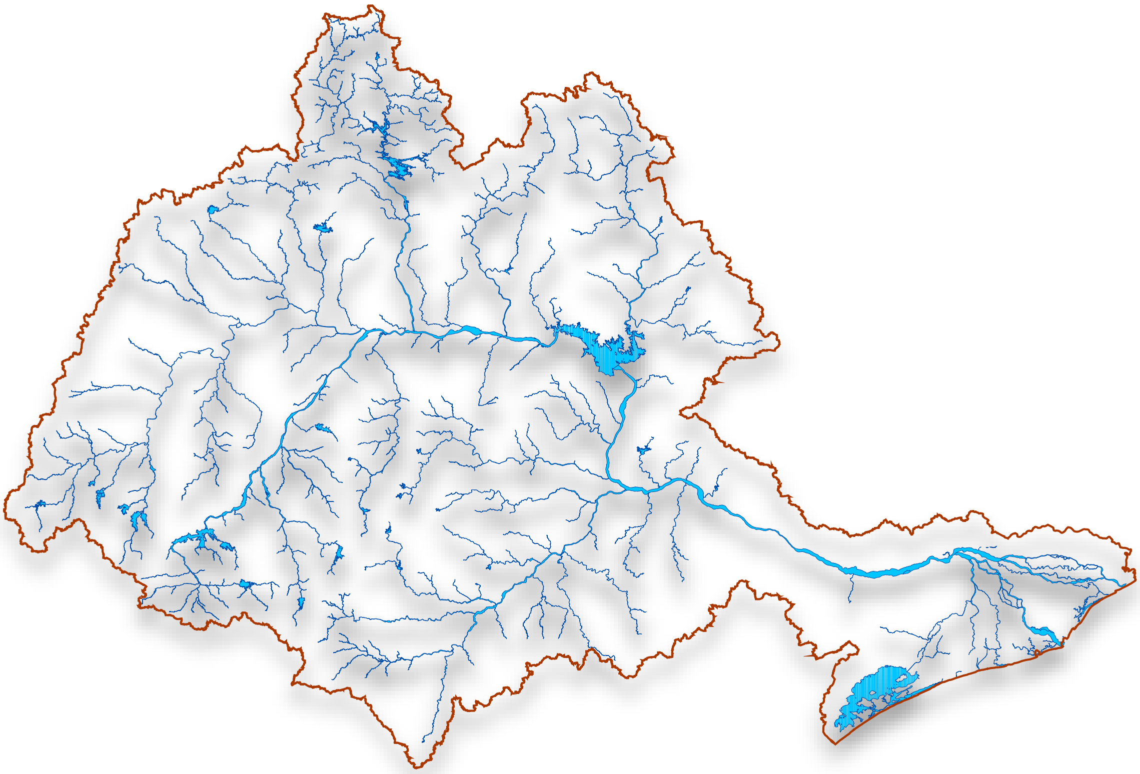
National River Conservation Directorate
Ministry of Jal Shakti,
Department of Water Resources,
River Development & Ganga Rejuvenation
Government of India

Waterbodies Atlas

Mahanadi River Basin



October 2025

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National River Conservation Directorate (NRCD)

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

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Centres for Mahanadi River Basin Management Studies (cMahanadi)

The Center for Mahanadi River Basin Management 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

Centre for Ganga River Basin Management and Studies (cGanga)

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

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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 Studies (cMahanadi)
NIT Raipur & NIT Rourkela

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Abbreviations and Acronyms

CAMP	Condition Assessment and Management Plan
CGWB	Central Ground Water Board
cMahanadi	Centre for Mahanadi River Basin Management and Studies
NWIC	National Water Informatics Center
IIT	Indian Institute of Technology
MRB	Mahanadi River Basin
JRC	Joint Research Centre
WRD	Water Resource Department

1. Introduction

The Water-bodies Atlas of the Mahanadi River Basin provides a comprehensive inventory and assessment of the basin's diverse water resources, including reservoirs, lakes, tanks, and wetlands that play vital roles in regional hydrology, water security, and ecological sustainability. Spanning a catchment of approximately 1,41,589 square kilometers across Chhattisgarh, Odisha, and parts of neighboring states, the basin supports major agricultural activities and is subject to seasonal variability, frequent flooding, and water stress in certain areas. The Atlas serves as a baseline for evaluating current conditions, infrastructure, and water-body health to inform integrated management planning.

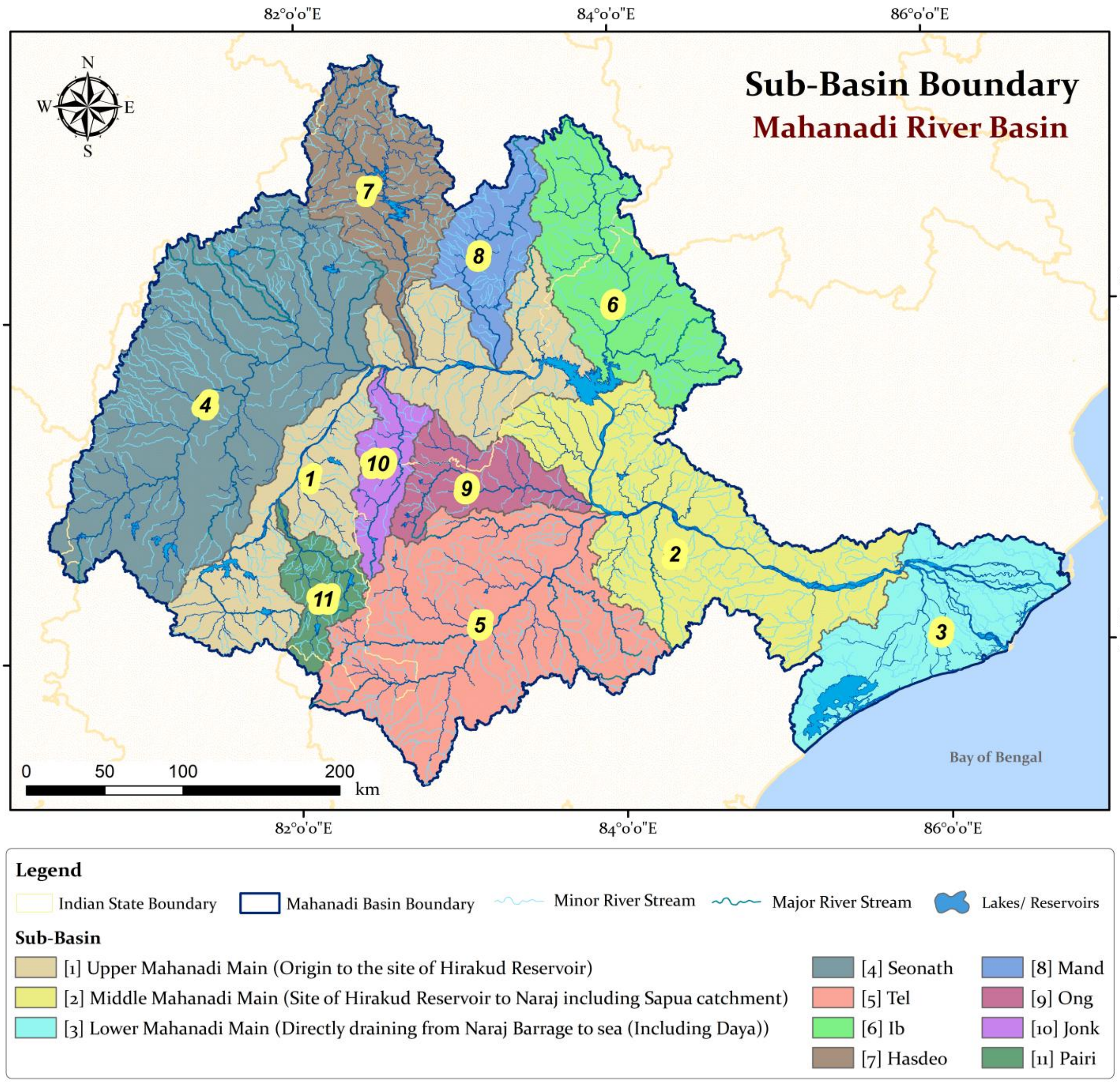


Figure 1: Mahanadi River Basin - Subasins

2. Distribution of Reservoir/Tanks, and Lakes/Ponds [Present Status]

2.1. Present condition of Water Bodies under Irrigation Projects

Water bodies are categorized as "Major", "Medium", or "Minor" irrigation projects based on their storage and command area as per national and state irrigation standards. The inventory for the MRB region under is as follows:

Table 1: Inventory for the water-bodies under the Irrigation projects of MRB
[Source: Chhattisgarh Water Resources Dept. of CG WRD and NWIC]

Type	Number of Water Bodies	Total Command Area (ha)	Percentage of Total Command Area
Chhattisgarh State			
Major	15	12,66,929.53	57.37%
Medium	30	2,23,276.90	10.10%
Minor	1,874	7,19,865.32	32.53%
Odisha State			
Major	11	6,11,000	47.14%
Medium	29	1,26,000	9.72%
Minor	538	5,59,000	43.13%

For Chhattisgarh state major projects comprise only 0.78% of the total number but command more than half (57.37%) of the total irrigated area. In contrast, minor projects represent 97.65% of all water bodies, yet together they irrigate about one-third of the total area at the micro scale.

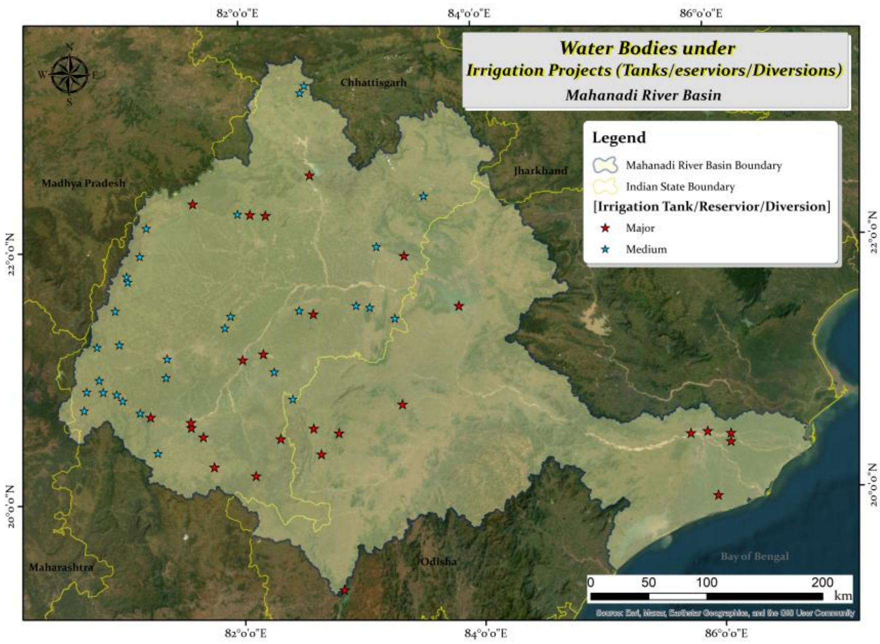


Figure 2: Mahanadi River Basin - Water Bodies under Irrigation Projects

For the Odisha portion of the Mahanadi Basin, the surface water resources are primarily supported by major and minor irrigation projects. The basin contains 11 major projects with a total command area of about 6,11,000 hectares (47.14%), 29 medium projects covering around 1,26,000 hectares (9.72%), and a substantial contribution from minor irrigation projects, which account for roughly 5,59,000 hectares (43.13%).

2.2. Present condition of Water Bodies under Water Harvesting & Conservation Projects

The current inventory of water storage structures within the Chhattisgarh part of the basin is characterized predominantly by small-scale units, with ponds comprising the largest category at 91,399 units, followed by check dams (approximately 1,585), tanks (919), and stop dams (554), along with several localized variations. These decentralized water bodies form the essential infrastructure supporting water resource management throughout the region.

Analysis of functional usage reveals that fisheries constitute the primary activity, with over 66,000 water bodies dedicated to this purpose, underscoring their significant role in sustaining local economies and livelihoods. Domestic water usage also represents a substantial share, accounted for by nearly 26,000 structures, highlighting the importance of these water bodies in meeting rural household needs. In contrast, conservation-focused uses such as soil and water conservation, protective irrigation, and multipurpose water harvesting account for less than 5% of the total, reflecting their complementary rather than dominant role within the basin's water resource portfolio.

Overall, the distribution and functional emphasis of these water bodies point to a community-centric water management framework, prioritizing livelihood support and rural water security over large-scale irrigation schemes.

2.3. Overall condition of Water Bodies

The following assessment is based on the National Water Informatics Centre (NWIC, 2018) Waterbodies Database, which provides a spatial inventory of inland water bodies across the Mahanadi River Basin. The dataset classifies each feature by state and surface area, enabling a comparative overview of distribution patterns and storage scales. This summary presents the state-wise and area-class-wise status of water bodies within the basin as shown in Table 2.

Table 2: State-wise summary of water body status in the Mahanadi River Basin

State	Area Class	Count	Total Area (ha)
Chhattisgarh	<5 ha	79,243	66,128.70
	5–10 ha	1,429	9,817.00
	10–50 ha	953	18,897.30
	50–100 ha	89	6,198.70
	>100 ha	70	61,148.00
	Total	**81,784**	**1,62,189.80**
Odisha	<5 ha	40814	31,092.09
	5–10 ha	567	3,762.75
	10–50 ha	244	4,709.38
	50–100 ha	25	1,721.74
	>100 ha	41	1,34,557.19
	Total	**41,691**	**1,75,843.20**
Maharashtra	(All <50 ha)	258	213.4
Madhya Pradesh	(All <50 ha)	67	75.6
Jharkhand	(All <50 ha)	48	42.3

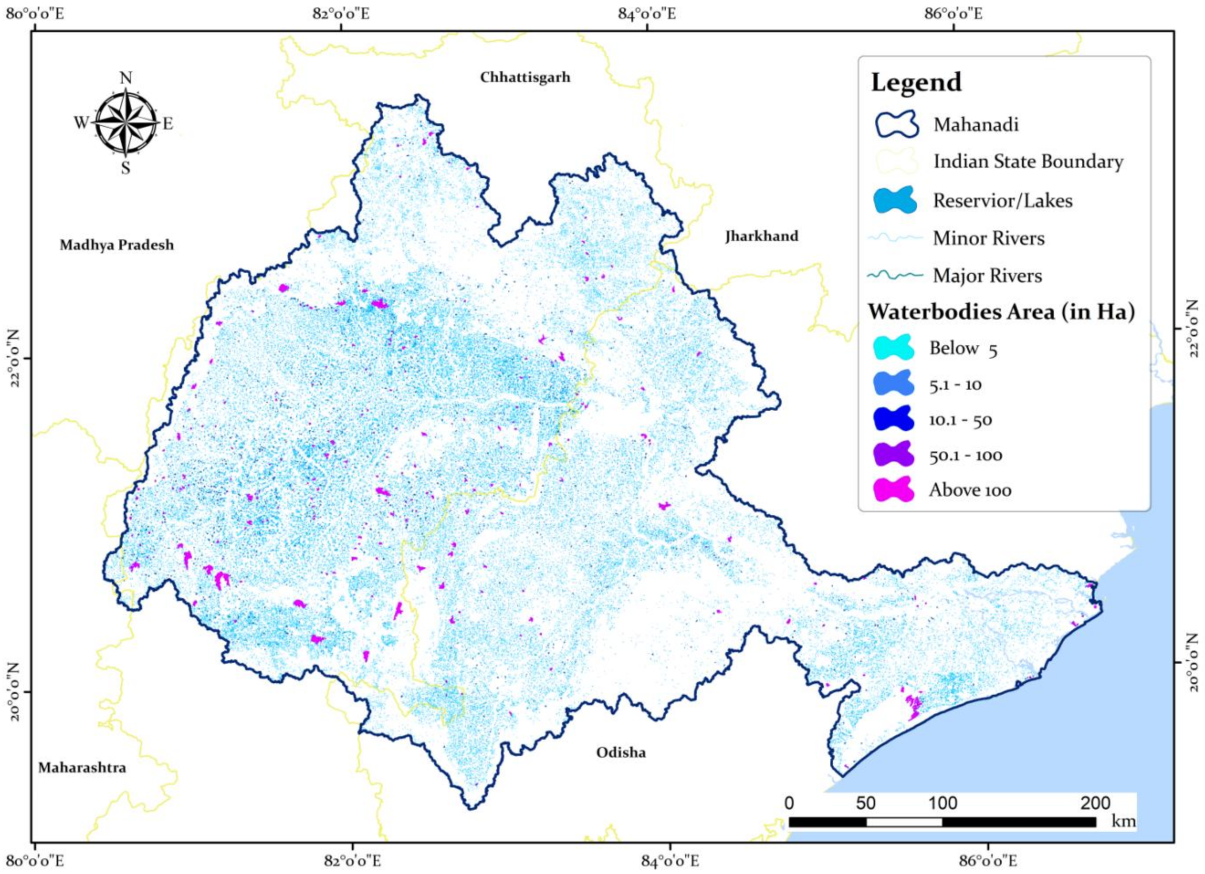
Key Insights

- Chhattisgarh and Odisha together account for over 99% of total water bodies in the Mahanadi Basin.

- Small water bodies (<5 ha) dominate numerically, over 75% of all entries.

- Small water bodies (<5 ha) dominate the landscape, forming over three-fourths of the total count across both major states. However, large water bodies (>100 ha), though fewer in number, contribute significantly to the overall surface area, especially in Chhattisgarh, where reservoir-type structures account for nearly 38 percent of the total storage area. This pattern reflects a strong regional variation in water body size and typology, with Chhattisgarh featuring more large reservoirs and Odisha exhibiting a greater number of small and medium-sized tanks and ponds.

- States like Maharashtra, Madhya Pradesh, and Jharkhand have minor areal representation within the basin extent



Source: *National Water Informatics Centre (NWIC, 2018)*

Figure 3: Mahanadi River Basin: Waterbodies Map

3. Surface Water Dynamics in the Mahanadi River Basin [Reference - 1984]

This section analyses the spatio-temporal dynamics of surface water bodies across the MRB using the JRC Global Surface Water Datasets (GSW v1.4) hosted on Google Earth Engine (GEE). The study aims to:

- Estimate the historical (1984–1999) and recent (2000–2021) water-body extents.
- Assess spatial patterns of water-body gain and loss.
- Evaluate persistence, recurrence, and seasonality of surface water.

3.1. Data Sources

- JRC Global Surface Water Dataset (GSW v1.4) - The JRC GSW v1.4 dataset is a 30 m global product derived from Landsat 5, 7 and 8 imagery (1984–2021). It provides multiple raster bands describing water-occurrence frequency, seasonality, recurrence, transitions, and epochal changes.

(Source: European Commission Joint Research Centre and Google, Dataset DOI: 10.1038/nature20584)

Table 3: JRC Global Surface Water Dataset - Band Details

Band	Description	Units
occurrence	% of valid observations classified as water	0–100 %
seasonality	Number of months water is present per year	0–12
recurrence	Frequency with which water recurs between years	0–100 %
transition	Category of change between first and last valid years	categorical
change_abs / change_norm	Absolute & normalized change between epochs	%
max_extent	Union of all detected water pixels	binary

3.2 Surface Water Occurrence (1984–2021)

The percentage occurrence of water in the Mahanadi River Basin (MRB), as derived from the JRC Global Surface Water (GSW) dataset, reveals detailed spatial variability in the persistence of water across the basin. The data indicate that large areas of the MRB experience water presence with low annual consistency, as shown by the highest area (463.57 sq km) corresponding to just 1% occurrence. This suggests extensive regions likely seasonally inundated floodplains, wetlands, or ephemeral water bodies—where water appears infrequently each year.

As the percentage occurrence increases, the corresponding area decreases sharply, with only a small fraction of the basin experiencing persistent or perennial water coverage. For example, at 10% occurrence, the area drops to approximately 112.91 sq km, showing a clear trend of decreasing water persistence across greater percentages. Areas with more than 50% occurrence indicating semi-permanent or permanent water bodies such as main river channels, major lakes, and reservoirs—are very limited in extent. Only a few locations demonstrate very high occurrence; at 100% occurrence, corresponding to permanent water bodies, the area is 149.52 sq km. Notably, there are isolated peaks at the very highest occurrence classes (e.g., 521.12 sq km at 99% occurrence), possibly due to reservoirs or regulated stretches where water is almost always present.

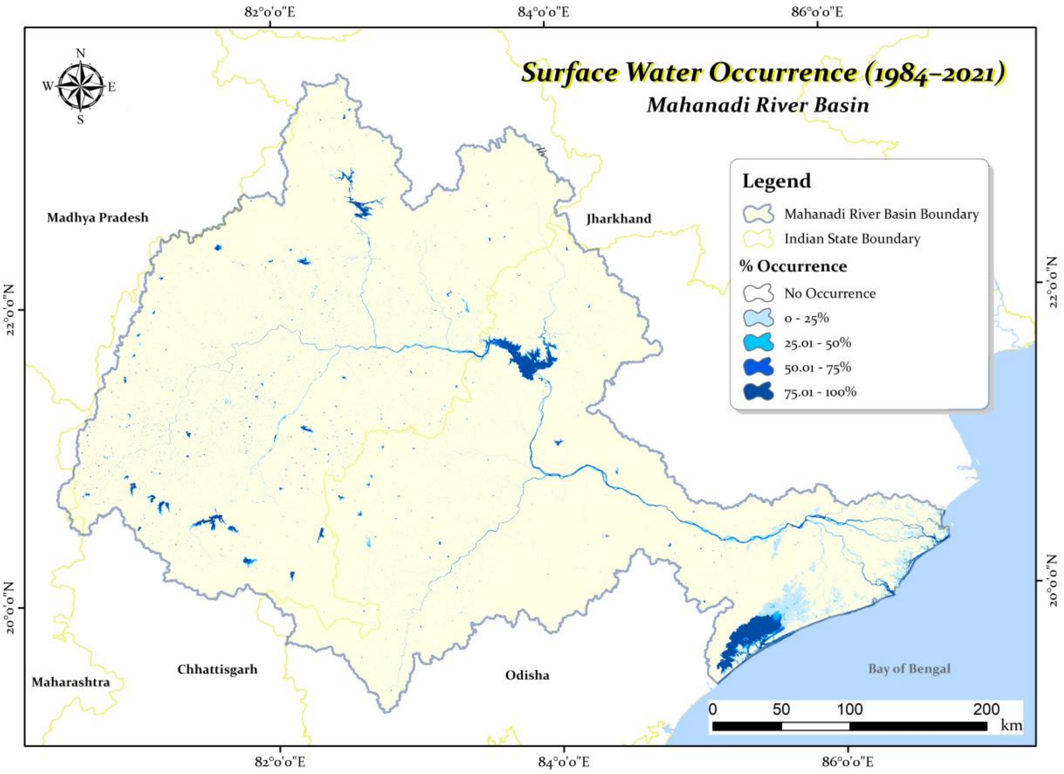


Figure 4: Mahanadi River Basin - Surface Water Occurrence (1984-2021)
Source: JRC Global Surface Water Mapping Layers, v1.4 [Using Landsat 5, 7, and 8] [Period - 16 March 1984 to 31 December 2021]

Overall, this pattern highlights the dynamic hydrological regime within the MRB, characterized by a small core of perennial water and extensive areas with only episodic surface water presence. This has implications for water resource management, ecosystem conservation, floodplain agriculture, and wetland protection, emphasizing the need to integrate hydrological variability in basin planning based on satellite-derived surface water occurrence metrics.

3.3 Seasonality of Surface Water (Average Months per Year)

The seasonality of surface water in the Mahanadi River Basin (MRB), based on the JRC GSW data, shows significant variability in how long different areas remain inundated throughout the year. The data indicate that the largest segment 2,013.94 sq km is classified as having surface water present for all 12 months of the year, representing the basin's permanently water-covered regions such as main river channels, major lakes, and major reservoirs such as Hirakud and Hasdeo.

Areas with water present in fewer than 12 months are much smaller in extent. For instance, regions with water for only 1 month per year cover 693.25 sq km, signifying large stretches of lands that are inundated only briefly, likely during peak monsoon months or flood events. Between 2 to 8 months, the area under water presence ranges from around 252.94 to 438.81 sq km, indicating significant seasonal fluctuation. This includes both floodplains and wetland zones that experience water for considerable but not the full duration of the year.

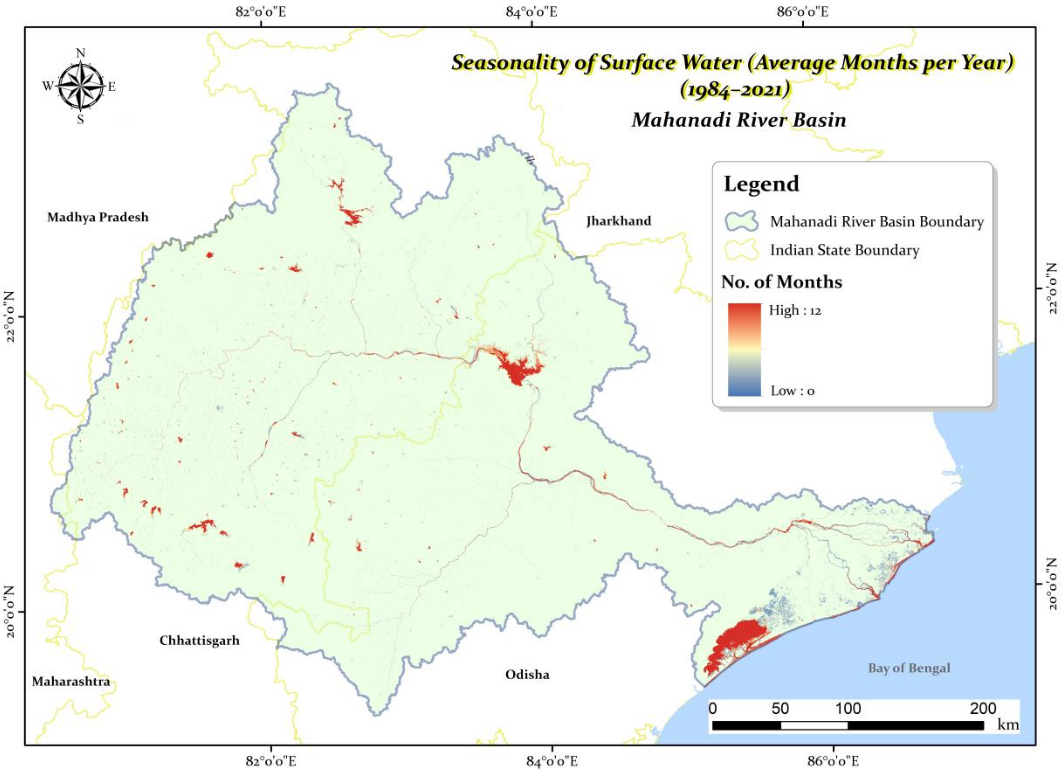


Figure 5: Mahanadi River Basin - Seasonality of Surface Water (Average Months per Year)
Source: JRC Global Surface Water Mapping Layers, v1.4 [Using Landsat 5, 7, and 8] [Period - 16 March 1984 to 31 December 2021]

Surface water persistence rapidly decreases after 8 months, with just 179.84 sq km experiencing 9 months of water, and this further drops for 10 and 11 months to 91.32 sq km and 33.91 sq km, respectively. This distribution underscores that perennial water bodies form a small, but important, core of the MRB, while the remaining areas reflect strong intra-annual variability tied closely to monsoon-driven hydrological cycles. These findings emphasize the dynamic surface water landscape in the MRB, with important implications for water management, ecosystem support, and planning for both wet and dry season needs.

3.4 Categorical Classification of Surface Water Transition/Change

The analysis of water transition classes in the Mahanadi River Basin (MRB) from 1984 to 2021, using JRC GSW data shows that the largest category is "Permanent," with 1,570.67 sq km, representing areas with consistently stable water bodies that have shown little variation over the monitoring period. Additional growth in the coverage of water bodies is reflected in the "New Permanent" class (271.98 sq km), indicating locations that have transitioned to permanent water in recent decades, possibly due to reservoir creation, persistent flooding, or land use changes. Conversely, only a small area (29.50 sq km) falls under "Lost Permanent," where water bodies have disappeared.

"Seasonal" water extent is also substantial, at 1,522.82 sq km, signifying regions where water appears regularly but not year-round. The emergence of new seasonally inundated areas is evident in the "New Seasonal" class (1,502.02 sq km), while "Lost Seasonal" (859.63 sq km) highlights regions that previously experienced recurring seasonal surface water but have since diminished—potentially due to reduced monsoon flow, water management interventions, or land cover change.

Transitions between categories capture the changing hydrological character. For instance, "Seasonal to Permanent" (171.29 sq km) shows locations where water presence has become more persistent, while "Permanent to Seasonal" (193.27 sq km) indicates a reduction in water permanence. Additionally, "Ephemeral Permanent" (10.43 sq km) and "Ephemeral Seasonal" (974.66 sq km) represent areas with highly variable or short-lived water occurrence, reflecting increased variability, possibly linked to climatic extremes or shifting land use practices. These transition patterns collectively highlight significant reorganization of surface water dynamics within the MRB across the past four decades, underscoring the need for adaptive water management strategies based on spatially explicit long-term monitoring data.

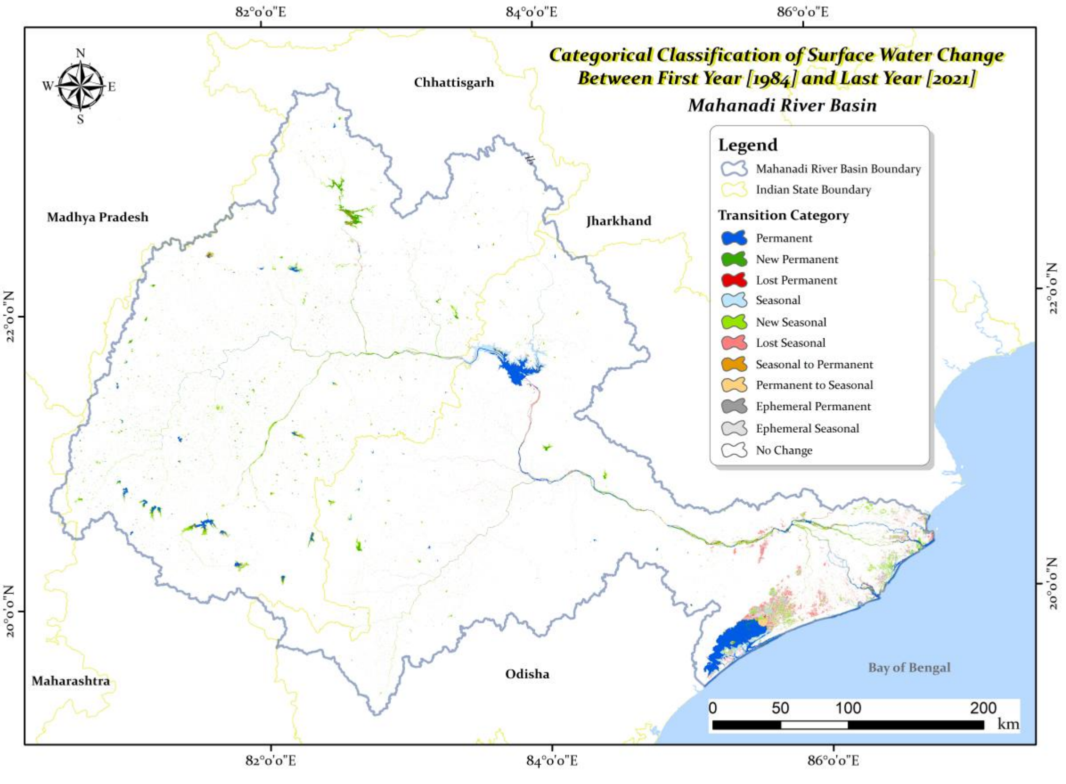
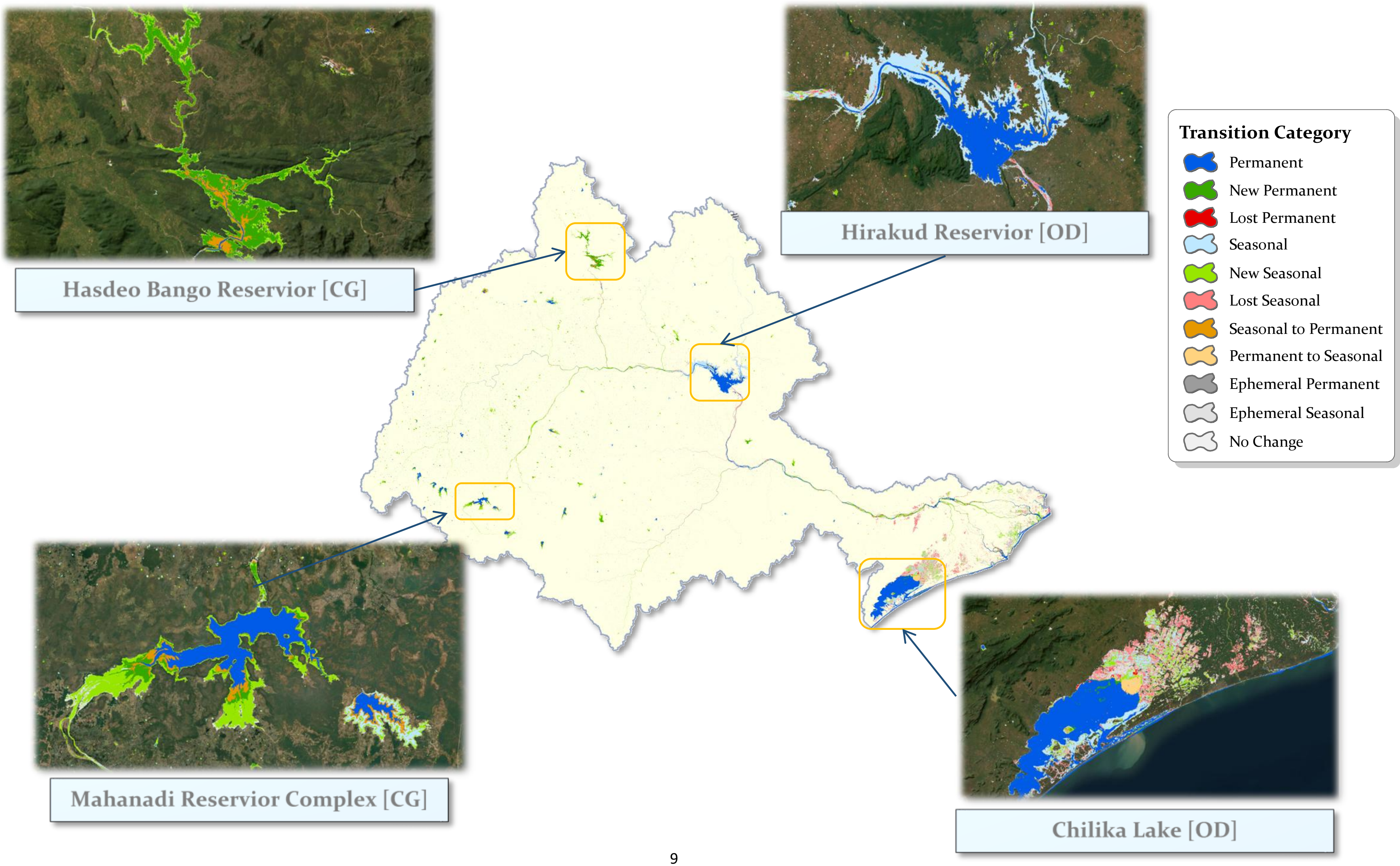


Figure 6:Mahanadi River Basin - Categorical Classification of Surface Water Change/Transition
Source: JRC Global Surface Water Mapping Layers, v1.4 [Using Landsat 5, 7, and 8] [Period - 16 March 1984 to 31 December 2021]

Figure 7:Surface Water Change/Transition of Major Water-Bodies under MRB



3.5 Change in Water Occurrence between Baseline period (Epoch 1 | 1984–1999) and Recent period (Epoch 2 |2000–2021)

A) Absolute Change

$$change\_abs = occurrence\_epoch2 - occurrence\_epoch1$$

The analysis of absolute change in surface water occurrence across the Mahanadi River Basin (MRB), using JRC GSW data, reveals distinct spatial variability in hydrological conditions between the two epochs. The data indicate substantial reductions in water occurrence, with the most extreme decline (–100%) covering approximately 101.68 sq km, representing areas that have completely lost surface water. These zones likely correspond to drained wetlands, diminished floodplains, or regions affected by intensive land-use conversion.

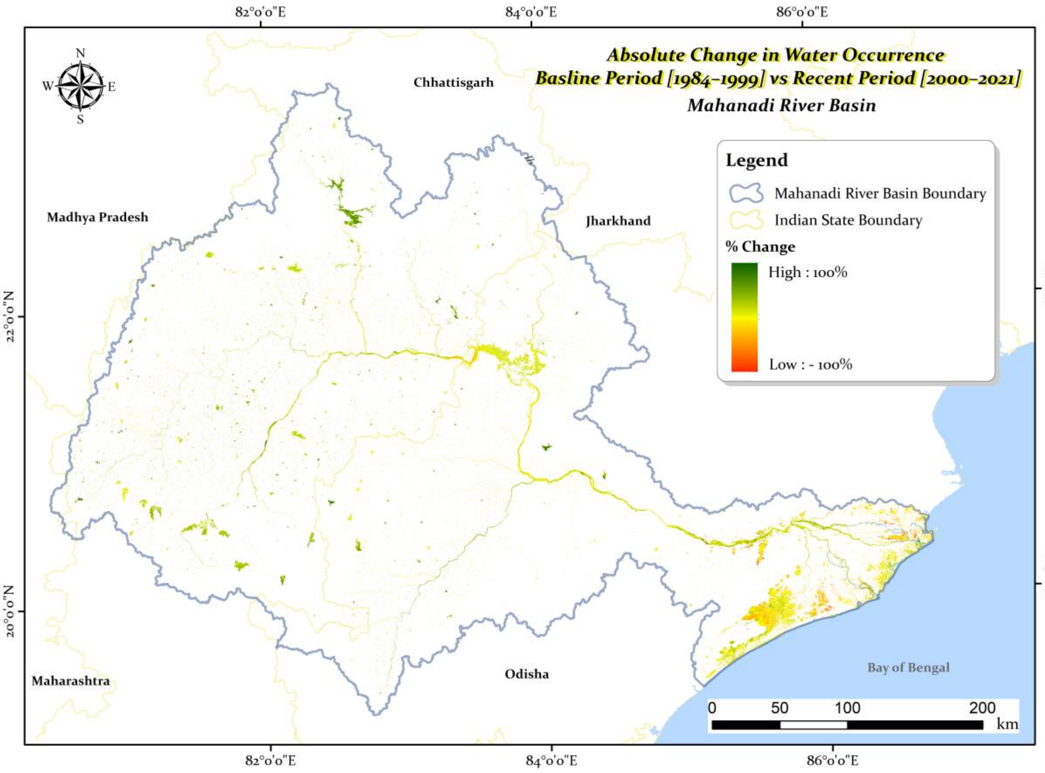


Figure 8: Mahanadi River Basin - Absloute Change in Water Occurrence Between Basline and Recent Period

Source: JRC Global Surface Water Mapping Layers, v1.4 [Using Landsat 5, 7, and 8] [Period - 16 March 1984 to 31 December 2021]

Gradual decreases from –99% to –1% reflect progressive contraction of seasonally or intermittently inundated lands, whereas the majority of the basin (133,772.31 sq km) shows no absolute change (0%), signifying stable terrestrial areas with minimal variation in water presence over the study period. Conversely, positive values denote zones of increased water occurrence. Incremental gains between +1% and +99% mark areas where water persistence has improved, possibly due to wetland restoration, reservoir expansion, or flow regulation. Intermediate change classes (±10% to ±50%) highlight transition zones responding to climatic fluctuations or anthropogenic influences.

Overall, the pattern illustrates a dynamic hydrological landscape, characterized by both notable loss and gain in surface water distribution. These findings provide essential insight for identifying priority zones for water conservation, restoration, and basin-level management planning.

B) Normalised Change

$$change\_norm = \frac{occurrence\_epoch2 - occurrence\_epoch1}{occurrence\_epoch2 + occurrence\_epoch1} \times 100$$

Normalized change in water occurrence, representing relative (percent-scaled) variation compared to baseline conditions, highlights proportional gains and losses across the MRB. The most significant reductions are observed where 534.52 sq km exhibit a complete (–100%) normalized loss, indicating total disappearance of surface water features. Smaller areas show moderate declines (–99% to –1%), each typically covering less than 15 sq km, signifying localized contraction of seasonal or temporary water bodies.

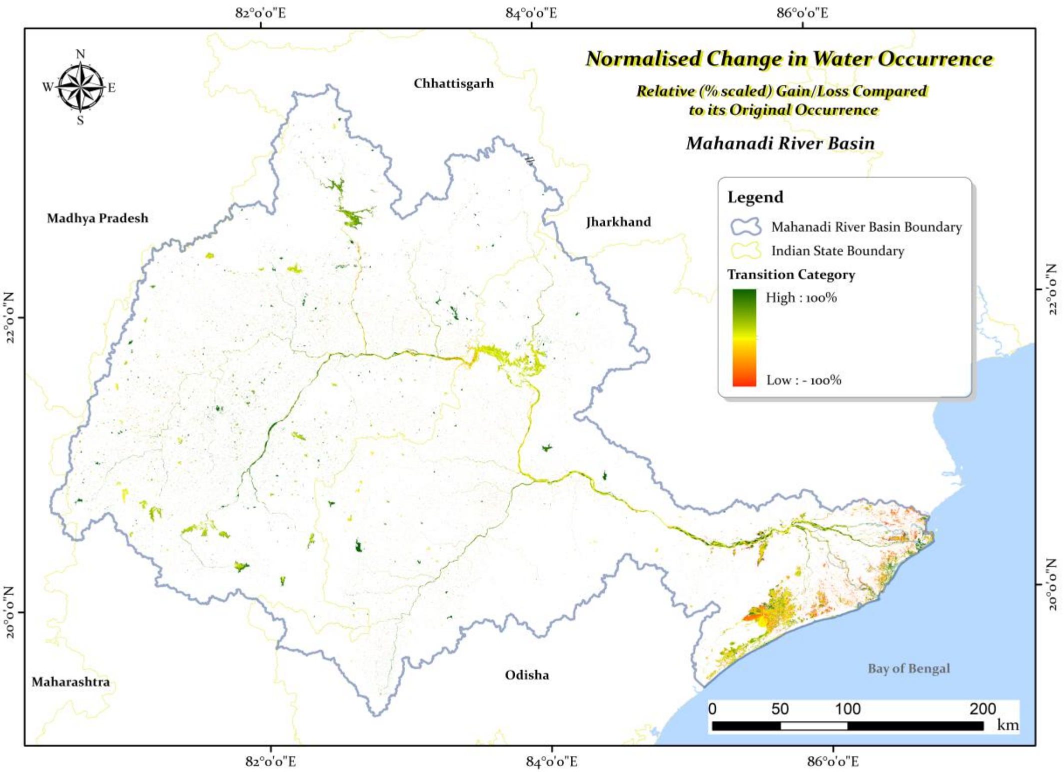


Figure 9: Mahanadi River Basin - Normalised Change in Relative Gain/Loss of Water Compared to its Original Occurrence

Source: JRC Global Surface Water Mapping Layers, v1.4 [Using Landsat 5, 7, and 8] [Period - 16 March 1984 to 31 December 2021]

Stable conditions dominate the basin, with 133,812.21 sq km classified under the 0% change category, reaffirming hydrological stability across large terrestrial expanses. On the other hand, normalized gains (+1% to +100%) occur in limited but distinct areas. A +100% increase, extending over 845.85 sq km, represents newly formed or significantly expanded water bodies, likely associated with anthropogenic interventions such as reservoir creation, irrigation development, or wetland rehabilitation.

The overall distribution underscores that while complete losses and gains are geographically confined, the majority of the MRB exhibits minor, incremental shifts in relative water occurrence. This normalization enhances comparability across sub-regions and supports assessment of hydrological resilience and human-induced changes.

4. Major Wetlands

Wetlands within a river basin act as natural water infrastructure that store monsoon flows, recharge groundwater, and release water gradually, thereby stabilizing baseflows through dry months and reducing flood peaks during storms. Situated along floodplains, riparian corridors, and depressions, they intercept sediments and nutrients, improving water quality and lowering the need for hard treatment and flood-control structures. By linking land and water, wetlands enhance the resilience of irrigation, drinking water systems, and fisheries, while providing cost-effective nature-based solutions for basin management. Integrating wetland conservation and wise use into river basin planning ensures appropriate water allocation to sustain these hydrological and purification functions alongside economic uses.

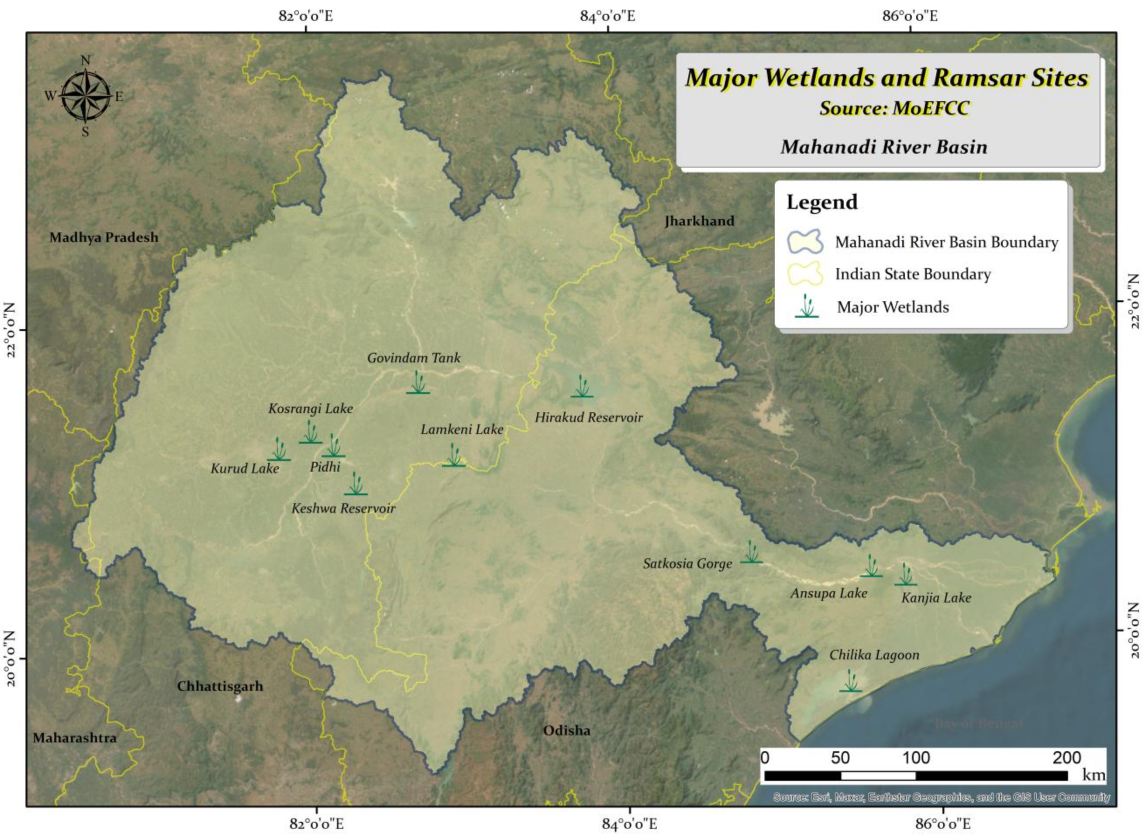


Figure 10: Mahanadi River Basin - Major Wetlands
Source: MoEFCC

The CG segment of the Mahanadi basin comprises six predominantly human-made wetlands totaling about 700 ha, anchored by four medium-sized storages (Kurud, Kosrangi, Keshwa, Lamkeni) that exceed 120 ha each and two smaller tanks acting as local feeders and contingency buffers. Although no site currently holds Ramsar status, recognizing the major wetlands of the state as Ramsar sites would bring international recognition, boost conservation funding, and enhance ecological restoration, flood resilience, and sustainable livelihoods for the communities dependent on these landscapes.

The Odisha segment of the Mahanadi basin is ecologically defined by a core network of four designated Wetlands of International Importance (Ramsar Sites), totaling approximately

280,000 ha, (Chilika, Satkosia, Hirakud, and Ansupa), ranging from the open sea to man-made inland reservoirs. The wetlands also include a significant local anchor like Kanjia Lake (105 ha), which, while not carrying Ramsar status, functions as a crucial reservoir for biodiversity and a freshwater resource in the Bhubaneswar area.

Proposed Ramsar Site Nominations (Mahanadi Basin)

Based on state-level wetland prioritization and ecological screening, six wetlands have been identified as candidates for future Ramsar nomination:

For Chhattisgarh State

- Gidwha–Parasada
- Kopra
- Mandhar
- Gangrel
- Kurandi
- Neemgaon

Source: Wetland Authority of Chhattisgarh, State Wetland Inventory & Prioritization List (2023–2024). Government of Chhattisgarh.

For Odisha State

- Tampara Lake (Ganjam)
- Bahuda Wetland Complex (Ganjam)
- Nandankanan–Kanjia Wetland Complex (Khordha)
- Hirakud Fringe Wetland Clusters (Sambalpur–Bargarh)
- Mangalajodi Expansion Zone (Chilika fringe wetlands)
- Ansupa Peripheral Wetland System Enhancements
- Joranda–Dhauli Wetland Cluster (Khordha–Cuttack)

Source: Odisha Wetland Authority (OWA), "State Wetland Inventory and Priority List," 2023–2024; Environment Department, Government of Odisha.

Note: A few of these (e.g., Chilika, Ansupa) already contain Ramsar-notified core sites; the proposal relates to expansion zones or adjunct wetland systems identified for future designation based on biodiversity value, hydrological function, and Ramsar Criteria 2, 5, and 6.

Collectively, these water bodies face recurring challenges such as inlet siltation and the spread of invasive macrophytes - both indicators of nutrient and sediment pressures within the catchment. This underscores the importance of implementing inlet silt traps, vegetated buffer zones, and phased de-weeding measures to maintain live storage capacity and ensure smooth intake operations.

5. Conclusion & Recommendations

Conclusion

The Water-bodies Atlas of the Mahanadi River Basin provides an extensive inventory and assessment of the basin's diverse water resources, spanning over 141,589 square kilometers across Chhattisgarh, Odisha, and neighboring areas. The basin supports critical agricultural activities yet faces seasonal variability, frequent floods, and localized water stress. The basin's water bodies are predominantly small and decentralized, emphasizing community-centric management focused on livelihoods and rural water security. Despite this, large reservoirs play a vital role in irrigated agriculture.

Surface water dynamics show a highly variable hydrological regime with a small core of perennial water bodies amidst extensive seasonal and ephemeral water presence. There have been notable spatial changes over recent decades, with some water bodies gaining permanence while others experience losses, reflecting climatic and anthropogenic influences. Wetlands act as crucial natural infrastructure for water storage, purification, and flood mitigation but face challenges such as siltation and invasive species pressure.

The findings highlight the importance of adopting integrated and adaptive river health and basin management approaches that incorporate long-term spatial monitoring, hydrological variability, and ecosystem services to sustain water security, ecological integrity, and community livelihoods across the Mahanadi Basin.

Recommendations

River Health Management

- Develop and implement adaptive monitoring programs using satellite and ground data to track surface water changes and water quality continuously.
- Prioritize restoration of degraded wetlands and water bodies through interventions such as silt trap installation, vegetated buffer zones, and invasive macrophyte control.
- Enhance protective measures for perennial and semi-permanent water bodies critical for ecosystem services and local livelihoods.
- Integrate water quality monitoring and pollution control within basin-wide management to safeguard aquatic biodiversity and human water uses.
- Promote sustainable fisheries and domestic water usage practices aligned with ecological conditions to reduce stress on water bodies.

Basin Management

- Strengthen policy and institutional frameworks to support coordinated water resource management across states and sectors within the Mahanadi Basin.

- Implement community-inclusive water governance structures that prioritize equitable water allocation for irrigation, conservation, and domestic use.

- Advance nature-based solutions such as wetland conservation, floodplain protection, and groundwater recharge to enhance basin resilience to floods and droughts.

- Encourage multi-scale water harvesting and conservation projects, emphasizing decentralized small water body management to complement major irrigation infrastructure.

- Foster inter-agency collaboration utilizing spatial data analytics for holistic planning and management to balance development needs with ecosystem sustainability.

These recommendations aim to improve river health and holistic basin management, ensuring the long-term sustainability of water resources and socio-economic benefits throughout the Mahanadi River Basin

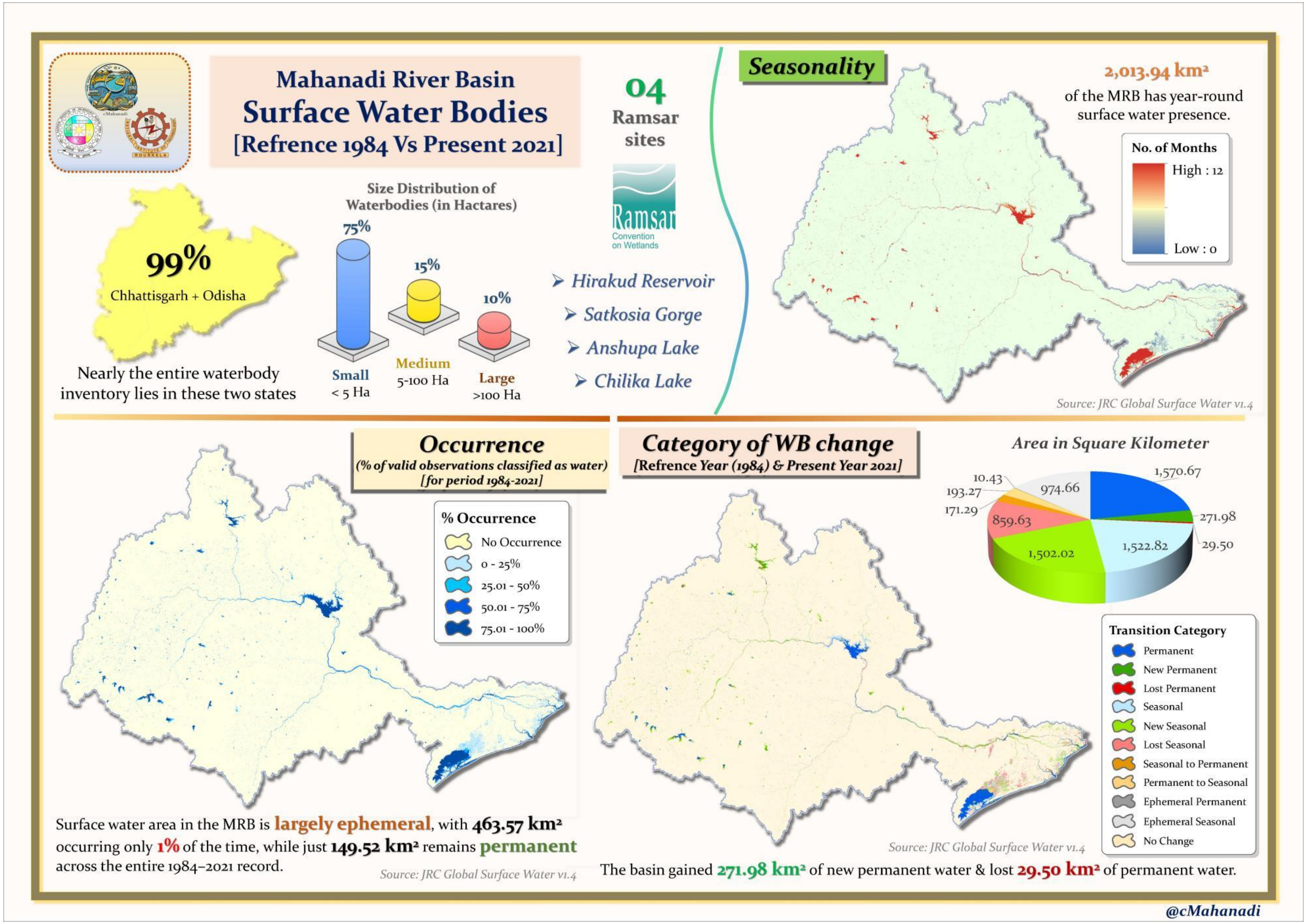


Figure 11: MRB Surface Water Bodies

Acknowledgement

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- European Commission – Joint Research Centre (JRC)
  [JRC/GSW1_4/GlobalSurfaceWater (1984–2021)]

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