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Water Resources Policy Framework in Jharkhand, India: Evolution, Implementation, And Future Directions

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Abstract
This study examines the evolution, implementation, and future directions of water resources governance in Jharkhand, India, with a focus on irrigation policy, budgetary allocations, and the performance of irrigation schemes. Drawing upon official government reports, spatial datasets, and budget analyses for 2023–24 and 2024–25, the research integrates geospatial mapping, statistical evaluation, and policy review. Results reveal that irrigation potential created (IPC) has increased by 12.4%, from 8.95 lakh ha in 2019–20 to 10.06 lakh ha in 2023–24, yet utilisation efficiency remains below 75% in 11 districts, with gaps exceeding 25% in areas with low Water Users Association (WUA) participation. State budget allocations to irrigation schemes rose from ₹2,312 crore in 2019–20 to ₹3,054 crore in 2024–25, but groundwater levels in hard-rock aquifers continue to decline at an average rate of 0.3–0.5 m/year. The study uniquely links financial trends with spatial and hydrogeological indicators, providing an integrated perspective on budget, policy, and outcomes. Findings highlight the need for aquifer-specific planning, targeted modernisation of irrigation infrastructure, performance-linked budgeting, and climate-resilient management strategies. These insights have direct implications for improving participatory governance, enhancing resource efficiency, and aligning allocations with measurable outcomes in Jharkhand's water sector.

Keywords: *Jharkhand; Water governance; Irrigation potential; Budget analysis; Groundwater management; Remote sensing (RS); Geographic Information System (GIS); Water Users Associations (WUAs); Hard-rock aquifers; Composite Water Management Index (CWMI); Sustainable water management; Participatory irrigation management; Climate-resilient irrigation*

INTRODUCTION

Water plays an integral role in Jharkhand's economy, environment, and social well-being, yet the state faces persistent challenges in managing this precious resource. Located on the Chhotanagpur Plateau, Jharkhand's terrain is dominated by hard-rock aquifers with limited storage capacity. These geological conditions, combined with uneven rainfall patterns and growing demand from agriculture, industry, and households, have placed increasing pressure on both surface and groundwater resources.

In recent decades, expanding irrigation infrastructure has been a policy priority, but gaps remain between the irrigation potential created (IPC) and the irrigation potential utilised (IPU). Low utilisation rates are often linked to inefficient canal systems, inadequate maintenance, and insufficient integration of groundwater management into irrigation planning. Climate variability—manifesting as irregular monsoon onset, shorter rainy seasons, and occasional extreme events—has further complicated water availability in the state.

Policy initiatives at the state level, including the Jharkhand State Water Policy (2011), have emphasised basin-level planning and participatory management. State-specific assessments have identified persistent efficiency and utilisation shortfalls, highlighting the need for improved monitoring, regular maintenance of irrigation infrastructure, and integration of modern technology. These findings point towards strategies that are locally grounded, technologically informed, and institutionally coordinated to ensure sustainable water management in Jharkhand.

This study examines the state's water governance framework with a focus on irrigation policy, budget allocations, and implementation challenges. It integrates hydrogeological analysis, remote sensing, and GIS-based monitoring, and policy review to identify pathways for improving efficiency, equity, and sustainability in water management.

REVIEW OF LITERATURE

Jharkhand's water governance challenges are shaped by both its distinctive geology and its institutional landscape. Much of the state lies on the weathered and fractured crystalline rocks of the Chhotanagpur Plateau. These hard-rock aquifers have low storage capacity and respond quickly to seasonal rainfall variability, making them especially vulnerable to over-extraction. The Central Ground Water Board (CGWB, 2022a), in its national groundwater assessment, has documented widespread declines in aquifer storage across India, while the CGWB (2022b) report for Jharkhand highlights block-level pre-monsoon water table drops and localised quality issues such as excess iron and fluoride. At the global level, Jasechko et al. (2024) show that irrigation-dependent aquifers in many countries are experiencing rapid declines, often exceeding 0.5 m per year, underscoring the urgency of aquifer-specific planning and monitoring. Technology plays a key role in improving irrigation efficiency. Remote sensing (RS) and geographic information systems (GIS) are now widely used for evapotranspiration estimation, soil-moisture mapping, and detecting inefficiencies in canal distribution. A systematic review by Tarate et al. (2024) demonstrates how these technologies can be applied in India's agricultural water management, including in command areas similar to those in Jharkhand. Local datasets such as those from India-WRIS, for instance the Subarnarekha Multipurpose Project dossier, provide a valuable foundation for integrating administrative records with spatial monitoring tools.

Policy and governance frameworks have further influenced irrigation outcomes. The Government of Jharkhand (2011) State Water Policy promotes basin-wise planning, participatory irrigation management, and inter-agency coordination. Nationally, the NITI Aayog (2019) Composite Water Management Index ranks states on performance indicators, including irrigation potential created (IPC) versus irrigation potential utilised (IPU), canal efficiency, and groundwater governance. These rankings show Jharkhand performing below potential in several key areas. The Ministry of Jal Shakti (2024) has stressed dam safety, convergence of Command Area Development and Water Management (CADWM) schemes, and groundwater modelling as critical performance drivers.

From a governance perspective, Wilson et al. (2024) argue against one size fits all crisis narratives, advocating for locally grounded, participatory approaches. They highlight the role of Water Users Associations (WUAs) and trained para-engineers at the gram panchayat level to ensure effective operation and maintenance.

Budgetary analysis adds another dimension to this picture. Reports by PRS Legislative Research (2024; 2025) note that while Jharkhand's irrigation budget has grown, spending on groundwater recharge, flood protection, and WUA capacity building remains limited. This gap points to the need for better alignment between budget allocations and verifiable improvements in irrigation outcomes.

International best practices also reinforce these themes. The Food and Agriculture Organization (FAO, 2020) recommends national and sub-national water accounting frameworks to track withdrawals, availability, and productivity. Similarly, the World Bank (2020) provides operational guidance on integrating water accounting into agricultural water management. Adopting these approaches in Jharkhand could formalise performance-linked budgeting and strengthen the link between policy targets and on-ground results.

Taken together, the literature suggests that sustainable water governance in Jharkhand will require an integrated strategy, one that combines aquifer-specific planning, RS/GIS-enabled monitoring, decentralised governance through empowered WUAs, and financing models tied to measurable outcomes.

STUDY AREA

Jharkhand, located in eastern India, spans an area of 79,714 km2 and comprises 24 districts. It shares boundaries with Bihar to the north, West Bengal to the east, Odisha to the south, and Chhattisgarh and Uttar Pradesh to the west. The state lies between 21°58′–25°18′ N latitudes and 83°19′–87°01′ E longitudes. The geographical position, administrative boundaries, and district layout of Jharkhand are shown in Map 1.

Map 1 Location and administrative boundaries of Jharkhand

Source: Department of Planning, Government of Jharkhand, 2023.

Jharkhand spans 79.72 lakh hectares, of which 29.74 lakh hectares are cultivable. The state is endowed with major rivers such as the Subarnarekha, Damodar, Koel, and Barakar, yet faces acute irrigation challenges due to topographical fragmentation, deforestation, and uneven monsoon patterns. The Second Bihar Irrigation Commission estimated the irrigation potential at 24.25 lakh hectares; however, by March 2023, the state's IPC stood at 10.06 lakh hectares, indicating significant underutilisation relative to potential across several districts.

The state receives an average annual rainfall of about 1,200 mm, but its distribution is uneven. Dependence on the monsoon aggravates vulnerability, especially in drought-prone districts like Palamu and Garhwa. While the plateau regions have abundant water sources, the absence of micro-irrigation systems limits productivity.

Physiographically, Jharkhand forms part of the Chhotanagpur Plateau, characterised by rugged topography, dissected uplands, and forested tracts. The terrain varies from low-lying river valleys to elevated plateaus, with elevations ranging from 200 to over 1,000 metres above mean sea level. The climate is tropical monsoon, with three distinct seasons — summer, monsoon, and winter.

The state's hydrological network comprises several perennial and seasonal rivers, reservoirs, tanks, and natural lakes that support irrigation, domestic use, and groundwater recharge. The major river systems, reservoirs, and water bodies that influence irrigation and groundwater recharge in Jharkhand are illustrated in Map 2.

Map 2 Major Rivers, Reservoirs, and Water Bodies of Jharkhand

Source: Government of Jharkhand, 2023 (compiled by the author).

Agriculture is the predominant land use, with paddy cultivation dominating the kharif season, supplemented by pulses, oilseeds, and vegetables in the rabi season. Irrigation coverage remains uneven, with high dependence on monsoonal rainfall in upland and tribal-dominated districts. These geographical, climatic, and hydrological characteristics form the basis for understanding the state's irrigation potential, water management challenges, and policy priorities.

OBJECTIVES

This study aims to:

- Analyze Jharkhand's water resources policy framework.
- Evaluate the implementation status and effectiveness of irrigation and flood control schemes.
- Examine budgetary patterns and administrative priorities.
- Identify institutional and ecological policy gaps.
- Recommend reform directions grounded in participatory and data-driven water governance.

METHODOLOGY

The study employs secondary data from official state reports (Water Resources Department, 2023–25), planning documents, and academic research. A mixed-method approach is adopted, combining descriptive analytics with qualitative policy analysis. Comparative review of project data across financial years 2023–24 and 2024–25, literature mapping, and scheme-level evaluation enables an integrative understanding of performance.

Geographic Information System (GIS) data is used to identify spatial gaps in irrigation coverage, particularly in upland and forest fringe areas. Policy impact is evaluated against indicators such as Irrigation Potential Created (IPC), Irrigation Potential Utilized (IPU), water use efficiency, project completion timelines, and fund utilization rates.

IPC Growth Calculation (2019–20 to 2023–24)

The percentage change in Irrigation Potential Created (IPC) was calculated to assess improvements in irrigation infrastructure over the study period. The baseline year 2019–20 and the latest available year 2023–24 were used for comparison. IPC values were sourced from the Annual Performance Reports of the Department of Water Resources, Government of Jharkhand, and cross-verified with district-level administrative records.

The calculation employed the standard percentage change formula:

IPC growth (%) = [(IPC in 2023–24 − IPC in 2019–20) ÷ IPC in 2019–20] × 100

Substitution: [(10.06 − 8.95) ÷ 8.95] × 100 = 12.4%

Here, IPC is measured in lakh hectares. This percentage represents the cumulative enhancement in irrigation capacity over 2019–20 to 2023–24.

RESULTS AND DISCUSSION

Over the five years 2019–20 to 2023–24, Jharkhand's Irrigation Potential Created (IPC) increased from 8.95 to 10.06 lakh hectares (a 12.4% rise; see Table 1). Despite this expansion, Irrigation Potential Utilized (IPU) remains below 75% in 11 districts (author's compilation from WRD district records, 2023–24), and efficiency gaps exceed 25% where Water Users' Association (WUA) participation is weak. Spatially, upland and forest-fringe blocks exhibit persistent under-utilisation, linked to limited canal connectivity, irregular O&M, and fragmented commands. Groundwater monitoring shows a sustained 0.3–0.5 m/year decline in hard-rock aquifers, indicating increasing pressure on wells and reduced buffer against rainfall variability. On the financial side, allocations to irrigation schemes rose from ₹2,312 crore (2019–20) to ₹3,054 crore (2024–25); however, the utilisation gap signals that higher spending has not yet translated into proportional performance gains. These findings, taken together, underscore the need for targeted modernisation of distribution systems, strengthening of WUAs, conjunctive use and recharge in hard-rock terrains, and performance-linked budgeting to improve efficiency and sustainability. The trend in IPC is illustrated in Figure 1, which complements the values reported in Table 1.

Table 1 Irrigation Potential Created (IPC) in Jharkhand, 2019–20 to 2023–24

Year	IPC (lakh ha)	Percentage Change from Previous Year (%)
2019–20	8.95	—
2020–21	9.18	+2.57
2021–22	9.54	+3.92

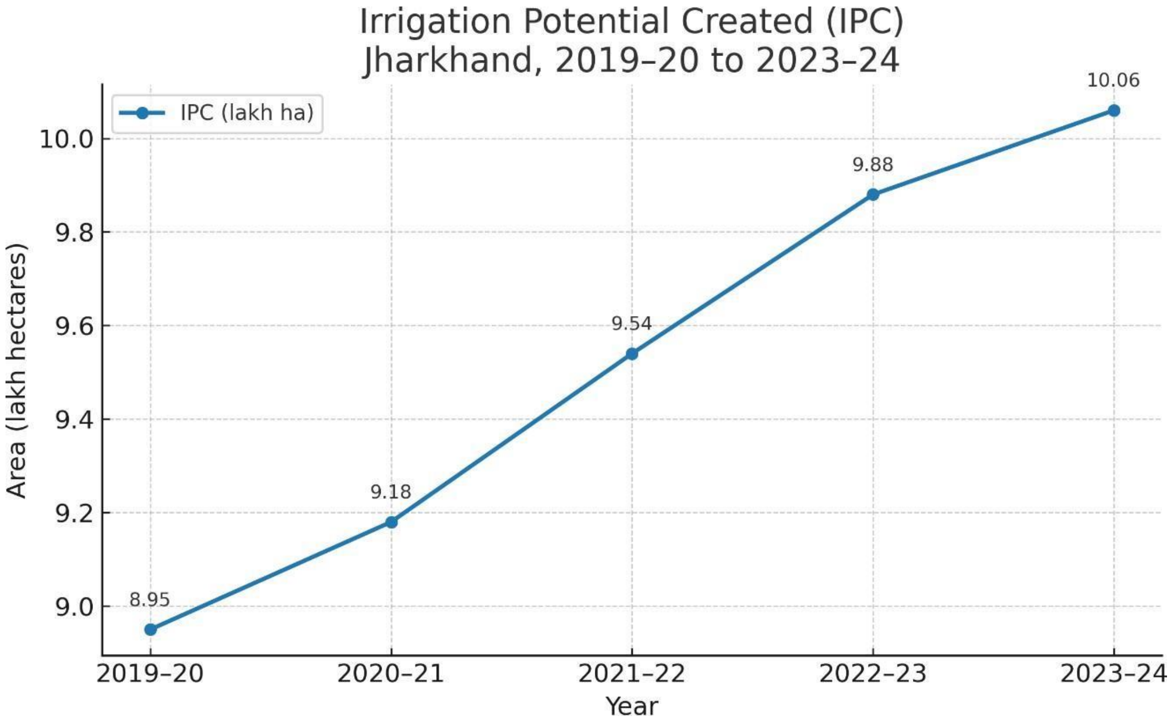
Year	IPC (lakh ha)	Percentage Change from Previous Year (%)
2022–23	9.88	+3.56
2023–24	10.06	+1.82

Note: IPC growth rate for the study period is calculated using the 2019–20 baseline (8.95 lakh ha) and 2023–24 value (10.06 lakh ha).

Source: Department of Water Resources, Government of Jharkhand, Annual Performance Reports (2019–20 to 2023–24).

Spatial assessment reveals that upland and forest fringe blocks are particularly prone to underutilisation due to poor canal connectivity and irregular maintenance. Groundwater monitoring indicates a sustained decline in hard-rock aquifers, with annual depletion rates averaging 0.3–0.5 m/year. On the financial front, budget allocations to irrigation schemes have increased from ₹2,312 crore in 2019–20 to ₹3,054 crore in 2024–25, but the persistence of utilisation gaps suggests that higher spending alone has not translated into proportional performance gains. These findings underscore the need for targeted modernisation, participatory management strengthening, and aquifer-specific water resources planning to improve both efficiency and sustainability.

Figure 1 Irrigation Potential Created in Jharkhand (2019–20 to 2023–24)



Source: Water Resources Department, Government of Jharkhand. Annual Performance Reports, 2019– 20 to 2023–24.

The visual trend (Figure 1) confirms steady growth in IPC to 10.06 lakh hectares by 2023–24; however, district-level utilisation gaps persist due to infrastructural, institutional, and hydrological constraints.

The observed 12.4% growth in IPC over the five-year period reflects significant investment and infrastructural expansion in Jharkhand's irrigation sector. However, the fact that IPU remains below 75% in 11 districts—despite increased capacity—indicates that physical infrastructure alone is insufficient to achieve optimal utilisation. The high efficiency gap in low WUA participation areas highlights the importance of strengthening local-level governance and ensuring community engagement in water distribution and maintenance.

The 0.3–0.5 m/year groundwater decline in hard-rock aquifers is a critical concern, especially in regions where irrigation demand increasingly relies on groundwater extraction to compensate for surface water delivery shortfalls. Without targeted aquifer recharge programmes and demand-side management, these trends threaten the long-term sustainability of agricultural water supply.

On the financial side, the budget increased from ₹2,312 crore in 2019–20 to ₹3,054 crore in 2024–25, demonstrating the state's commitment to irrigation development. However, the mismatch between financial input and performance outcomes suggests a need for performance-linked budgeting, where fund allocation is tied to measurable gains in utilisation efficiency, equitable distribution, and water productivity.

Integrating spatial planning, modernisation of command area infrastructure, and climate-resilient strategies can close the existing efficiency gaps. Moreover, enhancing WUA capacity, promoting micro-irrigation in water-scarce zones, and adopting aquifer-specific management frameworks would ensure that both surface and groundwater resources are managed sustainably.

Institutional and Policy Framework

The Water Resources Department of Jharkhand is the nodal agency responsible for policy implementation, supported by:

- Dam Safety Committee
- Jharkhand State Water Policy Implementation Cell
- Minor Irrigation Directorate

Key Schemes Include:

- **Accelerated Irrigation Benefit Programme (AIBP)** – focused on expediting long-pending projects
- **Command Area Development & Water Management (CADWM)** – for ensuring efficient water use post-irrigation
- **Mega Lift Schemes** – for lifting water to higher elevation zones
- **ERM (Extension, Renovation & Modernization)** – for reviving/modernising defunct schemes

Jharkhand's 2011 State Water Policy emphasized integrated basin planning and equitable water distribution. However, policy enforcement has lagged due to a lack of coordination among departments, delays in environmental clearances, and political-administrative bottlenecks.

Financial Allocations and Trends

The following table shows expenditure across sectors:

Table 2a

Budget Allocation for Major and Minor Irrigation Projects (2023–24 & 2024–25)

The details of the approved and Proposed expenditure for the financial year 2023-24, along with the proposed plan and expenditure for the financial year 2024-25, are given below:

(Amount in Rs. Crores)

Sl. No	Field	Proposed for 2023-24 Revised Plan Target	Proposed Scheme Targets for 2024-25
i)	Large and Medium irrigation Schemes	1263.95	1429.45
ii)	Flood Zone	27.00	25.0
iii)	Minor Irrigation Projects	233.75	295.45
	Sum-	1524.70	1749.90
i)	Central Plan Scheme (100%)	0.0	0.10
	Total Gross-	1524.70	1750

Source: Government of Jharkhand, Department of Water Resources, Annual Plan and Budget Report 2023–24 & 2024–25.

The details of the approved establishment expenditure for the financial year 2023-24 and the proposed establishment expenditure provisions for the financial year 2024-25 are as follows:

Table 2b

Establishment Expenditure for Major and Minor Irrigation Projects (2023–24 & 2024–25)

(Amount in Rs. Crores)

Sl. No.	Area	Updated Provisions of 2023-24	Proposed Provision of 2024-25
i)	Large and Medium irrigation Schemes	384.361	402.095
ii)	Minor Irrigation Projects	79.437	87.728
	Sum -	463.798	489.823

Source: Government of Jharkhand, Department of Water Resources, Annual Plan and Budget Report 2023–24 & 2024–25.

A comparative budget analysis reveals that:

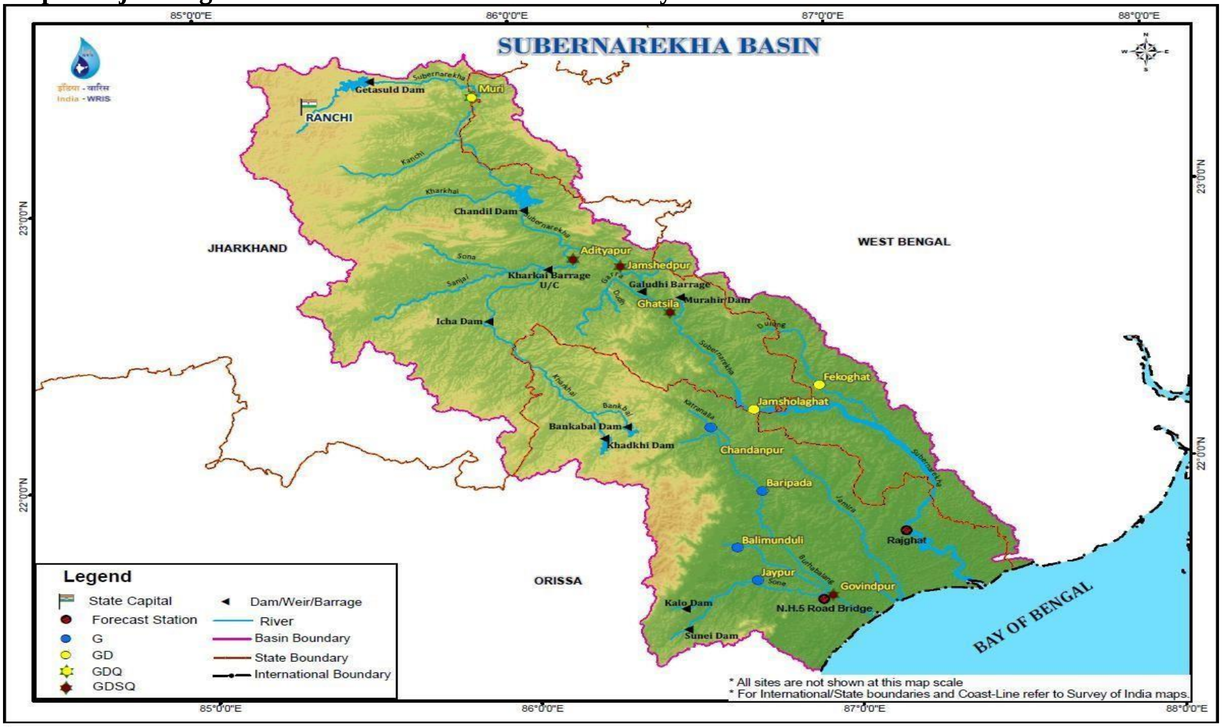
- Allocation for major/medium irrigation increased from ₹1263.95 Cr in 2023–24 to ₹1429.45 Cr in 2024–25.
- Minor irrigation received ₹295.45 Cr in 2024–25 compared to ₹233.75 Cr the previous year.
- Flood control and embankment works received under ₹30 Cr, which is relatively low given climate variability.

Despite higher allocations, delays in fund release and uneven expenditure patterns have limited the impact of irrigation investments. State budget allocations to irrigation schemes rose from ₹2,312 crore in 2019–20 to ₹3,054 crore in 2024–25, yet underutilisation persists. This suggests that budgetary increases alone do not guarantee improved irrigation outcomes, particularly when groundwater depletion—averaging 0.3–0.5 metres annually in hard-rock zones—continues unchecked.

Major and Medium Irrigation Projects

Key irrigation infrastructure locations across major basins are shown in Map 3.

Map 3 Major irrigation infrastructure locations across key river basins in Jharkhand.



Source: India-WRIS, Government of India, 2023.

Key Projects:

- **Subarnarekha Multipurpose Project**: Delayed due to inter-state disputes; potential to irrigate 2.72 lakh hectares.
- **Konar Reservoir**: Recently revived under ERM; serves Giridih and Hazaribagh.
- **Punasi Scheme**: Faces land acquisition delays; irrigation potential of 11,000 hectares.
- **North Koel Reservoir**: Revived with central assistance; important for Palamu Tiger Reserve and command area agriculture.

Table 3 Progress and Status of Major/Medium Irrigation Projects in Jharkhand

Project Name	**Status**	**Irrigation Potential (ha)**	**Districts Covered**
Subarnarekha Project	Delayed	2,72,000	East Singhbhum, Seraikela
Konar Reservoir	Revived	Not specified	Hazaribagh, Giridih
North Koel Reservoir	Revived	Not specified	Palamu
Punasi Scheme	Pending	11,000	Jamui, Deoghar

Source: Compiled by the author from the Government of Jharkhand, Water Resources Department, Annual Plan and Budget Report 2023–24 & 2024–25.

Challenges include forest clearances, resistance from local communities, lack of convergence with watershed missions, and cost overruns.

Minor Irrigation and Mega Lift Systems

Jharkhand's minor irrigation landscape includes ahar-pyne systems, check dams, farm ponds, and tanks. These are critical in tribal and upland areas. Between 2020–24, more than 1,200 minor schemes were implemented, but seasonal dependence and poor maintenance limit impact.

Mega Lift schemes have shown promise in plateau regions:

- Use of underground pipes has reduced water loss by ~25%.
- Solar-powered lifts have reduced operation costs.

Table 4 Fund Allocation across Water Resource Divisions in Jharkhand (2023–24 & 2024–25)

District	Minor Irrigation Schemes	Mega Lift Projects	Area Irrigated (ha)
Ranchi	95	18	3,420
Palamu	78	12	2,870
Dumka	81	9	2,110
Giridih	64	11	1,940
East Singhbhum	71	13	2,600
Total	**389**	**63**	**12,940**

Source: Compiled by the author from the Government of Jharkhand, Water Resources Department, Annual Plan and Budget Report 2023–24 & 2024–25.

However, WUA participation in O&M (Operation and Maintenance) remains low, leading to system breakdowns.

ERM (Extension, Renovation & Modernization) aims to revive, modernise, and complete irrigation projects by repairing canals and structures, reducing losses, and improving command performance. Under ERM (2023–24):

- 14 major/medium schemes were revived
- 59 minor schemes became operational
- An additional 29,420 hectares brought under irrigation

Table 5 ERM (Extension, Renovation & Modernization) outcomes and budget (2023–24)

Scheme Type	Number Revived	Area Irrigated (ha)	Budget Allocated (₹ Cr)
Major/Medium	14	19,000	105.0
Minor Irrigation	59	10,420	40.0
Total	**73**	**29,420**	**145.0**

Source: Compiled by the author from the Government of Jharkhand, Water Resources Department, Annual Plan and Budget Report 2023–24 & 2024–25.

The revival success was higher in districts where local NGOs collaborated with line departments, such as in Dumka and Chatra.

Flood Protection and Risk Reduction

Flood-prone districts include Sahibganj, Pakur, and East Singhbhum. However, only ₹29.64 Cr was sanctioned in FY 2023–24, and less than 50% was utilized. Embankment works often lack proper slope protection, and floodplain zoning is absent.

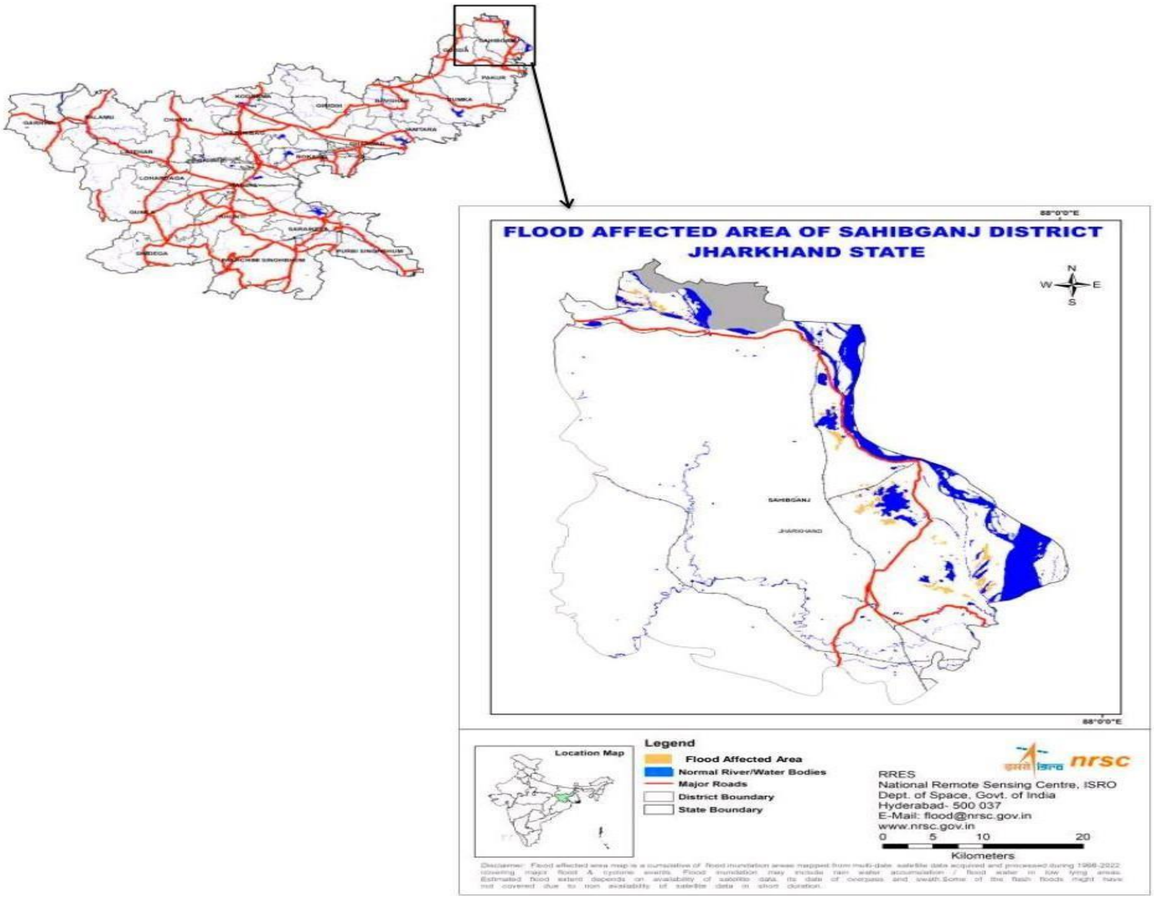
Table 6 Erosion and Flood Control Works – District-wise Allocation and Status (2023–24)

District	Works Sanctioned	Budget Allocated (₹ Cr)	Status
Sahibganj	**11**	**8.25**	**Ongoing**
Pakur	**9**	**7.15**	**Partially Done**
East Singhbhum	**8**	**5.80**	**Completed**
Dhanbad	**7**	**4.25**	**Ongoing**
Chatra	**5**	**4.19**	**Planning Stage**
Total	**40**	**29.64**	**-**

Source: Compiled by the author from the Government of Jharkhand, Water Resources Department, Annual Plan and Budget Report 2023–24 & 2024–25.

Flood exposure in Sahibganj district is illustrated in Map 4.

Map 4 Flood-Affected Areas of Sahibganj District, Jharkhand



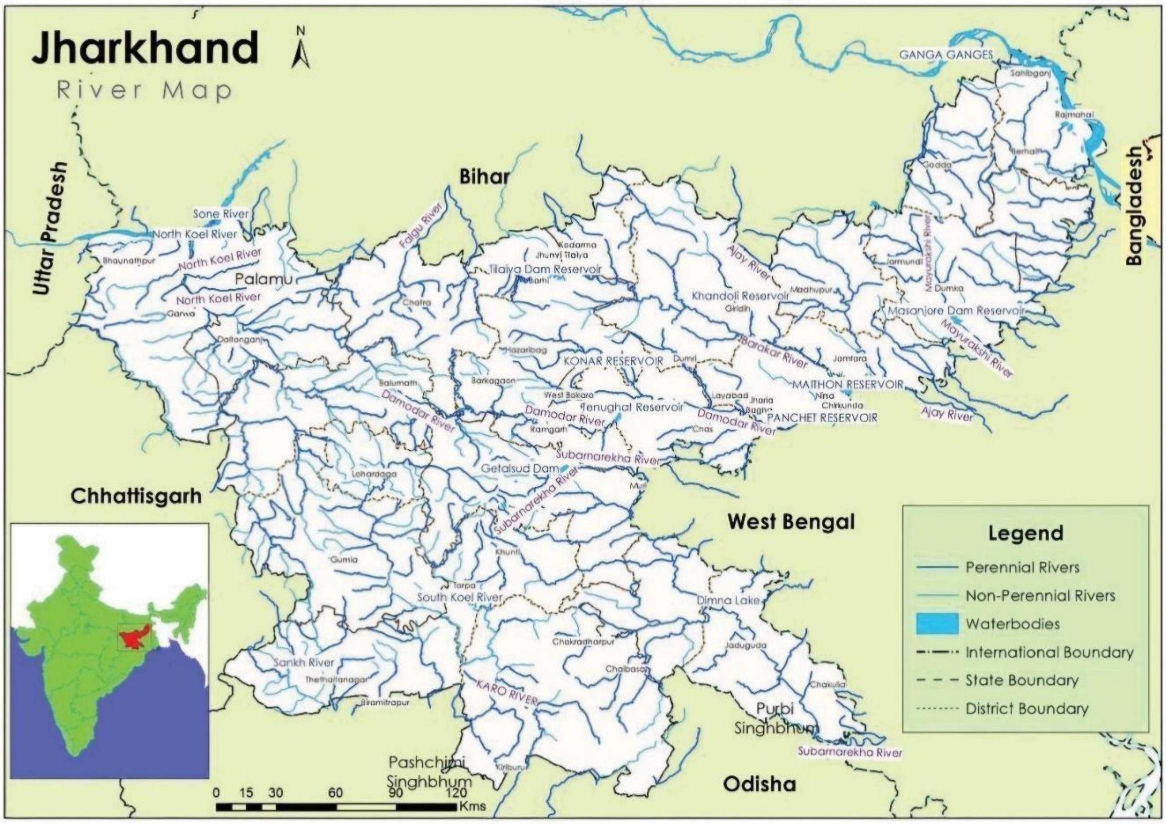
Source: National Remote Sensing Centre (NRSC), Indian Space Research Organisation (ISRO), Government of India, 2022.

As per GIS and remote sensing-based analysis (2022), approximately 18% of riverbank villages fall under moderate to high flood risk zones.

Geohydrological Basis of Water Resources Management in Jharkhand

Aquifer potential and geohydrological zones are depicted in Map 5.

Map 5 Groundwater potential and geohydrological zones of Jharkhand



Source: Central Ground Water Board (CGWB), Government of India, 2022.

Jharkhand's hydrogeological profile plays a crucial role in shaping its water resource policies and irrigation strategies. The state lies predominantly on the Chhotanagpur Plateau, a region dominated by hard rock terrain comprising granites, gneisses, and schist formations. These rocks have low porosity and permeability, making groundwater extraction and recharge a major challenge.

Groundwater availability varies significantly across districts due to the fractured nature of the subsurface and limited aquifer thickness. This uneven distribution directly impacts the planning and implementation of minor irrigation projects, especially in tribal and upland areas where surface water schemes are also scarce.

The Central Ground Water Board (CGWB) classifies Jharkhand's groundwater zones based on yield potential and recharge capacity. In many regions, groundwater levels show seasonal fluctuations, with declining trends during pre-monsoon periods. Over-dependence on hand pumps and shallow wells, without adequate recharge structures, has further aggravated the issue in rural belts.

To address these concerns, state agencies have initiated water harvesting structures, check dams, and groundwater recharge plans, often in conjunction with Mega Lift Irrigation Schemes and ERM (Extension, Renovation & Modernization) projects. These interventions aim to improve water availability while reducing extraction pressure on limited aquifers.

An integrated understanding of the terrain and its water-holding capacity is essential for climate-resilient and sustainable water resources planning in Jharkhand. Future water policies must prioritize geospatial analysis and aquifer mapping to optimize resource allocation and ensure equitable access.

Challenges and Limitations

- Delayed project execution due to multi-agency approvals
- Absence of real-time data on groundwater and canal flow

- Low WUA formation (only 21% of irrigation commands have active WUAs) (author's compilation from departmental records, 2023–24).
- Inadequate training of field-level staff
- Poor convergence with MGNREGA for water structure development
- Lack of monitoring indicators and third-party audits

Recommendations and Future Directions

To improve water governance and policy implementation in Jharkhand, this study recommends the following forward-looking interventions with practical and administrative significance:

1. **Aquifer-specific planning –** Integrate CGWB block-level groundwater assessments into irrigation design, focusing on hard-rock aquifers with declining pre-monsoon levels.
2. **Technology-driven efficiency –** Expand the use of RS/GIS for canal leak detection, soil-moisture monitoring, and performance evaluation at the command-area scale.
3. **Strengthen participatory governance –** Provide financial and technical incentives to increase WUA formation and build capacity for operation and maintenance at the community level.
4. **Performance-linked budgeting –** Align budget allocations with verified IPC–IPU improvements, ensuring faster asset utilisation and project completion.
5. **Integrated monitoring systems –** Establish a real-time dashboard combining budget, spatial, and performance data for state-level review and course correction.
6. **Climate-resilient crop planning –** Promote the adoption of drought-tolerant and less water-intensive crop varieties, supported by seasonal climate forecasts and advisory services.
7. **Integration of AI and predictive analytics –** Deploy artificial intelligence models to forecast irrigation demand, optimise water release schedules, and anticipate groundwater stress zones.

CONCLUSION

The analysis reveals that Jharkhand's irrigation potential has expanded by 12.4% over the last five years, yet significant gaps persist in utilisation efficiency, particularly in districts with low Water Users Association participation. Groundwater depletion in hard-rock aquifers remains a critical concern, compounded by climate variability and uneven access to irrigation. Financial allocations have increased, but the linkage between budget outlays and measurable outcomes is inconsistent. Policy directions should prioritise aquifer-specific management, performance-linked budgeting, and targeted modernisation of irrigation infrastructure. Addressing these gaps requires immediate, data-driven interventions to modernise infrastructure, strengthen community participation, and ensure that every rupee invested in Jharkhand's water sector translates into measurable, equitable, and climate-resilient outcomes.

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