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A report prepared for the Minor Water Resources Department (MWRD), Government of Bihar

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CEEW Report

Institutional Reform for Improved Service Delivery in Bihar

Economic Growth, Agricultural Productivity, and a Plan for Reorganising the Minor Water Resources Department

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Institutional Reform for Improved Service Delivery in Bihar: Economic Growth, Agricultural Productivity, and a Plan for Reorganising the Minor Water Resources Department

A report prepared for the Minor Water Resources Department (NWRD), Government of Bihar

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Principal Investigator
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A report on reorganisation of the Minor Water Resources Department for the Government of Bihar.

This report was prepared by the Council on Energy, Environment and Water. The report was commissioned on the request of the Minor Water Resources Department, Government of Bihar to the International Growth Centre, Bihar.

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FOREWORD

India's sustainable development depends only in part on national level policy frameworks. The real test of any policy proposal is how it is implemented at the state level. Promoting economic growth while paying attention to social development and environmental sustainability is not an easy task. State governments, district officials and field level officers often face tradeoffs between different policy priorities. This is why the Council on Energy, Environment and Water (CEEW) promotes the development of integrated energy, environment and water plans, so that tradeoffs may be recognised and potential opportunities for co-benefits are identified and exploited.

Bihar's extraordinary economic growth in recent years has raised expectations of continuing high growth rates in future. If this record has to be sustained, then agricultural growth will have to play a critical part. Agricultural development depends, in turn, on increasing irrigation and cropping intensity. And for a state with 96% of the farmers classified as small and marginal, the focus must be on developing and maintaining minor irrigation infrastructure in the state. This was the premise for conducting this study, following a direct request from the Minor Water Resources Department, Government of Bihar. The study focuses on the steps needed to reorganise and strengthen the department to achieve its irrigation intensity targets during the 12th and 13th Five Year Plan periods (2012-22).

This report, Institutional Reform for Improved Service Delivery in Bihar: Economic Growth, Agricultural Productivity and a Plan for Reorganising the Minor Water Resources Department, prepared by CEEW researchers, draws on lessons from eight other states in India, international best practices, consultations with officials in Patna, and field visits to five districts to interview field level irrigation officials, farmers and water user associations. Based on this extensive research, the report offers recommendations for staff allocation and organisational design, groundwater management through improved data collection, maintenance and quality of irrigation infrastructure, and participatory irrigation management via strengthened Water User Associations.

I congratulate the researchers for this comprehensive study, based not just on abstract concepts, but reflecting realities observed on the ground. In this manner, the report has shown how agriculture, irrigation and water management are interlinked in Bihar and kept its focus on the needs of the vast majority of small and marginal farmers in the state. I hope that the recommendations of the report will be considered by the Government and that it will set a benchmark for consultative irrigation and water management reform in other states as well.

Suresh P. Prabhu
Chairperson

Mumbai
26 July 2012

ABOUT CEEW

The Council on Energy, Environment and Water is an independent, not-for-profit policy research institution. CEEW addresses pressing global challenges through an integrated and internationally focused approach. It does so through high quality research, partnerships with public and private institutions, and engagement with and outreach to the wider public. Among its major initiatives, CEEW has: published the 584-page National Water Resources Framework Study for India's 12th Five Year Plan; written India's first report on global governance, submitted to the National Security Adviser; assessed India's 22 gigawatt solar mission; developed an innovation ecosystem framework for India; facilitated the $100 million India-U.S. Joint Clean Energy R&D Centre; worked on geoengineering governance (with UK's Royal Society and the IPCC); created the Maharashtra-Guangdong partnership on sustainability; published research on energy-trade-climate linkages (including on governing clean energy subsidies for Rio+20); produced comprehensive reports and briefed negotiators on climate finance; and supported Bihar (one of India's poorest states) with minor irrigation reform and for water-climate adaptation frameworks.

CEEW's work profile covers all levels of governance: at the global/regional level, these include climate finance, energy-trade-climate linkages, geoengineering governance, and bilateral collaborations with China, Israel, Pakistan, and the United States; at the national level, it covers energy and resource efficiency and security, water resources management, renewable energy policies, India and global governance, and innovation strategies; and at the state/local level, CEEW develops integrated energy, environment and water plans, and facilitates industry action to reduce emissions or increase R&D investments in clean technologies. More information about CEEW is available at: http://ceew.in/.

ABOUT THE AUTHORS

Arunabha Ghosh

Arunabha Ghosh is CEO of the Council on Energy, Environment and Water (CEEW), an independent, policy research institution in India.

He is also associated with Oxford's Global Economic Governance Programme and its Smith School of Enterprise and the Environment. He is involved with the UK Royal Society's Solar Radiation Management Governance Initiative and has co-chaired its international governance working group. He is a member of three track II initiatives: the India-US Dialogue on Climate Change and Energy, the India-Israel Forum, and the Islamabad Dialogue. He sits on the Governing Board of the International Centre for Trade & Sustainable Development, Geneva.

Dr Ghosh was previously Global Leaders Fellow at Princeton's Woodrow Wilson School of Public & International Affairs, and at Oxford's Department of Politics and International Relations. He was also Policy Specialist at the United Nations Development Programme in New York and has worked at the World Trade Organization in Geneva.

Arunabha's interests intersect international relations, global governance and human development, including climate, energy, water, trade and conflict. He currently works on: climate governance (financing, R&D, geoengineering); energy-trade-climate linkages; global energy governance; water governance and institutions; and international regime design. His recent and forthcoming publications include: Governing Clean Energy Subsidies (for Rio+20); Laying the Foundation of a Bright Future (on India's national solar mission); Understanding Complexity, Anticipating Change (on India and global governance, submitted to the National Security Adviser); National Water Resources Framework Study (for India's Planning Commission); Harnessing the Power Shift (on sources and governance of climate finance); International Cooperation and the Governance of Geoengineering (for the Intergovernmental Panel on Climate Change); and three UNDP Human Development Reports (including the 2006 report on water). Arunabha has worked on trade governance for several years (his doctoral thesis on the WTO's monitoring system was nominated by Oxford for the Best Thesis Prize at the British International Studies Association) and previously led research on intellectual property, financial crises, development assistance, indigenous people, extremism and violent conflict.

Dr Ghosh has presented to a former President of India, India's Parliament, the European Parliament, Brazil's Senate, the Andhra Pradesh Legislative Assembly and other legislatures; trained ministers in Central Asia; and hosted a documentary on the water crisis set out of Africa, Diary of Jay-Z: Water for Life, recognised as an Official Honoree at the Webby

Awards. His op-eds have appeared in the Business Standard, Financial Express, India Today, Indian Express, Mint, Seminar, Tehelka, and The Hindu. Dr Ghosh has delivered public lectures in several countries, and been interviewed by ABC (Australia), BBC, NDTV (India) and Voice of America, among other news outlets. He has also been consulted by DFID (UK), UK Ministry of Justice, IDRC (Canada), International Energy Agency, the Commonwealth Secretariat (London), Oxfam International, and Transparency International. He has served as Assistant Editor and Book Review Editor of the Journal of Human Development and Capabilities. In 2011, the Asia Society named him an Asia 21 Young Leader.

Arunabha holds a D.Phil. (Ph.D.) and M.Phil. in international relations from Oxford, where he was the Clarendon Scholar and Marvin Bower Scholar. He holds an M.A. (First Class) in Philosophy, Politics and Economics from Balliol College, Oxford, as Radhakrishnan-Chevening Scholar. He graduated at the top of his class with a B.A. (Honours) in Economics from St. Stephen's College, Delhi University. He lives in New Delhi, India and speaks English, Hindi, Bengali and basic Spanish. He can be contacted at: arunabha.ghosh[at]ceew.in. Some of his publications are available at: http://ceew.in/publications.

Rudresh Sugam

Rudresh Kumar Sugam is a Programme Officer at the Council of Energy, Environment and Water (CEEW), India. He has recently conducted evidence-based research for the Minor Water Resources Department, Government of Bihar exploring institutional reforms that are required in minor irrigation to achieve agricultural growth targets set by the State. He has also worked with the Cola Cola Company advising them on ways to adopt efficient measures for water resource management in their bottling plants. His interest areas include water use efficiency, water resources optimisation, impact of climate change on water resources, Integrated Watershed Management, and sustainable development.
His educational qualifications include a Post Graduate degree in Water Resources Management from The Energy and Resources Institute (TERI) University, Delhi and a B.Sc. in Botany from Kirori Mal College, University of Delhi. His post-graduate dissertation was on storm water pond efficiency with the Yale School of Forestry and Environment Studies, Yale University, United States.

EXECUTIVE SUMMARY

This report is the outcome of a direct request by the Principal Secretary, Dr Deepak Prasad, of the Minor Water Resources Department (MWRD), Government of Bihar to the International Growth Centre (IGC) and the Council on Energy, Environment and Water (CEEW) to conduct a research study on how to reform the Minor Water Resources Department. Agriculture is the mainstay of Bihar's economy and the economic growth of the state is dependent on the growth of the agricultural sector. This growth is, in turn, fuelled by irrigation facilities. With small and marginal farmers having 96% of landholdings, the major share of irrigation (70%) is provided by the minor sources, namely tube wells.

For agricultural productivity and cropping intensity to increase, Bihar's irrigation intensity has to increase from 85% today to 158% in 2017 and 209% in 2022. Given the importance of minor irrigation, the MWRD has a crucial role in the development and maintenance of irrigation infrastructure in order to drive agricultural growth and increase on-farm productivity. However, currently, the MWRD lacks human resources as well as skills and technology. Only 46% of the sanctioned staff positions are filled. The purpose of this study is to advise the MWRD, Bihar on the steps needed to reorganise and strengthen the department to achieve its irrigation intensity targets during the 12th and 13th Five Year Plan periods (2012-22).

The current state of Bihar's irrigation infrastructure and is poor. Of about 4.23 lakh ha. of TW-covered area, operational TWs cover only 1.05 lakh ha. The MWRD's minor irrigation and tube well divisions do not cover all 38 districts and staffing gaps are especially severe at the field level. For instance, of the 619 sanctioned posts for junior engineers, only 132 are occupied by regular staff and another 158 by contract staff (but the latter are not trained).This situation is compounded by an unclear organisational structure and a poor working relationship with the district administration. Financing of projects have also fallen short (only one-sixth of the requested budgets have been allocated to the MWRD). Further, there is poor quality data, limited monitoring of groundwater resources, and little attention to quality control and maintenance of projects. These challenges have meant that the MWRD also suffers from a deficit of trust with farmers, while water user associations have largely failed in the state.

In order to address these challenges, the study covers: assessments of the overall targets (set against past performance); analysis of human resource deficiencies and addressing the appropriate structure and positioning of critical divisions within the Department); steps to improve groundwater management; the imperatives of monitoring, maintenance, and quality control and the organisational and technological needs for the same; and ways to improve participatory irrigation management.

The study drew on a combination of desktop research, intensive interviews, and field visits. The desktop research on national (eight other states) as well as international best practices helped to benchmark institutional designs against which to compare Bihar's performance. This was combined with three rounds of consultations with senior officials in Patna to discuss preliminary hypotheses and for detailed data collection. More importantly, our research covered field visits in five districts, covering 21 blocks, and consultations with more than 100 farmers, water user association representatives, and irrigation officials. The most appropriate and feasible options for Bihar are, therefore, recommended as follows.

Overall Targets to be Achieved (section IV)

Recommendation 4.1: Evaluate performance for both minor irrigation and tube wells based on outcomes (irrigation achievement) rather than merely based on expenditure and investment.
Recommendation 4.2: Explore ways to increase the allocation of NREGS funds dedicated to minor water resources, in line with other states.

Organisational Restructuring: Allocating Staff; Defining Responsibilities (section V)

Recommendation 5.1: Restructure the MWRD along four lines, namely operations (minor irrigation; tube wells), management (monitoring and quality control; human resources), research (data; groundwater), and capacity building (training; participatory irrigation management)
Recommendation 5.2: Increase staff strength for Minor Irrigation and Tube Well Wings
Recommendation 5.3: Shift the lift irrigation functional area to the Tube Well Wing
Recommendation 5.4: Form a Human Resources Wing
Recommendation 5.5: Create a Water Management Training Institute

Groundwater: Better Data for Strategic Management (section VI)

Recommendation 6.1: Give Groundwater Directorate a larger role
Recommendation 6.2: Focus on water quality and testing
Recommendation 6.3: Develop detailed water maps for Bihar

Maintenance & Quality: Monitoring Performance; Applying New Technologies (section VII)

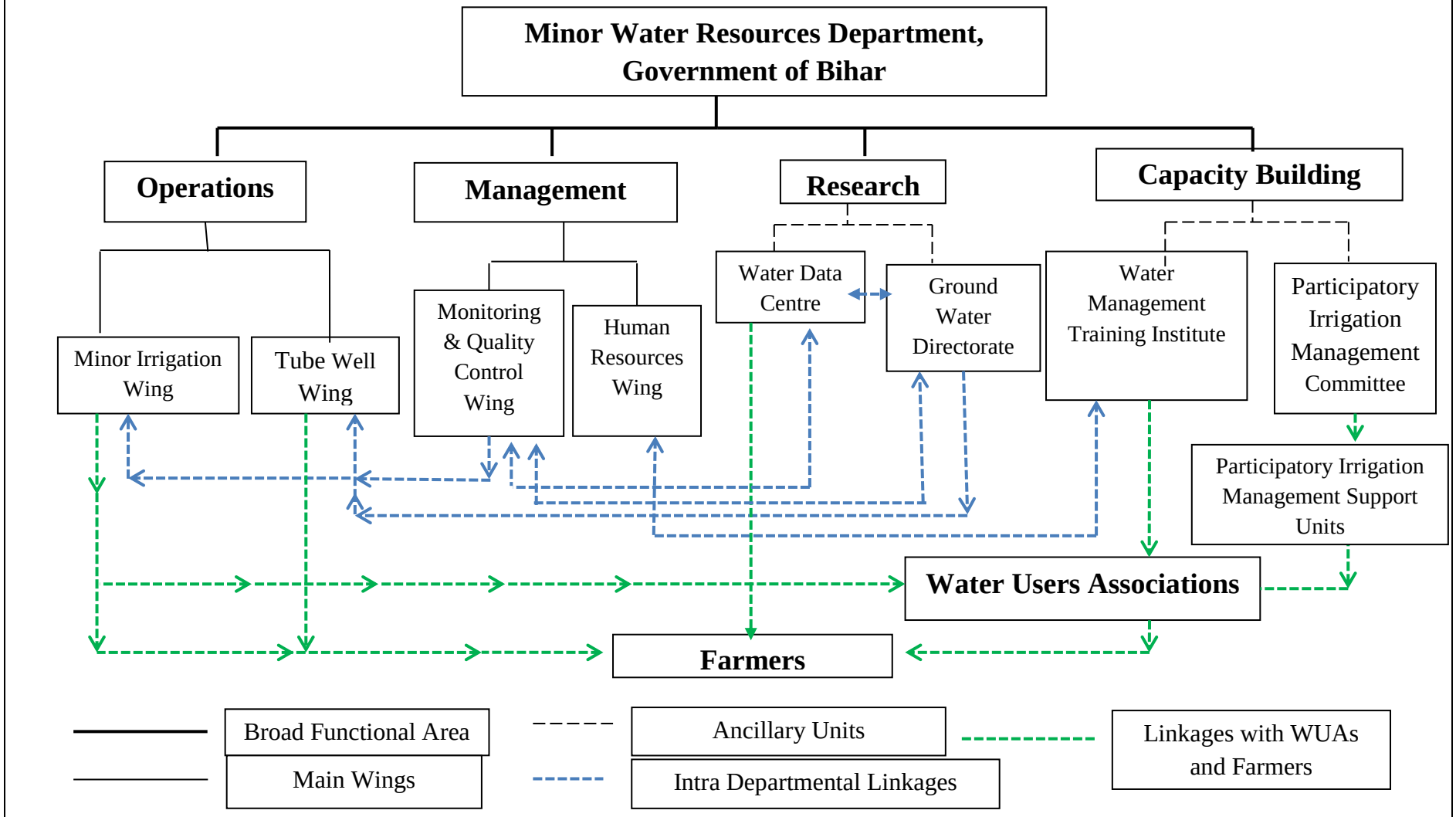
Recommendation 7.1: Establish a dedicated Monitoring and Quality Control Wing (M&QC)
Recommendation 7.2: Create a Water Data Centre
Recommendation 7.3: Pay attention to infrastructure and instrument requirements

Participatory Irrigation Management: Strengthening WUAs; Developing a Service Ethic (section VIII)

Recommendation 8.1: Create a Participatory Irrigation Management Committee and WUA Support Units
Recommendation 8.2: Give incentives for WUAs to register
Recommendation 8.3: Separate governance and management of the WUA
Recommendation 8.4: Allow WUAs to set and collect the service fee
Recommendation 8.5: Grant each WUA an entitlement to water
Recommendation 8.6: Increased awareness and training
Recommendation 8.7: Change attitude and role of the MWRD

This report is unique and, should the recommendations be adopted by MWRD, Bihar, could set a benchmark for consultative irrigation and water management reform in other states as well. Conducted as a "rapid response" to the Government of Bihar's request, the study has revealed further areas of research, namely detailed budgetary analysis of staffing recommendations, inquiry into alternative sources of finance for MWRD's activities, scope for alternative energy sources for minor irrigation, and the pathways for more integrated and coordinate governance between the MWRD and other relevant departments in Bihar. IGC and CEEW are grateful to the MWRD, Bihar for facilitating this research and the close engagement of the senior members of the Department throughout the course of this study. We welcome the opportunity to support the Government of Bihar with further innovative research and offer the evidence base for sustaining its remarkable growth trajectory in the coming years.

Recommended Structure of Minor Water Resources Department



Source: Authors

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I. INTRODUCTION

Bihar is richly endowed with water, both in groundwater and surface water resources. It receives average annual precipitation of 1232 mm, compared to the national average of 1182mm. It also has considerable water supply from major rivers that flow through its territory (**table 1.1**). The Ganga is joined by tributaries with their sources in the Himalayas (Kosi, Saryu (Ghaghra), Gandak, Budhi Gandak, Bagmati, Kamla-Balan and Mahananda) and the plateaus (Sone, Uttari, Koyal, Punpun, Panchane and Karmnasha). Its groundwater resources (**table 1.2**) have potential for further exploitation. The Central Groundwater Board has not identified any over-exploited, critical or semi-critical blocks in the state. But Bihar has to avoid the pitfalls of unregulated groundwater mining while paying attention to groundwater quality. There are also variations in the type of groundwater availability across the state. There are alluvial formations in North Bihar and a part of the region south of the Ganga, while South Bihar has hard rock formations. Tube wells (TW) in alluvial formation regions yield 120-247 m^3/hr but in hard rock regions only about 10-50 m^3/hr.[1]

TABLE 1.1: Major rivers of Bihar and their characteristics

Name of the Basin	Catchment Area (Sq. Km)	Length of River in Bihar (Km)	Embankment Constructed (Km)	Flood Prone Area (FPA) (Sq. Km)	Protected Area (Sq. Km)	Flood vulnerable area (as % of FPA)
Ganga	19322	445	537.81	12920	4300	66.72
Kosi	11410	260	797.90	10150	9300	8.37
Burhi Gandak	9601	320	656.00	8210	4010	51.16
Kiul Harohar	17225		7.00	6340	NIL	100.00
Punpun	9026	235	40.60	6130	260	95.76
Mahananda	6150	376	247.80	5150	1210	76.50
Sone	15820	202	51.69	3700	210	94.32
Bagmati	6500	394	313.73	4440	3170	28.60
Kamla Balan	4488	120	155.50	3700	2810	24.05
Gandak	4188	260	456.04	3350	3350	0.00
Ghaghra	2995	83	125.00	2530	790	68.77
Chandan	4093	118	65.00	1130	80	92.92
Badua	2215	130	NIL	1050	NIL	100.00
Total			**3454.07**	**68800**	**29490**	**57.14**

Source: Water Resources Department, Government of Bihar

[1] Central Ground Water Board (CGWB)

TABLE 1.2: Groundwater Resources of Bihar	
Annual Replenishable Groundwater Resource	29.19 BCM
Net Annual Groundwater Availability	27.42 BCM
Annual Groundwater Draft	10.77 BCM
Stage of Groundwater Development	39 %
Source: Central Ground Water Board (CGWB)	

Irrigation Potential[2]

Bihar's ultimate irrigation potential is 98.38 lakh hectares (ha.) of which about 53.53 lakh ha. can be created through major and medium irrigation schemes. Until March 2010, only 28.86 lakh ha. had been created through 15 major and 78 medium schemes. Further, another 10 major and 3 medium schemes were underway at that date. In 2009-10 the utilization efficiency was estimated to be 57 per cent with total irrigated area being only 16.37 lakh hectares.

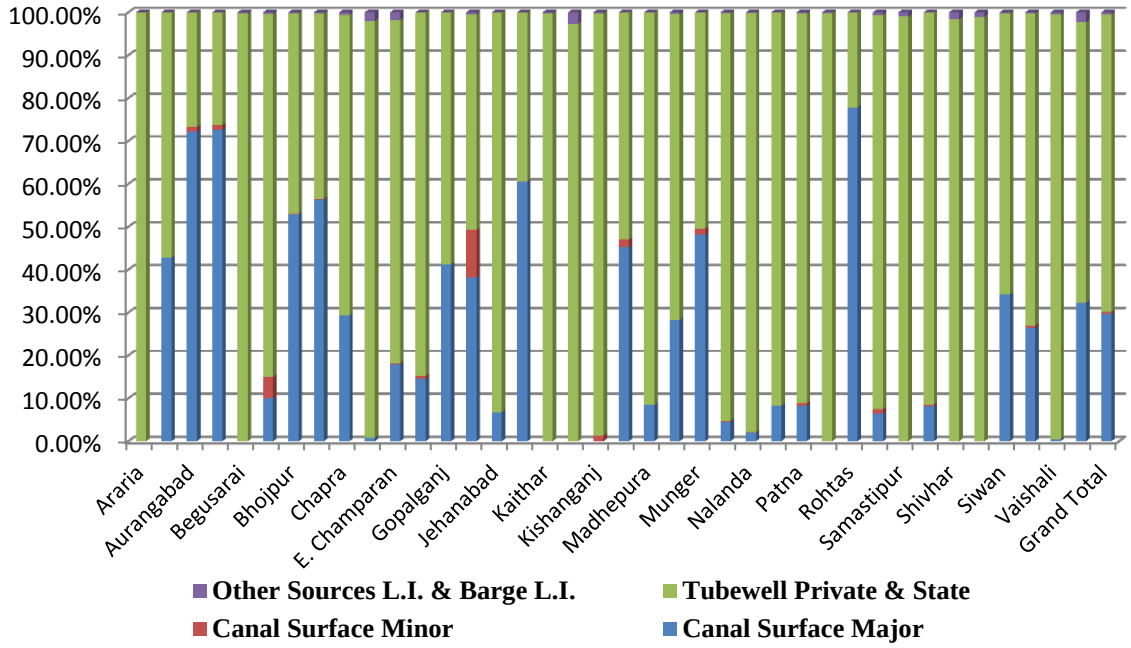
Marginal Farmers and the Importance of Minor Irrigation

Minor irrigation schemes have a significant role in Bihar. In almost all districts tube wells are the primary source of irrigation (**figure 1.1**). In some districts tube wells account for all irrigation. For the state as a whole, minor irrigation sources provide more than 70% of the total irrigation**.**

The role of minor irrigation is further established thanks to Bihar's landholding patterns, which are dominated by marginal and small farmers. They account for 96% of the landholdings (figure 1.2) and 73% of the area under cultivation (**figure 1.3**).

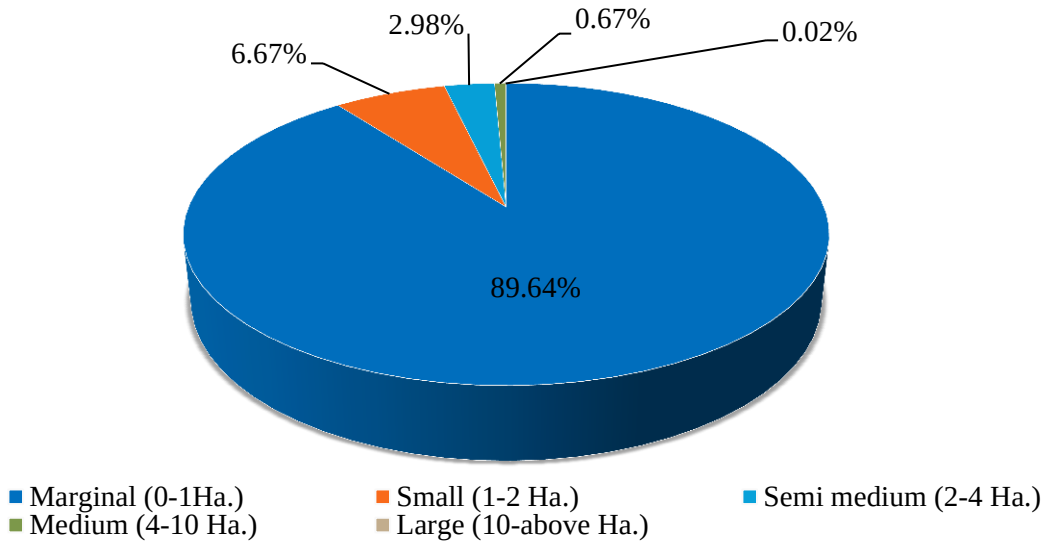
[2] Water Resources Department, Government of Bihar

FIGURE 1.1: Bihar Irrigation Source-Wise (2009-10)



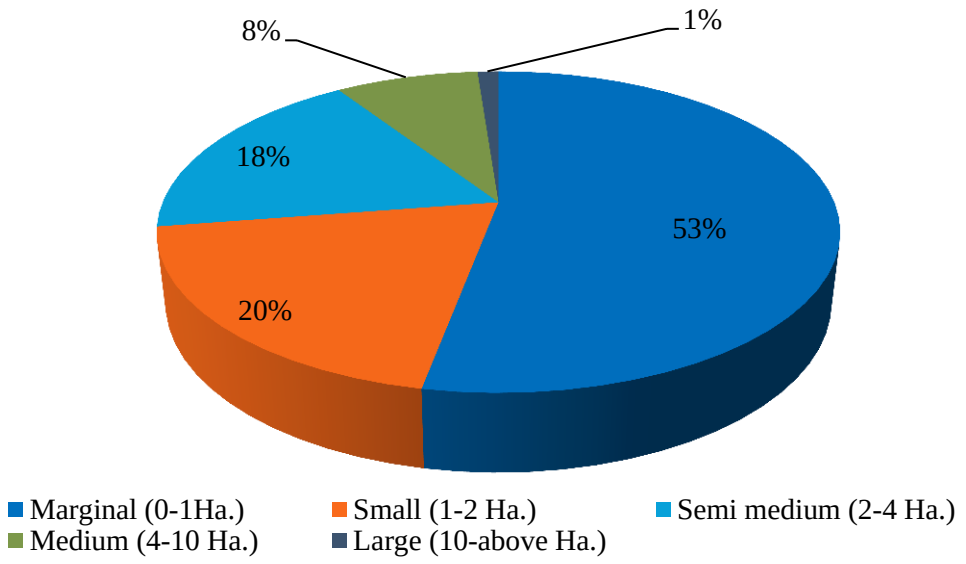
Source: Economic Survey 2010 – 11, Finance Department, Government of Bihar, February 2011, p.57

FIGURE 1.2: Share of different land holdings (number), 2005-06



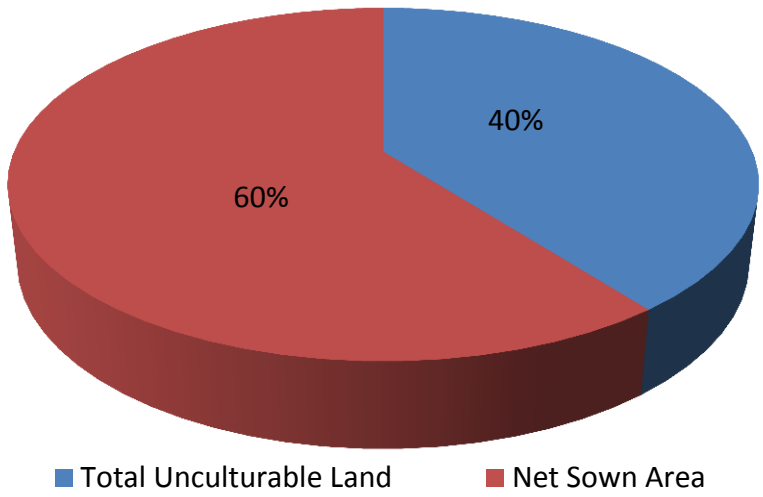
Source: Agricultural Census, 2005 – 06 (http://agcensus.dacnet.nic.in/StateT1table1.aspx accessed on 13 June 2012)

FIGURE 1.3: Share of different land holdings (area), 2005-06



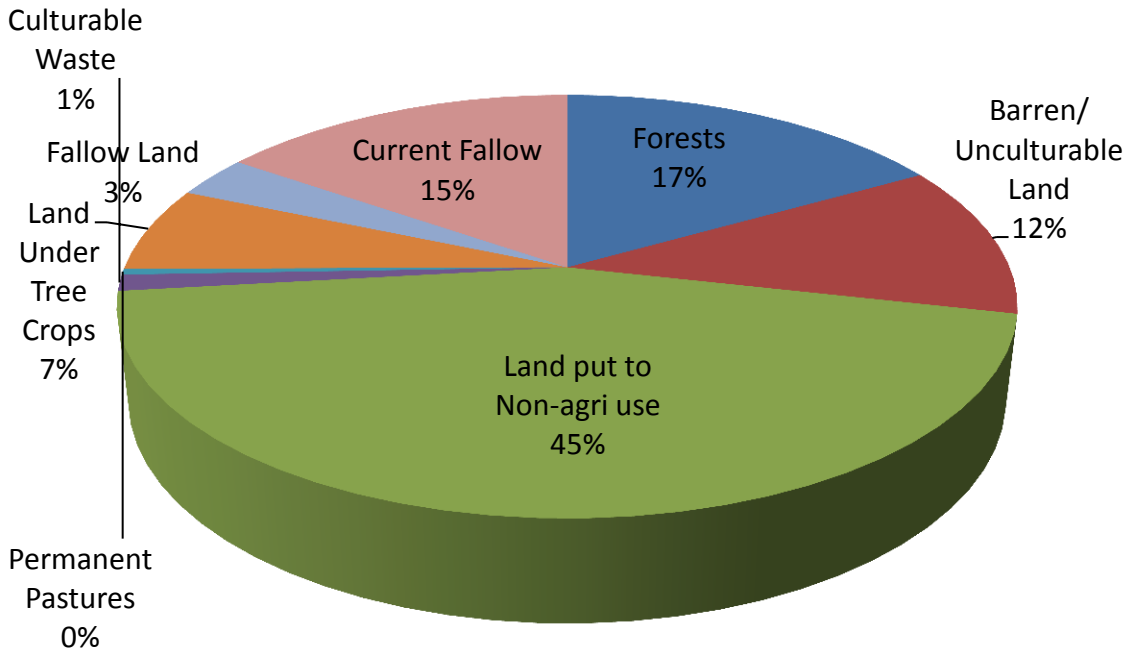
Source: Agricultural Census, 2005 – 06 (http://agcensus.dacnet.nic.in/StateT1table1.aspx accessed on 13 June 2012)

FIGURE 1.4: Bihar LULC (2007-08)



Source: Economic Survey 2010 – 11, Finance Department, Government of Bihar, February 2011, p.35

FIGURE 1.5: Total Unculturable Land further classified (2007-08)



Source: Economic Survey 2010 – 11, Finance Department, Government of Bihar, February 2011, p.35

II. PROBLEM STATEMENT

Bihar's economy has been growing rapidly in recent years. Its annual growth rate of 13.1% for 2011-12 was the highest in the country. Agricultural growth is a big part of Bihar's growth strategy over the next decade. An "agricultural cabinet" is spearheading the initiative for a ten year agricultural roadmap. The agriculture roadmap targets to achieve the objective of a 'rainbow revolution' by increasing the income of farmers, ensuring electricity, enhancing storage facilities, and promoting food processing activities.[3] The agriculture roadmap has set out the following targets:

a) Currently, cropping intensity (total cropping area as a % of net sown area) is 158%
b) Currently, irrigation intensity (total irrigated area as a % of net) is 85%
c) Bihar aims for a cropping intensity of 191% by 2017 and 243% by 2022
d) Correspondingly, irrigation intensity has to reach 158% in 2017 and 209% in 2022.

Set against these ambitious targets in the agriculture roadmap is the reality of poor quality irrigation infrastructure, little investment and weak systems in place for financing and ensuring adequate maintenance, and staff and technical capacity limitations. How will Bihar double or triple irrigation intensity to supply adequate water for raising cropping intensity and agricultural yield? Given the importance of minor irrigation in Bihar, this study asks: what kind of organisational restructuring does Bihar's Minor Water Resources Department (MWRD) need in order for it to deliver the services consistent with the state's ambitious irrigation and agricultural growth plans?

In our initial meetings with officials from the MWRD as well as Department of Environment and Forests, Water Resources Department, and other experts in the state, we discovered that water management in Bihar was plagued by several challenges. These include: regular occurrence of both floods and droughts; low operational efficiency of water resources systems; deteriorating quality of both surface and ground water[4]; limited awareness about sanitation and hygiene practices; lack of community participation.

Moreover, the MWRD faces particular challenges as outlined below.[5]

a) **Targets & achievements:** Targets for infrastructure creation and achievements are largely based on accounting for expenditures and supply side management. There has

[3] http://www.newsreporter.in/bihar-agriculture-road-map-to-focus-on-rainbow-revolution-2, accessed 28 June 2012.

[4] High fluoride (>1.5 mg/l), arsenic (>0.05 mg/l) and other chemical contamination of groundwater is a cause of worry in parts of several districts.

[5] Interview with Secretary, Minor Irrigation Department, Government of Bihar, 22 November 2011 and 9 February 2012. Also, surveys with farmers, Water User Associations, and irrigation officials in April 2012.

traditionally been little emphasis on evaluating the outcomes of spending on minor irrigation projects.

b) **Poor state of existing infrastructure:** The MWRD has installed only around 10500 tubewells till date, of which only half are electrified, only one half of which (i.e. about 2500) are working that too very poorly due to poor quality of electricity or defective conducting wires, transformers, etc. Thus, of about 4.23 lakh ha. of TW-covered area, operational TWs cover only 1.05 lakh ha. This is illustrative of why farmers have low confidence in TW infrastructure, even though much of groundwater (GW) potential remains to be exploited.

c) **Lack of human resources capacity:** There are 28 TW divisions and 22 minor irrigation (MI) divisions in the state. These do not cover all 38 districts. Moreover, many positions remain unfilled. Divisions are headed by executive engineers (EE) who are assisted by assistant engineers (AE), who prepare the detailed project reports (DPRs) and execute them. Each division has 4-5 sub-divisions and each sub-division has 3-4 junior engineers (JE). The JEs are the entry-level officers with minimal qualifications (they have only diplomas). Of the 619 sanctioned posts for JE, only 132 are occupied by regular staff and another 158 by contract staff (but the latter are not trained and, therefore, cannot be counted). There are similar deficiencies with staffing of AEs.

d) **Unclear organisational structure:** Currently, the MWRD has to seek staff from the Irrigation Department, which controls the cadre of engineers. But it is not clear how many additional staff would be needed to meet the goals of increasing irrigation water availability to fuel agricultural growth in the state. An earlier administration had proposed merging the TW division with the MI division, because trust in TW infrastructure was low. But, if TWs have to play a renewed important role, then the staff requirements have to be calculated accordingly. The skill requirements for MI and TW divisions also have to be assessed. The organisational structure also has to account for varying geographical size of districts as well as the type of relevant irrigation potential in each district (MI versus GW).

e) **Lack of support from district administration and poor ownership of MI projects:** The relationship between the district administration and the MI divisions is not well defined, which affects ownership of the projects as well as the quality of the delivery of the services.

f) **Poor financing:** Banks are unwilling to offer credit to farmers. Current government schemes offer 45% government subsidy combined with 10% beneficiary capital contribution to complement loans that would cover 45% of project cost. If the number

of private TWs has to increase (from the current level of 16 lakhs) then bank financing of these projects has to improve. Since the subsidy schemes were announced in 2009, only 50% of loan targets have been met. Likewise, budgetary allocations for MWRD are one-sixth the requested amount, which severely reduces the funds available for training and skill development for improved service delivery.

g) **Groundwater monitoring and regulation:** Since much of the GW abstraction will occur through private TWs, the role of the GW Directorate is critical. While the TW divisions simply install the TWs, the GW Directorate has to monitor usage. The national ratio for monitoring stations to abstraction devices is 1:500. Bihar has to perform the delicate balancing act of promoting GW use but avoiding the pitfalls that other states (in the northwest and southeast of India) have experienced resulting in severely depleted resources. Meanwhile, the GW Directorate also has a role in recharging GW levels via check dams and water harvesting schemes.

h) **Problems with alternative sources of power:** Solar energy is being deployed to achieve the desired irrigation potential but faces the problem of security. A demonstration project conducted in Patna district was found to be effective for running pump sets. Based on that pilot, 34 solar panels were installed in Biharsharif in Nalanda district. But at three locations, the panels were stolen within a months' time.

i) **Trust deficit with farmers:** Thanks to the above *internal* organisational and performance challenges, farmers do not have much faith in the MWRD as they have not seen too many concrete results for many years. Consequently, MWRD officials face resistance when they initiate new projects. However, only in the past year, intensification of work under the MWRD has earned some credit from farmers.

"*Humlog kabhi soch bhi nahi sakte the ki hum itna badhiya kaam is janm mein dekh payenge. Hum gaonwale is kaam se kafi khush hain aur Laghu Sichai Vibhag ke abhari hain*." (*We had never imagined that we would witness such good quality work in our lives. We villagers are quite happy with the work and are grateful to the MWRD.)*
- Farmer in Bahbalpur village, Block Nathnagar, Patna (on restoration work for Ahar and Pyne infrastructure)

j) **Poor performance of Water User Associations (WUAs):** Compared to the rest of the country, WUAs have not worked well in Bihar. Their renewed role in operationalising plans for irrigation expansion has to be assessed.

These challenges are not insurmountable but they need a comprehensive strategy of reform. This study was conducted with that aim. Section III outlines the key thematic

areas and the methodology that we followed. Section IV focuses on overall targets that the MWRD has set for itself in line with its vision to provide irrigation for agricultural productivity increase in Bihar. The section also analyses past performance for each of the MWRD divisions and considers the role of the National Rural Employment Guarantee Scheme in providing some of the resources that would be needed if MWRD's targets had to be met. Sections V to VIII offer analyses on four main areas of concern that the MWRD highlighted: the organisational structure, including human resource capacity and vacancies, benchmarking against other states, skill gaps and training requirements, and performance appraisal (section V); the structure and role of the Groundwater Directorate and the need for improved groundwater data (section VI); the need for improving monitoring and quality control, including the use of new technologies, and the design of a robust data collection and analysis infrastructure (section VII); and the relationship between the MWRD and farmers through participatory irrigation management (section VIII). Throughout the report, we draw on national or international contexts to benchmark the MWRD's structure and performance, or offer lessons based on best practices. The concluding section IX emphasises on the need of further research to be done in order to analyse sectors such as funds crisis, alternate sources of energy and interdepartmental relationship. Organisational restructuring, improved data collection, better monitoring, and engagement with farmers are interlinked interventions. Success in one area will be contingent on progress in others.

III. KEY THEMATIC AREAS & METHODOLOGY OF THE STUDY

Reorganising the MWRD will, therefore, require a holistic assessment of the challenges. Based on our understanding of the issues and in consultation with the Government of Bihar, which posed numerous questions to the research team, this study focuses on five key thematic areas.

1. Overall targets and resources

a) Overall targets for minor irrigation in Bihar based on the agricultural growth strategy for the state
b) Set against these overall targets, the study examines district-wise past performance and targets for future performance
c) It examines whether some of the additional financial requirements could be sourced from funds allocated under the National Rural Employment Guarantee Scheme

2. Organisational restructuring and human resources

a) The study evaluates the current status of sanctioned versus actual strength for the MWRD
b) It uses comparable states in India to establish a benchmark for staff strength and organisational structure
c) It examines new roles and responsibilities facing the MWRD and accordingly recommends additional staff requirements and organisational structure for the MWRD
d) It examines the skill gaps and training requirements for the department's staff, including for field officers such as junior engineers
e) It also considers how the organisational structure can incorporate training cells at each level (headquarters, district, field)
f) It assesses the promotions system in the department to suggest how staff can be incentivised to increase productivity
g) The study also considers the correct departmental positioning of the Tube Well Division and whether there is a case or not for merging the TW Division with Bihar's Irrigation Department

3. Groundwater management

a) We study the structure of the Groundwater Directorate and compare it with structures in other states

b) It assesses whether the Groundwater Directorate should be expanded and how it would fit in with the overall organisational balance and focus of the MWRD

4. Technology, monitoring, and maintenance

a) The study investigates the quality, frequency and accessibility of data collected at different levels of the MWRD
b) It compares with other available technologies to improve data collection and monitoring
c) It also examines whether there are readily available and cost-effective technologies that could help in the MWRD's work
d) It examines the processes related to maintenance of irrigation infrastructure
e) It offers recommendations on the organisational staff and technologies needed for greater emphasis on maintenance and whether a dedicated monitoring and quality control wing is justified

5. Participatory Irrigation Management

a) The study inquires how WUAs have performed in the state
b) It examines the relationship between the MWRD and WUAs
c) It considers whether WUAs are currently capable of rehabilitating and managing the Ahar and Pyne systems
a) It advises on the resources needed and the role of support units for effective participatory irrigation management

Methodology

Our methodology focused primarily on the organisational roles, responsibilities, capacity, training, and resources of the Minor Water Resources Department at various levels. We covered:

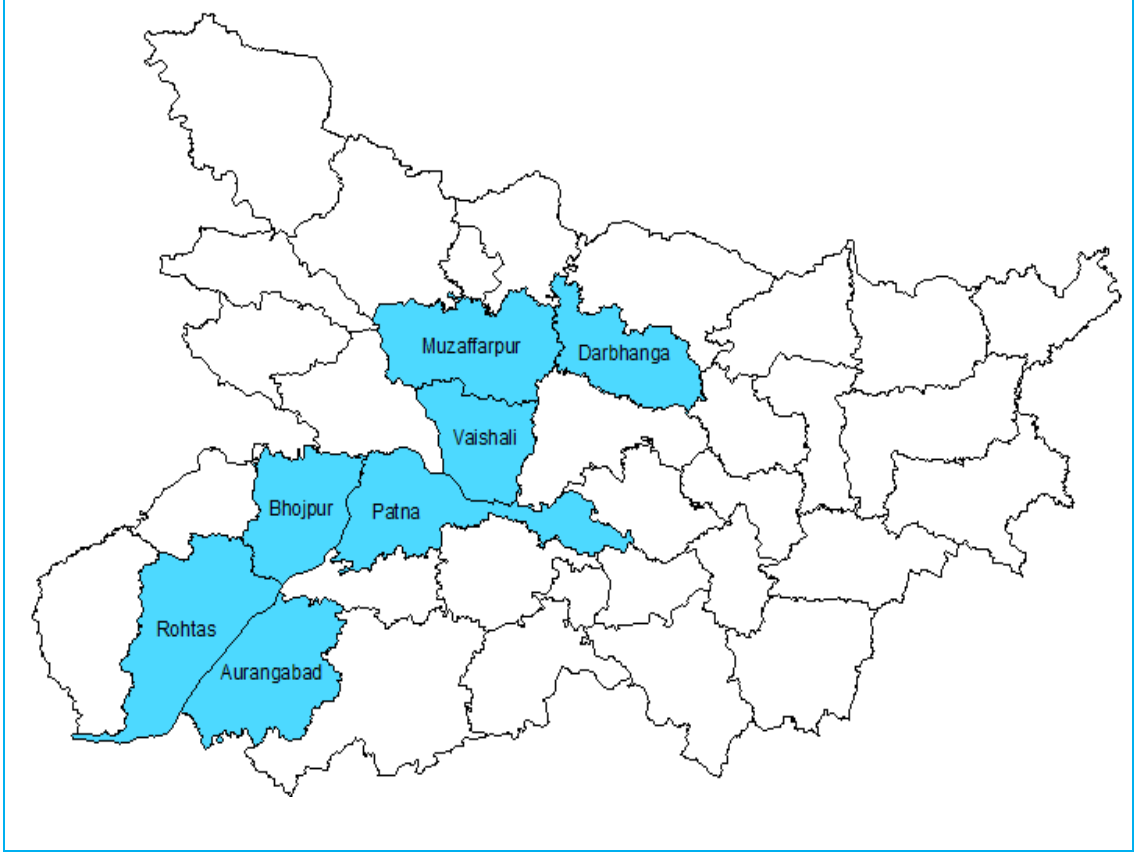
1. Desktop research: For the purposes of benchmarking, institutional best practices, preliminary data collection, survey design
2. Engagement with MWRD in Patna: For the purposes of detailed data collection, understanding scale and nature of the challenges, discussing preliminary hypotheses
3. Data collection from primary and secondary sources in other states, in particular Karnataka, Odisha, Rajasthan, and Tamil Nadu.
4. Field research: For the purposes of surveying MWRD officials, WUA representatives, and farmers

Survey design & primary data collection

In addition to the desktop research and consultations with irrigation officials in Bihar and other states, this study also had an important component of primary data collection via field visits. Initially seven districts were selected (**figure 3.1**) to conduct field visits. Apart from the proximity to Patna, there were other reasons for selecting the sites:

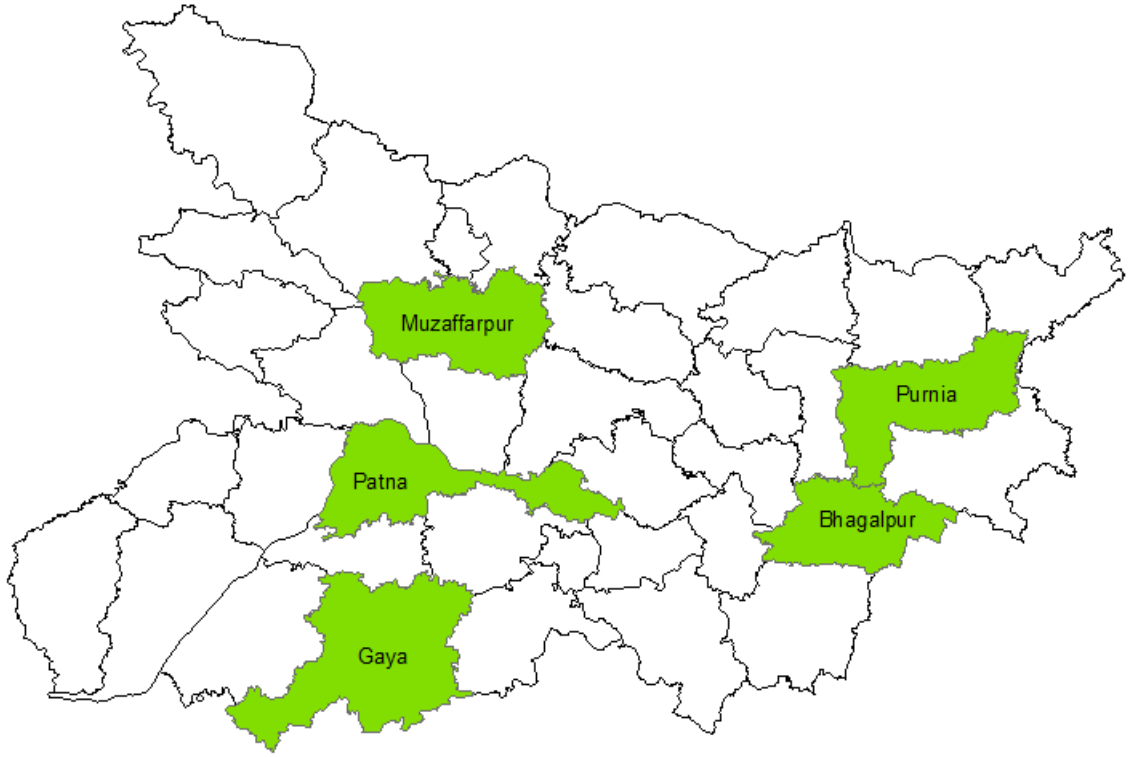
1. **Patna** – In order to observe the success of participatory irrigation management in , Paliganj village
2. **Bhojpur** – Affected by both floods and droughts
3. **Darbhanga** – Flood prone and a seismic zone V area
4. **Vaishali** – Arsenic-affected district
5. **Muzzafarpur** – Iron-affected district
6. **Rohtas** – Nitrate-affected district
7. **Aurangabad** – Fluoride-affected district

FIGURE 3.1: Districts proposed for field visit



But due to time and budget constraints we could survey only five districts (**figure 3.2**). The districts were selected in consultation with the MWRD. Although fewer in numbers, we were able to cover areas in the east of the state, even though these were further away from Patna.

FIGURE 3.2: Districts surveyed during the field visit



Details of the field visit are as follows:

Period of Visit: 2-Apr-2012 – 11-Apr-2012
Districts Visited: Patna, Muzaffarpur, Gaya, Bhagalpur, and Purnia
Number of Blocks covered: 21
Number of farmers consulted: More than 50
Number of WUAs officials consulted: 10
Number of MWRD officials consulted: More than 40
Chief Engineer: 5
Superintending Engineer: 8
Executive Engineer: 8
Assistant Engineer: 8
Junior Engineer: 12
Groundwater Directorate: 1 (with the head of the GWD)

An overview of the questionnaire

Appendices I, II and III provide details of the questionnaires that were prepared for the field visits, targeting farmers, representatives of Water User Associations (WUAs), and irrigation officials.

Farmers: A detailed questionnaire (**Annexure I**) of 74 questions was prepared focussing on:

- general information
- socio economic profile
- quality and quantity of water resources available
- irrigation practices
- approach towards PIM
- relationship with MWRD officials
- production related information

WUA Members: A similar questionnaire **(Annexure II)** was framed for members of WUAs to inquire the following**:**

- Condition under which WUA formed
- Problems faced during WUA formation
- Facilitators
- Members profile
- Major changes observed after formation
- Type of help required from various departments
- Problems in sharing water
- Dominance of president/secretary of association
- Role of MWRD in proper functioning of WUA

MWRD Officials: MWRD officials of the Minor Irrigation and Tube Well wings at various levels were interviewed using a comprehensive survey form (**Annexure III**) on:

- Lack of Staff
- Multiple responsibilities
- Work Pressure
- Relationship with farmers
- Type of information system
- Training record
- Infrastructure facilities
- O & M activities
- Past work and performance record
- Policy changes required

IV. OVERALL TARGETS TO BE ACHIEVED

MWRD Vision

Irrigation potential, both from surface and groundwater sources, remains underutilised in Bihar (**table 4.1**). In pursuit of the targets for agricultural growth in Bihar and the related increase in irrigation intensity required, the MWRD has laid out its vision in the agriculture road map as follows.

- To create 100% of surface irrigation potential in 10 years
- To utilise 100% of the dynamic groundwater potential in addition to tapping 0.3% of the state's groundwater resources beyond the available dynamic groundwater resources
- To control the depletion of groundwater level by constructing artificial recharge and water harvesting schemes, especially in water scarce areas of South Bihar
- To know the characteristics of aquifers and availability of groundwater through resistivity tests and exploratory drilling
- The overall vision is to achieve 209% irrigation intensity so as to meet the required cropping intensity as per the state's agricultural road map

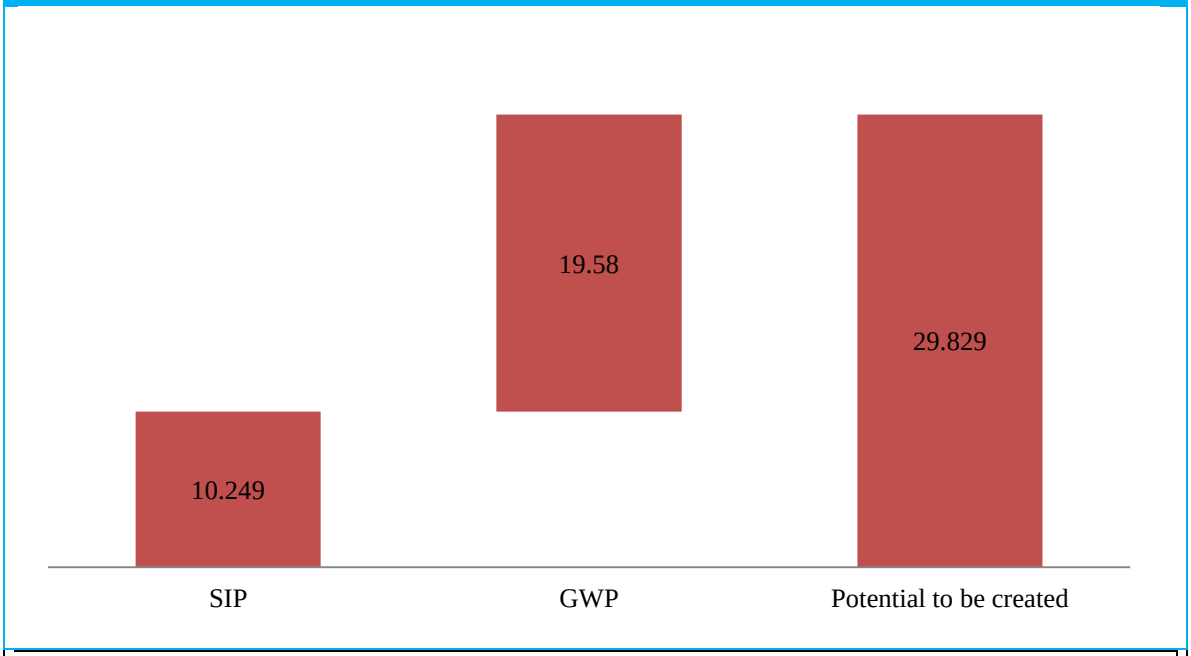
Table 4.1: Current Status of Irrigation Potential in Bihar

Total Surface Irrigation Potential (SIP)	15.44 Lakh ha
Irrigation Potential Created (IPC) through SI	5.191 Lakh ha
Irrigation Potential Utilized (IPU) through SI (MI Scheme)	2.358 Lakh ha
Ground Water Potential (GWP)	48.57 Lakh ha
Irrigation Potential Created (IPC) through GW	28.99 Lakh ha
Irrigation Potential Utilized (IPU) through GW	26.75 Lakh ha
Source: Minor Water Resources Department, Bihar	

Strategy

MWRD has a target to create an additional potential of 29.829 Lakh ha (10.249 Lakh ha from surface schemes and 19.589 from ground water schemes and renovate (created but unutilised) potential of 5.073 Lakh ha in 10 years (2012-22).

FIGURE 4.1: Irrigation Potential to be created in Lakh ha (2012-22)

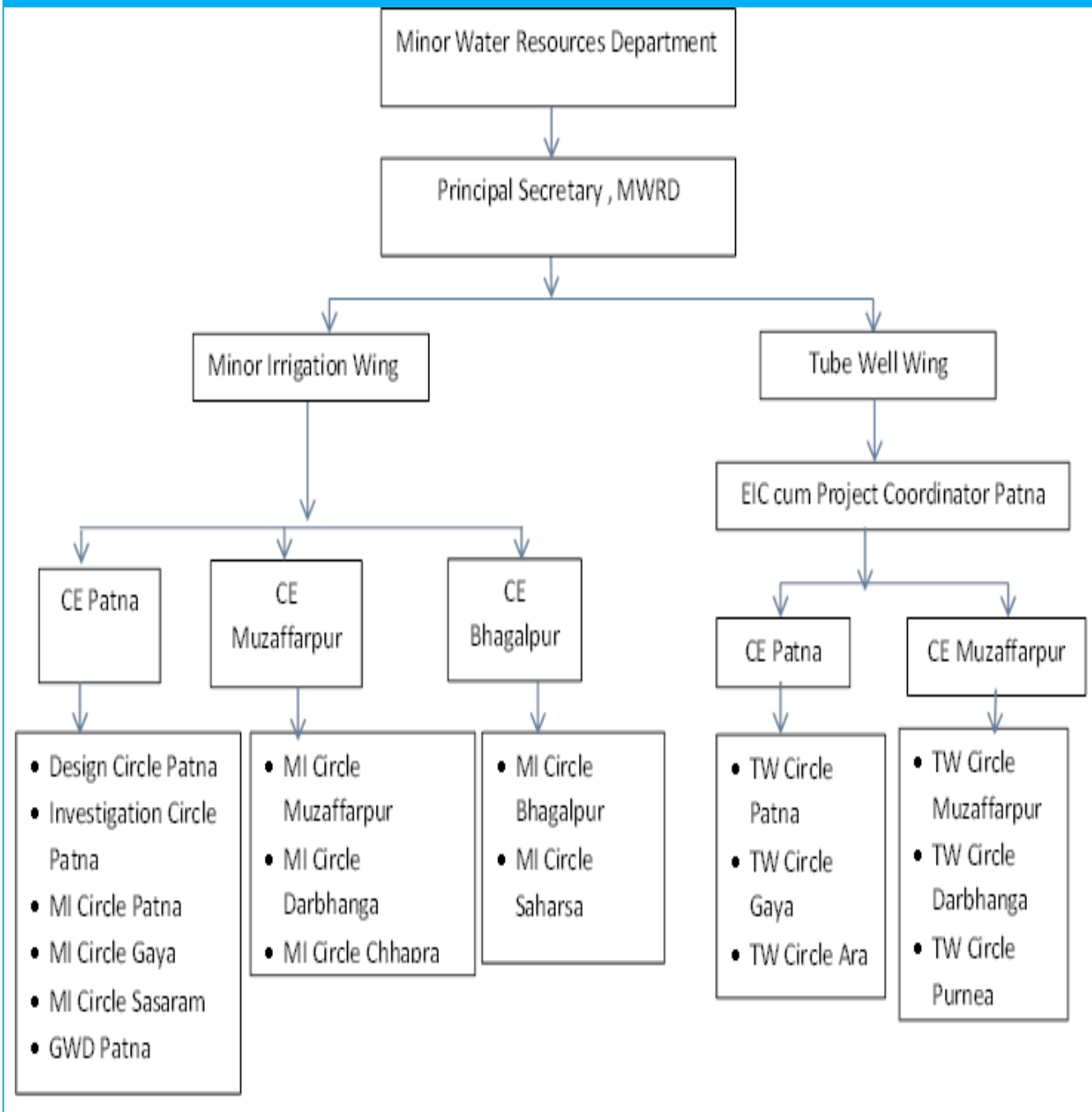


Source: Minor Water Resources Department, Bihar

Current structure of MWRD

Before analysing the past performance of main wings of MWRD, let us look at the existing organisational structure of the department (figure 4.2). The current structure of MWRD has two main wings, namely Minor Irrigation (MI) and Tube Well (TW). MI wing is in charge of the management of minor irrigation through surface water schemes. Its responsibility involves creation, renovation and maintenance of ahars (small ponds) and pynes (channels carrying water from ahars to agriculture fields) and development of other possible surface minor irrigation schemes like barge and lift irrigation schemes. The Tube Well wing is responsible for providing minor irrigation services through the development of groundwater usingtube wells. There is a Groundwater Directorate under the supervision of the MI wing, which is assigned the duty of groundwater surveys and investigations through various means.

FIGURE 4.2: Organogram of Minor Water Resources Department Government of Bihar



Source: MWRD, Patna

Analysis of past performance

For achieving the targets it is necessary to assess the past performance of the Department. **Figures 4.3 and 4.4** show the performance of the minor irrigation wing in recent years. While there has been an improvement in the performance of the MI wing, it is still nowhere near the targets. Only a few divisions like Gaya, Betia and Jehanabad have performed well while other divisions need to catch up.

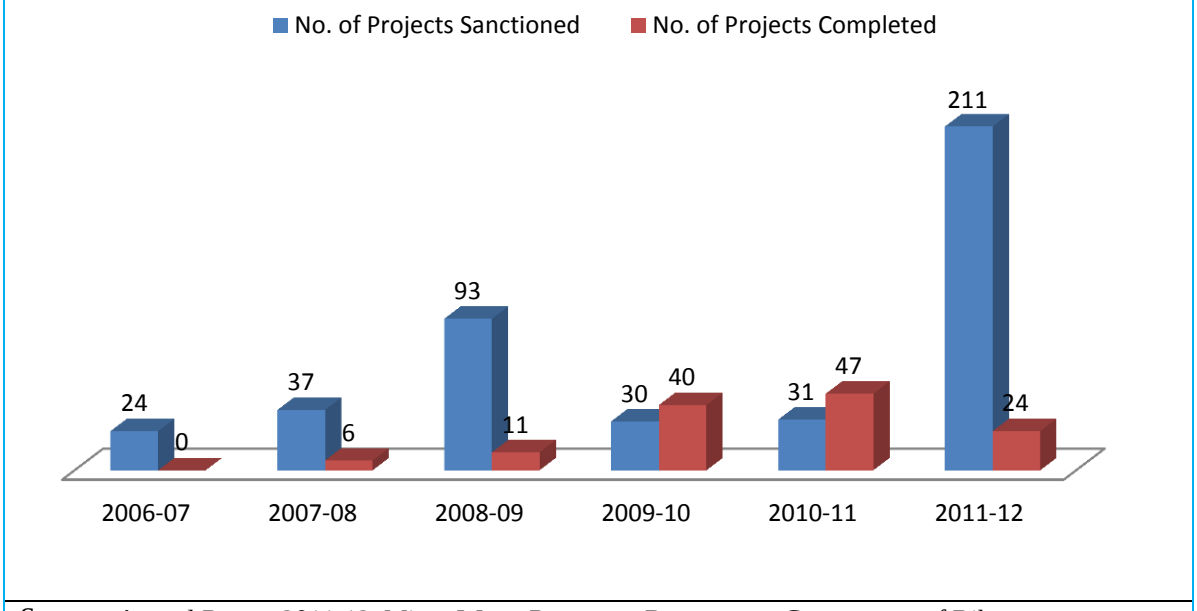
Similarly there is huge disparity in the performance of divisions under the Tube Well (TW) wing (**figure 4.5**).

The MWRD applies two criteria to analyse division-wise performance:

a. Irrigation achievement as a percentage of the total target, and
b. Irrigation achievement as a percentage of total state achievement

For final evaluation, it weighs achievements against the state's overall achievement at 60% and the remainder to achievements against each TW division's target. This method focuses on outcomes rather than investments. Patna West division stands out in 2011-12 on this basis.

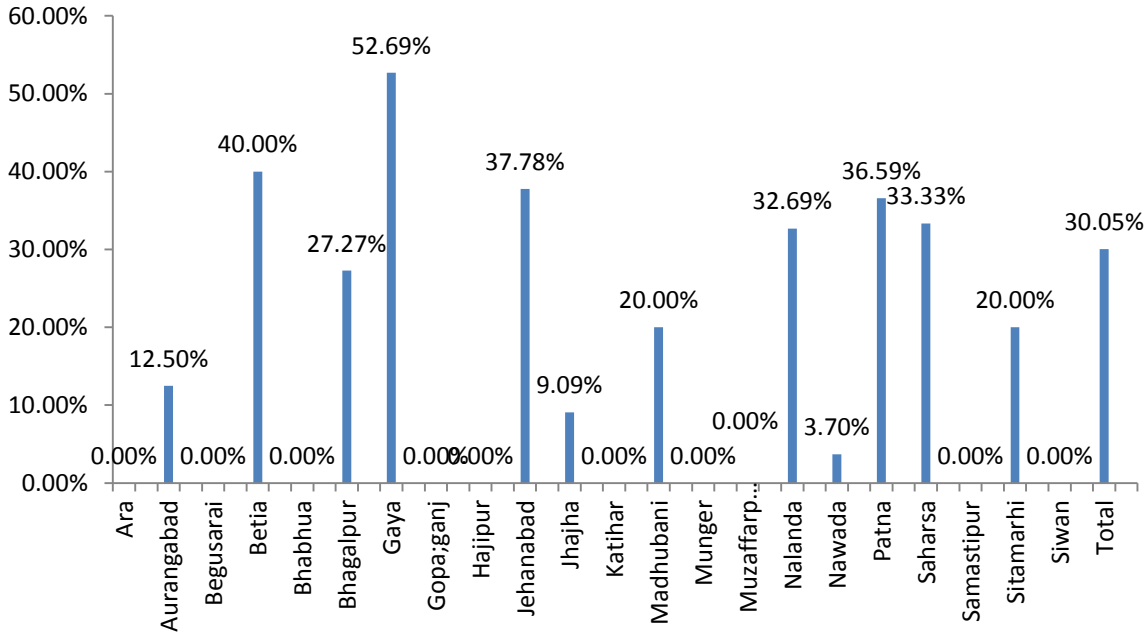
FIGURE 4.3: Work Performance of MI Wing MWRD, Bihar



Source: Annual Report 2011-12, Minor Water Resources Department, Government of Bihar

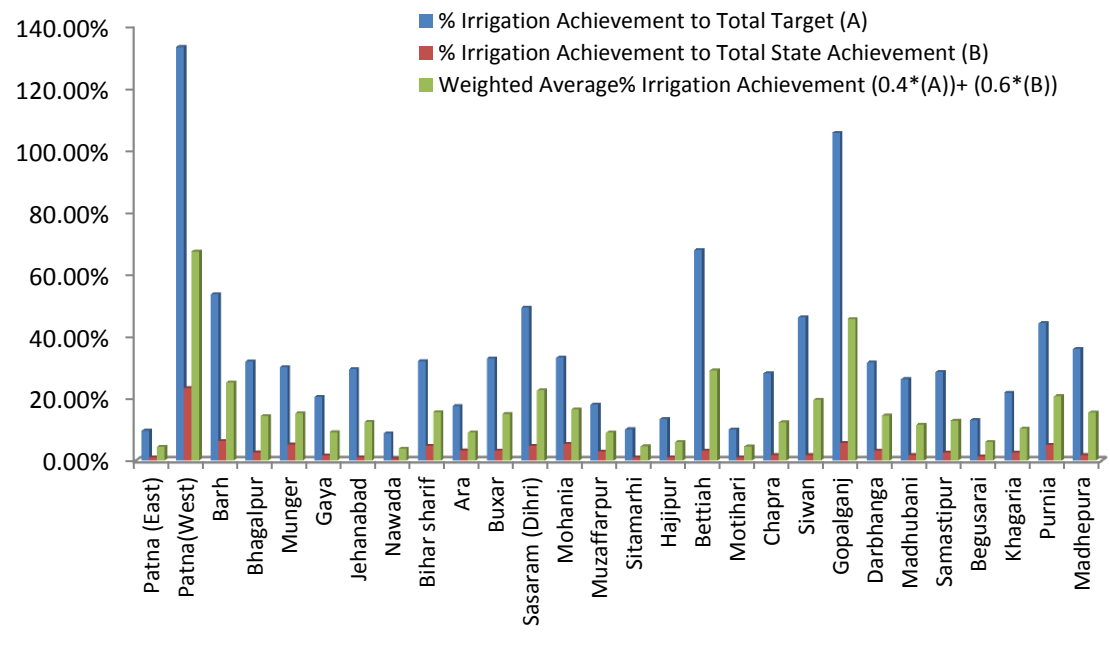
Recommendation 4.1: Evaluate performance for both minor irrigation and tube wells based on outcomes (irrigation achievement) rather than merely based on expenditure and investment.

FIGURE 4.4: Division-Wise Performance of MI Wing (% of project completed against sanctioned, 2007-12)



Source: Annual Report 2011-12, Minor Water Resources Department, Government of Bihar

FIGURE 4.5: Division-Wise Performance of TW Wing (2011-12)



Source: Minor Water Resources Department, Government of Bihar

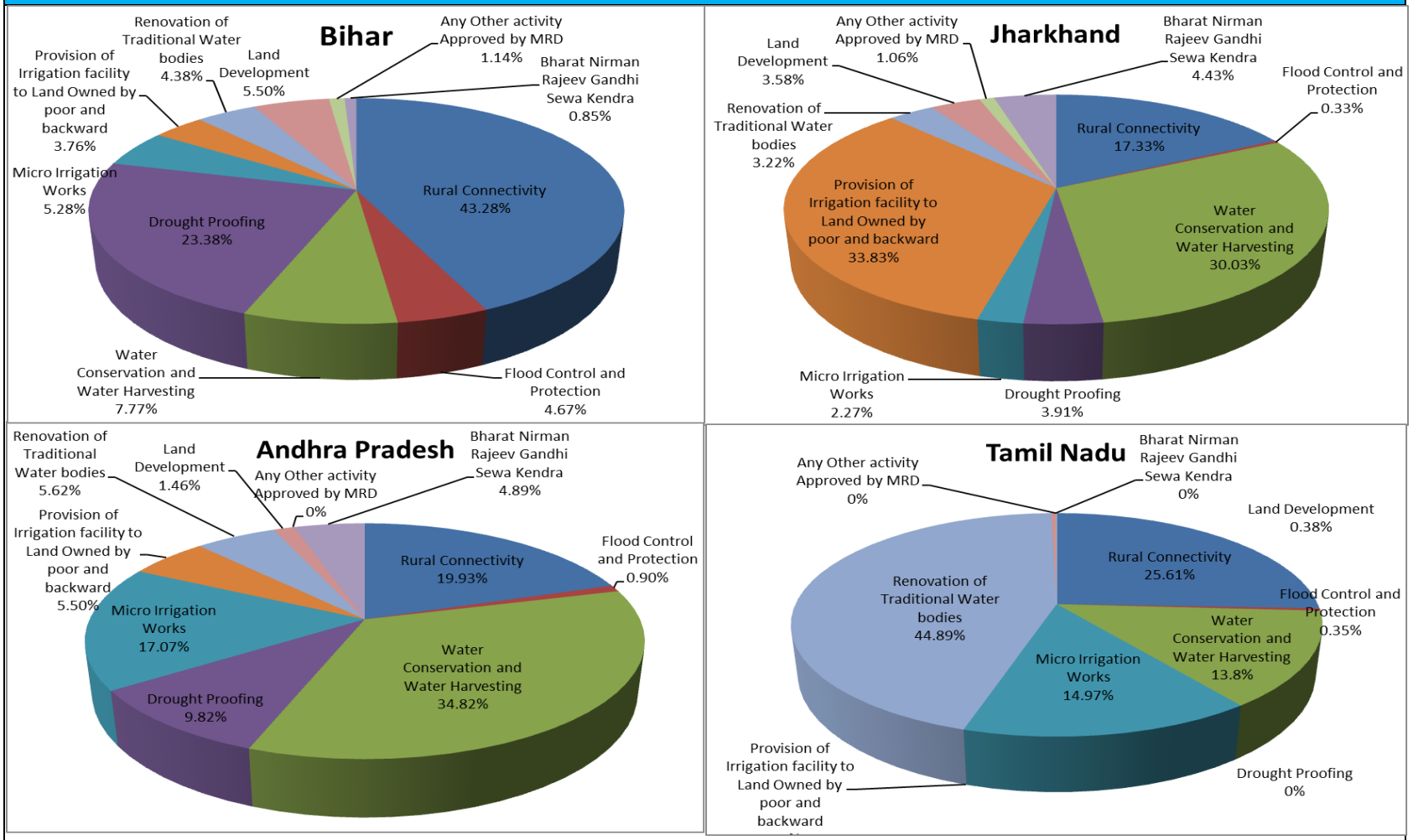
Role of NREGS funds in the MWRD

According to the work progress report 2011-12 of the Mahatma Gandhi National Rural Employment Guarantee Scheme (NREGS), out of the total funds allocated to Bihar 44.57% was spent on activities like water conservation and water harvesting, drought proofing, micro irrigation works, provision of irrigation facility to land owned by poor and backward, and renovation of traditional water bodies. These are all tasks under the responsibility of the MWRD.

F**igure 4.6** compares expenditure allocation in Bihar with that in other states under the NREGS. Andhra Pradesh, Jharkhand, and Tamil Nadu spent 72.83%, 73.27%, and 73.66% of their NREGS funds, respectively, in 2011-12 on activities which are under the responsibility of the minor water resources department. Given that these shares are much higher than Bihar's 44.57%, there is scope for allocating additional funds for such activities.

Recommendation 4.2: Explore ways to increase the allocation of NREGS funds dedicated to minor water resources, in line with other states.

FIGURE 4.6: NREGS fund expenditure in different states sector-wise



Source: The Mahatma Gandhi National Rural Employment Guarantee Scheme Work Status Report 2011-12 (http://nrega.nic.in/netnrega/home.aspx accessed on 11 June 2012)

V. ORGANISATIONAL RESTRUCTURING: ALLOCATING STAFF; DEFINING RESPONSIBILITIES

Staff vacancies and other challenges

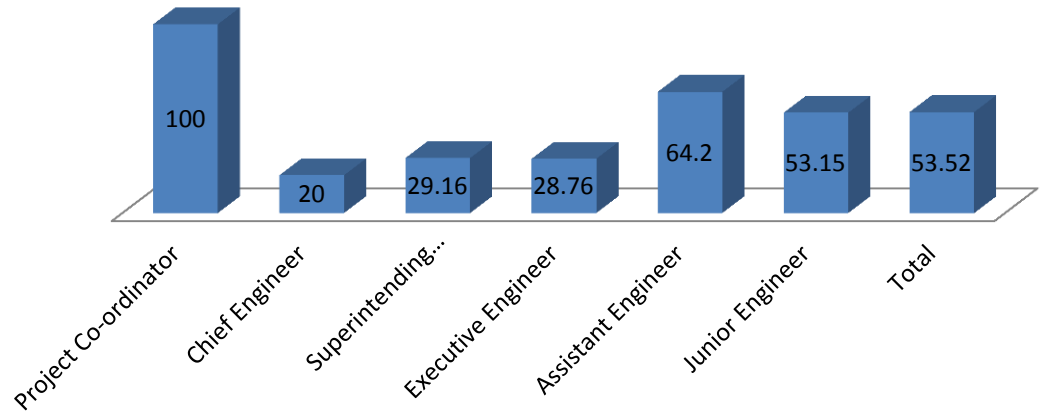
The ambitious surface and groundwater irrigation targets will need a step increase in effort to raise the completion rates of projects from 30% in the 11th Five Year Plan. Moreover, the skill profile of the MWRD staff will also have to evolve to deliver higher quality service and maintain the irrigation infrastructure. Currently, even sanctioned positions in the department remain vacant (**table 5.1; figure 5.1**). More troubling is the fact that more than half the posts are vacant at the levels of Assistant and Junior Engineers. These personnel are the frontline of the irrigation infrastructure and expected to have direct contact with water users. Vacancies of AEs and JEs would imply that the farm level irrigation infrastructure has to improve the most in the next decade.

Table 5.1 Staff Situation at different levels in MWRD, Bihar

S.no.	Position	Sanctioned Posts (SP)	Working Strength	Vacant Posts (VP)	% VP against SP
	Project Co-ordinator	1	0	1	100
	Chief Engineer	5	4	1	20
	Superintending Engineer	24	17	7	29.16
	Executive Engineer	73	52	21	28.76
	Assistant Engineer	257	92	165	64.20
	Junior Engineer	619	Regular – 132 Contract – 158	329	53.15
	Total	979	455	524	53.524

Source: Annual report 2011-12, Minor Water Resources Department, Government of Bihar

FIGURE 5.1: Vacancy at different positions in MWRD, Bihar



Source: Annual report 2011-12, Minor Water Resources Department, Government of Bihar

Our surveys did not yield encouraging news on the human resources front:

1. **Lack of staff:** There has been no hiring from more than 15 years, resulting in only 46% of the positions occupied at present. Critically, what the numbers do not reveal is the age profile of current staff. At all the levels, more than half the staff are found to be in the age group of 57-59. When these officials retire in the next couple of years, vacancies and skill deficits in the MWRD will become more apparent. It will also be mid-way through the 12th Five Year Plan period, raising the urgency of meeting plan targets with a limited number of staff.

2. **Multiple responsibilities:** Fewer staff has also meant that each person is, in effect, responsible for two or more positions. At times, the person in charge of several irrigation sites is unable to visit all the locations under his jurisdiction in a single month.

   Let us consider the example of an operator who should be in charge of a single bore well and should always be present there in case maintenance needs arise. Indeed, for this purpose an operator house is built in close proximity to each government owned bore well. Currently, however, a single operator is in charge of 5-10 bore wells situated in different villages. On average it takes more than 30 minutes to travel from one site to another. This makes valve operation, maintenance and service provision difficult on a real time basis. One Assistant Engineer of the TW Division in Gaya mentioned that he was responsible for 4 sub-divisions when the normal ambit of responsibility should be one sub-division.

3. **Lack of training:** As reported during interviews, no training programme has been conducted for MWRD officials at any level. However, some officials received training from the water and land management institute (WALMI) while they were working in the Irrigation Department.

"Field training for Junior Engineers (JE) should be conducted regularly. Even other trainings like computer training should be provided to each of the officials."
- Chief Engineer of the TW Division, Muzzafarpur

4. **Contract-based Junior Engineers (JE):** More than half of the total JEs are hired on an annual contract basis and they are hired by the Irrigation Department. These JEs complain about the uncertainty of their tenure. Security of tenure seemed to be more important to the contract workers than the remuneration. Moreover, they are not allowed to receive any cash advance for maintenance work, which affects their functioning. A third problem is they are not given due respect by the farmers, unlike the JEs who are direct employees of the MWRD.

   "The farmers are not respectful to us and we are in a situation of dilemma whether we would be absorbed for the next year or not. All these conditions have bad effects on our performance"
   -Junior Engineer of the TW Division, Bhagalpur

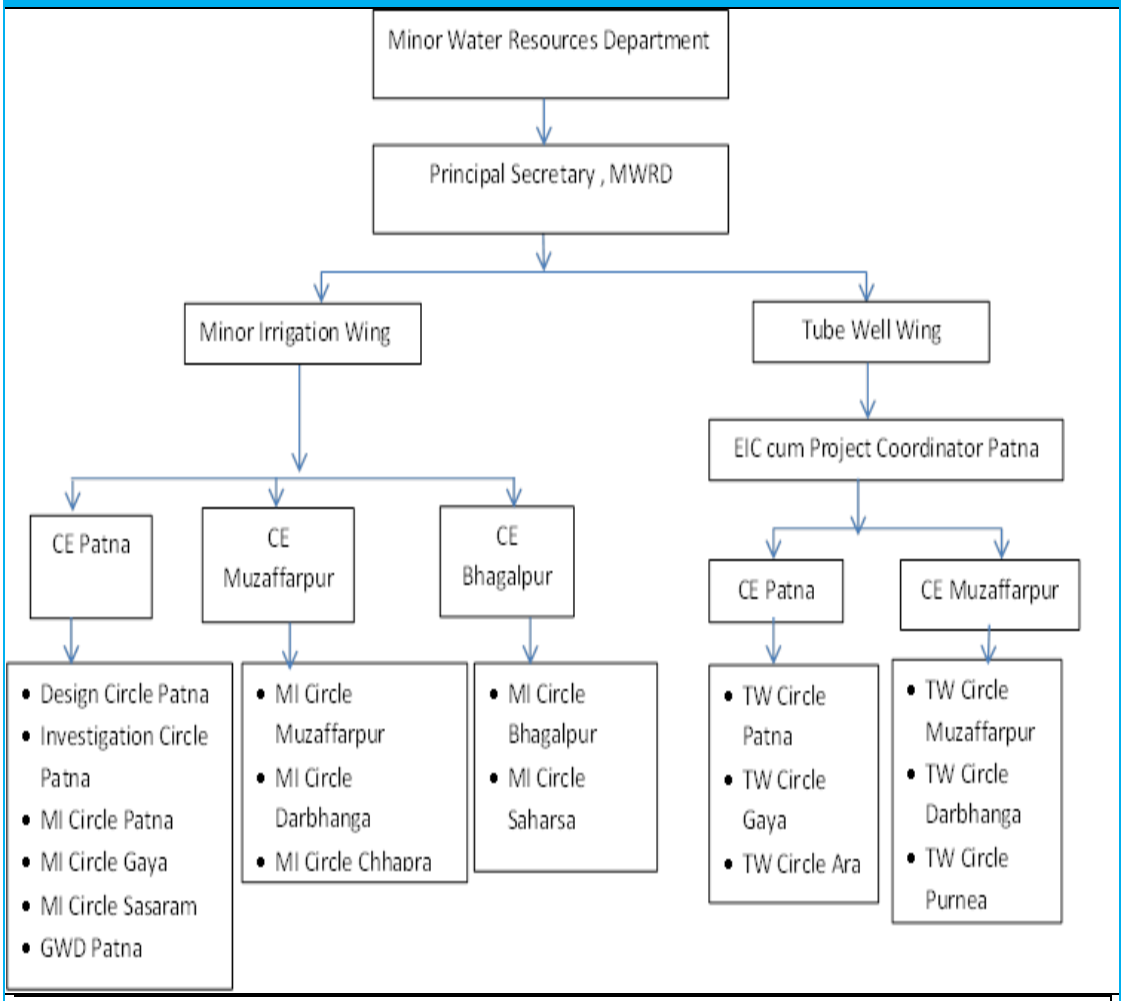
5. **Lack of stability in staffing:** The MWRD is dependent on the Irrigation Department for the supply of staff. Employees can be transferred from one department to another at short notice, which leads to an unstable situation and makes it harder to plan for the staffing requirements in line with the irrigation targets to be achieved. A related problem is the lack of experienced staff. Even though many of the officials are on the verge of retirement, they do not have much experience in minor irrigation as they were transferred to the MWRD only a year or two earlier. Thus, inexperience in the current human resources profile of the MWRD is doubly problematic. Existing staff have little experience in minor irrigation and, once they retire, vacancies will be filled by inexperienced younger, contract-based staff, who cannot expect to receive much training.

6. **Mismatch between qualification and responsibility assigned:** Some of the mechanical engineers who are supposed to be working in the TW Division are working in the Minor Irrigation Wing. Likewise, some civil engineers who should be in the MI Wing are working in TW Division.

Comparison with other states and benchmarking

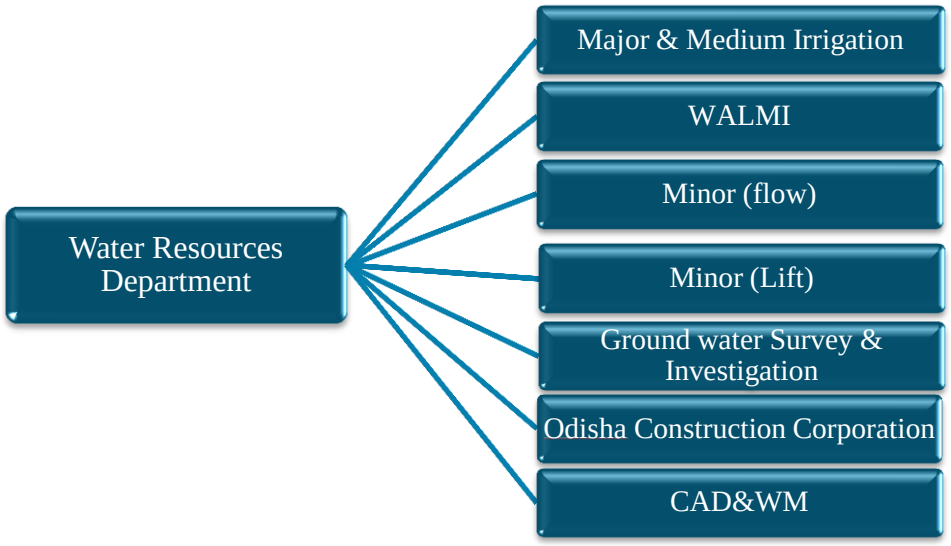
In order to evaluate the MWRD's current organisational structure and design one appropriate for the department's targets, we compared several states in India. The figures below outline the organisational structure for the water resources and minor irrigation departments in Bihar (**figure 5.2**), Odisha (**figure 5.3**), Tamil Nadu (**figure 5.4**), Maharashtra (**figure 5.5**), Andhra Pradesh (**figure 5.6**), Madhya Pradesh (**figure 5.7**), Rajasthan (**figure 5.8**), Karnataka (**figure 5.9**), and Uttar Pradesh (**figure 5.10**).

FIGURE 5.2: Organogram of Minor Water Resources Department, Bihar



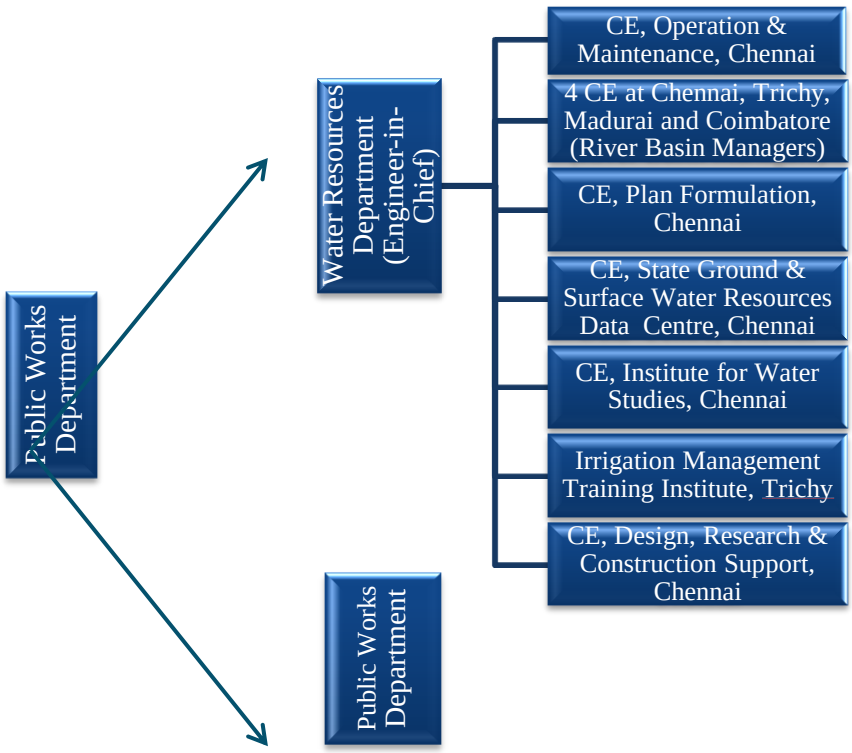
Source: Minor Water Resources Department, Government of Bihar

FIGURE 5.3: Organisation Structure of Water Resources Department, Odisha



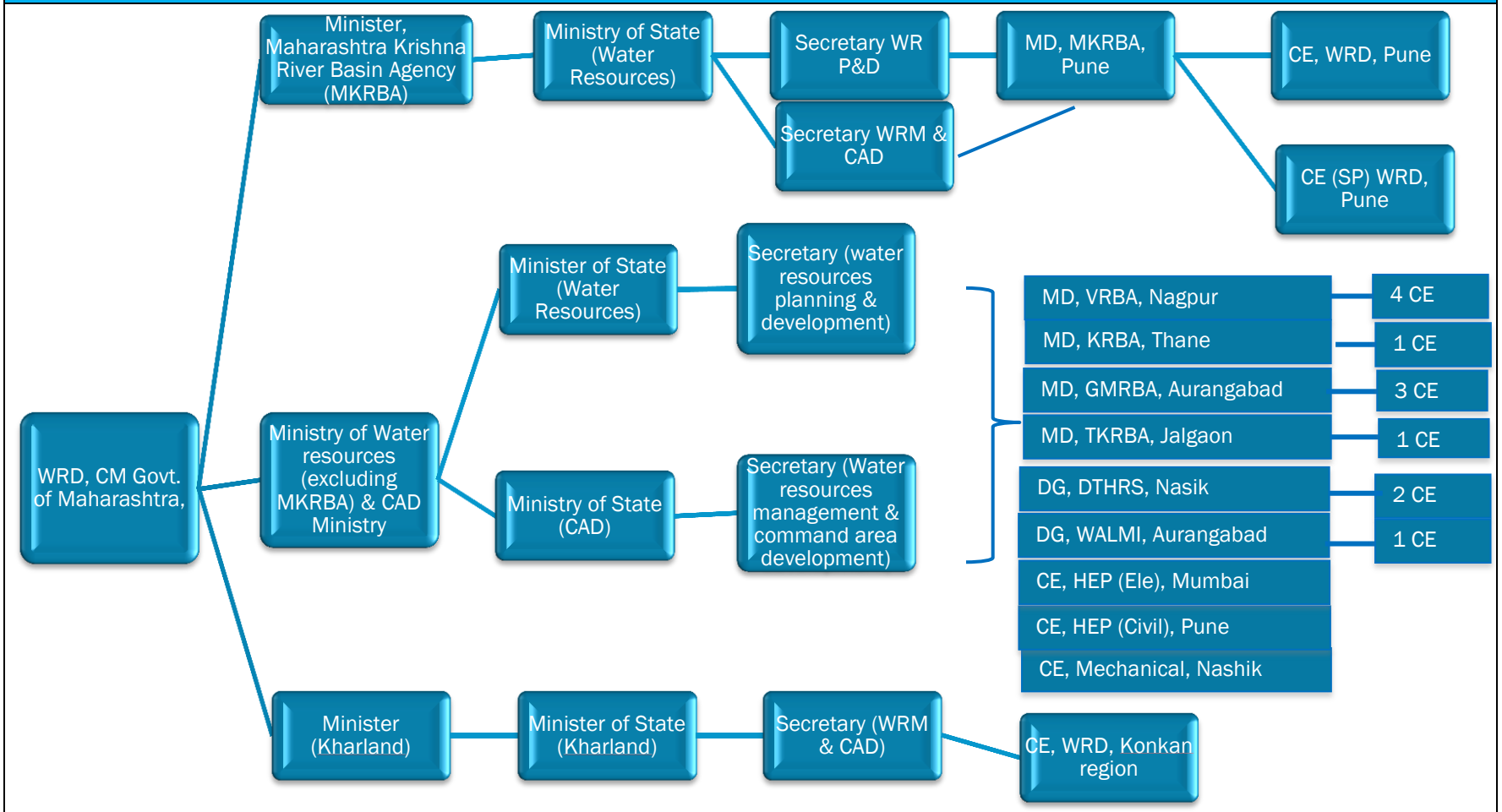
Source: Department of Water Resources Odisha (http://www.dowrorissa.gov.in/AboutDoWR/AboutDoWR.pdf assessed on 1 May 2012

FIGURE 5.4: Organisation Structure of Water Resources Department, Tamil Nadu



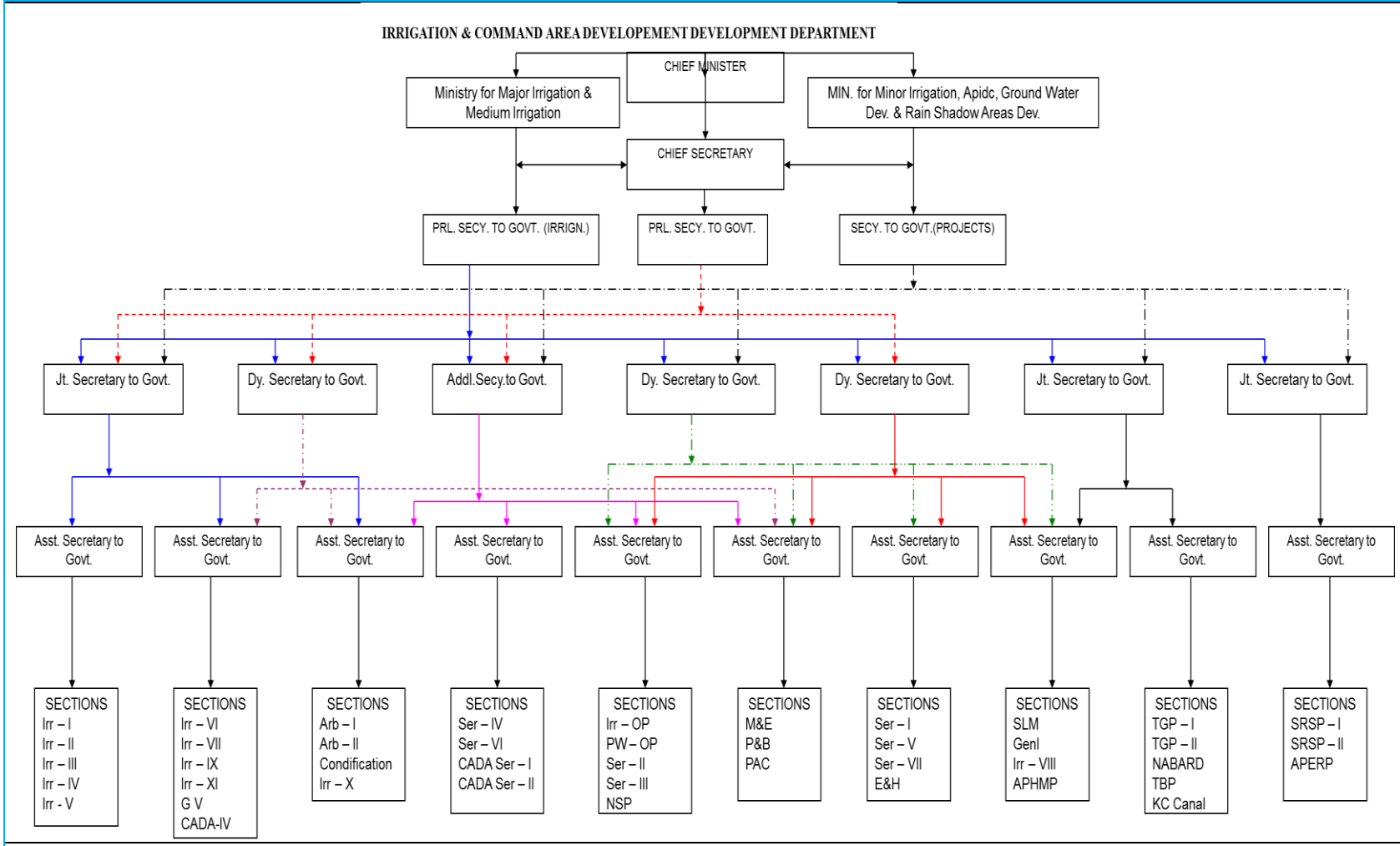
Sources: http://www.tn.gov.in/policynotes/pdf/pwd_irrigation.pdf assessed on 2 May 2012

FIGURE 5.5: Organisation Structure of Water Resources Department, Maharashtra



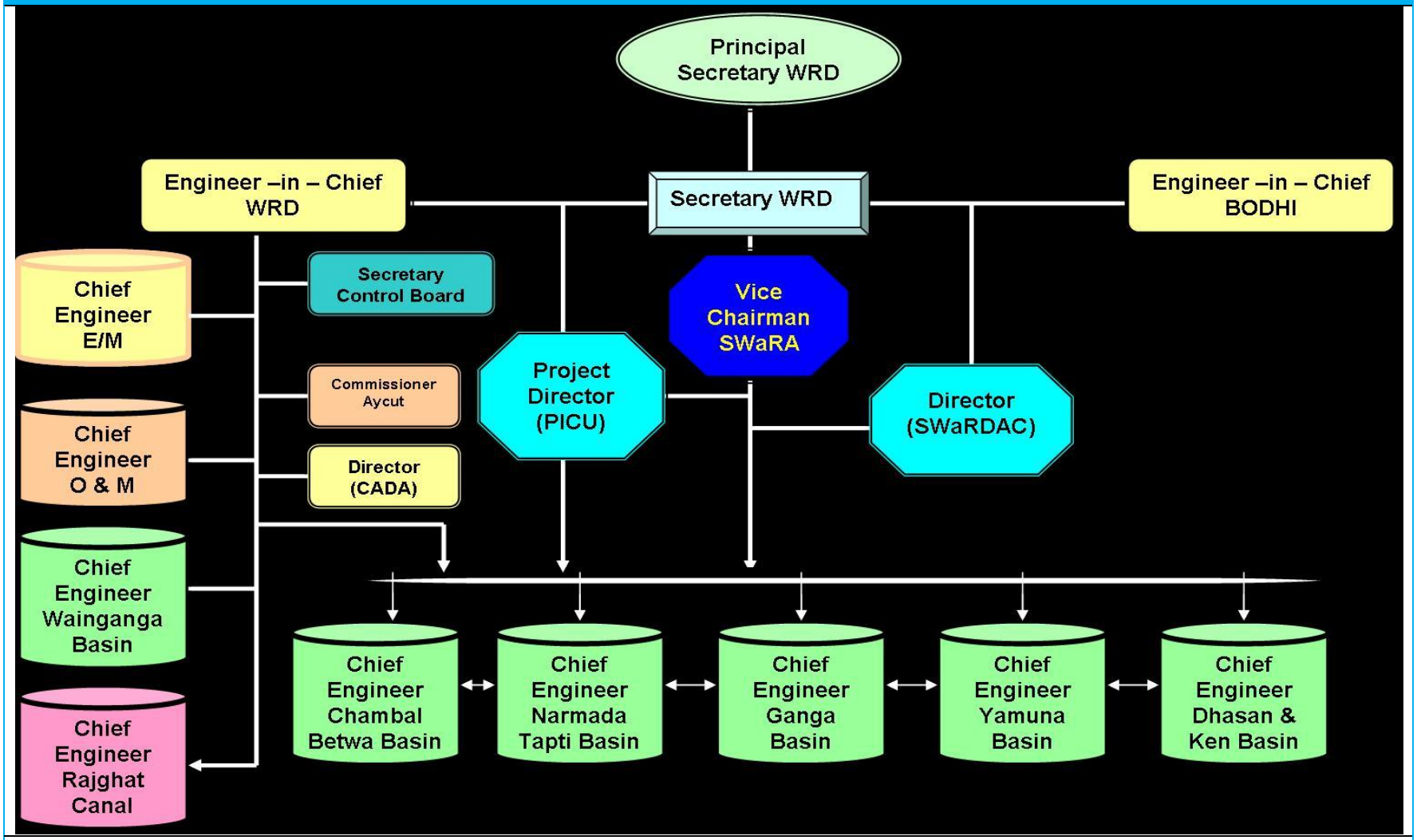
Source: Maharashtra Water Resources Department (http://mahawrd.org/ accessed on 30 April 2012)

FIGURE 5.6: Organisation Structure of Irrigation and Command Area Development Department, Andhra Pradesh



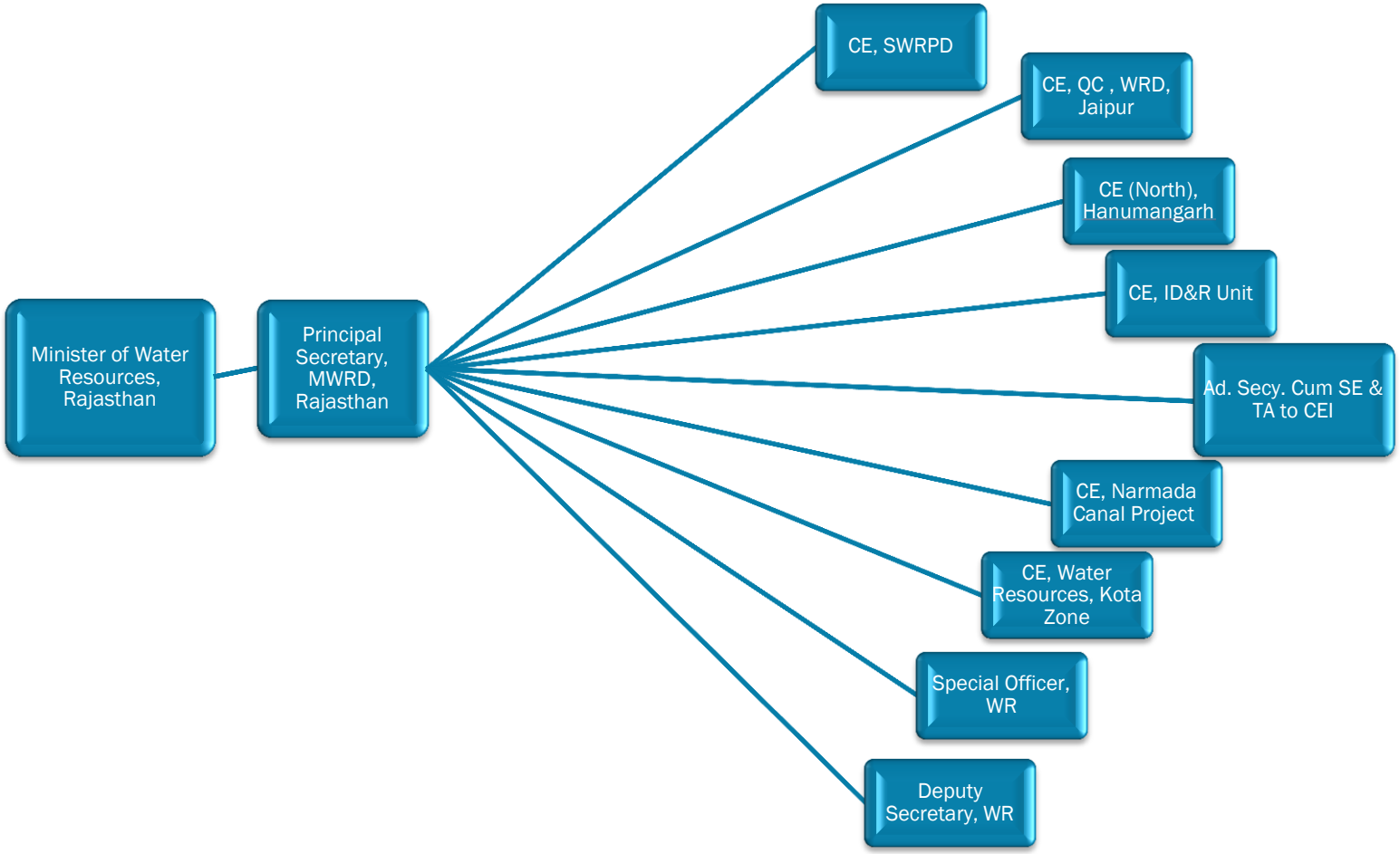
Source: http://www.aponline.gov.in/apportal/departments/PortalListofOrgsbyDepts.aspx?deptdesc=Irrigation accessed on 3 May 2012

FIGURE 5.7: Organisation Structure of Water Resources Department, Madhya Pradesh



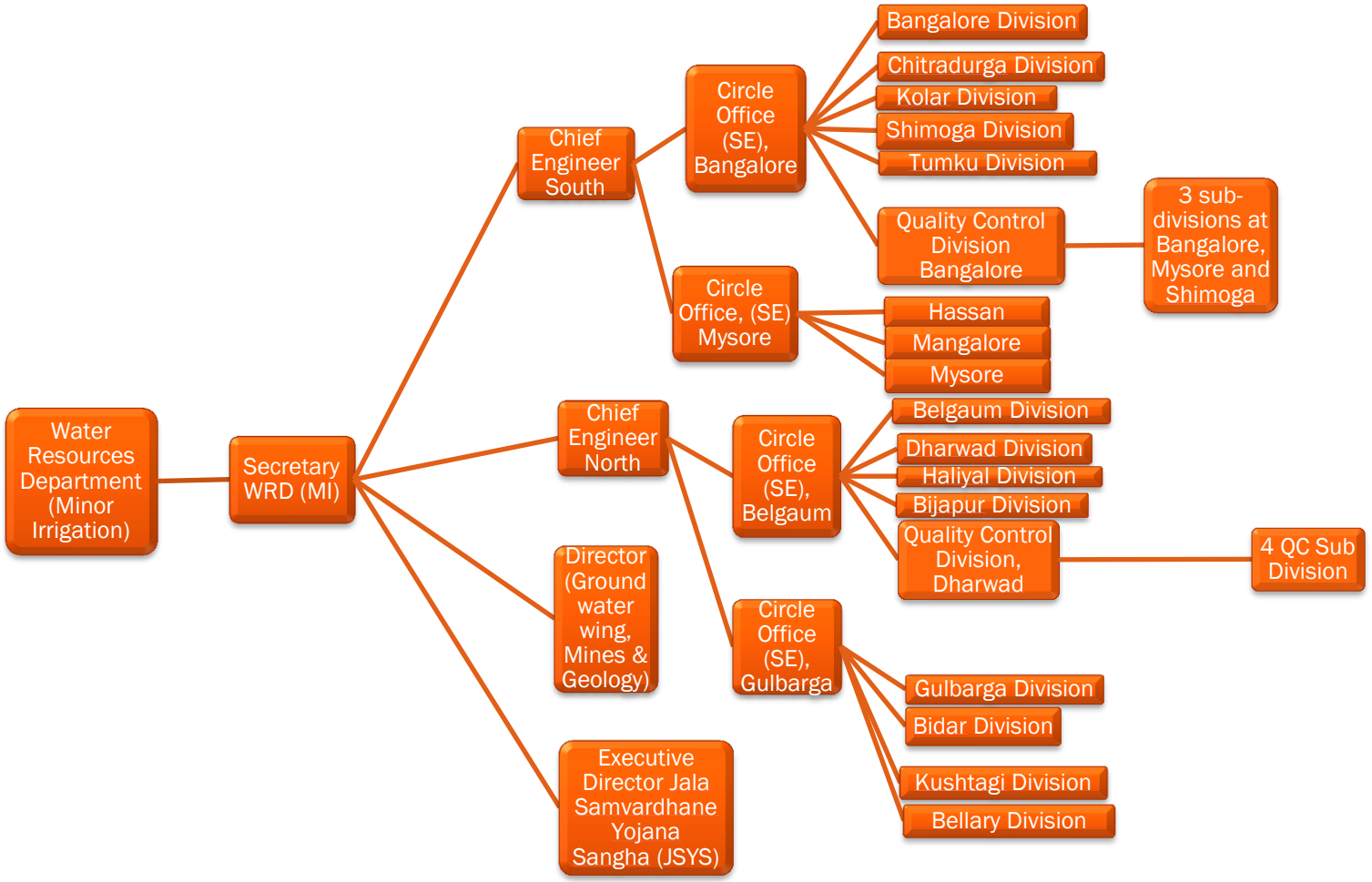
Source: http://www.mp.gov.in/wrd/Organ/Title2.html accessed on 2 May 2012

FIGURE 5.8: Organisation Structure of Water Resources Department, Rajasthan



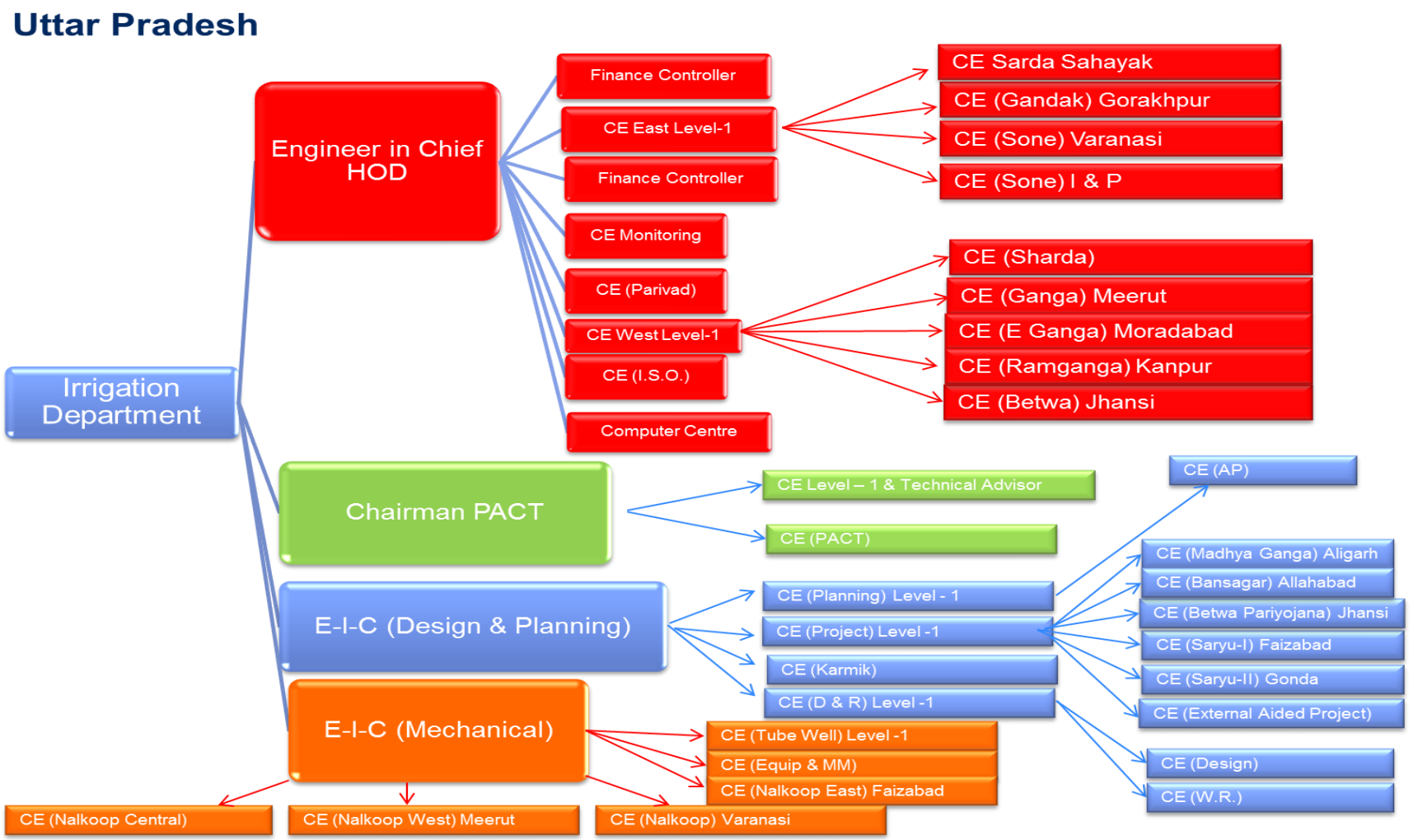
Source: http://waterresources.rajasthan.gov.in/Org_Chart_WRD_upto_EE__Hindi__as_on_101125.pdf accessed on 30April 2012

FIGURE 5.9: Organisational structure of Minor Irrigation Department, Karnataka



Source: http://karunadu.gov.in/minorirrigation/adminsetup.html accessed on 29 April 2012

FIGURE 5.10: Organisational structure of Irrigation Department, Uttar Pradesh

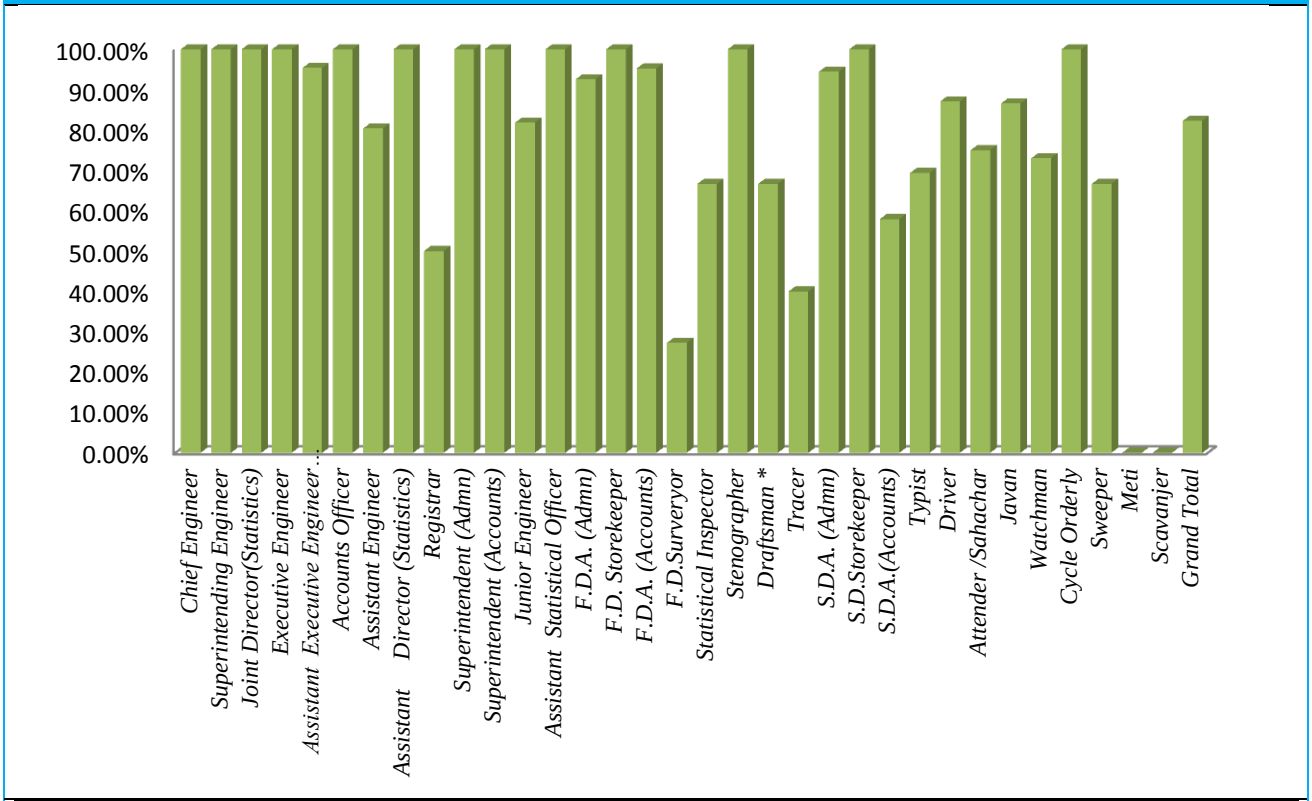


Source: http://irrigation.up.nic.in/orgn_chart_english.pdf accessed on 1 May 2012

There are elements from each state's organisational structures that might hold lessons for Bihar. States like Andhra Pradesh, Madhya Pradesh, Maharashtra, Uttar Pradesh, Rajasthan, and Tamil Nadu have established irrigation divisions on the basis of basin boundaries rather than administrative boundaries. This is desirable practice since water can be managed properly only if it is assessed accurately and the basin forms the appropriate unit for such measurements and assessments.

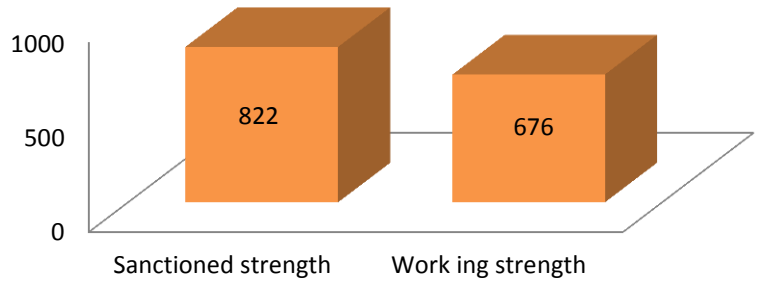
However, a majority of the states do not have a separate department for minor irrigation. Karnataka resembles Bihar in that it has a dedicated Minor Irrigation Department. The two states also resemble each other in net area under irrigation and the organisational structure of the MID. Therefore, Karnataka can act as an appropriate benchmark for assessing and reorganising the MWRD in Bihar. Moreover, as **figure 5.11** shows, more than 80% of the sanctioned positions in the Karnataka MID are filled.

FIGURE 5.11: Working vs Sanctioned Strength Position-Wise South Zone, MID, Karnataka



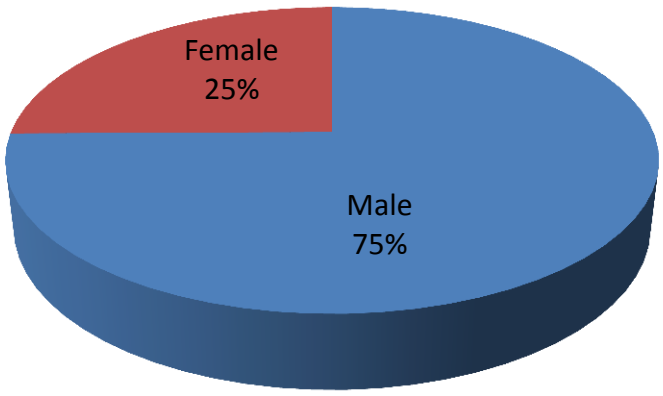
Source: Annual Administration Report 2010-11, Department of Minor Irrigation (South) Zone, Bangalore

FIGURE 5.12: Total working vs Sanctioned Strength South Zone, MID, Karnataka



Source: Annual Administration Report 2010-11, Department of Minor Irrigation (South) Zone, Bangalore

FIGURE 5.13: Gender wise Staff Distribution in South Zone, MID, Karnataka



Source: Annual Administration Report 2010-11, Department of Minor Irrigation (South) Zone, Bangalore

Skill gaps

Given their pressures, MWRD officials handle multiple responsibilities well during field visits, but there is a lack of skills in the following areas:

- **Water resources management:** Officials are good in designing and planning irrigation systems but management skills are lacking.
- **Public Awareness:** Officials have to regularly respond to farmers' demand but their skills for spreading awareness about water conservation and efficient use are limited.
- **Data Management:** Data management practices are poor and it is very difficult to retrieve data from different levels of governance.
- **IT skills:** Limited IT skills, even among senior officers, mean that officials are dependent on others for minutiae tasks.
- **Modellers:** The MWRD does not have staff trained in GIS or water resources modellers.
- **Performance management:** Monitoring the performance of engineers and ensuring that all staff are measured for their technical know-how, etc.

Training requirements

In order to improve training of staff at all levels, a Water Resources Management Training Institute should be set up. It would be responsible not only for conducting training programmes at different levels but would also help the Government in formulating policies concerning Bihar's water resources**.** Although the Water and Land Management Institute (WALMI) in Bihar is ostensibly geared to providing training, so far no training has been provided to MWRD officials (as reported by MWRD officials during our surveys). The WALMI is primarily responsible for training Irrigation Department officials. Moreover, MWRD officials claimed that the infrastructure and capacity of the institute had declined. A new institute is desirable in order to specifically understand the needs of minor irrigation and participatory irrigation management in Bihar. Alternatively, a dedicated section focused on minor irrigation could be created within the WALMI but with adequate capacity (see below). In any case, in order to utilise the experience of WALMI in the irrigation sector we recommend the involvement of WALMI officials while designing training courses.

As a representative example, we illustrate here the structure and functions of the **Irrigation Management Training Institute in Tamil Nadu** (IMTI).[6] This detailed description of the structure, scope and activities of the IMTI in Tamil Nadu offers a template for rejuvenating water resources management training for the MWRD in Bihar.

The IMTI was established in 1984 with financial assistance from the United States Agency for International Development (USAID) under the Water Resources Management and Training

[6] Annual Report 2009-10, Irrigation Management Training Institute, Tamil Nadu

Project. The main objective of the Institute is to impart need based training to all those involved in irrigated agriculture so as to achieve higher productivity with optimum water use. The ultimate goal of the institute is to increase irrigated agricultural production through improved efficiency of irrigation systems and improved productivity of water delivered for irrigation. Towards these ends, the IMTI works to strengthen the institutional capabilities of water resources-related organisations and orient their workings to the needs of farmers. The IMTI is also expected to showcase modern irrigation techniques for water use efficiency, update the skills of government officials and water users, and conduct research on ways to incorporate new irrigation management practices.

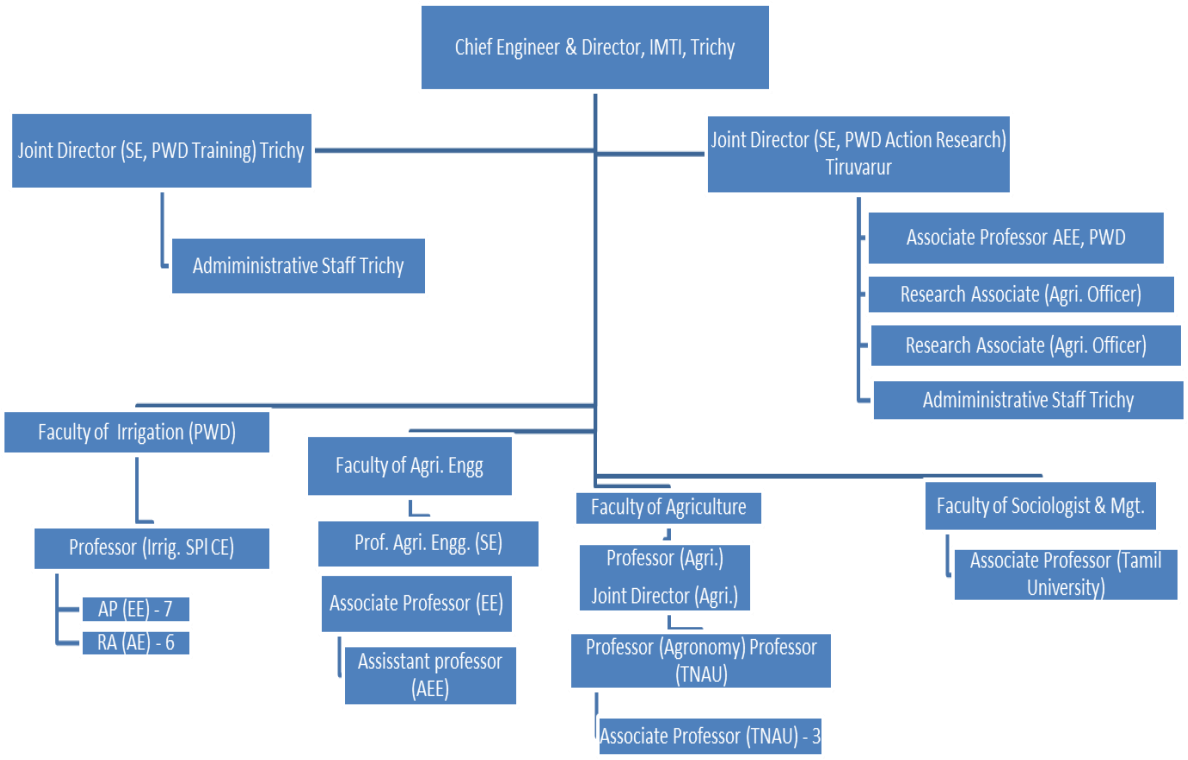
The Institute is headed by a Director and assisted by an inter-disciplinary team of 32 faculty drawn from Public Works, Agriculture and Agricultural Engineering Departments, and the Tamil Nadu Agricultural University (**figure 5.14**). In 2009-10, the Irrigation Wing had 10 faculty members, the Agriculture Engineering Wing had 4, the Agriculture Wing had 5, and the Sociology and Economics Wing had only 1 faculty members (**table 5.2**). With the Director and Joint Director (Training), this amounted to 22 faculty positions filled against 32 sanctioned posts. Although the profile is intended to be multidisciplinary, agriculture, economics and sociology need more attention, in line with the need to shift practices towards water use efficiency and not just building additional irrigation infrastructure. The faculty are supported by 54 administrative staff. An Action Research Programme Unit conducts diagnostics studies of irrigation systems and participatory irrigation management (PIM) to train field staff of the Public Works Department. A Publications Unit is responsible for publishing books and other reference materials for both officials and farmers.

In terms of physical infrastructure, the IMTI campus (spread over 30 acres) comprises an Administrative Block, Class Rooms Block, Library Block, Laboratory Block, Auditorium, Hostel Block, Staff Quarters and a Guest House. Moreover, a Computer Centre, Field Hydraulic Laboratory, Agro-Meteorological Observatory and Demonstration Farm are also part of the campus.

IMTI, Trichy has been imparting training to in-service Engineers (Junior, Middle and Senior Level) and farmers on water management and PIM. Officers and farmers are taken on study tours to other states. Courses are also offered on computer applications like Open Office, Auto CAD and GIS and on diverse topics such as Disaster Management, Quality Control and Quality Assurance in Cement and Concrete, Environmental Engineering, and Human Resources Development. Regular training programmes on are also organised for field level staff of the Water Resources Organisation and Agricultural Engineering Departments, viz. Technical Assistants, Work Inspectors, Irrigation Assistants, Head Mazdoors, and Assistant Soil Conservation Officers at the Action Research Programme Unit at Tiruvarur. Since inception, more than 49,000 (**49326**) government officers and staff had been trained at IMTI by 2010. In addition, more than 57,000 (**57528**) farmers had also been trained (see **figure 5.15**). In 2009-10 alone, training programmes covered all levels of officers

and staff (**figure 5.16**) and, in particular, covered a large number of junior and mid-level officers, field staff and WUA officials (**figure 5.17**).

FIGURE 5.14: Organisation structure of IMTI, Tamil Nadu



Source: Data Provided by Mr Nagarajan, Multi-Disciplinary Project Unit, Tamil Nadu

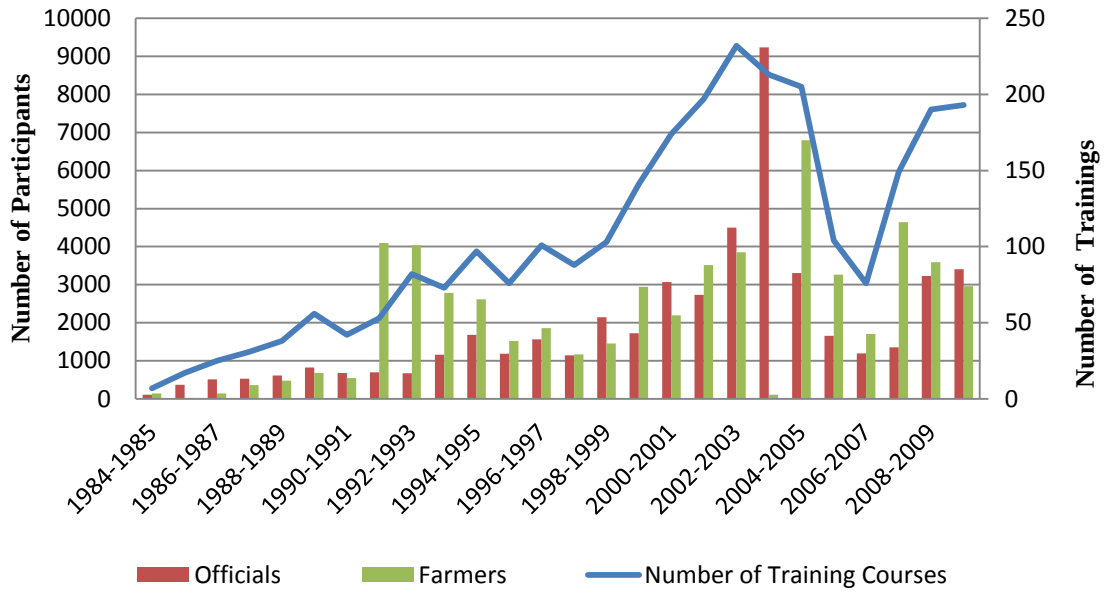
Table 5.2: Tamil Nadu Irrigation Management Training Institute Faculty Positions, as on 31.3.2010

Designation	Sanctioned Strength	Actual Strength	Name	Designation in Parent Department	Parent Department
Director	1	1	M.Ilangovan	Chief Engineer (Retd.), Central Water Commission	On Contract
Joint Director (Trg.)	1	1	Dr. M.Sheik Dawood A.Premsekar (From 31.09.09)	Superintending Engineer	PWD

Irrigation Wing					
Professor	1	1	C.Ponnuraj	Superintending	PWD
Associate Professor	1	0	G.Anbalagan (upto K.Udaiyar (upto	Executive Engineer	
Assistant Professor	6	4	T.Jayanthi G.Balasubramanian S.Shanmugavadivu L.Jothimani	Assistant Executive Engineer	
Research Associate	5	5	G.Murugavel R.Manivannan C.Geethalatha S.Revathi R.Maharajothi	Assistant Engineer	
Agricultural Engineering Wing					
Professor	1	0	P.Sundar (upto 15.02.09)	Superintending Engineer	AED
Associate	2	1	R.Mani	Executive Engineer	
Assistant Professor	1	1	M.Shiek Aslam Ahamed	Assistant Executive Engineer	
Research	2	2	V. Ravichandran K. Rajamani	Assistant Engineer	
Agriculture Wing					
Professor	1	1	Dr. I .Mohamed Iqbal Dr. M. Dhakshinamurthy (From 14.11.09)	Professor	TNAU
Associate	2	1	Dr. R.Marimuthu	Associate Professor	
Assistant	1	1	V. Alagirisamy	Assistant Director	AGRI.
Research Associate	2	2	M P .Prabakar V. Sujatha	Agricultural Officer	
Sociology & Economics Wing					
Professor	1	0	—	—	
Associate	1	1	Dr. R Udhayakumar	IMTI	
Assistant	1	0	—	—	
Research	1	0	—	—	
Management Wing					
Associate	1	0	—	—	
Total	**32**	**22**			

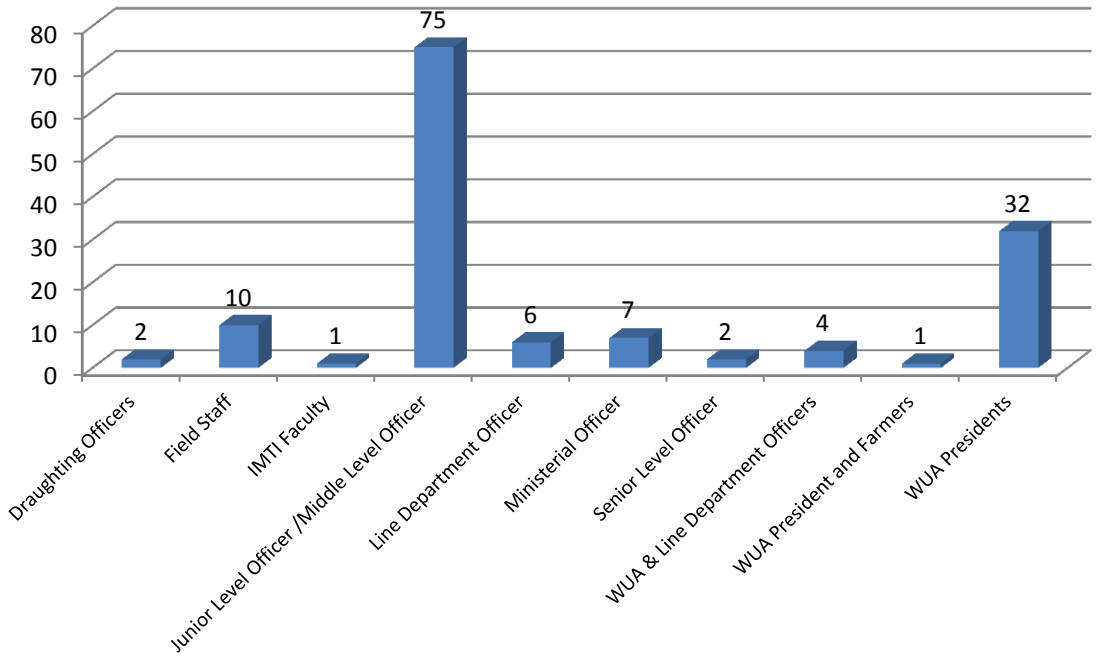
Source: Annual Report 2009-10, Irrigation Management Training Institute, Tamil Nadu

FIGURE 5.15: Training Record of IMTI (1985-2010)



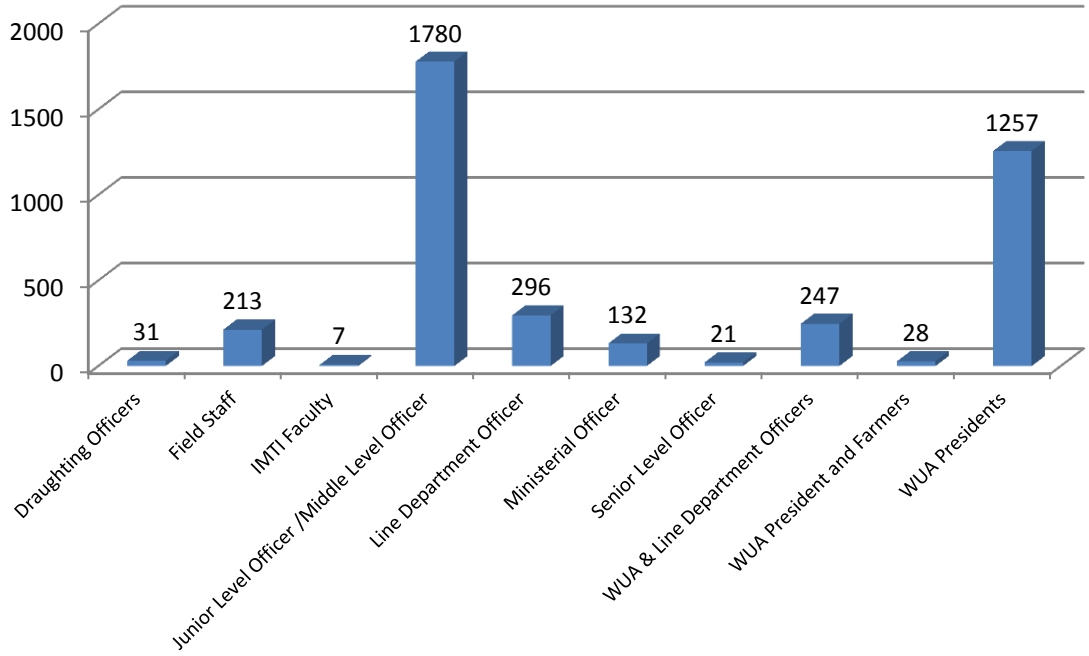
Source: Annual Report 2009-10, Irrigation Management Training Institute, Tamil Nadu

FIGURE 5.16: Number of trainings provided by IMTI to various participants in 2009-10



Source: Annual Report 2009-10, Irrigation Management Training Institute, Tamil Nadu

FIGURE 5.17: Number of Participants under various training programmes in 2009-10



Source: Annual Report 2009-10, Irrigation Management Training Institute, Tamil Nadu

Performance appraisal system

The MWRD promotion system is as follows:

1. An official needs to spend about 7 years at a particular position before he/she is eligible for promotion to the next level
2. Each year an Annual Confidential Report (ACR) is prepared for every official by two of his/her immediate seniors (for example, for AEs, report are prepared by the EE and the SE)
3. Reserved category officials are given priority over general category officials for promotion to the next level. [7]

The above mentioned system is called the conventional closed system of ACR in which the complete process is kept secret. This system is the most commonly practiced performance appraisal system in India. The Performance Management Division, an office within the Cabinet Secretariat and headed by a Secretary to Government of India, observed the following limitations with this appraisal and promotion system: [8]

[7] We gained this insight from consultations with some MWRD officials but have not been able to verify it independently.

[8] http://performance.gov.in/Performence-management.html, accessed on 11June 2012

a. It lacks in quantification of targets and evaluation against achievement of targets.
b. Confusion still prevails among civil servants regarding metrics for good performance and the level of performance expected from them, by their department, superiors, and the public. The system is affected by unclear performance standards, possible bias on the part of superiors, political influence, etc.
c. The existing performance appraisal does not solve the problem of poor performance.
d. Performance appraisal becomes meaningless in certain cases where the job fit is ignored while posting an officer, and where there are frequent transfers. At the same time, a perceived clash between an individual's career goals and organisational goals further compounds the situation.
e. The format may be good but sometimes the way it is filled up shows lack of due care and seriousness. This could also be because of the large span of supervision of most Government officers, which mandates them to write the ACRs of so many officers, some of whom they may not even personally recognise.
f. Since the present system shares only an adverse grading, a civil servant remains unaware about how he/she is rated in his/her work.
g. Many reporting officers pay little attention to distinguishing good and average workers while grading them. Consequently, most Government officials end up getting very good/outstanding grading, which is considered "good for promotion" and hence there is no motivation for real performers.
h. The system of deciding on representations against an adverse entry sometimes take so long that reporting officers avoid giving an adverse entry. Many a time, for want of evidence against the reported civil servant, the reporting officer is in a defensive position and thus unable to justify his/her adverse remarks.

The new performance appraisal system suggested by the Performance Management Division has tried to overcome many of the shortcomings by including a participative work plan through a transparent process. It involves setting goals at the start of the assessment period, reviews during the period and final assessment against achievement of goals. Finally, performance excellence is decided by a number (grades of 1-10) to be assigned by the reporting officer.

Elsewhere, a new system called "360 degree evaluation system" or "multi-source feedback system" has gained momentum in recent years and is being used in Australia, the European Union, and the United Kingdom. In this system a holistic approach is considered and feedback from self, superiors, peers, subordinates and other stakeholders is required for complete evaluation. It might not be possible to implement this system in India immediately, but a more transparent system is required for performance appraisal.

Recommendations for restructuring the MWRD

Recommendation 5.1: Restructure the MWRD along four lines, namely operations, management, research, and capacity building

The primary driving force of the MWRD's restructuring should be promoting improved service delivery to farmers and, thereby, increasing agricultural productivity and overall economic growth in Bihar. Viewed in this manner, the structure of the MWRD has to be oriented both *within* the department (that is, the relationship between wings and their staffing requirements) as well as *outside* the department (that is, the relationship with other supporting entities, water user associations, and farmers). We, therefore, recommend that the MWRD could be structured as follows (see **figure 5.18**).

Main Wings

Currently, there are only two main wings of the MWRD, namely minor irrigation and tube well. These wings are primarily operational wings, responsible for executing irrigation infrastructure plans. However, for improved service delivery as well as better coordination within the department, two management wings are recommended. Thus, a restructured MWRD could have the following four wings.

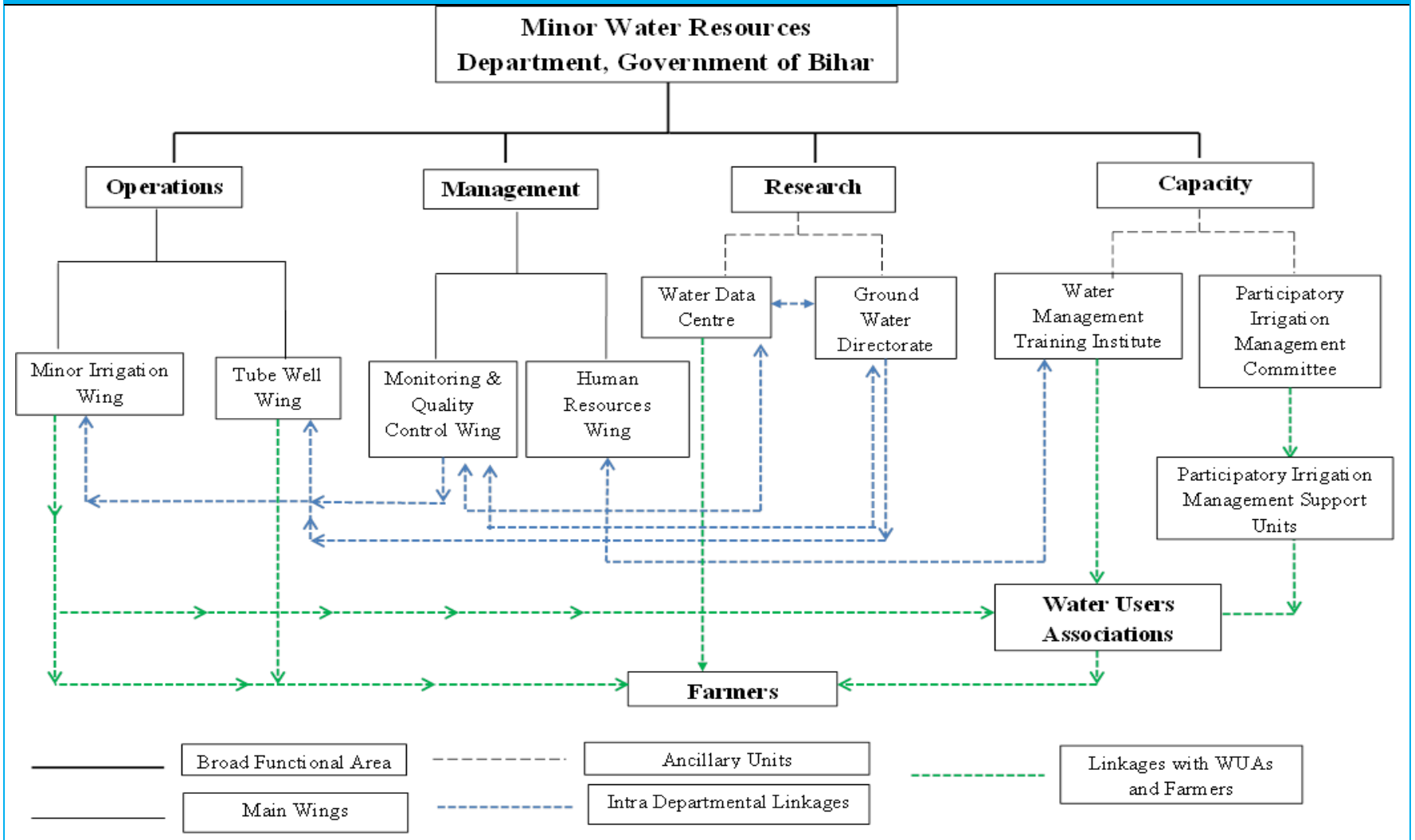
- Operations: Minor Irrigation Wing and Tube Well Wing
- Management: Monitoring and Quality Control Wing and Human Resources Wing

Ancillary Units

In addition to the four wings of a restructured MWRD, there is also the case for creating "ancillary units" that would support and strengthen the work of the Department and its service delivery relationship with farmers. These ancillary units would, in some cases, be formally part of the MWRD and, in other cases, affiliated to and supported by the MWRD. We identify four such ancillary units for research and capacity building.

- Research: Ground Water Directorate (see recommendation 6.1)
- Research: Water Data Centre (see recommendation 7.2)
- Capacity Building: Participatory Irrigation Management Committee (see recommendation 8.1)
- Capacity Building: Water Management Training Institute (recommendation 5.5)

FIGURE 5.18: Recommended Structure of Minor Water Resources Department



Source: Authors

Recommendation 5.2: Increase staff strength for Minor Irrigation and Tube Well Wings

Division level

During the field visit we observed that staff capacity at various levels is insufficient and further hiring is an immediate requirement. There is no set benchmark for defining the administrative area under the responsibility of various staffs. It varies for different types of irrigation systems according to the setup of the system. However, after consulting several documents, such as codes of the Public Works Department for different states of India, and discussions with MWRD officials, we drew the following conclusions.

Junior Engineer (JE) – The JE is a section level officer who is in charge of a section (an area smaller than a block and defined on the basis of the number of projects). However, currently most of the junior engineers have charge of more than one block due to the lack of staff. Even if we allocate one JE per block the total required number would be 1068 (534 blocks with one JE each for MI and TW).

Assistant Engineer (AE) – The AE is a sub-divisional officer, also called SDO, and is in charge of a sub-division. The number of administrative sub-divisions in Bihar is 101, so the total required number of AEs would be 202. But the administrative sub-divisions and MWRD sub-divisions have different boundaries. Here, we will follow the department's thumb rule of providing 1 AE for every 4 JEs, which makes the required number of AE as 267.

AEs are also hired as technical advisers (TA) to Executive Engineers. If we assign one TA to every EE, then 76 additional AEs would be required (see below for EE requirements). The sanctioned strength is 257 but it should be 343 (76 as TA and 267 for the sub-divisions).

Executive Engineer (EE) – The EE is a district level officer, also called a division officer. Currently there are 22 MI divisions and 28 TW divisions. However, the state has 38 districts. Therefore, 76 EEs are required at the division level of MI and TW. The sanctioned strength up is only for 50 positions out of which only 33 are currently filled.

Circle level

Superintending Engineer (SE) – The SE is a regional officer and is in charge of several divisions. Currently 18 SEs (excluding 2 SEs for monitoring and 1 SE for purchase) have been sanctioned for design, investigation and project work inspection. However, for the 76 divisions at least 19 SEs are recommended.

Executive Engineer – Executive engineers act as technical advisers to SEs, so we need 19 more EEs at the circle level.

Engineer in Chief Office

Engineer in Chief (EIC)/ Project Coordinator – The EIC directly reports to the Secretary and is responsible for reviewing monthly progress reports from different chief engineers. Currently, only 1 EIC is sanctioned when ideally there should be 1 each for the MI and TW wings.

Chief Engineers (CE) – The CE is ultimately responsible of all the work underway in the circle offices under his jurisdiction. Currently, the sanctioned strength for CE is 5 while one position is vacant. There is no need to increase the number of sanctioned strength at this level.

Superintending Engineers (SE) – 5 SEs are required as technical advisers for Chief Engineers and 2 for the two Project Coordinators.

Therefore, the number of staff required for the MI and TW wings are as follows:

TABLE 5.3: Number of staff required for the MI and TW wings

Designation	Required Strength
Junior Engineers	1068
Assistant Engineers	343
Executive Engineers	95
Superintending Engineer	26
Chief Engineer	5
Engineer in Chief / Project Coordinator	2

Recommendation 5.3: Shift the lift irrigation functional area to the Tube Well Wing

There have been proposals to merge the Tube Well Division (effectively a wing of the MWRD) with the Irrigation Department. Whether it should stay within the MWRD or be shifted to the Irrigation Department is, perhaps, less important than organising the division in a manner that the skills, technologies and responsibilities for the division are coherent and complementary.

During interactions with MWRD officials, we found a mismatch between the qualifications of staff and the responsibilities assigned to them. Some civil engineers who were supposed to be designing drainage systems are working in the TW division, whereas mechanical engineers who should be in the TW division to take care of functioning of motors and pumps, were found to be working in the minor irrigation division.

The analysis of the organisational structure of water departments in other states suggests that there might be an alternative solution. The divisions could be separated on the basis of work responsibilities and technology usage, rather than dividing them on the basis of surface water and

groundwater. Such an approach can be found in the structure of Odisha's WRD (**figure 5.3**), which has two divisions for Minor Irrigation:

1. **Minor Flow:** This division looks after the structures where water gets stored and flows under hydraulic gradient and no pump or motor is required. This would be similar to Bihar's Ahar & Pyne schemes. The work involved in this division primarily needs civil engineering skills.
2. **Minor Lift:** This division deals with withdrawal/extraction of water using pumps and motors, whether it is surface or ground water. The work of this division primarily requires mechanical engineering skills.

A similar approach could be followed in the case of Bihar, whereby the minor flow works remain under the Minor Irrigation wing, whereas the minor lift activities are brought under the scope of the TW wing.

Recommendation 5.4: Form a Human Resources Wing

The formation of an HR wing is required to keep records of MWRD officials, projects assigned to them and their performance, and preparing an annual training schedule for different officials, especially for the freshly hired officials. A central office in Patna is needed, headed by a Human Resources Manager working directly under the Secretary. Several junior staff are required, who can be assigned the duty of keeping records of a single circle. Their major duty would be to keep a track on the officials being hired, vacant positions, maintaining training schedules, conducting meetings, and preparing performance records. Any senior official would be then able to easily analyse past performance of an official by looking at the records. This process would also make the performance appraisal system more dynamic (with regular updating) and transparent. Total staff required would be:

TABLE 5.4: Number of staffs required for the Human Resources Wing

Designation	Required Strength
Human Resources Manager	1
Junior Staff	24 (19 MI and TW and 4 for M&QC wing and 1 for GWD wing)

Recommendation 5.5: Create a Water Management Training Institute

A Water Management Training Institute (WMTI) would take time to develop gradually. In the interim, various departments like Agriculture, Forestry, Water Resources, PWD and training institutes like Water and Land Management Institute (WALMI) and the National Institute of Hydrology (NIH) could be requested to help in providing trainings to new officials. In the

meantime, experts from IMTI, Tamil Nadu may be called on to help and discuss the establishment of a similar institution in Bihar. The WMTI would, in turn, support the Human Resources Wing by training MWRD officials, and also train Water User Associations in irrigation management tasks.

The other ancillary units – Groundwater Directorate, Data Centre, and Participatory Irrigation Management Committee – are discussed in sections VI, VII and VIII, respectively.

VI. GROUNDWATER: BETTER DATA FOR STRATEGIC MANAGEMENT

The Groundwater Directorate (GWD) is the nodal wing of the MWRD for managing groundwater resources. Since there is no groundwater wing within the Irrigation Department, the GWD has a particularly important position given the quantity of unexploited groundwater resources in the state, and also for quality concerns. Its responsibilities include survey, investigation and exploration to assess the amount of groundwater available; chemical testing; and data management of groundwater resources. However, the staff scenario of the GWD is worse than that for the Department as a whole. Out of 82 sanctioned positions, only 16 are currently filled (**table 6.1**).

Table 6.1: Current Staff situation in GWD, Bihar

S.No.	Designation	Sanctioned Strength	Working Strength	Vacant
A.	Ground Water Directorate, Patna, Bihar			
	Director	1	0	1
	Assistant Engineer	1	0	1
	Geophysicist	1	0	1
	Assistant Director (Statistics)	1	0	1
	Chemist	1	0	1
	Senior Hydrologist	1	0	1
	Senior Geologist	1	0	1
B.	Groundwater Survey Division, Patna			
	Executive Engineer	1	1	0
	Assistant Engineer	5	0	5
	Junior Engineer	11	2	9
	Geologist	2	1	1
C.	Groundwater Survey Division, Bhagalpur			
	Deputy Director	1	0	1
	Assistant Engineer	3	1	2
	Junior Engineer	7	2	5
	Geologist	1	0	1
	Assistant Geologist	1	0	1
D.	Groundwater Survey Division, Muzzafarpur			
	Deputy Director	1	0	1
	Assistant Engineer	4	0	4
	Junior Engineer	13	3	10
	Geologist	2	1	1
E.	Groundwater Survey Division, Saharsa			

	Deputy Director	1	1	0
	Assistant Engineer	4	0	4
	Hydrologist	1	0	1
	Junior Engineer	10	1	9
F.	Groundwater Design Division, Patna			
	Deputy Director	1	1	0
	Assistant Engineer	3	0	3
	Junior Engineer	3	2	1
	Total	82	16	66

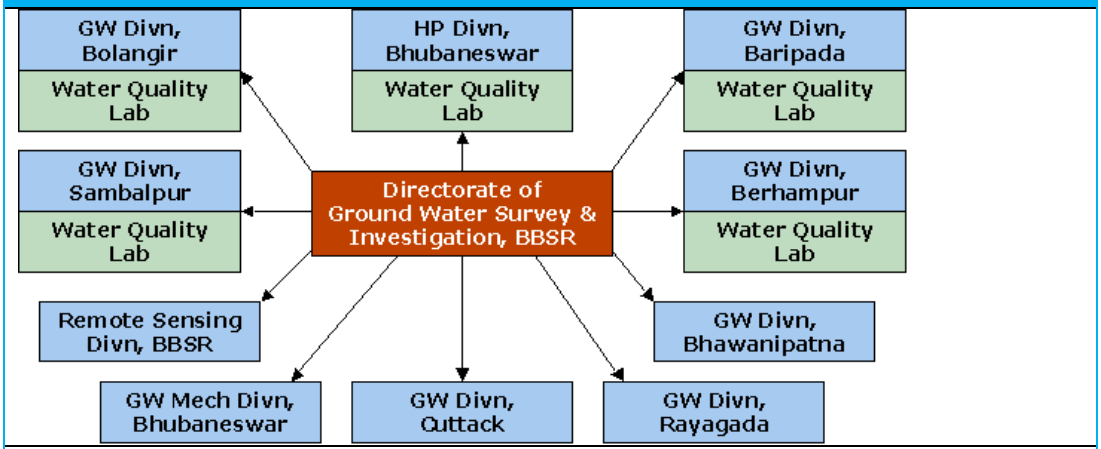
Source: Annual Report 2011-12, Minor Water Resources Department, Government of Bihar

Structure of the Groundwater Directorate in comparison with other states

Odisha[9]

The Ground Water Survey & Investigation (GWS&I) directorate, headed by a Director, functions as the nodal agency for monitoring of groundwater resources in Odisha, under the administrative control of the Department of Water Resources. The GWS&I has two circles, ten field Divisions and five Water Quality Laboratories. The Divisions are facilitated by Data Processing Centres. At the State level a Groundwater Data Processing Centre (SGWDPC) and a Data Storage Centre (SDSC) have been set up at Bhubaneswar to handle the entire hydrological data of the State for dissemination to the Hydrological Data Users Group (HDUG). It also provides technical support for sustainable groundwater explorations to user agencies and individuals.

FIGURE 6.1: Official set up of GWSI, Odisha



Source: http://www.dowrorissa.gov.in/Organograms/ORGN-GWSI.htm accessed on 4 june 2012

[9] http://www.dowrorissa.gov.in/GWSI/GWSI.pdf

Karnataka[10]

The functions of the Groundwater Wing in Karnataka are:

a) Groundwater resources estimation;
b) Groundwater level monitoring;
c) Selecting sites for drilling bore wells for domestic, agricultural and industrial purposes.

The geophysical section conducts geophysical investigations through vertical depth probes and profiling. Geophysicists also conduct geophysical surveys to pinpoint sites for drilling bore wells and to understand subsurface in homogenetics.

Hydrogeologists within the department are assisted by the Drilling Section in drilling experimental bore wells and determining yield in the bore wells. The Drilling Section assumes responsibility for cleaning bore wells and retrieving pumps from bore wells. Groundwater and surface water samples are analysed in the chemical laboratory in the Director's office and also in divisional laboratories in Mysore, Chitradurga, Dharwad, Belgaum, Bellary and Gulbarga.

Expanding the Groundwater Directorate and its position within Bihar's MWRD

The thrust on groundwater is already increasing exponentially to support a rising population, and growing irrigation and industrial needs. The conjunctive use of surface and groundwater will be critical for Bihar's water management practices in future. If a complacency regarding water availability sets in, thanks to abundant groundwater resources at present, then there is a danger that Bihar's water practices would suffer the same unsustainable trajectories that other states in the northwest and southeast of the country have followed. The conjunctive use of ground and surface water is also contingent on water quality and deterioration in one resource would put strains on the demands for the other. Therefore, a comprehensive understanding of the groundwater regime and its recharge and discharge characteristics is very important to evolve a strategy for its optimal use. Hence, precise assessments of the quantity and quality of groundwater resources are a pre-requisite for planning its development.

Recommendations for Improved Groundwater Management

Recommendation 6.1: Give Groundwater Directorate a larger role

The GWD should be repositioned within the MWRD as a larger ancillary unit. The composition and proposed sanctioned strength of GWD is sufficient but the working strength is less than 20% and requires immediate attention.

[10] http://www.karnataka.gov.in/minorirrigation/aboutus.html

The resources required by the GWD extend beyond human resources to also include technological hardware and software needs. Currently, there is a lack of software that can estimate/model the rate of recharge and actual flow of groundwater. Several tests like resistivity test are required to find out potential aquifer zones and several other parameters like hydraulic conductivity, transmissivity, permeability etc. needs to be calculated. Therefore, the GWD should work in close functional coordination with a new Water Data Centre (see recommendation 7.2) and could develop a groundwater database for the state.

Recommendation 6.2: Focus on water quality and testing

Groundwater is the major source of irrigation in Bihar and in the recent past quality problems like arsenic, fluoride and iron contamination have been observed. The usable water for farmers has reduced as a result. There is a need to upgrade research and investigations before even the purest sources of groundwater become unusable.

The MWRD should also have its own water testing laboratories – at least one per district – to keep a regular check on water contamination. This will be a preventive step for areas with contaminated ground water and a precautionary measure for other areas where groundwater is as yet uncontaminated.

Recommendation 6.3: Develop detailed water maps for Bihar

Another group of technical experts should be constituted under the GWD to conduct research to develop a water potential map in different areas of Bihar. This research would help, not only the government but also farmers, to have an idea about available resources, based on which areas may be classified into different zones. This would help farmers decide which crops to grow and which irrigation practices to follow in the various zones. Training for government officials at the field level and to farmers and WUAs could also be tailored to the needs of each zone.

VII. MAINTENANCE & QUALITY: MONITORING PERFORMANCE; APPLYING NEW TECHNOLOGIES

Quality, frequency and accessibility of data

As discussed earlier, due to the lack of staff in the Minor Irrigation and Tube Well wings as well as the Ground Water Directorate, data collection and investments in operation and maintenance were minimal. During our field surveys we found the following challenges.

1. **Operation & Maintenance (O&M):** O&M of Ahar and Pyne schemes as well as tube wells is very poor. Most of the tube wells in the areas visited were non-functional and many have lost their command area. Ahar and Pyne systems have degraded due to non-maintenance.

   Moreover, many unauthorised houses have been built on the Pynes, which has made it difficult for the government to relocate people who have been living in these areas for the last 20-30 years. The rehabilitation of the minor irrigation systems is affected as a result.

2. **Lack of infrastructure:** Several offices operate from rented spaces and face the pressure of rising rents. There is no scope of any alteration in the work space either. Although every division has been supplied with computers, half of them are not operational or are underutilised due to the absence of trained computer operators.

   A vehicle is a must for field officers but they were not available at most of the locations we visited. Thanks to this, junior engineers who are in-charge of several irrigation blocks, are unable to inspect each site.

3. **No Quality Control Division:** The MWRD lacks a quality control division. Such a division can ensure that the infrastructure is of standard quality, through both field and laboratory tests, on one hand, and having an oversight to prevent substandard construction, on the other.

4. **Many schemes like barge and Lift Irrigation (L.I.**) have not proved to be successful due to poor O&M. Yet, L.I. schemes were found to have been revived at few sites receiving perennial rivers. In Muzzafarpur and Bhagalpur, the observed L.I. schemes were serving as a vital source of irrigation. Further development of these schemes could lead to higher productivity and less dependency on groundwater.

Improving asset management planning

Asset management planning is increasingly being used to address the issues of deterioration of physical infrastructure.[11] The approach brings together several key elements in sustaining I&D infrastructure: (i) assessment of the condition of the physical infrastructure; (ii) assessment of the performance of the system; (iii) discussion and agreement with users on standards and levels of service required; (iv) assessment of the users' ability and willingness to pay for the desired level of service; (v) determination of the short to long-term maintenance, repair and replacement needs, costs and income stream; and (vi) long-term monitoring of implementation of the asset management plan, the condition and performance of the infrastructure. The process can be used by irrigation departments to quantify and define the maintenance, repair and replacement needs and costs over time (20-25 years, broken down into 5 year segments) of the main system infrastructure, as well as by WUAs to establish their maintenance, repair and replacement costs and income stream over time (generally a shorter period of 5-10 years).

Figure 7.1 provides an overview of asset management planning for irrigation. The process is intended to be participatory in nature, involving joint inspections by irrigation officials and WUA. With the ID and WUAs jointly identifying the maintenance, repair and replacement needs and agreeing the costs over time there is a far greater likelihood that water users will be prepared to increase the fee levels to cover the agreed costs as they can: (i) see what they are paying for; (ii) monitor what is being spent; and (iii) monitor the level of service provided and the performance of the system for which they are paying.

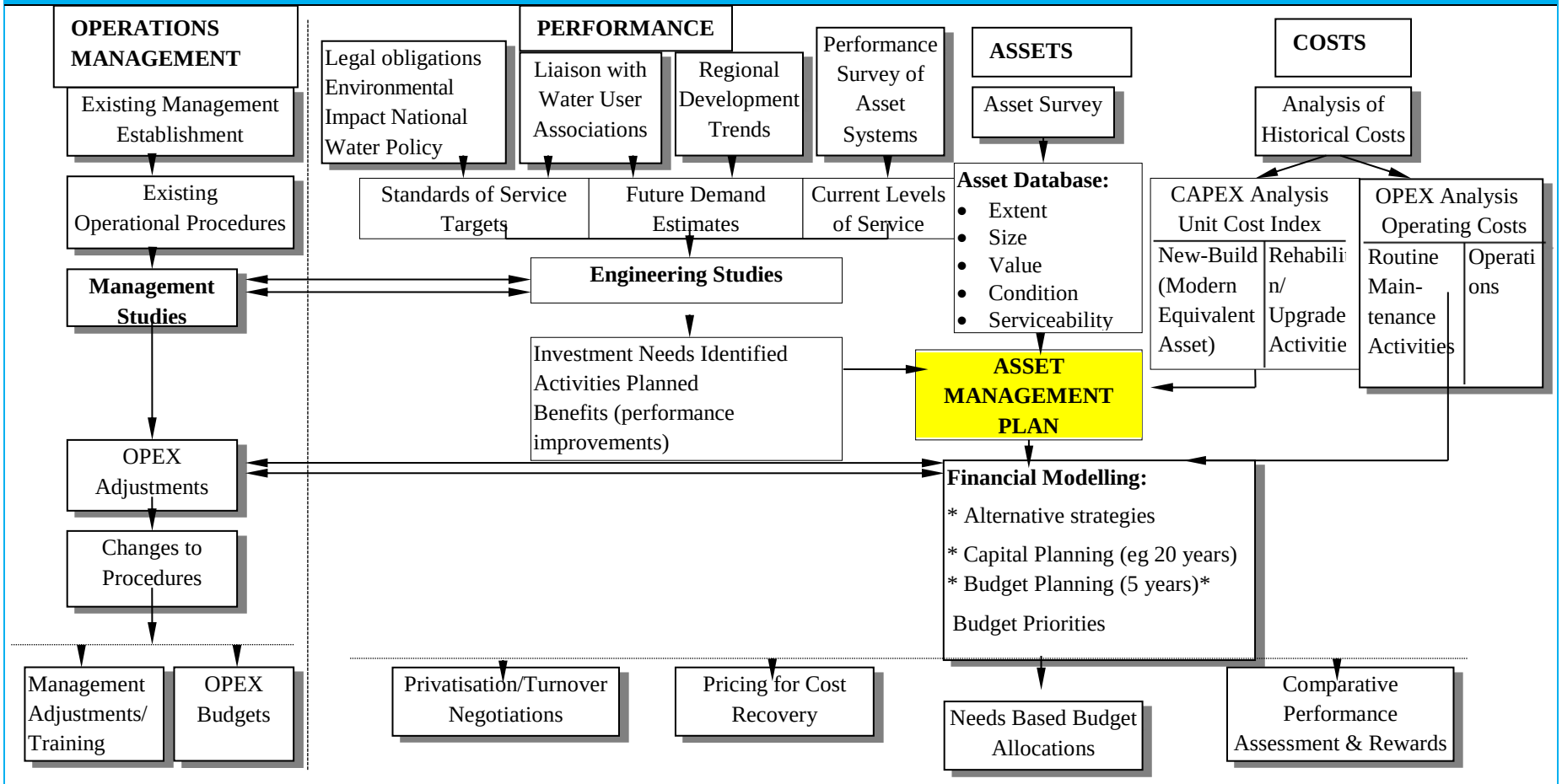
Thus, there are at least three possible approaches:

- Adoption of more transparent and accountable systems for assessing maintenance and repair requirements over time using asset management planning;
- Use of the asset management planning process to make the maintenance, repair and capital replacement costs over time more open and transparent to water users, resulting in increased levels of service fee payment;
- Quantification of the real costs of failing to maintain I&D systems through commissioned studies. A form of this quantification is often carried out when a system is being considered for rehabilitation in that the cost of the investment required to rehabilitated the deteriorated system is measured against the anticipated benefit from increased agricultural production (often in the form of increased irrigated area and increased yields). It is an anomaly that similar calculations are not carried out to assess the cost of *not* adequately maintaining the irrigation and drainage system (namely, reduced yields, areas lost to production, social inequity between head and tail enders)

[11] Martin A. Burton, Rahul Sen, Simon Gordon-Walker, Anand Jalakam, and Arunabha Ghosh (2011) *National Water Resources Framework Study: Research Report Submitted To The Planning Commission For The 12th Five Year Plan*, September, New Delhi: Council On Energy, Environment and Water, and 2030 Water Resources Group, pp. 144-146.

compared to the cost of adequate maintenance. It is likely that the cost of adequate maintenance would be significantly less than the value of the lost production.

FIGURE 7.1: Asset Management Plan

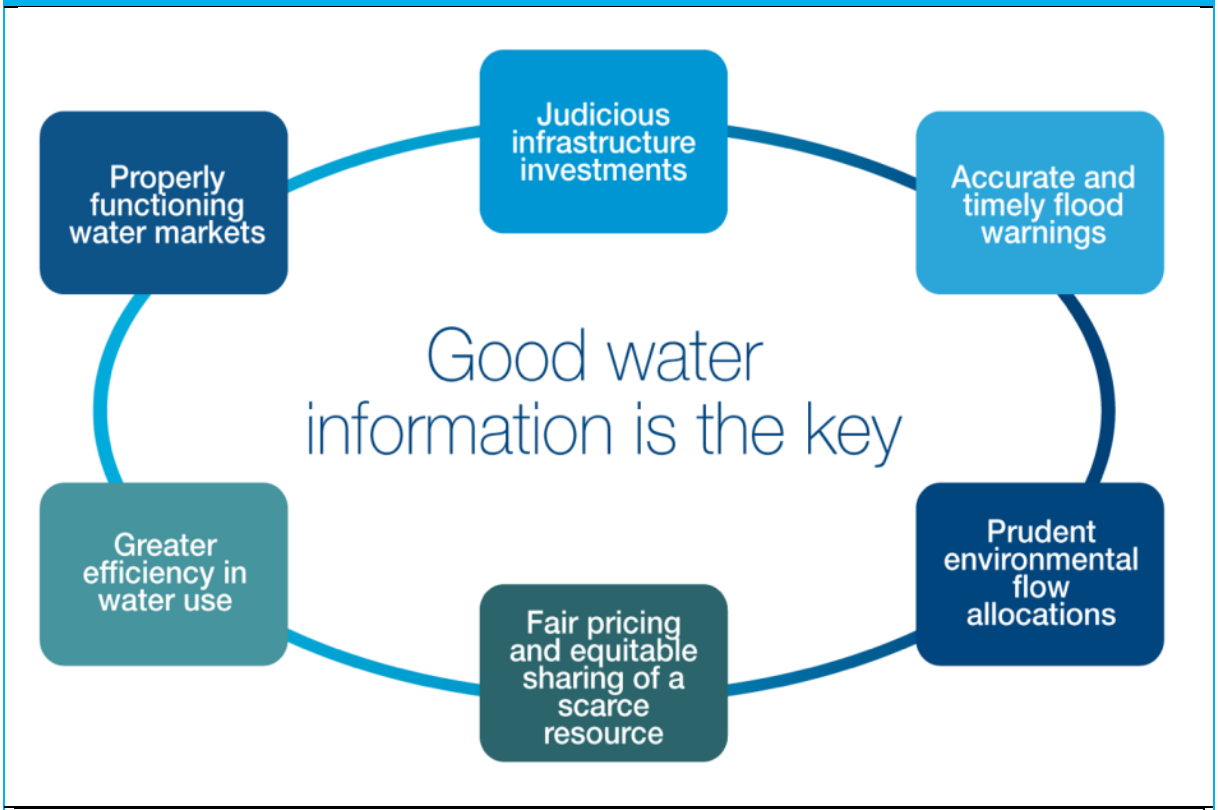


Source: Martin A. Burton, Rahul Sen, Simon Gordon-Walker, Anand Jalakam, And Arunabha Ghosh (2011) National Water Resources Framework Study: Research Report Submitted To The Planning Commission For The 12th Five Year Plan, September, New Delhi: Council On Energy, Environment and Water and 2030 Water Resources Group, p. 163.

Improving data collection and management

As regards data collection, **figure 7.2** illustrates the importance of a robust hydrological information system (HIS). Here, we describe innovative approaches adopted within and outside India to develop sound water data systems.

FIGURE 7.2: Importance of good information on water resources



Source: Presentation on "*Water Information in Australia: status and directions*" by Dr Bill Young, Director, Water for a Healthy Country Flagship, Australia, , 13th April 2012 during India Water Week Side Event Organised by Council on Energy, Environment and Water

International practices for hydrological information

Australia

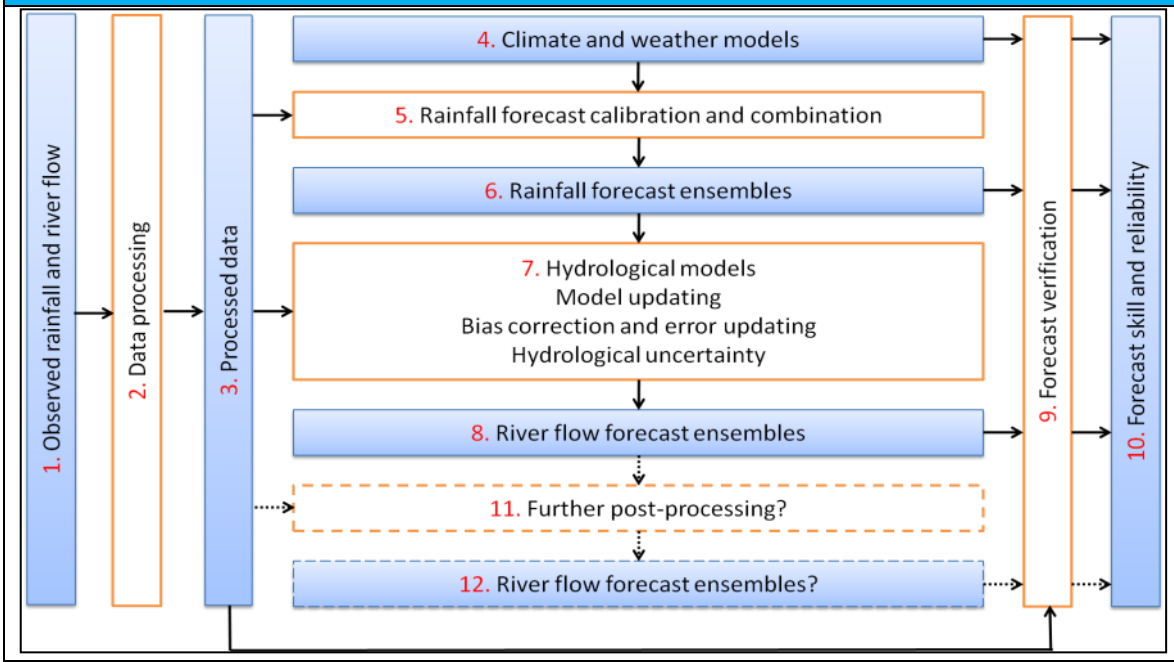
Australia's Bureau of Meteorology, under authority from the Commonwealth Water Act 2007, compiles and delivers water information and conducts rigorous and independent assessments of water resources.[12] The Bureau, along with the Commonwealth Scientific and Industrial Research Organisation (CSIRO), formed the Water Information Research and

[12] http://www.bom.gov.au/water/awra/2010/documents/summary.pdf

Development Alliance (WIRADA) to combine R&D in water and information sciences with hydrological analysis and prediction. The Alliance covers data interoperability, hydrologic modelling, water accounting, and water resources management.

Of the various research areas within WIRADA's ambit, the two most important ones from Bihar's perspective are: (a) water resources assessment and water use accounting to developing technologies to integrate surface and groundwater assessments and scenarios; and (b) short-term water and flood forecasting and predictions (see **figure 7.3**).[13]

FIGURE 7.3: WIRADA Framework for ensemble short-term streamflow forecasting



Source: Presentation on "*Water Information in Australia: status and directions*" by Dr Bill Young, Director, Water for a Healthy Country Flagship, Australia, , 13th April 2012 during India Water Week Side Event Organised by Council on Energy, Environment and Water

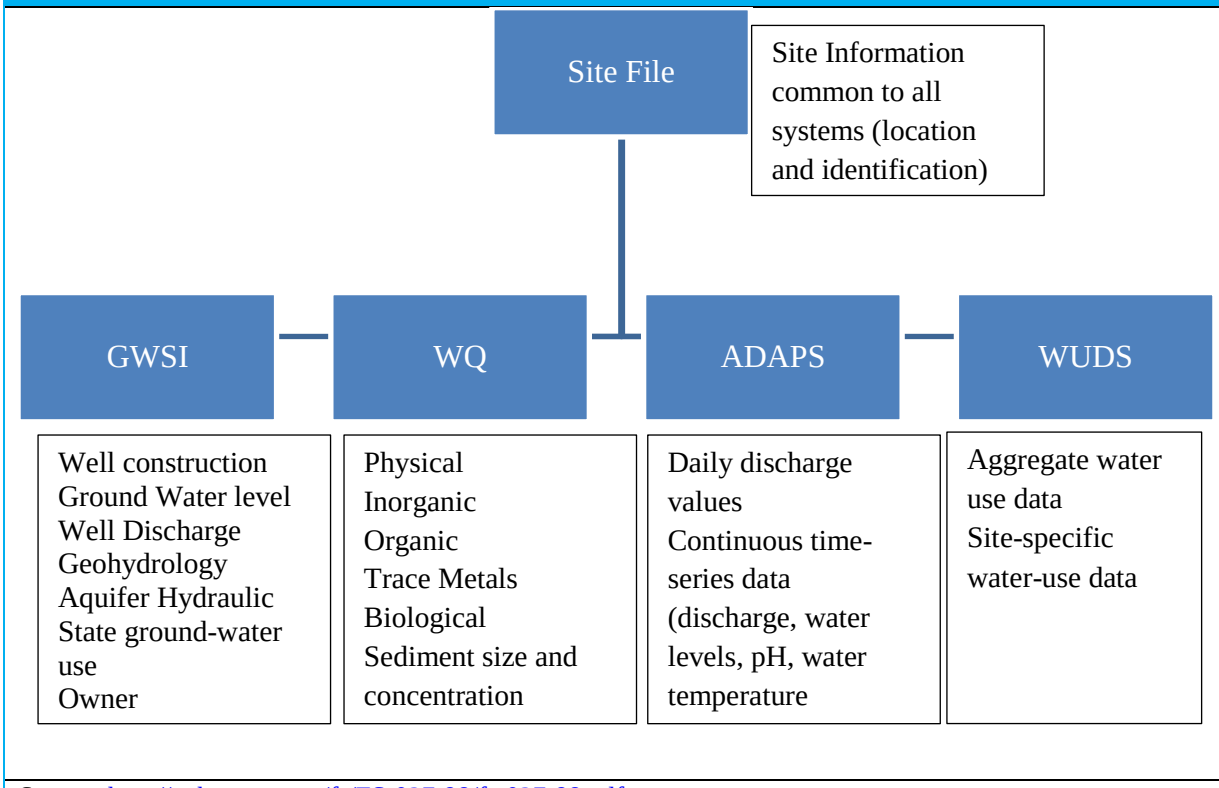
United States[14]

In the United States, the U.S. Geological Survey (USGS) is the main water-data agency at the federal level, which then disseminates data to State and local governments, public and private utilities, and other Federal agencies. The USGS's Water Resources Division (WRD) maintains a network of computers and fileservers to store and retrieve water data at about 1.4 million sites, which together constitute the National Water Information System (NWIS). The NWIS structure and the types of data available in the four subsystems are shown in **figure 7.4**.

[13] http://www.csiro.au/partnerships/wirada#a3 accesed on 4 May 2012

[14] http://pubs.usgs.gov/fs/FS-027-98/fs-027-98.pdf

FIGURE 7.4: The NWIS structure and the types of data available in the four subsystems



Source: http://pubs.usgs.gov/fs/FS-027-98/fs-027-98.pdf

Two of the sub-systems in the NWIS database are particularly relevant for Bihar:

1. The Ground-Water Site-Inventory System; and
2. The Water-Quality System

1. Ground-Water Site-Inventory System

The Ground-Water Site-Inventory (GWSI) System gives access to information about measuring sites at stream reaches, wells, test holes, springs, tunnels, drains, lakes, reservoirs, ponds, excavations, and water-use facilities. The GWSI data files contain information on well-construction, groundwater level, groundwater well discharge, geohydrologic characteristics, observation-well report header, aquifer hydraulic, State groundwater use, and miscellaneous data.

2. Water-Quality System

The Water-Quality (WQ) System hosts results of more than 3.5 million analyses of water samples to describe chemical, physical, biological, and radiochemical characteristics of both surface and groundwater resources. The water samples data are analysed at laboratories to

examine the presence of simple inorganic compounds, such as chlorides, as well as complex organic compounds, such as pesticides. The verified results are stored in the water quality database.

National practices for hydrological information

Rajasthan[15]

Rajasthan's Water Resources Information System (WRIS) allows water users to maintain up-to-date information on projects, dams, reservoirs, canals, anicuts, weirs, surface and ground water resources including recharge, chemical analysis and water quality of available water, crops, Water User Associations, etc.

The WRIS serves both to support decision-making on water management for irrigation, drinking and other purposes as well as for government to citizen information sharing. As primarily a Hindi speaking State, the WRIS supports bilingual data collection and dissemination. This feature would be relevant be relevant for Bihar as well.

The WRIS Application integrates Geographical Information Systems (GIS) and Management Information Systems (MIS) with several modules, including: project management for irrigation (structures, reservoirs, dam, canal, barrage, anicut, weir, tunnel, dam and canal regulation programmes, river and canal gauges, project physical & financial progress, etc. including irrigation scheduling); surface water hydrology; groundwater hydrology; meteorology; geology; agriculture; environment; socio-economic issues, including domestic consumers and Water User Associations; location module to manage administrative data identify assets of the Water Resources Department; and administration and report. Many of these modules would be applicable for the MWRD, Bihar as well.

Nine Peninsular States[16]**:** *Andhra Pradesh, Chhattisgarh, Gujarat, Kerala, Karnataka, Madhya Pradesh, Maharashtra, Orissa and Tamil Nadu*

The Hydrology Project Phase I (HP-I) developed an integrated hydrological database for relevant data: quantity and quality of surface and groundwater and meteorology. In order to increase coordination between participating agencies, HP-I standardised systems, rationalised networks, data exchange protocol and procedures; trained manpower for monitoring sites; created user friendly data storage and dissemination systems; build Hydrologic Data Users Groups; undertook R&D studies for emerging issues like fresh-salt water interface, integrated river basin planning and management, and modelling for water quality/sedimentation.

[15] http://wris.rajasthan.gov.in/AboutUs.aspx

[16] http://www.nih.ernet.in/HP2/index.htm

Readily available and cost-effective technologies that could help in the MWRD's work

The MWRD could consider the deployment of the following technologies:

Piezometers,[17] which are non-pumping observation wells to vertically measure aquifer depths and sampling groundwater, can provide information on lithology, water bearing zones, discharge, water level, water quality monitoring and hydrogeological/geophysical investigations.

Digital Water Level Recorders,[18] which automate collection of data from a large number of monitoring wells, as per the desired frequency, with higher accuracy than manual measurements, and are reliable and easy to operate. High frequency water level measurement data has allowed hydrogeologists update groundwater resource estimations and estimate the amount of recharge required to rehabilitate groundwater levels.

GIS Software, in order to collect information on: catchment area of Ahars; length of distribution network and pondage area of Ahar & Pynes; mapping tube wells and measuring groundwater level fluctuation and quality; mapping contaminated areas; mapping water stressed areas; mapping bore wells; preparing different maps based on lithology and aquifer characteristics; and developing hydrology models for forecasting.

Tensiometers,[19] typically a sealed, water-filled tube with a ceramic porous cup and a vacuum gauge at the top, provide estimates of soil moisture. As soil moisture decreases, the water level in the tube goes down. If the indicated soil moisture is lower than the desired level for a crop, farmers know that it is time to irrigate. This process saves water by using it only when needed and improves crop yields.

Weather forecasting and information: Initiatives are also needed in Bihar for increasing weather stations (at least one per block) so that farmers receive reliable locally relevant meteorological and agricultural information.[20] Thanks to support from the Government of Australia,[21] three villages in the Warangal, Nalgonda and Mahabubnagar districts of Andhra Pradesh are receiving twice-weekly medium-range forecasts customised to weather scenarios. Based on this information, farmer groups meet fortnightly to discuss seasonal effects on crops and offer feedback on the accuracy of the weather forecasts. A recent initiative of the National Bank for Agriculture and Rural Development is offering weather forecasts and crop advisory

[17] http://cwc.gov.in/main/HP/download/Advancement%20in%20tech%20in%20GW%20by%20Mani.pdf
[18] http://cwc.gov.in/main/HP/download/Advancement%20in%20tech%20in%20GW%20by%20Mani.pdf
[19] http://water.columbia.edu/research-projects/india/punjab-india/
[20] http://www.wotr.org/climate-change-adaptation/agro-meterology/
[21] http://aciar.gov.au/node/13541

(based on data from the Indian Meteorological Department) to farmers in Maharashtra via a free SMS service. It is expected to reach 50,000 farmers in 2012-13.[22]

Recommendations for technology, monitoring, maintenance and quality control

Recommendation 7.1: Establish a dedicated Monitoring and Quality Control Wing (M&QC)

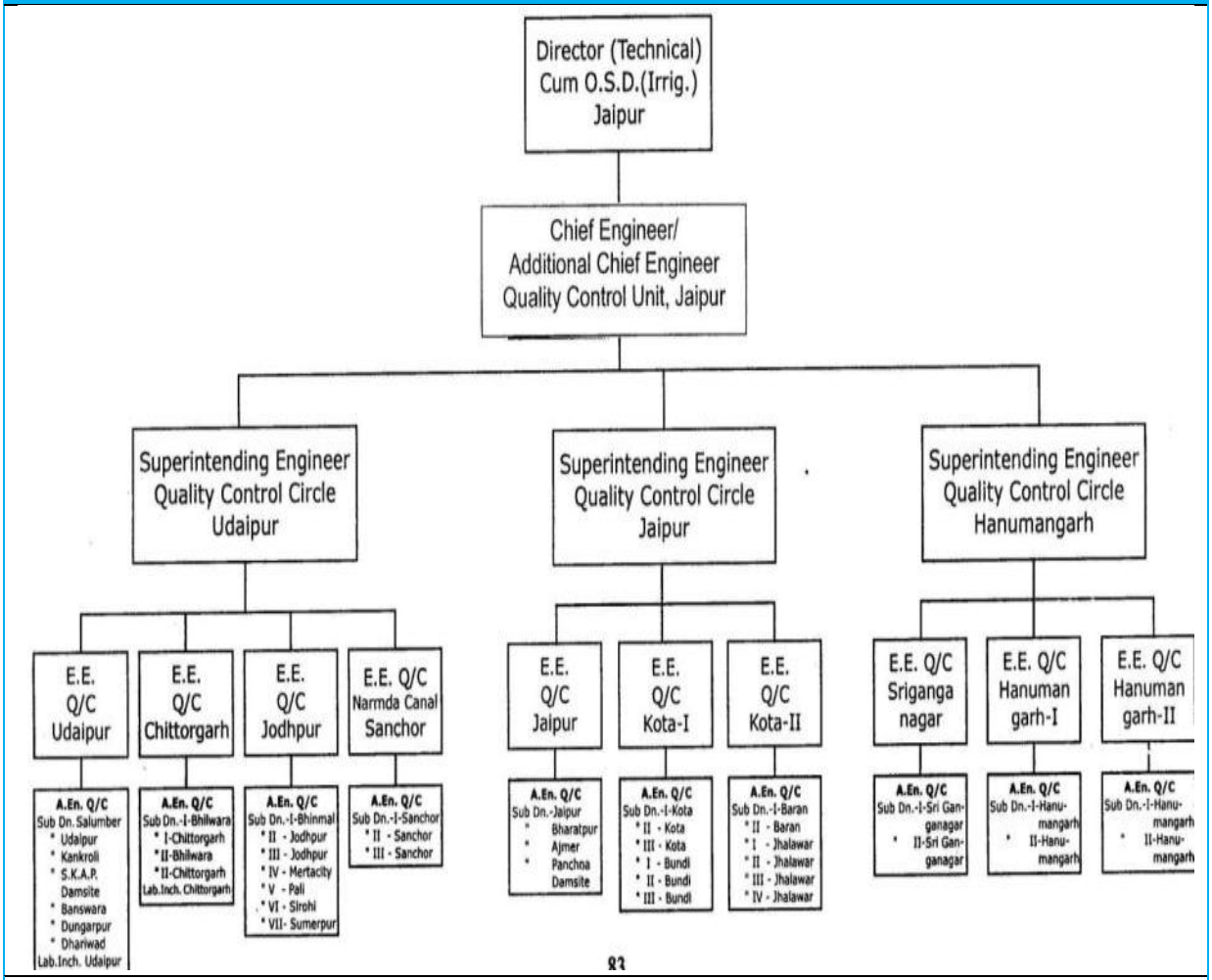
A dedicated monitoring and quality control wing is strongly recommended. In examining the structures of other states, we found Rajasthan's quality control division to be the most useful in terms of its design and functions (**figure 7.5**).[23] Rajasthan's quality control units have the following main functions:

1. Ensuring that all the required tests are conducted prior to and during execution of projects. At least 10% of the tests are to be conducted by the quality control units.
2. Arranging the conditions for routine field tests; maintaining equipment and personnel at site laboratories; and recording field tests in prescribed formats.
3. Suspending project work if deficiencies or defects are observed.
4. Maintaining an inspection book at field sites to record comments by quality control staff. Any deficiencies recorded have to be brought to the notice of the concerned officer of the Quality Control Unit.
5. The Chief Engineer/Additional Chief Engineer for Quality Control ensures at least one test check each year of all the works that cost more than Rs.25 lakhs.

[22] http://articles.timesofindia.indiatimes.com/2012-04-12/pune/31330798_1_dairy-project-dairy-sector-nabard

[23] http://waterresources.rajasthan.gov.in/6manualQC2.htm#2

FIGURE 7.5: Organisational Chart of the Quality Control Unit, Irrigation Department, Rajasthan



Source: http://waterresources.rajasthan.gov.in/6manualQCA2.htm accessed on 10 June 2012

The Rajasthan quality control and assurance unit not only monitors work but also helps in maintaining a specified standard for all the work being conducted. Bihar's MWRD awards many contracts to private entities for building irrigation structures. Although financial due diligence is necessary prior to selecting contractors, the lack of a quality control division for material testing and quality assurance could result in the use of cheaper materials and deterioration of the infrastructure. Moreover, trainings and skill development (e.g. ISO trainings) are needed to develop a robust quality control team.

In Bihar, at present, there are only two monitoring circles, one under MI and one under TW. The quality control division is completely absent. Since procurement should be based on quality control the circle office for purchase may be merged under this wing. The current monitoring structure needs strengthening. A new Monitoring and Quality Control Wing

should have a separate Chief Engineer, with at least 10 years of experience in quality control and assurance, should be allocated to carry out this task. In total 4 circles, two each for TW and MI, are required. Further, 16 divisions and 64 sub-divisions are recommended. The recommended required strength for the Monitoring and Quality Control Wing is 365 (**table 7.1**).

Table 7.1: Number of staff required for the Monitoring and Quality Control Wing

Designation	Required Strength
Junior Engineers (4 per sub-division)	256
Assistant Engineers (4 per division)	84 (64 for sub-divisions + 20 as TA to EE)
Executive Engineers (4 per circle)	20 (16 for divisions and 4 as TA to SE)
Superintending Engineer (1 each circle)	4
Chief Engineer	1

Recommendation 7.2: Create a Water Data Centre

A strong database is required for good management of water resources. The MWRD needs to establish a data centre for water resources, which will store, manage and provide data for the specific purposes. This centre can act as a nodal point in association with the Indian Meteorological Department (IMD) for providing information and forecasts about weather conditions in the state and support decision making regarding cropping and irrigation activities.

The Water Data Centre will also need GIS specialists for creating data and maps on:

- Catchment Area
- Length of distribution network and pondage area of Ahar & Pynes
- Location of tube wells
- Description of GW level fluctuation and quality tube well wise
- Mapping areas having contaminated water
- Mapping water stressed areas
- NABARD Phase -3, 8 and 11, State owned and private tube wells
- Lithology and aquifer characteristics
- Developing Hydrology models for future forecasts etc.

These GIS specialists should be hired to work in coordination with hydrologists and hydrogeologists to develop the water database and models. Surface water bodies and other visible entities could be mapped using satellite images. A team of 5 GIS specialists, hired on a yearly contract, can be established with immediate effect.

Recommendation 7.3: Pay attention to infrastructure and instrument requirements

Buildings

A separate and government-owned property is required for all MWRD offices. Even at the few places where government-owned offices are used by the TW wing, the MI offices operated out of rented properties, or vice versa. There should be more coordination within the department to identify a single property sufficient for both the wings.

Vehicles

One four wheeler vehicle is must for every circle and division office. As reported during the survey, earlier Sub-Division offices had been allocated four-wheel drive vehicles but these are no longer functional and have not been replaced. While motorcycles were provided to Junior Engineers, they complain about problems regarding reimbursement of fuel expenses.

Therefore, we recommend that the department provide AEs and JEs with motorcycles. Alternatively, at least AEs should be allocated motorcycles and JEs be given a monthly fuel allowance. More importantly, as with all other assets of the department, proper asset management planning is critical to allow for depreciation of mobile and immobile assets, so as to replace them on a regular basis.

Quality testing laboratories

A material testing laboratory for quality control and quality assurance and a water quality testing laboratory for testing several water quality parameters needs to be set up.

Tensiometers

There are various models of tensiometers available in the market but they are quiet expensive. However, soil scientists at the Punjab Agricultural University have developed a simpler model of the device costing only $6.[24] In order to justify the expense, we recommend that a few blocks are randomly selected where farmers are supplied with tensiometers and trained in their usage as part of a pilot programme. Once the yields and water management improve, concessional loan schemes could be devised to offer the instruments to farmers across the state. The procurement and supply of tensiometers could be a joint venture by the Water Resources Department and Minor Water Resources Department, in order to reduce costs.

[24] http://blogs.ei.columbia.edu/2010/11/17/%E2%80%9Csmall-is-also-beautiful%E2%80%9D-%E2%80%93-appropriate-technology-cuts-rice-famers%E2%80%99-water-use-by-30-percent-in-punjab-india/

Piezometers and DWLRs

A few of the old wells and new wells could be converted to piezometers i.e. non-pumping monitoring wells. This would help in measuring aquifer depths and sampling groundwater. It can provide information on lithology, water bearing zones, discharge, water level, water quality monitoring and assist with hydrogeological / geophysical investigations. Similarly, these wells could be fitted with DWLRs (with support from the National Institute of Hydrology and the Central Ground Water Board), again as a pilot programme to demonstrate the usefulness of these technologies.

VIII. PARTICIPATORY IRRIGATION MANAGEMENT: STRENGTHENING WUAS; DEVELOPING A SERVICE ETHIC

Performance of Water User Associations and relationship with MWRD

There are very few registered WUAs in Bihar (around 64), although the total number is higher. This is because, although nominal, WUAs have to pay a fee to be registered under the Societies Registration Act. From our field surveys, we made some general observations:

1. **Non-functional WUAs:** The WUAs are either non-functional or are not serving the purpose for which they have been formed. As NABARD's criteria was to hand over all the bore wells to water users societies, there are as many WUAs as bore wells constructed during NABARD's phases 8 (2005-07) and 11 (2007-2012). However, in many cases the well has been dug in an area that belongs to the most dominant person in the command area; very little water is supplied to other members of the WUAs.

2. **Dominance of the Powerful:** Related to the above, one important fact we observed was that the president of the WUA is also often the *mukhiya* or the *sarpanch* of the village and the secretary is usually a relative or the former *mukhiya*. This system provides all the water access rights to an already dominant person, resulting in inequity in access to water and in governance decisions.

3. **Lack of Guidance:** WUAs are being formed just for the sake of meeting contractual obligations to NABARD. No training is being provided to the WUA members.

Most of the WUAs have not performed well primarily due to the lack of coordination and understanding among members of roles and responsibilities of the association. Lack of training and skills makes the situation more challenging. There is no social group involved in forming these WUAs, which can conduct fair votes for the positions of president or secretary. WUAs have been formed just to meet contractual obligations to NABARD and there is no interest among the officials to keep it functional.

Although the MWRD has no administrative control over the WUAs, it has been asked to improve their performance. But there are no incentives to do so. One option could be to assign an NGO or institution that has the background in training and operationalising WUAs with the responsibility of forming WUAs as well as regular auditing and training of the members. It should not be considered only a formality because agriculture productivity depends on an efficient irrigation system, which in turn needs effective coordination between irrigation officials and WUA members.

At a few places WUAs were performing well. For example, in Marenga (west), East Purnia Block, Purnia district, a WUA representative claimed that the association was running successfully for the last 15 years. In Muzaffarpur district, another well-functioning WUA was in Majhuala Village, Minapur Block, where the bore well had been dug in 2009. The common claim was that members were coordinating activities in both places. But more research is needed to identify the reasons behind successful practices in certain areas.

Are WUAs capable of rehabilitating and managing the Ahar and Pyne systems?

Managing Ahar and Pyne systems is a far more demanding task than managing bore wells because they require regular maintenance. Further, the success of the system depends on rainfall, which is unpredictable. In Bihar there are about 20938 traditional Ahar/Pyne schemes. Out of these 3255 schemes are non-functional. A census of minor irrigation schemes was last conducted in 2000-01 and published in October, 2005. **Table 8.1** shows district-wise distribution of Ahar & Pyne schemes. There has been a huge reduction in the culturable command areas of the functional Ahar & Pyne schemes. Therefore, there is need to renovate these structures which were once the lifelines of Bihar irrigation system.

Table 8.1: District-wise distribution of Ahar & Pyne Schemes

S.No.	District	Functional Schemes	Non-functional Schemes	Total
1	Patna	212	86	298
2	Nalanda	238	82	320
3	Bhojpur	93	31	124
4	Buxar	69	0	69
5	Kaimur	1330	71	1401
6	Rohtas	398	19	417
7	Aurangabad	1251	442	1693
8	Gaya	6502	762	7264
9	Nawada	1488	1371	2859
10	Jahanabad	406	95	501
11	Arwal	91	11	102
12	Bhagalpur	472	50	522
13	Banka	2146	117	2263
14	Munger	162	4	166
15	Jamui	2449	73	2522
16	Lakhisarai	251	15	266
17	Shekhpura	125	26	151
Total		**17683**	**3255**	**20938**

Source: Annual Report 2011-12, Minor Water Resources Department, Bihar

As reported by farmers and officials no renovation work has been done on these minor irrigation systems for the last 25 years. When the MWRD started renovation work last year it began facing problems regarding land acquisition. Although rehabilitation programmes have been launched to relocate the communities that have built houses on land intended for the schemes, it is too early to tell whether the approach has been successful.

Resources and support units for effective participatory irrigation management

If WUAs have to become more effective, equitable and have a role in Ahar and Pyne rehabilitation and reconstruction, then they would need resources and support. Here, we outline examples from other states in the country, whose infrastructure facilities and best practices can be used as a benchmark for Bihar.

Karnataka[25]

Karnataka has a unique division called the **Jala Samvardhane Yojana Sangha** (*JSYS*), which looks after the formation and training of WUAs. It is a registered society established by the government and serves as the nodal agency for Community Based Tank Management in the State.

JSYS works, in particular, for the minor irrigation sector to strengthen participatory systems in tanks and groundwater management. Its chair is the State Minister of Water Resources and it reports directly to an Executive Committee, chaired by the Additional Chief Secretary. Its multidisciplinary team operates out of nine District Project Units whose responsibility is to transfer the development and management of tank systems to the communities. The structure and human resource profile of JSYS are outlined in **figure 8.1** and **table 8.2**, respectively.

[25] http://www.jsysindia.org/chart.asp

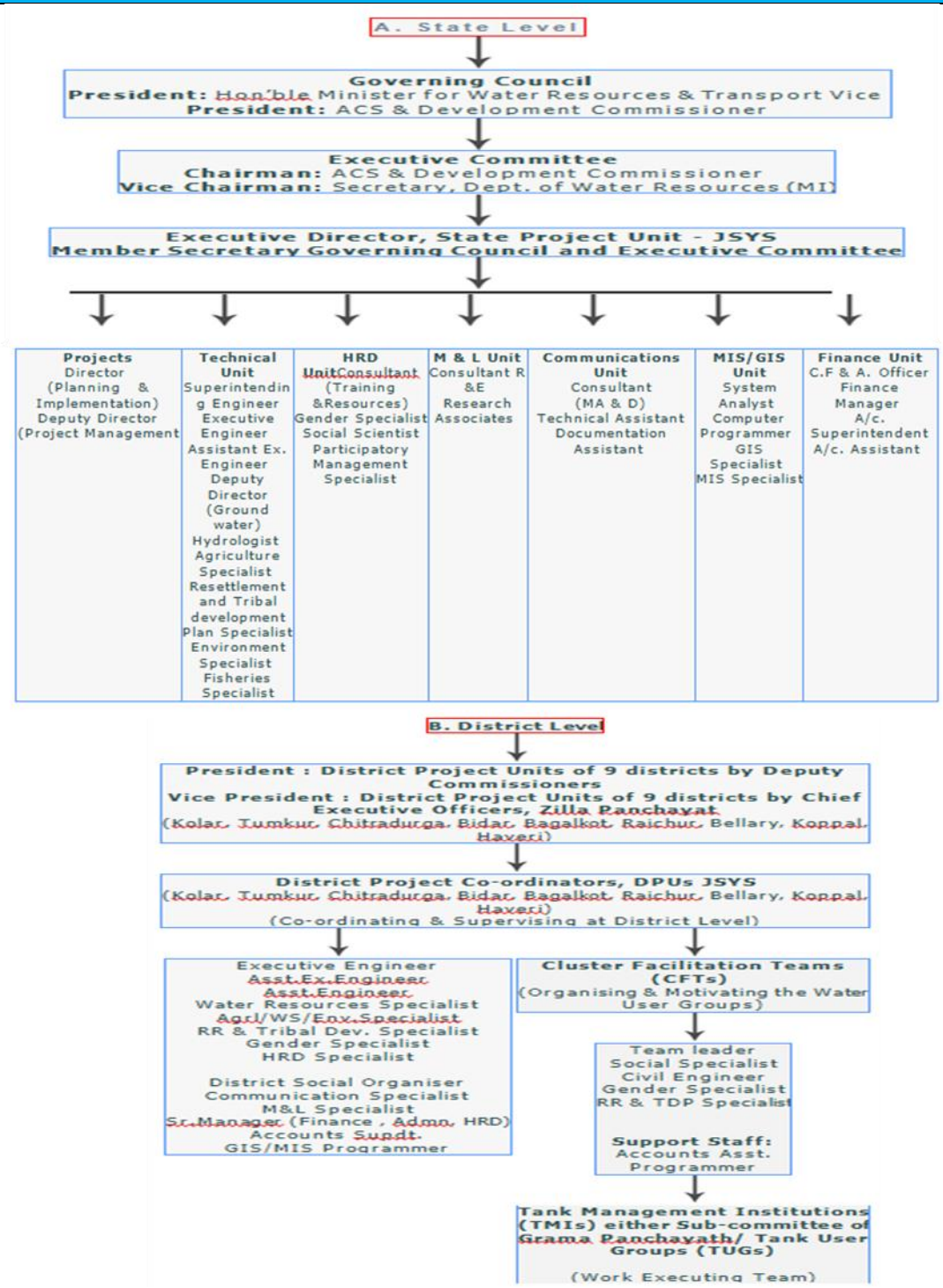
Table 8.2: Human Resources Profile of Jala Samvardhane Yojana Sangha

Minister of State for Water Resources	President
Additional Chief Secretary &Development Commissioner.	Vice President
Principal Secretary/Secretary, Dept. of Minor Irrigation	Member
Principal Secretary/Secretary, Dept. of Agriculture and Horticulture	Member
Principal Secretary/Secretary, Dept. of Animal Husbandry & Fisheries	Member
Principal Secretary/Secretary, Dept. of Rural Development & Panchayat Raj	Member
Principal Secretary/Secretary, Dept. of Finance	Member
Principal Secretary/Secretary, Dept of Planning, Institutional Finance, Statistics & Science &Technology	Member
Principal Secretary/Secretary, Dept. of Forest, Environment & Ecology	Member
Secretary, Dept of Major &Medium Irrigation	Member
Representative from the Ministry of Water Resources,Govt. of India	Member
Director, Dept. of Mines & Geology	Member
Director, Watershed Development Dept.,	Member
Regional Chief, HUDCO, Bangalore	Member
One expert to be nominated by HUDCO	Member
Two or three representatives from funding Agencies	Member
Four persons drawn from NGOs engaged in Rural Development in the State out of which, atleast two would be women, to be nominated by the State Government	Members
Six eminent persons representing Indian Institute of Science, Indian Institute of Management, Institute for Social and Economic Change National Law School of India University, University of Agricultural Sciences, Agricultural Finance Corporation Ltd., to be nominated by the State Government	Members
Executive Director , JSYS	Member Secretary
Executive Committee	
Additional Chief Secretary & Development Commissioner	Chairman
Principal Secretary/Secretary, Dept. of Water Resources (Minor Irrigation) Vice	Chairman
Principal Secretary/Secretary, Dept. of Agriculture and Horticulture	Member
Principal Secretary/Secretary, Dept. of Animal Husbandry & Fisheries	Member
Principal Secretary/Secretary, Dept. of Rural Development &Panchayat Raj	Member
Principal Secretary/Secretary, Dept. of Finance	Member

Principal Secretary/Secretary, Dept of Planning, Institutional Finance, Statistics & Science &Technology	Member
Principal Secretary/Secretary, Dept. of Forest, Environment & Ecology	Member
Secretary, Dept of Major & Medium Irrigation	Member
Commissioner of Agriculture, Seshadri Road, Bangalore	Member
Representative from the Ministry of Water Resources,Govt. of India	Member
Director, Dept. of Mines & Geology	Member
Director, Watershed Development Dept.,	Member
Director of Horticulture, Lalbagh, Bangalore.	Member
Project Director, Karnataka Rural Water Supply and Sanitation Agency (Jala Nirmal Project), 2nd Floor, Cauvery Bhavan, Bangalore	Member
Regional Chief, HUDCO, Bangalore	Member
One expert to be nominated by HUDCO	Member
One or two representatives from funding Agencies	Members
Three eminent persons representing from any of the following Institutions. Indian Institute of Science, Indian Institute of Management, Institute for Social and Economic Change, National Law School of India University, University of Agricultural Sciences, Agricultural Finance Corporation Ltd., to be nominated by the State Government	Members
One Chief Engineer, Minor Irrigation (North or South)	Member
One Superintending Engineer, Minor Irrigation (by rotation)	Member
Deputy Commissioners of concerned Districts where project is being Implemented	Members
CEOs of Zilla Panchayats of concerned districts where the project is being implemented	Members
Two representatives of Voluntary agencies from the Districts from the area of programme implementation out of whom one shall be woman to be nominated by State Government.	Members
Executive Director , JSYS	Member Secretary

Source: http://www.jsysindia.org/chart.asp

FIGURE 8.1: Organisation Structure of JSYS



Source: http://www.jsysindia.org/chart.asp

Elsewhere, our extensive analysis of participatory irrigation management within and outside India highlights at least two examples that could hold lessons for Bihar.

Andhra Pradesh[26]

The state government enacted the Andhra Pradesh Farmers Management of Irrigation System Act in 1997. Under the APFMIS Act, WUAs are constituted at three different levels in major irrigation projects: minor canal level, distributary canal level, and main canal level. In medium irrigation projects they are constituted at two levels: minor canal level and the main canal level. In minor irrigation tanks, a single WUA covers the entire tank command area. A total of 10,748 WUAs have been constituted – 2261 in major irrigation projects, 410 in medium irrigation projects and 8077 in minor irrigation tanks.

The Farmers' Organizations (FOs) undertake minimum rehabilitation works and O&M works for irrigation systems under their responsibility. This process has allowed the farmers to acquire experience in undertaking maintenance works and also to understand the complexity of operating and maintaining the irrigation system. A "mobilization advance" is made available for farmers to commence work. In future, however, the WUA role in operation and maintenance of irrigation systems would depend on its ability to generate resources. As per the APFMIS Act, provisions are made to generate revenue for WUA to self-manage and achieve financial reliance and sustainability.

Ever since the inception of PIM in the state in 1997, the level of water tax collection has been too low for any effective resourcing of the WUAs for O&M. This is further complicated by the Revenue Department by taking enormous time to plough back the water tax to WUAs. Consequently, between 2004 and 2006 there was no revenue plough back to the WUAs and no O&M works were taken up by them. In order to rectify this situation, in 2006-07 the government started a process to simplify water tax collection, O&M planning, and a procedure to plough back 100% of water tax collected by the WUAs.

Further, to improve the performance of the WUAs, and to institutionally strengthen the farmers' organisations and to empower them to take up the responsibilities given to them, the Irrigation and Command Area Development Department devised an elaborate capacity building and training programme for the WUAs. This included awareness generation camps, exposure visits, training workshops, work books for irrigation assessment and tax collection, and self-evaluation. **Table 8.3** outlines the subjects and intended targets for eight modules for training WUAs.

[26] Martin A. Burton, Rahul Sen, Simon Gordon-Walker, Anand Jalakam, and Arunabha Ghosh (2011) *National Water Resources Framework Study: Research Report Submitted To The Planning Commission For The 12th Five Year Plan*, September, New Delhi: Council On Energy, Environment and Water and 2030 Water Resources Group.

Table 8.3: Subject and Target of Modules for WUAs in Andhra Pradesh

Sl. No.	*Module*	*Targets*
1	*WUA Awareness Generation Camp Through*	*All WUA Members*
2	*WUA Roles & Responsibilities*	*WUA MC Members*
3	*Finance Management*	*Sub Committee*
4	*Works Management*	*Sub Committee*
5	*Water Management*	*Sub Committee*
6	*Monitoring& Evaluation & Training*	*Sub Committee*
7	*Self-Assessment*	*WUA MC Members*
8	*Exposure Visit*	*WUA Presidents*

Source: Martin A. Burton, Rahul Sen, Simon Gordon-Walker, Anand Jalakam, and Arunabha Ghosh (2011) National Water Resources Framework Study: Research Report Submitted To The Planning Commission For The 12th Five Year Plan, September, New Delhi: Council On Energy, Environment and Water, and 2030 Water Resources Group.

The trainings are carried out locally either at the Sub-Division or Division level by the Competent Authorities and the Training Coordinators. The training and capacity building programme for the farmers' organisations will need to cover over 3000 WUA/DCS/PCs of the major and medium irrigation projects in the state. To systematically organise these numbers of training and capacity building activities there was a need to design and adopt an effective implementation arrangement. Towards this end, in each irrigation circle, one Field Training Centre (FTC) has been established in an existing Irrigation Department building by providing training infrastructure facilities like furniture, computer and printer, LCD projector, audio visuals and sound systems, etc.

The FTC is manned by a team of professional support staff consisting of one Training Coordinator and one Irrigation Engineer (Retired). The support team functions under the Superintending Engineer and coordinates and carries out the training and capacity building programme for the farmers' organisations. The support team provides training and facilitation support to the Competent Authorities (irrigation engineers) and the WUAs. They also monitor the progress and outcome of the training and capacity building programme. Sixteen Training Coordinators have been engaged for the 18 irrigation circles. In order to assist the Training Coordinators, selected component authorities and DC Presidents (as roving trainers) who have good communication skills and show aptitude for farmer training, have been trained through Training of Trainers programme. The overall responsibility of the training and capacity building programme for the farmers' organizations is with WALAMTARI (i.e. the state's WALMI).

Gujarat: Dharoi Irrigation Project[27]

In 1995 the Government of Gujarat allowed Water Users Associations (Irrigation Cooperatives) to take over the management of their irrigation and drainage systems for an initial period of 5 years by signing a Memorandum of Understanding (MoU) with the system's ID Executive Engineer. The MoU defines the roles and responsibilities of the different parties, with the following roles transferred to the WUA:

- Operation and maintenance of the canal system;
- Crop planning;
- Setting and collection of water charges.

The WUAs were also given the following responsibilities:

- Timely and equitable water supply to all users in the command area;
- Timely payment of water charges due to the ID;
- Timely resolution of water-related disputes between water users;
- Adequate and timely maintenance of the system;
- Sustaining agricultural productivity and water use efficiency in the command area.

Farmers in the right bank command of the Dharoi Irrigation Project, supported by an NGO, (Development Support Centre, DSC), took over the management and control of a 25,000 ha command area serving some 90 villagers. Of the 130 WUAs in the command area 30 agreed to take over the management of the system following rehabilitation, whilst 100 agreed to take over the management of the system prior to rehabilitation, in the expectation that they could manage it better than the ID despite its poor physical condition.

The Dharoi command area lies in a low rainfall area (<700 mm/year) where water is in short supply. The command is supplied from a reservoir which has filled only 10 times in the last 25 years. Surface irrigation water supplies from the reservoir are supplemented by many hundreds of private tubewells in the command area.

Allocation of water is decided at a meeting in September of the Advisory Committee comprising the WUA office bearers (usually the President and Secretary), the ID Superintending and Executive Engineers, the Member of Parliament, local MLA and *Sarpanchs*. At the meeting, the Executive Engineer provides information on the water available for irrigation (based on the storage in the reservoir and precipitation) and makes recommendations on the number of irrigations possible in each command area. The

[27] Martin A. Burton, Rahul Sen, Simon Gordon-Walker, Anand Jalakam, And Arunabha Ghosh (2011) National Water Resources Framework Study: Research Report Submitted To The Planning Commission For The 12th Five Year Plan, September, New Delhi: Council On Energy, Environment and Water and 2030 Water Resources Group.

Committee decides on whether critical irrigation can be provided in Kharif, and publishes the decisions in the local newspapers and ID Sub-Divisional offices. Generally, single irrigation is provided in Kharif and 5-6 irrigations during Rabi, with the canals being operated for 15-20 days at a time on an agreed roster.

Following the meeting the WUAs call a General Meeting of the members to share the information on the number of waterings available, following which there is discussion and agreement on the cropping pattern for each WUA command. In general the Irrigable Command area of a WUA is 300-500 ha, with a membership of 70%-95% of farmers within that command area. In a good year 70%-80% of the command area can be cropped, with cotton and millet grown in Kharif and wheat, mustard, fennel, alfalfa and some other crops grown in the Rabi season. At or following the meeting each farmer completes the demand forms, which are colour coded to the crops to assist illiterate farmers.

At the start of the Rabi season the WUAs hold another meeting with the ID to present their irrigation needs based on their cropping patterns. Based on these figures the ID then informs the WUAs on the rotations and the number and timing of irrigations that can be supplied. If the water requested by the WUAs is more than that to be provided by the ID the WUA takes on the responsibility of meeting the farmers' demands. It has been found that the ID estimates are generally on the conservative side, and that the WUAs can support a larger area by working with the water users to make water delivery more efficient and effective (such as timely desilting and repairs to canals). In years with a shortage of water it has been found that farmers prefer to practise extensive, rather than intensive irrigation, and will often adopt less water intensive crops. In these cases the surface irrigation water is supplemented by irrigation from groundwater, which is factored into the equation by the WUAs and the farmers.

For water distribution during the season the farmers submit the area they want to irrigate to the WUA Secretary at least 15 days before the date the water is to be released. They pay their water fees in advance and receive a gate pass from the WUA Secretary, which the farmer then passes on to the WUA's gate operators. The farmer is also informed of the date, time and duration of his/her irrigation. The WUA secretary also provides each gate operator with the list of farmers to be provided with water during each irrigation.

Each WUA employs between 2-5 gate operators, each gate operator being responsible for a command area of some 40-50 ha. The gate operators are appointed locally through a formal recruitment process, and are employed at local wage rates to work 12 hour shifts, day or night, during the irrigation season. The gate operators report to the WUA Chairman or Secretary on a daily basis.

A central feature of the arrangements on the Dharoi scheme is that the water users decide the water charges for their command area. Each June, the WUA budgeting working group submits

a budget to the WUA General Body meeting for discussion and approval. The budget includes the service fee charged by the ID, plus an additional amount required for the management, operation and maintenance of the WUA. The current government rates are Rs.199/ha (US$ 4.4/ha), excluding a 20% local cess for the Panchayat Development Fund). Under the agreed WUA rules farmers are required to pay the water charges before each irrigation. Farmers not paying beforehand are charge an additional 50% and non-members can be charged 30% extra. Prior to the turnover of management to water users the ID collection water charge collection rate was 50%-60% percent but since the handover WUAs have been able to collect 100% water charges each year. In addition the Cooperative Department carries out a financial audit of the registered WUAs.

A number of criteria and indicators have been developed for assessing the performance of the WUAs. **Table 8.4** summarises these indicators while **figure 8.2** links these factors together as issues influencing WUA sustainability.

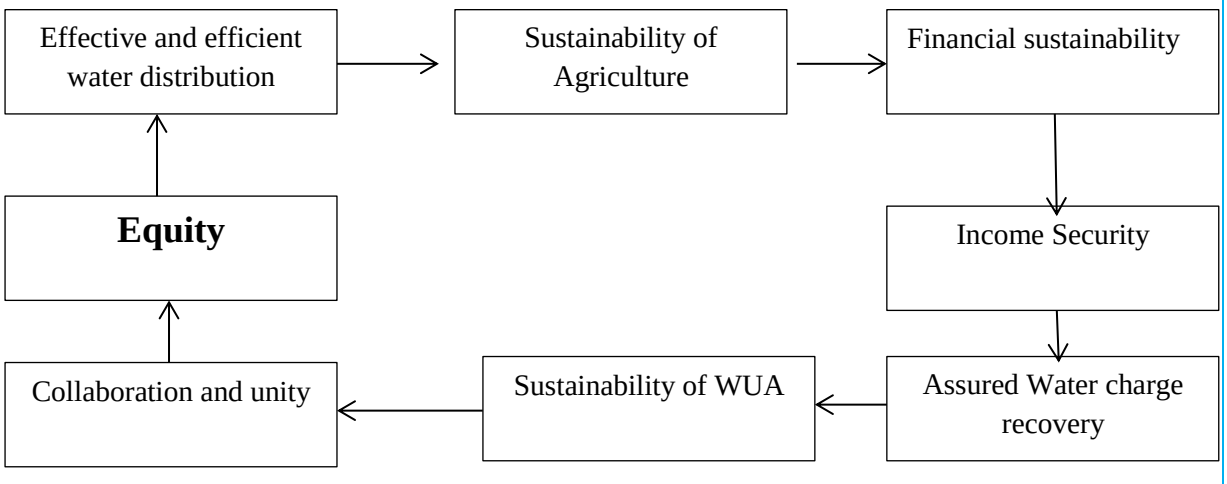
Table 8.4: Summary of WUA performance criteria and indicators:

Criteria	Explanation	Indicator	Results
Equity	All members get proportionally equal benefits regardless of caste, class, sex and location in the system. If there is any discrimination it should be in favour of the disadvantaged.	Disputes Access to irrigation water	Number of disputes reduced through better water management
Efficient water distribution system	Includes efficient utilization of water, prevention of wastage, water-logging, etc.	Area irrigated	Net area irrigated has increased by 40 percent since management transfer
Effective water distribution	Increased crop production due to timely irrigation.	Crop yield and production Fee recovery	Wheat yields have increased from 28.6 quintal/ha to 31.1 quintal/ha 100 percent fee collection of Rs 91 lakh, with Rs 51 lakh retained by WUAs and Rs 39 paid to government

Sustainability of WUA	Refers mainly to the financial sustainability of the WUA, but also relates to social cohesion and cooperation	Fee recovery Cash reserves Dispute resolution	Fee recovery has increased from 50- 60 % to 100 %. WUAs are building cash reserves, those working for more than 3 years have reserves of over Rs 1 lakh WUAs have resolved 99 cases of disputes
Sustainability of agriculture	Refers to the maintenance of land fertility and productivity due to farmers' cultivation and irrigation practices, and reduction of adverse impacts (waterlogging, salinisation, etc.)	Crop yield and production	

Source: Martin A. Burton, Rahul Sen, Simon Gordon-Walker, Anand Jalakam, and Arunabha Ghosh (2011) National Water Resources Framework Study: Research Report Submitted To The Planning Commission For The 12th Five Year Plan, September, New Delhi: Council On Energy, Environment and Water, and 2030 Water Resources Group.

FIGURE 8.2: Relationship of factors influencing WUA sustainability



Source: Martin A. Burton, Rahul Sen, Simon Gordon-Walker, Anand Jalakam, and Arunabha Ghosh (2011) National Water Resources Framework Study: Research Report Submitted To The Planning Commission For The 12th Five Year Plan, September, New Delhi: Council On Energy, Environment and Water, and 2030 Water Resources Group.

Recommendations for strengthening PIM and equitable access to irrigation in Bihar

Based on the initiatives and experiences in Andhra Pradesh, Gujarat and Karnataka, we offer some broad suggestions for strengthening PIM in Bihar.

Recommendation 8.1: Create a Participatory Irrigation Management Committee and WUA Support Units

The PIM Committee should be developed along the lines of the JSYS in Karnataka. It does not need to hire any new officials at this stage but should be composed of officials from various departments in order to coordinate the support functions that the MWRD offers to WUAs.

Further, WUA Support Units should be formed, trained and resourced to train and provide support to WUAs over a minimum 10-year time frame. A state-wide WUA support organisation and training centre should be established, which should report directly to the Minister for Water Resources. The PIM Committee should be made responsible for framing the MoUs between the MWRD and the WUAs and monitoring performance in different districts and blocks. The Support Units should be located at the district and block levels where the WUAs operate as well as in a central cell in Patna.

Recommendation 8.2: Give incentives for WUAs to register

A service agreement ought to be signed between the WUAs and the MWRD in order to encourage more WUAs to register and clear terms of reference be agreed for the roles and responsibilities of field level MWRD officials and the WUAs.

Recommendation 8.3: Separate governance and management of the WUA

Governance and management should be separated, with elections to appoint 10-12 WUA Committee members who in turn elect a WUA President. At least half of the members of the WUA Committee, including the President, should be persons who are not representatives in the Panchayati Raj institutions, in order to ensure that dominant local officials do not take over the governance of WUAs as well. The WUA Committee should then appoint paid staff to carry out the day-to-day management of the minor irrigation system.

Recommendation 8.4: Allow WUAs to set and collect the service fee

WUAs should be able to set, collect and spend their own service fee (as agreed by the General Assembly of members), though a portion may be passed on to the MWRD for capital expenditures associated with installing or replacing minor irrigation systems.

Recommendation 8.5: Grant each WUA an entitlement to water

There should be an entitlement to water, from both surface water and groundwater. This entitlement can be allocated to the WUA rather than individual members, and can be based on allocation of a fair share of the available water supplies in the basin.

Recommendation 8.6: Increased awareness and training

A significant awareness raising and training programme should be carried out, followed by ongoing support and hand-holding from WUA Support Units.

Recommendation 8.7: Change attitude and role of the MWRD

Rather than consider the formation of WUAs as merely obligations to be fulfilled in order to secure NABARD funding, the MWRD should promote an organisational culture that treats WUAs as partners in the strengthening and rehabilitation of minor irrigation systems in the state. Given the staff deficiencies within the MWRD, WUAs can fill some of the on-field system management gaps, if they are adequately trained and have the governance authority to collect and spend fees on management. The role of MWRD, in turn, would be to ensure that WUA governance does not get restricted in the hands of the powerful with detrimental consequences for access to irrigation for the majority of small and marginal farmers in the state. The importance of minor irrigation in Bihar stems from its landholding patterns; hence equity must be the dominant theme in determining reforms and innovations in participatory irrigation management in the state.

IX. CONCLUSION AND FURTHER RESEARCH

This study has comprehensively assessed the deficiencies in the current structure of the MWRD, Bihar, in light of its important role in support agricultural productivity increase and overall economic growth in the state. We examined the Department's targets set against its past performance. Given that until very recently, not much was being invested in the minor irrigation sector, the MWRD has to find additional financial resources, additional staff, new sources of data, and greater capacity to invest in infrastructure while maintaining quality and monitoring performance and water resources regularly. Our recommendations, therefore, cover organisation restructuring, the creation of new wings focused on management, in addition to operational wings, and the need to develop ancillary units dedicated to data and research and to capacity building. We also outline how to bolster the Groundwater Division, create the infrastructure for a Water Data Centre and a Monitoring and Quality Control Wing, and the need above all for a service delivery ethic that could underscore a renewed relationship between farmers, WUAs and irrigation officials.

While designed as a "rapid response" to a set of queries from the Government of Bihar, the study has also given rise to new questions and suggested directions for further research. Some of these questions could not be answered due to the lack of available information; others were not within the scope of the study but answers to them could help the MWRD in its quest for reform. First, there is a need for more detailed budgetary analysis on the cost implications of expanding staff in the Department. In many cases, we observed vacant positions, the budgets for which have been sanctioned. But there are additional staffing needs for quality control, monitoring, data collection and analysis, and training. We were not privy to salary payscales and were, consequently, unable to calculate the full budgetary implications.

Secondly, a related inquiry could be conducted on the alternative sources of finance for the MWRD. We analysed the potential to use more funds from the National Rural Employment Guarantee Scheme. But other sources, such as taxes, water charges, savings through rehabilitation rather than reconstruction, sharing water data collection costs with the Irrigation Department, support from multilateral institutions for covering technology costs, etc. should be evaluated.

Thirdly, due to the limitations of time and resources, we were unable to further investigate the scope of alternative energy sources, such as solar power or biomass, in running tube wells and pumpsets. We did find that in some cases, solar panels had been stolen within a few months, so the feasibility of using clean energy for water management depends on technology, costs, maintenance requirements, and processes to prevent theft and pilferage.

Fourthly, the relationship between the MWRD and other departments of the Government of Bihar should be studied. If Bihar's growth is contingent on agricultural productivity increase, and if, thanks to its landholding patterns, agriculture is largely concentrated in small and marginal farmers, then the MWRD has a central role in the state's economic trajectory for the coming decade. However, this also means that the MWRD's plans and actions have to run in conjunction with other departments, such as finance, environment and forests, agriculture, rural development, and so forth. More research is needed into the institutional processes that could facilitate such coordination in the state capital and the operational division of tasks that would ensure joint action by different departments at the field level. Such an integrated approach could, in fact, open up new opportunities for co-benefits across Bihar's water, agriculture, energy, environment and growth imperatives. If pursued, it could make the investment in reorganising the Minor Water Resources Department even more worthwhile.

ANNEXURE I – SURVEY FORM FOR FARMERS

A	**General Information**			
	Date of Survey			
	Name of District	**Tehsil**	**Block**	**Village**
	Name of respondent	**Age**	**Education Qualifications**	**Name of house head and Relationship with respondent**
	Contact Details:			
B	**Socio Economic Profile**			
	Religion of the Household			
	A. Hindu	**B. Muslim**	**C. Sikh**	**D. Others**
	Caste of the House hold			
	A. Gen	**B. OBC**	**C. SC**	**D. ST**
	Major and Seasonal Occupation			
C.	**Water Resources Details**			
	What is your primary source of Irrigation			
	A. Rainfall	**B. Pond**	**C. River**	**D. Canal**
	E. Bore well (Public/Private)	**F. Neighbour's water source**	**G. Dug well (public/private)**	**H. Other**
	Percentage use of different sources (%)			
	A. Rainfall	**B. Pond**	**C. River**	**D. Canal**
	E. Bore well (Public/Private)	**F. Neighbour's water source**	**G. Dug well (public/private)**	**H. Other**
	Quality of water from these Sources	**1. Hand pump** **2. Dug well** **3. Bore well** **4. River** **5. Pond** **6. Canal**		
	In your village which is the major source of Irrigation:	**1. Hand pump 2. Dug well 3. Bore well** **4. River 5. Pond 6. Canal**		
	Most reliable source of Irrigation			

	A. Rainfall	**B. Pond**	**C. River**	**D. Canal**
	E. Bore well (Public/Private)	**F. Neighbour's water source**	**G. Dug well (public/private)**	**H. Other**
	Any water shortage faced during summer: Yes No			
	If yes, who helps you and in what ways?			
	Do you have a rainwater harvesting system	**A. Yes B. No**		
	What is the level of water in dug wells/bore well around your house			
	What is the trend of water level in the dug wells over past:			
	A.5 Years, ……..feet above/ below	**B. 10 Years, ……feet above/ below**		
	What are causes of change in water availability for irrigation	**1. Population demand 4.Decreased rainfall** **2. Agricultural demand 5.Other specify……** **3. Industrial demand**		
	How many ahar and pynes units are there in you village?			
	Which unit provides you water for irrigation?			
	What is the reliability of water supply by MWRD in these ahar & pynes?			
	Has quantity and quality of ahar & pynes water improved/ deteriorated over last 10 years	**1. Improved 2. Deteriorated**		
	What do you think is the reason behind the change?			
	What is your opinion about O&M of these ahar & pynes being done by MWRD? Do you co-operate in these activities?			
	Are you facing any other problem related to water quality like presence of arsenic in groundwater?			
D.	**Agriculture**			
	Available land (consolidated)			
	Main Crops	**1. Kharif Crops**		

		2. Rabi Crops	
		3. Summer/Zaid Crops	
	Source of water for Irrigation (Main & Optional)	**1. Groundwater 2. River 3. Canal 4. Others……**	
	Duration of pump operated per day	**1. Kharif Crops**	
		2. Rabi Crops	
		3. Summer/Zaid Crops	
	Number of days for irrigation	**1. Kharif Crops**	
		2. Rabi Crops	
		3. Summer/Zaid Crops	
	What is the capacity of the pump?	**…….. liters/hour**	
	What is the trend of irrigation?	**1. Increased 2. Decreased**	
	What is the trend of rainfall pattern?	**1. Remains same 2. Increased 3. Decreased**	
	Has flood/drought occurred in past years?	**1. Yes 2. No**	
	If Yes, is flood/drought a frequent phenomenon	**1. Yes 2. No**	
	Are you shifting from agriculture to different occupation?	**1. Yes 2. No**	
	If Yes, Cause behind it ……...		
	Amount of fertilizers and pesticides being used	**1. Fertilizers …… kgs/ha.** **Specify……..** **2. Pesticides ……..……. kgs/ha.** **Specify……..**	
	What is the trend of fertilizer use?	**1. Remains same 2. Increased** **3. Decreased**	
	Any soil conservation practice followed	**1. Yes 2. No**	
E.	**Relationship with MWRD**		
	What kind of relationship do you share with the MWRD officials?	**1. Excellent 2. Good 3. Average** **4. Fair 5. Bad**	
	What are your complaints against MWRD officials and their functionality?		

	Is any training being provided to you by MWRD officials? Kindly brief about the same:	
	Are you informed about: **to whom/when/ and how much amount of water will be supplied and what is the mode of information:** **1. Yes 2.No**	**1. Announcement** **2. Notice** **3. SMS**
	What is the system of water allocation? Or **Priority for water allocation is decided on what factors?**	
	Has there been any fight amongst farmers due to this system? If yes, kindly brief about the incident:	
	Is there any favoritism done by MWRD officials? If yes, please specify	
	Do you pay for the water being provided by MWRD? If yes, what is your opinion regarding the water rates?	
	Are panchayats and MWRD working in co-ordination? If not, major causes of differences:	
	What initiatives do you want to be taken by the govt. to improve the functionality of the MWRD?	
F.	**Approach towards PIM**	
	What is your view regarding the PIM practice?	**1. Good 2. Neutral 3. Bad**
	Do you practice the same?	**1. Yes 2. No 3. Want to practice**

		4. Don't want to practice
	If you practice PIM and think it is good, how has it improved your access to water and crop productivity?	
	If you practice PIM and think it is bad, what is the reason behind this?	
	Which organization has helped you in forming WUA or any other committee for practicing PIM?	
	What kind of help do you require to further improve the functioning of PIM committee?	
	If you don't practice PIM but willing to do so, what type of initiatives do you want to be taken by the government?	
	If you neither practice PIM nor want to practice, please share your experience about PIM that has lead you to this conclusion.	
G	**Production related information**	
	What is the production per acre? **Kharif Crops** **Rabi Crops** **Zaid/Garma/Summer Crops**	
	Do you remember any sudden increase or decrease in agricultural production? What was the reason for the change?	

	Has any initiative by MWRD lead to improvement in production? If yes, please specify	
	According to you what is the major problem affecting the production?	
	Is there any watershed management programme in the village?	**1. Yes 2. No**
H	**Climate Change Perception**	
	Have you observed any temporal variation in the major cropping seasons?	
	If Yes, from when are you observing this and is this a regular phenomenon?	
	What is your view about the changing temperature variation during different seasons?	
	What are the problems you have faced because of this?	
	Has there been any sudden change in rainfall pattern?	
	If yes, has the amount changed or no. of rainy days changed or just the time of monsoon changed?	
	What type of losses occurred due to this?	

	Do you receive any prior information about the monsoon/monsoonal changes?
	If yes, who provides it and how?
	Has the information been accurate?
	What type of information do you need for avoiding any losses?

ANNEXURE II – SURVEY FORM FOR WUA REPRESENTATIVES

A	**General Information**			
	Date of Survey			
	Name of District	**Tehsil**	**Block**	**Village**
	Name of the representative	**Age**	**Education Qualifications**	**WUA formation date and number of farmers**
	Contact Details:			
B.	**WUA Formation Details**			
	When was your WUA formed?			
	Under what circumstances was this WUA formed?			
	Who were the facilitators and what sort of help they provided?			
	What sort of oppositions did you face and how did you tackle them?			
C.	**WUA members details**			
	How many members are participating in WUA			
	Could you brief about the socio-economic status of the members?			

	What is the average size of land holdings?			
	What is the structure of your association?			
	Who is the head/president of the WUA? Is he/she also a panchayat official?			
	What is the election process for electing president?			
	In how many years does the election take place?			
	Are the members willingly participating in elections?			
C.	**Water resources details**			
	What are the sources of water for irrigation?			
	A. Rainfall	**B. Pond**	**C. River**	**D. Canal**
	E. Bore well	**F. Lake**	**G. Dug well (public/private)**	**H. Other**
	In your village which is the major and most reliable source of Irrigation:		**1. Hand pump 2. Dug well 3. Bore well** **4. River 5. Pond 6. Canal**	
	Quality of water from these Sources		**1. Hand pump** **2. Dug well** **3. Bore well** **4. River** **5. Pond** **6. Canal**	
	If the source is rainwater, how does the WUA store the water for irrigation?			

	If the source is pond, how many ponds do you have and how much volume of water does it supply?
	If the source is river, do you have a canal system for water supply?
	If the source is groundwater, kindly provide the details about the water management practice…
	If the source is Canal water controlled by Govt. Please specify the volume and timings of water supply….
	If any other source is being used, please specify
	Kindly describe the water supply, distribution and management practices that you follow…
	Any water shortage faced during summer: Yes No
	If yes, who helps you and in what ways?
	Do you have a rainwater harvesting system | **A. Yes B. No**
	What is the level of water in dug wells/bore well around your house
	What is the trend of water level in the dug wells over past:
	A.5 Years, ……..feet above/ below | **B. 10 Years, ……feet above/ below**
	What are causes of change in water availability for irrigation | **1. Population demand 4.Decreased rainfall**

		2. Agricultural demand 5.Other specify…… **3. Industrial demand**	
	How many ahar &pynes units are there in your village?		
	Which ahar & pynes unit provides you water for irrigation?		
	What is the reliability of water supply by MWRD in these ahar & pynes?		
	Has quantity and quality of ahar water improved/ deteriorated over last 10 years	**1. Improved 2. Deteriorated**	
	What do you think is the reason behind the change?		
	What is your opinion about O&M of ahars & pynes being done by MWRD? Do you co-operate in these activities?		
	Are you facing any other problem related to water quality like presence of arsenic in groundwater?		
D.	**Agriculture**		
	Available land (consolidated)		
	Main Crops	**1. Kharif Crops**	
		2. Rabi Crops	
		3. Summer/Zaid Crops	
	Source of water for Irrigation (Main & Optional)	**1. Groundwater 2. River 3. Canal 4. Others……**	
	Duration of pump operated per day	**1. Kharif Crops**	
		2. Rabi Crops	
		3. Summer/Zaid Crops	
	Number of days for irrigation	**1. Kharif Crops**	
		2. Rabi Crops	
		3. Summer/Zaid Crops	
	What is the capacity of the pump?	**…….. liters/hour**	
	What is the trend of irrigation?	**1. Increased 2. Decreased**	

	What is the trend of rainfall pattern?	**1. Remains same 2. Increased 3. Decreased**
	Has flood/drought occurred in past years?	**1. Yes 2. No**
	If Yes, is flood/drought a frequent phenomenon	**1. Yes 2. No**
	Are you shifting from agriculture to different occupation?	**1. Yes 2. No**
	If Yes, Cause behind it ……...	
	Amount of fertilizers and pesticides being used	**1. Fertilizers …… kgs/ha.** **Specify……..** **2. Pesticides ……..……. kgs/ha.** **Specify……..**
	What is the trend of fertilizer use?	**1. Remains same 2. Increased** **3. Decreased**
	Any soil conservation practice followed	**1. Yes 2. No**
E.	**Relationship with MWRD**	
	What kind of relationship do you share with the MWRD officials?	**1. Excellent 2. Good 3. Average** **4. Fair 5. Bad**
	What are your complaints against MWRD officials and their functionality?	
	Is any training being provided to you by MWRD officials? Kindly brief about the same:	
	Are you informed about: **to whom/when/ and how much amount of water will be supplied and what is the mode of information:** **1. Yes 2.No**	**1. Announcement** **2. Notice** **3. SMS**
	What is the system of water allocation? Or **Priority for water allocation is decided on what factors?**	

	Has there been any fight amongst farmers due to this system? If yes, kindly brief about the incident:
	Is there any favoritism done by MWRD officials? If yes, please specify
	Do you pay for the water being provided by MWRD? If yes, what is your opinion regarding the water rates?
	Are panchayats and MWRD working in co-ordination? If not, major causes of differences:
	What initiatives do you want to be taken by the govt. to improve the functionality of the MWRD?
F.	**Approach towards PIM**
	What is your view regarding the PIM practice? | **1. Good 2. Neutral 3. Bad**
	How has it improved the WUAs productivity and access to water?
	What kind of help do you require to further improve the functioning of PIM committee?
G	**Production related information**

	What is the production per acre? **Kharif Crops** **Rabi Crops** **Zaid/Garma/Summer Crops**	
	Do you remember any sudden increase or decrease in agricultural production? What was the reason for the change?	
	Has any initiative by MWRD lead to improvement in production? If yes, please specify	
	According to you what is the major problem affecting the production?	
	Is there any watershed management programme in the village?	**1. Yes 2. No**

ANNEXURE III – SURVEY FORM FOR MWRD OFFICIALS

A.	**General Information**				
	Date of Survey				
	Name of District	**Tehsil**	**Block**	**Village**	
	Name of respondent	**Age**	**Department**	**Designation**	**Mobile/email id**
B.	**Human Resources Details**				
	No. of employee's in your office				
	Description/Organogram of the organization and the responsibilities				
		Planned/Required	**Allocated**		
	No. of Assistant Engineers				
	No. of Junior Engineers				
	Precisely Define Your Responsibilities				
C.	**Skills & Training**				
	What are your educational qualifications?				
	Are you getting any training from the experts? If yes, what kind of training is provided?				

	Do you think that there is a need of any particular training that is not being provided?
	Which institution is being involved/hired for providing you training?
D.	**Irrigation Details**
	What is the command area under your department?
	Number of villages in the command area.
	Volume of water controlled by your dept./ annual water budget of last 3 years
	Number of Ahar & pynes under your control:
	Source of Ahar & pynes water
	In which season water demand is maximum and how much?
	If water is supplied from a storage structure, please provide its storage capacity

	If alternate sources are used, please specify		
E.	**Agriculture**		
	Main Crops	**1. Kharif Crops**	
		2. Rabi Crops	
		3. Summer/Zaid Crops	
	Source of water for Irrigation (Main & Optional)	**1. Kharif Crops**	
		2. Rabi Crops	
		3. Summer/Zaid Crops	
	Number of days for irrigation	**1. Kharif Crops**	
		2. Rabi Crops	
		3. Summer/Zaid Crops	
	What is the trend of irrigation	**1. Increased 2. Decreased**	
	What is the trend of rainfall pattern	**1. Remains same 2. Increased 3. Decreased**	
	Has flood/drought occurred in past years?	**1. Yes 2. No**	
	If Yes, is flood/drought a frequent phenomenon	**1. Yes 2. No**	
	If Yes, Cause behind it ……..		
	What is the trend of fertilizer use?	**1. Remains same 2. Increased 3. Decreased**	
	Any soil conservation practice followed	**1. Yes 2. No**	
	Do you practice rainwater harvesting?	**1. Yes 2. No**	
	Is there any problem of Salinity?	**1. Yes 2. No**	
	If Yes, any remedial action done:		
F.	**Conveyance System Details**		
	What do you think about the Ahar and pyne system design? Is it……	**1. Good …….. 2. Neutral 3. Bad …….** **4. Major change required**	
	How many ahar & pynes are there? Please specify the number of functional units:		
	What is your view regarding maintenance of the system:	**1. Good 2. Neutral** **3. Bad**	

	Brief about the maintenance system	
	What is the frequency of maintenance?	**1. Annual 2.Half Yearly** **3. Quarterly 4. Other specify**
	What is the siltation rate of the Ahar & pynes?	
	Do you have any account of unwanted water losses? If yes, kindly brief about the same:	
	What share of revenue generated is spent on O&M?	
	From where do you get the funds for O&M?	
G.	**Relationship with Farmers**	
	What kind of relationship do you share with the farmers?	**1. Excellent 2. Good 3. Average 4. Fair 5. Bad**
	What are the general problems faced while dealing with farmers and how are these sorted out:	
	Do you provide training to farmers regarding the type and amount of irrigation to be done?	

	How do you inform farmers about: **to whom/when/ and how much amount of water will be supplied**	**Announcement** **Notice** **SMS**
	What steps do you take when there is a drought situation?	
	Any other beneficiaries/ services provided by the department:	**1. Yes 2. No**
	If Yes, What are those?	
	Is there any watershed management programme in the village?	**1. Yes 2. No**
	Are there any WUA in your area	**1. Yes 2. No**
	If yes, what is your opinion about these WUA	
	Have you provided any technical support to the WUA?	
H.	**Relationship with supporting departments**	
	Which are the departments that are assisting you directly/indirectly?	
	What kind of relationship do you share with these depts.?	**1. Excellent 2. Good 3. Average** **4. Fair 5. Bad**
	Do you have any problem working with any of these departments? If yes, what are those:	

	What kind of changes do you think is required for smooth functioning of all the departments?
I.	**Policy Changes**
	What kind of policy changes do you expect to come in future that will improve the performance of your dept.?

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Solar
ceew.in/solar

Facilitating R&D
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Energy-Trade-Climate linkages
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Resource Efficiency & Security
ceew.in/resources

Sustainability Finance
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Geoengineering Governance
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Water
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