



Water and Livelihoods in Bihar

JAL KAUSHAL: WATER, LIVES, AND LIVELIHOODS

Apoorva Dhingra and Nidhi Batra

July 2023



Water and Livelihoods in Bihar

STATE REPORT

Apoorva Dhingra and Nidhi Batra

July 2023

Published in July 2023 by JustJobs Network Inc.

Acknowledgement:

This state report was produced as part of Jal Kaushal, a research project funded by Arghyam. Arghyam is a charitable foundation based in Bengaluru, Karnataka, working to build water security at scale. The authors wish to express their deepest gratitude to Sabina Dewan, Manu Srivastava, and Gurudutt Ramachandra for their guidance; to Satyendra ji and Rambha ji from Nirdesh and Anna Ranjan for offering crucial support during this project's research in Bihar; and to Shreya Ramnath and Neha Margosa for copyediting and Minus Equals Plus and Venkatesh Bilvam for designing this report.

Contents

Abbreviations

Executive Summary

Chapter 1: Introduction 5

Chapter 2: Water Management – whose responsibility? 11

Chapter 3: Findings and Call to Action 20

ANNEXURE 1: Jobs and Tasks in Water Management

ANNEXURE 2: Methodology and Selection Criteria

References



Litchi tree bearing fruit in an orchard in Bihar.

Abbreviations

CLC	Central Level Committee
CSOs	Civil Society Organisations
DIP	District Implementation Partner
DPMU	District Project Management Unit
FHTC	Functional Household Tap Connection
GP	Gram Panchayat
HGNKJ	Har Ghar Nal Ka Jal
JJHM	Jal Jeevan Hariyali Mission
JJM	Jal Jeevan Mission
JJN	JustJobs Network
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
NGOs	Non-Governmental Organisations
ISA	Implementation Support Agency
ISRA	Implementation Support Research Agency
IWRM	Integrated Water Resource Management
O&M	Operations and Management
PDO	Panchayat Development Officer
PHED	Public Health and Engineering Department
PRD	Panchayati Raj Department
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
SC	Scheduled Caste
ST	Scheduled Tribe
VLC	Village Level Committee
VWSC	Village Water and Sanitation Committee
WIMC	Ward Implementation and Management Committee
WUA	Water User Associations
MGPNY	Mukhyamantri Gramin Peyjal Nischay Yojana

Executive Summary

In India, the world's largest user of groundwater, there are several government and civil society interventions that promote water management with the goal of making India's villages water secure.¹ Most interventions, whether initiated by state and central governments or by civil society, are decentralised, emphasising the role of community members in their implementation and management.² They build on the understanding that water is an essential component of rural economies and is necessary to create and maintain jobs across sectors.³ Integrated water management, which includes managing the source, infrastructure, and water services, is both a job creator as well as a job enabler.

However, despite the understanding that water and water management are job creators and enablers, there is little record of community members' or frontline workers' tasks, responsibilities, training, skills, remuneration, and working conditions. This is further complicated by the fact that water management work at the local level is often part-time, voluntary, or unpaid. Thus, despite consensus that community members perform critical water management tasks, there remains a gap in knowledge about the work they do, and the conditions they work in.

To address this, JustJobs Network (JJN) and Arghyam launched Jal Kaushal, a project that examines the jobs-tasks-skills nexus of rural water management. The study hypothesises that an investigation and understanding of livelihoods engendered by the sector can enhance the sustainability and success of water management. This project draws from both

secondary and primary research conducted in five states of focus.

A state-level study of Bihar, one of the five states studied as part of the Jal Kaushal project, this report helps ground secondary data through primary research and maps the "who" of the water management sector. It also helps examine whether jobs, tasks, and skills in the water management sector align with aspirations and the perceived value of employment in the sector. With a focus on irrigation as well household water management, JJN's research in Bihar reveals that:

- Household water management remains a technocratic exercise in Bihar. Most tasks like mapping, planning, and budgeting happen on state- and district-levels without the involvement of community members, GPs, and frontline workers.
- Irrigation management is overseen by Water User Associations (WUAs), which are active across Bihar. While the WUAs involve community members, gender diversity in the WUAs must be greater.
- Operations and maintenance (O&M) in household water management, the area in which frontline workers dominate, has been conceptualised in Mukhyamantri Gramin Peyjal Nischay Yojana (MGPNY), the Government of Bihar's household water supply resolution. Due to the lack of clarity in O&M guidelines and concerted attention, community involvement has suffered.

- Bihar's State Water Policy places an emphasis on community involvement. The state's flagship water supply scheme, Mukhyamantri Gramin Peyjal Nischay Yojana, which is locally known as Har Ghar Nal Ka Jal, builds on this emphasis by making frontline workers called Anurakshaks responsible for O&M. The state needs to build the capabilities of these Anurakshaks, streamline remuneration, and focus on source sustainability and water quality to ensure the safe, continued supply of water to all households.
- Watershed-level management is ignored in favour of management based on administrative boundaries.

Split into three sections, this report provides information about how water is managed and the people who manage it; the jobs and tasks this sector creates and does not create, and the impact of the lack of adequate community involvement in the state; and JIN's recommendations that can help ensure sustainable and integrated management of water.

This report's findings are supported by primary research conducted in five Gram Panchayats (GPs) each in Muzaffarpur and Begusarai. The GPs were selected based on ongoing government and non-governmental interventions, demography, infrastructure provisions, status of water security, and availability of respondents. Research methods and selection criteria for GPs in both districts are detailed in Annexure 2.

Chapter 1: Introduction

Predominantly rural, Bihar is the third most populous state in India. With nearly 88 of its population in villages, agriculture is the biggest sector of the state's economy, making rural water management a necessity.⁴ Though endowed with water, Bihar experiences flooding as well as drought, resulting in a complex relationship with water management.

In line with the Jal Kaushal project objectives, this report focuses on water management for household use and irrigation. Since water exists as part of an integrated ecosystem, researching household and irrigation management in conjunction allows an understanding of convergence or divergence in the two needs, and helps devise solutions to ensure the social and economic welfare of all rural residents.

Bihar's State Water Policy 2010 calls for holistic water management with an emphasis on demand-side management because the state faces grave uncertainty with regard to the availability of water.⁵ In spite of this, household water management in Bihar remains overshadowed by water supply initiatives. The central government's Jal Jeevan Mission (JJM) and the state government's Mukhyamantri Gramin Peyjal Nischay Yojana (MGPNY) remain the most popular water management missions and schemes currently in effect in the state. The table below maps the various water management tasks undertaken by the Government of Bihar's several departments.

As in other districts in Bihar and the rest of the country, Muzaffarpur and Begusarai's household water and irrigation needs are met largely through groundwater. Due to the presence of the Ganga,

Barhi Gandak, Baghmata and Baya rivers, groundwater in both districts is readily available at a depth of 40 feet onwards. Most households in Muzaffarpur and Begusarai, as a result, have historically relied on private or community handpumps, locally known as *chapakals*. This water, however, is often unfit for consumption, contaminated with arsenic and other pollutants.

Household water management

The need to provide water to all rural households and address the issue of water quality prompted the Bihar government to launch Mukhyamantri Gramin Peyjal Nischay Yojana (MGPNY) which, along with the central government's Jal Jeevan Mission (JJM), provides functional household tap connections (FHTCs) to rural households in Bihar. In Muzaffarpur, all FHTCs are provided through MGPNY, which launched in 2016 as part of Bihar government's *Vikas ke Saat Nishchay* programme, or the seven resolutions for development. In Begusarai, FHTCs were provided through a mix of MGPNY and the central government's Jal Jeevan Mission. In both districts, household supply systems created under MGPNY and JJM leverage groundwater without concern for source sustainability. Of all the GPs surveyed, only Dadar Kolua in Muzaffarpur reported the presence of groundwater recharge structures such as pits adjoining a borewell.

The problems of source sustainability, availability of potable water, and creation of necessary

Table 1

State Departments Involved in Rural Water Management

S No	State Departments	Dimensions of Rural Water Management		
		Source	Infrastructure	Services
1	Bihar Vikas Mission			
	Bihar Vikas Mission implements the seven resolutions of the government including the Mukhyamantri Gramin Peyjal Nischay Yojana resolution that has been instrumental in increasing households' access to water.			
2	Rural Development Department			
	The Rural Development Department (RDD) implements several programmes that alleviate rural poverty through the creation of infrastructure by generating sustainable employment opportunities for the rural poor. Most notably, RDD implements MGNREGS and Jal Jeevan Hariyali Mission/JJHM			
3	Water Resources Department			
	The Water Resources Department, formerly known as the Irrigation department, creates and helps realise the irrigation potential of the state by constructing, maintaining, and managing major irrigation projects.			
4	Minor Water Resources Department			
	The Minor Water Resources Department executes and maintains small irrigation projects and promotes conjunctive irrigation practices to ensure groundwater management.			
5	Public Health and Engineering Department			
	The PHED creates and maintains drinking water infrastructure for rural areas affected by water quality issues.			
6	Panchayati Raj Department			
	The PRD creates and maintains drinking water infrastructure for areas unaffected by water quality issues. It also handles the technical implementation of MGPNY while the Bihar Vikas Mission handles administrative responsibilities.			
7	Agriculture Department			
	The Agriculture Department works to enhance agricultural productivity in Bihar by changing cropping patterns and cultivation practices, enhancing irrigation coverage, improving water use efficiency through drip irrigation, making post-harvest technology available, and promoting soil health. The department implements schemes like PM-KISAN and PM-Krishi Sinchayee Yojana.			

infrastructure are supposed to be alleviated through the involvement of GP-level actors. Both HGKJ and JJM rely on village communities, sub-committees such as Village Water and Sanitation Committee (VWSC) and Ward Implementation and Management Committee (WIMC), frontline workers, and the Gram Panchayat to play integral roles in managing water. Additionally, water management initiatives launched by Civil Society Organisations (CSOs) and Non-Governmental Organisations (NGOs) also call on the community to lead, manage, and implement these solutions. It was the success of the Aga Khan Rural Support Programme India (AKRSPI)'s community-led water management initiative, in fact, that influenced the HGKJ resolution.

However, while community actors are used as a convenient tool to manage water, their involvement is not a cure-all for water security. As this report will detail, the government has a vital and active role to play in mobilising, sustaining, and supporting these community actors.

Irrigation Management

The Water Resources Department, Minor Water Resources Department, and the Agriculture Department play a vital role in helping manage water for irrigation in a state in which 76 percent of its population is engaged in agriculture. These departments are responsible for providing and managing water through three types of schemes: major and medium surface schemes, minor surface schemes, and life schemes.⁶ The Water Resources Department, especially, is supposed to enable and work closely with Water User Associations (WUAs), formulated after the Bihar Irrigation Act 1997 and Bihar Irrigation, Flood Management, and Drainage Rules 2003, came into effect. As is true across the country, WUAs are considered the primary vehicle through which governments introduce and implement participatory irrigation management.

Box 1

Aga Khan Rural Support Programme – India (AKRSPI)

Aga Khan Rural Support Program – India (AKRSPI) works to improve access to potable drinking water in rural areas. With an emphasis on community ownership, their programme in Bihar focused on promoting and improving private, household-owned water infrastructure, such as handpumps. Their interventions were ultimately fully managed and maintained by the community which influenced Mukhyamantri Gramin Peyjal Nischay Yojana, one of the Bihar government's most active initiatives.

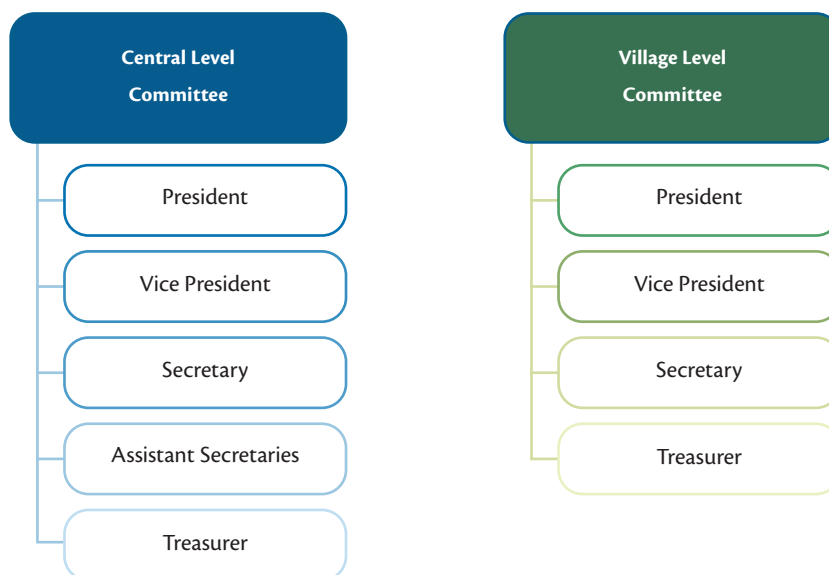
In other states where AKRSPI is an Implementation Support Agency, they also convene Gram Sabhas, launch public awareness campaigns, offer financial training to VWSCs, and involve SHGs as well as women members in water management initiatives.

Beyond WUAs, irrigation management in Bihar is sustained by two notable central schemes, namely Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) and PM-KUSUM (Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan); Bihar government's Jal Jeevan Hariyali Mission (JJHM); and CSO interventions. Both PMKSY and JJHM focus on infrastructure provision such as drip irrigation systems, sprinkler systems, rejuvenation of water storage structures, and construction of check dams.⁷ JJHM; Dept of Ag). PM-KUSUM, which ensures energy security for farmers, provides stand-alone and grid-connected solar pumps.⁸ But even though solar irrigation is a promising sector, PM-KUSUM's implementation remains fragmented in Bihar.⁹ In its stead, organisations such as the International Water Management Institute (IWMI) and AKRSPI

implement solar irrigation projects in the state where farmers receive subsidised solar pumps and PVC pipe distribution networks, which, in turn, help them maximise profits by driving down fuel and maintenance costs.¹⁰

In Bihar, PMKSY is largely centred around the extraction of groundwater without engaging in requisite management. This gap is filled by JJHM which, with its 11 components, focuses on nurturing natural resources through rejuvenating public water bodies, including *ahar-pynes*, and constructing soak and recharge pits near wells and handpumps. This leads to many job opportunities at the state- and district-level, including those of procurement officers, district mission managers, and accountants.¹¹ However, it is unclear what frontline workers JJHM empanels apart from construction workers.

Figure 1
[Structure of Water User Associations in Bihar](#)



In terms of livelihoods emerging from PIM, WUAs are expected to handle operation and maintenance (O&M), reliable service provision, and ensure full cost recovery.¹² However, given that they only exist in places with a canal network, there are a mere 64 WUAs in the entire state of Bihar.¹³ According to the Water Resources Department, these associations are regularly offered functional grants and training to ensure they remain effective. In line with the Paliganj WUA, which was the first WUA to be convened in Bihar, each canal system has a central level committee (CLC) which comprises an executive committee and includes the president, vice president, secretary, assistant secretaries and a treasurer.¹⁴ Several village level committees (VLCs) exist under the CLCs, and also

have an electable executive committee that comprises the president, vice president, secretary, and treasurer. The CLC is responsible for the overall scheduling and monitoring of water supply and liaising with the government, while VLCs are responsible for village-level scheduling and monitoring and tax collection.¹⁵

However, since WUAs only convene in areas in which canals are present, adequate management and associated job creation is severely restricted. A lack of political will, fragmented land ownership which disallows significant investment, and private ownership of groundwater results in the resource remains largely unmanaged. Even the *ahar-pyne* network,¹⁶ which was a traditional irrigation system

Box 2

Objectives of Participatory Irrigation Management (PIM)

Participatory Irrigation Management refers to the involvement of irrigation users in all aspects of irrigation management (World Bank). This can include planning, design, construction, financing, operation and maintenance, and monitoring. The primary objectives of PIM are:

- To improve irrigation and water use
- To make the best use of natural precipitation and groundwater in conjunction with canal water
- To facilitate users to have a choice in selecting crops, cropping sequence, timing of water supply and the frequency
- To delineate responsibility of water distribution and maintenance between the users and the department
- To promote equity amongst the users both relating to allocation and actual supply of water
- To facilitate resolution of conflicts among farmers
- To entrust WUAs with the responsibility to collect water charges and payment on behalf of the government
- To improve water delivery and reduce operational losses
- To create a healthy atmosphere between the managers and users of the entire operation

Source: Raju, 2006

popular in 20th century South Bihar that is now seeing renewed interest, struggles to be revived fully and to scale.

Experts attribute this to the absence of a once-existent community-centric approach, which was critical to this network's maintenance. That said, community centred CSO interventions do exist in one or two areas, such as the NGO DHAN's work in Munger district. DHAN's model involved organising village residents into a Village Level Association (VLA) or Vayalagam. The VLA takes ownership of the entire renovation process as well as managing and governing the use of the system after renovation. VLA members also organise themselves into Agriculture Finance Groups (AFGs), in which members pool financial resources and support the VLA to ensure the sustainability of the *ahar-pyne* system.

However, the full potential of community involvement has not been realised. For a state whose area under irrigation by groundwater continues to increase over time, dependence on this privately-owned resource is a cause for concern.¹⁷

Integrated Water Management in Bihar

In theory, government and CSO interventions aim to address all three components of integrated water management, namely source management, infrastructure management, and water services management.¹⁸ Source management includes integrated water resources management (IWRM) and ecosystem restoration and remediation. IWRM aims to ensure the protection, sustainable use and

regeneration of water resources by safeguarding ecosystems, rivers, lakes, and wetlands and building the necessary infrastructure (such as dams and aqueducts) to store water and regulate its flow.¹⁹ Infrastructure management encompasses the creation, running, and upkeep of both natural and artificial structures designed to manage water resources.²⁰ Water services management includes both water-related services for commercial purposes, such as in the energy, agricultural, and industrial sectors, as well as domestic services like water supply, sanitation and hygiene, and wastewater management.²¹ A collective emphasis on all three components is essential because source management helps prevent overreliance on a single source, such as groundwater or surface water, and promotes conjunctive use of water; infrastructure management across conservation and supply ensures the creation and maintenance of critical infrastructure such as pipelines, canals, and check dams; and service management ensures adequate distribution and water quality. However, JJN found that groundwater management is not a priority in Bihar. This could be attributed to the fact that both districts surveyed had perennial rivers which help recharge the aquifers, making groundwater management a matter of little concern for residents, civil society, and the government.²²

Additionally, across the three components of integrated water management, only water supply interventions are prioritised in Muzaffarpur and Begusarai. It is vital that this prioritisation not be mistaken for a job done well. As detailed in later chapters, water supply infrastructure built under both MGPNY and JJM is prone to damage in the absence of proper operation and maintenance.

Chapter 2: Water Management – whose responsibility?

In 2010, Bihar adopted a radical shift away from predominantly engineering-based solutions to local, community-based water and sanitation management solutions. The State Water Policy made clear that government authorities were to act as multi-disciplinary technical service providers rather than central control organisations.²³ Panchayati Raj institutions (PRIs) and WUAs, under the guidance of block- and district-level government officers, are thus supposed to play a critical role in managing water.

In line with Bihar's decentralised rural governance system, drinking water schemes such as the MGPNY are implemented on the ward level. This allows water provision systems to be uniquely designed to meet the needs of residents while ensuring local communities are involved and in control of managing domestic water.²⁴ However, JIN found that household water management remains technocratic, with minimal involvement of PRIs and community members. Irrigation management is not community-driven either. As mentioned in the previous chapter, this is due to several reasons, including the limited and weakened presence of WUAs, private ownership of groundwater, and indifferent implementation of government schemes and missions.

Table 2, which draws from secondary research, details the actors involved in implementing various water management initiatives and the tasks they are supposed to undertake. Figure 2 verifies this information through primary research and the status of tasks undertaken by state-, district-, and village-level actors across the four dimensions of integrated water management. The table, figure, and the following section make clear the following:

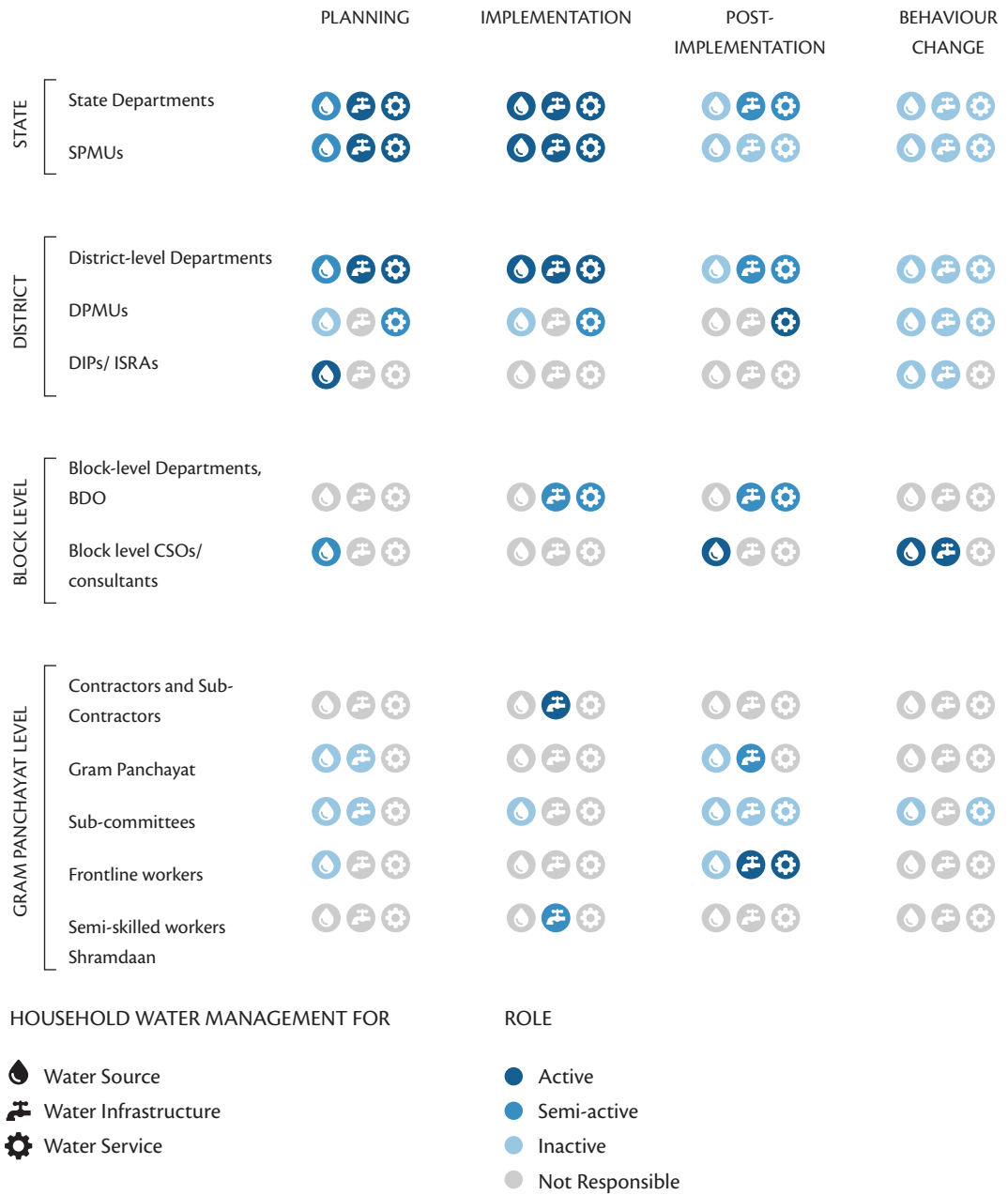
- State departments and SPMUs in Bihar are most active, followed by district-level departments, District Project Management Units (DPMUs), and District Implementation Partners (DIPs)/Implementation Support Research Agencies (ISRAs).
- Some frontline workers are present, but they do not have the requisite conditions to perform their duties.

Table 2

Community Involvement in Water Management Initiatives

Mission/Scheme/Resolution/ Acts	Department	Relevant purpose	Community's role	Frontline actors
Mukhyamantri Gramin Peyjal Nischay Yojana	Bihar Vikas Mission, Public Health and Engineering Department and Panchayati Raj Department	FHTC provision	Planning, implementation, operations, and maintenance	Ward Implementation and Management Committee, Ward members, Ward secretary, GP officials, Anurakshak
Gali Nali Yojana	Bihar Vikas Mission	Constructing wastewater and rainwater drainage systems	Planning, implementation, operations, and maintenance	Ward Implementation and Management Committee, Ward members, Ward secretary, GP officials
Jal Jeevan Hariyali Mission	Rural Development Department	Rejuvenating and creating water harvesting structures and promoting irrigation management		
Jal Jeevan Mission	Panchayati Raj Department and Public Health and Engineering Department	FHTC provision	Planning, implementation, operations, and maintenance	Village Water and Sanitation Committee, Pump Operator, GP members, GP officials
Mahatma Gandhi National Rural Employment Guarantee Scheme	Rural Development Department	100 days of guaranteed employment per household	Natural resource management (NRM) asset construction including ponds, dug wells, check dams, embankments, farm ponds, soak pits, and compost pits	MGNREGS workers, GP members, GP officials
Bihar Irrigation, Flood Management and Drainage Rules, 2003	Government of Bihar	Participatory Irrigation Management	Manage water allocation, collect user fees, operation, and maintenance	Water User Associations (WUAs) – Water Distribution Committees, Village Level Committees, Central Level Committees
Integrated Watershed Management Programme (GoB)	Agriculture Department	Harnessing, conserving and developing degraded natural resources such as soil, vegetative cover and water through watershed management initiatives		Watershed Committees, SHGs and User Groups

Figure 2
Integrated Water Management tasks across levels



	PLANNING	IMPLEMENTATION	POST-IMPLEMENTATION	BEHAVIOUR CHANGE	
STATE	State Departments				
	SLC				
DISTRICT	District/ Dam level: Water Resources Departments				
BLOCK LEVEL	Canal level: Apex WUA				
GRAM PANCHAYAT LEVEL	Village level committees (WUA)				
	Solar Entrepreneurs				
	CSO led Village level associations for Ahar-Pyne system				

IRRIGATION WATER MANAGEMENT FOR

- Water Source
- Water Infrastructure
- Water Service

ROLE

- Active
- Semi-active
- Inactive
- Not Responsible

Actors managing household water

While community members and frontline workers are expected to play an important role throughout the life cycle of water management initiatives, their role in Bihar is severely constrained. JJN found that most tasks, such as mapping, planning, and budgeting, happen only on the state- and district-levels without any involvement of community members and frontline workers. This is especially true for household water management where village residents are mere recipients of water supply provisions as opposed to being active participants.

As the above graphic notes, planning, mapping, and budgeting as well monitoring and reporting remain absent on the village-level. Sherukahi, a Gram Panchayat in Muzaffarpur, is the exception: an initiative-taking *mukhiya* identified the water needs of the village residents and included them in the Gram Panchayat Development Plan. Resource mapping and planning are critical because they help assess the needs of village residents, identify current and future sources of water, gauge the community's willingness and capacity to contribute in cash, kind, or labour, ensure availability of land, and assign roles and responsibilities to community members. Without the community's involvement, a lot of these questions remain unanswered. Additionally, when maps and plans are created solely by state- or district-level officials, there is also an added risk of managing water based on administrative boundaries as opposed to doing so on a watershed level and as an integrated resource.

The above graphic also makes clear that infrastructure provision and behaviour change

happen inadequately. JJN researchers found that in some GPs such as Harchanda, Bhatauna, and Sherukahi, where groundwater in shallow aquifers is contaminated, village residents were sending water from government-installed FHTCs to their fields while continuing to rely on their handpumps to extract drinking water. A village resident from Harchanda said,

Peene ka paani humare purane chapakal se aata hai. In sarkari nalkon ke paani se hum kheti karte hai. [drinking water comes from our old handpumps. We use these government taps to irrigate our land.]

Village residents do this because the water supplied through FHTCs tastes different. The household water is extracted from borewells of a depth of 300-400 feet while their personal handpumps, which offer familiar-tasting water, are only 40-100 feet deep and extract contaminated water. These problems can be easily alleviated with the help of frontline workers trained in behaviour change communication who can "drive positive change and promote behaviour change towards health and hygiene aspects".²⁵

In both Muzaffarpur and Begusarai, Anurakshaks/pump operators were the most common frontline workers. However, they neither receive training nor timely remuneration. Since water supply is facilitated through small, ward-level schemes, the individual who donates their land for the water tank to be built, locally known as *bhoomidata*, is usually appointed the pump operator. In the absence of any compensation for their land, the understanding is that being a pump operator will provide the *bhoomidata* a livelihood



A functional household tap connection (FHTC).

opportunity. This, however, is rarely the case given that no pump operators across the ten GPs surveyed reported receiving remuneration. Additionally, because this position remains undefined and underfunded, JJN researchers observed that ward members would routinely step in to fill the role of the pump operator. A ward member from Dadar Kolua said,

Kabhi pump chalu mai karti hoon aur kabhi operator. Mil baat kar karte hai lekin iss kaam ki koi tankha dono ko nahi milti. [Sometimes I run the pump and sometimes the pump operator does. We split responsibilities but neither of us gets paid for this work.]

In some cases, as noted in the box below, pump operators and ward members also borrow money from local moneylenders to fix a faulty motor or pipe, driving them into personal debt. This is because funds are not made available for O&M to the ward member

or the WIMC. The Gram Panchayat does not allocate funds, and households refuse to pay the monthly user fee due to the easy availability of groundwater and the low costs of installing the handpump.

According to the Project Leader of Bihar Vikas Mission, the pump operator position is being reimagined in the second edition of MGPNY resolution. Pump operators, henceforth known as Anurakshaks, will be hired across wards in rural Bihar and will be entitled to monthly remuneration of at least INR 2000 monthly. They will also be paid INR 72,000 over the year, directly into the WIMC's bank account, to handle the repair and upkeep of ward-level supply systems.

This is a welcome initiative as several stakeholders such as the District Program Management Unit of JJM, village residents, and WIMC members shared that low-quality work, irregular power supply, damage to pipelines, and pump breakdowns are recurring issues that impede stable household water supply in

Box 3

Frontline Worker Profile



(L to R) Manu Devi, former ward member, Apoorva, JJN researcher, and Ranjit Sahni, Pump Operator

Manu Devi and Ranjit Sahni are former ward member and current pump operator respectively of Ward 6, Makdumpur Kodana, Muzaffarpur. In 2018, when Manu Devi was still a ward member, she was the first in the entire Panchayat to implement the Mukhyamantri Gramin Peyjal Nischay Yojana scheme in her ward. Under her supervision, all 300 households – a majority of whom are Maha Dalits – received a tap connection. Ranjit, a friend of Manu Devi's and the *bhoomidata* (the person who donated their land for the OHT) of the ward, was appointed the pump operator three years ago through the recommendation of the Ward Sabha, and supported Manu Devi in overseeing the contractor. While Manu Devi is no longer a ward member, they continue to handle all water-related problems in the ward together. But both also remain unremunerated. Manu Devi complained that over the years, she and Ranjit have contributed personal funds to repair and replace faulty pumps, pipes, and taps, which has occasionally driven them into debt. According to them, the GP laments the lack of funds while households refuse to pay taxes.

both Muzaffarpur and Begusarai.²⁶ This is a common occurrence despite the fact that Bihar's State Water Policy highlighted low level of expenditure for O&M as a critical issue in the water and sanitation sector as early as 2010.²⁷

This lack of emphasis on O&M from the departments, which is a key responsibility of frontline workers, causes the weakening of sub-committees. Without adequate power and responsibilities, WIMCs and VWSCs become redundant and do not convene, further diminishing the possibility for other water management activities to occur. This also has a cascading impact on jobs in the water management sector. According to UNESCAP, O&M tasks are some of the most critical tasks performed by frontline workers, and as JIN observed in Karnataka, water management jobs and tasks in the community are largely concentrated around O&M.²⁸ In Bihar, the pump operator position is undesirable and the few operators who do exist do not aspire to take on other water management tasks. Therefore, without adequate measures taken to promote O&M, community involvement in the sector shrinks, opportunities for jobs are lost, and holistic water management suffers.

In conclusion, decentralisation of governance in Bihar has not translated to community involvement in household water management. The sector remains technocratic, with no emphasis on water jobs at the very bottom. While some water workers like private plumbers, electricians, and contractors do exist, household water management is neither taking place in an integrated fashion nor creating livelihood opportunities.

Actors managing irrigation water

Irrigation in Bihar is largely groundwater-dependent and since groundwater is a privately owned resource, it is not managed. According to AKRSPI, there is little political will to manage groundwater for irrigation because of how abundantly available it is in most of the state. There is greater impetus to ensure a steady supply because of which solar pump provision is a popular intervention in the irrigation sector in Bihar.

As stated previously, IWMI and AKRSPI are cultivating buyer-friendly solar irrigation service markets in Bihar. In Samastipur, Bihar, they support solar entrepreneurs who are offered ownership of the pump and the distribution network for five years. To own, manage, and operate these pumps, they have to pay a fixed lease amount every year which "exerts pressure on the entrepreneur to maximise returns from the asset by operating it throughout the year to sell irrigation services to the farmer".²⁹ In just one year of operation, farmers' operating costs have reduced, they have begun cropping in summers, and agricultural profits have more than doubled.³⁰ Due to the success of this program, there is interest from Bihar Rural Livelihoods Promotion Society in scaling this to 100 villages and creating many such solar entrepreneur positions.

While this is a welcome intervention, Bihar's WUAs, which are the primary vehicle for participatory irrigation management, need to be reformed as well. Despite reservation for women, which enables their presence in executive committees of the WUA, their "role in decision-making is mostly restricted to voicing their needs and concerns".³¹ The same research study also noted that women's representation in leadership roles while present is inadequate, and not enough

efforts were being made to include them in decision-making.

This is true for other WUA roles such as canal inspectors, secretaries, and seasonal workers as well. In Maharashtra, where the WUA model is most successful, male WUA members and government officials alike remarked, “women are already burdened by domestic responsibilities and making regular visits to the canals and farms work is just not possible for them” (interview with Maharashtra WRD minister).

There is, however, potential for the goals stated in Bihar’s State Water Policy to be realised. The next chapter summarises findings and offers policy recommendations to manage water sustainably and collectively.

Box 4

Managing floods in Bihar

Bihar is among India’s most flood-prone states, with residents in Northern Bihar constantly under the threat of imminent floods. These floods are caused by several reasons such as conversion of forest land to agricultural land, occupation of floodplains, water release from Nepal, and increased and erratic rainfall. Over the years, the Government of Bihar has enhanced its disaster preparedness and engaged in flood management by undertaking measures such as building embankments, enhancing its drainage system, and enabling afforestation. In line with water management broadly, frontline workers have emerged as a significant actor in flood management as well. For instance, the lack of clean water after floods is an urgent concern, as handpumps get silted and deliver polluted water; in response, CSOs and the government engage a cadre of frontline workers who desilt and repair handpumps. Moreover, frontline workers undertake work such as distributing relief material, generating awareness on sanitation and diseases, and constructing toilets. By involving the community in flood management and relief work, governments and CSOs can help offset livelihood loss and build the region’s resilience to floods and their impact.

Chapter 3: Findings and Call to Action

Secondary and primary research on household and irrigation water management in Bihar allowed JIN researchers to make the following observations:

1. Barring rare seasonal water shortages, both districts surveyed in Bihar are well-endowed with water; there is therefore no urgent need to introduce water management practices. However, as the State Water Policy 2010 notes, rainfall in Bihar is erratic and unpredictable, meaning that the state is only one monsoon away from water shortages.³² As a result, despite current water availability, Bihar can benefit from managing both demand and supply of water for household and agriculture use.
2. Water management in the state remains a technocratic exercise. Most tasks such as mapping, planning, and budgeting happen at state- and district-levels without the involvement of community members, GPs, and frontline workers. This lack of involvement is not for lack of interest — ward members and Anurakshaks, while disempowered, continue to remain involved in water supply and management. It is instead a result of the absence of a government-enabled ecosystem that can appoint, skill, and train frontline workers.
3. As of now, frontline workers in Bihar do not have access to enabling work conditions such as timely remuneration, adequate training, and clarity in responsibilities. Additionally, not enough frontline workers are hired at the village level. It is necessary to hire workers to encourage village residents to pay water taxes, monitor their usage, consume potable water, and irrigate judiciously.
4. It is unclear whether the ward is an effective unit of water governance and management. While this level of decentralisation theoretically allows for water systems to be customised to the needs of the community, communities are not actually consulted in planning processes. Additionally, by viewing wards or GPs as administrative entities independent of each other, watershed level management is entirely ignored. It is also important to emphasise the spatiality of water governance approaches.

Jal Kaushal Project suggests the following:

1. **Advocacy and outreach** – The dominant demand in Bihar’s villages is the regular and equitable supply of water. This should be converted into an opportunity to inform village residents of the utility of managing water through advocacy and outreach. In the next iteration of HGKJ, the Government of Bihar should build outreach and awareness activities on water management with a special emphasis on groundwater and a focus on water quality-related issues. They should also emphasise community involvement in water management, which, in turn, can help communities realise the need for frontline workers.
2. **Strengthen the existing water cadre** – Existing frontline jobs and tasks are limited, unproductive, and lack aspiration. Similar to the training offered by the Water and Land Management Institute located in Patna to central- and village-level committee members, frontline workers and sub-committee members should be offered training

and skilling opportunities. This will allow them to plan, budget, map, and test water quality, key water management activities that are currently missing at the village level. Additionally, they should be offered clear avenues to become vertically mobile.

3. **Provide adequate compensation** – It is necessary to declassify frontline workers as volunteers and provide them with a salary commensurate with their skills. Currently, most water management tasks are performed by volunteers under the instruments of VWSCs and WIMCs. This mode prevents the conversion of these jobs and tasks into livelihood opportunities. Where workers are entitled to a salary, it is important that they actually receive it. Additionally, in cases where ward members and frontline workers have taken out loans to repair supply infrastructure and pay electricity bills, it is important to relieve them of this debt so they can reassume their duties without financial burden.

4. **Watershed management** – In addition to strengthening ward- and GP-level actors, it is also important to adopt a watershed lens. By viewing water supply, water quality, drainage, stormwater runoff, water rights, and land rights in conjunction, water can be managed sustainably. This may require spatial reorientation, which can be achieved by involving all actors across wards and GPs who fall within a particular watershed.

ANNEXURE 1: Jobs and Tasks in Water Management

Through primary research in Muzaffarpur and Begusarai, JIN researchers observed the following jobs and roles in Bihar. These are split into technical, supporting, and institutional/administrative job to better reflect their major characteristics. Within each category, they are divided into district-, block-, and village-levels. It is important to note that this is not an exhaustive list of jobs and roles and consequently only offers a cursory insight into the jobs and tasks nexus of water management.



Table 3

Technical Water Jobs

S No	Job/Role	Formal/ Informal	Paid/Unpaid	Work hours	Tasks	Skills and Training
DISTRICT LEVEL						
1	Executive Engineer	Formal	Paid	8 hours/full day work		
BLOCK LEVEL						
1	Junior Engineer, PHED	Formal	Paid	8 hours/full day work		
VILLAGE LEVEL						
1	Pump Operator/ Anurakshak	Formal	Paid, INR 2000 monthly + 50 percent of public contribution	2 hours/day	<p>Mukhyamantri Gramin Peyjal Nischay Yojana Guidelines in development but will include the following duties:</p> <ul style="list-style-type: none"> Releasing water thrice a day – morning, afternoon, and evening Minor repair works Cleaning and maintenance of tanks 	None
2	Ward Member	Formal	Paid, INR 500 monthly	8 hours/full day work	<ul style="list-style-type: none"> De facto pump operators, handling operations and maintenance work. Often covering expenses out-of-pocket because of lack of WIMC funds 	None
3	Ward Secretary	Formal	Paid		<ul style="list-style-type: none"> Receiving and handling the ward's budget Opening and maintaining a bank account Supporting ward member in ad-hoc tasks Stepping in as a pump operator occasionally Basic electrical and plumbing repair work 	Some knew basic electrical and plumbing work. No training offered for their official duties
4	Contractors	Formal	Paid	8 hours/full day work	<ul style="list-style-type: none"> Creating and installing the water supply system, including laying pipelines, building overhead water tanks (OHTs), and installing household tap connections 	
5	Canal Inspector	Informal	Paid	Sporadic work	<ul style="list-style-type: none"> Releasing water from the minor to the farms Monitors the discharge of water 	
6	Seasonal Worker	Informal	Paid	Sporadic work	<ul style="list-style-type: none"> Cleaning and desilting minors Supporting the canal inspector in monitoring water discharge Supporting the office assistant in monitoring rainfall 	

Table 4

Supporting Water Jobs

S No	Job/Role	Formal/ Informal	Paid/ Unpaid	Work hours	Tasks	Skills and Training
BLOCK LEVEL						
1	Secretary, CLC	Formal	Paid	8 hours/full day work		
2	Treasurer, CLC	Formal		8 hours/full day work		
VILLAGE LEVEL						
1	Ward Secretary	Formal	Paid		<ul style="list-style-type: none"> • Planning, approvals, supervision, monitoring, part of committees such as the WIMC • MGNREGS work allocation • Handling budgeting, accounting, and finances • Household and water tax collection 	None received, many in Muzaffarpur struggled on the job
2	Secretary, VLC	Informal	Paid	8 hours/full day work	<ul style="list-style-type: none"> • Collecting water tax from farmers • Maintaining ledgers and send collected tax to the CLC 	
3	Treasurer, VLC	Formal		8 hours/full day work		
4	MGNREGS worker	Formal	Paid, INR 210 per day		Creating basic NRM infrastructure such as tanks/ lakes, recharge pits, farm ponds, check dams, dug wells, contour, and trenches amongst others	

Table 5

Institutional/Administrative Water Jobs

S No	Job/Role	Formal/ Informal	Paid/ Unpaid	Work hours	Tasks	Skills and Training
DISTRICT LEVEL						
1	District Program Officer, MGNREGS	Formal	Paid	8 hours/full day work		
2	District Program Officer, Panchayati Raj	Formal	Paid	8 hours/full day work		
3	District Coordinator, Bihar Vikas Mission	Formal	Paid	8 hours/full day work		
BLOCK LEVEL						
1	Block Development Officer	Formal	Paid	8 hours/full day work		
2	President, CLC	Formal		8 hours/full day work		
3	Vice President, CLC	Formal		8 hours/full day work		
VILLAGE LEVEL						
1	Ward Member	Formal	Paid, INR 500 monthly		<ul style="list-style-type: none"> • Convening Ward Sabha meetings • Tax collection with Ward Secretary • Chairing the WIMC 	None
2	Ward Implementation and Management Committee (WIMC) Member	Formal	Unpaid, but WIMC has INR 4000 from 15th FC + INR 2000 honorarium		<ul style="list-style-type: none"> • Attending the Ward Sabha and chaired by the ward member • Convening meetings to discuss water, sanitation, health, social and other issues • Supporting the Ward Sabha in generating awareness on social issues 	
3	Gram Panchayat Secretary	Formal	Paid, INR 50,000 monthly		<ul style="list-style-type: none"> • Preparing GPDP and other plans • Manage and release funds • Attending all Gram Sabha meetings 	
4	President, VLC	Formal				
5	Vice President, VLC	Formal				
6	Office Assistant	Informal	Paid		<ul style="list-style-type: none"> • Office upkeep • Hiring and supervising seasonal workers • Ad-hoc office work • Monitoring rainfall 	

ANNEXURE 2: Survey Methodology and Selection Criteria Management

District Selection

JJN researchers shortlisted Muzaffarpur and Begusarai districts for primary research. These districts were chosen due to their geographical location, distinct hydrogeological profiles, water security context, and active missions, schemes, programmes, and resolutions.

Muzaffarpur

Muzaffarpur, one of 38 districts in Bihar, is renowned for its litchi production. The district lies in the fertile Gangetic plains and has highly calcareous soil, making it productive for agriculture.³³ It covers 3.4 percent of Bihar's total area and about 48 lakh individuals reside in the district, most of whom work in the agriculture sector.³⁴

In terms of Muzaffarpur's hydrogeology, the area's drainage system originates from the Himalayas and has three major rivers, all flowing in the south-easterly direction: Burhi Gandak, Baghmata, and Baya. Though all three rivers and their tributaries are perennial, they can become highly unpredictable during the monsoon.³⁵ Rainfall during monsoons is the main source of groundwater recharge in the district. Other sources of recharge are the return flow from groundwater irrigation, seepage from canal, ponds, tanks and direct infiltration from river beds during

stream flow.³⁶ As of 2019, there are 27 groundwater monitoring stations in Muzaffarpur.³⁷

Begusarai

Begusarai is a water-abundant district which lies on the northern bank of River Ganga. Much like other districts in Bihar, agriculture is the main source of sustenance in the district. The district has nearly 30 lakh residents of which 24 lakh reside in the rural areas and rely primarily on agriculture.³⁸

The soil in Begusarai is alkaline and most suited for water-intensive crops such as rice, sugarcane, and jute. However, the shallow aquifers of the state are contaminated with arsenic which, while not a concern for irrigation, poses a serious concern for household water supply. According to the Central Groundwater Board, the district relies on wells, tube wells, tanks, ponds and rivers for irrigation, practicing conjunctive use of water. However, given that only 48 percent of farmland is irrigated, rain-fed agriculture is still common in Begusarai.³⁹

Primary Research Methodology

Muzaffarpur

In the Gram Panchayats visited, the JJN team conducted seven focus group discussions (FGDs) across wards. These FGDs were attended by 83 respondents including ward members, ward *sacheev* or secretary, village residents, and Gram Panchayat officials. The JJN research team also conducted in-depth interviews with frontline workers such as pump operators. These discussions were conducted in Hindi, a language in which the research team is fluent.

On a block- and district-level, the team interviewed one Block Development Officer and the District Program Officers from MGNREGA and Panchayati Raj, as well as the District Coordinator of Bihar Vikas Mission. Finally, on a state-level, the team interviewed the Executive Engineer from the Public Health Engineering Department and the Panchayati Raj Department as well as the Project Leader for Bihar Vikas Mission.

In Muzaffarpur, access to all five GPs visited was facilitated by Nirदेश, a woman- and child-centred social service organisation based in the district. JJN researchers wish to express their deepest gratitude towards Rambha ji, Satyendra ji, and Binod ji – Nirदेश members who supported, accompanied, and welcomed them.

Table 6

Sample size, criteria, and methods, Muzaffarpur

Sample	Sampling criteria	Methods
NGO/CSO members (N=3)	Criterion sampling	Scoping Interviews
Village residents (N=26)	Criterion sampling (adults living in the village); Snowball sampling	Focus Group Discussions
Frontline workers (N=6)	Criterion sampling (technical and supporting workers, as defined by the study)	Semi-structured Interviews and Focus Group Discussions
Ward members and GP officials (N=51)	Criterion sampling (current and former ward members as well as officials); Snowball sampling	Semi-structured Interviews
Block- and District officials (N=4)	Criterion sampling	Semi-structured Interviews
State officials (N=2)	Criterion sampling	Semi-structured Interviews

Table 7

Profiles of GPs visited, Muzaffarpur

S No	Gram Panchayat	Block	No. of Wards	No. of HHs	% of households with FHTC	Methods
1	Dadar Kolhuwa	Kanti	12	1652	100%	Groundwater
2	Sherukahi	Kanti	12	427	100%	Groundwater
3	Harchanda	Kanti	15	1165	100%	Groundwater
4	Makdumpur Kodana	Marwan	10	1147	100%	Groundwater
5	Bhatauna	Marwan	15	1484	100%	Groundwater

Begusarai

In the Gram Panchayats visited, the JJN team conducted seven focus group discussions (FGDs) across wards. These FGDs were attended by 66 respondents including ward members, ward *sacheev* or secretary, village residents, and Gram Panchayat officials. The JJN research team also conducted in-

depth interviews with frontline workers such as pump operators. These discussions were conducted in Hindi, a language in which the research team is fluent. At the district level, the team interviewed PHED officials, members of JJM's DPMU, and Zilla Parishad members.

Table 8

Sample size, criteria, and methods – Begusarai

Sample	Sampling criteria	Methods
NGO/CSO members (N=4)	Criterion sampling	Scoping Interviews
Village residents (N=19)	Criterion sampling (adults living in the village); Snowball sampling	Focus Group Discussions
Frontline workers (N=5)	Criterion sampling (technical and supporting workers, as defined by the study)	Semi-structured Interviews and Focus Group Discussions
Ward members and GP officials (N=47)	Criterion sampling (current and former ward members as well as officials); Snowball sampling	Semi-structured Interviews
Block- and District officials (N=6)	Criterion sampling	Semi-structured Interviews
State officials (N=2)	Criterion sampling	Semi-structured Interviews

Table 9

Profiles of GPs visited, Begusarai

S No	Gram Panchayat	Block	No. of Wards	No. of HHs	% of households with FHTC	Source of Water
1	Banwaripur	Bhagwanpur	14	601	100%	Groundwater
2	Maheshpur	Bhagwanpur	11	874	100%	Groundwater
3	Takiya	Bhagwanpur	5	524	100%	Groundwater
4	Lakho	Begusarai	15	1796	100%	Groundwater
5	Samsa	Naokothi	17	1500	100%	Groundwater

Notes

- ¹ World Bank, *India groundwater: A valuable but diminishing resource*, 2012, <https://www.worldbank.org/en/news/feature/2012/03/06/india-groundwater-critical-Diminishing>.
- ² Government of India, *Community participation in water related programmes*, Press Information Bureau, 2021. <https://pib.gov.in/PressReleaselframePage.aspx?PRID=1703211>.
- ³ United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), *Economic and Social Survey of Asia and the Pacific 2016: Year-end Update*. 2016. <https://www.unescap.org/sites/default/files/2016-year-end-update.pdf>
- ⁴ Government of Bihar, *Rural and urban population - Bihar and India 1901-2011*, 2011. <https://state.bihar.gov.in/main/cache/1/Figures/Table-011.pdf>
- ⁵ Government of Bihar, *State Water Policy Draft 2*. Government of Bihar: Public Engineering and Health Department, 2010. <http://sambal.bihar.gov.in/document/view/211/State-Water-Policy-Draft-2--10th-March--2010>
- ⁶ K.V. Raju, *Participatory irrigation management in Bihar: Status and issues*, 2006. <http://www.isec.ac.in/Draft02-Bihar-PIM-090406.PDF>
- ⁷ Jal Jeevan Hariyali Mission, Bihar, n.d. <https://www.jaljeevanhariyali.bih.nic.in/JalJeevanHaryali/Default.aspx> and Government of Bihar, *Agriculture department*, n.d. <http://horticulture.bihar.gov.in/PMKSYMI/AboutPMKSY.aspx>
- ⁸ Government of India, *PM-KUSUM (Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan) Scheme*, National Portal of India, n.d. <https://www.india.gov.in/spotlight/pm-kusum-pradhan-mantri-kisan-urja-suraksha-evam-utthaan-mahabhiyan-scheme>
- ⁹ Interview with AKRSPI.
- ¹⁰ G. Jolliffe, *How a solar irrigation entrepreneurship project transformed agriculture in a village in Bihar*, Video Volunteers, 2019. <https://www.videovolunteers.org/how-a-solar-irrigation-entrepreneurship-project-transformed-agriculture-in-a-village-in-bihar/>
- ¹¹ Jal Jeevan Hariyali Mission, *Job openings*, n.d. <https://jjhm.info/about/JobOpenings>
- ¹² V.P. Gandhi et al., "Institutional structure, participation, and devolution in water institutions of Eastern India," *Water* 12, no. 2 (2020): 476. <https://www.mdpi.com/2073-4441/12/2/476>
- ¹³ Government of Bihar. *Water resources department*, n.d. <https://wrdfmiscwrdbihar.gov.in/>
- ¹⁴ V.P. Gandhi et al., "Institutional structure, participation, and devolution in water institutions of Eastern India," 2020.
- ¹⁵ Ibid.
- ¹⁶ *Ahars* are reservoirs embanked on three sides; *Pyne* are channels constructed to divert water from a river or catchment area, which then flows into the *Ahar*. A single *Pyne* can provide irrigation for up to 400 acres. This system serves to manage floods and droughts and acts as a protective mechanism for nearby villages.
- ¹⁷ Central Ground Water Board (CGWB), *Dynamic ground water resources of Bihar as on 31st March 2020*, 2022. http://cgwb.gov.in/GW-Assessment/GWR-2020-Reports%20State/Bihar_State_Report_Resource2020.pdf
- ¹⁸ United Nations World Water Assessment Programme (UN WWAP), *The United Nations world water development report 2016: Water and jobs*, 2016. <https://www.unesco.org/en/wwap/wwdr/2016>
- ¹⁹ Ibid. and Uta When and Carlos Montalvo, "Exploring the dynamics of water innovation: Foundations for water innovation studies," *Journal of Cleaner Production* 171 (2018): S1–S19. <https://doi.org/10.1016/j.jclepro.2017.10.118>

- ²⁰ Ibid.
- ²¹ Ibid.
- ²² Central Ground Water Board (CGWB), *Ground Water Information Booklet Muzaffarpur District, Bihar State*, Ministry of Water Resources, 2013. http://cgwb.gov.in/District_Profile/Bihar/Muzaffarpur.pdf
- ²³ Government of Bihar, *State Water Policy Draft 2*. Government of Bihar: Public Engineering and Health Department, 2010.
- ²⁴ Government of Bihar, *The Bihar Panchayat Raj (Amendment) Act 2017*, 2017; and Government of Bihar, *The Bihar Ward Sabha & Ward Implementation and Management Committee Conduct of Business Rules, 2017*, 2017b.
- ²⁵ Government of India, *Operational Guidelines for the Implementation of Jal Jeevan Mission*. Government of India: Ministry of Jal Shakti, 2019. https://jalshakti-ddws.gov.in/sites/default/files/JJM_Operational_Guidelines.pdf
- ²⁶ Personal interviews; and Jal Jeevan Mission, *Functionality assessment of household tap connection under national Jal Jeevan Mission-2022; State report Bihar*. Jal Jeevan Mission, 2022. <https://jaljeevanmission.gov.in/sites/default/files/2022-10/functionlity-report-bihar.pdf>
- ²⁷ Government of Bihar, *State Water Policy Draft 2*. Government of Bihar: Public Engineering and Health Department, 2010.
- ²⁸ United Nations World Water Assessment Programme (UN WWAP), *The United Nations world water development report 2016: Water and jobs*, 2016; and JustJobs Network, *Water and livelihoods in Karnataka*, Jal Kaushal: Water, Lives, and Livelihoods, 2023.
- ²⁹ S. Verma et al., *SoLAR: Solar Irrigation for Agriculture Resilience – A New SDC-IWMI Regional Partnership*, 2018. https://www.iwmi.cgiar.org/iwmi-tata/PDFs/iwmi-ta-ta_water_policy_discussion_paper_issue_03_2018.pdf
- ³⁰ Ibid.
- ³¹ Varsha Khandker, Vasant P. Gandhi, and Nicky Johnson. “Gender Perspective in Water Management: The Involvement of Women in Participatory Water Institutions of Eastern India,” *Water* 12, no. 1 (2020): 196. <https://doi.org/10.3390/w12010196>
- ³² Government of Bihar, *State Water Policy Draft 2*. Government of Bihar: Public Engineering and Health Department, 2010.
- ³³ Department For Promotion Of Industry And Internal Trade, *District Development Plan – Muzaffarpur*, Office of Economic Advisor, Ministry of Commerce and Industries District, 2019. https://eaindustry.nic.in/ddp/Muzaffarpur_DDP_Report_Final.pdf
- ³⁴ Ibid.
- ³⁵ Central Ground Water Board (CGWB), *Ground Water Information Booklet Muzaffarpur District, Bihar State*, Ministry of Water Resources, 2013.
- ³⁶ Ibid.
- ³⁷ Central Ground Water Board (CGWB), *Ground Water Year Book (2019-2020)*, Ministry of Water Resources, 2021.
- ³⁸ Central Ground Water Board (CGWB), *Ground Water Information Booklet Begusarai District, Bihar State*, Ministry of Water Resources, 2013. http://cgwb.gov.in/district_profile/Bihar/Begusarai.pdf
- ³⁹ Ibid.

References

- Central Ground Water Board (CGWB). *Dynamic ground water resources of Bihar as on 31st March 2020, 2022*. http://cgwb.gov.in/GW-Assessment/GWR-2020-Reports%20State/Bihar_State_Report_Resource2020.pdf
- Central Ground Water Board (CGWB). *Ground Water Information Booklet Begusarai District, Bihar State*. Ministry of Water Resources, 2013. http://cgwb.gov.in/district_profile/Bihar/Begusarai.pdf
- Central Ground Water Board (CGWB). *Ground Water Information Booklet Muzaffarpur District, Bihar State*. Ministry of Water Resources, 2013. http://cgwb.gov.in/District_Profile/Bihar/Muzaffarpur.pdf
- Central Ground Water Board (CGWB). *Ground Water Year Book (2019-2020)*. Ministry of Water Resources, 2021.
- Department For Promotion Of Industry And Internal Trade. *District Development Plan – Muzaffarpur*. Office of Economic Advisor, Ministry of Commerce and Industries District, 2019. https://eaindustry.nic.in/ddp/Muzaffarpur_DDP_Report_Final.pdf
- Gandhi, V. P., N. Johnson, K. Neog, and D. Jain. "Institutional structure, participation, and devolution in water institutions of Eastern India." *Water*, 12(2), 476. 2020 <https://www.mdpi.com/2073-4441/12/2/476>
- Government of Bihar. *Agriculture department*, n.d. <http://horticulture.bihar.gov.in/PMKSYMI/AboutPMKSY.aspx>
- Government of Bihar. *Water resources department*, n.d. <https://wrd.fmiscwrdbihar.gov.in/>
- Government of Bihar. *The Bihar Panchayat Raj (Amendment) Act 2017*, 2017. [https://state.bihar.gov.in/biharprd/cache/33/31-Jul-22/SHOW_DOCS/ACT_Bihar%20Panchayat%20Raj%20\(Amendment\)%20Act%202017.pdf](https://state.bihar.gov.in/biharprd/cache/33/31-Jul-22/SHOW_DOCS/ACT_Bihar%20Panchayat%20Raj%20(Amendment)%20Act%202017.pdf)
- Government of Bihar. *The Bihar Ward Sabha & Ward Implementation and Management Committee Conduct of Business Rules, 2017*, 2017b. https://state.bihar.gov.in/bihar-prd/cache/33/31-Jul-22/SHOW_DOCS/RULE_Bihar%20Ward%20Sabha%20&%20Ward%20Implementation%20and%20Management%20Committee%20Conduct%20of%20Business%20Rules%202017.pdf
- Government of Bihar. *Rural and urban population - Bihar and India 1901-2011*, 2011. <https://state.bihar.gov.in/main/cache/1/Figures/Table-011.pdf>
- Government of Bihar. *State Water Policy Draft 2*. Government of Bihar: Public Engineering and Health Department. 2010. <http://sambal.bihar.gov.in/document/view/211/State-Water-Policy-Draft-2--10th-March--2010>
- Government of India. *PM-KUSUM (Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan) Scheme*. National Portal of India, n.d. <https://www.india.gov.in/spotlight/pm-kusum-pradhan-mantri-kisan-urja-suraksha-evam-utthaan-mahabhiyan-scheme>
- Government of India. *Community participation in water related programmes*. Press Information Bureau. 2021. <https://pib.gov.in/PressReleaseSelfPage.aspx?PRID=1703211>
- Jal Jeevan Hariyali Mission, Bihar, n.d. <https://www.jaljeevan-hariyali.bih.nic.in/alljeevanHariyali/Default.aspx>
- Jal Jeevan Hariyali Mission. *Job openings*, n.d. <https://jjhm.info/about/jobOpenings>
- Jal Jeevan Mission. *Functionality assessment of household tap connection under national Jal Jeevan Mission-2022*; State report Bihar. Jal Jeevan Mission, 2022. <https://jaljeevan-mission.gov.in/sites/default/files/2022-10/functionlity-report-bihar.pdf>
- Jolliffe, G. *How a solar irrigation entrepreneurship project transformed agriculture in a village in Bihar*. Video Volunteers, 2019. <https://www.videovolunteers.org/how-a-solar-irrigation-entrepreneurship-project-transformed-agriculture-in-a-village-in-bihar/>
- JustJobs Network. *Water and livelihoods in Karnataka*. Jal Kaushal: Water, Lives, and Livelihoods, 2023.
- Khandker, Varsha, Vasant P. Gandhi, and Nicky Johnson. "Gender Perspective in Water Management: The Involvement of Women in Participatory Water Institutions of Eastern India" *Water* 12, no. 1 (2020):196. <https://doi.org/10.3390/w12010196>

Raju, K. V. *Participatory irrigation management in Bihar: Status and issues*, 2006. <http://www.isec.ac.in/Draft02-Bihar-PIM-090406.PDF>

United Nations Department of Economic and Social Affairs (UNDESA). *International standard industrial classification of all economic activities: Revision 4*. Statistical Papers Series M. No. 4. New York: United Nations, 2008.

United Nations World Water Assessment Programme (UN WWAP). *The United Nations world water development report 2016: Water and jobs*, 2016. <https://www.unesco.org/en/wwap/wwdr/2016>

Verma, S., Kashyap, D., Shah, T., Crettaz, M., and Sikka, A. *SoLAR: Solar Irrigation for Agriculture Resilience - A New SDC-IWMI Regional Partnership*, 2018. https://www.iwmi.cgiar.org/iwmi-tata/PDFs/iwmi-tata_water_policy_discussion_paper_issue_03_2018.pdf

Wehn, Uta, and Carlos Montalvo. "Exploring the dynamics of water innovation: Foundations for water innovation studies." *Journal of Cleaner Production* 171 (2018): S1–S19. <https://doi.org/10.1016/j.jclepro.2017.10.118>

World Bank. *India groundwater: A valuable but diminishing resource*, 2012. <https://www.worldbank.org/en/news/feature/2012/03/06/india-groundwater-critical-diminishing>

JustJobs

NETWORK

JustJobs Network is an applied research institute finding evidence-based solutions to pressing labour market challenges. We produce research on good job creation and workforce development, focusing our work on the critical knowledge gaps in the employment landscape.

JustJobs convenes a global network of diverse stakeholders — including policy shapers, academics, and grassroots leaders — to deepen the practical implications of our research endeavours and amplify their impact. Through the combination of cutting-edge research and global knowledge sharing, we aim to forge a fresh, dynamic channel for policy dialogue on employment at national, regional and international levels.