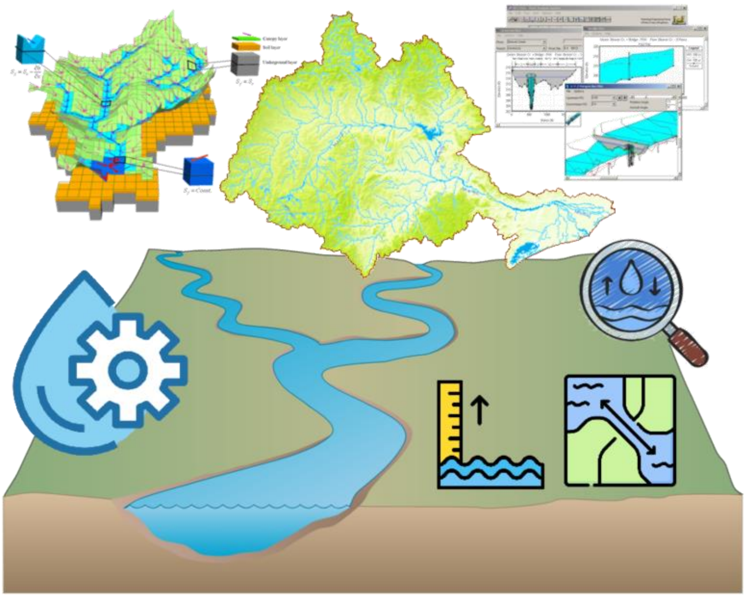
National River Conservation Directorate
Ministry of Jal Shakti,
Department of Water Resources,
River Development & Ganga Rejuvenation
Government of India

सत्यमेव जयते

Hydraulic Status of

Mahanadi River Basin



December 2024

cMahanadi

ROURKELA

cGanga

Hydraulic Status of Mahanadi River Basin

National River Conservation Directorate (NRCD)

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

www.nrcd.nic.in

Centres for Mahanadi River Basin Management and Studies (cMahanadi)

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

www.cmahanadi.org

Centres for Ganga River Basin Management and Studies (cGanga)

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

www.cganga.org

Acknowledgment

This report is a comprehensive outcome of the project jointly executed by NIT Raipur (Lead Institute) and NIT Rourkela (Fellow Institute) under the supervision of cGanga at IIT Kanpur. It was submitted to the National River Conservation Directorate (NRCD) in 2024. We gratefully acknowledge the individuals who provided information and photographs for this report.

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Preface

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

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

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

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

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

Centre for Mahanadi River Basin
Management and Studies (cMahanadi)
NIT Raipur & NIT Rourkela

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Abbreviations and Acronyms

cMahanadi	Centre for Mahanadi River Basin Management and Studies
BCM	Billion Cubic Meters
CG	Chhattisgarh
CGL	Central Gauge Line
CWC	Central Water Commission
HEC	Hydrologic Engineering Centre
IIT	Indian Institute of Technology
MCM	Million Cubic Meters
MRB	Mahanadi River Basin
NIT	National Institute of Technology
NRSC	National Remote Sensing Centre
OD	Odisha
RAS	River Analysis System
sq.km.	square kilometer
SoI	Source of Information
SWMM	Storm Water Management Model
WRIS	Water Resource Information System

1. Introduction

The Mahanadi basin extends over states of Chhattisgarh, Odisha and comparatively smaller portions of Jharkhand, Maharashtra and Madhya Pradesh, draining an area of 1,41,589 Sq.km which is nearly 4.3% of the total geographical area of the country (Table 1). The Mahanadi River Basin (MRB) is endowed with substantial water resources and hydraulic infrastructure (Figure 1), including surface water and groundwater which are utilized for various purposes, including irrigation, hydropower generation, domestic water supply and industrial use. However, the equitable distribution and sustainable management of these resources remain significant challenges.

The average annual surface water resource potential is estimated to be around 66.9 billion cubic meters (BCM), with a utilizable potential of approximately 50 BCM (India-WRIS). This surface water is harnessed through major reservoirs like the Hirakud and Hasdeo Bango dams, which provide a total storage capacity of over 14 BCM. These stored waters are crucial for irrigation, supporting extensive agriculture in the basin, as well as for hydropower generation, contributing significantly to the region's energy needs.

In addition to surface water, the basin also holds a substantial amount of groundwater, with estimates suggesting a utilizable potential of around 16.5 BCM. This groundwater resource is vital for supplementing surface water for irrigation, domestic use, and maintaining base flows in rivers, especially during dry periods. Effectively managing both these surface and groundwater resources is crucial for maximizing the basin's potential for agricultural development, industrial growth and ensuring water security for the millions who depend on it.

The MRB is characterized by its complex hydrology and hydraulic behaviour. The basin experiences significant seasonal variations in rainfall, leading to both floods and droughts. The river's flow is influenced by factors such as topography, geology and land use patterns. Understanding these hydraulic characteristics is essential for effective water resource management and flood control.

Hydraulic structures play a critical role in the Mahanadi Basin, enabling effective water resource management and mitigating flood risks. These structures, such as dams, barrages and canals, provide numerous benefits, including irrigation for agriculture, hydropower generation, flood control and inland navigation. However, they also present potential drawbacks, such as environmental impacts, displacement of communities and the risk of structural failures. Careful planning, design, and operation of these structures are essential to maximize their benefits while minimizing their negative consequences.

Figure 1: Mahanadi River Basin Map.

Table 1: Salient Features of Mahanadi River Basin.

Basin Extent Longitude Latitude	 80° 28’ to 86° 43’ E 19° 8’ to 23° 32’ N
Length of Mahanadi River (Km)	851
Catchment Area (Sq.km.)	141589
Average Water Resource Potential (MCM)	66880
Utilizable Surface Water Resource (MCM)	50000
Live Storage Capacity of Completed Projects (MCM)	12799.0
Live Storage Capacity of Projects Under Construction (MCM)	1465.0
Total Live Storage Capacity of Projects (MCM)	14244.0
No. of Hydrological Observation Stations (CWC)	39
No. of Flood Forecasting Stations (CWC)	4

The Mahanadi River, the "Great River," is the lifeblood of eastern India, its significance deeply intertwined with the ecology, economy, and culture of the region. Originating in the Sihawa hills of Chhattisgarh, the Mahanadi traverses through diverse landscapes before emptying into the Bay of Bengal. Its network of tributaries (Table 3), including the Seonath, Hasdeo, Mand, Ib, Pairi on the left bank, and the Jonk, Ong, and Tel on the right, play crucial roles in augmenting its flow and extending its influence.

The Mahanadi River Basin is divided into three sub-basins: Upper, Middle, and Lower Mahanadi (Figure 2, Table 2). The Upper basin, primarily in Chhattisgarh, is saucer-shaped. The Middle basin traverses through both Chhattisgarh and Odisha, characterized by hilly terrains and valleys. The Lower basin, situated in Odisha, comprises the fertile delta region where the river meets the Bay of Bengal. The basin's diverse topography influences its hydrology, with the upper reaches receiving substantial rainfall, leading to seasonal floods, while the lower deltaic region experiences frequent riverine floods and tidal impacts.

Table 2: Detail of Sub-Basin of Mahanadi River Basin.

S.No	Sub-basin	Area (Sq. km)	Size Range of Watershed (Sq. km)	No. of Watersheds
1	Mahanadi Lower Sub Basin	57958.88	320.05- 1457.59	91
2	Mahanadi Middle Sub Basin	51895.91	301.22 - 902.46	88
3	Mahanadi Upper Sub Basin	29796.64	314.34 - 907.63	48

(Source: India-WRIS)

Table 3: Major River and Tributaries of Mahanadi River Basin.

River/Tributary	Origin	Elevation at source above msl	Length (km)	Catchment Area (sq.km)	% of Total Area	Significance
Mahanadi (Main River)	Sihawa hills, Dhamtari district, Chhattisgarh	442	851	48,230	34.1	Main artery of the basin, Source of water for irrigation, drinking, and industry, Supports diverse ecosystems, Site of major hydroelectric projects
Left Bank Tributaries						
Seonath	Rajnandgaon district, Chhattisgarh	533	383	30,761	21.7	Largest tributary of the Mahanadi, Crucial for irrigation in Chhattisgarh, Supports agriculture and livelihoods
Hasdeo	Koriya district, Chhattisgarh	915	333	9,803	6.9	Known for its coalfields, Important for industrial activities and power generation
Mand	Surguja district, Chhattisgarh	686	242	5,237	3.7	Contributes significantly to the Mahanadi's flow, flows through hilly terrain, influencing local ecosystems
Ib	Raigarh district, Chhattisgarh	762	251	12,447	8.8	Basin rich in mineral resources, Supports industrial and mining activities
Right Bank Tributaries						
Jonk	Nuapada district, Odisha	762	196	3,673	2.6	Important for agriculture in western Odisha, Supports local communities and ecosystems
Ong	Kalahandi district, Odisha	457	204	5,128	3.6	Flows through a predominantly agricultural region, Vital for irrigation and local livelihoods
Tel	Koraput district, Odisha	700	296	22,818	16.1	Longest right bank tributary, Vital for irrigation and supporting the local ecosystem, Influences the hydrology of the southern part of the basin
Pairi	Bhatigarh hills, Gariaband district, Chhattisgarh-	488	113	3,503	2.5	Joins the Mahanadi near Rajim, a significant religious and cultural site, Important for local agriculture and water supply in the Gariaband district
			Total	141,600		

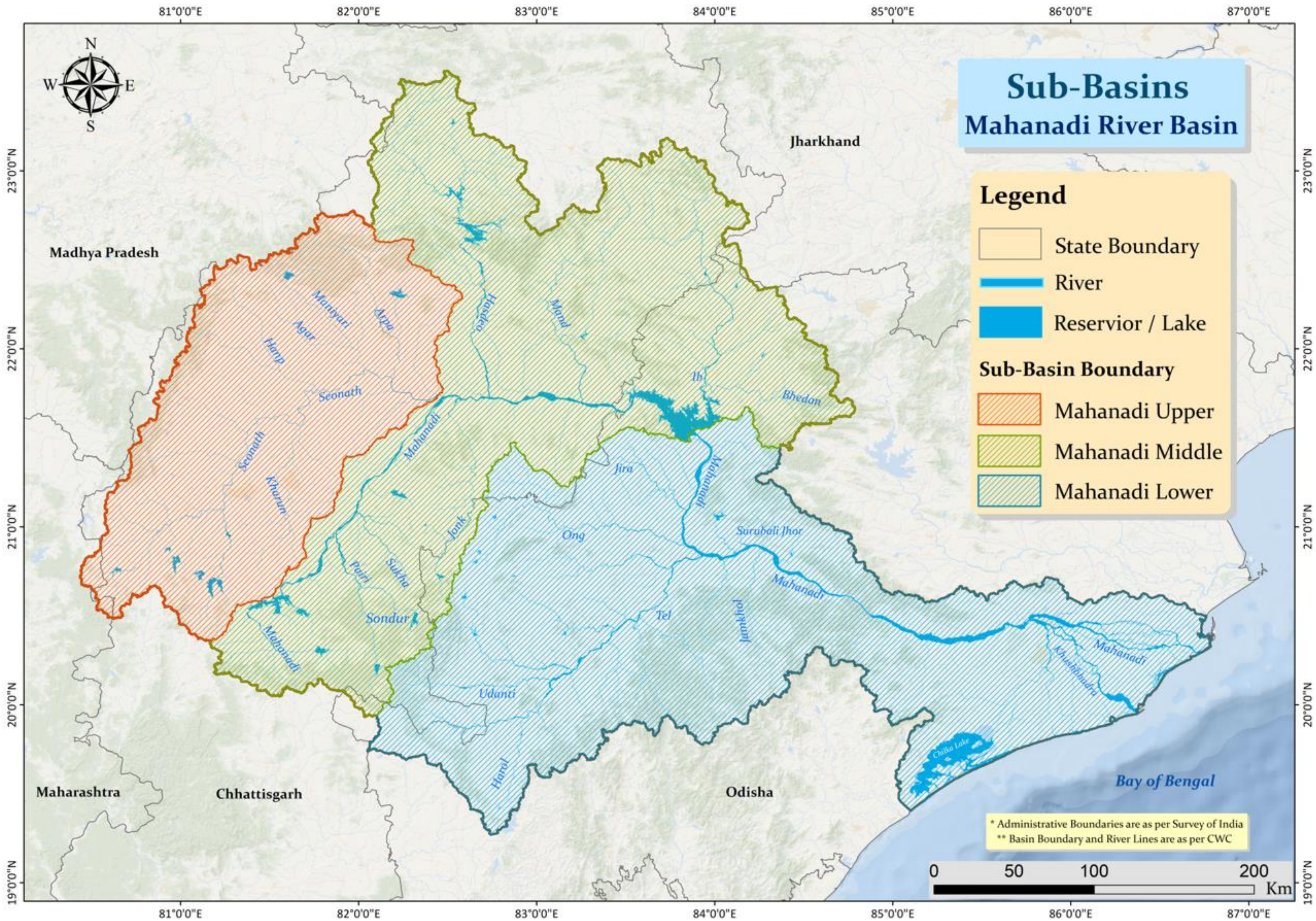


Figure 2: Delineation of Sub-Basins within the Mahanadi River Basin.

The Mahanadi River Sub-Basin distinct characteristics:

1. Upper Mahanadi Basin:

- **Location:** Primarily in Chhattisgarh.
- **Topography:** Characterized by a saucer-shaped terrain with gentle slopes.
- **Key Features:**
    - Dominated by tributaries like Seonath, Hasdeo, Mand, Ib, and Jonk.
    - Significant for agriculture and irrigation due to its fertile plains.
    - Contains several hydroelectric power projects.

2. Middle Mahanadi Basin:

- **Location:** Spans parts of Chhattisgarh and Odisha.
- **Topography:** Hilly terrain with valleys and gorges.
- **Key Features:**
    - River flows through narrow valleys, increasing its velocity.
    - Important for hydropower generation due to the steep gradient.
    - Supports diverse ecosystems, including forests and wildlife habitats.

3. Lower Mahanadi Basin:

- **Location:** Primarily in Odisha.
- **Topography:** Fertile deltaic plains.
- **Key Features:**
    - River branches into distributaries before emptying into the Bay of Bengal.
    - Highly productive agricultural region due to fertile alluvial soils.
    - Vulnerable to floods and cyclones.
    - Supports diverse coastal ecosystems, including mangroves and wetlands.

These sub-basins, while interconnected, have unique hydrological, ecological, and socio-economic characteristics. Understanding these differences is crucial for effective water resource management and sustainable development in the Mahanadi River Basin.

The MRB offers substantial hydraulic benefits that are crucial for the region's well-being. Primarily, the construction of reservoirs has played a vital role in flood control and mitigation, reducing the risk of devastating floods, especially in the vulnerable delta region. The river also serves as a reliable source of water for domestic and industrial needs, supporting urban centres and economic growth. Furthermore, the extensive irrigation network fed by the Mahanadi and its tributaries significantly boosts agricultural productivity, ensuring food security and supporting the livelihoods of a large farming population. This reliable water supply also enables dry season farming, further enhancing agricultural output.

Hydropower generation, particularly from major projects like the Hirakud Dam, provides a clean and renewable energy source, powering industries and reducing reliance on fossil fuels.

While not fully realized, the Mahanadi holds potential for inland navigation, offering a sustainable transportation alternative. Additionally, the river system contributes to groundwater recharge, replenishing vital aquifers. Finally, regulated river flows, while primarily managed for human use, also play a role in maintaining essential aquatic ecosystems. However, effectively harnessing these hydraulic benefits requires careful management to balance competing water demands and mitigate potential environmental impacts associated with hydraulic structures.

1.1 Scope of Work

The Mahanadi River Basin, a vital resource for millions in India, faces complex hydrological challenges compounded by rapid development and the impacts of climate change. Effective water resource management and sustainable development within the basin necessitate comprehensive hydraulic studies.

This report provides a comprehensive overview of the available data within the Mahanadi basin. It details cross-sectional information collected from the main river, major tributaries, and drains, offering valuable insights into channel geometry and flow characteristics. Furthermore, the report includes details of the river infrastructure throughout the basin, providing context for water resource management and development. Crucially, it presents discharge and sediment data gathered from gauging stations located on the main river and its major tributaries. This hydrological and sedimentological data is essential for understanding the basin's water resources, sediment transport dynamics, and overall health, all of which are critical inputs for accurate hydraulic modeling. The combination of cross-sectional, Longitudinal section, infrastructure, discharge, and sediment data presented in this report serves as a valuable resource for developing and calibrating hydraulic models, enabling a deeper understanding of flow dynamics and facilitating more effective water resource management. This information is vital for:

- Flood Control and Mitigation
- Water Resource Management
- Navigation and Inland Waterways
- Hydropower Development
- Environmental Management

By utilizing this data effectively, engineers and policymakers can make informed decisions to address the challenges facing the Mahanadi River Basin and ensure its sustainable development.

1.2 Data sources

Table 4: Dataset Used

S. No	Data	Source (Agency/Department)	Data Type
1	Cross Section	Central Water Commission (CWC)	Excel Sheet, Report
2	Longitudinal Section	India-WRIS	Shapefile
3	Infrastructure	State Water Resource Department, India-WRIS	Excel Sheet, Report
4	Discharge	Central Water Commission (CWC)	Excel Sheet, Report
5	Sediment	Central Water Commission (CWC)	Excel Sheet, Report

This study relies on a multi-source approach to characterize the Mahanadi River Basin's. The Central Water Commission (CWC), India's leading national agency for water resources development and planning, serves as a primary data source, particularly for river cross-sections, discharge and sediment. The CWC operates a network of 39 gauge-discharge stations across the basin, providing critical flow data. Sediment observations are also conducted at 13 of these stations, offering valuable insights into sediment transport. To support flood forecasting efforts, the CWC maintains four dedicated stations within the basin. This multi-source data approach provides a comprehensive foundation for understanding the basin's hydrological processes.

This report utilizes secondary data gathered from Central Water Commission (CWC), Water Resources Department (WRD), relevant departmental annual reports and peer-reviewed journal articles pertaining to the Mahanadi River Basin. While a comprehensive dataset was initially sought, some data requests remain pending with relevant departments. Official requests have been submitted and we are awaiting their response. Therefore, this report is based on the currently available data and represents the most complete analysis possible at this time.

2. Hydraulic Data

Hydraulic data, encompassing measurements of discharge, velocity, channel characteristics and sediment transport, is fundamental to understanding water flow and behaviour in natural and engineered systems. Studying this data is crucial for effective water resource management, flood control, and the design of hydraulic structures. Furthermore, hydraulic modeling, which utilizes mathematical equations and computer simulations to represent water flow, relies heavily on accurate hydraulic data for calibration and validation. These models allow engineers and scientists to simulate various scenarios, such as flood events or the impact of infrastructure development and predict their effects on water flow and surrounding environments. By combining the analysis of observed hydraulic data with sophisticated modeling techniques, we can gain valuable insights into complex hydrological processes, enabling informed decision-making for water resource management, infrastructure planning and environmental protection.

2.1 Cross-Section Data

Cross-section data, in the context of river studies and hydraulics, refers to measurements taken across a river or channel at a specific point. Imagine slicing through the river perpendicular to its flow and measuring various parameters along that line. Cross-section data is crucial for a variety of reasons, particularly in river engineering, hydrology and environmental studies. Locations of CWC Cross-Section Measurement Stations are shown in Figure 3.

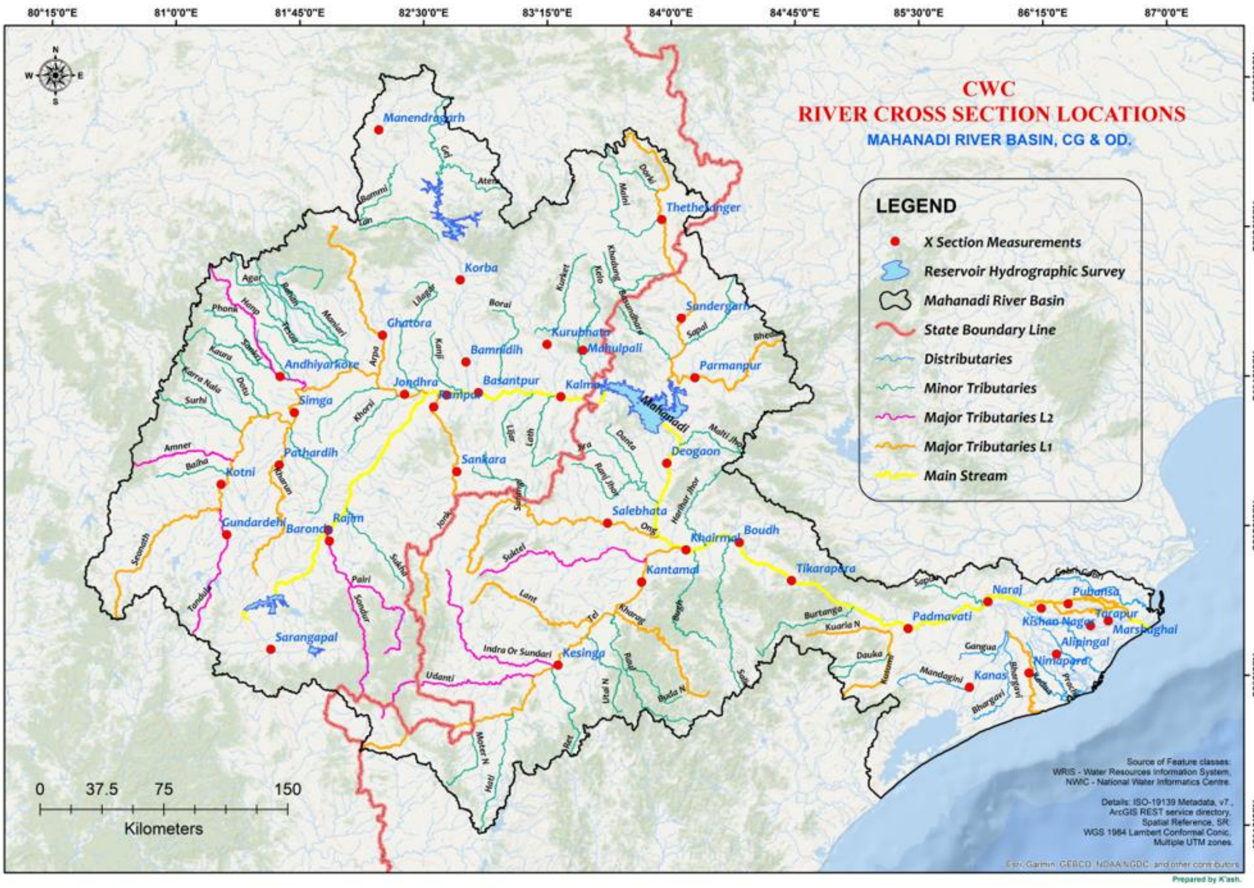


Figure 3: River X-section measurement locations, CWC, Mahanadi River Basin.

- **Flood Modeling:** Cross-section data is used in hydraulic models to simulate flood events and predict flood levels. This information is crucial for flood risk management and planning.
- **Calculating Flow Area**: The cross-sectional area, calculated from the bed elevation and water depth data, is essential for determining the discharge (flow rate) of the river.
- **Estimating Flow Velocity**: Combined with discharge data, the cross-sectional area helps in estimating the average flow velocity in the river.
- **Understanding Channel Morphology**: Cross-section data helps in understanding the shape and form of the river channel, including its width, depth and bank slopes. This is important for understanding erosion and deposition processes.

- **Designing Hydraulic Structures:** Cross-section data is essential for designing bridges, culverts and other structures that cross rivers. It helps in determining the appropriate size and shape of these structures to ensure they can handle the river's flow.
- **Sediment Transport Studies:** Cross-section data, along with flow velocity and other parameters, helps in understanding how sediment is transported by the river. This is important for managing erosion and sedimentation problems.
- **Environmental Assessments:** Cross-section data can be used to assess the impact of human activities on river channels and ecosystems.

In summary, cross-section data provides a snapshot of the river channel at a specific location, offering valuable information for a wide range of applications in water resource management, engineering and environmental studies.

Cross-sectional data for the Mahanadi River Basin, sourced from the Central Water Commission (CWC), forms a key component of this report. The locations and data availability of the CWC monitoring sites within the basin for the specified period are detailed in Table 5. Graphical representations of recent cross-sectional data from the main river gauge station are included herein (Figure 4). To provide a broader historical perspective, supplementary cross-sectional data of stations in main river, major tributaries and drains spanning from 1972 to 2012 is provided in the Annexure, which is prepared using data of CWC and State Water Resource Department.

Table 5: Site Location for Cross-Section Data (CWC).

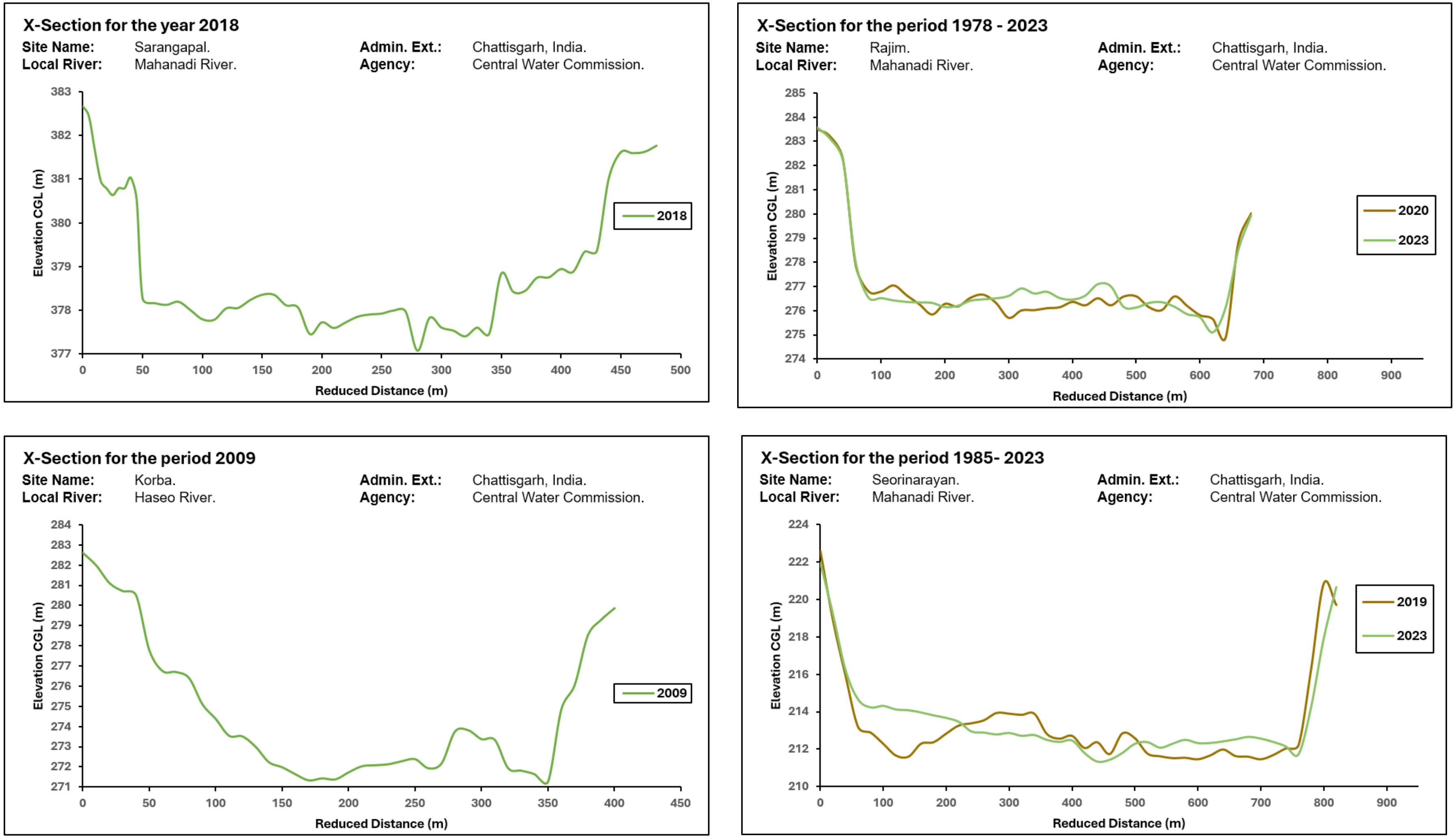
Station Count	CWC_Site	Latitude	Longitude	Elevation	State	River	Tributary	Distributary	Period of data available	10-year Decadal Interval
1	Sarangapal	20.313	81.532	378.0	CG	Mahanadi	-	-	2018	
2	Rajim	20.974	81.880	287.0	CG	Mahanadi	-	-	1978 - 2010; 2020 2023	1978, 1980, 1990, 2000, 2010
3	Korba	22.358	82.692	281.0	CG	Mahanadi	-	-	2009	2009
4	Seorinarayan	21.717	82.597	215.0	CG	Mahanadi	-	-	1985 - 2011; 2019 2023	1985, 1990, 2000, 2010, 2011
5	Basantpur	21.727	82.788	210.0	CG	Mahanadi	-	-	1972 - 2011; 2022	1972, 1980, 1990, 2000, 2010, 2011
6	Deogaon	21.308	83.900	139.0	OD	Mahanadi	-	-	2005; 2017	2005
7	Khairmal	20.822	84.000	106.0	OD	Mahanadi	-	-	2009; 2017	2009
8	Boudh	20.855	84.317	82.0	OD	Mahanadi	-	-	2019	
9	Tikarapara	20.633	84.619	64.0	OD	Mahanadi	-	-	1975 - 2012, 2021 2023	1975, 1980, 1990, 2000, 2010, 2012
10	Padmavati	20.343	85.298	47.0	OD	Mahanadi	-	-	2017	
11	Naraj	20.475	85.775	21.0	OD	Mahanadi	-	-	2019	
12	Kishan Nagar	20.426	86.089	17.0	OD	Mahanadi	-	-	2017	
MAJOR TRIBUTARIES										
Station Count	**CWC_Site**	**Latitude**	**Longitude**	**Elevation**	**State**	**River**	**Tributary**	**Distributary**	**Period of data available**	**10-year Decadal Interval**
1	Manendragarh	23.203	82.218	440.0	CG	Mahanadi	Hasdeo/Hasiya	-	1987 - 2011	1987, 1990, 2000, 2010, 2011
2	Thettatanger	22.668	83.910	387.0	CG	Mahanadi	Ib	-	2017	
3	Gunderdehi	20.955	81.278	296.0	CG	Mahanadi	Tandula	-	2015-2018, 2020	
4	Baronda	20.913	81.886	291.0	CG	Mahanadi	Pairi	-	1980 - 2011	1980, 1990, 2000, 2010, 2011
5	Kotni	21.236	81.247	273.0	CG	Mahanadi	Seonath	-	1980 - 2011	1980, 1990, 2000, 2010, 2011
6	Sankara	21.289	82.650	272.0	CG	Mahanadi	Jonk	-	1995 - 2003	1995, 2000, 2003
7	Andhiyarkore	21.834	81.606	267.0	CG	Mahanadi	Hanp	-	1980 - 2011	1980, 1990, 2000, 2010, 2011

8	Ghatora	22.057	82.221	263.0	CG	Mahanadi	Arpa	-	1978 - 2010	1978, 1980, 1990, 2000, 2010
9	Pathardhi	21.341	81.594	258.0	CG	Mahanadi	Karun	-	1989 - 2011	1989, 1990, 2000, 2010, 2011
10	Simga	21.632	81.688	255.0	CG	Mahanadi	Seonath	-	1973 - 2011	1973, 1980, 1990, 2000, 2010, 2011
11	Mohulpali	21.950	83.417	242.0	CG	Mahanadi	Kelo	-	2009	2009
12	Rampur	21.652	82.519	237.0	CG	Mahanadi	Rampur	-	1976 - 2011	1976, 1980, 1990, 2000, 2010, 2011
13	Jondhra	21.725	82.347	234.0	CG	Mahanadi	Seonath	-	1979 - 2011	1979, 1980, 1990, 2000, 2010, 2011
14	Raigarh	21.891	83.401	221.0	CG	Mahanadi	Kelo		2010 - 2011	2010, 2011
15	Bamnidhi	21.899	82.717	227.0	CG	Mahanadi	Hasdeo	-	1974 - 2011	1974, 1980, 1990, 2000, 2010, 2011
16	Kurubhata	21.988	83.204	222.0	CG	Mahanadi	Mand		1980 - 2012	1980, 1990, 2000, 2010, 2012
17	Sundergarh	22.115	84.011	223.0	OD	Mahanadi	Ib	-	1978 - 2012; 2022 2023	1978, 1980, 1990, 2000, 2010, 2012
18	Parmanpur	21.781	84.082	210.0	OD	Mahanadi	Bhedan	-	2008 - 2011	2008, 2010, 2011
19	Kesinga	20.198	83.225	177.0	OD	Mahanadi	Tel	-	1978 - 2012; 2020	1978, 1980, 1990, 2000, 2010, 2012
20	Salebhata	20.983	83.539	134.0	OD	Mahanadi	Ong	-	1983 - 2012	1983, 1990, 2000, 2010, 2012
21	Kantamal	20.650	83.732	133.0	OD	Mahanadi	Tel	-	1977 - 2012; 2023	1977, 1980, 1990, 2000, 2010, 2012

DRAINS OF THE RIVER

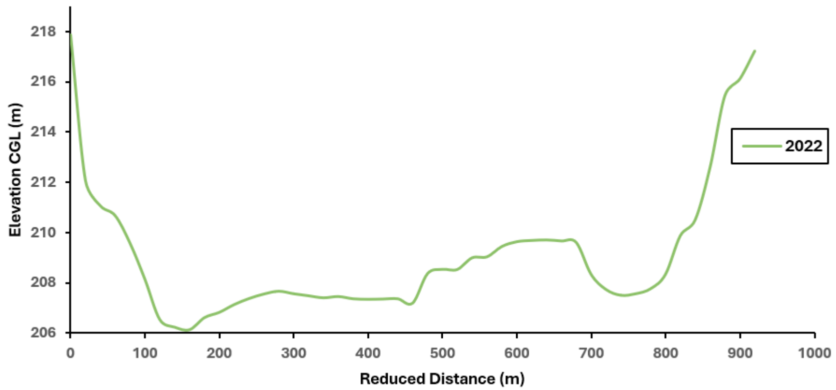
Station Count	CWC_Site	Latitude	Longitude	Elevation	State	River	Tributary	Distributary	Period of data available	10-year Decadal Interval
1	Pubansha	20.444	86.248	15.0	OD	Mahanadi	-	Luna	2006	2006
2	Alipingal	20.167	86.167	13.0	OD	Mahanadi	-	Devi	2005 - 2006	2005, 2006
3	Nimapara	20.069	86.000	13.0	OD	Mahanadi	-	Kushabhadra	2004 - 2005	2004, 2005
4	Kanas	20.002	85.646	10.0	OD	Mahanadi	-	Daya	2006	2006
5	Marshanghai	20.340	86.481	9.0	OD	Mahanadi	-	Luna	2006	2006
6	Tarapur	20.317	86.375	7.0	OD	Mahanadi	-	Mond	2017	

Figure 4: Main Stream Cross Sectional Datasets - Present



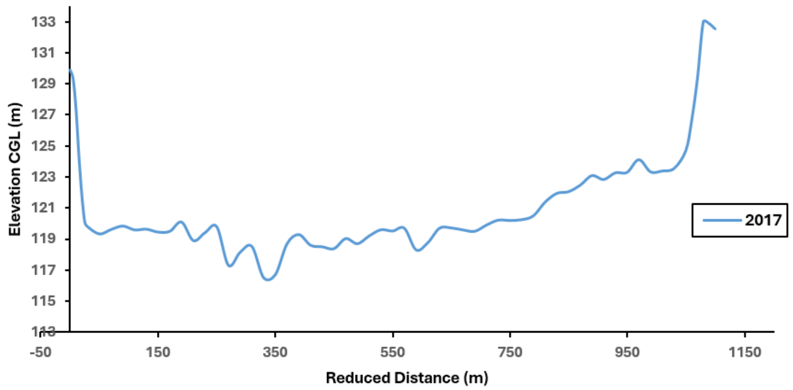
X-Section for the period 1972 - 2022

Site Name: Basantpur. **Admin. Ext.:** Chattisgarh, India.
Local River: Mahanadi River. **Agency:** Central Water Commission.



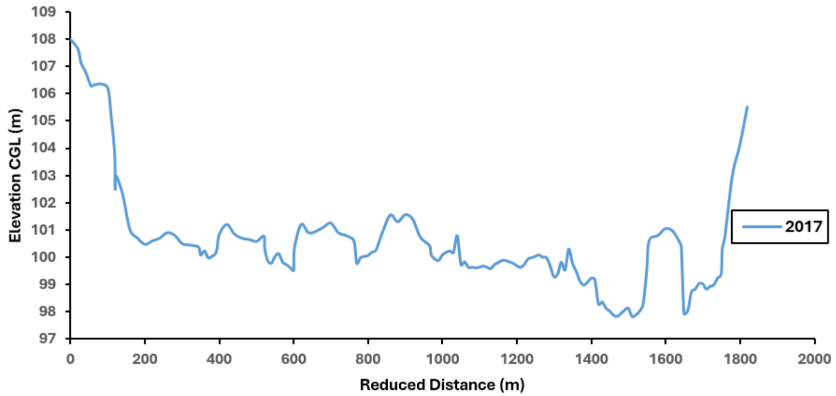
X-Section for the year 2005 & 2017

Site Name: Deogaon. **Admin. Ext.:** Chattisgarh, India.
Local River: Mahanadi River. **Agency:** Central Water Commission.



X-Section for the period 2009 & 2017

Site Name: Khairmal. **Admin. Ext.:** Odisha, India.
Local River: Mahanadi River. **Agency:** Central Water Commission.



X-Section for the year 2019

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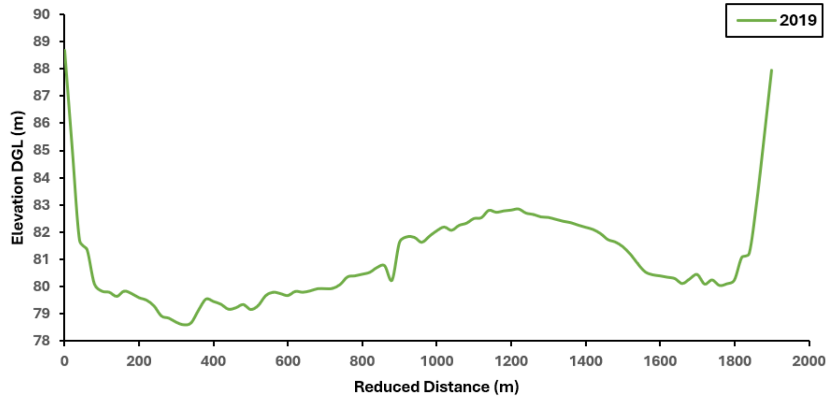
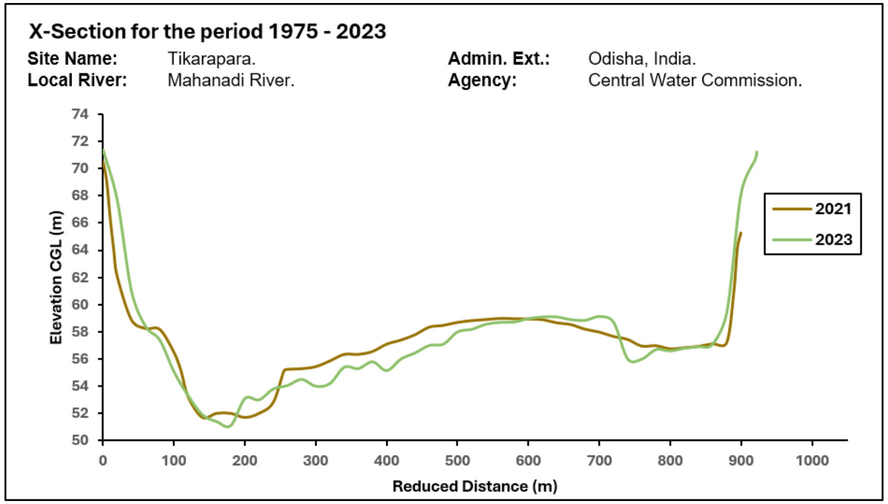
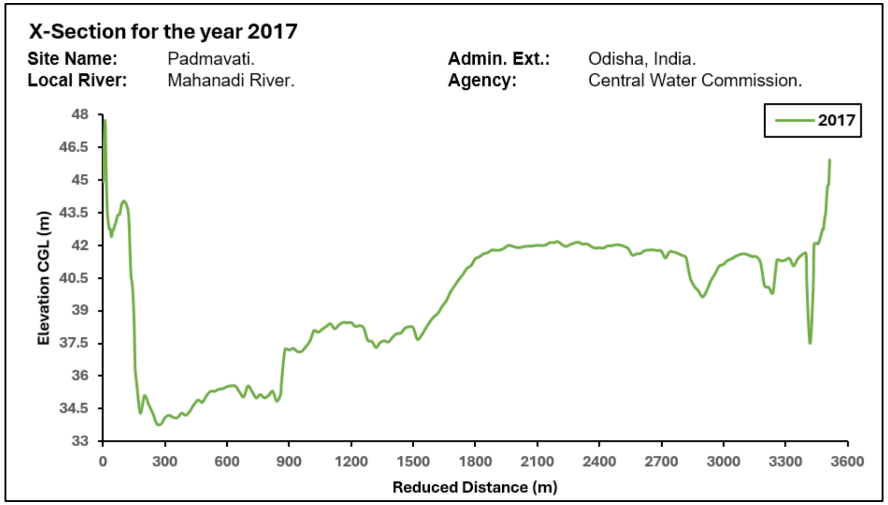
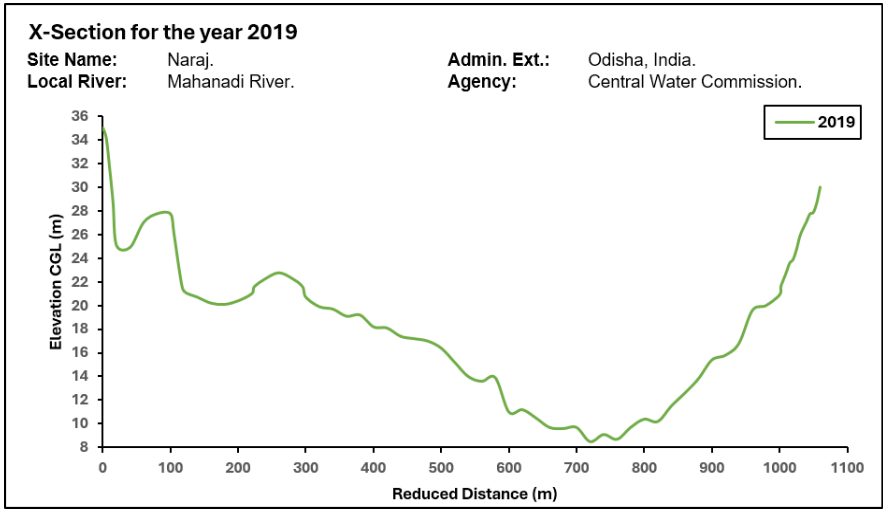
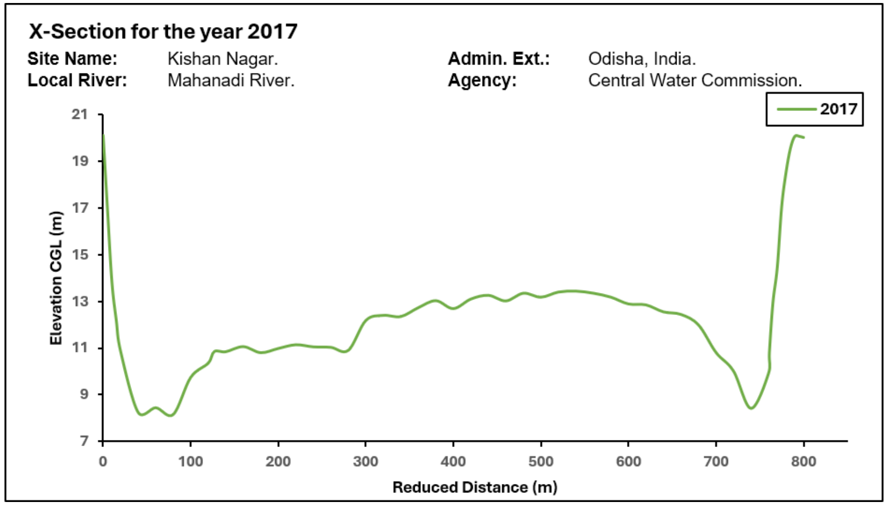
Local River: Mahanadi River. **Agency:** Central Water Commission.




X-Section for the period 1975 - 2023
Site Name: Tikarapara.
Local River: Mahanadi River.
Admin. Ext.: Odisha, India.
Agency: Central Water Commission.
2021
2023
Elevation CGL (m)
Reduced Distance (m)


X-Section for the year 2017
Site Name: Padmavati.
Local River: Mahanadi River.
Admin. Ext.: Odisha, India.
Agency: Central Water Commission.
2017
Elevation CGL (m)
Reduced Distance (m)


X-Section for the year 2019
Site Name: Naraj.
Local River: Mahanadi River.
Admin. Ext.: Odisha, India.
Agency: Central Water Commission.
2019
Elevation CGL (m)
Reduced Distance (m)


X-Section for the year 2017
Site Name: Kishan Nagar.
Local River: Mahanadi River.
Admin. Ext.: Odisha, India.
Agency: Central Water Commission.
2017
Elevation CGL (m)
Reduced Distance (m)

2.2 Longitudinal Section

The longitudinal section of a river represents the profile of its channel along its flow direction, showing variations in bed elevation with respect to distance. This cross-sectional portrayal provides invaluable insights into the topographic, hydraulic, and geomorphic characteristics of a river system. Hydraulic modeling, a critical tool in water resources management, leverages such profiles to simulate river flow behaviour under various scenarios. The longitudinal section plays an indispensable role in the development, calibration, and validation of hydraulic models, directly influencing their accuracy and predictive capability.

Longitudinal Section shown in Figure 5 has been extracted from IWRIS- India Water Resources Information System provided at the ArcGIS REST Server Layer. The details of the features of said layer have been furnished below. Major Tributary L1 and L2 refers to the tributaries having "rilcode" (River Line Code) as classified by CWC. Additional information is provided subjective to the data preparation of CWC from the layer River Line Code.

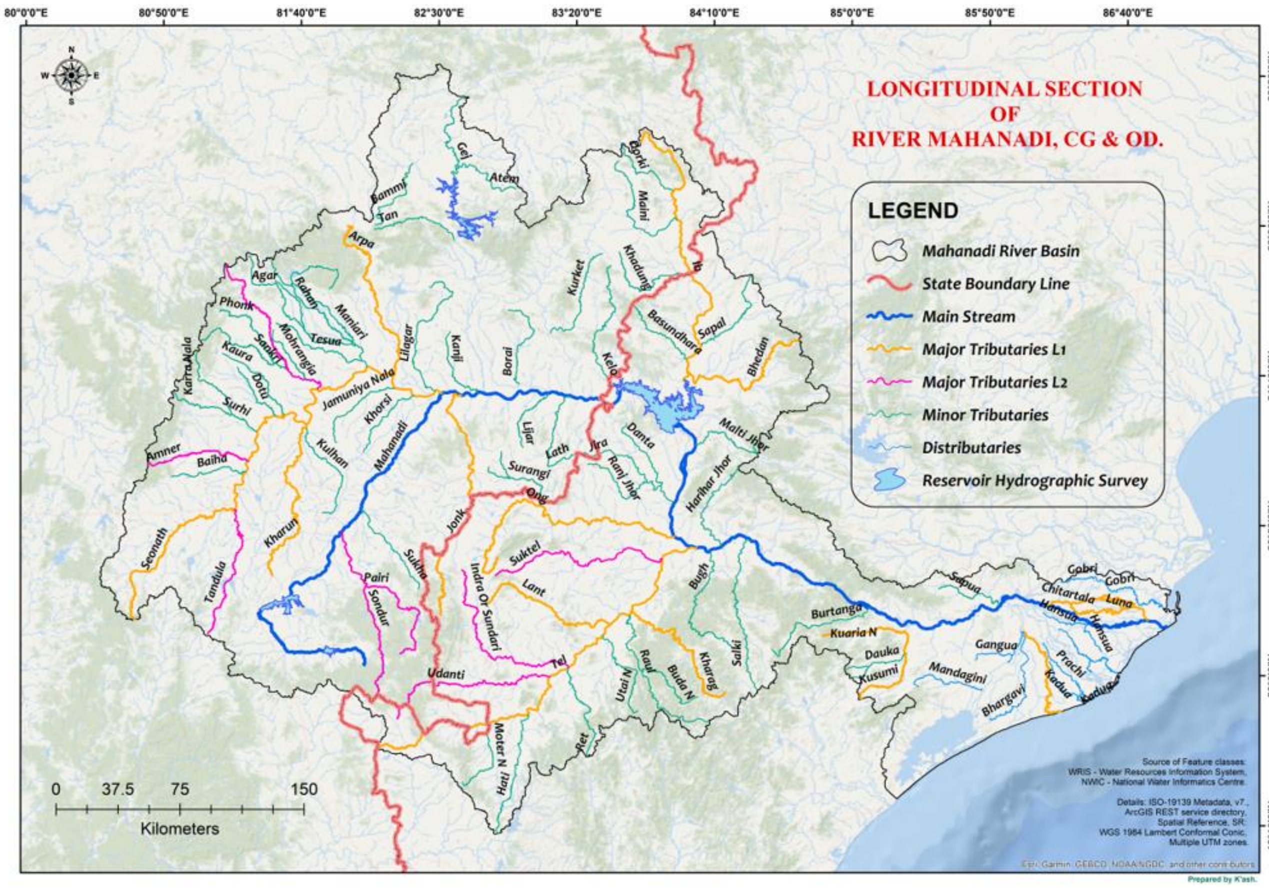


Figure 5: Longitudinal Section of Mahanadi River and its tributaries.

Longitudinal data for the Mahanadi River Basin is presented in Table 6 and elevation to longitudinal section of Main River is in illustrated Figure 6. Elevation to Longitudinal Section of Major Tributaries (L1) and (L2) Inside Mahanadi River Basin is in Figure 7 and Figure 8 respectively.

Table 6: Longitudinal Information for Mahanadi River Basin. (Source: IWRIS, 2022).

S. No.	River Name	Sub Basin	Stream Length (m)
1	Mahanadi	-	1047415.57
2	Arpa	Mahanadi Upper	150609.38
3	Bhedan	Mahanadi Middle	125410.29
4	Chitartala	Mahanadi Lower	71589.43
5	Ib	Mahanadi Middle	255807.47
6	Jonk	Mahanadi Middle	201674.66
7	Kharag	Mahanadi Lower	126343.24
8	Kharun	Mahanadi Upper	145672.31
9	Kuaria N	Mahanadi Lower	62757.29
10	Kushabhadra N	Mahanadi Lower	86897.44
11	Lant	Mahanadi Lower	117835.43
12	Ong	Mahanadi Lower	215465.04
13	Seonath	Mahanadi Upper	384874.46
14	Tel	Mahanadi Lower	307309.56
15	Kusumi	Mahanadi Lower	77158.32
16	Luna	Mahanadi Lower	100024.19
17	Amner	Mahanadi Upper	85682.23
18	Hanp	Mahanadi Upper	164314.77
19	Indra Or Sundari	Mahanadi Lower	141157.37
20	Sondur	Mahanadi Middle	91946.99
21	Suktel	Mahanadi Lower	137669.18
22	Udanti	Mahanadi Lower	145278.05

23	Pairi	Mahanadi Middle	141650.16
24	Tandula	Mahanadi Upper	108286.73
25	Ret	Mahanadi Lower	90597.22
26	Surangi	Mahanadi Lower	87178.43
27	Atem	Mahanadi Middle	65591.03
28	Burtanga	Mahanadi Lower	102422.28
29	Dorki	Mahanadi Middle	64275.63
30	Dotu	Mahanadi Upper	62755.68
31	Bhargavi	Mahanadi Lower	85478.34
32	Gej	Mahanadi Middle	103128.64
33	Gobri	Mahanadi Lower	121165.63
34	Harihar Jhor	Mahanadi Lower	84299.82
35	Hati	Mahanadi Lower	108112.14
36	Buda N	Mahanadi Lower	62411.55
37	Jamuniya Nala	Mahanadi Upper	71741.03
38	Jira	Mahanadi Lower	94528.75
39	Kanji	Mahanadi Middle	64882.36
40	Kaura	Mahanadi Upper	93903.44
41	Kelo	Mahanadi Middle	122374.45
42	Khorsi	Mahanadi Upper	63919.07
43	Danta	Mahanadi Lower	60046.74
44	Kulhan	Mahanadi Upper	87346.59
45	Kurket	Mahanadi Middle	87223.54
46	Lath	Mahanadi Middle	85984.23

47	Lilagar	Mahanadi Upper	127764.41
48	Maini	Mahanadi Middle	100214.34
49	Moter N	Mahanadi Lower	67547.77
50	Phonk	Mahanadi Upper	102904.10
51	Rahan	Mahanadi Upper	139968.65
52	Ranj Jhor	Mahanadi Lower	63756.54
53	Raul	Mahanadi Lower	133600.64
54	Sankri	Mahanadi Upper	111605.96
55	Sapal	Mahanadi Middle	82050.41
56	Sapua	Mahanadi Lower	64781.53
57	Tan	Mahanadi Middle	73891.77
58	Utai N	Mahanadi Lower	86067.39
59	Sukha	Mahanadi Middle	76660.95
60	Surhi	Mahanadi Upper	91304.87
61	Borai	Mahanadi Middle	78512.17
62	Alanka	Mahanadi Lower	93218.15
63	Hansua	Mahanadi Lower	72042.57
64	Gangua	Mahanadi Lower	64727.76
65	Maniari	Mahanadi Upper	169984.06
66	Salki	Mahanadi Lower	133296.70
67	Agar	Mahanadi Upper	150540.48
68	Baiha	Mahanadi Upper	65204.90
69	Bammi	Mahanadi Middle	76952.84
70	Malti Jhor	Mahanadi Lower	76111.00

71	Mandagini	Mahanadi Lower	67185.23
72	Basundhara	Mahanadi Middle	68617.36
73	Bugh	Mahanadi Lower	119373.31
74	Prachi	Mahanadi Lower	61143.79
75	Khadung	Mahanadi Middle	79004.63
76	Mohpar	Mahanadi Upper	66609.03
77	Mohrangia	Mahanadi Upper	64877.03
78	Tesua	Mahanadi Upper	92654.77
79	Kadua	Mahanadi Lower	80736.14
80	Karra Nala	Mahanadi Upper	71893.94
81	Dauka	Mahanadi Lower	67593.89
82	Lijar	Mahanadi Middle	62658.91

(**Major Tributaries of:** 1. **Mahanadi River** - Seonath, Hasdeo, Jonk, Mand, Kelo, Ib, Ong, Tel. 2. **Ib River** - Maini, Kokiya, Sapal, Bhedan. 3. **Ong River** - Surangi. 4. **Seonath River** - Arpa, Maniari, Hanp, Kharun, Tandula. 5. **Tel River** - Hati, Udanti, Indra or Sundari, Suktel, Raul., *SoI: IWRIS, 2022*)

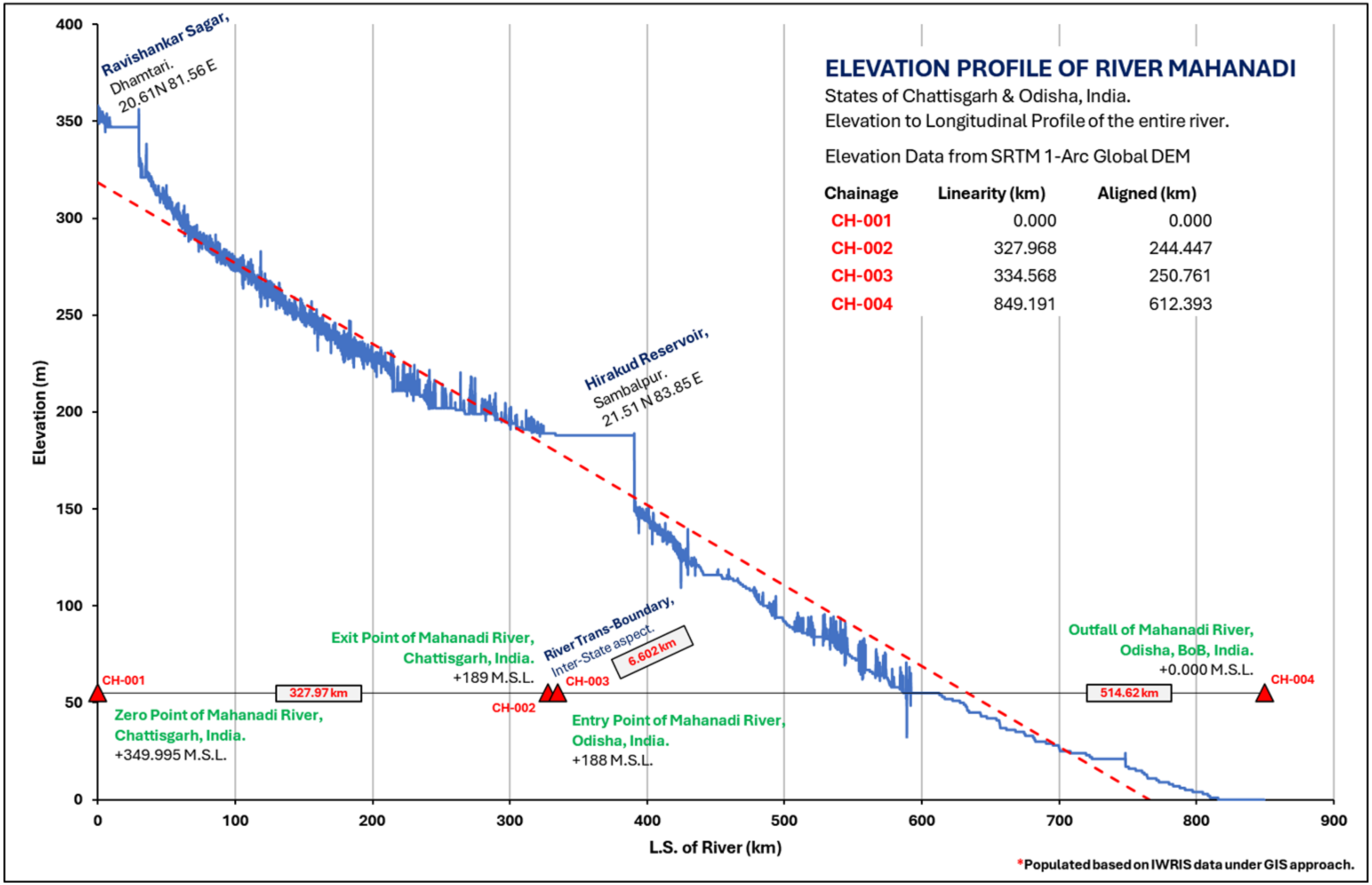
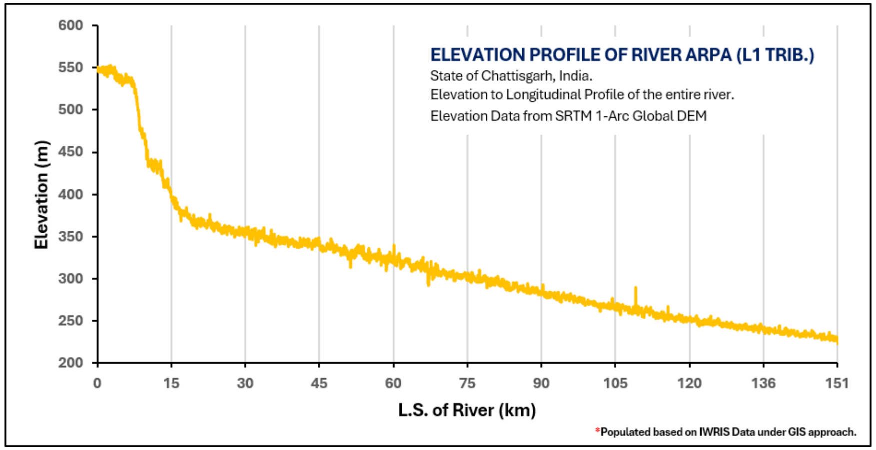


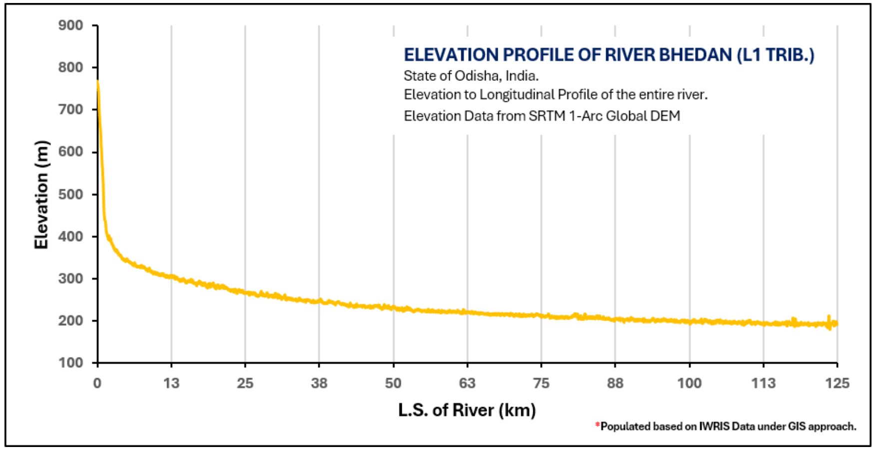
Figure 6: Elevation to Longitudinal Section of River Mahanadi

Figure 7: Elevation to Longitudinal Section of Major Tributaries (L1) Inside Mahanadi River Basin

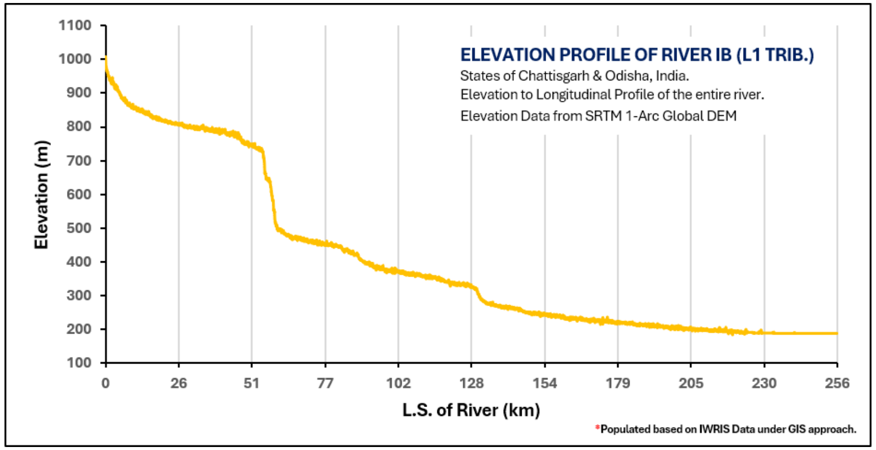
River Name: Arpa **Administrative Extent:** State of Chhattisgarh



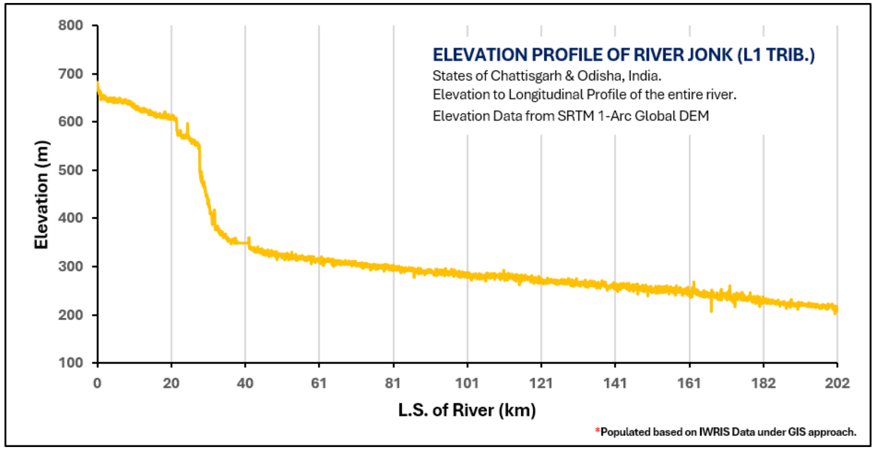
River Name: Bhedan **Administrative Extent:** State of Odisha



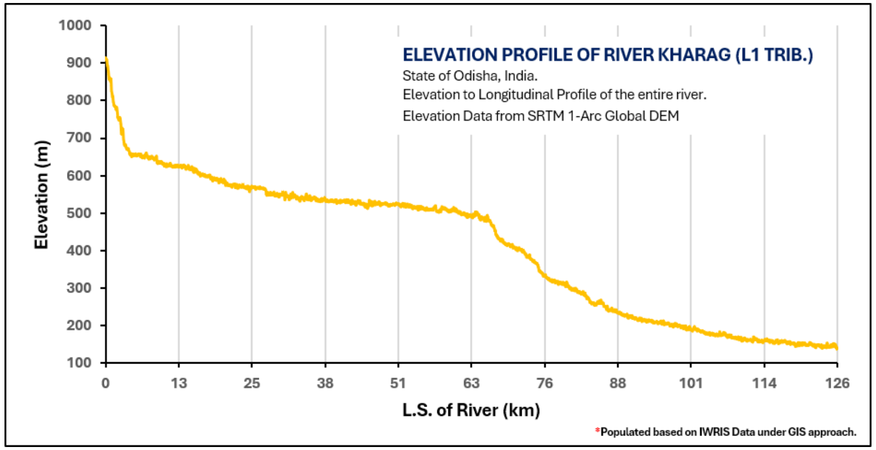
River Name: Ib **Administrative Extent:** State of Chhattisgarh & Odisha



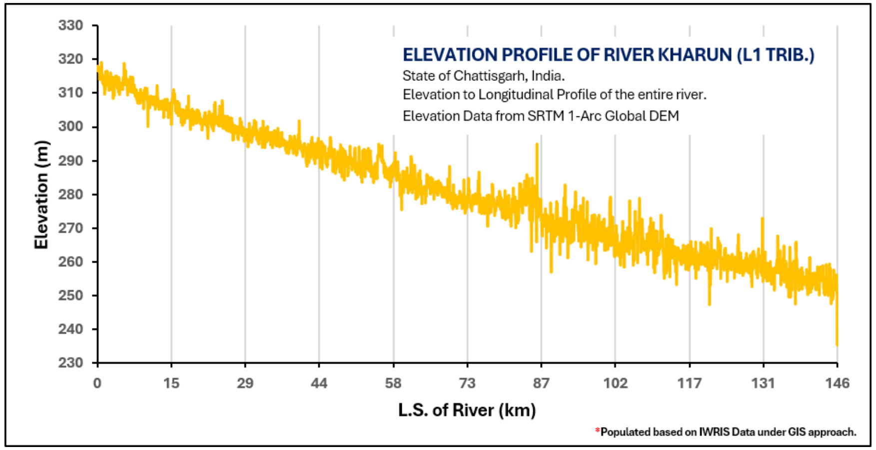
River Name: Jonk **Administrative Extent:** State of Chhattisgarh & Odisha



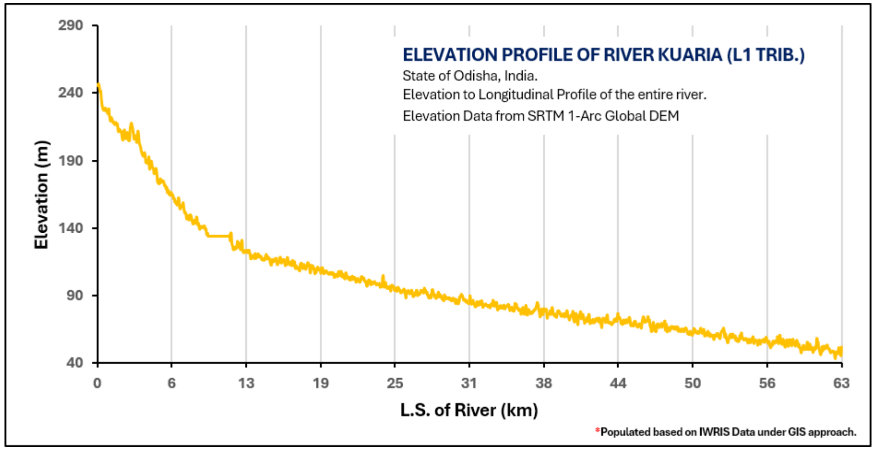
River Name: Kharag **Administrative Extent:** State of Odisha



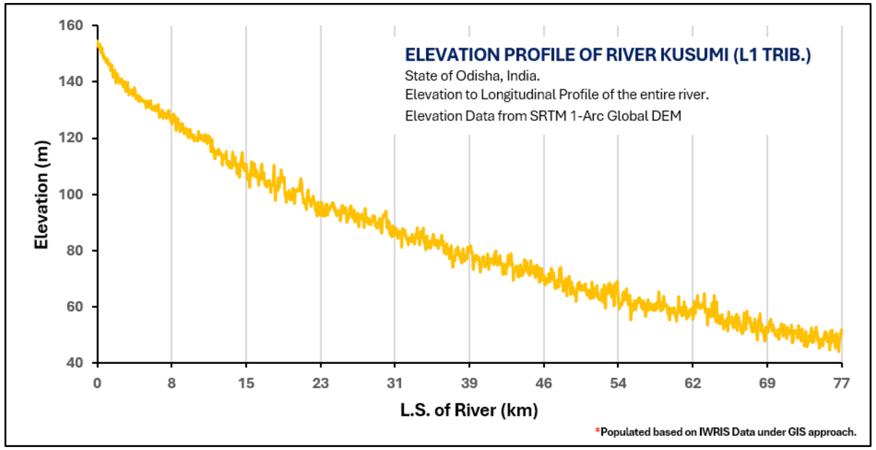
River Name: Kharun **Administrative Extent:** State of Chhattisgarh



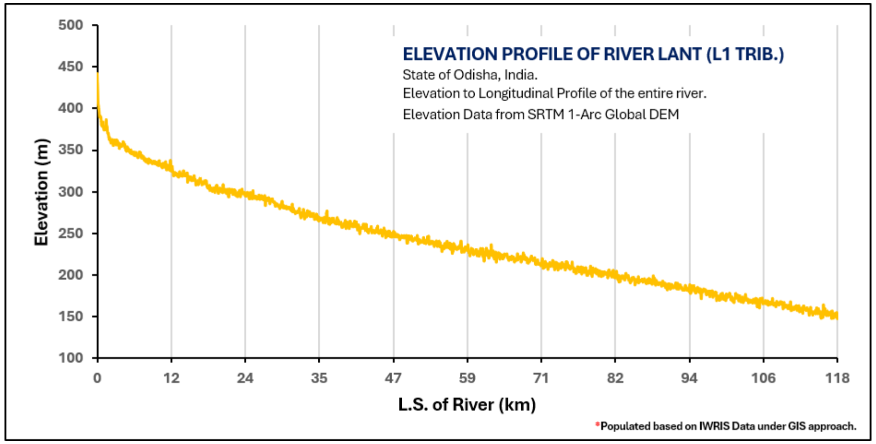
River Name: Kuaria **Administrative Extent:** State of Odisha



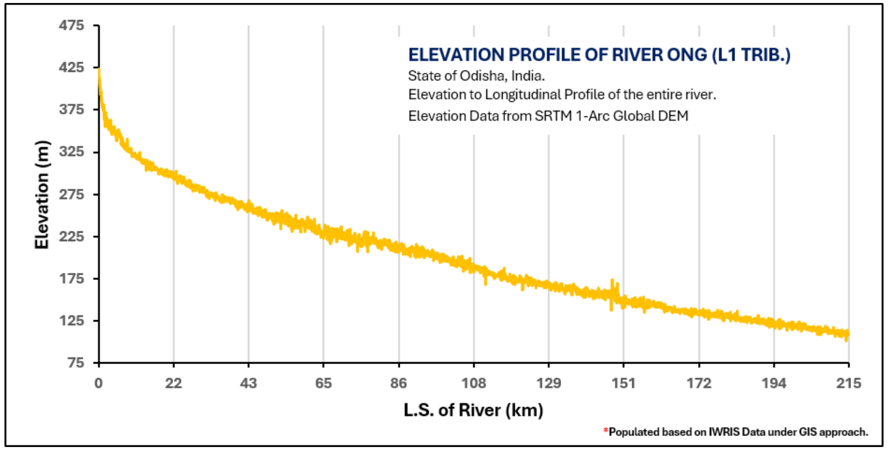
River Name: Kusumi **Administrative Extent**: State of Odisha



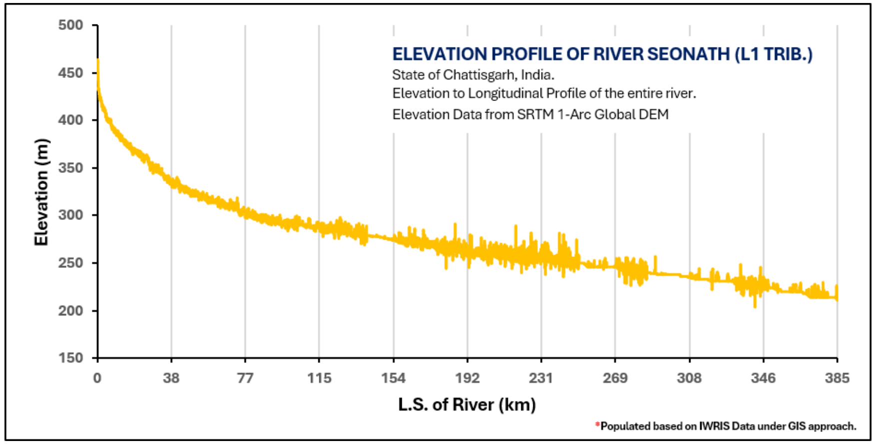
River Name: Lant **Administrative Extent:** State of Odisha



River Name: Ong **Administrative Extent:** State of Odisha



River Name: Seonath **Administrative Extent:** State of Chhattisgarh



River Name: Tel **Administrative Extent:** State of Odisha

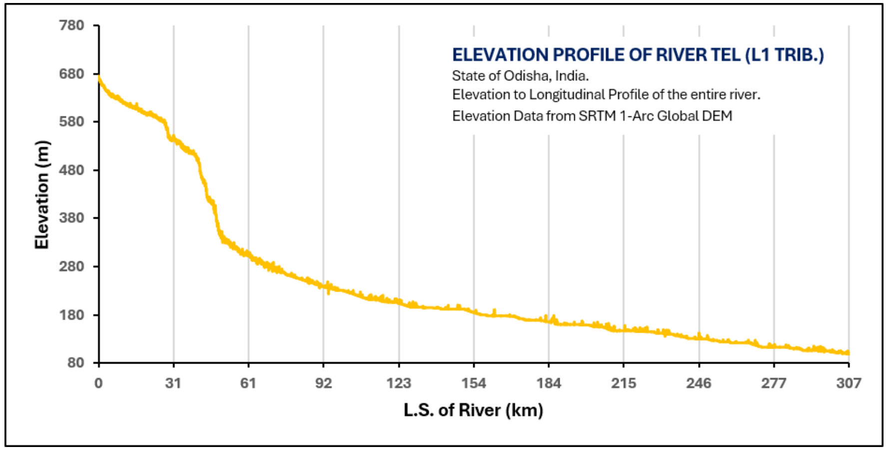
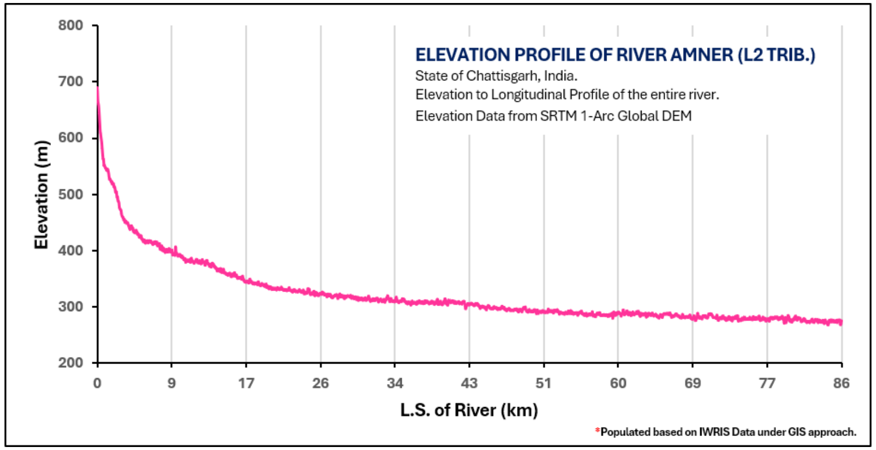
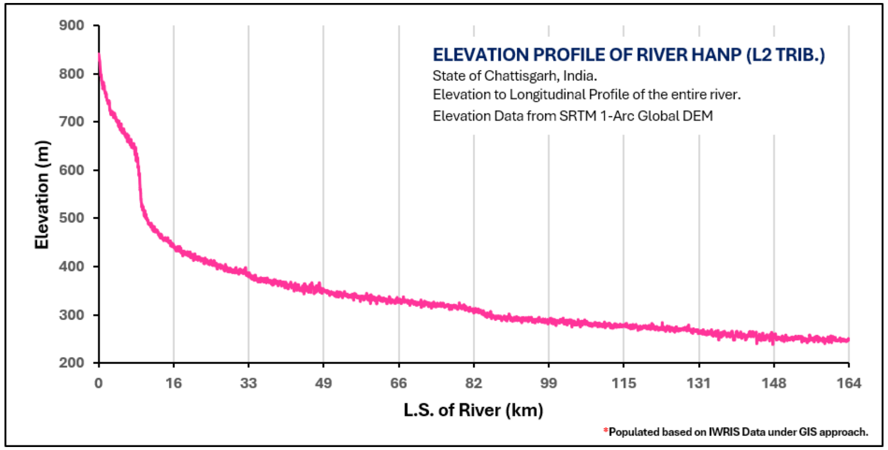


Figure 8: Elevation to Longitudinal Section of Major Tributaries (L2) Inside Mahanadi River Basin

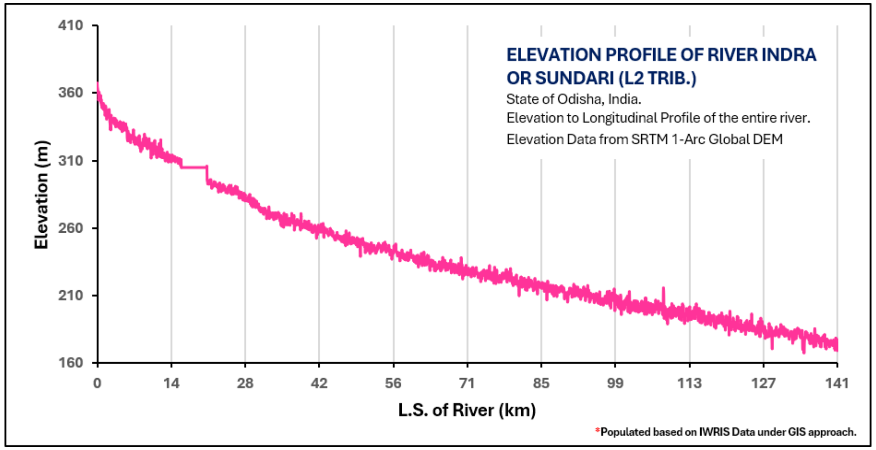
River Name: Amner **Administrative Extent:** State of Chhattisgarh



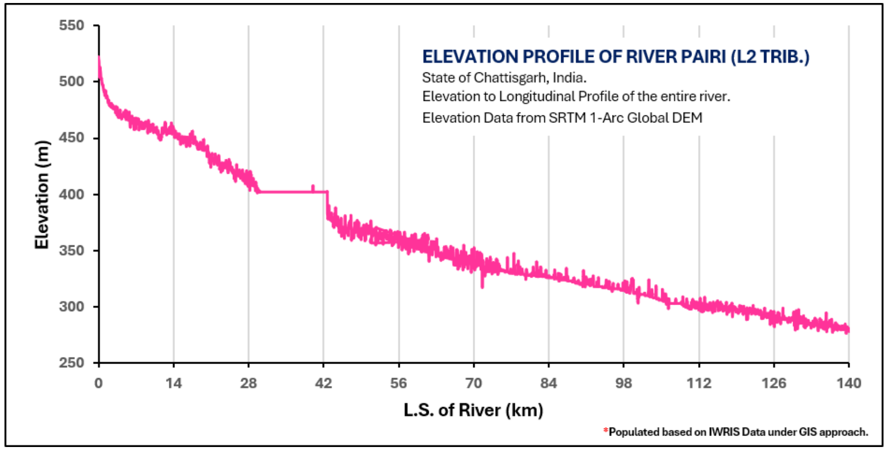
River Name: Hanp **Administrative Extent:** State of Chhattisgarh



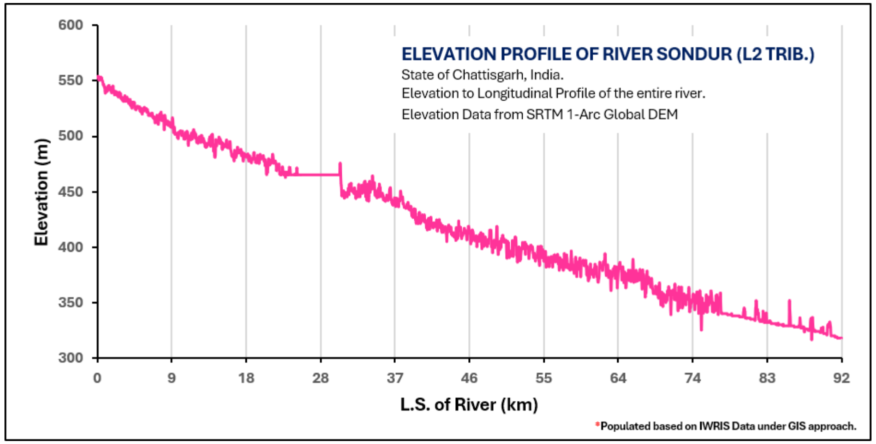
River Name: Indra or Sundari **Administrative Extent:** State of Odisha



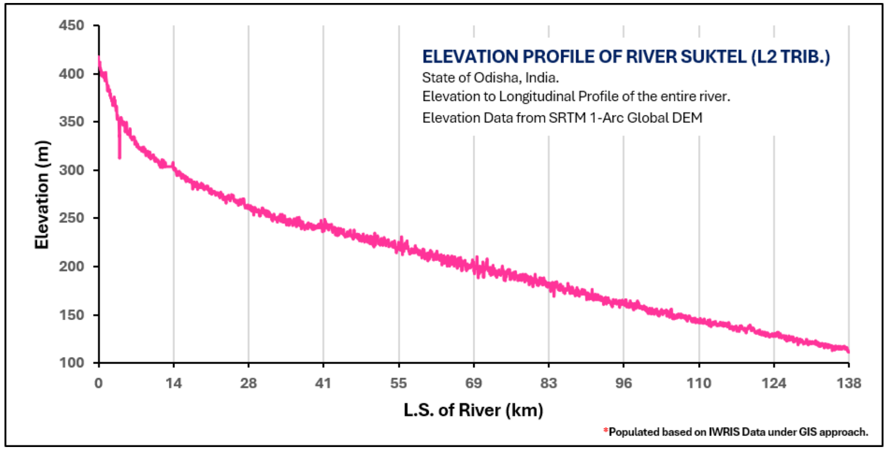
River Name: Pairi **Administrative Extent:** State of Chhattisgarh



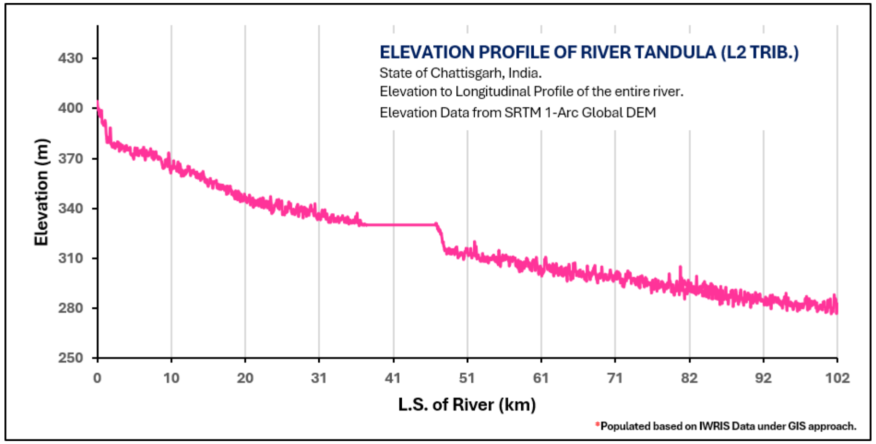
River Name: Sondur **Administrative Extent:** State of Chhattisgarh



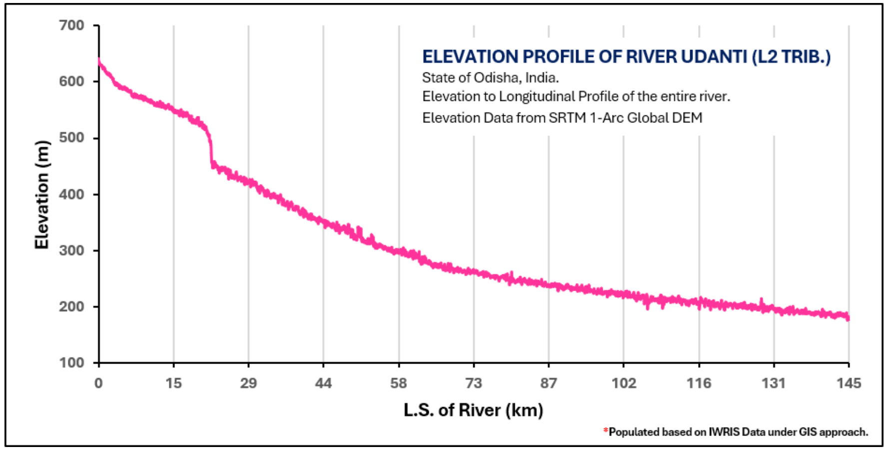
River Name: Suktel **Administrative Extent**: State of Odisha



River Name: Tandula **Administrative Extent:** State of Chhattisgarh



River Name: Udanti **Administrative Extent:** State of Odisha



Understanding River Dynamics
The longitudinal section encapsulates essential river dynamics, encompassing gradient, channel depth, and morphological changes. The slope of the river, inferred from this section, governs the velocity of flow and sediment transport processes. Gradual changes in slope can indicate sediment deposition zones, while steeper sections may highlight areas prone to erosion. These characteristics are fundamental for modeling flow patterns, sediment transport, and predicting responses to natural and anthropogenic changes.

Key Role in Hydraulic Models
Hydraulic models, such as HEC-RAS, SWMM, or MIKE 11, utilize longitudinal data to simulate one-dimensional and two-dimensional flow behaviour. The data serve as a baseline for determining water surface elevations, flow velocities, and flood extents during extreme events. The accuracy of these models depends on the precision of input data, including the longitudinal section.
The longitudinal profile ensures realistic representation of:

- Energy gradients for flow computation.
- Boundary conditions for model calibration.
- Identification of critical sections prone to hydraulic jumps or backwater effects.

Flood Risk Assessment
Flood modeling relies heavily on longitudinal sections to delineate inundation zones. The integration of high-resolution longitudinal profiles allows for:

- Identification of low-lying areas vulnerable to flooding.
- Predictive analysis of flood propagation during storm events.
- Assessment of impacts due to structural interventions like levees or dams.

2.3 Infrastructure

The Mahanadi River Basin is extensively developed with a network of hydraulic infrastructure, playing a crucial role in water resource management and regional development. The Basin has witnessed the construction of several significant infrastructure projects to harness its water resources (Figure 9).

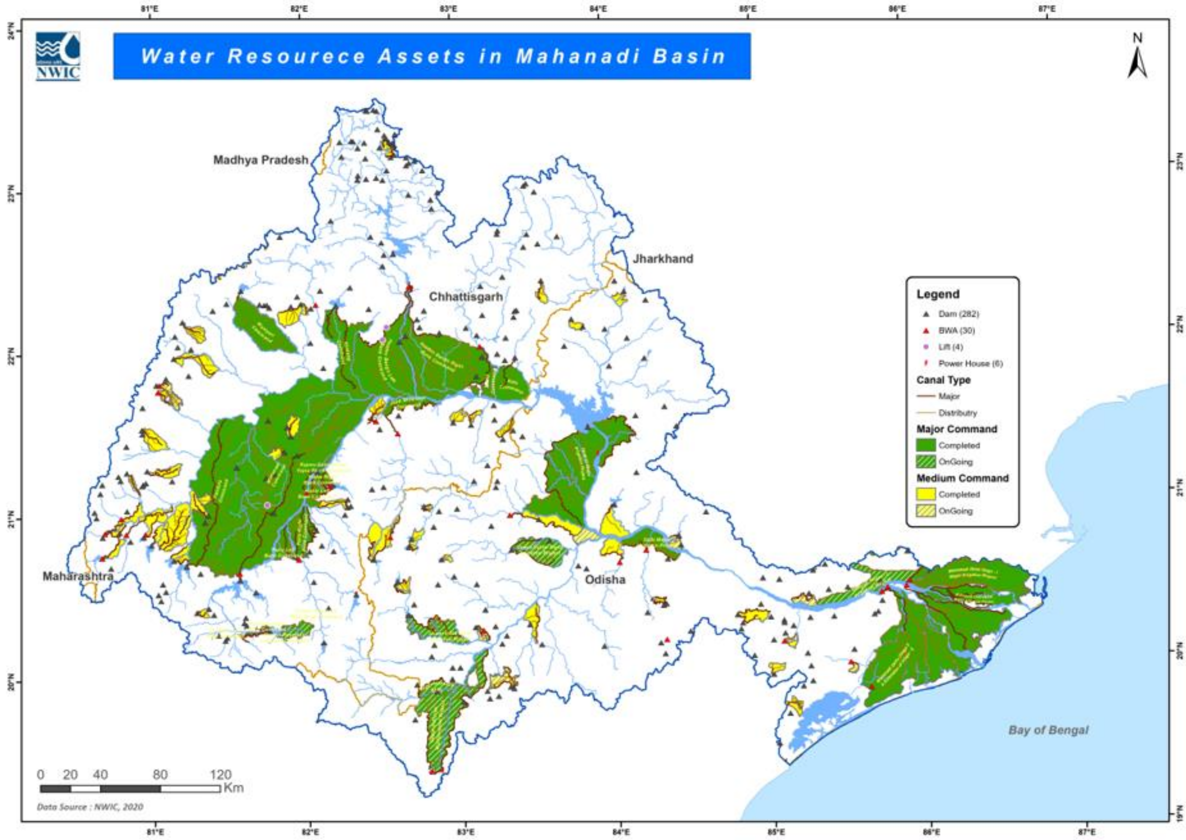


Figure 9: Major Infrastructure of the Mahanadi River Basin *(Source: NWIC, 2020)*

A comprehensive overview of the major hydraulic infrastructure Dam in the Mahanadi River Basin is provided in Table 7. The locations of dams within the upper, middle, and lower sub-basins are illustrated in Figures 10 and 11. The basin features an estimated 282 dams of varying sizes, ranging from approximately 10-15 major dam, serving multiple purposes such as flood control, irrigation, and hydropower generation. Notable structures include the Hirakud Dam located in Odisha, one of Asia's largest earthen dams, which provides irrigation, flood control, and hydroelectric power. The Hasdeo Bango Dam, a significant landmark in Chhattisgarh, provides irrigation to agricultural lands, generates hydroelectric power, and supplies water to industries and urban areas. The MRB encompasses several dozen medium and more than 200 minor irrigation projects.

These dams are often associated with powerhouses that generate electricity, contributing significantly to the region's energy supply. Key powerhouses include those at the Hirakud Dam (with an installed capacity of 347.5 MW) and the Hasdeo Bango Dam (120 MW). While precise figures for all powerhouses, especially those associated with smaller projects, are difficult to ascertain, the presence of these facilities underscores the basin's importance for hydropower generation. The location of major powerhouses is illustrated in Figure 9.

Table 7: Hydraulic Infrastructure (Dams) in Mahanadi River Basin.

Structure	Lat.	Long.	City	District	State	River	Length	Height	Vol.
Upper Mahanadi Sub Basin									
Belhari Dam	21.86	81.09	Kawardha	Kabeerdham	CG	Local	400	15.64	
Bhagwantola Dam	20.69	80.72	Raj Nandgaon	Rajnandgaon	CG	Local	411	11.71	14.44
Bhoramdeo Dam	22.12	81.15	Kawardha	Kabeerdham	CG	Local	570	11.24	
Bhortola Dam	20.59	81.06	Durg	Durg	CG	Local	780	15.3	
Chaker Dam	22.04	81.26	Kawardha	Kabeerdham	CG	Local	900	12.65	
Champi Dam	22.39	82.11	Kota	Bilaspur	CG		2160	15.42	335
Chikhali Dam	20.55	81.08	Balod	Durg	CG	Local	975	10.56	
Adpather Dam	21.55	81.88	Raipur	Raipur	CG	Local	1200	13.85	143
Agariya Dam	22.30	81.74	Mungeli	Bilaspur	CG	Local	1080	16.89	204
Amachuwa Dam	22.28	82.05	Kota	Bilaspur	CG	Local	223	11.88	98
Amgaon Dam	20.91	80.78	Raj Nandgaon	Rajnandgaon	CG	Local	630	10.66	
Ayabhandha Dam	20.86	80.85	Raj Nandgaon	Rajnandgaon	CG	Local	495	16.2	67.25
Barat Sagar Dam	22.31	81.71	Mungeli	Bilaspur	CG	Gabda	1600	13.5	125
Paniyajob Dam	21.21	80.67	Dongargarh	Rajnandgaon	CG	Dhardhara	1220	19.46	71.22
Sawatpur Dam	22.29	81.77	Takhatpur	Bilaspur	CG	Local	1080	16.89	110
Torenga Dam	21.24	81.74	Raipur	Raipur	CG	Local	1189	15.09	230
Tulutolia Dam	21.91	82.13	Bilaspur	Bilaspur	CG	Patilha	1187	13.87	
Churiyapat Dam	21.00	80.63	Raj Nandgaon	Rajnandgaon	CG	Local	690	10.8	117
Darritola Dam	20.66	81.31	Balod	Durg	CG	Local	1219	15	384
Deokatta Dam	21.23	80.79	Dongargarh	Rajnandgaon	CG	Local	548	18.42	30.28
Dhanras Dam	22.29	81.92	Kota	Bilaspur	CG	Local	450	11	175
Dhawanpur Dam	22.35	81.96	Mungeli	Bilaspur	CG	Baghaiha Nala	1204	10.1	98
Fulwari Dam	22.30	81.76	Mungeli	Bilaspur	CG	Local	1525	11	83
Gatatola Dam	21.04	80.83	Raj Nandgaon	Rajnandgaon	CG	Local	330	15	14.85
Ghughwa Dam	21.60	81.76	Raipur	Raipur	CG	Local	2317	13.4	371
Gunderdehi Dam	20.97	81.34	Durg	Durg	CG	Local	1351	10.06	
Hathlewa Dam	21.87	81.24	Kawardha	Kabeerdham	CG	Local	1350	15.18	
Khursipar Dam	21.22	80.95	Dongargarh	Rajnandgaon	CG	Terhi Nala	930	10.2	28.46
Kohkatta Dam	21.26	80.77	Dongargarh	Rajnandgaon	CG	Chhipa Nala	823.17	10.06	

Koliyari Dam	20.88	80.67	Raj Nandgaon	Rajnandgaon	CG	Local	1140	12.57	112.79
Kopra Dam	22.07	82.04	Takhatpur	Bilaspur	CG	Local	1680	10.96	113
Kranti Dam	22.27	81.40	Pandaria	Kabeerdham	CG	Local	2040	11.52	82
Malhaniya Dam	22.72	81.85	Pendra Road	Bilaspur	CG		2700	21.8	677
Manki Dam	21.21	80.94	Dongargarh	Rajnandgaon	CG	Local	2010	9.75	106.33
Masooljob Dam	21.04	80.62	Raj Nandgaon	Rajnandgaon	CG	Jhariya	1050	11.17	102.22
Purena Dam	21.20	80.93	Dongargarh	Rajnandgaon	CG	Local	1800	9.27	107.87
Rochand Dam	22.05	81.17	Kawardha	Kabeerdham	CG	Jamjhori Nala	1330	16.6	
Saila Dam	22.40	82.31	Katghora	Korba	CG	Local	1500	11.96	265
Salap Dam	21.31	81.55	Durg	Durg	CG	Kharun River	870	12.2	127
Salihapara Dam	22.27	82.43	Katghora	Korba	CG	Local	960	10.1	64
Udka Dam	22.31	81.49	Pandaria	Kabeerdham	CG	Local	780	12.5	98
Uperwah Dam	21.23	81.13	Raj Nandgaon	Rajnandgaon	CG	Local	1736	10.66	52.37
Usaritola Dam	20.49	81.05	Balod	Durg	CG	Local	870	10.25	
Piparia Subsidiary Dam	21.52	80.93	Chhuikhadan	Rajnandgaon	CG	Nathella nalla	286.6	19.54	
Sutiapat Dam	21.82	81.03	Kawardha	Kabeerdham	CG	silhati	450	30	
Tandula Dam	20.70	81.22	Balod	Durg	CG		4350	21.95	
Maniyari Dam	22.39	81.59	Mungeli	Bilaspur	CG	Maniyari	2095	28.96	1050
Nawagaon Dam	21.44	80.83	Khairagarh	Rajnandgaon	CG	Local	414.6	10.06	
Dhara Dam	21.28	80.83	Dongargarh	Rajnandgaon	CG	Dhara	807	15.26	36.94
Ghongha Dam	22.31	81.98	Kota	Bilaspur	CG	Ghongha	720	17.88	301
Gondli Dam	20.74	81.13	Balod	Durg	CG	Tujra Nalla	1100	28.4	
Khapri Dam	21.02	81.36	Durg	Durg	CG	Local Nalla	2410	11.11	
Kharkhara Dam	20.83	80.99	Balod	Durg	CG	Kharkhara	1463	37.9	
Kharung Dam	22.29	82.21	Kota	Bilaspur	CG	Kharung	495	21.31	1057
Kumhari Dam	21.50	81.91	Raipur	Raipur	CG	Banjari Nalla	2076	11.82	325
Matia Motinalla Dam	20.88	80.94	Raj Nandgaon	Rajnandgaon	CG	Motinalla	1367	18.53	
Pindrawan Dam	21.40	81.86	Raipur	Raipur	CG	Kulhan Nalla	2012	10.82	
Piparia Dam	21.54	80.93	Chhuikhadan	Rajnandgaon	CG	Pipariya nalla	1953	21	
Ruse Dam	21.29	80.96	Khairagarh	Rajnandgaon	CG	Baitha Nalla	2660	11.5	91.77
Saroda Dam	21.98	81.14	Kawardha	Kabeerdham	CG	Uttari	469	36.61	
Chhirpani Dam	22.20	81.20	Kawardha	Kabeerdham	CG	Phonk Nalla	450	31.64	
Bordi Dam	20.53	81.03	Balod	Durg	CG				
Kurud	21.26	81.79	Raipur	Raipur	CG	local	1981	10.21	
Mudiyan Tank	21.15	80.65	Sambalpur	Rajnandgaon	CG	Local nalla	823	12.65	30.86
Surhi	21.68	80.93	Rajnandgaon	Rajnandgaon	CG	Local	2166	21.03	

Middle Mahanadi Sub Basin									
Charcha Dam	23.34	82.55	Baikunthpur	Koriya	CG	Local	429	17.56	118
Charpara Dam	23.22	82.62	Baikunthpur	Koriya	CG	Nakti Nadi	570	19.16	286
Chhuwari Pali Dam	21.67	83.24	Sarangarh	Raigarh	CG	Local	579	12.8	135
Amakhokhra Dam	22.53	82.53	Katghora	Korba	CG	Local	744	10.8	57
Amakoni Dam	21.01	82.25	Mahasamund	Mahasamund	CG		1200	10.9	
Auramimunda Dam	22.20	83.38	Gharghoda	Raigarh	CG	Local	1080	11.44	204
Badesathi Dam	23.06	82.54	Manendragarh	Koriya	CG	Local Nalla	450	17	177
Badra Dam	23.49	82.43	Baikunthpur	Koriya	CG	Soi Nala	288	20.58	164
Badrika Ashram Dam	23.18	82.75	Surajpur	Surguja	CG	Local	690	10.5	111
Banjaridand Dam	23.20	82.43	Manendragarh	Koriya	CG	Kudra Nala	780	17.92	344
Bardar Dam	23.07	82.37	Manendragarh	Koriya	CG	Local Nalla	810	18.3	367
Barkela Dam	23.21	82.27	Manendragarh	Koriya	CG	Local Nalla	610	17.56	142
Barpara Dam	23.20	82.60	Baikunthpur	Koriya	CG	Gorindhodhi	840	12.4	184
Belbehra Dam	23.30	82.26	Manendragarh	Koriya	CG	Local Nalla	1035	14.16	289
Palachur Dam	20.28	81.42	Kanker	Uttar Bastar Kanker	CG	Local	933	14.63	151
Pandridand Dam	22.94	82.85	Ambikapur	Surguja	CG	Nakti Nala	930	16.2	181
Parasrampur Dam	23.12	82.80	Surajpur	Surguja	CG	Garasili	1260	20.7	1500
Pelam Dam	22.10	83.14	Dharmjaygarh	Raigarh	CG		820	11.5	157
Piperchedi Dam	20.79	82.18	Bindra Nawagarh	Raipur	CG	Ghutiya Nala	2103	15.18	422.27
Silphoda Dam	23.27	82.61	Baikunthpur	Koriya	CG	Silphorwa Nala	645	15.9	227
Singhora Dam	21.30	83.19	Seraipali	Mahasamund	CG	Local	600	12.15	
Salkha Dam	22.72	83.29	Dharmjaygarh	Raigarh	CG	Local	750	12.5	167
Sardih Dam	22.97	83.54	Bagicha	Jashpur	CG	Local	540	19	266
Sawla Dam	23.08	82.50	Manendragarh	Koriya	CG	Local	990	15.3	324
Shivepur Dam	23.16	82.71	Surajpur	Surguja	CG	Local	600	10	88
Nagoi Dam	22.14	83.07	Kharsia	Raigarh	CG	Local	810	18.5	380
Nawkerra Dam	22.71	83.48	Sitapur	Surguja	CG	Local	518	18.89	97
Sistringa Dam	22.45	83.32	Dharmjaygarh	Raigarh	CG	Local	750	12.5	167
Sonhat Dam	23.49	82.51	Baikunthpur	Koriya	CG	Local	230	15.6	81
Sonpur Dam	20.35	81.59	Kanker	Uttar Bastar Kanker	CG	Local	792	10.4	93
Thakurdiya Dam	21.18	82.51	Mahasamund	Mahasamund	CG	Saragi Nalla	982.98	10.21	
Tamdand Dam	23.07	82.43	Manendragarh	Koriya	CG	Local	425	17	170
Tamta Dam	22.65	83.55	Pathalgaon	Jashpur	CG	Kurmeth Nala	793	14.45	232
Thelka Dam	21.03	81.79	Raipur	Raipur	CG	Local	701.28	10.97	
Toulidih Dam	21.61	82.62	Kasdol	Raipur	CG	Tundri	300	11.11	

Tumdih Dam	22.08	83.33	Gharghoda	Raigarh	CG	Kosam Nala	1200	19	593
Dandgaon Dam	22.88	82.86	Ambikapur	Surguja	CG	Local	1410	17.12	117
Deogaon Dam	21.16	82.43	Mahasamund	Mahasamund	CG	Local	1494	11.43	
Deoripali Dam	22.12	82.89	Sakti	Janjgir-Champa	CG	Local	570	11.7	44
Ganeshpur Dam	23.12	82.57	Manendragarh	Koriya	CG	Local	405	19	348
Ganiyari Dam	20.92	82.07	Rajim	Raipur	CG	Local	1871	13.3	307
Ghatoi Dam	21.85	83.13	Sakti	Janjgir-Champa	CG	Ghatoi Nala	1950	10.15	73
Ghoghra Dam	23.01	83.47	Sitapur	Surguja	CG	Local	347	20.97	198
Ghumarapadar Dam	21.28	82.08	Raipur	Raipur	CG	Mahanadi River	900	20.8	375.36
Gobari Dam	23.29	82.58	Baikunthpur	Koriya	CG	Local	430	16.15	155
Gouri Dam	20.44	81.36	Kanker	Uttar Bastar Kanker	CG	Local	856	14.02	95
Gursia Dam	22.68	82.52	Katghora	Korba	CG	Local	130	17.15	440
Jagatpur Dam	23.29	82.42	Manendragarh	Koriya	CG	Local	180	18.86	191
Junwani Dam	22.25	82.80	Korba	Korba	CG	Local	675	10.5	54
Kanesar Dam	20.82	82.10	Bindra Nawagarh	Raipur	CG	Mura Nala	1097	10.03	140.015
Karakachhar Dam	22.63	83.46	Pathalgaon	Jashpur	CG	Local	660	11.3	244
Katangi Dam	21.58	83.24	Sarangarh	Raigarh	CG	Katang Nala	309	19.5	160
Kathripali Dam	22.24	83.39	Gharghoda	Raigarh	CG	Local	690	12.15	146
Kehra Dam	22.15	82.76	Korba	Korba	CG	Bendo Nala	1320	11.8	300
Khadgawan Dam	23.09	82.37	Manendragarh	Koriya	CG	Local	130	15	78
Khairkheda Dam	20.41	81.39	Kanker	Uttar Bastar Kanker	CG	Local	975	10.3	46
Khallari Dam	21.10	82.27	Mahasamund	Mahasamund	CG	Local	704	10.8	48
Khanda Dam	23.29	82.61	Baikunthpur	Koriya	CG	Local	510	10.3	79
Kokanitarai Dam	21.94	83.32	Raigarh	Raigarh	CG	Local	1500	12.9	356
Kopar Dam	22.40	83.17	Dharmjaygarh	Raigarh	CG	Kopar nala	600	17.2	113
Kosmi Dam	20.44	82.14	Bindra Nawagarh	Raipur	CG	Local	765	11.5	65
Kotarimal Dam	22.24	83.40	Gharghoda	Raigarh	CG	Local	675	11.9	138
Kothari Dam	22.10	82.67	Korba	Korba	CG	Local	660	13	117
Koushalpur Dam	23.20	82.70	Surajpur	Surguja	CG	Satikhara Nala	660	11	116
Kumharta Dam	22.74	83.29	Dharmjaygarh	Raigarh	CG	Sangul Nadi	813	16.4	303
Kunkuna Dam	22.60	82.54	Katghora	Korba	CG	Local	720	12.1	303
Kusmaha Dam	23.37	82.51	Baikunthpur	Koriya	CG	Local	580	15.34	190
Lai Dam	23.30	82.33	Manendragarh	Koriya	CG	Local	518	16.5	374
Lohakhan - I Dam	21.96	83.17	Kharsia	Raigarh	CG	Dantar Nala	420	15.5	140
Maharajpur Dam	23.30	82.35	Manendragarh	Koriya	CG	Jura	518	16.5	195

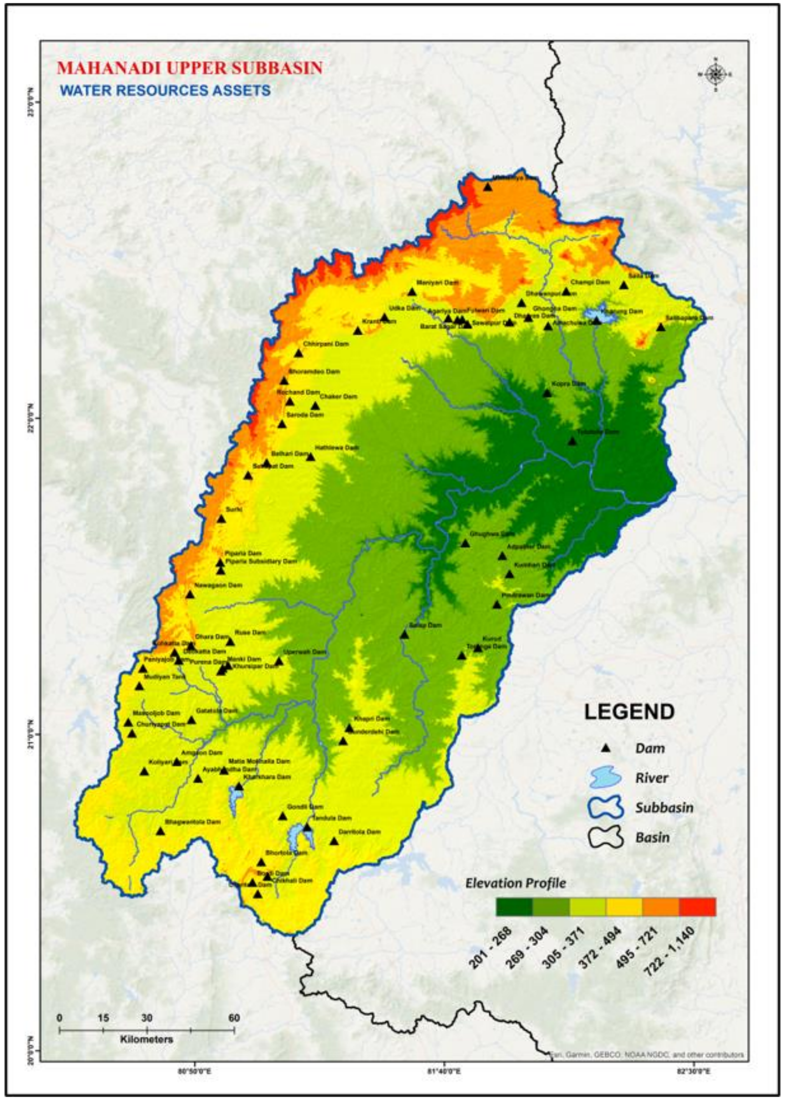
Manikpur Dam	20.34	81.60	Kanker	Uttar Bastar Kanker	CG	Local	734.57	13.41	69
Mankeshwari Dam	20.25	81.47	Kanker	Uttar Bastar Kanker	CG	Local	676	15.23	162
Morga Dam	23.26	82.38	Manendragarh	Koriya	CG	Local	495	21	296
Murma Dam	23.34	82.62	Baikunthpur	Koriya	CG	Local	1035	14.2	293
Murwadand Dam	22.72	82.45	Katghora	Korba	CG	Bhalgur Nala	210	15.9	153
Pv-133 Dam	20.26	81.48	Kanker	Uttar Bastar Kanker	CG	Local	480	16.12	
Rajoli Dam	23.49	82.44	Baikunthpur	Koriya	CG	Local	585	18.76	282
Rajpuri Dam	23.50	82.49	Baikunthpur	Koriya	CG	Ghunghuti ya	1260	15.6	186
Ramanujganj Dam	23.15	82.70	Surajpur	Surguja	CG	Kachhardol i Nala	1390	13.98	100
Rikhi Dam	22.98	82.90	Ambikapur	Surguja	CG	Local	810	14.4	129
Risewada Dam	20.39	81.60	Kanker	Uttar Bastar Kanker	CG	Local	1219	11.64	150
Sadamar Tank	22.82	82.19	Katghora	Korba	CG	Local	610	10.67	138
Sajapani Dam	22.69	83.68	Bagicha	Jashpur	CG	Local	570	13.6	133
Sakarsundari Dam	22.22	83.18	Dharmjaygarh	Raigarh	CG	Local	315	13.13	77
Salihabhata Dam	22.20	82.75	Korba	Korba	CG	Local	690	11.5	56
Saliyadih Dam	23.02	83.49	Sitapur	Surguja	CG	Local	465	15.9	163
Pairi Dam	20.52	82.32	Bindra Nawagarh	Raipur	CG	Pairi	1540.17	31.7	
Ravishankar Sagar Dam	20.62	81.56	Dhamtari	Dhamtari	CG	Mahanadi	1246	31.57	
Ballar Dam	21.53	82.49	Kasdol	Raipur	CG	Balar Nalla	945.12	19.7	
Gej Dam	23.32	82.57	Baikunthpur	Koriya	CG	Gej	4065	27.5	3504
Minimata (Hasdeo) Bango Dam	22.61	82.60	Katghora	Korba	CG	Hasdeo	554.5	87	
Jhumka Dam	23.26	82.52	Baikunthpur	Koriya	CG	Gej	2820	29.8	3365
Kedarnalla Dam	21.56	82.97	Sarangarh	Raigarh	CG	Kedar Nalla	792	20.12	437
Kelo Dam	21.95	83.39	Raigarh	Raigarh	CG	Kelo	2270	24.22	
Keshwa Dam	21.06	82.27	Mahasamund	Mahasamund	CG		475	17	
Khamhar Pakut Dam	22.42	83.57	Gharghoda	Raigarh	CG	Kharung	960	22.15	620
Kinkari Dam	21.46	83.30	Sarangarh	Raigarh	CG	Kinkari Nalla	295.655	17.68	126
Kodar Dam	21.20	82.18	Mahasamund	Mahasamund	CG	Kodar Nalla	2347	23.32	894.6 26
Maroda Dam	20.60	82.04	Bindra Nawagarh	Raipur	CG	Local Nalla	1410	11.5	110
Mayana Dam	20.42	81.28	Kanker	Uttar Bastar Kanker	CG	Naini Nalla	1310.64	15.32	308
Putka Dam	21.55	83.09	Sarangarh	Raigarh	CG	Putka Nalla	734.57	26.14	611
Sondur Dam	20.23	82.10	Dhamtari	Dhamtari	CG	Sondur	3177	24.26	2065
Dudhawa Dam	20.30	81.75	Kanker	Uttar Bastar Kanker	CG	Mahanadi	2907	26.54	2856
Saraphgarh Dam	22.18	83.76	Sundargarh	Sundargarh	OD	Ichha	319	25.5	236.65
Talasara Dam	22.35	84.12	Sundargarh	Sundargarh	OD	Bandajore nalla	1095	25.82	507.75

Kumbho Dam	21.51	83.36	Bargarh	Bargarh	OD	DharkutaNalla	158.5	18.24	48.22
Masina Dam	22.12	83.98	Sundargarh	Sundargarh	OD		816.86	15.47	22.11
Rungaon Dam	22.29	84.26	Sundargarh	Sundargarh	OD	Sapai	865	14.23	138.26
Diona Dam	20.79	82.02	Bindra Nawagarh	Raipur	CG				
Tilipada Dam	21.51	84.43	Kuchinda	Sambalpur	OD	Dudhia nalla	282.42	18.75	139
Upper Jonk Dam	20.73	82.44	Nuaparha	Nuapada	OD	Jonk	647	33.6	
Banksal Dam	21.63	84.36	Kuchinda	Sambalpur	OD	Banksal nalla	609	14.63	110
Chhatenjore Dam	22.02	83.71	Sundargarh	Sundargarh	OD	Chhatenjore	865	15.15	124.35
Gurlijore Dam	22.06	84.13	Sundargarh	Sundargarh	OD	Gurlijore	593.3	12.19	56.23
Hatianalla M.I.P Dam	21.93	84.24	Jharsuguda	Jharsuguda	OD	Hatia	137.16	15.7	
Murramsilli Dam	20.54	81.67	Dhamtari	Dhamtari	CG	Sillari	2591	27.4	1619
Jharianalla M.I.P	21.89	84.01	Banki	Jharsuguda	OD	jharia nalla	685.8	11.9	
Katanganallah M.I.P	22.41	84.06	Sundergarh	Sundargarh	OD	dudunga nalla	600	14.33	
Bargaonmal M.I.P	22.14	83.84	Sundergarh	Sundargarh	OD	Dungajorenalla	750	15.1	
Nawangaon	21.38	81.94	Raipur	Raipur	CG	Local nalla	1415	10.06	
Hasdeo Barrage	22.07	82.63	Korba	Janjgir Champa	CG	Hasdeo	283.76	17.15	
Bilaspur Tank	21.98	83.27	Sambalpur	Raigarh	CG	Local nalla	122	15.24	40
Raima Tank	22.97	82.71	Surajpur	Surguja	CG	Local nalla	900	13.95	247
Khallari Tank	23.10	82.27	Mahasamund	Mahasamund	CG	Local	704	10.8	48
Kopar Nalla Tank	22.33	83.17	Dharmjaygarh	Raigarh	CG	Kopar Nala	600	17.2	245
Lower Mahanadi Sub Basin									
Hirakud Dam	21.52	83.85	Sambalpur	Sambalpur	OD	Mahanadi	4800	60.96	19330
Dhupkot Dam	19.96	82.70	Bindra Nawagarh	Raipur	CG	Nagal Dih Nadi	1320	11.59	159.13
Kalidaraha Dam	21.20	83.10	Seraipali	Mahasamund	CG	Local	701	14.3	
Lower Indra Dam	20.39	82.66	Nuaparha	Nuapada	OD	Indra	3780	22	
Lower Suktal Dam	20.78	83.34	Balangir	Balangir	OD		1410	30	
Badabandha Dam	20.09	85.24	Nayagarh	Nayagarh	OD	Karanjinalla	1006	15.22	216.29
Pilasalki Dam	20.42	84.34	Khondmals	Kandhamal	OD	Salki	441	26.5	633
Ret Dam	19.94	83.31	Bhawanipatna	Kalahandi	OD	Ret	880	36.4	
Upper Suktel Dam	20.73	82.88	Patnagarh	Balangir	OD	Suktel	1573	21.66	546
Hadua Dam	20.46	85.26	Athagarh	Cuttack	OD	Hadua	366	42.8	
Manjhor Dam	20.83	84.43	Athamallik	Anugul	OD	Manjhor	2090	28	
Kuanria Dam	20.34	84.80	Nayagarh	Nayagarh	OD	Kuanria	1576	21	730
Jharbandha Dam	21.05	82.77	Padmapur	Bargarh	OD	Kukri Jhore Nalla	97.8	19.8	10.505
Budhabudiani Dam	19.97	85.02	Nayagarh	Nayagarh	OD	Budhabudiani	1341	24.39	435

Hariharjore Dam	21.04	84.02	Sonapur	Subarnapur	OD	Hariharjore	2260	18.5	
Dumerbahal Dam	20.85	82.69	Titlagarh	Balangir	OD	Ong	380	21.75	65.09
Baghjharan Dam	20.57	82.85	Patnagarh	Balangir	OD		1524	13.31	65
Balaskumpa Dam	20.41	84.32	Khondmals	Kandhamal	OD	Tributary of Pilasalki	421	17.96	
Sundar(Od) Dam	20.60	82.59	Nuaparha	Nuapada	OD	Sunder	2700	19.76	
Kangani Dam	20.37	84.21	Khondmals	Kandhamal	OD	Kangani nalla	281.5	21.74	
Kantesir Dam	20.20	83.26	Bhawanipatna	Kalahandi	OD	Kantesir nalla	1074	12.46	61.65
Karada Dam	20.47	85.39	Athagarh	Cuttack	OD	Dobhani nalla	380	19.94	
Karanjkote Dam	20.06	82.94	Dharamgarh	Kalahandi	OD	Karanjkote nalla	365.4	21.57	82.4
Khajuria Dam	20.31	85.42	Banki	Cuttack	OD	Khajuria nalla	670.5	17.73	123
Khandijharan Dam	20.93	82.83	Padmapur	Bargarh	OD	Khandijhar an	1310.64	17.03	219.52
Khasbahal Dam	20.20	82.82	Nuaparha	Nuapada	OD	Artatrana nalla	1075	23	128
Kodabhal Dam	19.99	82.93	Dharamgarh	Kalahandi	OD	Kodabahal nalla	210.35	21.52	201.16
Koska Dam	20.32	85.01	Nayagarh	Nayagarh	OD	Bandha pathar	322.9	16.74	274.8
Kusunpur Dam	20.51	85.73	Athagarh	Cuttack	OD		892.1	16.13	36.7
Laigam Dam	20.70	84.35	Bauda	Baudh	OD	Gouduni nalla	579.27	14.33	
Lakhaparbat Dam	20.65	83.82	Bauda	Baudh	OD	Mehurani	1495	11.14	160.14
Laupal Dam	20.78	84.44	Athamallik	Anugul	OD	Laupal	1170.5	10.5	130
Liar Dam	20.13	82.80	Nuaparha	Nuapada	OD	Baranjore nalla	533.4	16.66	177
Magara Dam	21.02	82.87	Padmapur	Bargarh	OD	Magaranall a	831	19.78	
Maharanisaga r Dam	19.54	85.04	Chatrapur	Ganjam	OD	Maharani sagar n.	780	10.65	107.6
Mahisanalla Dam	20.25	84.82	Nayagarh	Nayagarh	OD	Mahisanall a	914.65	12.2	156.16
Malakangiri Dam	19.92	82.83	Dharamgarh	Kalahandi	OD		122.5	16.7	46.29
Mathan Pal Dam	20.31	83.22	Titlagarh	Balangir	OD	Konda	1454	15.24	2260
Padampur Dam	21.03	82.99	Padmapur	Bargarh	OD	Padampur nalla	1828.8	14.17	4.87
Paitagam Dam	20.25	84.49	Baligurha	Kandhamal	OD	Paitagaon nalla	568	22.7	270.1
Panaskhal Dam	20.09	84.90	Nayagarh	Nayagarh	OD	Panaskhal nalla	915	14.32	122.7
Parhal Dam	20.67	83.77	Bauda	Baudh	OD	Parhal nalla	530	16	177.12
Pipal Dam	19.88	83.23	Bhawanipatna	Kalahandi	OD	Tel	480	23.57	253
Pujiladu Dam	20.19	83.52	Bhawanipatna	Kalahandi	OD	Pujiladu nalla	823	21.04	94
Randa Dam	19.92	85.27	Khordha	Khordha	OD	Kusumi	1098	16.7	247.96
Saipala Dam	20.80	82.66	Patnagarh	Balangir	OD	Trb to Ong	330	20.12	203.76
Deras Dam	20.31	85.69	Bhubaneshwar	Khordha	OD				

Goibali Dam	20.17	83.92	Baligurha	Kandhamal	OD				
Haripur Dam	20.69	85.92	Cuttack	Cuttack	OD				
Kiajhar Dam	20.30	85.10	Nayagarh	Nayagarh	OD				
Pani-Pailla Dam	20.22	85.10	Nayagarh	Nayagarh	OD				
Sunamuhin Dam	20.26	85.16	Nayagarh	Nayagarh	OD				
Sapua (Medium) Dam	20.60	85.30	Hindola	Dhenkanal	OD	Sapua nalla	1290	25.56	
Suhagi Dam	20.56	84.97	Athagarh	Cuttack	OD	Suhagi Nalla	2270.55	21.34	687.13
Talkhol Dam	21.20	83.25	Padmapur	Bargarh	OD	Sanjo nalla	573	19.75	154.5
Tangarakana Dam	19.91	83.16	Bhawanipatna	Kalahandi	OD	Vamsadhar a	570	21.74	156.05
Tikarpada Dam	19.87	83.17	Bhawanipatna	Kalahandi	OD	Sagada	373	15.2	120
Upper Lanth Dam	20.62	82.96	Patnagarh	Balangir	OD	Lant Nalla	495	23.5	
Behera Dam	19.75	82.69	Dharamgarh	Kalahandi	OD	Behera Nalla	111		29.5
Benikpur Dam	20.32	83.44	Bhawanipatna	Kalahandi	OD	Uttei	306.5		80.5
Bhatrajore Dam	19.85	83.00	Dharamgarh	Kalahandi	OD	Bhatrajore	670.6	12.19	150
Bhetabar Dam	20.01	85.26	Nayagarh	Nayagarh	OD	Kankadajha r	1402	16.16	295.92
Debijharan Dam	19.72	85.12	Chatrapur	Ganjam	OD	Debijharan nalla	399.4	17.99	84.5
Deojharan Dam	21.23	84.16	Sambalpur	Sambalpur	OD	D. Nalla	478.53	14.21	168.22
Dhulipaunsia Dam	20.18	85.03	Nayagarh	Nayagarh	OD	Dhu'sia Nalla	573	10.97	60.78
Domkutch Dam	20.55	85.08	Athagarh	Cuttack	OD	Beherasahi Nalla	354	24.5	
Gaikhai(Mino r) Dam	20.96	83.52	Balangir	Balangir	OD	Gaikhai nalla	670	15.84	140.81
Gayapathar Dam	20.31	85.27	Nayagarh	Nayagarh	OD	Gayapathar nalla	1328	12.2	163.27
Ghagara Dam	20.40	84.95	Nayagarh	Nayagarh	OD	Ghagara nalla	707.32	14.89	205.05
Haguri Dam	20.29	84.83	Nayagarh	Nayagarh	OD	Haguri Nalla	738	12.8	210.72
Jaigarh Dam	20.98	84.61	Athamallik	Anugul	OD	Jaigarh nalla	146.88	19.31	112
Jamboonala Dam	20.83	83.58	Balangir	Balangir	OD	Jamboonall a	365.76	15.24	137.56
Jamuna Bundha Dam	20.49	85.52	Athagarh	Cuttack	OD	Gadagadi nalla			214.37
Jhumuka Dam	20.33	85.71	Bhubaneshwar	Khordha	OD	Jhumukana lla	402.34	20.68	124.6
Kalijodi Dam	20.63	85.37	Hindola	Dhenkanal	OD	Kalijodi nalla	290	18.5	92.18
Titilagarh(Sta ge- Ii) Dam	20.30	83.09	Titlagarh	Bolangir	OD	Kankadjhor e nallah	2500	14	
Hanumantia (Khurda)	20.10	85.54	Khordha	Khordha	OD	hanumanti a	853	17.23	141
Ashok Nalla	19.89	85.21	Banpur	Khordha	OD	Ashoknalla	580	22.08	279.05
Sankundeswa r	21.58	84.17	Sambalpur	Sambalpur	OD	Sealjore	280.42	15.466	

Dumerbahal Mip	20.41	83.16	Titilagarh	Balangir	OD	dumarbahal nalla	1385	21.75	65.09
Pendrawan	20.45	82.69	Khariar	Balangir	OD	Katparo	443	16	143
Modanalla M.I.P	20.28	85.10	Khandapada	Nayagarh	OD	modanalla	412.5	17.68	
Kalanaju M.I.P	20.11	84.32	G.Udayagiri	Kandhamal	OD	Local nalla	189	19.81	
Karkata M.I.P	19.93	83.33	Bhawanipatna	Kalahandi	OD	KARKATA	520	17.35	
Ghatapada M.I.P	20.25	83.29	Kesinga	Kalahandi	OD	giderjore	721	13.19	
Kumarkhunti M.I.P	20.55	84.75	Chandaka	Khordha	OD	keonjharnalla	921.97	13.25	
Ostali M.I.P	20.57	83.10	Patnagarh	Balangir	OD	ostali nalla	1067	11	
Kuliarijore M.I.P	21.45	83.42	Bhartli	Bargarh	OD	Local nalla	1345	13.05	
Victoriasagar M.I.P	21.16	83.24	Padampur	Bargarh	OD	badhaghat nalla	145	11.65	
Chahaka M.I.P	20.06	82.99	Bhawanipatna	Kalahandi	OD	Mod Nadi	930	17.1	
Malkennalla M.I.P	20.92	83.21	Padampur	Bargarh	OD	malken nalla	1530		
Burbinaju Mip	20.18	84.29	Tikabali	Kandhamal	OD	salki	366	18.36	



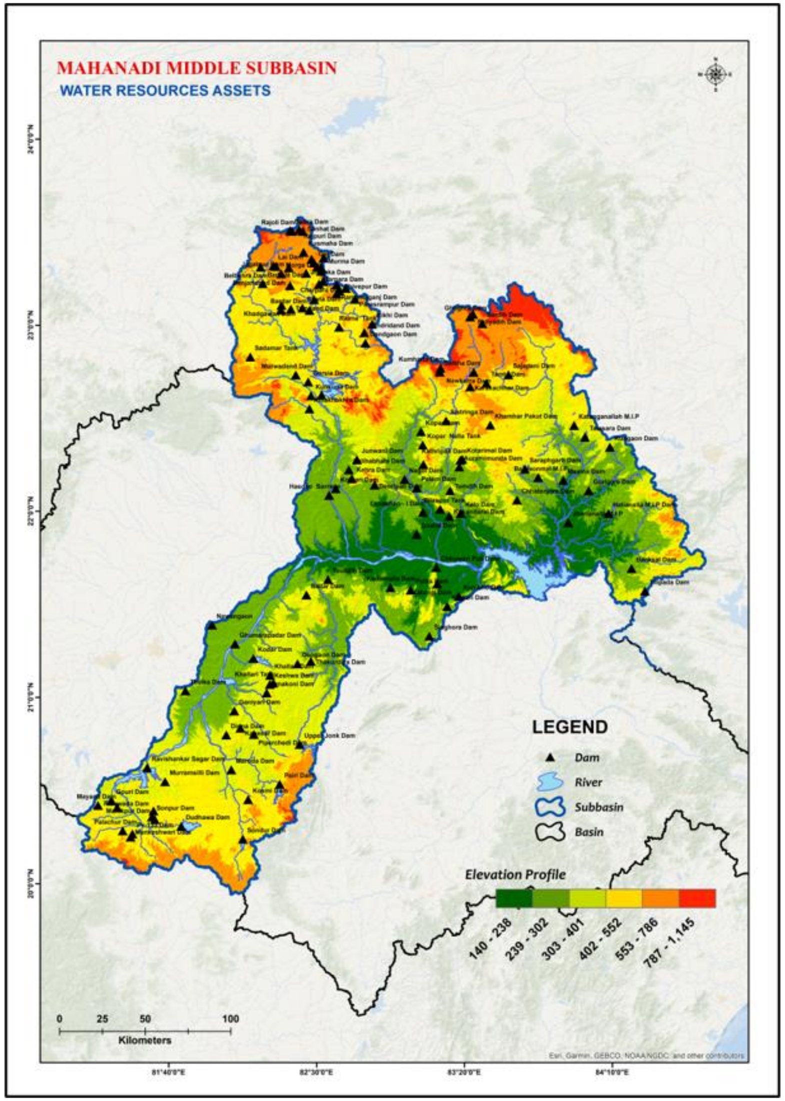


Figure 10: Water Resources Assets (Dams) inside Upper (L) & Middle (R) Mahanadi River Basin.

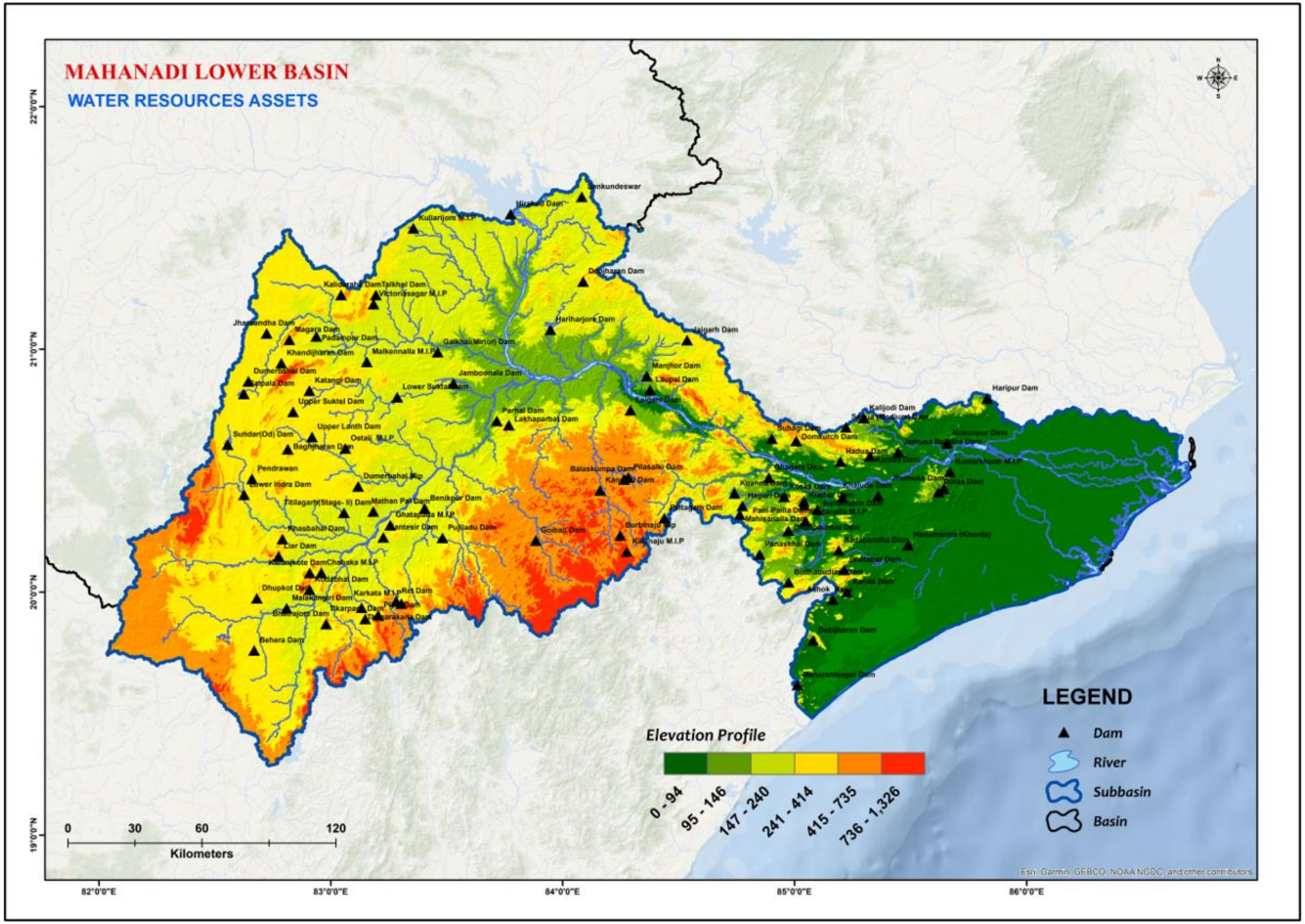


Figure 11: Water Resources Assets (Dams) inside Lower Mahanadi River Basin.

The Mahanadi River basin is extensively developed with a network of numerous weirs and barrages, constructed to divert or temporarily store water. Table 8 lists these weirs and barrages at the sub-basin level, while their locations are mapped in Figures 12 and 13.

Table 8: Hydraulic Infrastructure (Barrage/Weir/Anicut) in Mahanadi River Basin.

Structure	Lat.	Long.	City	District	State	River	Length	Height
Upper Mahanadi Sub Basin								
Silhati Weir	21.82	81.04		Kabeerdham	CG		0.00	
Matia Motinalla Weir	20.90	80.95	Raj Nandgaon	Rajnandgaon	CG	Motinalla	0.00	
Mongra Barrage	20.76	80.67	Raj Nandgaon	Rajnandgaon	CG	Shivnath	155.00	15.9
Sukha Nalla Barrage	21.00	80.79	Raj Nandgaon	Rajnandgaon	CG		100.70	
Ghumariya Barrage	20.91	80.68	Raj Nandgaon	Rajnandgaon	CG	Ghumariya	96.60	9.5
Karra Nalla Barrage	21.77	81.04	Kawardha	Kabeerdham	CG	Karra Nalla	68.00	18.89
Shivnath Weir	20.90	80.82	Raj Nandgaon	Rajnandgaon	CG	Shivnath	275.00	3.2
Arpa-Bhaisajhar Barrage	22.30	82.08					0.00	
Middle Mahanadi Sub Basin								
New Rudri Weir	20.66	81.56	Dhamtari	Dhamtari	CG	Mahanadi	405.50	
Hasdeo Barrage	22.41	82.70	Katghora	Korba	CG	Hasdeo	283.00	
Pairi Weir	20.74	81.95	Bindra Nawagarh	Raipur	CG	PAIRI	237.13	
Ballar Weir	21.58	82.47	Kasdol	Raipur	CG	Jonk	61.00	4.27
Jonk Weir	21.50	82.61	Kasdol	Raipur	CG	Jonk	134.10	7.7
Kodar Barrage	21.19	82.16	Mahasamund	Mahasamund	CG	Kodar Nalla	807.72	
Mand Weir	22.03	83.16	Kharsia	Raigarh	CG	Mand	365.74	3.87
Rajiv Samoda Barrage	21.15	82.01	Raipur	Raipur	CG		0.00	
Kharkhara Weir	20.87	82.55		Nuapada	OD		0.00	
Lower Mahanadi Sub Basin								
Salki Weir	20.75	84.21	Bauda	Baudh	OD	Salki	140.20	
Birupa Barrage	20.51	85.92	Cuttack	Cuttack	OD	Mahanadi	203.00	
Mahanadi Barrage	20.48	85.90	Cuttack	Cuttack	OD	Mahanadi	1928.00	
Naraj Barrage	20.48	85.78	Cuttack	Cuttack	OD	kathjuri	940.00	6.9
Uttei Weir	20.20	84.33	Baligurha	Kandhamal	OD	Uttai	77.73	
Munduli Barrage	20.45	85.74	Athagarh	Cuttack	OD	Mahanadi	0.00	
Bagh Barrage Phase - I	20.68	84.04	Bauda	Baudh	OD	Bagh	167.00	
Ong Weir	20.99	83.33	Balangir	Balangir	OD	ONG	350.50	
Mangalpur Barrage	19.43	82.79	Dharamgarh	Kalahandi	OD	Hati	113.50	
Dahuka Weir	20.17	85.09	Nayagarh	Nayagarh	OD	Dahuka ,Baghamari	128.00	
Titlagarh Barrage	20.29	83.14	Titlagarh	Balangir	OD	Jamuna jore	90.00	
Gobardhanpur Barrage	19.87	85.65		Puri	OD	Bhargavi	0.00	
Rajua Weir	20.03	85.52		Khordha	OD		0.00	

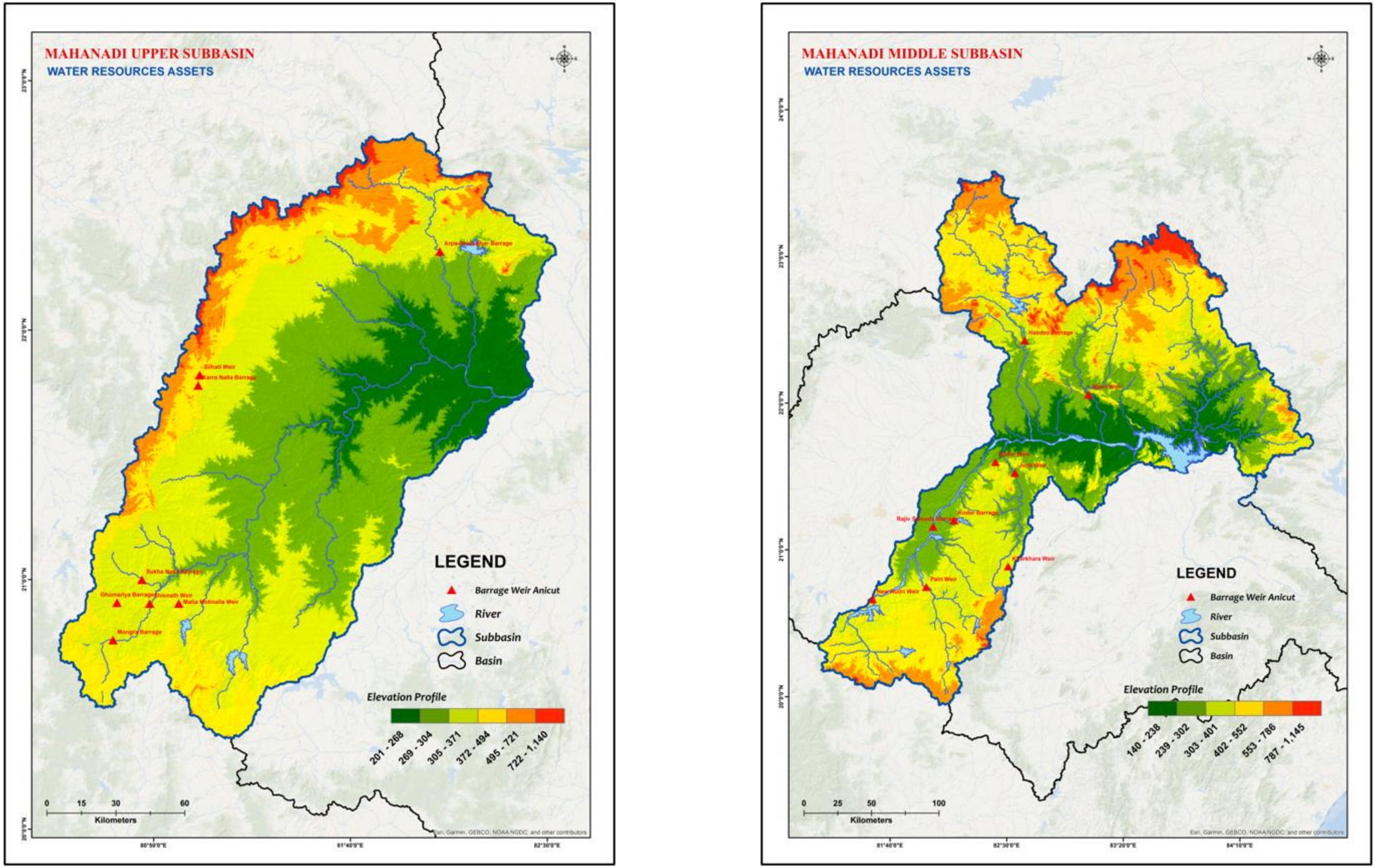


Figure 12: Water Resources Assets (Barrage Weir Anicut) inside Upper (L) & Middle (R) Mahanadi River Basin.

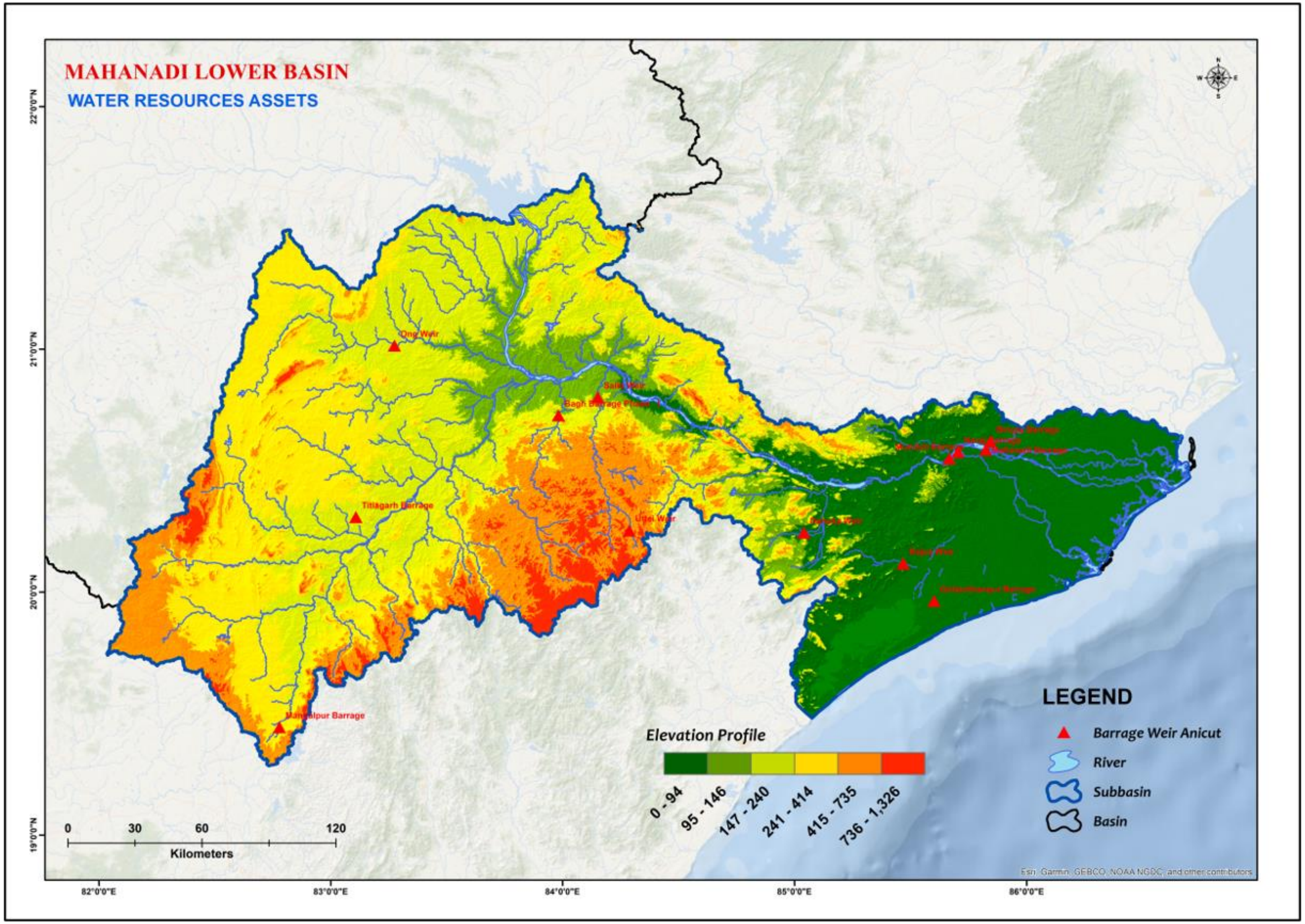


Figure 13: Water Resources Assets (Barrage Weir Anicut) inside Lower Mahanadi River Basin.

The secondary canal dataset, sourced from the India-WRIS (IWRIS) portal, has been systematically structured for hydraulic assessment, categorized under Project Name, Canal Name and Canal Type (Table 9). Projects are classified into Major and Medium Irrigation Projects, while canal types, as defined by IWRIS, include

1. Main Canal,
2. Branch Canal,
3. Distributary,
4. Minor,
5. Sub-Minor,
6. Sub-Sub Minor,
7. Power Channel,
8. Feeder,
9. Approach Canal,
10. Pipe,
11. Other.

These classifications are mapped across the Upper, Middle & Lower Mahanadi River Basin Levels, ensuring spatial consistency in analysis (Figure 14 and 15). The dataset has been reorganized at the sub-basin level, with matrix and chart-based representations enhancing data visualization. A helper column computes the total canal length at both project and basin-wide scales, ensuring a consolidated and interpretable format for engineering analysis and reporting.

Table 9: Mahanadi River Basin Canal System/Network

S. No.	Name of the Project inside the basin	Canal Length (km)
Upper Mahanadi River Basin Canal System/Network		
1	Chirpani Medium Irrigation Project	112.36
2	Dhara Medium Irrigation Project	25.98
3	Ghongha Tank Medium Irrigation Project	103.20
4	Ghumaria Medium Irrigation Project	72.18
5	Gondli Medium Irrigation Project	46.30
6	Hasdeo Bango Major Irrigation Project	331.97
7	Karra Nalla Medium Irrigation Project	33.39
8	Khapri Medium Irrigation Project	45.87
9	Kharang Major Irrigation Project	412.92
10	Kharkhara Medium Irrigation Project	302.46
11	Kumbhari Medium Irrigation Project	26.34
12	Mahanadi Major Irrigation Project	1582.18
13	Maniyari Major Irrigation Project	437.70
14	Maroda Tank Medium Irrigation Project	38.15
15	Matia Motinalla Medium Irrigation Project	60.85
16	Mongra Medium Irrigation Project	27.33
17	Pindrawan Medium Irrigation Project	31.37
18	Piparia Nalla Medium Irrigation project	97.67
19	Ruse Medium Irrigation Project	47.68
20	Saroda Medium Irrigation Project	105.44
21	Shivnath Medium Irrigation project	75.18
22	Sukha Nalla Barrage Medium Irrigation Project	23.54
23	Sutiapat Medium Irrigation Project	62.46
24	Tandula Major Irrigation Project	878.42
25	Unnamed Project/Canal	2.37
Grand Total		**4983.28**

Middle Mahanadi River Basin Canal System/Network		
1	Ballar Medium Irrigation Project	92.98
2	Bogbura Weir	7.50
3	Ganiyari	8.67
4	Gej Medium Irrigation Project	47.02
5	Hasdeo Bango Major Irrigation Project	2423.48
6	Jonk Diversion Major Irrigation project	166.78
7	Kedarnalla Medium Irrigation Project	46.76
8	Kelo	150.02
9	Keshwa Nalla Medium Irrigation Project	33.28
10	Khamhar Pakut Medium Irrigation Project	38.74
11	Kinkari Nalla Medium Irrigation Project	47.96
12	Kodar Major Irrigation Project	261.06
13	Mahanadi Major Irrigation Project	826.70
14	Mand Major Irrigation Project	138.10
15	Mayana Medium Irrigation Project	13.73
16	Pairi Major Irrigation Project	465.51
17	Putka Nalla Medium Irrigation Project	28.43
18	Rajeev Samvardhan Yojna Ph - II Major Irrigation Project	19.98
19	Saraphgarh Medium Irrigation Project	38.66
20	Sondur Reservoir Major Irrigation Project	150.71
21	Talsara Medium Irrigation Project	55.28
22	Upper Jonk Kharkhara, Chhattisgarh	4.09
23	Upper Jonk Medium Irrigation Project	146.84
24	Unnamed Project/Canal	40.88
Grand Total		**5253.13**
Lower Mahanadi River Basin Canal System/Network		
1	Bagh Barrage Medium Irrigation Project	123.77
2	Budhabudhiani Medium Irrigation Project	45.12
3	Dahuka Medium Irrigation Project	40.59
4	Dalak (Hadua) Medium Irrigation Project	44.98
5	Dumerbahal Medium Irrigation Project	50.95
6	Hariharjore Medium Irrigation Project	144.81
7	Hiradharbati Medium Irrigation Project	2.81
8	Hirakud Major Irrigation Project	1020.63
9	Jharabandha Medium Irrigation Project	19.37
10	Katangi Irrigation Project	31.58
11	Kuanria Medium Irrigation Project	57.73
12	Lower Indra (KBK)	258.30
13	Lower Suktel Major Irrigation Project	131.62
14	Mahanadi Chitrotpala Major Irrigation	199.46
15	Mahanadi Delta (Stage II & Extension of Stage - I)	1170.05
16	Mahanadi Delta Stage - I Major Irrigation Project	1241.95
17	Manjhore Medium Irrigation Project	37.12
18	Ong Diversion Weir Irrigation Project	125.63
19	Pillasalki Medium Irrigation Project	59.97

20	Rajua Medium Irrigation Project	25.58
21	Rengali Phase - I Irrigation Project	134.01
22	RET Irrigation	197.95
23	Saipala Medium Irrigation Project	39.98
24	Salia Medium Irrigation Project	76.78
25	Salki Major Irrigation Project	249.79
26	Sapua Badajore Medium Irrigation Project	9.20
27	Sundar Major Irrigation Project	87.51
28	Titilagarh Medium Irrigation Project	45.46
29	Upper Indravati Multipurpose Project	983.65
30	Upper Suktel Medium Irrigation Project	24.46
31	Uttei Medium Irrigation Project	131.22
32	Unnamed Project/Canal	109.26
Grand Total		**6921.28**

These infrastructure projects have played a crucial role in the development of the Mahanadi River Basin. They have provided numerous benefits, including:

- **Irrigation:** These structures have significantly increased agricultural productivity in the region by providing reliable water supply. For example, the Hirakud Dam irrigates over 1.5 million hectares of land in Odisha and Hasdeo Bango Dam irrigate approx half million hectares of land in Chhattisgarh.
- **Hydropower generation:** Dams like Hirakud have contributed to the power generation capacity of the region.
- **Flood control:** Dams and barrages have helped to mitigate the impact of floods, protecting lives and property.
- **Drinking water supply:** Intake wells and canals have ensured the availability of drinking water for millions of people. Canals like the Mahanadi Delta Irrigation Canal provide drinking water to many villages and towns.
- **Industrial development:** Water from the river has been used for industrial purposes, contributing to economic growth. Industries in the region, such as steel and textile, rely on water from the Mahanadi River.

However, these projects have also had some negative impacts:

- **Environmental degradation:** Construction of dams and barrages can lead to habitat loss, alteration of river flows and sedimentation.
- **Social displacement:** Many people have been displaced due to the construction of these projects.
- **Water quality issues:** Pollution from industrial and domestic sources can degrade the water quality of the river.

To mitigate these negative impacts, it is important to adopt sustainable water management practices and to carefully consider the environmental and social consequences of future infrastructure projects

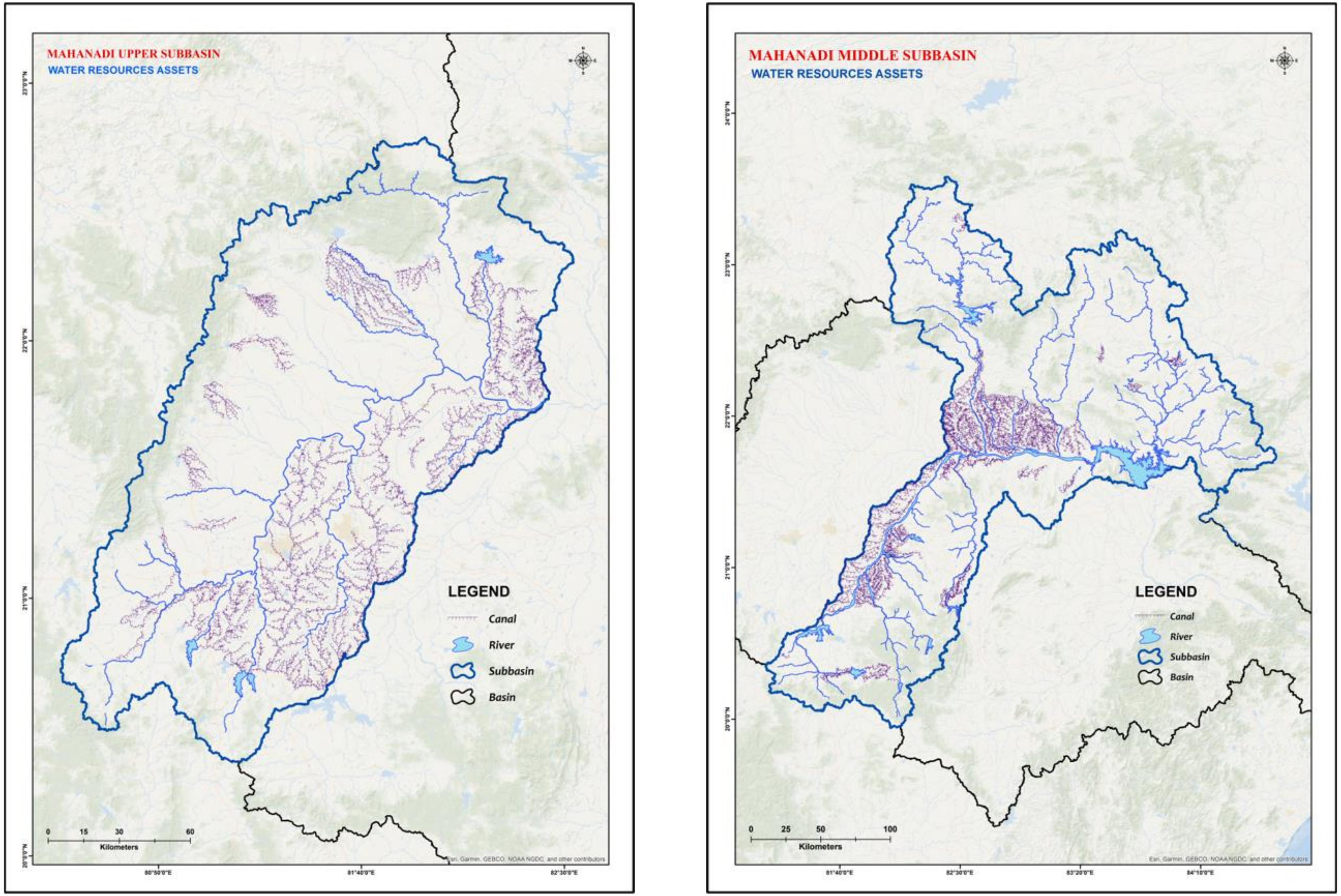


Figure 14: Water Resources Assets (Canal Network) inside Upper (L) & Middle (R) Mahanadi River Basin.

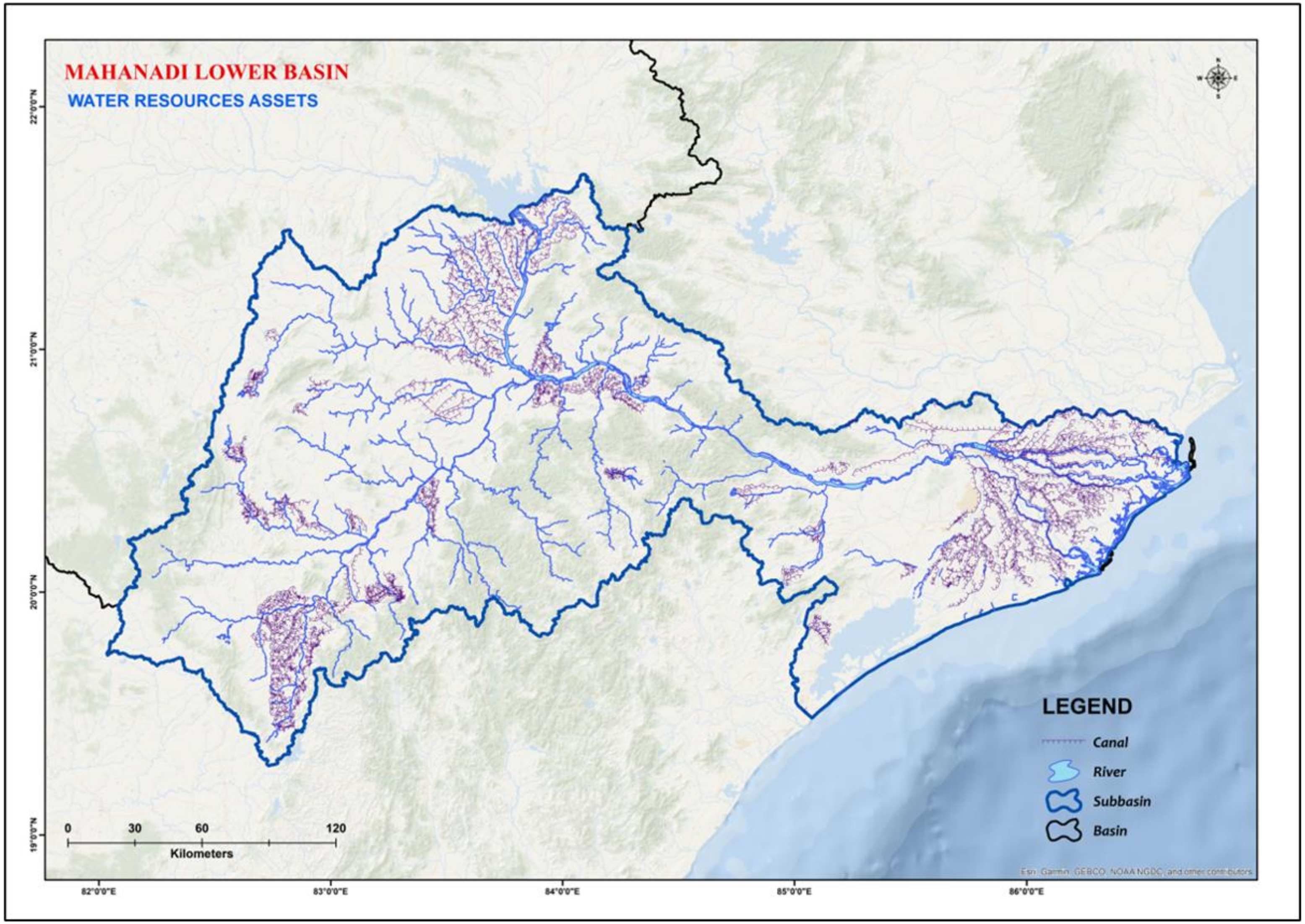


Figure 15: Water Resources Assets (Canal Network) inside Lower Mahanadi River Basin.

2.4 Gauge Discharge

Discharge data, representing the volume of water flowing through a river at a specific point and time, is fundamental to understanding the complex hydrological dynamics of the Mahanadi River basin. The Central Water Commission (CWC) maintains a network of numerous gauge stations throughout the basin, strategically positioned to monitor these crucial hydrological parameters. These stations, strategically positioned along the main stream and key tributaries, collect essential hydrological data, including water level, discharge, and other parameters. It offering valuable insights into the river's flow patterns, seasonal variations, and overall water availability. This information is critical for a range of applications, including water resource management, flood forecasting, irrigation planning, environmental monitoring, ultimately supporting sustainable development, flood forecasting and drought monitoring to long-term assessments of water availability, ecosystem health and the well-being of communities dependent on the Mahanadi River.

Each gauge station along the Mahanadi River plays a vital role in monitoring and understanding the river's complex dynamics, providing crucial data that informs water resource management and reveals the river's profound influence on the surrounding environment and dependent communities. The data collected at each station contributes to a comprehensive picture of the river's behavior, enabling informed decision-making regarding water allocation, irrigation planning, and environmental protection. Furthermore, this information empowers local communities, who often rely directly on the river for their livelihoods, to better adapt to changing river conditions and contribute to sustainable water use practices. By providing a continuous record of the river's flow, these gauge stations serve as invaluable tools for ensuring the long-term health and vitality of the Mahanadi River basin.

Data collected by the Central Water Commission (CWC) at various stations along the main stem of the Mahanadi River and its major tributaries, spanning different time periods, the availability of data is presented in the accompanying Table 10. Overall, the data highlights the Mahanadi basin's monsoon-dominated hydrology, significant inter-annual variability and regional differences in flow patterns. All stations show a strong seasonal pattern. Discharge is highest during the monsoon season (June-September), peaking in July and August. Flow decreases significantly in the post-monsoon and dry seasons (October-May), with minimal or zero flow in some stations during the driest months. This is typical of rivers in monsoon-dominated regions.

Table 10: Details of discharge monitoring stations on the Main stream and Major tributaries of the Mahanadi River (CWC).

Main Stream								
Station Count	**CWC_Site**	**Latitude**	**Longitude**	**Elevation**	**State**	**River**	**Tributary**	**Data Available**
1	Rajim	20.974	81.880	287.0	CG	Mahanadi	-	1971-2019
2	Seorinarayan	21.717	82.597	215.0	CG	Mahanadi	-	1985-2024
3	Basantpur	21.727	82.788	210.0	CG	Mahanadi	-	1971-2020
4	Boudh	20.855	84.317	82.0	OD	Mahanadi	-	1979-2024
5	Tikarapara	20.633	84.619	64.0	OD	Mahanadi	-	1972-2024
Major Tributaries								
Station Count	**CWC_Site**	**Latitude**	**Longitude**	**Elevation**	**State**	**River**	**Tributary**	**Data Available**
1	Manendragarh	23.203	82.218	440.0	CG	Mahanadi	Hasdeo/Hasiya	1989-2020
2	Baronda	20.913	81.886	291.0	CG	Mahanadi	Pairi	1977-2020
3	Kotni	21.236	81.247	273.0	CG	Mahanadi	Seonath	1978-2020
4	Andhiyarkore	21.834	81.606	267.0	CG	Mahanadi	Hanp	1977-2019
5	Ghatora	22.057	82.221	263.0	CG	Mahanadi	Arpa	1979-2020
6	Pathardhi	21.341	81.594	258.0	CG	Mahanadi	Karun	1989-2020
7	Simga	21.632	81.688	255.0	CG	Mahanadi	Seonath	1971-2020
8	Rampur	21.652	82.519	237.0	CG	Mahanadi	Rampur	1971-2021
9	Jondhra	21.725	82.347	234.0	CG	Mahanadi	Seonath	1979-2020
10	Bamnidhi	21.899	82.717	227.0	CG	Mahanadi	Hasdeo	1971-2020
11	Kurubhata	21.988	83.204	222.0	CG	Mahanadi	Mand	1978-2020
12	Sundergarh	22.115	84.011	223.0	OD	Mahanadi	Ib	1979-2022
13	Parmanpur	21.781	84.082	210.0	OD	Mahanadi	Bhedan	2001-2011
14	Kesinga	20.198	83.225	177.0	OD	Mahanadi	Tel	1978-2024
15	Salebhata	20.983	83.539	134.0	OD	Mahanadi	Ong	1971-2020,
16	Kantamal	20.650	83.732	133.0	OD	Mahanadi	Tel	1971-2024

Gauge station installed on the Main channel of the Mahanadi River:

Upstream Stations (Chhattisgarh): Rajim

- **Importance:** Rajim is located relatively upstream in the Mahanadi basin, specifically at the confluence of the Mahanadi, Pairi, and Sondur rivers. This station's lower discharge readings at different times suggest that the river's flow was still in the process of accumulating the full discharge from its tributary network.
- **Livelihood Impact:** The confluence supports agriculture through irrigation, directly impacting a large portion of the population engaged in farming. Fluctuations in river flow, as reflected in station data, directly affect crop yields and thus, agricultural income. The rivers' presence is also crucial for Rajim's religious significance, particularly for the annual Kumbh, which attracts significant tourism. Consistent flow supports the Triveni Sangam's sanctity, drawing pilgrims and boosting the local economy through hospitality, trade, and related services.

Midstream Stations (Chhattisgarh): Seorinarayan, Basantpur

- **Importance:** These stations capture the flow from a larger area and are critical for regional flood forecasting. They provide a better picture of the overall water availability in the middle reaches of the river.
- **Livelihood Impact:** The data from these stations is used for managing irrigation projects, hydropower generation and industrial water supply. They also inform decisions related to fisheries and navigation.

Downstream Stations (Odisha): Boudh, Tikarpara

- **Importance:** These stations measure the accumulated flow of the entire upstream catchment. They are crucial for managing irrigation schemes and for providing flood warnings to densely populated downstream areas. Tikarpara's data will reflect regulated releases from the dam.
- **Livelihood Impact:** The flow at these stations directly impacts large-scale irrigation, hydropower generation, industrial water supply and the livelihoods of millions of people living in the delta region. Flood control and water availability are critical concerns here. Data is used to optimize dam operations for water supply and flood mitigation.

Gauge station installed on the Major tributaries of the Mahanadi River:

Upstream Region (Chhattisgarh): Manendragarh, Kotni, Andhiyarkore.

- **Importance:** These stations provide crucial data on the initial flows of the Mahanadi and its upper tributaries. This information is essential for understanding the river's overall water availability and for managing water resources in the upper catchment. Data from these stations is important for assessing water availability for domestic use, small-scale irrigation, and other local activities.
- **Livelihood Impacts:** Communities rely on rainfall for agriculture, making them vulnerable to variations in monsoon patterns. Fishing in the upper reaches might be for local consumption or small-scale income generation. During dry periods, water availability can be a concern, impacting agriculture and domestic needs.

Middle Region (Chhattisgarh and Transition to Odisha): Ghatora, Simga, Rampur, Pathardhi

- **Impotance** This region includes areas where the Mahanadi receives significant tributaries like the Seonath, Hasdeo, Mand, and Ib. These stations track the increasing flow of the Mahanadi as it receives water from tributaries. The data is crucial for regional water management, planning irrigation projects, and assessing the impact of tributary flows on the main river. The middle reaches often support diverse aquatic habitats. Monitoring these stations helps understand the combined impact of upstream activities and tributary inputs on water quality and ecosystem health.

- **Livelihood Impacts:** Increased water availability supports more irrigated agriculture, with communities relying on the river for crop production. Development of agro-based businesses and related economic activities due to increased agricultural output. Increased water use for irrigation and other purposes can lead to competition and potential conflicts over water resources.

Downstream Region (Odisha): Sundergarh, Kesinga, Salebhata, Kantamal, Jondhra, Bamnidhi, Parmanpur

- **Importance:** This includes the lower reaches of the Mahanadi in Odisha, where it receives the Tel and Ong rivers, and encompasses areas around and the delta region. Highest in the basin, as it carries the accumulated flow from the entire upstream catchment and all major tributaries. These stations measure the accumulated flow of the Mahanadi, reflecting the combined influence of upstream factors and tributary contributions. The data is essential for managing water resources in the lower basin, including irrigation, industrial use, and flood control. Monitoring these stations helps assess the impact of upstream activities on these sensitive ecosystems.
- **Livelihood Impacts:** The fertile delta region supports intensive agriculture, with rice cultivation being a major activity. The delta and coastal areas support large-scale fishing and aquaculture, providing livelihoods for numerous communities. This region often has more industries and urban centers, with the river playing a role in water supply and industrial activities. The delta region is prone to flooding during the monsoon season, posing a risk to lives and livelihoods.

The importance of Discharge Data:

Water Resource Management:

- **Planning and Development:** Discharge data helps in planning and designing irrigation projects, hydropower plants, and water supply schemes. Understanding the river's flow regime over the years allows for efficient water allocation and utilization.
- **Flood Control:** Analysing historical discharge data, especially peak flows, helps in predicting flood events and designing flood control structures like dams, embankments, and channels.
- **Drought Management:** Studying low flow periods and their frequency helps in identifying drought-prone areas and developing strategies for water conservation and distribution during water scarcity.

Environmental Monitoring and Conservation:

- **Ecosystem Health:** Discharge is a key factor influencing the health of aquatic ecosystems. Data on flow variability, water temperature, and sediment transport helps in assessing the river's ecological condition and identifying potential impacts of human activities.

- **Pollution Assessment:** Discharge data is essential for estimating pollutant loads and their transport in the river. This information is crucial for water quality management and pollution control.
- **Climate Change Impact Assessment:** Analyzing long-term discharge trends helps in understanding the impacts of climate change on the river's flow regime, including changes in timing and magnitude of floods and droughts.

Research and Scientific Studies:

- **Hydrological Modeling:** Discharge data is used to calibrate and validate hydrological models, which are essential tools for predicting future flow patterns and assessing the impacts of various factors on the river's hydrology.
- **Sediment Transport Studies:** Understanding the relationship between discharge and sediment transport is crucial for managing river morphology, preventing erosion, and maintaining navigation channels.
- **Water Quality Research:** Discharge data is used in conjunction with water quality data to study the fate and transport of pollutants, nutrient cycling, and other biogeochemical processes in the river.

Socioeconomic Benefits:

- **Agriculture:** Reliable discharge data is essential for supporting agricultural activities, which are heavily dependent on water availability for irrigation.
- **Industry:** Many industries rely on the Mahanadi River for water supply. Discharge data helps in ensuring a sustainable water source for industrial use.
- **Navigation:** Understanding the river's flow regime is important for navigation and transportation, especially in the lower reaches of the river.

The long-term discharge data collected from various sites within the Mahanadi River basin is a valuable resource for water resource management, environmental monitoring, research, and socioeconomic development. By utilizing this data effectively, stakeholders can make informed decisions to ensure the sustainable management and conservation of the Mahanadi River basin for present and future generations.

2.5 Sediment

Sediment data collection in the Mahanadi River basin is crucial for effective planning and management of its water resources. Understanding sediment transport dynamics is essential for several reasons. Excessive sedimentation can reduce the storage capacity of reservoirs, impacting irrigation and hydropower generation. It can also degrade water quality, harming aquatic ecosystems and affecting downstream users. Conversely, a lack of sediment transport can lead to river channel changes, impacting navigation and potentially causing erosion in some areas and deposition in others. Sediment data informs the design and operation of hydraulic structures, helps in predicting reservoir lifespan, and enables the development of strategies for managing erosion and sedimentation. By providing insights into these processes, sediment data plays a vital role in ensuring the long-term sustainability and efficient utilization of the Mahanadi River basin's resources.

Table 11 presents sediment data available (CWC) from various stations within the Mahanadi River basin over different time periods. While the data available offers valuable general information regarding coarse, medium, sand, silt, and fine sediment composition, it also reveals gaps and uncertainties in the data. Specifically, comprehensive details for all sediment parameters are not consistently available across all stations, and some existing data may have limitations or require further validation. This highlights the ongoing need for more consistent and detailed sediment monitoring to improve our understanding of sediment dynamics within the basin.

Table 11: Details of Sediment monitoring stations on the Main stream and Major tributaries of the Mahanadi River (CWC).

Station Count	CWC_Site	Latitude	Longitude	Elevation	State	River	Tributary	Distributary	Data Available
Main River									
1	Rajim	20.974	81.880	287.0	CG	Mahanadi	-	-	1972-2020
2	Seorinarayan	21.717	82.597	215.0	CG	Mahanadi	-	-	2013-2019
3	Basantpur	21.727	82.788	210.0	CG	Mahanadi	-	-	1973-2019
4	Tikarapara	20.633	84.619	64.0	OD	Mahanadi	-	-	1973-2020
Major Tributaries									
1	Manendragarh	23.203	82.218	440.0	CG	Mahanadi	Hasdeo/Hasiya	-	1993-2019
2	Baronda	20.913	81.886	291.0	CG	Mahanadi	Pairi	-	1980-2019
3	Kotni	21.236	81.247	273.0	CG	Mahanadi	Seonath	-	2014-2018
4	Andhiyarkore	21.834	81.606	267.0	CG	Mahanadi	Hanp	-	1980-2018
5	Ghatora	22.057	82.221	263.0	CG	Mahanadi	Arpa	-	2001-2020
6	Simga	21.632	81.688	255.0	CG	Mahanadi	Seonath	-	1972-2020
7	Rampur	21.652	82.519	237.0	CG	Mahanadi	Rampur	-	1976-2018
8	Jondhra	21.725	82.347	234.0	CG	Mahanadi	Seonath	-	1980-2020
9	Bamnidhi	21.899	82.717	227.0	CG	Mahanadi	Hasdeo	-	1973-2020
10	Kurubhata	21.988	83.204	222.0	CG	Mahanadi	Mand	-	1978-2020
11	Sundergarh	22.115	84.011	223.0	OD	Mahanadi	Ib	-	1980-2019
12	Kesinga	20.198	83.225	177.0	OD	Mahanadi	Tel	-	2006-2020
13	Salebhata	20.983	83.539	134.0	OD	Mahanadi	Ong	-	1973-2019
14	Kantamal	20.650	83.732	133.0	OD	Mahanadi	Tel	-	1976-2020

3. Conclusion

The cross-sectional, longitudinal section and infrastructure data compiled from various departments provide a robust foundation for determining key hydraulic parameters of the Mahanadi River Basin. The availability and analysis of the data are fundamental to effective basin management. These data types provide critical insights into the physical characteristics of the river system, enabling informed decision-making across various aspects of basin management.

- **Cross-sectional data** available for 2015-2023 (1972-2012 for reference) which captures the shape and dimensions of the river channel at specific points, is essential for calculating flow area, estimating flow velocity, and understanding channel morphology. This information is crucial for designing hydraulic structures, assessing flood risk, and studying sediment transport.
- **Longitudinal section data**, depicting the elevation profile of the river along its course, helps in understanding the river's gradient, flow patterns, and overall hydrological behaviour. This data is vital for planning water resource infrastructure, managing navigation and assessing the impact of land use changes on river flow.
- **Infrastructure data**, detailing the location, type and operational characteristics of existing structures like dams, weir, barrages, and canals, is crucial for understanding how these structures influence water flow, sediment transport, and overall basin hydrology. This information is essential for optimizing water resource allocation, managing flood risks, and assessing the environmental impacts of infrastructure.
- **Discharge Data:** Discharge data spanning various years, is crucial for effective basin planning and management. This historical data provides a vital understanding of the river's flow regime, including its variability, extremes (floods and droughts) and seasonal patterns.
- **Sediment Data:** Analyzing this information allows for a comprehensive understanding of the basin's sediment budget and its impact on water quality, reservoir sedimentation, river morphology, and aquatic ecosystems.

The available data can support hydraulic modeling but requires significant interpolation and assumptions to fill existing gaps. By integrating diverse data sources, basin managers can develop more robust hydraulic models—powerful tools for simulating scenarios, predicting floods, optimizing water resources, and assessing the impacts of human activities and climate change. The availability and effective use of such data are essential for sustainable and integrated basin management, ensuring the long-term health of the river system and the well-being of dependent communities.

The currently available data provides a basic understanding of hydraulic parameters and basin characteristics but is not adequate for accurate hydraulic modeling and effective basin management Planning. One of the major challenges is the large distances between existing gauge, cross-drainage, discharge, sediment and water quality monitoring stations, which reduce spatial resolution, leading to interpolation errors and uncertainty in representing localized hydrological conditions.

With limited gauging stations, the basin's diverse geographical and climatic conditions are not well represented. Another issue is the difficulty in calibrating and validating the models. Without enough real-world data, it becomes challenging to adjust model settings to match actual conditions. Such challenges can lead to inaccurate flow predictions and reduced confidence in water resource planning and flood forecasting. In addition, limited gauging stations also make it harder to detect and respond to extreme events such as floods and droughts. This limits the effectiveness of early warning systems and can increase the risk to communities and infrastructure.

3.1 Stakeholder Engagement

This hydraulic report provides a valuable foundation of data for diverse stakeholders in the Mahanadi River Basin by compiling key information on the river's physical characteristics and flow regime. The report presents collected cross-section and longitudinal section data, offering insights into the river's geometry and elevation profile. Infrastructure data details the location and characteristics of existing structures such as dams, weir, barrages and canal network. Furthermore, the report includes available gauge discharge and sediment data, providing a record of river flow and sediment transport. By utilizing this data effectively, stakeholders can make informed decisions to ensure the sustainable management and conservation of the Mahanadi River basin for present and future generations. While this report focuses on data compilation rather than in-depth analysis, this information is crucial for stakeholders such as local communities, farmers and water resource managers.

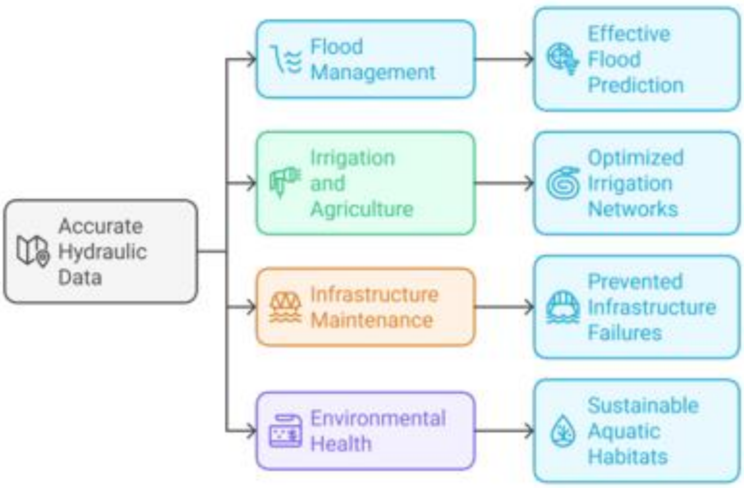


Figure 16: Significance of Data Presented

This report provides details on river monitoring stations, including those on the main river, major tributaries, and drains, along with data availability information. This information can be used by stakeholders to evaluate the efficiency of the current data collection process, identify areas for improvement, and inform policy recommendations for more effective data acquisition. The report also highlights data availability by department and offers suggestions for enhancing data collection techniques. Furthermore, the data presented can be used to identify peak and low water periods, facilitating trend analysis, flood and drought identification, and providing other essential hydraulic data for the Mahanadi basin. This information is valuable for researchers, policymakers involved in sustainable basin development, ecosystem monitoring, and even local farmers seeking awareness of water resources.

3.2 Gap Analysis and uncertainty

The adequacy of cross-sectional data for capturing the Mahanadi River's geometry is a significant concern. The limited gauging station network, with only 12 stations on the main stream, 21 on major distributaries, and 6 on drains spanning total 851 km river length, severely restricts the availability of representative cross-sections. This sparse distribution raises questions about whether existing cross-sections are spaced appropriately to capture the river's varying morphology. Compounding this issue is the fact that even at existing gauging stations, complete and continuous data records are not always available. Gaps in data collection, often due to equipment malfunction, maintenance schedules, or other unforeseen circumstances, mean that for many stations, data is not available for all years.

Moreover, the available cross-sectional datasets contain flaws and errors that become evident when the data is populated and visualized. In fewer instances, bank shifts are observed that appear abnormal, suggesting potential inaccuracies in data collection or processing. Consequently, significant gaps in both the spatial distribution and temporal availability of cross-sectional data exist, which can lead to potential inaccuracies in hydraulic modeling, especially in reaches with complex channel morphology, such as braided sections or areas experiencing significant changes in channel width.

In addition, the availability of hydraulic infrastructure data is sparse and highly limited. Assets like bridges, Intake wells, Sewer outfall, Ghats, etc… are not comprehensively documented, affecting the accuracy of river system modeling. Many of these datasets fall under Mission 1 (collection and collation of information), but secondary sources for such datasets are often becoming unreliable. Consequently, data must be collected directly from state government agencies and relevant inventories, adding further complexity to the compilation process.

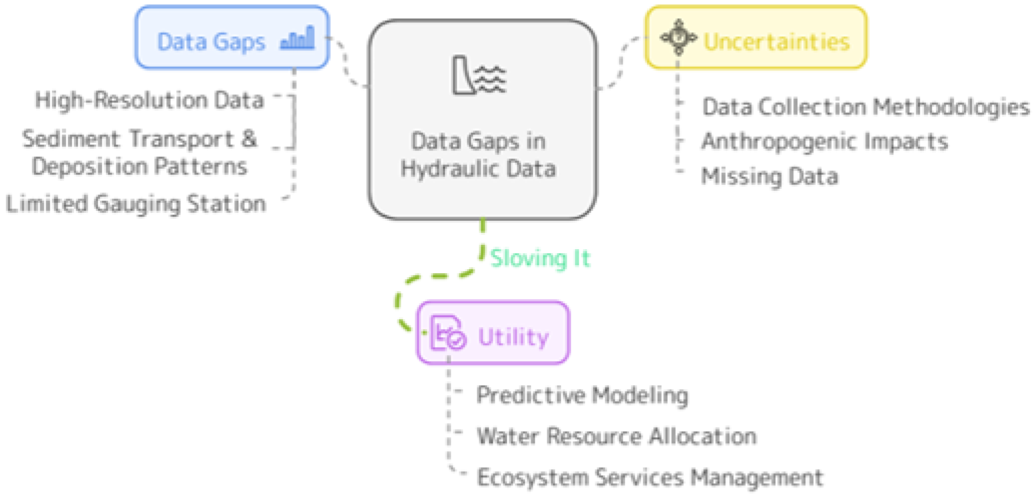


Figure 17: Data Gaps in the Report

The lack of detailed, void-free and consistent geometric and infrastructure information hinders a comprehensive analysis of river flow dynamics across the entire basin. The discharge and sediment data collected are discontinuous, exhibiting significant uncertainty and numerous gaps. Addressing these data deficiencies is crucial for improving the accuracy of hydraulic, sediment transport and hydrodynamic models, which are essential for effective river management and flood mitigation strategies.

3.3 Recommendations

Increase Cross-Sectional Data Density: Conduct targeted cross-sectional surveys, especially in reaches between existing gauging stations, in areas with complex channel morphology (braided channels, meanders, confluences), and in areas where significant changes in channel width or slope are observed.

When interpolating between cross-sections, use appropriate techniques that account for the river's morphology and hydraulic characteristics. Consider using methods that preserve channel sinuosity and avoid artificial channel straightening. Implement systematic maintenance and calibration of gauging equipment to minimize data gaps and errors, ensuring reliable and continuous cross-sectional records. Conduct field surveys to verify existing cross-sectional data, rectify abnormal bank shifts, and integrate remote sensing techniques for enhanced accuracy.

Employ Advanced Surveying Techniques: Utilize bathymetric surveys techniques to obtain detailed underwater channel geometry. Incorporate LiDAR data to obtain high-resolution topographic data of the floodplain and surrounding areas. This can provide valuable context for hydraulic modeling, especially for floodplain inundation studies.

Strengthen Hydraulic Infrastructure Documentation by developing a centralized database of hydraulic structures by collaborating with state government agencies to compile accurate and comprehensive datasets.

Bridging Data Gaps: A Roadmap for Enhanced Monitoring

In the Mahanadi River Basin, the accuracy and reliability of hydraulic modeling are limited by the gaps and constraints in the existing hydrological data network.Central Water Commission (CWC) stations are widely spaced, and there are a limited number of monitoring sites, particularly for sediment load and water quality, which are particularly important for assessing impacts in industrial clusters and mining areas where sedimentation and pollution loading affect river health. The State Water Resources Department (WRD) currently collects data on rainfall, water level (gauge), and discharge, but sediment data is largely confined to reservoir sites, with inadequate coverage along the main river stretches. Strengthening these monitoring networks will support the development of a more robust and comprehensive database, enabling better river health assessment, sediment management, and integrated basin-wide planning for the sustainable management of the Mahanadi River.

A detailed table is provided below outlining the Proposed Gauging Sites in Chhattisgarh and Odisha state within the Mahanadi River Basin. These proposed locations aim to fill critical gaps in the current hydrological monitoring network and will significantly contribute to improving the accuracy of hydrological models, flood forecasting, reservoir operations, and overall water resource management. Each site has been identified based on spatial distribution, hydrological relevance, and current data limitations in the basin.

Table 12: Proposed Locations for Gauging site in Chhattisgarh and Odisha to Enhance Spatial Coverage and Address Data Gaps in the Mahanadi River Basin

Chhattisgarh State			
S. No.	**Location**	**Proposed Site**	**Justification**
1	Upper Hasdeo River	Near Manendragarh or upstream of Korba	Captures inflows from forested, hilly terrain prone to flash floods, upstream of the existing Korba station. Sediment and Water Quality Monitoring, as this stretch passes through ecologically sensitive and mineral-rich zones, which are vulnerable to soil erosion and contamination due to mining and deforestation activities.

2	Mand River	Near Gharghoda or upstream	Fills monitoring gap in a major tributary; improves modeling and flood forecasting in the northern basin.
3	Seonath River	Between Durg and Raj nandgaon	Monitors flows through industrial/agricultural areas; supports water quality and quantity analysis.
4	Mahanadi Mainstream	Midway between Rajim and Jodhara (e.g., near Arang)	Covers ~120 km unmonitored stretch; improves data on runoff, sediment load, and flood forecasting.
5	Mahanadi Mainstream	Between Rajim and Gangrel Dam (approx. 65 km)	Provides inflow data for Gangrel Dam operations; essential for reservoir management and hydropower.
6	Pairi River	Between Sondur Reservoir and the confluence, near Gariaband	Monitors runoff from smaller tributaries and drainage networks; supports watershed and flood management.
Odisha State			
1	Mahanadi Mainstream	Near Chipilima	Monitors post-dam flow dynamics, assess flow regulation impacts
2	Mahanadi Mainstream	Upgrading the Deogaon Station from G to GDSQ	Provides better understanding of sediment transport and water quality dynamics.
3	Mahanadi Mainstream	Near Binka	Monitors cumulative flow assessments, tributary interaction analysis, and downstream flood preparedness. It's also valuable for tracking seasonal and inter-annual variations in discharge.
4	Mahanadi Mainstream	Upgrading the Khairmal Station from G to GDSQ	Provides crucial data to capture sediment and water quality assessments.
5	Mahanadi Mainstream	Near Routpada	Covers ~60 km of unmonitored stretch.
6	Mahanadi Mainstream	Upgrading the Padmabati Station from G to GDSQ	Monitors sediment deposition, floodplain dynamics assessment and water quality assessments.
7	Tel River	Before confluence with the Mahanadi near Sonepur	Measures total inflow from Tel River during peak discharge; improves basin-scale water assessment.
8	Ib River	Near Charbhati	Provides inflow data for Hirakud Dam operations; essential for reservoir management
9	Jira River	Near Tihikipala or upstream of Tihikipali	Adds Jira River inflow data for the Mahanadi River system.

10	Devi River	Downstream of Alipingal or near Nimapada	Monitors flow diversions and sediment transport near agricultural and coastal areas.
11	Brahmani-Mahanadi Inter-Distributary Zone	Near Jagatsinghpur	Critical for flood risk monitoring in coastal delta; aids in integrated delta and floodplain management.
12	Mahanadi Mainstream	Upgrading the Naraj Station from G to GDSQ	Monitors the Inflow and sediment transport upstream of the Delta.
13	Mahanadi Mainstream	Upgrading the Tarapur Station from G to GDSQ	Monitors sediment transport in the delta areas.
14	Bhargavi River	Upgrading the Balanga Station from G to GDSQ	Monitors sediment transport in the delta areas.
15	Kushabhadra River	Upgrading the Nimapara Station from G to GDSQ	Monitors sediment transport in the delta areas.
16	Kuakhai River	GDS observation station upstream of the Kuakhai River Bridge station	Fills the monitoring gap in a major distributary.
17	Daya River	Near or upstream to the Daya River Bridge Station with upgradation from G to GD	Fills monitoring gap for flow and sediment data in the distributary.

Roadmap for Improving Data Collection in the Mahanadi Basin

Responsible Institutions:

- Mahanadi & Eastern Rivers Organisation (MERO), CWC Bhubaneswar,
- Water Resources Department, Government of Chhattisgarh,
- Department of Water Resources, Government of Odisha,
- Central Pollution Control Board (CPCB),
- Chhattisgarh Environment Conservation Board,
- Odisha State Pollution Control Board ,
- Academic Institutions.

Key Requirements:

- **Expand Monitoring Network:**
  - ✓ Establish additional gauging stations at critical ungauged sub-basins and confluence points.
  - ✓ Increase the number of water quality and sediment monitoring stations to ensure representative basin coverage (e.g., at industrial clusters, upstream/downstream of urban areas, and major tributaries).
- **Ensure High-Frequency Data Collection:**
  - ✓ Implement automatic water level and discharge sensors.
  - ✓ Deploy real-time water quality sensors (e.g., for DO, pH, BOD, nitrates, heavy metals).
- **Digitization and Data Sharing:**
  - ✓ Centralized basin-level data portal with open access for government and researchers.
  - ✓ Standardize formats for data entry, QA/QC protocols and real-time transmission.
- **Community and Institutional Involvement**
  - ✓ To strengthen grassroots-level participation, involve educational institutions (Shiksha Vibhag, colleges) to collect basic information on nearby river stretches.
  - ✓ Raise awareness among students and local communities on river conservation and sustainable water management.
  - ✓ Collect river-related data from farmers, local residents, and institutions on water sources, pollution, riverbank issues, aquatic life, and solid waste to build a comprehensive database for targeted river management. A mobile application "NEERJAL" is being developed for this purpose, with a pilot project planned soon.

Timeline and Milestones:

Phase	Timeline	Objectives
Phase I	1 Year	Needs assessment, station planning, stakeholder coordination.
Phase II	2 Year	Installation of new monitoring stations (hydrological, sediment, water quality)
Phase III	2 Year	Full automation, real-time data transmission, integration with basin models, and operational forecasting tools

This roadmap aligns with the larger goals of integrated river basin management and supports evidence-based policymaking. Strengthening the data infrastructure across the Mahanadi Basin will reduce modelling uncertainties, improve flood and pollution management, and ensure the long-term sustainability of water resources in the region.

Acknowledgement

The Centre for Mahanadi River Basin Management and Studies (cMahanadi), NIT Raipur and NIT Rourkela expresses its sincere gratitude to the following agencies and institutions for their invaluable support and contributions in the preparation of the "**Hydraulic**" report for the Mahanadi Basin:

We extend our thanks to the following agencies for providing data and support in the preparation of the report –

- Central Water Commission (CWC), Bhubaneswar,
- Data Centre, Water Resource Department, Govt. Of CG
- Department of Water Resources, Government of Odisha,

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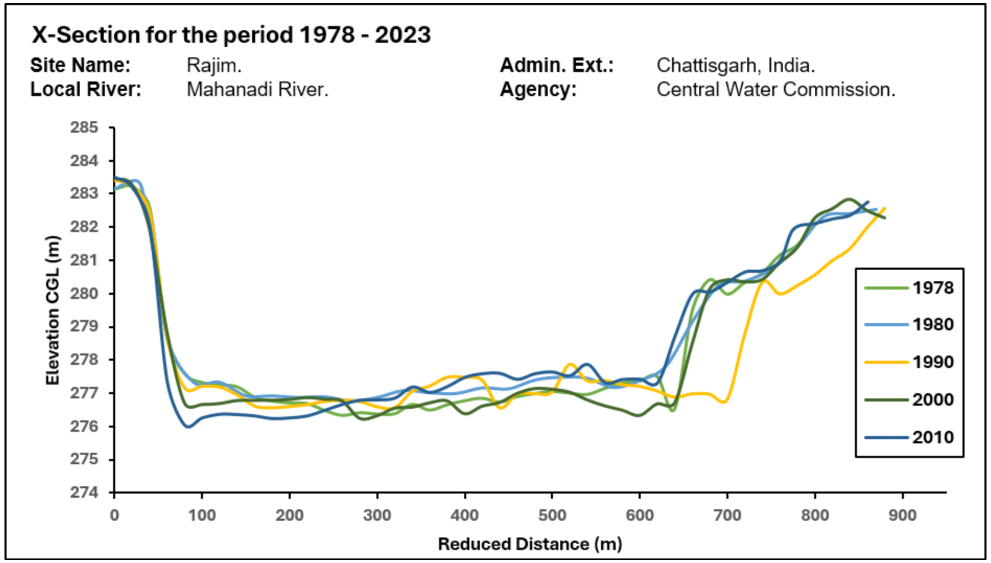
ANNEXURE

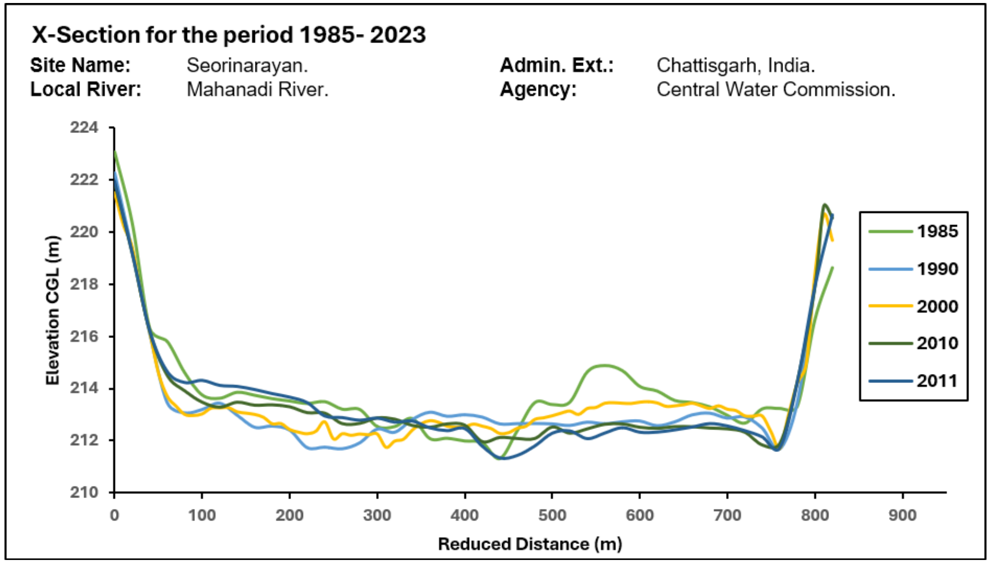
Supplementary Historical Cross-Sectional Data (CGL)

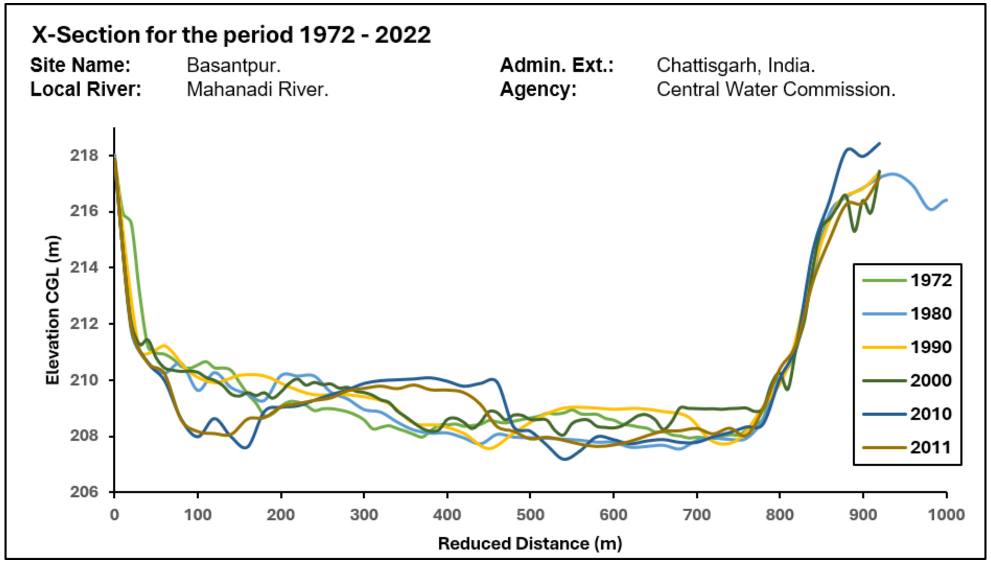
An infographic revealing the CWC river cross-section measurement locations, Mahanadi River Basin CG & OD.

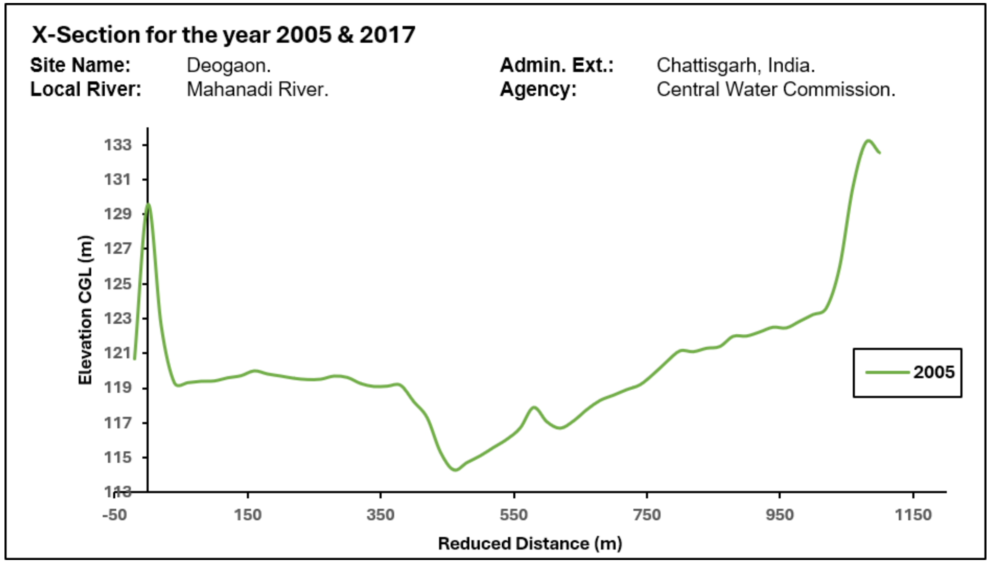
MAIN STREAM CROSS SECTIONAL DATASETS.

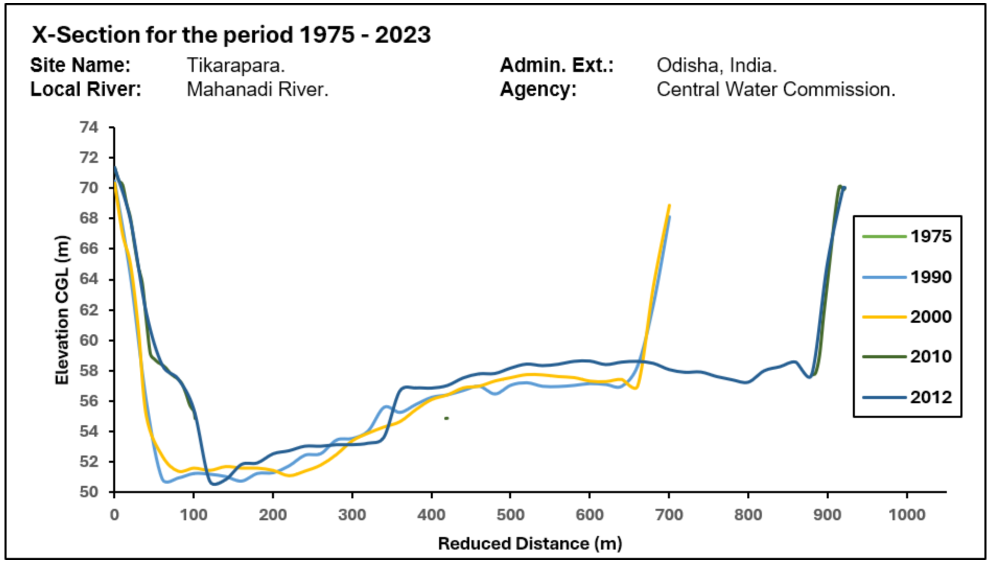
Station Count	CWC Site	Latitude	Longitude	Elevation (DEM)	State	River	Tributary	Distributary	Period of data available	Populated at decadal time-step
1	Rajim	20.974	81.880	287.0	CG	Mahanadi	-	-	1978 – 2010, 2020 2023	1978, 1980, 1990, 2000, 2010, 2020, 2023
2	Seorinarayan	21.717	82.597	215.0	CG	Mahanadi	-	-	1985 – 2011, 2019 2023	1985, 1990, 2000, 2010, 2011, 2019, 2023
3	Basantpur	21.727	82.788	210.0	CG	Mahanadi	-	-	1972 – 2011, 2022	1972, 1980, 1990, 2000, 2010, 2011, 2022
4	Deogaon	21.308	83.900	139.0	OD	Mahanadi	-	-	2005, 2017	2005
5	Tikarapara	20.633	84.619	64.0	OD	Mahanadi	-	-	1975 – 2012, 2021 2023	1975, 1980, 1990, 2000, 2010, 2012, 2021, 2023






X-Section for the period 1972 - 2022
Site Name: Basantpur.
Local River: Mahanadi River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
1972
1980
1990
2000
2010
2011

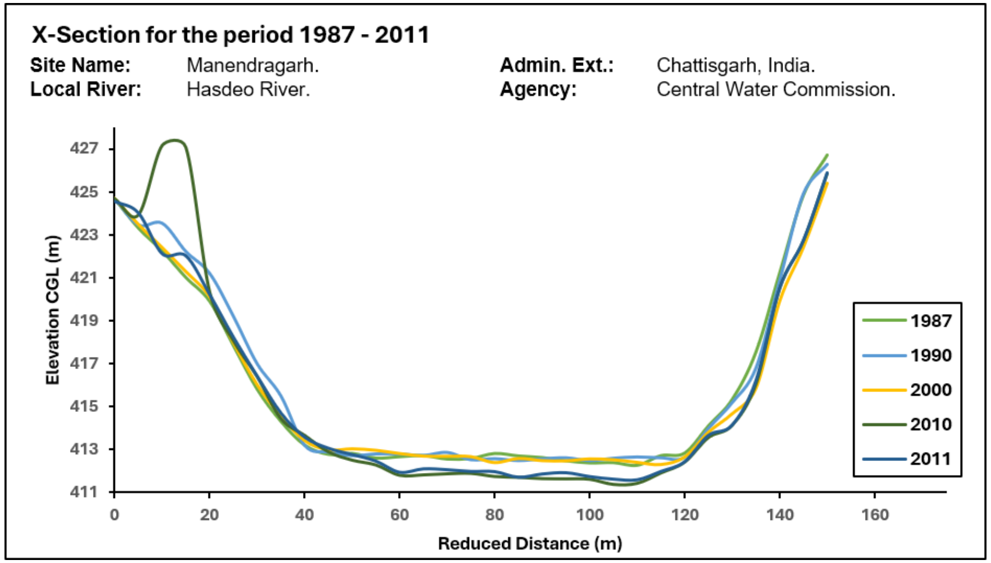

X-Section for the year 2005 & 2017
Site Name: Deogaon.
Local River: Mahanadi River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
2005

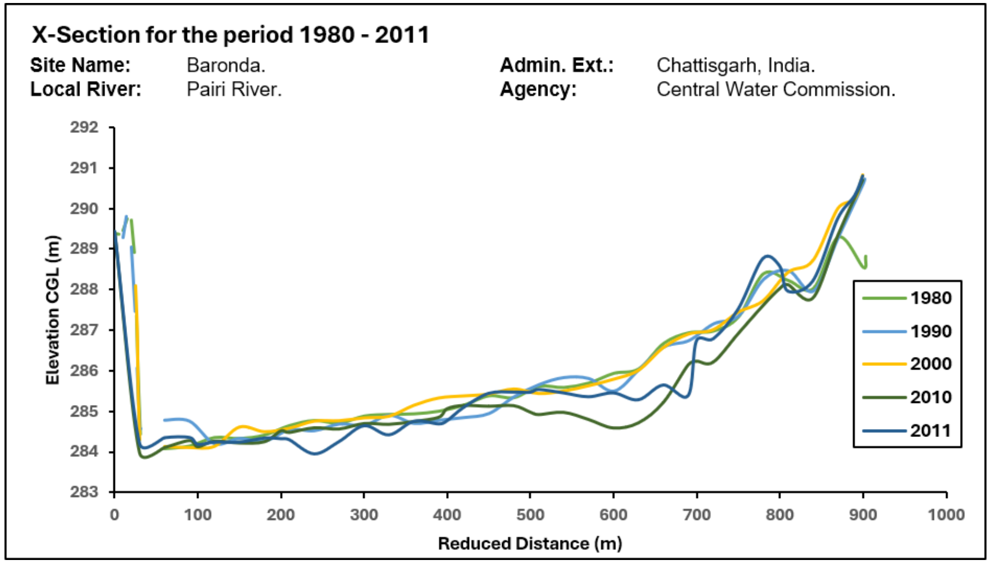

X-Section for the period 1975 - 2023
Site Name: Tikarapara.
Local River: Mahanadi River.
Admin. Ext.: Odisha, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
1975
1990
2000
2010
2012

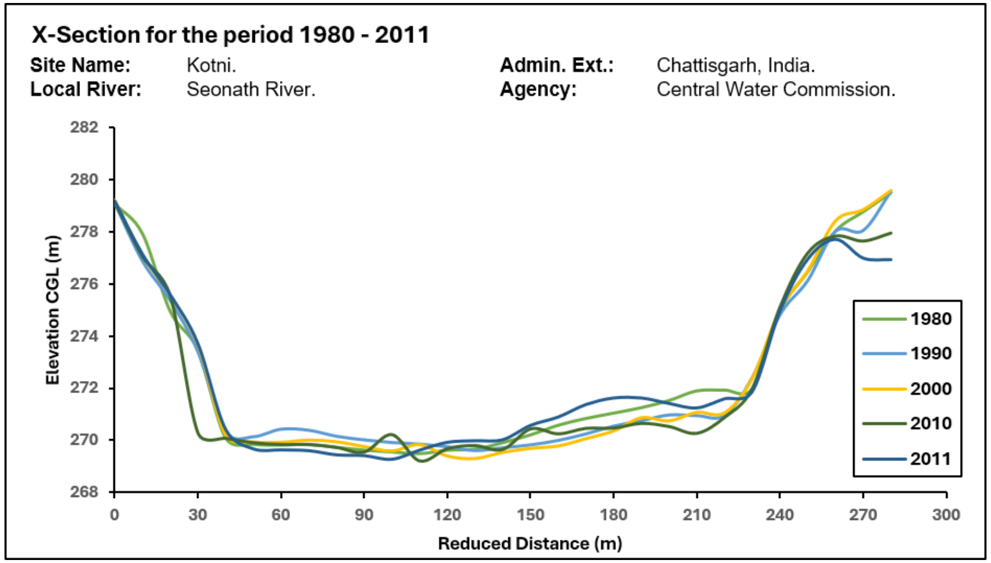
MAJOR DISTRIBUTARIES CROSS SECTIONAL DATASETS.

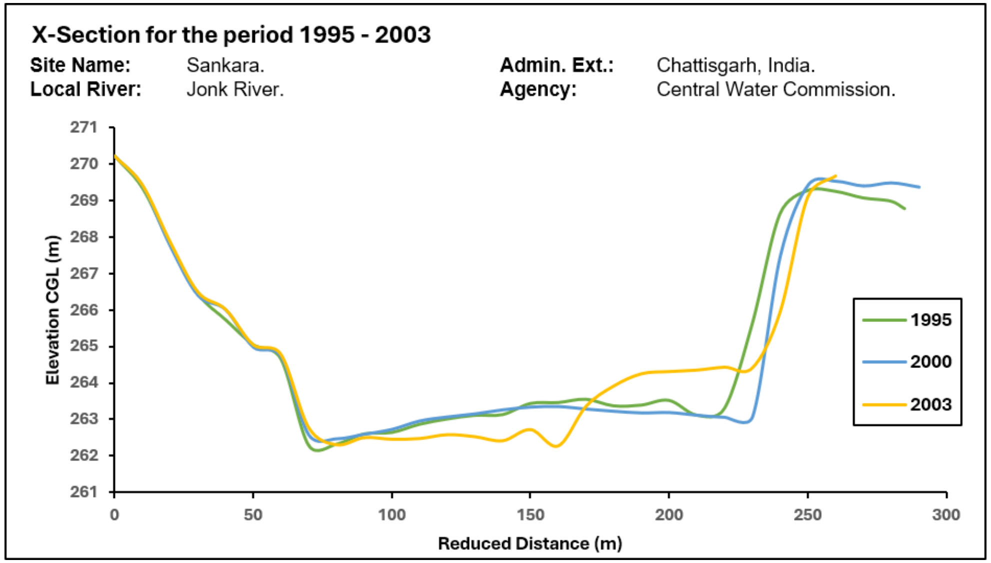
Station Count	CWC Site	Latitude	Longitude	Elevation (DEM)	State	River	Tributary	Distributary	Period of data available	Populated at decadal time-step
1	Manendragarh	23.203	82.218	440.0	CG	Mahanadi	Hasdeo/ Hasiya	-	1987 - 2011	1987, 1990, 2000, 2010, 2011
2	Thettatanger	22.668	83.910	387.0	CG	Mahanadi	Ib	-	2017	-
3	Gunderdehi	20.955	81.278	296.0	CG	Mahanadi	Tandula	-	2020	-
4	Baronda	20.913	81.886	291.0	CG	Mahanadi	Pairi	-	1980 - 2011	1980, 1990, 2000, 2010, 2011
5	Kotni	21.236	81.247	273.0	CG	Mahanadi	Seonath	-	1980 - 2011	1980, 1990, 2000, 2010, 2011
6	Sankara	21.289	82.650	272.0	CG	Mahanadi	Jonk	-	1995 - 2003	1995, 2000, 2003
7	Andhiyarkore	21.834	81.606	267.0	CG	Mahanadi	Hanp	-	1980 - 2011	1980, 1990, 2000, 2010, 2011
8	Ghatora	22.057	82.221	263.0	CG	Mahanadi	Arpa	-	1978 - 2010	1978, 1980, 1990, 2000, 2010
9	Pathardhi	21.341	81.594	258.0	CG	Mahanadi	Karun	-	1989 - 2011	1989, 1990, 2000, 2010, 2011
10	Simga	21.632	81.688	255.0	CG	Mahanadi	Seonath	-	1973 - 2011	1973, 1980, 1990, 2000, 2010, 2011
11	Mohulpali	21.950	83.417	242.0	CG	Mahanadi	Kelo	-	2009	2009
12	Rampur	21.652	82.519	237.0	CG	Mahanadi	Rampur	-	1976 - 2011	1976, 1980, 1990, 2000, 2010, 2011

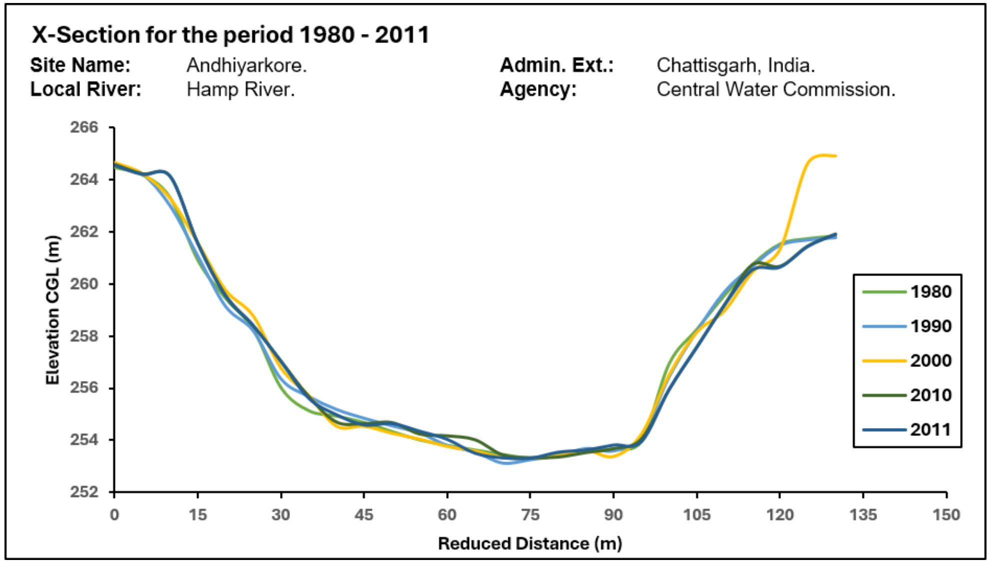
Station Count	CWC Site	Latitude	Longitude	Elevation (DEM)	State	River	Tributary	Distributary	Period of data available	Populated at decadal time-step
13	Jondhra	21.725	82.347	234.0	CG	Mahanadi	Seonath	-	1979 - 2011	1979, 1980, 1990, 2000, 2010, 2011
14	Raigarh	21.891	83.401	221.0	CG	Mahanadi	Kelo	-	2010 - 2011	2010, 2011
15	Bamnidhi	21.899	82.717	227.0	CG	Mahanadi	Hasdeo	-	1974 - 2011	1974, 1980, 1990, 2000, 2010, 2011
16	Kurubhata	21.988	83.204	222.0	CG	Mahanadi	Mand	-	1980 - 2012	1980, 1990, 2000, 2010, 2012
17	Sundergarh	22.115	84.011	223.0	OD	Mahanadi	Ib	-	1978 – 2012, 2022 2023	1978, 1980, 1990, 2000, 2010, 2012, 2022, 2023
18	Parmanpur	21.781	84.082	210.0	OD	Mahanadi	Bhedan	-	2008 - 2011	2008, 2010, 2011
19	Kesinga	20.198	83.225	177.0	OD	Mahanadi	Tel	-	1978 – 2012, 2020	1978, 1980, 1990, 2000, 2010, 2012, 2020
20	Salebhata	20.983	83.539	134.0	OD	Mahanadi	Ong	-	1983 - 2012	1983, 1990, 2000, 2010, 2012
21	Kantamal	20.650	83.732	133.0	OD	Mahanadi	Tel	-	1977 – 2012, 2023	1977, 1980, 1990, 2000, 2010, 2012, 2023

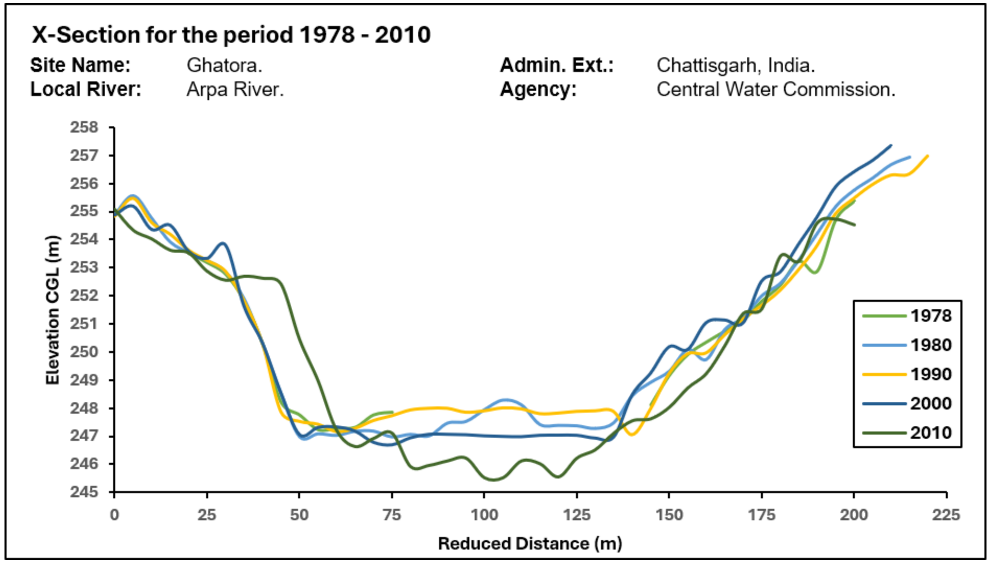

X-Section for the period 1987 - 2011
Site Name: Manendragarh.
Local River: Hasdeo River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
1987
1990
2000
2010
2011

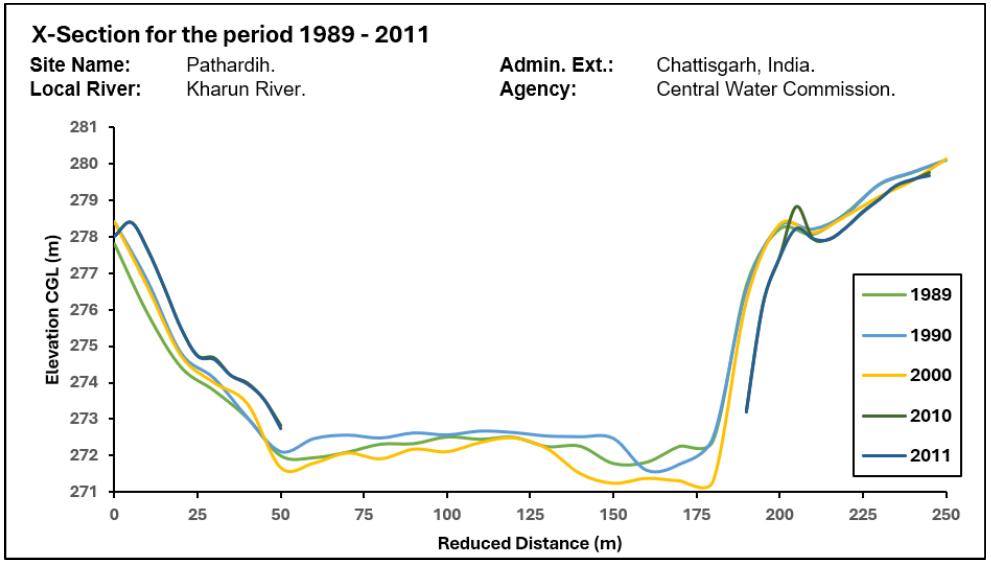

X-Section for the period 1980 - 2011
Site Name: Baronda.
Local River: Pairi River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
1980
1990
2000
2010
2011

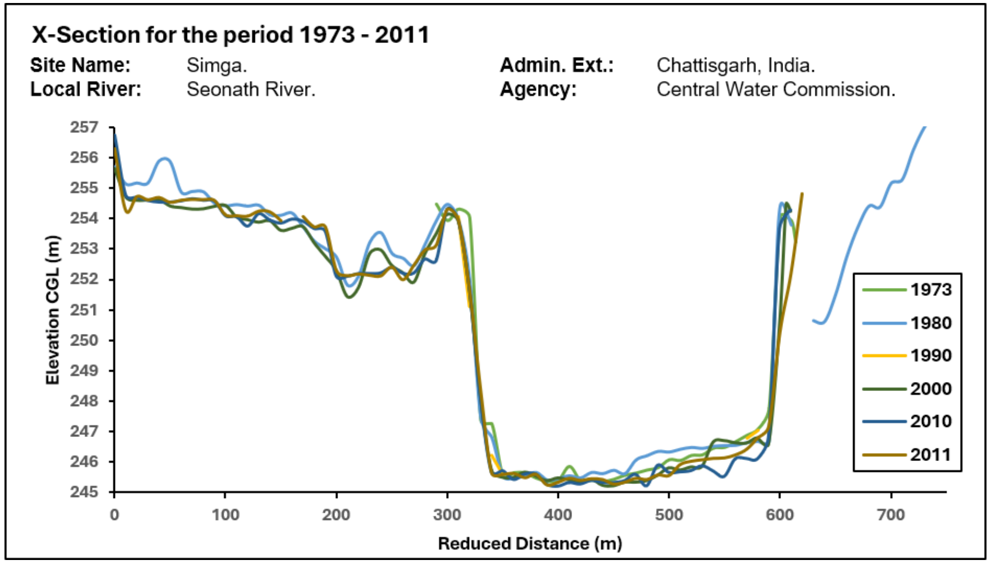

X-Section for the period 1980 - 2011
Site Name: Kotni.
Local River: Seonath River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
1980
1990
2000
2010
2011

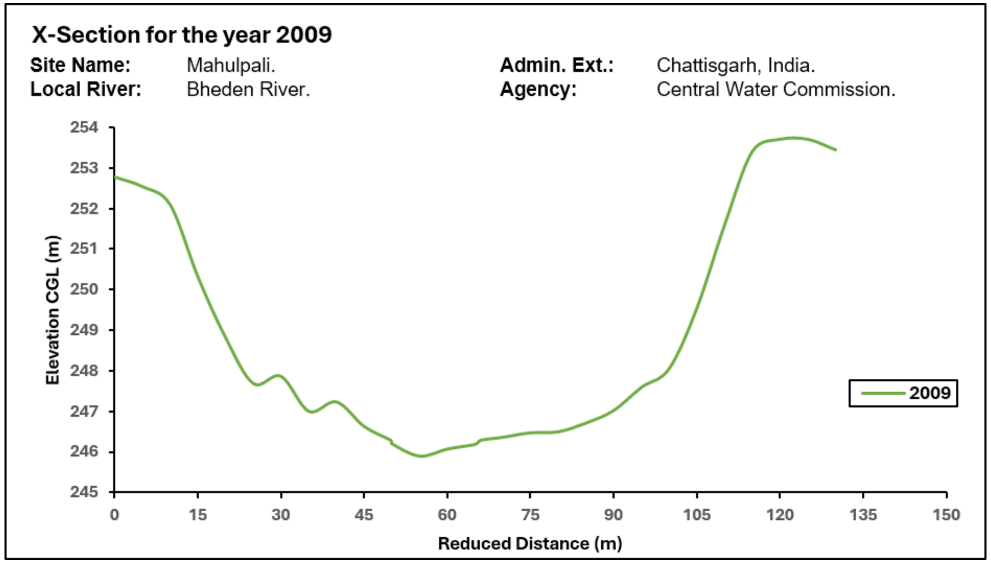

X-Section for the period 1995 - 2003
Site Name: Sankara.
Local River: Jonk River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
1995
2000
2003

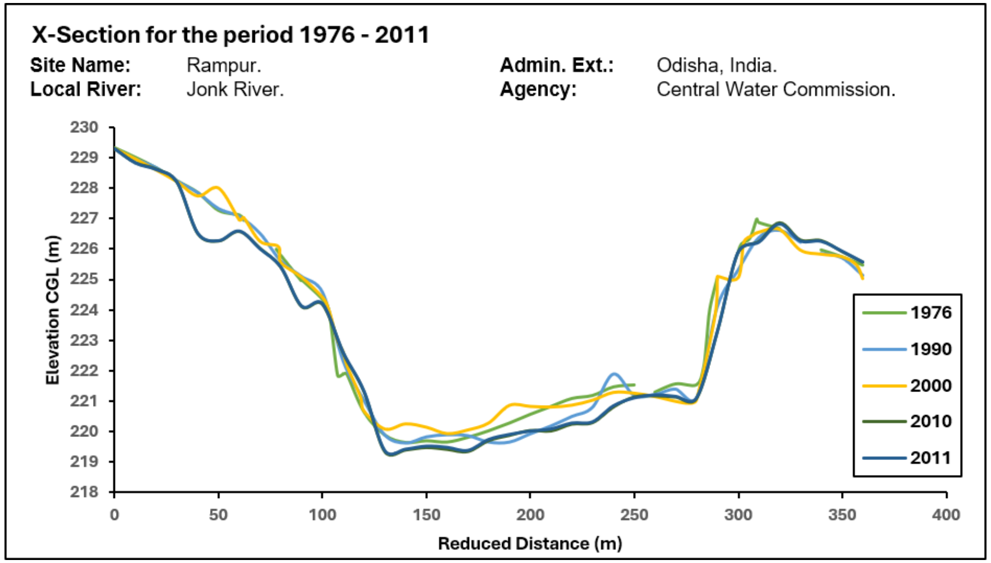

X-Section for the period 1980 - 2011
Site Name: Andhiyarkore.
Local River: Hamp River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
1980
1990
2000
2010
2011

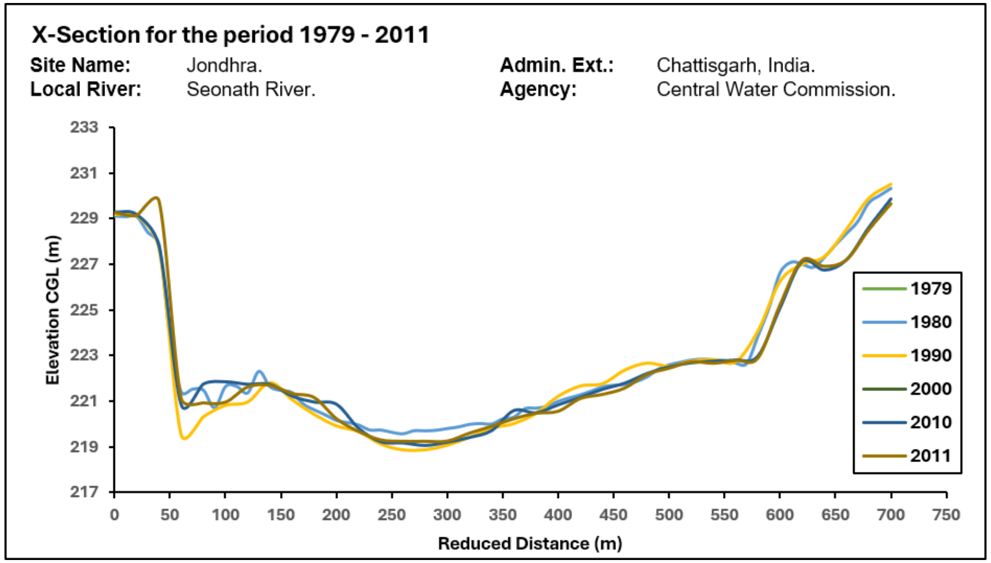

X-Section for the period 1978 - 2010
Site Name: Ghatora.
Local River: Arpa River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
1978
1980
1990
2000
2010

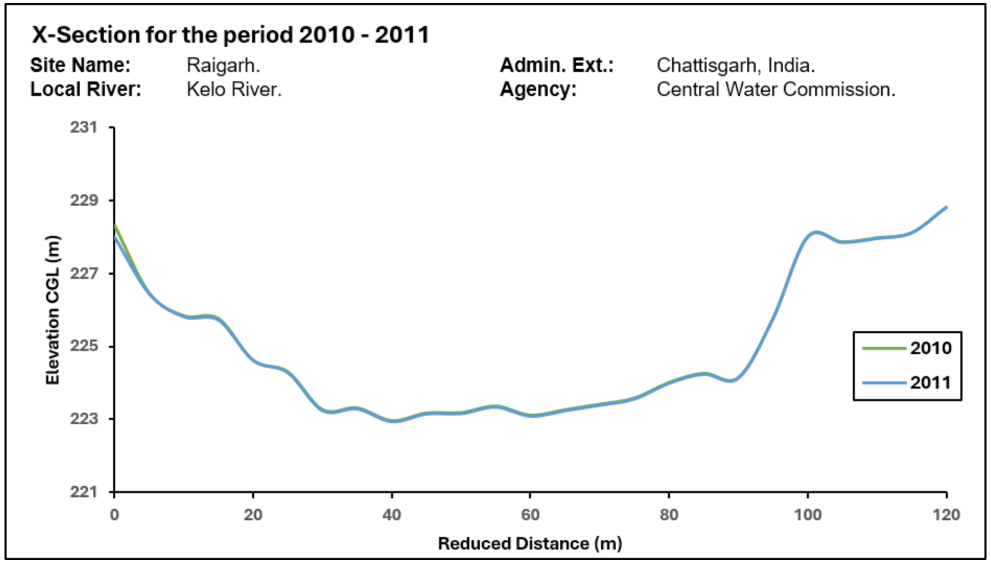

X-Section for the period 1989 - 2011
Site Name: Pathardih.
Local River: Kharun River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
1989
1990
2000
2010
2011

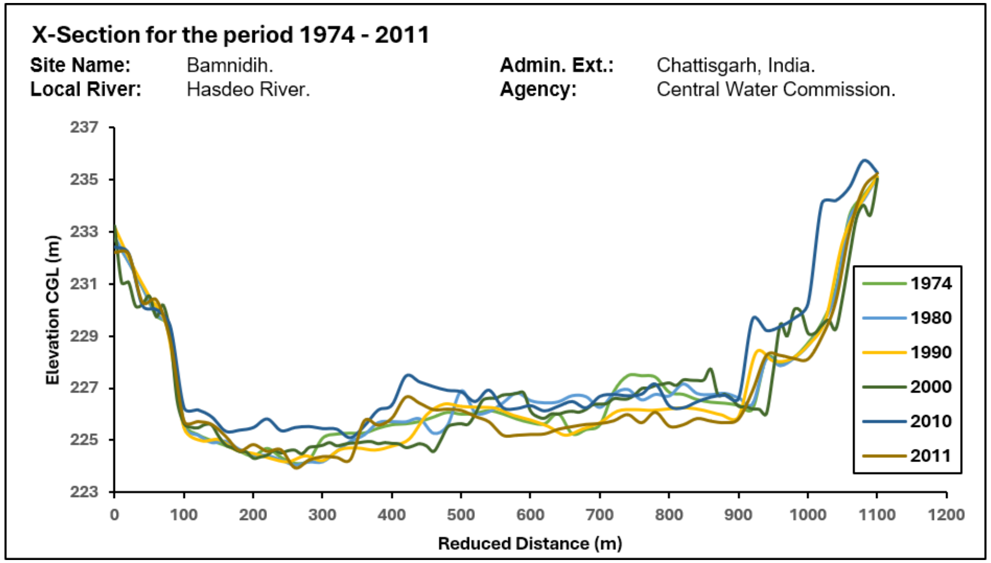

X-Section for the period 1973 - 2011
Site Name: Simga.
Local River: Seonath River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
1973
1980
1990
2000
2010
2011

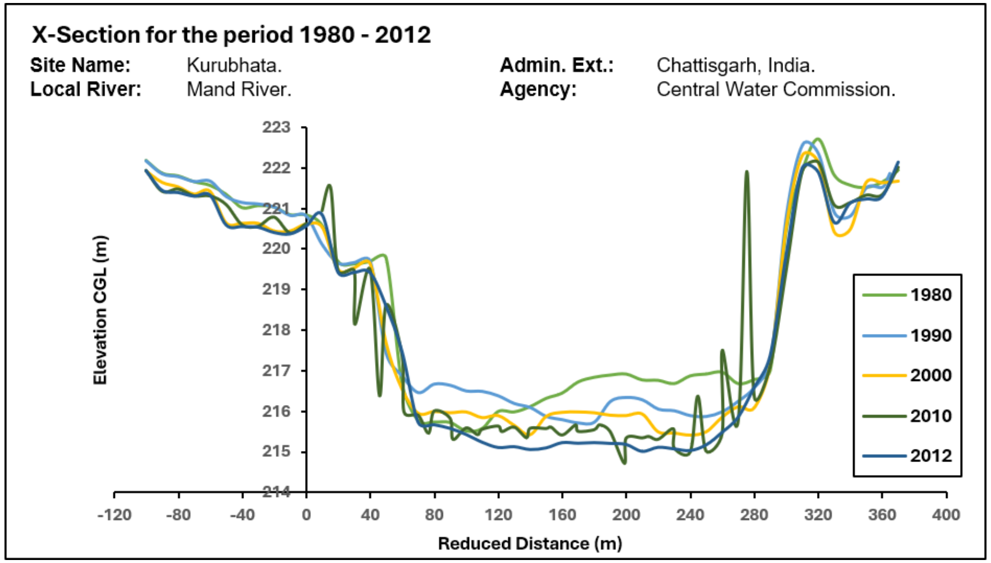

X-Section for the year 2009
Site Name: Mahulpali.
Local River: Bheden River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
254
253
252
251
250
249
248
247
246
245
0
15
30
45
60
75
90
105
120
135
150
Reduced Distance (m)
2009

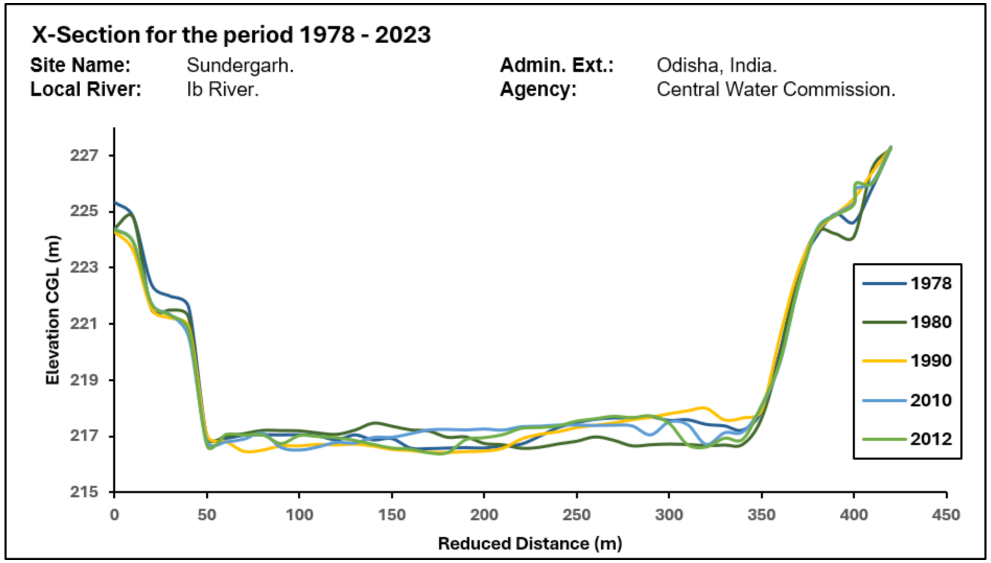

X-Section for the period 1976 - 2011
Site Name: Rampur.
Local River: Jonk River.
Admin. Ext.: Odisha, India.
Agency: Central Water Commission.
Elevation CGL (m)
230
229
228
227
226
225
224
223
222
221
220
219
218
0
50
100
150
200
250
300
350
400
Reduced Distance (m)
1976
1990
2000
2010
2011

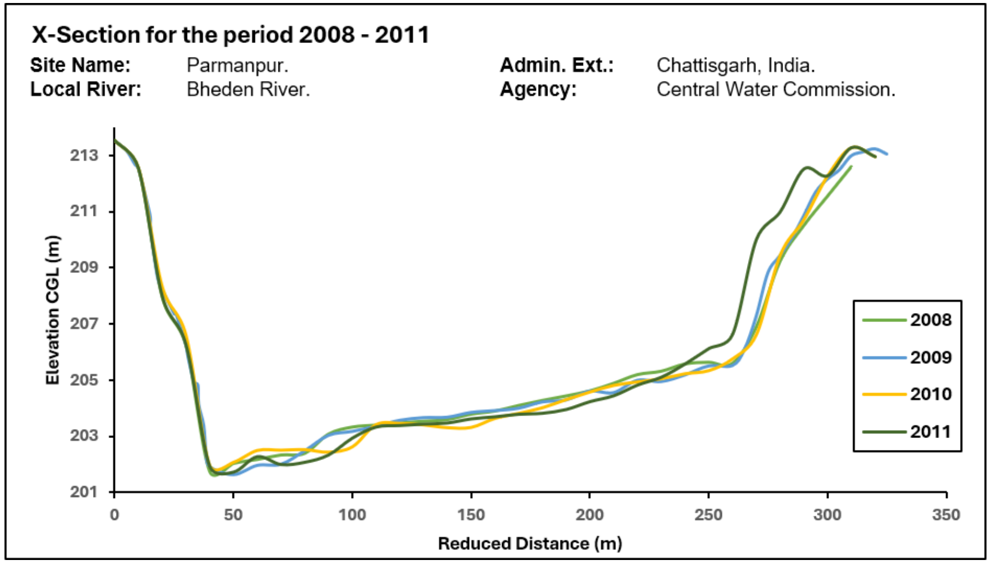

X-Section for the period 1979 - 2011
Site Name: Jondhra.
Local River: Seonath River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
233
231
229
227
225
223
221
219
217
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
Reduced Distance (m)
1979
1980
1990
2000
2010
2011

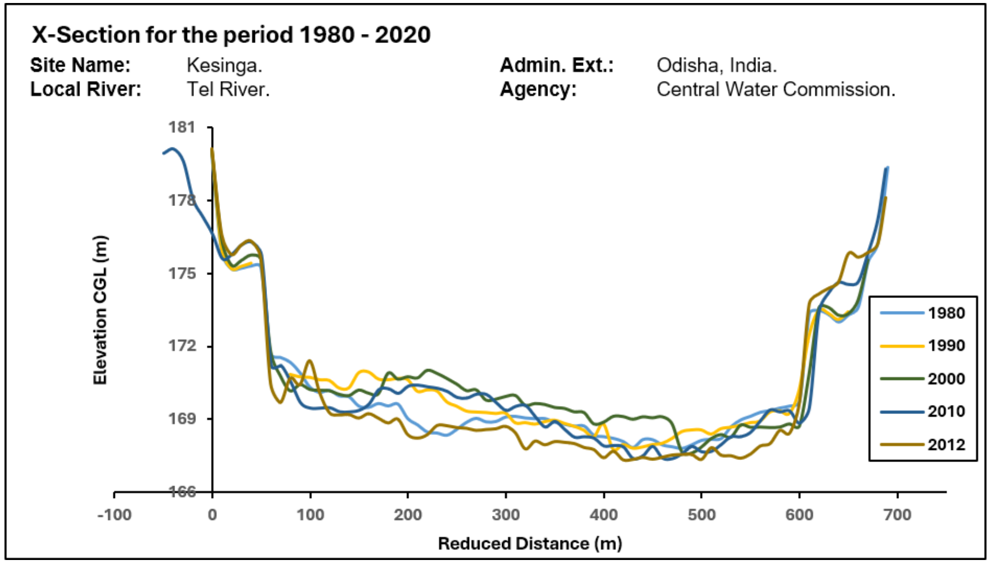

X-Section for the period 2010 - 2011
Site Name: Raigarh.
Local River: Kelo River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
231
229
227
225
223
221
0
20
40
60
80
100
120
Reduced Distance (m)
2010
2011

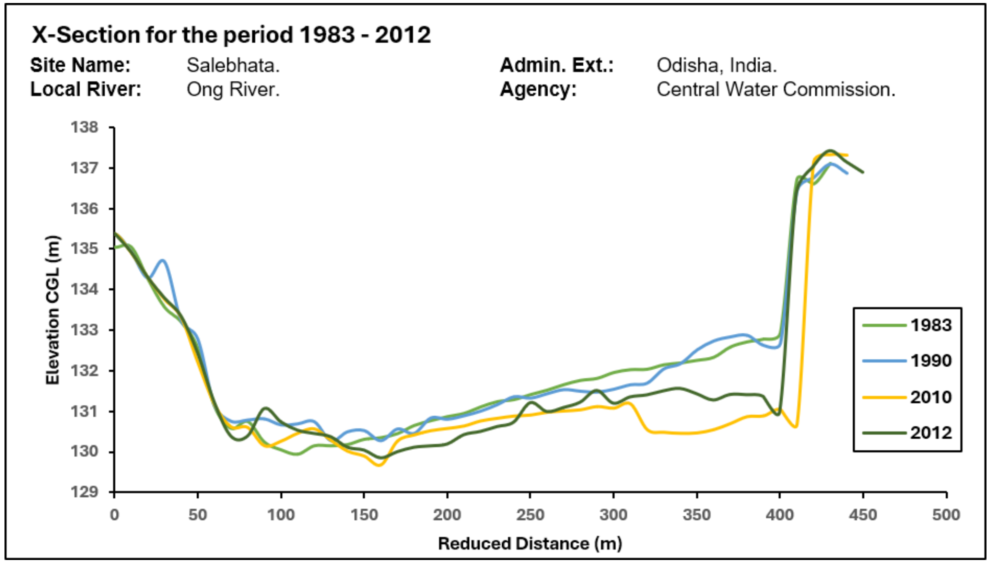

X-Section for the period 1974 - 2011
Site Name: Bamnidih.
Local River: Hasdeo River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
1974
1980
1990
2000
2010
2011

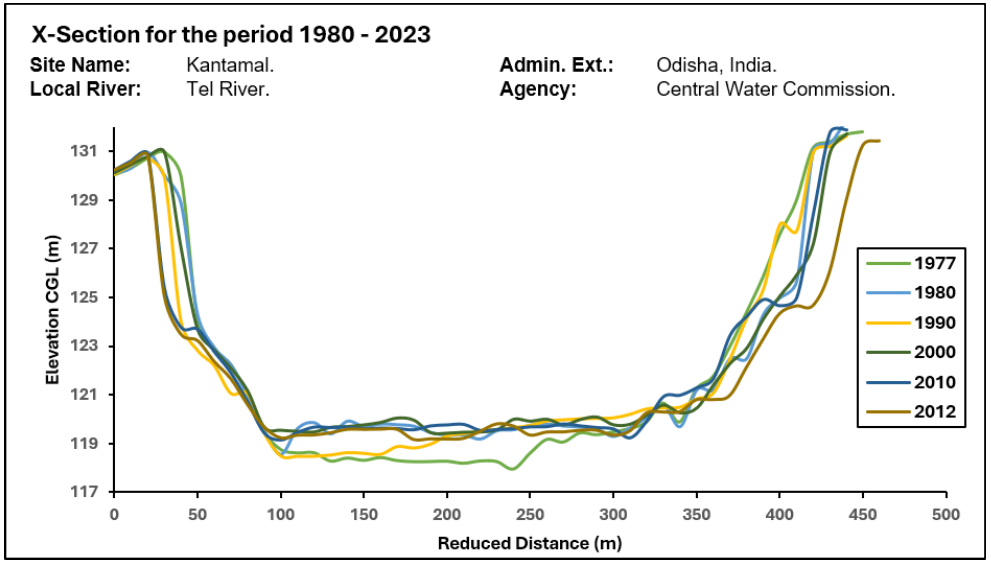

X-Section for the period 1980 - 2012
Site Name: Kurubhata.
Local River: Mand River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
1980
1990
2000
2010
2012


X-Section for the period 1978 - 2023
Site Name: Sundergarh.
Local River: Ib River.
Admin. Ext.: Odisha, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
1978
1980
1990
2010
2012


X-Section for the period 2008 - 2011
Site Name: Parmanpur.
Local River: Bheden River.
Admin. Ext.: Chattisgarh, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
2008
2009
2010
2011

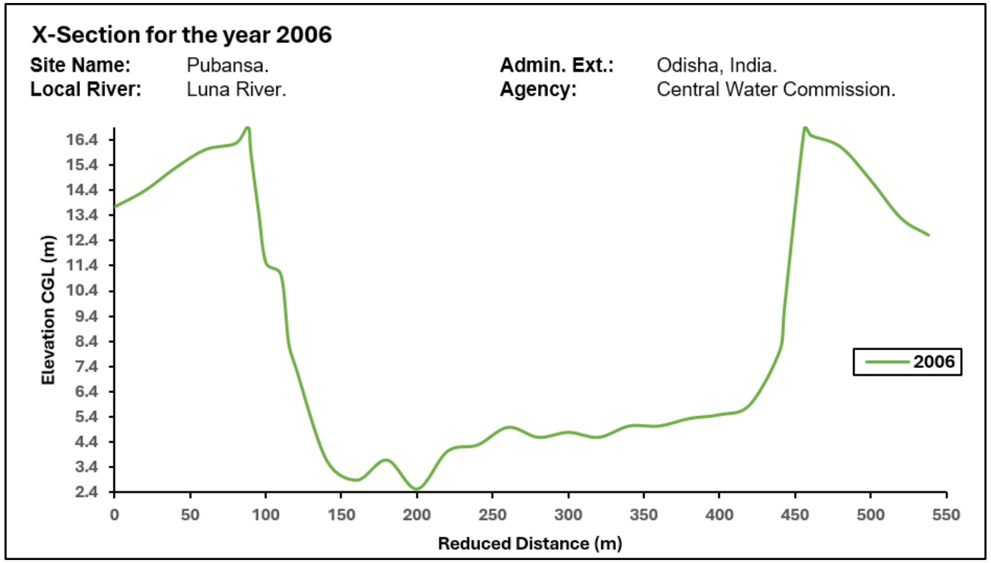

X-Section for the period 1980 - 2020
Site Name: Kesinga.
Local River: Tel River.
Admin. Ext.: Odisha, India.
Agency: Central Water Commission.
Elevation CGL (m)
181
178
175
172
169
166
-100
0
100
200
300
400
500
600
700
Reduced Distance (m)
1980
1990
2000
2010
2012

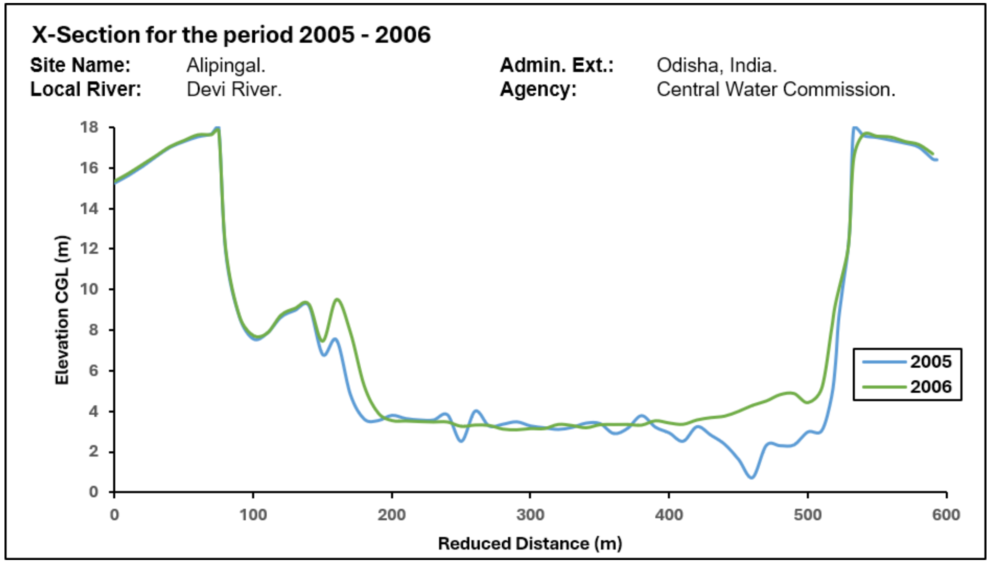

X-Section for the period 1983 - 2012
Site Name: Salebhata.
Local River: Ong River.
Admin. Ext.: Odisha, India.
Agency: Central Water Commission.
Elevation CGL (m)
138
137
136
135
134
133
132
131
130
129
0
50
100
150
200
250
300
350
400
450
500
Reduced Distance (m)
1983
1990
2010
2012

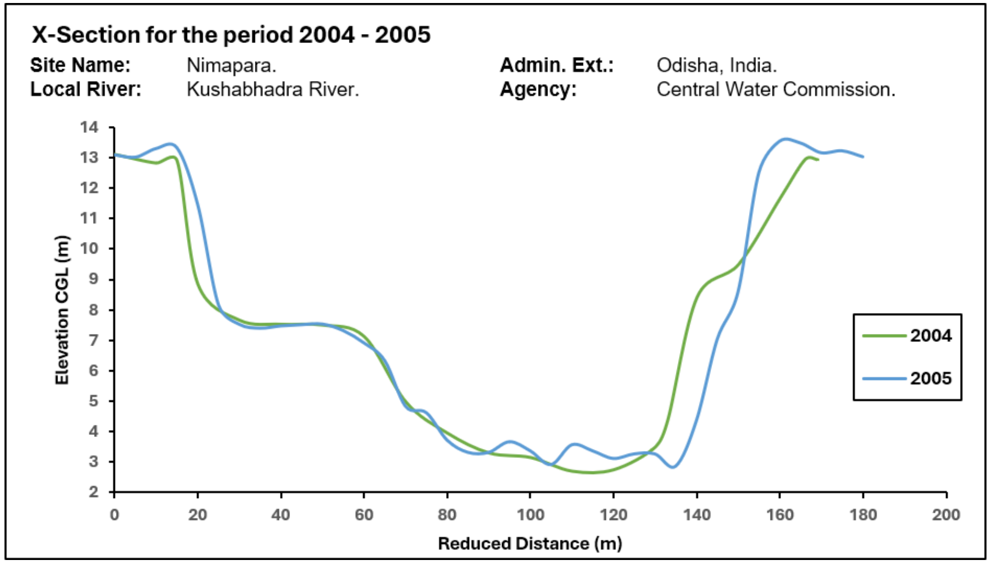

X-Section for the period 1980 - 2023
Site Name: Kantamal.
Local River: Tel River.
Admin. Ext.: Odisha, India.
Agency: Central Water Commission.
Elevation CGL (m)
131
129
127
125
123
121
119
117
0
50
100
150
200
250
300
350
400
450
500
Reduced Distance (m)
1977
1980
1990
2000
2010
2012

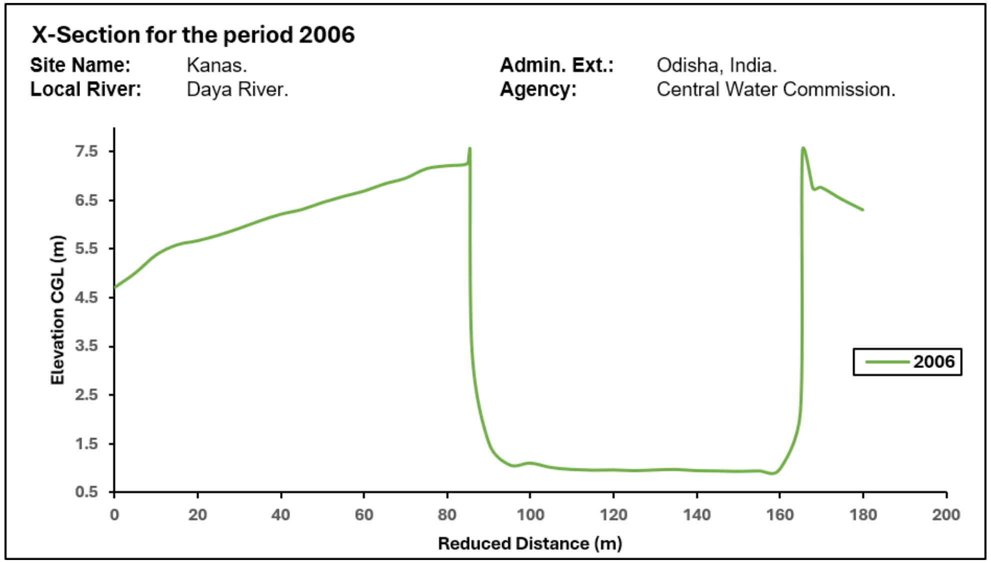
RIVER DRAINS CROSS SECTIONAL DATASETS.

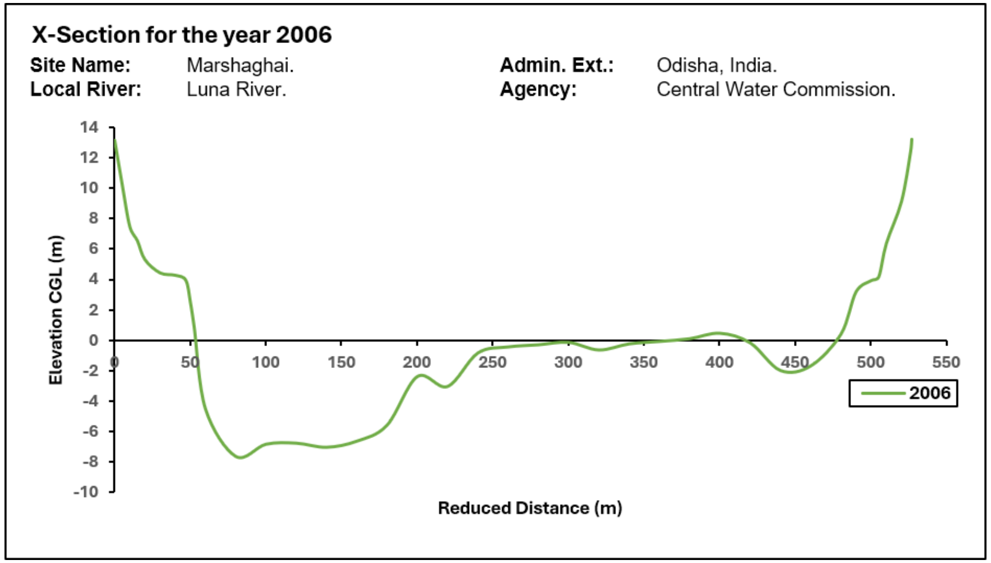
Station Count	CWC Site	Latitude	Longitude	Elevation (DEM)	State	River	Tributary	Distributary	Period of data available	Populated at decadal time-step
1	Pubansha	20.444	86.248	15.0	OD	Mahanadi	-	Luna	2006	2006
2	Alipingal	20.167	86.167	13.0	OD	Mahanadi	-	Devi	2005 - 2006	2005, 2006
3	Nimapara	20.069	86.000	13.0	OD	Mahanadi	-	Kushabhadra	2004 - 2005	2004, 2005
4	Kanas	20.002	85.646	10.0	OD	Mahanadi	-	Daya	2006	2006
5	Marshanghai	20.340	86.481	9.0	OD	Mahanadi	-	Luna	2006	2006






X-Section for the period 2004 - 2005
Site Name: Nimapara.
Local River: Kushabhadra River.
Admin. Ext.: Odisha, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
2004
2005


X-Section for the period 2006
Site Name: Kanas.
Local River: Daya River.
Admin. Ext.: Odisha, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
2006


X-Section for the year 2006
Site Name: Marshaghai.
Local River: Luna River.
Admin. Ext.: Odisha, India.
Agency: Central Water Commission.
Elevation CGL (m)
Reduced Distance (m)
2006