods to use treated wastewater and ensure proper flow of the river -** The objective is associated with providing adequate treatment facilities to ensure that adequate demand is created for treated wastewater for activities that include non-domestic use. Both these aspects are critically important for ensuring urban water management and improving groundwater recharge. This directs us to ensure that the interventions to be implemented in the city give back the same amount of water as it takes for various activities. Based on the primary study, most of the river stretches were inundated, carrying a flow of untreated sewage from industrial and residential uses in the vicinity. Though Nag River also ensures the flow of stormwater outside the city, acting as a catchment for most of the city areas, due to its non-perennial nature, it has been identified that it is difficult to maintain an adequate flow of clean treated water.

- **To develop an eco-friendly riverfront project and leverage the river's economic potential -** The key rationale behind the objective is to redefine the river as an economic asset to the city**.** This directs the actions to rethink the riverfront as a source of revenue generation. Efforts must be made using several mechanisms to identify various sources of revenue generation so that the river rejuvenation projects are self-financed after the post-construction phase for operation and maintenance. Considering the present interventions for river rejuvenation, very few efforts are made to make urban local bodies self-sufficient to undertake such capital-intensive projects. In most river rejuvenation projects in India, most of the financial aid is covered using centrally sponsored schemes and grants. High dependency on central agencies and other public stakeholders is assumed to be a major delay in implementing the Nag River Pollution Abetment and River Rejuvenation program. Hence identifying, the feasibility of various other financing options like land value capture and viability gap funding must be identified to explore the opportunities in the case of Nag River.

- **Inculcating river-sensitive behavior among citizens and improving the engagement in river conservation efforts –** The objectives focus on the engagement of 'citizens as actors' to undertake efforts of river rejuvenation as a social responsibility. From past experiences, it is observed that the local efforts were more effective because of their bottom-to-top approach in the case of environmental subjects. Here the focus is given to governing authorities to induce river-sensitive behavior through various means of engagement with citizens, which is also the first step in participatory planning. In the context of Nag River, based on the primary observations, there is no awareness among citizens. Though various efforts were made in the past to engage the community in cleaning riverbanks as a part of participatory planning and engagement of people on a grassroots level, no efforts are seen from local governing bodies. In this case, the lack of public participation in Nag River's pollution abetment was also due to frequent failure to implement the project. With respect to the spatial planning domain, the key role of professionals will be to engage citizens in various models of participatory planning and preference for bottom-to-top initiatives.

Considering the above debate, where the objectives of URMP are critically questioned based on their feasibility in the context of Nag River, though most of them are generic, some of the objectives directly address the immediate actions undertaken to improve the condition of the river. These include delineating the floodplain and regulating activities along Nag River, preventing additional damages using strict development control regulations and regulating constant flow in the river, etc., directly addressing the key problems for addressing the poor health of Nag River.

6.5 Critical Overview of URMP with respect to Nag River Situation

Urban River Management Framework initiates the actions essential to improve urban rivers' liveability and health to combat pollution. Based on the objectives and rationale mentioned in URMP Framework, we identify that all the necessary aspects associated with urban rivers (economic, environmental, and social). Most of the objectives also highlight essential actions that need to be undertaken, like delineating floodplains, etc. But considering the above arguments, which highlight the fundamental condition of land availability in urban to carry out any interventions is missing throughout the

URMP framework. The land management practices and spatial planning approach to deal with urban rivers did not find any place in a framework which may result in poor implementation of objectives through master plans. Though URMP Framework agrees on a master plan as the essential document in making URMP feasible, the framework itself does not provide any solutions on how the listed objectives can be implemented using spatial planning. For example, one of the most important objectives is to improve riparian cover, which seems very holistic and abstract as it does not address prima-facia requirements to have a riparian buffer – the availability of open space for riparian plantation. Based on the primary survey, specifically in the case of Nag River, it can be seen clearly that the fundamental problem of managing urban rivers has its roots in how efficiently we formulate spatial regulations and methods to regulate activities in the delineated floodplain. As a result, the way ahead will be to identify key objectives and to detail the working mechanism of how these can be implemented in various urban contexts, which is attempted in the successive section.

6.6 Institutional Structure and Key Stakeholder's related to Nag River Pollution Abetment Program

So far, we have encountered various institutions, both public and private, which are responsible for providing data and collection of information, involvement in decision making as well as in mobilization of capital investment for the projects. Some of the key institutions with their roles and responsibilities with respect to the Nag River's case is mentioned here. It is essential to understand the stakeholders involved with respect to the subject of Nag River and to understand the involvement of public and private agencies-their roles and responsibility so that the institutional malfunctions can be fixed to develop better urban management. The successive sections here examine the inter-relationship between various public and private institutions as a key stakeholder in Nag River's subject.

6.6.1 Key Institutions and their Roles and Responsibilities

Statutory Institutions –

The apex executive body with organizes the urban local body is the Department of Urban Development, Govt. of Maharashtra. This is a also the statutory body with sanctioning of statutory plans, preparation of legislatures applicable throughout the state. The institutions that are set up under the provision of statutory legislation like the MRTP Act 1966, Maharashtra Municipal Corporations Act 1951 (i.e. Nagpur Municipal Corporation), or

Improvement Trust Acts (i.e. Nagpur Improvement Trust), etc. In case of Nagpur, NIT and NMC are two executive bodies where NMC also performs the role of urban local body. In subject to all the matters of statutory planning at all levels NIT has given full execution powers. With two executive bodies under one jurisdiction unnecessarily complicates the functioning and overlapping of powers, roles and responsibilities. From the past decade legislature to pass a bill underway to dissolve Nagpur Improvement Trust and vests its power with Nagpur Municipal Corporation.

Advisory Public Institutions – These institutions are public agencies that are either set up based on statutory provisions but do not have any legislative roles and responsibilities in the administration of the state.

- **Maharashtra Pollution Control Board (MPCB) –** Constituted under Environmental Protection Act 1986,
- **Central Ground Water Control Board (CGWB) -** Constituted under Environmental Protection Act 1986, the key role of this agency is to conduct annual assessment of groundwater quality, its availability and suggest various solutions that can be implemented to improve the condition of groundwater.
- **National Environmental Engineering and Research Institute (NEERI) -** NEERI is a pioneer laboratory in the field of environmental science and engineering and is constituent laboratory of the Council of Scientific and Industrial Research (CSIR). The institute is funded by the Government of India for research focusing on various engineering practices. In past several studies conducted by NEERI were helpful to highlight the pollution related issues of Nag River and various other water bodies.
- **National Institute of Technology (VNIT) Nagpur –** Recognized as the Institute of National Importance, this institute is associated with undertaking of academic research to highlight the major issues and problems in various fields like urban infrastructure, water and sanitation, etc.
- **Maharashtra Remote Sensing and Application Centre (MRSAC) –** An autonomous body set up by government of Maharashtra to utilize and operationalize the use of remote sensing, GIS based analysis, UAV Drone based

  surveys and satellite data processing.

There as several other agencies that have indirect association with Nag River where annual studies or reports published helps in understanding of Nagpur and its region's key aspects from time to time. Such institutes include Regional Remote Sensing Centre (RRSC), National Bureau of Soil Survey and Land Use Planning (NSBB & LUP), etc.

Non-government / private agencies – non-government agencies include various group of stakeholders including NGOs and editorial boards of newspapers which are actively involved in bringing out key issues and problems in public domain. Societies of professional institutes like, Indian Institute of Architects and Institute of Town Planners of India which are registered as societies under govt. of India also forms the set of concerned stakeholders which are indirectly involved. Some of the key agencies associated with the Nag River program is Vidarbha Heritage Committee (VHC), Times News Network, Nagpur (TNN, Nagpur) and various NGO's working on environmental front.

6.6.2 Key Concerns and Issues: Stakeholder's Perspective of Nag River Project

From the previous section which highlights the major institutions associated directly or indirectly with Nag River gives the brief idea of involvement of various experts and professional which are actively involved periodically or daily basis in assessment of Nag River, its quality check, in academic research, in spread awareness as well as in the process of statutory decision making. Stakeholder's consultation includes discussion with such experts which can understand the inferences that are developed as a part of this research. The further section highlights major points based on interviews with various stakeholder's groups –

6.7 Stakeholder's Consultation: Private Stakeholder's Perspective

- **Real Estate Developers:** As mentioned in the project earlier, understanding the potential of brownfield areas in proximity to the Nag River is critical aspect of the project. The major intent to interview Real Estate Developers is to understand market trend and mechanism and redevelopment strategies. Further, interaction with the real estate market experts also helped in identifying the gap in perspective of public stakeholders and key issues faced in terms of undergoing redevelopment

of specific areas. Some of the key highlights based on interview is mentioned below –

- **Environmental and Heritage NGOs –** The intent to interview NGOs that are actively involved in public participation and awareness is to understand the perspective of citizens which are key stakeholders of the city.

  Interview with heritage NGO was essential to understand the urban fabric of old city areas and various problems in Mahal and Sitabuldi. Key problems that are highlighted from the discussion gave insight on unwillingness of people to shift to other area with better facilities due to location advantage, poor condition of urban infrastructure due to lack of upgradation efforts, etc.

  Interview with environment NGO was conducted to understand the major drawbacks in the recent actions undertaken by government with respect to controlling pollution of Nag River and to understand the perspective of citizens.

- **Discussion with Experts, Professionals and Citizens –**

  As mentioned earlier, the project has various perspective of every expert to deal with restoring river as the topic of the research is multi-disciplinary in nature. Discussion with various experts from the diverse field is essential to understand the missing gap to undertake cohesive actions against polluted rivers in generic way. Efforts were made to identify the experts that were previously involved in any social or professional initiative in subject of Nag River.

  - **Environmentalist's perspective of restoration** stressed more on nature-based ecological solution to restore riverfront.
  - **Architect and Planner's perspective of river restoration** stressed more on improving socio-cultural identity of the city and developing riverbanks for various activities. This perspective does not involve any solution to improve river health and therefore with respect to the scope of research is secondary in nature.
  - **Perspective of Water resource expert on river restoration** highlights the poor water resource management without prior assessment may lead to the failure of project which is also highlighted in literature study. In case of Nagpur there is a lack of institutional expertise in various assessment that are necessary to detail out technical aspects of project**.**

- **Citizen's perspective of river restoration –** mixed reactions from the interaction with the citizens were seen. Various issues of backflow of water in monsoon, foul smell and unhealthy conditions are confirmed from various interviews.

6.8 Stakeholder's Consultation: Public Stakeholder's Perspective

Public Stakeholders includes experts that are directly linked to the legislature or executive functioning of the city. Interaction with the public stakeholders is essential to understand the rationale behind various initiatives. Considering the case of Nag River, where various secondary sources identified that the major reason for the delay in implementation of Nag River Pollution Abetment Program is due to poor decision making and financial capacity of urban local bodies. Following are the major highlights of stakeholder's consultation with public department and ULBs-

- **Development of South-west Nagpur near Airport is priority for next coming years –** The public agency is focussing more on greenfield development near Airport due to rising demand for development in these areas.
- **Poor institutional capacity, lack of expertise –** This validates the information from various secondary source and data collected. Hence in case of Nag River involvement of various national and state level agencies is seen for financial and technical support.
- **Working to improve TDR mechanism –** The public authority are rethinking ways in which TDR can be effectively used as a tool for compensation.
- **Lack of land as a public asset with government especially in old city areas** Improving urban infrastructure in brownfield areas is capital intensive and hence improving coverage in all these areas is poor.

6.9 Highlights from the Stakeholder's Consultation

Given below are the key highlights which forms the conclusion to the stakeholder's consultation and expert opinion with respect to the research project –

- **Poor Performance of ULB -** Poor performance of ULB is confirmed by various stakeholders including NGOs and journalists. Apart from collection efficiency of NMC no new taxed were added resulting in complete dependency on grants for Nag River Pollution Abetment Plan.

- **Citizen's perspective towards Nag River -** As per the existing condition, clean Nag River is perceived as a dream for most of the citizens. As per the environmental activists there is a lack of awareness about river conservation.
- **Opportunity to promote TDR as a tool –** Considering the potential of redevelopment in the brownfield areas adjacent to the Nag River, the existing mechanism of TDR fails to be advantageous to the real estate players. TDR can be used as an effective tool and medium of compensation.
- **Old City has highest vulnerability in terms of restoring Nag River and improving urban infrastructure conditions -** Stakeholders confirms that the encroachment in Old City is major problem to take necessary actions to decontaminate river. Since area is near to CBD, people prefer to live in poor conditions and lack of infrastructure.

The stakeholder's consultation overall indicates that the core problem which hinders the various implementable solution is unplanned and organic urban form in area of old city. This also related to the scope and opportunities which were mentioned that the project possesses considering spatial planning as the key focus of research. Also, the stakeholders also validate some of the key inferences and issues that were identified based on existing situation study and analysis derived from various secondary resources. This chapter therefore is a bridge between the study and analysis done so far as a part of this research project and the successive section of recommendations following to this.

Rethinking restoration of polluted water stretch using spatial planning techniques: A Case of Nag River, Nagpur

7 RECOMMENDATIONS

7.1 Background

Based on the inferences, analysis, and major findings, this section details major recommendations that are essential to meet the desired aim of the research. Prior to concluding is essential to understand the layout of the recommendation to cover all the aspects associated with the study conducted above; the recommendations put forth can be classified in three formats-

- **Recommendations focusing on improving the condition of Nag River using spatial planning aspects in the city –** Considering multiple approaches and various disciplines involved in the aspects of river rejuvenation and studies based on pollution abetment of water bodies, from the given aims and objectives it is clear that the major focus of research is to identify the potential of land management practices and statutory micro-planning approaches in river rejuvenation and improving the condition of Nag River. The detailed intent, recommendations, and key focus areas focusing on the significance of the micro-planning approach and land value capture tools are mentioned in detail.
- **Recommendations based on spatial hierarchy -** Based on the existing condition of the river, although the scope of research is limited to the urban river which limits details of interventions to Nagpur's city limits, several key recommendations need to be highlighted which are outside the scope of research but has a direct relation to the condition of Nag River in an urban context. Hence with respect to the Nag River, there is an immediate need to counter problems at all levels of statutory mechanism i.e., regional level, metropolitan level, city level, and at the micro-level as well where at all levels major or minor recommendations to the concerned stakeholders are necessary.
- **Recommendations based on spatial, administrative, legislative, financial, and existing situation analysis of Nag River and its context –** It is clearly visible that not only has statutory planning failed to take necessary actions, but several legislative, financial, and administrative domains are also responsible for the existing condition of the river. No implementation can occur if there is no defined role of spatial planning with no legislature or financial backing. A few

recommendationss with respect to the stakeholder's consultation and the above-mentioned study are proposed as a part of this section.

With a major focus on recommendations based on spatial planning, based on the analysis, three major problems were identified and based on each key problem, desired recommendations are listed in the following sections.

7.2 Key Problem I

"No land reservations for facilitating urban utilities and improving infrastructure to facilitate and improve the condition of Nag River. The main reason is the poor implementation of statutory plans and existing development control regulations."

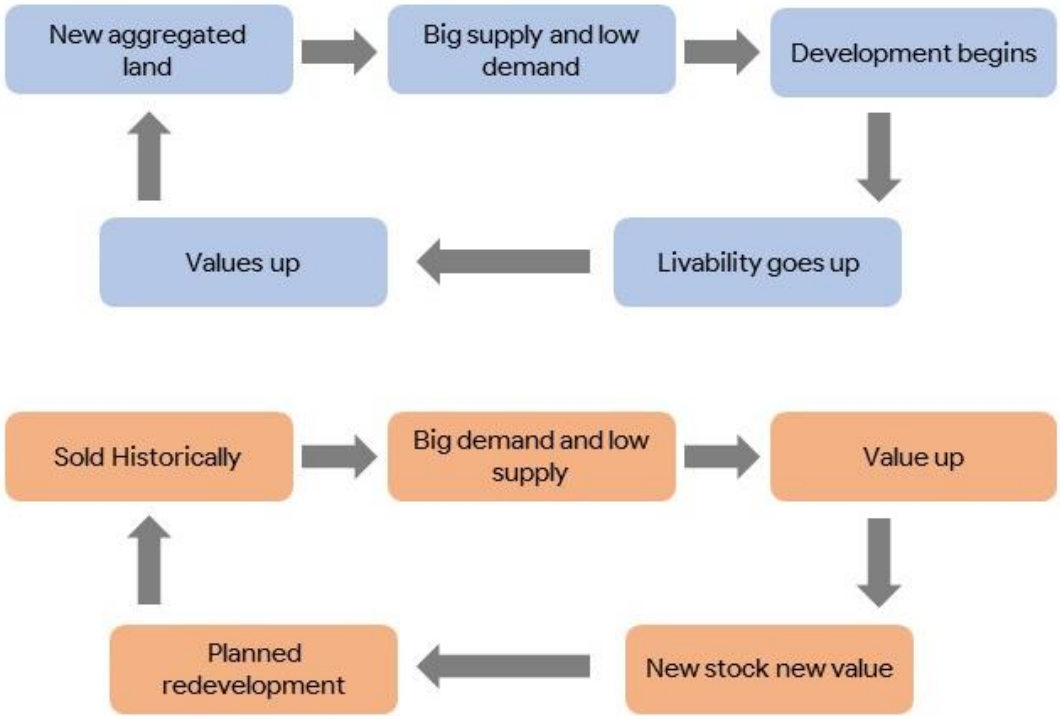
7.2.1 Understanding Development Cycles and Price Trends in the Context of Both Greenfield and Brownfield Developments

Development in urban areas can be broadly classified into greenfield development and brownfield development based on the spatial structure where the development occurs. It is obvious that both natures of development have different development cycles and price trends that need to be understood before proposing any generic interventions with respect to any urban context.

In the brownfield development cycle, the city authority intervenes to identify the poor liveability and lack of infrastructure facilities over time. The pattern of land value changes every 20-30 years in residential areas where the land value overtakes demand as the area's liveability decreases. (Kurup, 2018). In the brownfield city area, there is no new land for development. As a result, the land value is unlocked by undergoing redevelopment. As the redevelopment takes place, the existing units are demolished, and new units are created using new permissible FAR, bringing the market back into the saleable business. The price of the total sq. ft plus the notional value of land becomes the new price per sq. yd and thus becomes the new benchmark land value of the locality (Kurup, 2018)

In the greenfield development cycle, new land is included in the city limits by conversion of rural to urban through a change of land use. During the initial stages, where NA conversion is done, or the area is brought under the jurisdiction of the Development Authority/ Municipal Corporation, the value of land suddenly rises. Newly aggregated land has considerably lower land prices than developing areas of the

city, as the infrastructure during the initial stages is poorly laid. With plenty of supply of land outskirts and less demand value of land is low. The developers start taking advantage of fewer land prices and developing land based on market demand and soon, infrastructure follows to facilitate the market forces. After the development begins, it normally takes five years to increase liveability, and the property's value goes up. (Kurup, 2018).



Source Kurup, 2018

Figure 76: Life cycle and price trend of land under greenfield and brownfield development

Both examples highlight the dynamics of the land market in the case of both brownfield and greenfield development. Comparing both options, the value of greenfield development rises much faster after the market forces come into play. With plenty of lands available, it is easy to undergo plotted development and lay infrastructure based on identifying carrying capacity. Whereas in the case of brownfield development, the development must take place without hampering the existing context, redevelopment takes considerable time to increase property prices, and laying robust infrastructure is also a major challenge. In the case of greenfield development, there is a high possibility for the authority or developer to undergo land acquisition to kick start development by providing necessary compensation, which is still difficult after the enactment of LARR Act 2013, where four times the base price must be provided as a compensation in case

of land acquisition. But the major advantage is that the land can be reserved for urban utilities and used for infrastructure development. In the case of brownfield development, compensation must be paid with additional carpet area (as per UDCPR 2022), which requires consent from stakeholders. Providing fair compensation to every landowner is a huge responsibility, which is a difficult and tedious task. Without the statutory exercise supply of land for urban utilities, it is difficult, especially in brownfield development. Since most of the land within the city limits belongs to private ownership, for laying any urban infrastructure services, the authority must undergo a tedious process of land acquisition which cost more money than the actual infrastructure development resulting in a high cost of infrastructure development on urban local bodies. Hence irrespective of any kind of development, unlocking land for urban utilities is going to be a huge problem soon with increasing land prices which directs us to rethink urban land management practices and increase the supply of urban land for utilities and services.

In urban rivers like Nag River in Nagpur, the entire stretch of 17 km passes through brownfield development with varying urban character and population density. In such cases providing land for buffer spaces, development of riverfront, or creating a riparian zone, as well as providing land for decentralized treatment plants, is the major challenge. It is essential to provide land for improving infrastructure coverage and creating ecological niches to improve the condition of urban rivers. Therefore, the problem of polluted river stretch in an urban context directs attention towards formulation and adaptation of innovative land management practices that are statutory feasible and implementable.

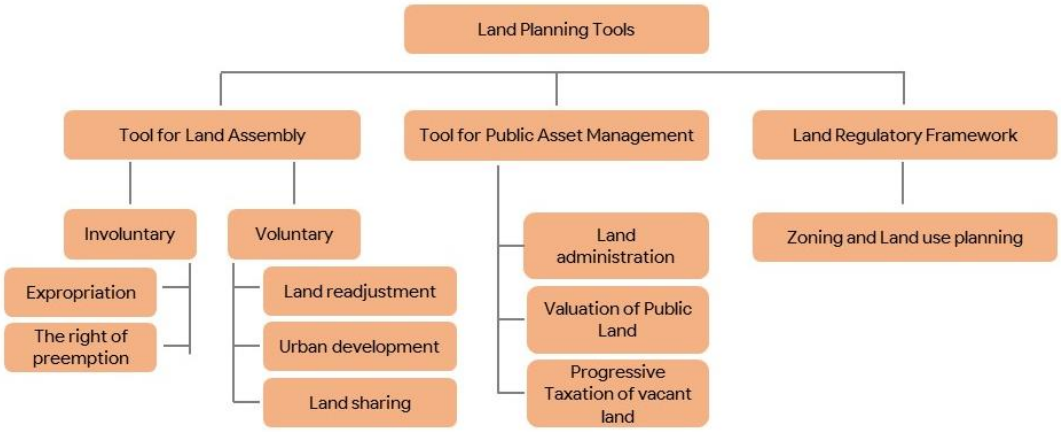
7.2.2 Alternative Statutory Means to Facilitate Supply of Land

Several alternatives to compulsory land acquisition have been tested in India and worldwide. Following are some of the key alternatives and their applications in various urban contexts –

- **Guided Land Developments** for townships and special economic zones (Eg. MIHAN-SEZ, national manufacturing hubs, and satellite towns like Navi Mumbai)
- **Town Planning Schemes** (in Gujarat and other states)

- **Land Reconstitution Mechanism / Urban Redevelopment** (in-situ upgradation of core urban areas)
- **Joint Sector Model** for land assembly and development (Ex. Greater Noida and Navi Mumbai)
- **Transferrable Development Rights (TDR)** (in case of Mumbai Metropolitan Region as an alternative to compensation of land undertaken for public use)

"**Concept of access condemnation"** can be used in the development of transport infrastructure facilities (like the case of Delhi Metro Rail Corporation is using land adjacent



Source: *Wahba, Altman and Others*
Figure 77: Land tools alternative to Land Acquisition

Since all these alternatives have very limited case studies in India, legislative provisions for all these alternative mechanisms were introduced after the LARR Act 2013 made land acquisition difficult. These models are tried, tested, and implemented in other countries which have different ideological approaches to urban land compared to the Indian context. Yet the core objective of how efficiently the land market can be mobilized for urban development from the perspective of various stakeholders is the key to all these methods. In Japan, land readjustment is used because in urban fringe areas, most of the farmlands have irregularly shaped plots and it is difficult for property developers to assemble. In Korea, fiscal policies are more focused on encouraging faster use of vacant land and discouraging speculations (Jain & Gupta, 2018. p.67).

In the case of Singapore, the entire area near the polluted Singapore River was

undertaken as an Urban Redevelopment Project which, over the period, improved the river water quality and became a successful land development model. Innovations in on-site policies are tried, such as land sharing in Bangkok. Similarly, Myanmar is famous for its hut-to-apartment scheme, where there is a public-private partnership to supply housing for the urban poor. Jakarta, Manila, and Dhaka are other examples based on the context of the urban land management practices that have been adopted instead of traditional mechanisms. The above-mentioned examples identify various alternatives which can be applied in Nag River's context to rethink redevelopment along the banks and abetment of pollution by making the availability of urban land parcels for improving urban infrastructure or planning ecological riparian buffers. Among which the most famous and tried and tested models are Town Planning Schemes and Local Areas Planning for greenfield and brownfield urban areas as a micro-planning spatial tool

7.2.3 Town Planning Scheme (TPS) and Local Area Plan (LAP) as a Micro-planning Tool for River Rejuvenation

TP & LAP mechanisms are third-tier spatial models in cities with statutory regional and development plans at (the city level). These tools, one in greenfield and the other in brownfield context respectively, are used to implement the higher-order statutory plans and backed by statutory legislation (like GTPUDA Act, 1976 and MRTP Act 1966 in the case of Gujarat and Maharashtra, respectively). The following section gives a brief understanding of both the micro-planning aspects.

Town Planning Scheme

The fundamental concept of the TP scheme is to pool a parcel of land typically (100-200 hectares or even more based on the context) belonging majorly to the private ownership and to reconstitute the plots by carving out the land for public domain i.e., roads, open spaces, land for social amenities and EWS housing, etc. The exercise helps to develop the land by taking a considerable share of each plot avoiding land acquisition. Each land parcel is given an original plot (OP) number, and the final plot (FP) is allotted based on proportional deduction. Value capture financing (VCF) tools, such as betterment or development charges and the sale of reserved plots, can finance the provision of urban infrastructure and amenities under the TP Scheme. (Jain. V, 2019). Therefore, TP schemes are called self-financing modules.

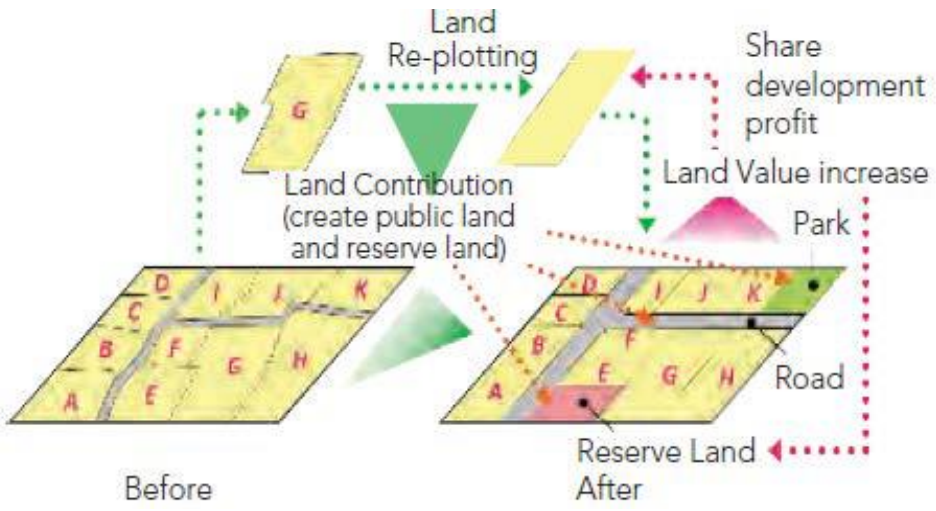


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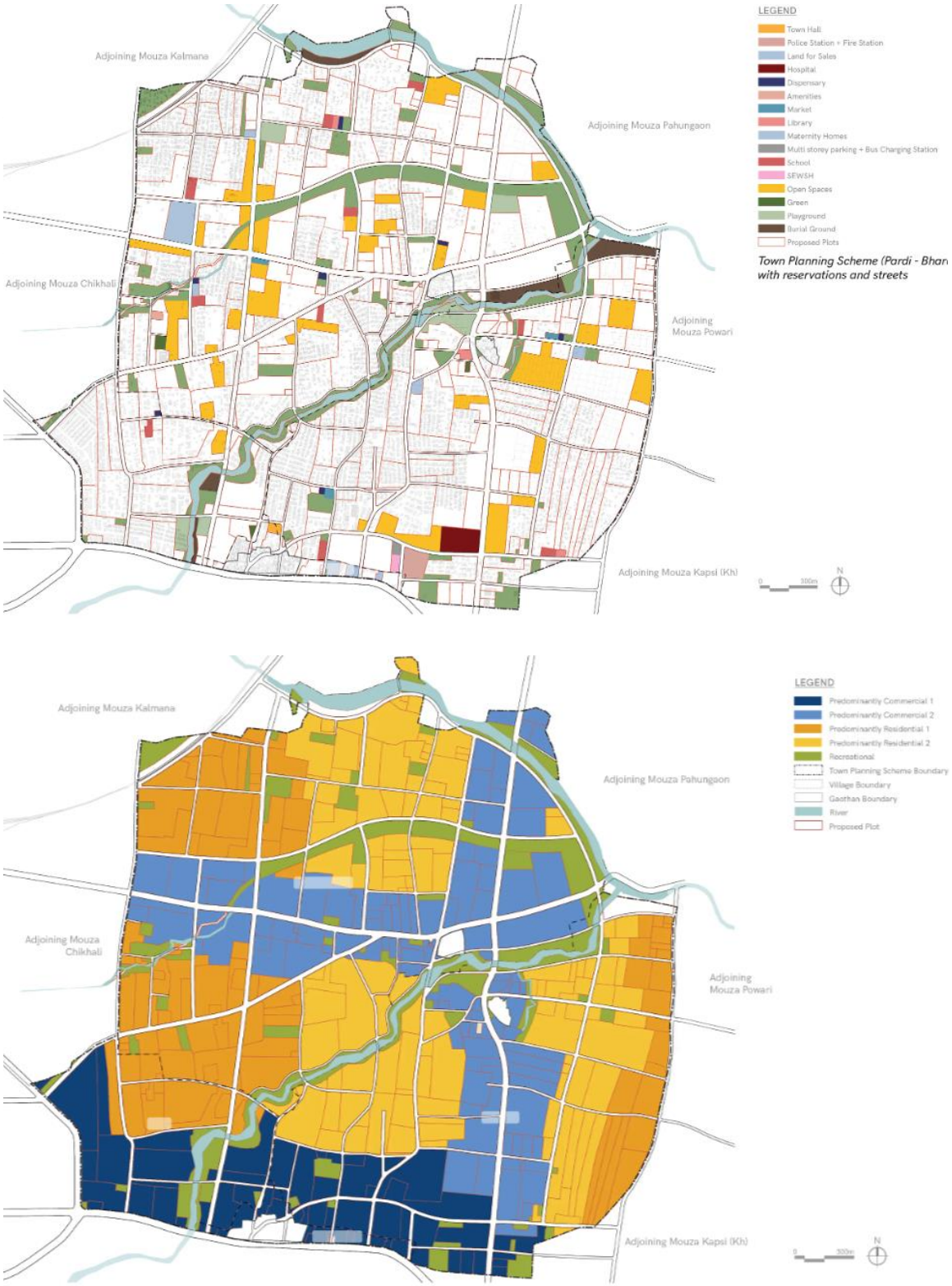
Figure 78: Conceptual illustration showing land readjustment mechanism.

In Maharashtra State, the Town Planning Scheme is prepared under the MRTP Act, 1966, which has a similar provision of land readjustment as in the GTPUDA Act 1976. However, the Maharashtra Act does not provide for subdividing the TP scheme into preliminary and final schemes (Vaidya, 1984). The recent development in sanctioning and preparation of town planning schemes can be seen in the case of the greenfield development of Navi Mumbai Airport Influence Notified Area (NAINA) Township developed by City Industrial Development Corporation Limited (CIDCO). Similarly,



Source: *Official Website HCP DPM*

Figure 79: Existing Situation Map, Map Showing Reservations and Proposed Zoning Map of proposed TPS for Pardi-Punapura Bharatwada and Bhanewadi, in context of Nag River, Nagpur

Town Planning Schemes and Urban Rivers: Opportunities

The primary survey observed that even in the upcoming greenfield areas, poor implementation of the development plan is seen in urban sprawl and improper coverage of urban infrastructure. The city with newly developed areas along urban fringes lacks sewerage infrastructure (E.g., Wathoda Layout). As a result, sewage is directly dumped in the Nag River. Urban sprawl near rivers results in encroachment directly into floodplains leading to poor edge conditions. As discussed earlier, it is easier to reconstitute land in the case of greenfield sites compared to brownfield ones; the city is losing an opportunity to prevent additional damage to Nag River by providing necessary steps, which is still lacking. As a part of the MRTP Act 1966, special provisions in the case of DCRs can be applied to sanctioned TPS, which can cater to issues related to land availability for urban utilities and the implementation of riparian buffers. Therefore, in the case of Nag River's context, implementing the micro-planning approach is the first step towards protecting the river from 'business as usual' actions that will create a nuisance.

Town Planning Schemes: Opportunities to Improve Urban Rivers

The primary survey observed that even in the upcoming greenfield areas, poor implementation of the development plan is seen in urban sprawl and improper coverage of urban infrastructure. The city with newly developed areas along urban fringes lacks sewerage infrastructure (E.g. In the case of Wathoda Layout). As a result, sewage is directly dumped in the Nag River. Urban sprawl near rivers results in encroachment directly into floodplains leading to poor edge conditions. As discussed earlier, it is easier to reconstitute land in the case of greenfield sites compared to brownfield one; the city is losing an opportunity to prevent additional damage to Nag River by providing necessary steps, which is still lacking. As a part of the MRTP Act 1966, special provisions in the case of DCRs can be applied to sanctioned TPS, which can cater to issues related to land availability for urban utilities and the implementation of riparian buffers. Therefore, in the case of Nag River's context, implementing the micro-planning approach is the first step towards protecting the river from 'business as usual' actions that will create a nuisance.

Local Area Planning Tool

Local area planning is a tool that deals the urban regeneration and development, where

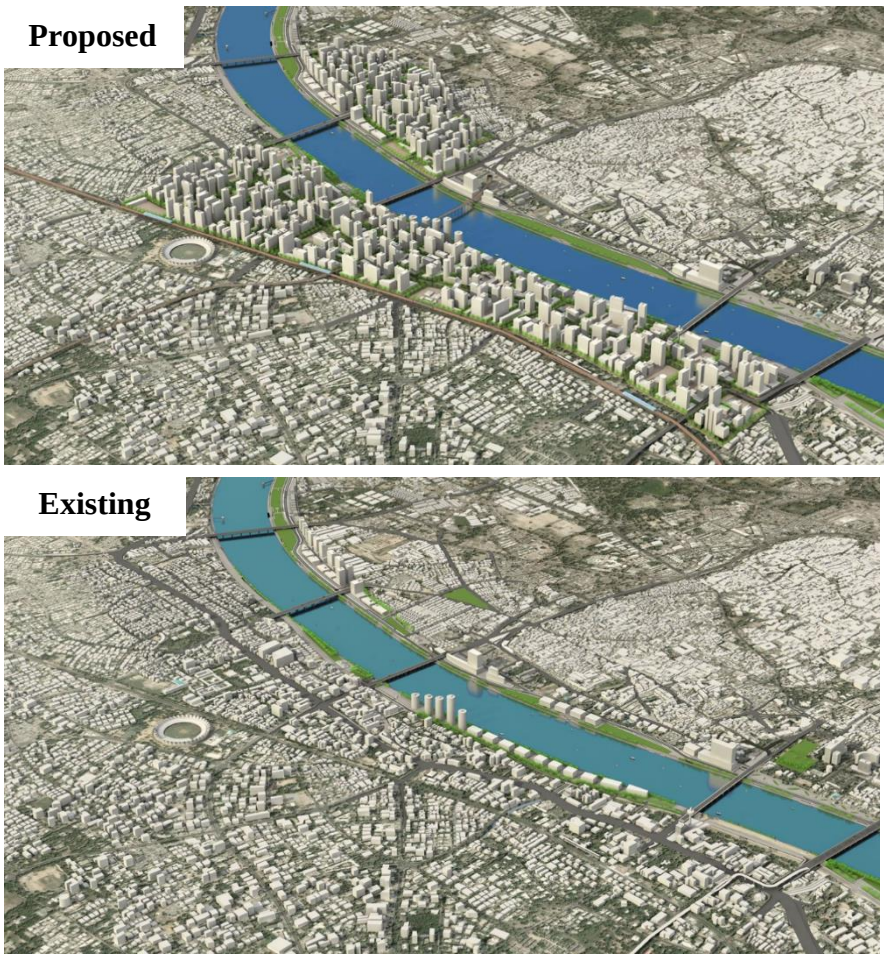
spatial planning tool is used along with land value capture methods to improve the degraded condition of brownfield areas in the city. Some of the key challenges that are worked upon include enhancement of utility of the area by providing improvements for walkability, parking management, transport, and physical and social infrastructure upgradation considering the existing character, land uses, and activities taking place in the area (Tatu, 2015). The delineated area for the purpose of the local area plan varies from 2-4 sq. km, where every property is associated with the original plot (OP) number, and the revised plot (RP) number is allotted after necessary deductions based on the area taken under public domain. The property owners are given incentives for compensation for their land surrendered, which they can use after the land parcel undergoes redevelopment. Time-bound incentives to speed up the redevelopment in the area where speed-up redevelopment can be undertaken. Like the TP scheme, this mechanism functions from bottom to top. After the land is available for public purposes with development authority, it is used to lay necessary infrastructure.

Local Area Planning in other countries is termed urban redevelopment. This practice is widely followed to improve the infrastructure condition and capture the potential of prime urban areas. Some prominent examples of urban redevelopment are the Redevelopment of Canary Wharf in London Downtown along the river Thames and the redevelopment of urban neighbourhoods along the banks of the Singapore River. In the Indian context, Ahmedabad Urban Development Authority (AUDA) successfully sanctioned the local area plan for Ashram Road CBD Area (AUDA) based on the recommendation in the development plan.

Significance of Local Area Planning in the Context of Nagpur's Nag River

About 17 km of Nag River flows through the city's developed areas. Like all old city areas, Mahal lacks poor infrastructure, lack of liveability, and poor utilization of land due to its unplanned organic structure. The same condition is with the CBD area of Dhantoli and Sitabuldi, where the introduction of rapid rail brings the potential of high-density development leading to development-oriented transit (DOT). A huge paradigm shift in urban redevelopment is expected in Nagpur's context. With polluted river stretch along the major location with a high potential of undergoing redevelopment provides a unique opportunity to acquire land for public purposes, which includes reserving land parcels for urban utilities for decentralized infrastructure or developing a series of buffer and open spaces to regulate activities. However, the spatial micro-

planning approach will not be feasible if poor fiscal and value capture mechanisms exist. In the case of in-situ slum upgradation along Nag River can be formalized, if possible, interventions focusing on providing land rights and tenure of the land can improve the condition of the urban poor, the condition of the river as well as improving coverage of infrastructure. Therefore, it is essential to explore the domain of local area planning and experiment with its micro-planning aspects in case of urban redevelopment and river rejuvenation.



Source: Official Website, HCP DPM

Figure 80: Existing and Future Scenario based on Proposed Local Area Plan for Ashram Road Area, Ahmedabad

7.2.4 Application of Micro-planning Approach in Nag River's context

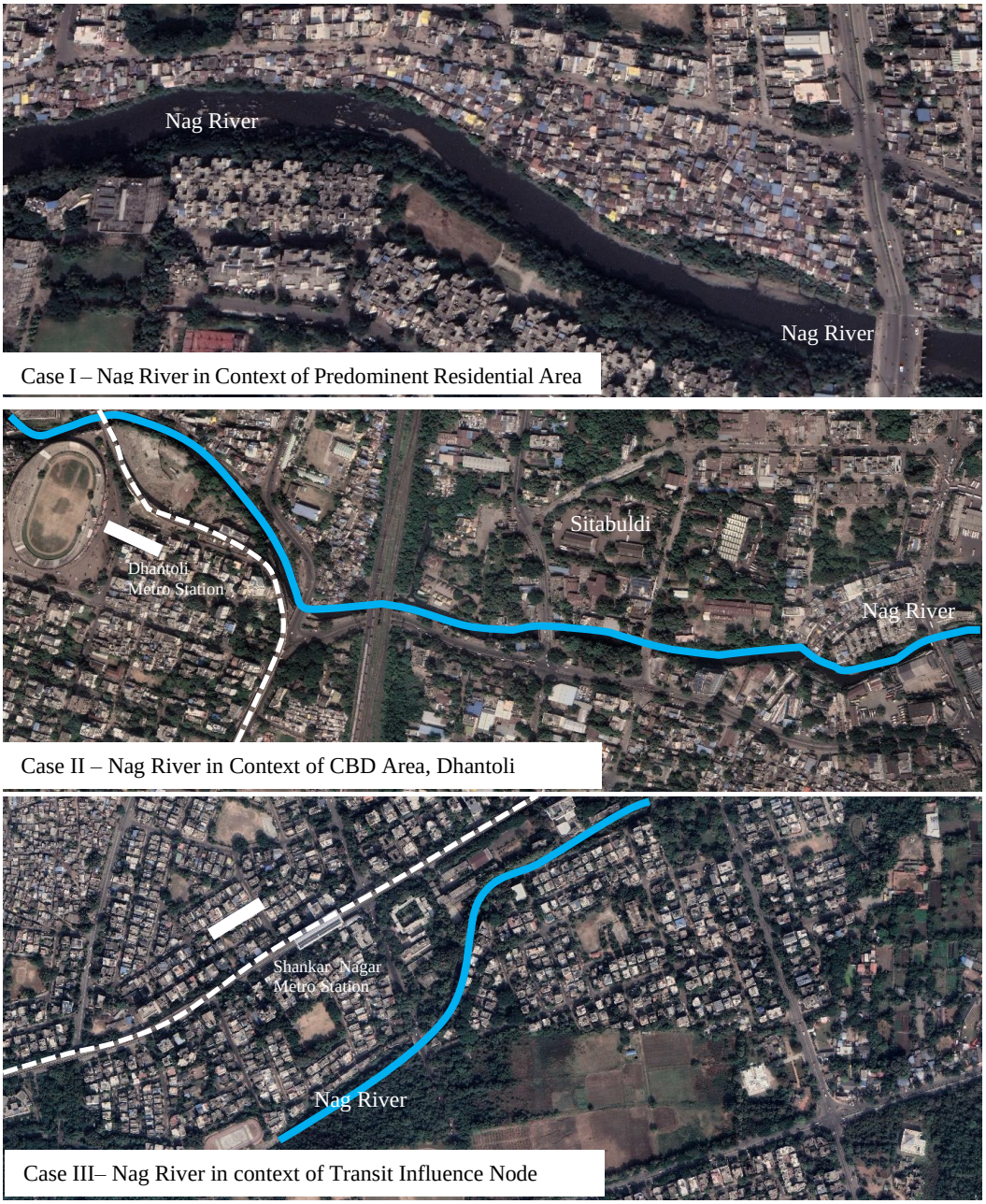
The generic aspects of micro-planning tools may not give desirable results when it is expected that both pollution abetment of urban rivers and urban redevelopment is being addressed. This is also applicable in the context of the Nag River. Considering Nag River's urban setting, a large part of the intervention will be taken as a part of

brownfield development. But it is not sensitive enough to have a generic strategy throughout the 17 km stretch of the entire urban river flowing through the city. Nagpur's Nag River is one of the most key examples where the river passes through varying brownfield settings with varying land uses and population densities throughout its stretch. This is the major flaw of the URMP where it has only stressed improving the condition of urban rivers with no strategized objectives for the urban river context. It is essential to propose interventions and classify the river stretch both based on the degree and nature of pollution and based on the urban context on either side of the river stretch.

Referring to the primary survey conducted earlier in this research, the entire Nag River passes through new city areas, then CBD, further down to Old City Areas, and finally towards greenfield areas along urban fringes. Each of these areas has its unique challenges. Hence, the statutory decisions will depend not only on assessing the condition of river pollution but also on the existing density, potential of redevelopment, and condition of structure and infrastructure in the vicinity. With respect to this, the urban river based on the existing urban context of either greenfield or brownfield development can be further classified into three characteristic areas mentioned below. The following three categories, classified based on urban character and redevelopment potential, need a unique approach to make micro-planning feasible in the case of brownfield development.

- **Polluted river (Nag River) stretches with Predominantly Residential development (Nandanwan and Mahal) in brownfield conditions –** Fig. __ shows a satellite image of the Nandanwan area adjacent to the polluted stretch of Nag River. This is a unique case where regularizing the informal settlements will be a key challenge. The focus will be more on pooling land for public use and on in-situ rehabilitation of slums.
- **Polluted river (Nag River) stretches within proximity to CBD area (Sitabuldi and Dhantoli) under brownfield conditions –** Local Area Planning in case of CBD like the example of Ashram Road in Ahmedabad is a unique case where the key challenge is to use maximum limit of floor space by undertaking the development of robust infrastructure. With the rising demand for land values in CBD areas after the redevelopment is undertaken as a part of the micro-planning approach, the key challenge will be making high-quality

land available for creating a buffer and public open space for river rejuvenation and preventing encroachments.



Source: Google Earth Imagery

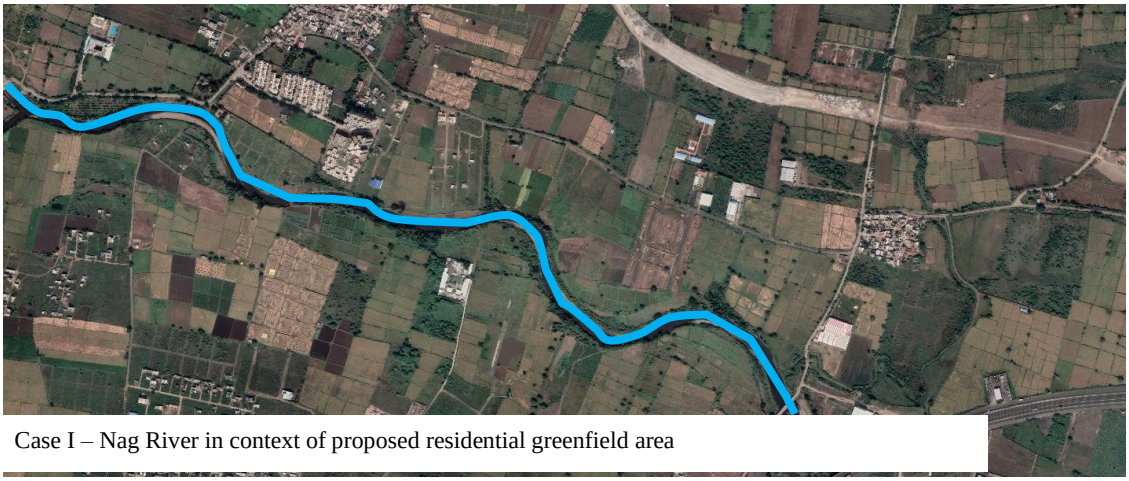
Figure 81: Three major brownfield cases based on urban context.

- **Polluted river (Nag River) stretches within proximity to Transit Influence Node (Shankar Nagar, Nagpur) under brownfield conditions –** Transit influence areas established due to the introduction of a rapid rail network and public transport throughout the stretch of Nag River from Ambazari Lake to Jhansi Rani Square, Sitabuldi is going to trigger the development since there are

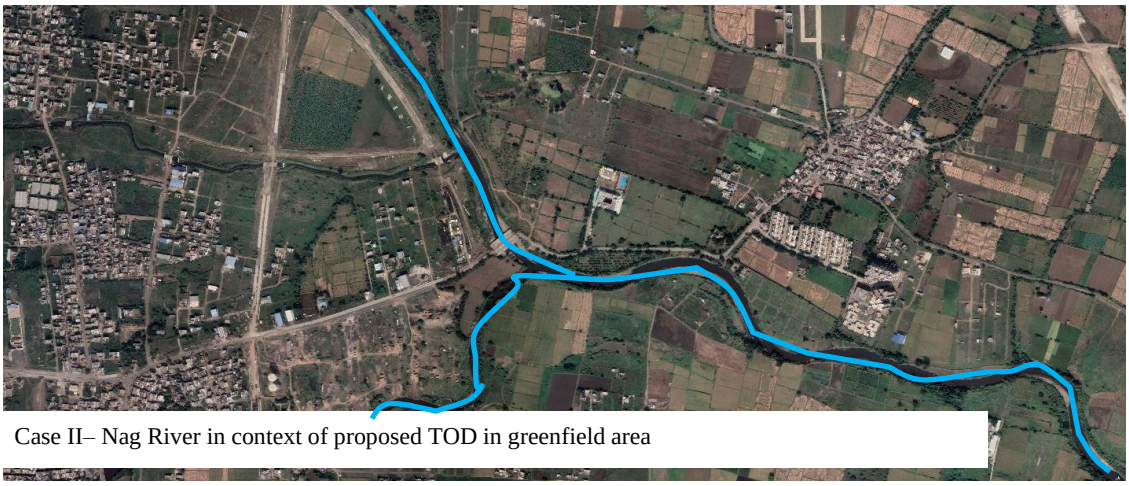
high chances that area will be developed as per TOD regulations. Promoting high-density mixed-used neighbourhoods along with the reservation of open spaces for buffer and urban utilities is going to be a huge challenge.

Similar cases in greenfield development will have to be explored where riverfronts can be restored along with regularizing the uneven land parcel and providing the necessary infrastructure. Compared to the case of brownfield development, interventions in the following cases is more feasible as land parcels are yet to be developed. But in the case of sanctioned TP at Paldi-Bhanewadi, it is observed that though the area was undertaken as a greenfield to implement the development plan, a major part of the area was already developed as a sprawl. Hence such exceptions are also common in cases if the city has large portions of urban sprawl. The key cases are discussed below.

- **Polluted river (Nag River) stretches with proposed residential development (Wathoda Layout) in so-called greenfield conditions –** with this case, there is an opportunity to prevent additional encroachment in the floodplains (if there is floodplain mapping done in higher order plan) so that the activities in the periphery of the river can be regulated. Greenfield development allows adding a buffer zone of prescribed width, which is very difficult in the case of brownfield development. As a result, which pollution of Nag River downstream can be addressed.
- **Polluted river (Nag River) stretches within proximity to Transit Influence Node (Near Koradi) under greenfield conditions –** Newly urbanized areas with proposed rapid rail or public transport system is expected to have a dynamic land price increase as the urbanization starts. Apart from the above-mentioned aspects of delineating a buffer zone and reconstituting plots, such areas can be a fresh start for experimenting with land value capture methods for the city.



Case I – Nag River in context of proposed residential greenfield area



Case II– Nag River in context of proposed TOD in greenfield area

Source: Google Earth Imagery

Figure 82: Two cases of Nag River in greenfield context

Both classifications are essential to provide specific and context-based solutions to mitigate the problems of improving polluted river stretches and protecting urban contexts near rivers from additional degradation. But the spatial planning tool cannot solve the entire problem because all these processes require high financial backing. With limited options for financing TP schemes at the initial stage for urban local bodies depending on grants is not a good choice. Therefore, it is essential to understand and explore the potential of land value capture mechanisms to make micro-planning feasible and to achieve its objectives.

7.2.5 Challenges in the Implementation of TP/LAP Models in Urban Context -

Apart from all the significant aspects of the LP/TP model, which helps in the regularization of land parcels, improvement of infrastructure, and implementation of development plans for the city, there are several hindrances due to the existing

mechanism in place. The major limitations of the use of the TP scheme as a technique for urban land management in Gujarat and Maharashtra States are:

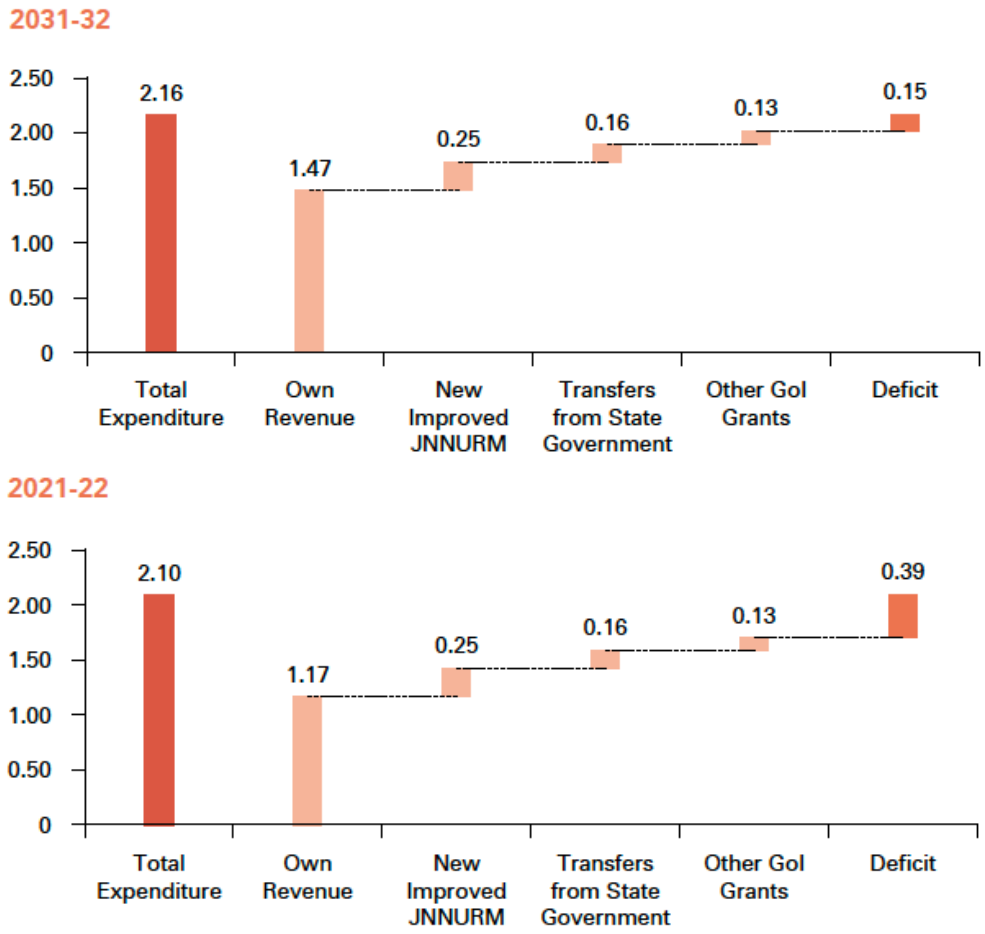
- **Required administrative and technical capacity** – Preparing TP/LAP schemes is cumbersome. With poor coordination between different stakeholders.
- **Except in Gujarat, the self-financing aspect of TP/LAP is yet not identified –** Considered a self-financing exercise, except in Gujarat. The present planning and implementation method of TPS does not provide for the project's financial viability, and it burdens the urban local bodies.
- **Failure in exploring the potential of land value capture instruments** - For the successful financial viability of the TP schemes, it is essential to back TP/LAP with tried and tested land value capture methods. Unlike all other countries, we have not used value capture instruments to their optimum potential in India. Therefore, it is essential to rethink value-capture financing methods.
- **TP/LAP approach is not feasible for medium-sized towns –** With many resources and expertise, it is difficult to involve tier-two and tier cities in the TP/LAP exercise.

7.3 Key Problem II

"Poor financial and administrative capacity to increase the coverage of urban infrastructure, which is resulting in the failure of the sanitation value chain and dumping wastewater into Nag River."

The above statement is very generic, considering the condition of urban infrastructure in most developing Indian cities due to a lack of effective financial resources. It is estimated that the capital investment of 840 billion (as per 2020 prices) will be required in fifteen years from 2021-2036, which will account for 1.18 % of the total GDP. (Fig. 81) Among

half of this, about 450 billion will be required for setting up basic infrastructure and municipal services (Phatak, 2023).



Source: Phatak, 2023

Figure 83: Financing of urban infrastructure in the percentage of GDP share

7.3.1 Land as an Asset: The Concept of Land Value Capture

Value Capture is widely known when we talk about an increase in the potential of land when certain infrastructure provision is made. For example, suppose the public authority builds a road, lays a sewer line, or proposes any social infrastructure facility. In that case, there is an immediate value impact on the land parcels near the proposed development. Therefore, it can be referred to as the method by which private land and buildings benefit from public investments in infrastructure and policy decisions of governments (e.g., change of land use or FSI). On the other hand, with the induced increase in land value in the area around a system improvement, the public authority can levy additional charges on the developable land; thereby, the capital cost of urban infrastructure can be recovered by capturing some or all the increments in land value

resultant from the investment through a fiscal mechanism such as tax, incentives, and development agreements.

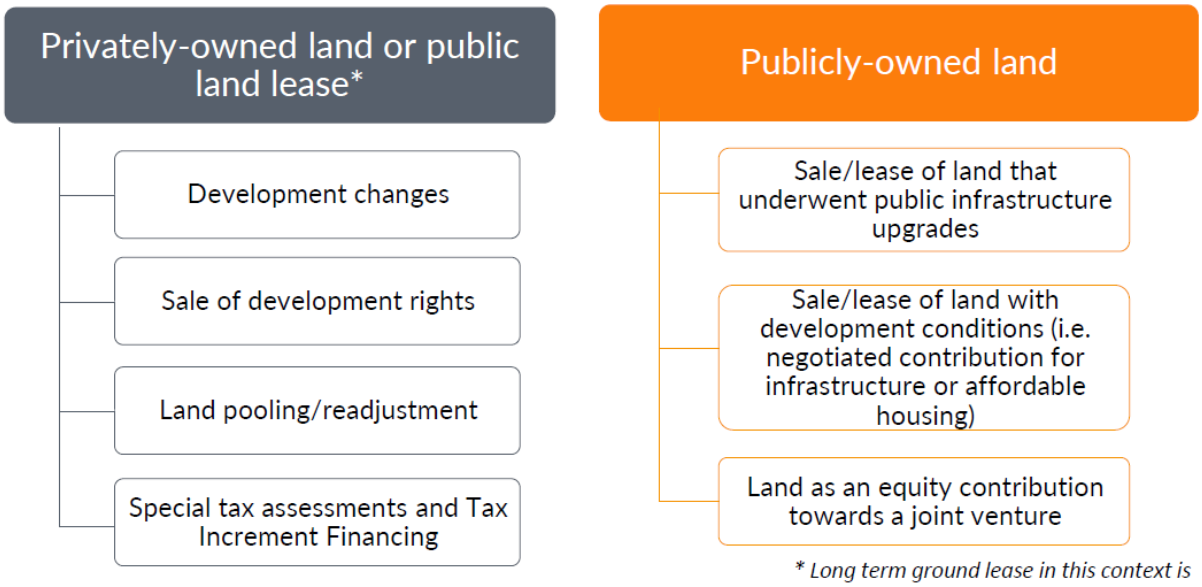
Appropriate VCF tools can be deployed to capture a part of the increment in the value of land and buildings. In turn, these can fund projects set up for the public by the Central/State Governments and ULBs. This generates a virtuous cycle in which value is created, realized, captured, and used again for project investment. As the additional value is generated by actions other than the landowner's direct investment, Value Capture differs from the user charges or fees agencies collect to provide services. It gives governments the opportunity to launch new projects, even with a small resource base. For the private actor, VCF is an opportunity because projects are properly planned and backed up by the government through the executive authority or risk sharing.

LVC mechanisms are widely used for funding infrastructure projects worldwide; some common examples include the urban redevelopment of Seoul Downtown and the restoration of Cheonggyecheon Canal, where the infrastructure cost was recovered by levying 25-50% (World Bank 2014). A similar value capture mechanism to capture the potential of proposed transit nodes is observed in the case of Japan. Transfer of Development Rights (TDR) is used widely in the American context, including New York, as a method to compensate for the lost development value of the land. In the Indian context, examples of land value capture are seen to be efficiently implemented in the case of Hyderabad, where improvement of road infrastructure was initiated using FSI as a resource and TDR as an incentive in case of compensation. Similarly, Sabarmati Riverfront Development initiated the sale and lease of land from land reclamation. Similar tradable rights are used as a part of incentives in Mumbai for in-situ slum rehabilitation and to transfer land development in suburban areas with high demand for development.

7.3.2 Classification of LVC based on various contexts and parameters.

The elements of LVC that are used in various urban contexts vary based on two major aspects. The first is based on ownership, where options are available for publicly owned and privately owned land to undergo land value capture successfully. Similarly, based on the nature and timing of value capture charges.

In this case, the methods are classified as tax-based, fee-based, or incentive-based. Further, based on the nature of the collection, the LVC tools are classified into three types: one-time or recurring and upfront or after completion. Apart from that, it is essential to identify the constraints based on which the implementation of LVC is highly dependent. With a country like India with poor urban policy in place resulting in poor land management mechanisms in place, not all LVC parameters are feasible to be implemented and levied (Fig.82)



Source: Lincoln Institute of Land Policy

Figure 84: Satellite image showing the three cases in greenfield conditions in the context of Nag River

7.3.3 Elements of Land Value Capture

- **Land value tax -** Land value tax is the most common method of LVC and is useful to stabilize property prices (MoHUA, 2022). This is considered the most efficient of all the LVC methods. The tax is collected rate based on the gain in value uniformly.
- **Fees for change of land use –** Charges taken from the private landowner for conversion of land use to permit desired land use for development. The charges are collected one time during the grant of permission.
- **Betterment levy –** These are one-time charges that are taken upfront on the land value gain caused by public infrastructure development like constructing roads or laying sewer trunk lines. These can be collected either with respect to area-based or project-based.

- **Development charges or Impact fees-** The exchange where the developer receives development rights by paying a certain chargeable amount as compensation. Charges are linked to the market rates, which are periodically revised.
- **Vacant land tax (VLT) –** is generally levied on the private owners where the development must be triggered to initiate land development.
- **Tax increment financing -**

Apart from the above-mentioned methods, there are various other methods like land acquisition and development, sale/ lease of public land, land readjustment, and land pooling. With plenty of tools available, it is essential to understand the nature of the tool and its applicability in the case of greenfield or brownfield development.

7.3.4 Urban Context Along Nag River and Applicability of LVC Tools –

Considering the 17 km wide stretch of Nag River passing through various transects viz. newly developed area, CBD area, Old City Precinct, predominantly residential area, and urban fringe, such cases are tested for different elements of LVC available –

- **Transect 1 – Ambazari Lake to Ramdaspeth (Nag River stretch of 0-4.2 km length)** The urban transects along this stretch throughout the length of Nag River up to 7.2 km are close to the transit influence zone. As a result, the neighborhoods near TOD with higher FSI than the other region will have to influence the redevelopment potential**.** *A similar context was seen in the case of Shinagawa, where the TOD influence zone was triggered using additional FAR for value capture. The most popular model successfully formulated for LVC along transit nodes is renting developed floor space for commercial use in the case of the Delhi-Merrut-Gaziabad RRTS Corridor.* Though both examples have a much wider scale of implementation yet, it highlights the potential of areas under the influence of proposed transit having the highest potential to undergo redevelopment. In most cases, to trigger development, vacant land taxes are also levied. Since the neighborhoods along this transect are well-planned, the intervention is possible with minimum complexities.

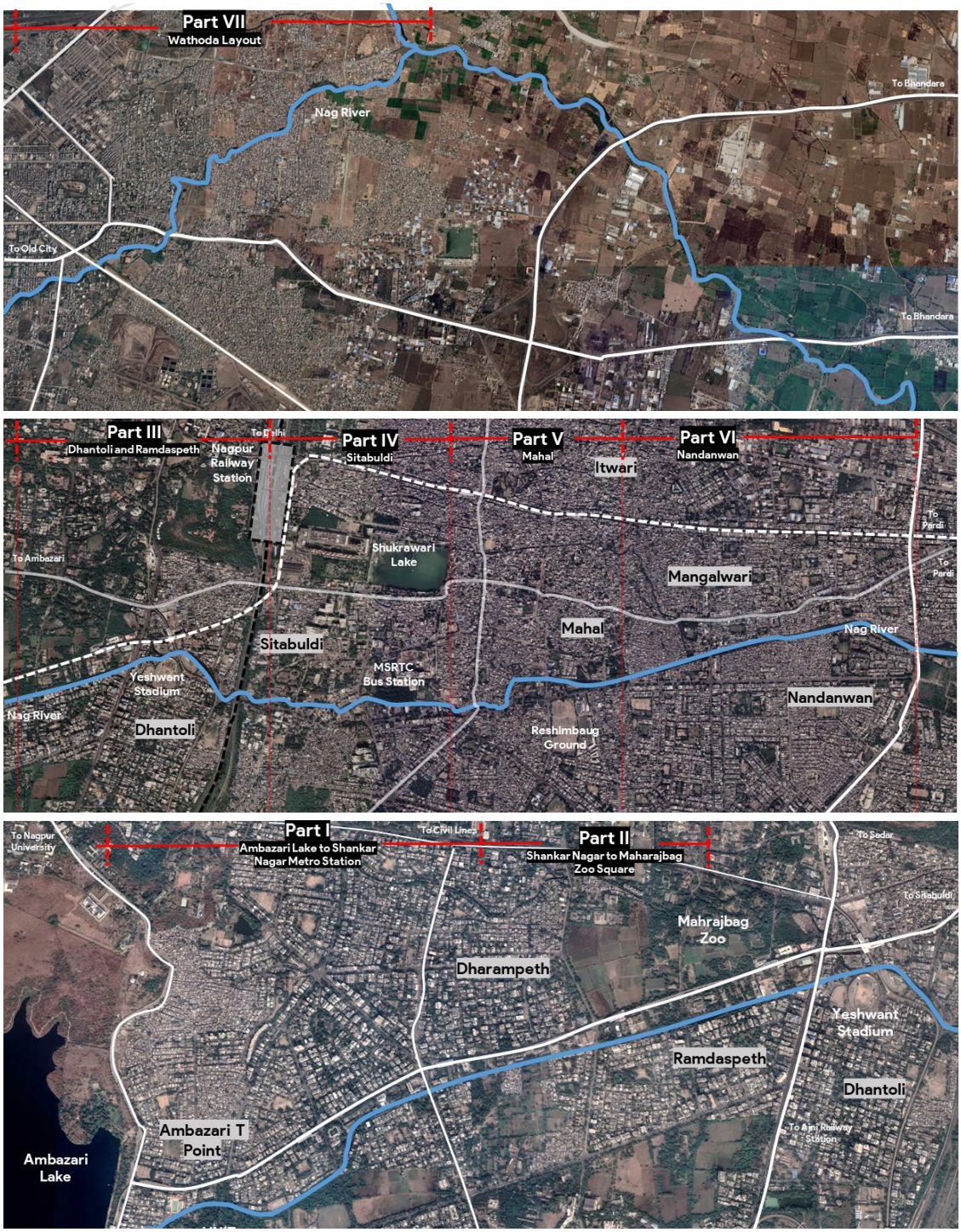
- **Transect II – Ramdaspeth – Dhantoli- Sitabuldi- Mahal- Mangalwari (Nag River Stretch of 7.2- 14.5 km)**

  The area, which includes CBD and Ramdaspeth along this transect, is influenced by TOD with a major interchange near Sitabuldi. This area has a high potential for redevelopment under a transit influence zone where mixed-used high-rise development can be triggered using land value capture tools. This is like the case of Canary Wharf in London or mixed-used redevelopment in King's Cross London, where development rights were traded over with assurance from property owners to provide affordable housing and local infrastructure. In such cases, a betterment levy is a suitable option for LVC.

  The other section of Mahal-Mangalwari is an Old City area with the highest population density. Unlike all other areas with plotted layouts, this area has organic settlements. Apart from high population density and poor condition of urban infrastructure, the area has poor cadastral records and a lack of land ownership in most cases. This makes the applicability of LVC more challenging in areas like Mahal. Moreover, if the area undergoes redevelopment, impact fees in the form of providing premium FSI for additional built floor space is the most efficient tool to recover infrastructure costs.

- **Transect III - Wathoda Layout-Pardi (Nag River stretch of 14.5 – 17 km)**

  The area is characterized by plenty of supply of land with less demand because of a lack of efficient connectivity and urban infrastructure. Since this transect is located at urban fringes with rapidly rising urban sprawl, the area is suitable for land readjustment. With the proposal of metro connectivity extending to this location, the area can experience increased demand. In such cases, development charges with rates based on market prices. Areas with Pardi and Bharatwada which are part of Nag River, are relatively new areas that are unlikely to redevelop, but transactions at increased prices may happen in such cases; stamp duty with surcharges is considered as most efficient.



Source: Google Earth Imagery

Figure 85: Satellite image showing Nag River passing through major urban transects.

7.3.5 Challenges in Applicability of LVC Tools –

Although with significant examples discussed above, land value capture tools are efficient for recovering the capital cost of infrastructure, it needs several prima-facia requirements so that tool can be regularized in the delineated areas. Working of various tools (as shown in Fig, 83) depends on the various existing conditions, which include the availability of land records, proper implementation of development control regulations in the area, access to capital markets, and devolved fiscal powers. Therefore, in most of the urban contexts like Old City areas where there is poor land management with encroachments and poor land ownership status, it is difficult to effectively implement LVC methods. In the table shown here, almost most of the LVC elements under major constraints identified in the practice of urban land management mention prohibitive and significant challenges in the implementation of LVC.

LVC Challenges / LVC tools	Unestablished land market	Lack of land use controls and regulations	Deficient land Cadaster / records	Insecure property rights	Limited access to capital markets	Non-devolved fiscal powers
Impact fees / Exactions	🟠	🟠	🟢	🟠	🟢	🟢
Betterment levies	🟠	🟠	🟠	🟠	🟢	🔴
Leveraging public assets	🟠	🟠	🟠	🟠	🟠	🟠
Land pooling / readjustment	🟠	🟠	🟠	🟠	🟢	🟠
Sale of development rights	🔴	🔴	🟠	🔴	🟠	🟢
Land value tax	🔴	🔴	🔴	🟠	🟢	🔴
Tax Increment Financing	🔴	🔴	🔴	🔴	🔴	🔴

🔴 Prohibitive challenge (regulatory / systemwide changes are prerequisite)
🟠 Significant challenge (regulatory/legislative changes required in certain conditions)
🟢 Limited systemwide arrangements needed. Respective implementation terms can be set at deal level

Source: Google Earth Imagery

Figure 86: Illustration showing feasibility of LVC tools based on the on-ground challenges in urban context

Despite this development regulation, the land-based fiscal tools are not well linked to the market value of land in Indian cities State governments typically maintain a guideline for land values for the purpose of levying stamp duty. The guideline for land value is periodically revised based on information from actual real estate transactions and treated as the official government prices for land. While the premium to be charged on additional FAR has been linked to this guideline in many cases, property tax and development charges are not. Among the cities being studied, only in Mumbai are the

development charge and property tax linked to the official government rates for the market value of the property. In the case of Maharashtra, the State Government has decided not to revise ready reckoner rates even though it was estimated that 10% of the rise in rate was expected in 2023-24. (Arya, 2023) It indicates that though the property price transactions will take place based on the market value, with no hike in the ready reckoner rate, the collection of stamp duty amount remains the same. These things have a very high impact on the collection of taxes cumulatively. Such aspects are going to impact the functioning of LVC financing elements.

Source: Lincoln Institute of Land Policy

Figure 87: Taxes and charges to the market value of land: Indian cities

7.4 Key Problem III

"Restoration of lower-order streams and pre-existing watersheds to naturally improve the riverine ecosystem in an ecological manner."

The above two problems are discussed along with necessary recommendations and targets for restoring urban rivers, which are a major part of the riverine ecosystem and delineated urban watershed. This approach lacks one of the key factors to restore the pre-degraded lower-order stream network which existed during past decades. Even though the higher-order stream is restored with all the necessary efforts, there is a pre-existing threat of making continuous river flow which is possible only when the low-order streams in micro-watersheds are connected to the successive higher-order. This is a very fundamental factor that provides a channel for stormwater during heavy rains and seems to be completely missing throughout the river restoration projects in the brownfield context. Compared to the case of newly urbanized areas where measures in terms of development control regulations can take place to protect the lower order streams, in developed areas, there is a lack of incentives and compensations to restore lost streams.

7.4.1 The Concept of Tradable Development Rights

It must be clearly taken into consideration that the Transfer of Development Rights does not use a land value capture tool, rather TDR is a compensation tool that is used as an alternative for compensating 'the land asset and benefit arising from it' instead of cash/money. (Phatak, 2023).

TDR is considered a typical market-based tool that encourages the voluntary transfer of growth where stakeholders would like to see less development (sending areas) to the places which have a high demand for development (receiving areas). The sending areas can be environmentally sensitive properties, open spaces, agricultural land, wildlife habitat, historical landmarks, or any other important places to a community. The reserve areas should be places the public has agreed to appropriate development because they are close to working places, commercial areas, schools, transportation, and other urban services.

TDR is a widely used concept worldwide in many cities like New York. In India, MMR Region has extensively used TDR as a means of compensation. An innovative aspect of TDR to compensate private owners of heritage property in the Old City of Ahmedabad was initiated by Ahmedabad Urban Development Authority (AUDA) in the form of Heritage TDR which can be availed by trading rights outside the area and using the benefit to maintain privately owned heritage structures.

7.4.2 Conceptualizing River-based TDR Mechanism

Like the case of surrender of land for 'road widening' for which road TDR is granted which is the simplest form of compensation in the form of TDR, the same fundamental can be applied if the private owner is required for land to be surrendered for the restoration of lower order water stream meeting the higher order river. The figure shows the conceptual outline of how tradable development rights can also be given as compensation to private owners for the purpose of restoring the floodplains with pre-existing natural drainage network. This can possibly help generate a tradable component for rivers like heritage TDR and slum TDR which will redefine the role of river as an asset for the city. Some of the key considerations based on the tradable development rights for rivers can be summarized below –

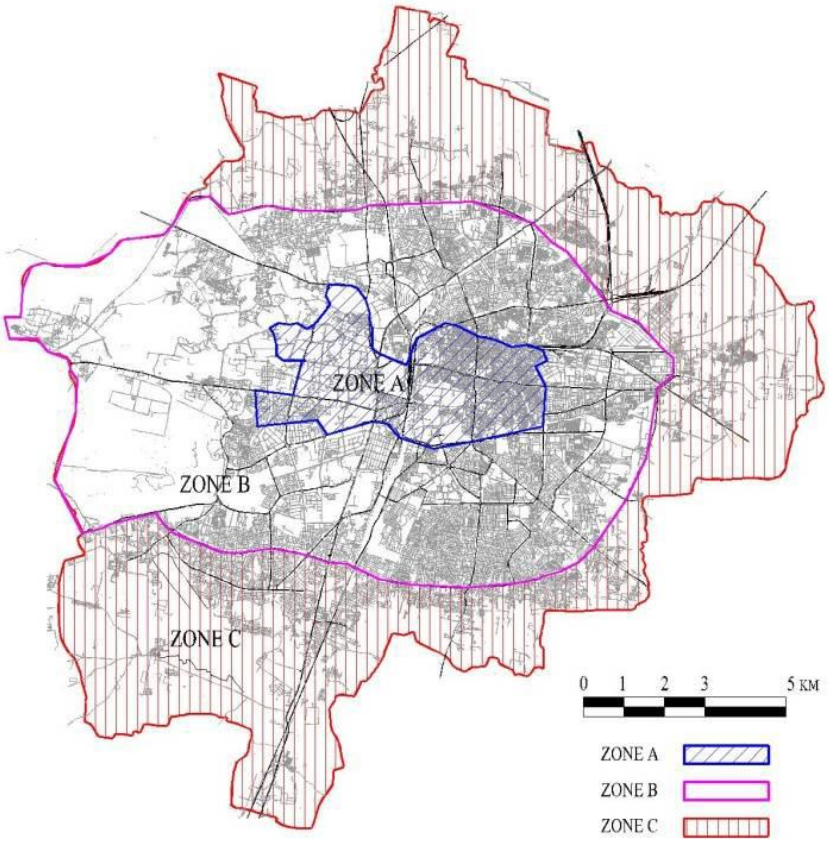
- **The compensation of River-based Tradable Rights will be based on the nature of stream order –** As the higher stream order will essentially need a higher surrender of land for its restoration, compensation based on TDR will ideally be the mathematical factor of the degree of stream order to which property is getting surrender.
- **Preference to be given to the river TDR within delineated micro-planning areas within proximity of Nag River –** As the brownfield urban areas in proximity to the Nag River will they are sending areas in case of River-TDR,

- **Regulating DCR to promote acceptance of TDR as compensation by private owners –**TDR is a voluntary form of compensation against the compensation through cash. The regulations should try to increase the quantum of generating River TDR for the market to make it feasible to absorb and purchase.
- **Making TDR as a trade-off against regulations on private land –** In cases where the private owners did not bring consensus with the public authority for the surrender of land, regulations on private land should be such that no development on the expected parcel to be surrendered cannot be used for any other activities except activities like groundwater recharge, tree plantations with thick cover, etc.
- **Conversion of River-TDR to slum TDR based on the formula-based method –** TDR being a market-based approach, there can be a backwash impact on the smooth trade of River TDR considering the dynamics of the market. Conversion of River-TDR to Slum TDR will be a step to constantly liquidate R-TDR as a medium for transactions between lenders and buyers.

In the case of River-based TDR as compensation, urban rivers will also be considered as financial and market assets for sending and receiving compensation prioritizing restoration of the lost catchment. Therefore, it may lead to redefining the river not only as an environmental asset but also as an element of generating development potential and compensating private owners for their surrender of land surrender as well.

7.4.3 Challenges in Making TDR an Effective Element for Compensation in Urban Areas

The introduction of tradable rights comes with its unique challenge to identify the areas which have the potential to absorb the generated tradable rights. Understanding the working of the real estate market to understand the development trend of the city. In the case of TDR, it is very important to leverage the gap for generated TDR otherwise the fundamentals of TDR as a compensation element will be lost. With the new TDR policy in 2016, Nagpur was divided into various TDR absorbing zones. The mismatches in the envisioned planned development by NMC whose function was to provide basic infrastructure did not follow the real estate growth potential. With no basic infrastructure, the deposition of TDR as expected in the demarcated zone did not meet the expected results. Hence to make TDR work it is essential to envision the



Source: Adane & Deshmukh
Figure 89: TDR Zones in Nagpur

(Note: All the TDR generated in the city was divided into three zones namely Central Area Zone A, Zone B up to inner ring road and Peripheral Zone C. TDR generation of sending and loading or receiving are same with the zones as its boundaries. Approximately, 80% of the TDR generated has already been loaded in Nagpur as per NMC records till 2016. TDR generated from zone A can loaded in zone A as well as can be loaded in zone B & zone C. TDR generated from zone B can be loaded in zone B and zone C but cannot be loaded in zone A. TDR Generated in zone C can only be loaded in zone C but cannot be loaded in zone A & zone B)

development scenario and provide such areas so that they can absorb the generated TDR. (Adane, 2017)Considering various types of TDR, it has been observed that Slum TDR has the highest demand due to its abundance and benefits. In the case of heritage TDR and Road TDR, it has been identified that the demand is very less as a result if the TDR is not being absorbed then it is not functioning as a compensation tool for private landowners. Similarly, introducing tradable rights based on river restoration, the demand for such TDR with small holdings needs to be provided for its efficient use.

7.5 Recommendation based on Spatial Hierarchy

Since the research is limited to the context of urban rivers, the approach to river rejuvenation and recreating the freshwater ecosystem starts with the river basin upstream. In the case of Nagpur, though the origin of Nag River is right in the vicinity of the urban context which is unlikely in the case of most of the rivers, it has been observed that the Ambazari Lake itself is polluted due to various activities within its catchment. Therefore, the solution to fix the pollution in the river starts with identifying various such issues on a regional scale so that the urban rivers are safe from pollution.

- **Strategies at District Level –** As per the functions stated u/s 10 of The Maharashtra District Planning Committee's (Constitutions and Functions) Act, 199, the District Planning Committee for the district with more than 20,00,000 population comprising elected and nominated members. The functions of such a District Planning Committee thus created with prime harmonizing the development within the district Based on the reports and research done by the central agencies like CGWB, National Bureau of Soil Survey and Land Use Planning (NSBB&LUP) as well as RRSC Regional Remote Sensing Centre (RRSC) following role can be undertaken by DPC-
- **Strategies to be undertaken at the Nagpur Metropolitan Region level -** Nagpur Improvement Trust (NIT) is the statutory body involved in preparing a statutory regional plan for sanctioned Nagpur Metropolitan Region (NMR) u/s 14 of the Maharashtra Metropolitan Region Development Authority Act 2016. Under the power and functions given to the Special Planning Authority (NIT in this case) following strategies can be introduced –

i. Undertaking restoration and rejuvenation work of nearby lakes and their catchment areas to reduce the impact of anthropogenic activities.
ii. Delineating floodplain areas for major waterbodies in the NMR region so that the details regarding permissible land use regulations can be implemented at the master plan level.

- **Strategies at Nagpur Municipal City Level (using development plan) –** As per MRTP Act 1966, Municipal Corporations are given roles and responsibilities for the preparation of existing land use (ELU) and proposed land use (PLU) plans for the city along with development control regulations (DCRs)

for the implementation of the development plan. The following strategies can be undertaken at the city level using statutory backing as listed below –

- Recommendations for areas necessary for urban redevelopment in Sanctioned Development Plan
- Provision of green zone and buffer areas along major water bodies including lakes and rivers
- Assessment of sending and receiving zones in case to improve the TDR mechanism.
- Identifying market demand using proper assessment to facilitate the key land value capture elements in the context of Nagpur.

7.6 Miscellaneous Recommendations

The following recommendations are essential to provide backing to spatial as well as hierarchical recommendations that are mentioned above.

- **Legislative Recommendations –**

  As per the latest MRTP Act 1966, there is no provision for urban redevelopment. As a result, most of the urban redevelopment projects were undertaken from time to time u/s 46 of the MRTP Act 1966, which states the delineation of area for Plan for Comprehensive Development. The said act includes the provision of urban renewal, urban redevelopment of transit influence zones, improvement of social and physical infrastructure, and slum redevelopment. But the past actions undertaken under this act did not have significant results, for example, in the case of Brihanmumbai Municipal Corporation (BMC). Interestingly, the Development Plan of Mumbai recommends that several areas under Greater Mumbai and Mumbai suburbs undergo local area planning. Still, since there is no specific legislature, none of the suggested areas were taken for redevelopment. ***Like the GTPUDA Act, 1976 special section that includes the process, timeline, and program for the preparation and implementation of brownfield development projects at the neighborhood level must be made under MRTP Act, 1966 by the GoM.***

- **Administrative Recommendations -**

One of the major reasons for the delay in the Nag River Pollution Abetment Project over the past two decays is a lack of administrative coordination between various statutory bodies. As per the 74th Constitutional Amendment Act, there should be only one planning authority in one city, whereas, in Nagpur, both NIT (as an executive body under NIT's Act) and NMC (as the legislative and executive body under Municipal Corporation's Act) are two parallel planning authorities administering the same jurisdiction which creates constraints in efficient working. The parallel administration body is leading to harassment of citizens, increasing establishment costs and administrative expenses, which are recovered from taxpayers. ***Hence for proper functioning and promoting a single window clearance system in the administration of Nagpur, it is essential to dissolve NIT with the transfer of its full assets to NMC, making it the highest authority for legislative and executive roles in Nagpur's jurisdiction.***

- **Financial Recommendations –**

  Apart from the various recommendation on improving financial viability for urban redevelopment projects, as mentioned in the section on LVC, the following recommendations are important to improve the creditworthiness of public-private engagement –

  - Revision of ASR or ready reckoner rates annually to reduce the gap between the market value and the circle rates.
  - Incremental increase in municipal taxes and providing incentives to reduce past arrears.
  - Improving efficiency to avail non-binding grants by ensuring service level benchmarks and targeting performance-based grants.
  - Adoption of real-time financial accounting system (FIS) to stop using old manual tally-based accounting system.

7.7 Summary: Interrelationship of Various Spatial Recommendations – The Ideation of Create, Capture, and Compensate

Throughout the study there was a huge discussion on land as an asset and how the benefit of this asset can be leveraged in terms of improving the condition of urban

rivers. From the literature study itself, the past efforts of river restoration used infrastructure-based methods to improve the condition of rivers. It was later replaced by ecologically sensitive methods where nature-based solutions were widely used for rejuvenating polluted water stretches. In this paradigm shift from choosing ecologically sensitive methods and replacing them with engineering and infrastructure-based practices was conceptualized in Western countries and is blindly being followed in India to date. Examples of various riverfront development are appreciated without understanding the fact that the context in India is very different in terms of political, administrative, cultural, economic, and financial aspects when it comes to river rejuvenation. For example, the Singapore Riverfront is widely appreciated and is envisioned in every river-centric city in India. The ideation simply based on clean riverfronts is not going to solve the problem and the idea to solve the issues related to pollution or creating vegetation buffers should come from

"Creating Land Availability for Urban Utilities, Capturing Induced Land Value and Compensating the Land for Restoring River Ecosystem – The concept of 3C's".

A shift in rethinking river rejuvenation based on the above concept must be aligned with the objectives of restoring riverfronts. The figure outlines the interrelationship between spatial planning tools and elements of land value capture and TDR based compensation.

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CERTIFICATE OF COMPLETION

This is to certify that this thesis project titled "**Application of Spatial Planning Techniques to Restore an Urban River: Case of Nag River Nagpur**" was carried out by **Mr. Chaitanya Anant Joshi**, a student of the **Faculty of Planning at CEPT University**. The research for this project was undertaken under the guidance of the afore-mentioned institute and completed during the period of **09.01.2023** to **11.05.2023**.

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