PROCEEDINGS OF IRRIGATION SEMINAR 2025: WATER FOR AGRI FOOD SYSTEM TRANSFORMATION

Department of Water Resources and Irrigation (DWRI)

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Department of Water Resources and Irrigation

Proceedings of Irrigation Seminar 2025: Water for Agri Food System Transformation

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FOREWORD

It gives me great pleasure to present the Proceedings of Irrigation seminar 2025 titled **Water For Agri-food System Transformation**, jointly organized by the Department of Water Resources and Irrigation (DWRI), International Commission for Irrigation and Drainage (ICID), Nepal National Committee on Irrigation and Drainage (NENCID), Consortium of International Agricultural Research Centers (CGIAR), The International Water Management Institute (IWMI), and the Centre for Applied Research and Development at the Institute of Engineering (CARD/IoE). This collaborative effort brings together a broad spectrum of professionals and stakeholders committed to transforming Nepal's agri-food systems through sustainable irrigation and integrated water management.

Irrigation is more than just a means to watering crops—it is a strategic asset for achieving national food security, economic resilience, and inclusive development. In Nepal, where agriculture remains a backbone of livelihoods and a cornerstone of the economy, ensuring reliable, efficient, and timely irrigation services is fundamental. However, with the increasing challenges posed by climate change, resource scarcity, fragmented planning, and infrastructure inefficiencies, a paradigm shift is essential. We must rethink how we manage, invest in, and integrate water resources with agriculture to ensure our systems are productive, resilient, and equitable.

This seminar serves as a platform for reflection, dialogue, and action. It aimed promoting synergy between the irrigation and agriculture sectors, enabling informed policymaking, encouraging evidence-based practices, and aligning sectoral strategies with Nepal's development priorities and global commitments—particularly the Sustainable Development Goals (SDGs 1, 2, and 6). Through focused discussions on efficient water use, climate-smart agriculture, inclusive services, and enabling institutional frameworks, we hope to foster a shared understanding and commitment toward resilient and productive farming systems.

I extend my sincere appreciation to all the partners and participants whose expertise and dedication have enriched this seminar. Your insights, experiences, and recommendations are vital to shaping the future direction of irrigation and agri-food system transformation in Nepal. I am confident that the knowledge generated and shared through this forum will contribute significantly to informed planning, innovative solutions, and sustainable progress in the sector.

(Sanjeeb Baral)
Director General
31st July, 2025
Director General

Contents

ACRONYMS

BBDMP	Bheri Babai Diversion Multipurpose Project
CARD	Centre for Applied Research and Development
CGIAR	Consortium of International Agricultural Research Centers
CIAA	Commission for the Investigation of Abuse of Authority
DoA	Department of Agriculture
DWRI	Department of Water Resources and Irrigation
FANSEP	Food and Nutrition Security through Sustainable Agriculture
FMIS	Farmer Managed Irrigation Systems
GDP	Gross domestic product
IoE	Institute of Engineering
ICID	International Commission for Irrigation and Drainage
ICWMP	Integrated Crop and Water Management Program
IMEP	Irrigation Modernization Enhancement Project
IWMI	International Water Management Institute
JICA	Japan International Cooperation Agency
MIIP	Mechanized Irrigation Innovation Project
MIP	Mahakali Irrigation Project
MoEWRI	Minister for Energy, Water Resources, and Irrigation
NARC	Nepal Agricultural Research Council
NENCID	Nepal National Committee on Irrigation and Drainage (NENCID)
NGOs	Non-Governmental Organizations
NPC	National Planning Commission

PMAMP	Prime Minister Agriculture Modernization Project
PPP	Public Private Partnership
PSC	Public Service Commission
RJKIP	Rani Jamara Kulariya Irrigation Project
SDG	Sustainable Development Goals
SIP	Small Irrigation Project
TU	Tribhuvan University
WECS	Water and Energy Commission Secretariat
WUA	Water User Associations

1. Background

Irrigation serves as a foundational pillar for agriculture, food security, and economic development. In Nepal, where agriculture provides livelihoods for a substantial proportion of the population and contributes approximately 25% to the national gross domestic product (GDP), the availability of timely, reliable, and efficient irrigation is not merely supportive but imperative. Beyond its role as a production input, irrigation is transformative, reshaping agri-food systems, enhancing environmental sustainability, strengthening economic resilience, and fostering synergies across water, food, energy, land, and ecosystems.

However, emerging challenges such as climate change, escalating water scarcity, and suboptimal water use underscore the need for a paradigm shift in how irrigation and broader water resources are governed. Achieving high water productivity by improving irrigation efficiency and integrating irrigation with sustainable agricultural practices is essential to safeguard food systems and catalyze inclusive economic growth.

Given Nepal's vulnerability to climatic variability, aging irrigation infrastructure, and lack of coordination between the agriculture and irrigation sectors, the nation continues to face persistent barriers to enhancing agricultural productivity and ensuring food security. These complex challenges call for a systemic and transformative approach to irrigation and water governance, aligned with a holistic vision for agri-food systems transformation that secures long-term food sovereignty and resilient agricultural growth.

Strengthening agricultural extension systems and ensuring equitable access to affordable, high-quality agricultural inputs are vital for developing inclusive, climate-resilient farming landscapes. While irrigation expands cropping potential, its true impact is realized only when paired with improved agronomic practices, post-harvest technologies, institutional reform, supportive policy frameworks, and robust market connectivity. Strategic investments in integrated irrigation-agriculture planning will not only increase food production but also contribute to poverty reduction, improved rural livelihoods, inclusive development, and sustained national economic advancement.

This seminar was jointly organized by the Department of Water Resources and Irrigation (DWRI) in collaboration with the Nepal National Committee on Irrigation and Drainage (NENCID), The International Water Management Institute (IWMI), and the Centre for Applied Research and Development (CARD) at the Institute of Engineering (IoE).

2. Objectives

The primary objective of the seminar was to explore the critical importance of water in achieving sustainable agricultural development, ensuring food security, and promoting inclusive and equitable growth. The event convened a diverse range of stakeholders including policymakers, researchers, practitioners, development partners, and civil society actors to identify opportunities and co-develop strategies for improving irrigation access and efficiency. Emphasis was placed on creating effective linkages between irrigation and agriculture to enable transformative shifts in Nepal's agri-food systems.

Specific objectives included:

- To identify opportunities and challenges in fostering collaboration between the irrigation and agriculture sectors and to share innovative practices where water plays a significant role in agri-food transformation.
- To deliberate strategic approaches that strengthen coordination and constructive collaboration between irrigation and agricultural development, with a focus on achieving food security, inclusive economic growth, climate resilience, and sustainable rural livelihoods.

This seminar aimed at aligning interventions with Nepal's national priorities on agriculture and water, while also contributing to global commitments such as the Sustainable Development Goals (SDGs)—specifically SDG 1 (No Poverty), SDG 2 (Zero Hunger), and SDG 6 (Clean Water and Sanitation).

3. Participants

The seminar engaged a broad spectrum of participants, including:

- Government officials and policymakers from the National Planning Commission, Ministry of Energy, Water Resources and Irrigation, Department of Water Resources and Irrigation, Water and Energy Commission Secretariat, Water Resources Research and Development Centre, Ministry of Agriculture and Livestock Development, Department of Agriculture, Provincial and Local Governments, and related institutions.
- Researchers and academics from universities and think tanks, representatives from international organizations, development partners, and the private sector.
- Representatives from Water User Associations (WUAs), non-governmental organizations (NGOs), and civil society working at the intersection of irrigation, agriculture, and rural development.

4. Content of the Seminar

The main theme of the seminar was "Transforming Nepal's Agri-Food Systems through Sustainable Irrigation and Water Management." The whole program was divided into five sessions, viz:

i. The Opening Session

ii. Session 1 (Panel Discussion)

Irrigation for Food Security: Key Practices and Bottlenecks

iii. Session 2 (Group Work)

Identifying Pathways for Synergizing the Interventions of Irrigation and Other Agricultural Inputs for Food Security

iv. Session 3 (Panel Discussion)

Way Forward – Translating the Pathways (Developed in Group Work) into Action

v. Closing Session

5. The Opening Session

The opening session of the seminar was chaired by Mr. Sanjeeb Baral, Director General of the Department of Water Resources and Irrigation (DWRI). The event was graced by Hon'ble Dipak Khadka, Minister for Energy, Water Resources, and Irrigation (MoEWRI), who served as the chief guest. Distinguished special guests included Prof. Dr. Shiva Raj Adhikari, Hon'ble Vice Chairman of the National Planning Commission (NPC); Mr. Madhav Belbase, Hon'ble Member of the Public Service Commission; Mr. Suresh Acharya and Ms. Sarita Dawadi, Secretaries at MoEWRI; Dr. Govinda Prasad Sharma, Secretary at the Ministry of Agriculture and Livestock Development (MoALD); Mr. Madhu Prasad Bhetuwal, Secretary of the Water and Energy Commission Secretariat (WECS); Dr. Marco Arcieri, President of the International Commission for Irrigation and Drainage (ICID); and Dr. Mark Smith, Director General of the International Water Management Institute (IWMI).

The seminar commenced with a symbolic gesture of environmental consciousness, as Hon'ble Minister Dipak Khadka formally inaugurated the event by watering a plant. This was followed by the collective singing of the national anthem by all participants, setting a tone of unity and purpose.

Mr. Mitra Baral, Deputy Director General of DWRI, delivered the welcome address and outlined the objectives of the workshop. In his remarks, he emphasized the crucial linkages between irrigation, environmental sustainability, economic growth, and food security. Highlighting the pressing challenges posed by climate change, he stressed the importance of efficient water use in irrigation practices. Mr. Baral further noted that the seminar provided a vital platform for stakeholders to discuss strategies aimed at transforming agri-food systems. He underscored the need to prioritize climate-resilient irrigation policies and to empower farmers as central agents of change. Concluding his address, he called for the adoption of integrated water resource management practices that align with the broader goals of sustainable development.

Following the inauguration of the seminar, a series of keynote speeches were delivered by distinguished guests, beginning with Prof. **Dr. Shiva Raj Adhikari**. In his address, Dr. Adhikari provided critical insights into the national economy and underscored the pivotal role of the agricultural sector. He observed that although the post-pandemic economic recovery remains sluggish and the contribution of agriculture to GDP is declining, the sector's value addition has been increasing, demonstrating its relative stability compared to more volatile non-agricultural sectors.

Drawing from empirical data, he noted that agricultural value addition has risen by 52 percent over the past 15 years. Emphasizing the importance of maximizing public returns on irrigation investments, he advocated for controlling land fragmentation and discouraging the conversion of agricultural land for non-agricultural purposes. Dr. Adhikari concluded by reaffirming that agriculture is not only the backbone of the national economy but also foundational to other sectors. He emphasized that fostering synergy and strategic value trade-offs across all sectors is essential to achieving long-term food security. The major takeaways of his speech were that the underperformance of Nepal's agricultural sector is a national development challenge and sectoral integration is essential to transform agriculture form subsistence to enterprise and fuel inclusive growth. Finally, he stated that agriculture must work in synergy with infrastructure, industry, education and environmental management. Similarly, integrated planning and localized implementation are key to unlocking agriculture's full potential.

The second keynote speech was delivered **by Dr. Mark Smith** on the theme, *"How Can Water Systems Facilitate Agri-Food System Transformation: Experiences from Research for Development."* Dr. Mark Smith's presentation explores how water systems can drive the transformation of agri-food systems, particularly under the pressures of climate change, water insecurity, and socio-economic vulnerabilities. Dr. Smith opened his remarks by emphasizing the need to move beyond outdated assumptions and adopt a paradigm shift in response to escalating climate change scenarios. Citing his 2024 research, he highlighted that the global hydrological cycle is increasingly destabilized, posing a significant threat to an equitable and sustainable future. About food and water scarcity in Nepal, Dr. Smith stated that food systems in Nepal are stressed by urbanization, outmigration, and poor market access, Nepal's agricultural dependency on foreign markets increased 5-fold (2009–2018) and climate projections show rising temperatures (1.5–4.6°C by 2100) and erratic precipitation.

In addressing interconnected global challenges, he referred to as five "wicked problems": hunger, poverty, ecosystem degradation, climate change beyond 2°C, and deep uncertainty. He underscored the urgent necessity of addressing negative externalities arising from water misuse and pollution, framing these as critical challenges for contemporary water management. Symbolically referring to water as the "teeth and claws" of climate change, Dr. Smith emphasized the intensifying impact of climate-induced disruptions on water systems. He pointed out that the consequences are disproportionately borne by vulnerable populations, particularly farming communities, women, and marginalized groups. Strengthening the capacity and resilience of these groups, he argued, is essential for mitigating the broader impacts of climate change on the agricultural sector and ensuring a more inclusive and adaptive agri-food system transformation.

The final keynote speaker of the session was **Dr. Marco Arcieri**, who presented on the topic *"How the Challenges of Coherent Interventions in the Agriculture and Irrigation Sectors Can Be Translated into Opportunities: Learnings from Various Regions Across the Globe."* Dr. Arcieri opened by framing global agriculture within a moment of profound uncertainty. He highlighted the pressing challenge of feeding a growing global population expected to reach nearly 10 billion by 2050 while grappling with 20% less arable land per capita. Agriculture must produce 50% more food by 2030 and double output by 2050. Dr. Arcieri addressed the increasing need for higher agricultural productivity per hectare, driven by rapid urbanization, changing dietary patterns, and the compounding effects of climate change and water scarcity.

He emphasized that these challenges could be transformed into opportunities through strategic interventions. Key among his recommendations were improving irrigation efficiency through the correct timing and application of water and promoting innovation in water conveyance systems such as the incorporation of canal lining, pipelines and aqueduct restoration, photo-voltaic powered gates and sluices, automated delivery systems such as "Irri frame", electronic card-based remote water distribution and remote monitoring and emergency alerts. According to Dr. Arcieri, the adoption of such technologies has demonstrated up to 30% water savings and significantly enhanced irrigation efficiency in practice. The major takeaways of Dr Arcieri's speech are that the integration of modern irrigation technologies, efficiency practices, and alternative water sources is crucial, solutions must be context-specific, climate-resilient, and supported by institutional innovation, and global examples prove that even under crisis, innovation and informed interventions can turn challenges into opportunities.

After the Keynote speeches, there were remarks from the distinguished guests in the seminar. A five-minute time frame was provided for each speaker in this time slot. First to present his remarks was **Dr. Govinda Prasad Sharma**. Dr. Sharma opened his remarks by highlighting the fact that the Department of Agriculture and the Department of Water Resources and Irrigation have a long history of collaboration and the development of agriculture is impossible without this collaboration. He also gave emphasis to working hard to make water accessible year-round in agricultural lands with irrigation facilities. He focused that the government agencies who are directly responsible for upgrading agricultural sector in Nepal should work together for increased productivity. For this, the short-term and long-term studies should be carried out to address the issues such as defunct tube wells in the terai regions, water recharge issues, and so on. He also stated that we have not thought about the post-harvest water need which should be addressed in the future planning process.

The second set of remarks was delivered by Hon'ble Minister **Dipak Khadka**. He underscored the importance of the multipurpose use of water, emphasizing that water must be managed and utilized efficiently. Considering the increasing impacts of climate change in recent years, irrigation has become more critical than ever. Minister Khadka highlighted that irrigation extends beyond the construction of canals and infrastructure, it also involves empowering farmers to use water effectively and to enhance their agricultural livelihoods. He stressed the necessity of collaborative efforts among all stakeholders and reaffirmed the Ministry's strong commitment to working in close partnership with farmers and relevant actors to achieve sustainable outcomes. Concluding on a hopeful note, he stated, "Let's use water not just to grow crops, but also to grow health, hope, and hospitality."

The third remarks were provided by Secretary **Ms. Sarita Dawadi**, who began by asserting that irrigation is not an isolated sector but one that is essential for resilience and livelihoods. She noted that the regional and seasonal variability of water resources necessitates the advancement of technologies, institutional reforms, and robust stakeholder commitment. For the sustainable development of the irrigation sector, she emphasized the need to place farmers at the center of policy and implementation efforts, with particular attention to enhancing the capacities of women and marginalized communities. Secretary Dawadi also highlighted the importance of multi-stakeholder engagement, involving government bodies, inter-agency coordination, private sector participation, and international development partners. She concluded by emphasizing that the development of irrigation must address not only technical aspects but also social and institutional dimensions to ensure long-term sustainability.

The fourth remarks were provided by Hon'ble **Madhav Belbase**, who began by asserting that the vital nexus between water and food, a relationship deeply rooted in human history but increasingly urgent in the context of climate change. He emphasized that, despite its importance, water is often overlooked in climate change discussions and called for this gap to be addressed both globally and in Nepal. To institutionalize this approach, he proposed transforming Nepal's Water and Energy Commission into a Water and Climate Change Commission, reflecting the need for integrated solutions.

He highlighted the importance of fully implementing basin-level plans and adopting a new approach to irrigation one that blends traditional knowledge with modern technologies such as drones, AI-based design, pre-cast canals, rubber lining, and laser-guided systems. He also suggested multi-functional infrastructure, such as installing solar panels over canals and integrating fisheries. Belbase advocated for treating irrigation systems as industries, promoting commercialization and cooperative models that connect farmers directly to consumers, avoiding intermediaries. Finally, he raised concerns about groundwater depletion along Nepal's borders due to overextraction and proposed a joint study with IWMI to address transboundary water issues, especially groundwater.

The last remarks were delivered by **Mr. Sanjeeb Baral** who asserted that agriculture remains the backbone of Nepal's economy and livelihoods. Considering increasing water demand and climate-related pressures, he underscored the urgent need for a strategic shift in resource planning and allocation to ensure sustainable agricultural growth. He emphasized that water security is central to achieving the nation's long-term development vision, particularly in relation to food security, economic resilience, and rural transformation. To realize this vision, the speaker called for substantial investments in irrigation infrastructure to bring all irrigable land under reliable water supply. Referencing national frameworks such as the Irrigation Master Plan and the newly endorsed National Irrigation Policy 2080, the Mr. Baral highlighted their role in guiding efforts toward equitable access to irrigation, enhanced water storage, and integrated water resource management.

A key priority, he noted, is the modernization of Farmer Managed Irrigation

Systems (FMIS), which are essential for improving service delivery, water use efficiency, and climate resilience. The adoption of canal lining, automated gates, and other efficiency-enhancing technologies was cited as critical for reducing water losses. However, the speaker cautioned that technological and physical improvement alone are insufficient. He called for strengthened collaboration across institutions and sectors, emphasizing the need for integrated planning, joint management and monitoring mechanisms, and the empowerment of Water Users Associations (WUAs) as key actors in governance and local ownership. In closing, Mr. Baral recognized the seminar as a valuable platform for dialogue, knowledge exchange, and cross-learning, encouraging stakeholders to leverage such forums to accelerate progress toward a more inclusive, efficient, and climate-resilient irrigation sector.

6. Session 1 – Panel Discussion

"Irrigation for Food Security: Key Practices and Bottlenecks" was the theme of panel discussion in session 1. Mr. Nabin Chandra Adhikari, Project Director of Kaligandaki Tinau Diversion Multipurpose Project facilitated the discussion. First of all, the primer presentation was carried out by Mr. Tika Ram Baral, Joint Secretary, WECS. The topic of his presentation was "*Synchronizing Efforts of the Irrigation and Agriculture Sectors for Improved Agriculture Productivity*."

Mr. Tikaram Baral highlighted the importance of transforming successful collaborative initiatives between the irrigation and agriculture sectors into structured program modes to ensure better integration and long-term sustainability. He emphasized the need to revise the Integrated Crop and Water Management Program (ICWMP), underscoring its critical role in facilitating high-level coordination and joint implementation at the grassroots level. Mr. Baral also addressed ongoing policy dilemmas, particularly the difficulty in balancing target-based objectives with crop- and area-specific interventions, which can impede effective policy execution. He discussed the constitutional arrangements that define the roles of federal, provincial, and local governments in managing irrigation and agriculture, including responsibilities related to land use planning and natural resource conservation. In outlining the core objectives of project development, he emphasized investment in irrigation scheme modernization, agricultural production support, and the strengthening of water user associations. To illustrate the benefits of coordinated action, Mr. Baral referenced case studies such as TCP-PIAT, which demonstrate the value of synchronized efforts between the irrigation and agriculture sectors in achieving improved and sustainable outcomes.

The panelist of the discussion included Dr. Bimala Rai Paudyal, honorable member National Assembly, Federal Parliament of Nepal and Former Minister of Foreign Affairs, Mr. Susheel Acharya, Joint Secretary, MoEWRI, Mr. Prakash Sanjel, Director General, DOA, and Dr. K Yella Reddy, Former Vice President, ICID.

Dr. Bimala Rai Paudyal highlighted persistent structural challenges that hinder the effectiveness of investments in agriculture and irrigation. These include geographical constraints that limit the feasibility of large-scale projects, fragmented planning across sectors, and donor support that often fails to align with national priorities. She emphasized that smallholder farmers, particularly women and marginalized communities, continue to face significant obstacles in attaining food and nutrition security. To bridge these gaps, Dr. Paudyal advocated for a coherent policy and institutional framework that integrates agriculture and irrigation, promotes stronger public-private partnerships, and empowers local governments with greater authority and capacity. She underscored the importance of adopting a farmer-centric and context-sensitive approach, incorporating low-cost technologies, evidence-based planning, and a cultural shift toward collaboration and long-term thinking, all underpinned by robust research and development initiatives.

Mr. Prakash Sanjel, Director General of the Department of Agriculture (DoA), underscored that food security is a collective responsibility that relies on the coordinated application of multiple agricultural inputs, with reliable irrigation being a critical component. He acknowledged that inter-agency collaboration, particularly with the Department of Water Resources and Irrigation (DWRI), has shown significant improvement in recent years, as evidenced by joint recent initiatives such as the Rani Jamara Kulariya Irrigation Project, MIIP and IMEP. Mr. Sanjel stressed the importance of expanding spring paddy cultivation and addressing the approximately 20% cultivable land that remains fallow due to inadequate irrigation services. To enhance agricultural productivity, he advocated for the prioritization of efficient on-farm water management, and increasing the irrigation use efficiency, the integration of agricultural services at the local level through a single-window delivery mechanism, and the development of secondary and tertiary canal networks to ensure timely and equitable water distribution. Lastly Mr. Sanjel emphasized the importance of developing permanent infrastructure in command areas exceeding 10,000 hectares, proposing the implementation of targeted programs in these regions. This initiative is viewed as a promising step toward advancing agricultural development.

Mr. Susheel Acharya underscored that although the Ministry of Agriculture and the Ministry of Energy, Water Resources, and Irrigation (MoEWRI) share aligned objectives, their initiatives often operate in silos, diminishing overall effectiveness. He pointed out that reliable and timely water delivery is fundamental to successful agricultural interventions. However, only 1.5 million hectares of Nepal's 2.5 million hectares of irrigable land currently have access to irrigation services. He further identified key challenges such as seasonal water variability, inefficient service fee collection, institutional fragmentation, and inadequate agricultural extension services. To overcome these barriers, Mr. Acharya advocated safeguarding agricultural land from non-agricultural use, ensuring accountability within the irrigation department for consistent water delivery, and establishing formal coordination platforms such as integrated Agricultural Service Centres to connect irrigation systems with comprehensive agricultural support at the local level.

Dr. K. Yella Reddy, Former Vice President of the International Commission on Irrigation and Drainage (ICID), shared global perspectives drawn from ICID's extensive work, highlighting the critical role of integrated irrigation and agricultural strategies in achieving food security. Citing India's successful transition from famine to food self-sufficiency, he underscored the need to properly value water resources, implement people-centric development models, and scale up proven innovations such as micro-irrigation technologies. He inserted that Nepal has very pleasant climate, and a huge source of water and thus the country has great potential of agriculture and export the produce to other countries as well. Based on international experiences, Dr. Reddy advocated for incentivizing water use efficiency, establishing agricultural infrastructure funds, engaging youth through educational reforms, and strengthening the role of women in water governance and management.

7. Session 2: Group Work

Session 2 of the seminar had group work on the topic of "*Identifying pathways for synergizing the interventions of irrigation and other agricultural inputs for food security*." The session was facilitated by Dr. Santosh Nepal, Researcher of Water Resources and Climate Change, IWMI. Participants voluntarily divided themselves into groups aligned with the four key segments: Policy, Institution, Research and Practice. To guide the discussions, a set of focused questions was provided.

Group 1: Policy Coherence

The objective of this group was to identify opportunities for harmonizing irrigation, agriculture and climate policies for strengthening agri-food systems. The key questions for discussion were: i) Where do current policies conflict or overlap?, ii) What policy incentives could more effectively integrate irrigation, seed, fertilizer, and market access?, iii) Are there any good practices and examples of integrated policies between irrigation and agriculture that have reformed the agricultural sector?, iv) How can financial resources be leveraged to enhance agricultural productivity and food security and how can policy support and enable this process?

The group acknowledged that, although some coordination practices are in place, significant institutional barriers remain, primarily due to inadequate documentation and the lack of formalized coordination mechanisms. To address these challenges, they proposed the establishment of a quasi-institutional framework that would integrate Water Users' Associations (WUAs), agricultural cooperatives, and farmers' groups into a unified structure aimed at streamlining service delivery. Strengthening local institutions was deemed essential, with particular emphasis on enhancing market access, improving post-harvest management, and developing long-term storage infrastructure. At all levels of governance, the group advocated for targeted capacity-building initiatives linked to collaborative performance indicators. Additionally, they recommended reviving the practice of joint draft plan preparation, bringing together irrigation, agriculture, and financial institutions, prior to the finalization of sectoral plans, in order to ensure alignment and synergy across sectors.

Group 2: Institutional Strengthening

The objective of group was to explore institutional roles, coordination mechanisms, and capacity-building needs to strengthen agri-food system. The key questions for discussion were: i) What are the major institutional barriers to coordinated irrigation-agriculture sector?, ii) How can local institutions (eg. WUAs, agri cooperatives) be empowered? And iii) What capacities are most urgently needed at the federal, provincial and local levels to improve agricultural productivity and strengthen the agri-food system?

The group observed that irrigation, agriculture, and climate-related policies in Nepal frequently function in silos, characterized by overlapping institutional mandates, inconsistent data systems, and fragmented service delivery mechanisms. A significant gap in coordination was noted between key actors such as agricultural cooperatives and Water Users' Associations (WUAs), compounded by the absence of a unified monitoring and service delivery framework. To enhance policy integration and operational coherence, the group recommended the consolidation of farmers' groups and WUAs, the digitalization of agricultural and water management services, and comprehensive reforms in subsidy mechanisms. Successful initiatives—such as the Rani Jamara Kulariya Irrigation Project, the Irrigation and Water Resources Management Project, and the Climate Smart Villages program—were cited as exemplary models of coordinated policy implementation. For improved resource mobilization, the group proposed strategies including co-financing arrangements with the private sector, the promotion of public-private partnerships (PPPs), and the formalization of contractual agreements among cooperatives, farmers, and investors to strengthen accountability and attract long-term, sustainable investment.

Group 3: Role of research and Innovation

The objective of this group was to define the contribution of research to evidence-based solutions and technological advancements to transform agri-food systems. The key questions of the discussion were but not limited to i) What research gaps exist in understanding irrigation-agriculture linkages?, ii) How can innovations (digital tools, soil moisture sensors, forecasting) improve food security to transform agri-food systems?, iii) What models can support collaborative research between academia, government and communities?

The group identified several critical research gaps, including the weak linkage between irrigation and agricultural practices, limited climate-adaptive research, and inadequate integration of demand-supply trends in planning and implementation. To address these issues and foster technology adoption, they underscored the importance of conducting in-field demonstrations to build trust among farmers. In the pursuit of enhanced food security, the group recommended the adoption of innovative technologies such as soil moisture sensors, forecasting tools, and digital decision-support systems, including SCADA and now-casting tools to enable evidence-based decision-making. They advocated for the development of collaborative research models, including citizen science initiatives, autonomous research institutions, and improved information systems, to strengthen the interface among academic institutions, government agencies, and local communities. The Department of Water Resources and Irrigation (DWRI)'s initiative to fund student research was highlighted as a commendable example of fostering applied research in the sector.

Group 4: Strengthening Practices

The objective of group was to identify on-ground strategies that integrate irrigation with other agri-inputs for productivity and resilience. The key questions for discussion were: i) What practices (irrigation methods, cropping patterns, on-farm management, etc) have proven most effective in increasing productivity and water efficiency?, ii) How can climate-smart and inclusive practices be mainstreamed? And iii) What are the gaps in scaling successful models to transform agri-food system?

The group identified several effective field-level strategies that contribute to improved agricultural and irrigation outcomes, including micro and solar irrigation systems, lined canals, piped water distribution, watershed conservation, and soil health enhancement. They stressed the importance of integrating post-harvest management with market linkages and advocated for the promotion of women-friendly technologies, such as solar-powered grids and custom hiring centers. To mainstream climate-smart agricultural practices, the group recommended interventions such as optimized irrigation scheduling, regular field-level data updates, conservation-oriented farming, and increased mechanization. However, they also recognized significant challenges in scaling these successful models. Key barriers include weak policy enforcement, inadequate infrastructure and data systems, limited engagement of youth, and poor dissemination of proven practices such as those implemented under the Prime Minister Agriculture Modernization Project (PMAMP).

8. Session 3: Panel Discussion

"*Way Forward – Translating the Pathways (Developed in Group Work) into Action*" was the topic of the second panel discussion in the third session of the seminar. Prof. Dr. Vishnu Prasad Pandey, Director, CARD, IoE/TU facilitated the discussion. The panelists included Mr. Sanjeeb Baral, Director General, DWRI, Dr. Sabnam Shivakoti, Joint Secretary, MoALD, Dr. Ganesh Raj Joshi, Agri Economist and former Secretary, former Commissioner, CIAA, and Dr. Bhes Raj Thapa, Water Resources Expert, Associate Professor and Principal at Universal Engineering and Science College.

Mr. Sanjeeb Baral underscored the significance of intersectoral collaboration by referencing successful models such as the Rani Jamara Kulariya Irrigation Project (RJKIP), which has led to notable improvements in both cropping intensity and water-use efficiency. He outlined DWRI's current efforts to replicate this integrated approach in other major initiatives, including the Mahakali Irrigation Project (MIP), the Bheri Babai Diversion Multipurpose Project (BBDMP), and the third phase of RJKIP. However, Mr. Baral stressed that achieving systemic impact requires moving beyond isolated project-level achievements toward programmatic transformation that encompasses both government-led and donor-supported initiatives. He further argued that effective collaboration must not be limited to irrigation and agriculture alone but must also encompass complementary sectors such as land management, labor, and market systems to foster broader economic resilience and improve rural livelihoods. He emphasized the importance of documenting existing best practices in intersectoral collaboration as a critical step toward developing a comprehensive national roadmap for the transformation of Nepal's agri-food system.

Dr. Sabnam Shivakoti acknowledged the institutional challenges that prevent full structural integration between sectors such as agriculture and irrigation. However, she advocated for the establishment of quasi-institutional arrangements and collaborative operational models, particularly at the local level, as pragmatic solutions to enhance coordination. Dr. Shivakoti pointed to successful initiatives such as Gandaki Province's land consolidation program and integrated planning under projects like the Irrigation and Water Resources Management Project (IWRMP) and RJKIP, which have demonstrated measurable impact through joint implementation. She emphasized the necessity of conducting collaborative research and assessments, particularly in on-farm water management and water-use efficiency, to optimize the utility of existing infrastructure and policies. Additionally, she highlighted the need to formally recognize the shared contributions of both the agriculture and irrigation sectors in increasing crop yields and cropping intensity, thereby promoting mutual accountability and coordinated planning.

Dr. Ganesh Raj Joshi emphasized the pivotal role of irrigation in enhancing agricultural productivity and contributing to national economic growth. Citing empirical evidence, he noted that a 1% increase in year-round irrigated area can lead to a 3.9% rise in agricultural total factor productivity, with significant gains observed in staple crops such as rice and wheat. Given that Nepal has limited remaining potential for expanding arable land, Dr. Joshi called for a strategic shift from horizontal land expansion to the vertical transformation of agricultural production systems. This includes the integration of irrigation and agriculture, promotion of agro-industrial development, and value chain enhancement. He stressed the urgency of harmonizing agriculture, irrigation, and climate-related policies while improving institutional coordination through strengthened roles for Water Users' Associations (WUAs) and cooperatives. Moreover, he recommended active stakeholder engagement in planning, implementation, and monitoring processes. Dr. Joshi also highlighted the importance of collaborative research, particularly among DWRI, the Department of Agriculture (DoA), and the Nepal Agricultural Research Council (NARC), to assess water-use efficiency and technology suitability for evidence-based policy formulation.

Dr. Besh Raj Thapa argued for a shift from fragmented, sector-specific development toward an integrated approach that aligns irrigation, agriculture, and related services under a unified framework. While acknowledging the contributions of development partners such as JICA, SIPS, KISAN, and FANSEP in attempting to bridge the gap between infrastructure development and extension services, he noted that many initiatives still operate in isolation, undermining systemic impact. Dr. Thapa emphasized the necessity of synchronizing hardware components (e.g., irrigation infrastructure) with software elements (e.g., institutional capacity building and farmer training) to achieve sustainable and holistic outcomes. To institutionalize integration, he recommended documenting and synthesizing collaborative experiences into a national-level roadmap for irrigated agriculture. As strategic next steps, he proposed the establishment of a dedicated Department of Irrigated Agriculture and the prioritization of on-farm water management to enhance water productivity and extend the irrigated command area across the country.

Closing Session

The closing session was addressed by **Dr. Santosh Kaini**, Deputy Director General, DWRI. His reflection on the seminar was that irrigation plays a crucial role in providing reliable irrigation facility to irrigable land and enhance production and productivity of irrigable land and contribute significantly to achieving the National Goal of Food Security and support in advancing the commercialization of agriculture in the country. In addition to the various challenges we face, the impact of climate change and climatic variability has further complicated the pursuit of sustainable irrigation development. Reliability and adequacy of water is a challenge. In this context, it is essential to refine our processes and embrace new technologies to ensure efficient and effective execution of our initiatives. In that background, Irrigation seminar 2025 titled water for Agri-food System Transformation holds a great significance in today's country context. We had very esteemed keynote speakers and guests in the inaugural session. Many dimensions of Agriculture and Irrigation development were highlighted in the session

He reflected on the key takeaways from the seminar which are listed as follows:

1. Though Agricultural sector contribution is declining in GDP, value addition is increasing over the years. In such, Irrigation and Agricultural are not a stand-alone sector but each complement to the other.
2. Cross sectoral coordination is the major challenge. Coordination and cooperation from field level to policy level is imperative to address current issues. Coordination in field level for need assessment in project formulation and subsequent planning and budgeting and implementation of the program is imperative.
3. Mega irrigation (Inter-basin transfer, storage projects) is essential for increased access of irrigation facility to ensure year-round irrigation, contributing to increased agricultural productivity and climate resilience.
4. On farm water management another aspect which is often overlooked. Because of that, efficiency of irrigation system as well as crop production from command area is decreasing.

5. Cutting edge Research and Development are essentials for enhancing efficiency and development of technologies.
6. Intensive collaboration with multisector (Gov, Non-Gov, research academia) for technologies advancement and innovation is needed.
7. Private and public sector investment is crucial for the cost recovery of agricultural and irrigation system development.
8. A paradigm shift (such as PPPs) is needed from business-as-usual to demand-driven, profitable and commercially viable agriculture through strategic project prioritization, experience sharing, and timely execution.

The closing remarks were presented by **Mr. Madhu Prasad Bhetuwal,** former Secretary of the Water and Energy Commission Secretariat. Mr. Bhetuwal highlighted Nepal's growing vulnerability to climate change and underscored the urgent need for sustainable management of water and energy resources. He emphasized that Nepal's heavy dependence on climate-sensitive sectors, particularly hydropower and agriculture, necessitates a transformative approach to irrigation and water governance. While recognizing irrigation as a critical component for agricultural development, he stressed that it alone is insufficient. Sustainable agricultural transformation, he argued, must be underpinned by complementary factors such as improved agronomic practices, efficient post-harvest systems, access to quality inputs, enabling institutional frameworks, and robust market linkages.

Mr. Bhetuwal expressed optimism that the seminar had served as a vibrant platform for fostering collaborative action among experts, policymakers, and practitioners. He reiterated that building a climate-resilient and productive agri-food system in Nepal requires a holistic foundation, one that integrates sustainable irrigation practices, promotes social inclusion, aligns sectoral policies, and ensures balanced inputs. These elements, he concluded, are essential to achieving long-term resilience, productivity, and equity in the face of an increasingly uncertain climate future.

■■

Annex 1:

Agenda for the seminar

Time	Agenda
7:30 – 8:30	Breakfast and refreshments
8:30 – 9:00	Registration
Opening Session	
9:00 – 10:45	• **Session Chair:** Mr. Sanjeeb Baral, Director General, DWRI • **Chief Guest:** Hon'ble Dipak Khadka, Minister, MoEWRI • **Special Guests:** o Prof. Dr. Shiva Raj Adhikari, Hon'ble Vice Chairman, National Planning Commission o Mr. Madhav Belbase, Hon'ble Member, PSC o Mr. Suresh Acharya, Secretary, MoEWRI o Ms. Sarita Dawadi, Secretary, MoEWRI o Dr. Govinda Prasad Sharma, Secretary, MoALD o Mr. Madhu Prasad Bhetuwal, Secretary, WECS o Dr. Marco Arcieri, President, ICID o Dr. Mark Smith, Director General, IWMI
	National Anthem
	Welcome remarks and workshop objective: Mr. Mitra Baral, DDG, DWRI
	Inauguration by the Honorable Minister
	Keynotes [15 minutes each]:
	• How can water systems facilitate agri-food system transformation: experiences from research for development [**Dr. Mark Smith**, Director General, IWMI]
	• How the challenges of coherent interventions of agriculture and irrigation sectors can be translated into opportunities (Learnings from various regions across the globe) [**Dr. Marco Arcieri**, President, ICID]
	• Lost opportunities in economic growth with agricultural sector performance: Areas of consideration for sectoral integration [**Prof Dr. Shiva Raj Adhikari**, Honorable Vice Chairman, NPC, Government of Nepal]
	Remarks
	• Dr. Govinda Prasad Sharma, Secretary, MoALD [5 min]
	• Ms. Sarita Dawadi, Secretary, MoEWRI [5 min]
	• Mr. Madhav Belbase, Hon'ble Member, PSC [5 min]
	• Hon'ble Kham Bahadur Garbuja, State Minister, MoEWRI [5 min]
	• Hon'ble Dipak Khadka, Minister, MoEWRI [10 min]
	• Session Chair, Mr. Sanjeeb Baral, Director General, DWRI [5 min]

10:45 – 11:15	**Introduction of poster sessions** **Group Photo and Tea Break**
Session 1 [Panel Discussion]: **Irrigation for Food Security: Key Practices and Bottlenecks** [Facilitator: Mr. Nabin Chandra Adhikari]	
11:15 – 11:30	**Primer presentation:** Synchronizing efforts of the irrigation and agriculture sectors for improved agriculture productivity [**Mr. Tika Ram Baral, Joint Secretary, WECS**]
11:30 – 11:45	**Questions and answers**
11:45 – 12:45	**Panel discussion:** **Irrigation for Food Security: Key Practices and Bottlenecks** **Panelist:** 1. **Dr. Bimala Paudyal Rai**, Former Minister of Foreign Affairs 2. **Mr. Susheel Acharya**, Joint Secretary, MoEWRI 3. **Mr. Prakash Sanjel**, Director General, DOA 1. **Dr. K Yella Reddy**, Former Vice President, ICID
12:45 – 13:45	**Lunch Break**
Session 2 [Group Work]: **Identifying pathways for synergizing the interventions of irrigation and other agricultural inputs for food security** [Facilitator: Dr Santosh Nepal, IWMI]	
13:45-15:15	**Group discussions** *Guiding questions will be provided*
15:15 -15:30	**Tea Break**
Session 3 [Panel Discussion]: **Way Forward – Translating the Pathways (Developed in Group Work) into Action** [Facilitator: Prof Dr Vishnu Prasad Pandey]	
15:30 – 17:00	**Panel discussion on** Translating the Pathways (Developed in Group Work) into Action **Panelists:** 1. **Mr. Sanjeeb Baral,** Director General, DWRI 2. **Dr. Sabnam Shivakoti**, Joint Secretary, MoALD 3. **Dr. Ganesh Raj Joshi** (Agri Economist) [Former Secretary, CIAA commissioner]
Closing Session	
17:00 – 17:20	Reflections and Key Takeaways: **Dr. Santosh Kaini,** Deputy Director General, Department of Water Resources and Irrigation
17:20 – 17:30	Closing Remarks: **Mr. Madhu Prasad Bhetuwal,** Secretary, Water and Energy Commission Secretariat, Nepal
18:00 Onwards	**Networking Dinner**

Annex 2:

List of Poster Presentation

Mobilizing the Microbes: A Sustainable Approach to Water Management and Agri-food System Transformation

ID-01

Suman Sijapati[1,*]
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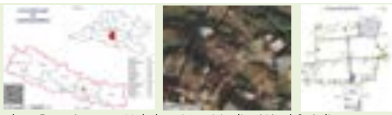
**Corresponding Author's Email: sumansij315@gmail.com*

1 Context and Objectives

Location:



- *Sijapati Permaculture Farm, Lamatar, Mahalaxmi Municipality, Ward-9, Lalitpur.*

Context and Rationale:

- *After 2015 earthquake - cheap land: sloping 23%, north-facing, undulated degraded soil, difficult access, no water source – demonstrate change.*

Objectives:

- *To grow organic food for fresh family consumption.*
- *To maintain a healthy environment, biodiversity, water and air purifying, etc.*
- *To make the place look aesthetically pleasing and mentally relaxing.*
- *To ensure sustainable use of available natural resources (soil building, rainwater harvesting, use of renewable energy, etc.)*

Duration:

- *Ten (10) years of persistent hard work and on-going*

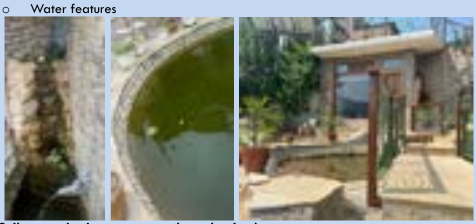
Financing Mechanism:

- *Personal*

3 Outcomes/Results

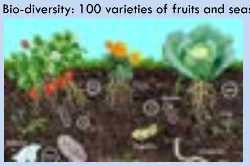
- **Farm layout – "open-book":**
  - Maximum visibility
  - Optimum utility of available land resources
  - Optimum capture of the solar radiation
  - Optimum use of available water resources

- **Terrace and plot layout:**
- **Establishment of basic infrastructure:**
  - Structured terraces and plots
  - Water features



- **Soil properties improvements through microbes:**

  - Texture and organic composition transformation
- **Water management improvements:**
  - 3 S: slow down, seep and store
- **Vegetative expansion:**
  - Bio-diversity: 100 varieties of fruits and seasonal vegetables



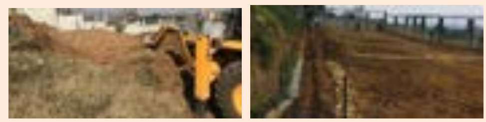
- **Synergy of various farming activities:**
  - Integration between different farming activities
  - Resource recycle – zero waste principle
- **Continuous adaptation and refinement as per permaculture principles.**

Acknowledgements:
Thanks to all who supported in the endeavor

2 Methodology

1. **Conduct survey and mapping:**
   - Survey – total station
   - Construction of boundary wall

2. **Design the layout:**
3. **Carry out land levelling:**



4. **Construct the basic infrastructure:**
   - Parking lot
   - Observation room
   - Water features
   - Greenhouse
   - Chicken coop
   - Footpath
   - Manure pits
   - Storage shade

5. **Improve the water management:**
   - Rainwater harvesting, mulching, irrigation through gravity (during deficit)
   - Sub-surface drainage, weephole with geotextile material, excess water goes to pond and gets recycled (during period of excess water).

6. **Enhance the soil properties:**
   - Composting – recycling of farm wastes
   - Soil texture improvement by adding silty soil "*pago mato*"
   - Mulching – use of fallen leaves for ground cover
   - Grow cover crops
   - Add aged animal manure
7. **Expand the vegetative coverage as per the farm plan:**
   - Fruits in surrounding fruit circle
   - Vegetables in raised bed

8. **Integrate crop cultivation with other farm activities:**
   - Chicken raising
   - Fisheries
   - Apiculture (bee keeping)
   - Rabbit keeping
9. **Continuous observation, monitoring and evaluation of the farm**

4 Key Message

- It is possible to conserve every drop of water that falls on the land and even those that passes by it
- Both soil and water can host millions of living creatures that can result in healthy terrestrial and aquatic ecosystem beneficial to all
- 3S (slow down, seep and store) principle helps in optimizing the use of available water
- Water can be used multiply and put to multiple use
- Water quality can be tested by the living things it supports
- Excess water can be duly expelled through proper design

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May 2025 [Thursday], Kathmandu, Nepal

Irrigation Modernization Enhancement Project: A case study of five irrigation projects in Nepal

ID-02

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1 Project Feature and Financing

Location & Purpose:
Implemented in **five provinces of Nepal** (Bagamati, Gandaki, Koshi, Lumbini, Madhesh), the IMEP aims to improve **farm productivity, climate resilience, and profitability** in **Farmer-Managed Irrigation Systems (FMIS).** It targets around **56,000 households,** aligning with national strategies to enhance **food security, water use efficiency,** and **climate adaptation.**

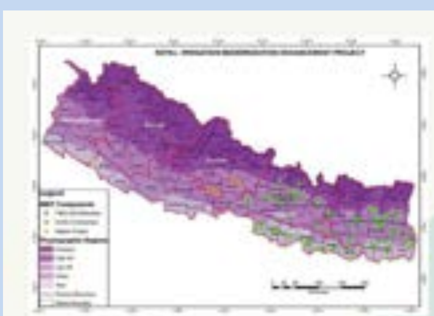
Project Duration: 72-month duration

Financing:

- **ADB Loan:** $85 million (63.6%)
- **Saudi Fund for Development:** $30 million (22.45%)
- **Government of Nepal:** $16.14 million (12.08%)
- **Beneficiaries (WUAs/WUCs):** $2.5 million (2%)
  Disbursement is coordinated via the **Central Project Management Office (CPMO)** at DWRI/MOEWRI.

3 Outcomes

- Modernization of 32,000 hectares of surface water irrigation systems
- Piloting hill lift irrigation to irrigate 1,354 hectares of dry uplands
- Capacity building for farmers and government institutions in ICWM
- Promoting mechanization and commercialization to improve productivity and profitability
- Enabling farmers to become self-sufficient in operation and maintenance of irrigation systems



Output 1: Irrigation infrastructure upgraded — 100 FMISs and the Rajapur Irrigation Project (totaling ~32,000 ha) were modernized, including intake structures, riverbank protection, canals, and 12 pilot hill lift systems.
Output 2: Institutional and farmer capacity strengthened — ICWM training provided to farmers, agencies, and local bodies; WUAs and WUCs established for irrigation and agribusiness; inclusive training with a focus on women and disadvantaged groups; national ICWM roadmap developed.
Output 3: Modern agriculture and value chains promoted — Introduced climate-smart farming, mechanization, and digital services; improved value chain infrastructure; supported WUAs/WUCs with equipment and financing for machinery and facilities.

Acknowledgements:

Thanks to all who supported in bringing the project

2 Project Implementation

- Federal Project Implementation Units (PIUs): Rajapur Irrigation Management Office (RIMO), Rajapur Agriculture Management Office (RAMO), and the Hill Lift Irrigation Project (HLIP) offices in Gorkha and Butwal.
- Provincial Project Implementation Units (PIUs): Respective Water Resources Irrigation Development Divisions (WRIDDs) and Agriculture Knowledge Centers (AKCs)

4 Key Message

The **Irrigation Modernization Enhancement Project (IMEP)** in Nepal aims to improve **farm productivity and sustainability** by modernizing irrigation systems, building institutional capacity, and promoting climate-smart agriculture. It operates through a **structured management framework** involving federal and provincial entities, supported by farmer organizations like WUAs and WUCs.

The project adheres to **ADB procurement policies** and includes robust monitoring, reporting, and grievance mechanisms to ensure effective implementation and accountability. With a focus on strengthening resilience and reducing rural poverty, IMEP is a strategic initiative aligned with Nepal's agricultural and climate goals.

Performance Evaluation of the Mahakali Irrigation Project, Phase-I (A Focus on Agricultural Impact)

ID-03

Crimsan S. Negi[1],, Ganesh Pant[1], Bijaya K. Oli[1], Hemant Joshi[1], Bashu D. Joshi[1], Himal Kunwar[1], Janardan Joshi[1]*
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1 Introduction, Objectives & Location

Introduction

This study was conducted in June 2024 as part of a credited seminar course in Civil Engineering at Far Western University, Nepal.

The Mahakali Irrigation Project, Stage-I was developed in 1988, which played a crucial role in agricultural development in the far western region of Nepal. Water diverted from the Sharada Barrage irrigates farmland in Nepal's Kanchanpur and Kailali districts. The Mahakali River, with an average flow of 658 cumecs, provides 4.25 cumecs during the dry season (May 15 – October 15) and 28.35 cumecs during the wet season (October 15 –May 15). Phase-I of MIP covers a command area of 5,100 hectares including 11 major distributaries supported by 71 main canal structures, 37 secondary canal structures, 201 tertiary canals, 38 km of drainage, and 98 km of gravel roads *(IWRMP n.d.)*. The Water Users' Association was established and actively engaged in efforts to enhance system performance and improve irrigation service delivery.

Fig 1: Location Map of the Study Area (MIP, Stage-I)

Objectives

- To assess water accessibility for irrigation, system reliability and crop productivity.
- To examine structural integrity and maintenance needs of the irrigation system.

2 Methodology

Methodology

The study comprised two key components:

- *Questionnaire survey:*
  Targeting farmers within the selected command areas to gather data on water, accessibility, reliability and agricultural impacts such as crop yield and productivity.
- *Structural inventory survey:*
  To assess the physical condition of the canal networks including minor canals, outlets, control gates and drainage facilities.

A *purposive sampling method* was employed to select sample size for questionnaire survey among three major distributaries (viz. Bhujela, Ultakham and Daijee) from a total of eleven within Mahakali Irrigation Project, Phase-I. These distributaries were chosen based on their distinct command area sizes and varying proximities to the main water source, ensuring diverse representation across the system.

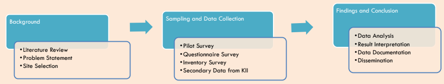

Fig 2: Study methodology to evaluate the performance of Mahakali Irrigation Project

Performance Indicators

The indicators used for performance evaluation under the **"Agricultural and Water Management"** category are listed below *(Nepal et al. 2024)* :

- Winter water availability
- Monsoon water availability
- Spring water availability
- Agricultural advice on time
- Operating agricultural equipment
- Intercultural operations due to lack of water
- Use of alternative irrigation method
- Lack of knowledge on A&I
- Soil fertility problem-Monsoon
- Soil fertility problem-Winter.

Fig 3: Project relevance with SDGs

3 Results & Discussion

Questionnaire Responses

The results presented below represent the percentage responses from a questionnaire survey of 108 farmers across the three major distributary command areas: Bhujela (48 respondents), Ultakham (43), and Daijee (17). About 77% of farmers experienced improved crop yields, with many cultivating over 10 Bigha/Kattha. Around 60% access water directly via canals, though 11.2% rely on alternatives. Continuous irrigation is favored (64.4%) over rotational. Despite high dependence (73%) on canal water, supplementary systems remain underused due to cost or limited availability.

Fig 4: Overall satisfaction of Farmers

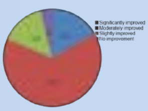

Fig 5: Improvement in crops

Fig 6: Water Application Pattern

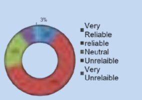

Fig 7: Reliability of MIP-I

Fig 8: *Awareness about WUA among farmers*

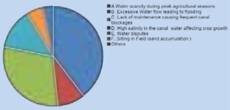

Fig 9: *Key Challenges faced by farmers*

A majority (85.4%) of farmers reported poor canal lining, leading to water loss; over 60% cited inadequate maintenance, while 67.6% noted issues like silting and vegetation. Additionally, 49.4% of respondents demonstrated limited understanding of the irrigation system, highlighting the need for improved infrastructure and user awareness.

Field Inspection Photographs

The field inventory revealed waterlogging near the source (Bhujela) and scarcity in distant areas (Ultakham, Daijee). Farmers noted water unavailability during critical periods. Poor maintenance across all sites led to damaged structures, silting, scouring, and vegetation overgrowth. Additionally, the Water User Association's activities lacked effectiveness in ensuring efficient irrigation management.

Fig 10: Vegetation in the tertiary canal

Fig 11 Water excess at Bhujela Minor

Fig 12: Damaged regulating structures

Fig 13: Water Scarcity at Ultakham

Fig 14: Using Alternative Irrigation

Fig 15: Using Alternative Irrigation

4 Conclusion

The performance assessment of Mahakali Irrigation Project, Phase-I shows notable progress in boosting agricultural productivity through improved water access and expanded land use. Most farmers observed better crop yields and cropping flexibility. However, recurring issues like seasonal water shortages, poor infrastructure maintenance, and inconsistent water supply remain. Additional concerns include canal blockages, silting and low adoption of alternative irrigation methods.

Addressing these challenges through infrastructure upgrades, equitable water distribution, farmer training, stronger Water User Associations, and promotion of supplementary irrigation systems is essential. These measures will enhance MIS-I's efficiency and ensure its long-term contribution to sustainable agricultural growth in the region.

Acknowledgements

We sincerely thank Asst. Prof. Toran Prasad Bhatt for his valuable guidance and supervision. We also appreciate Er. Aasish Bhatt for his technical support and the School of Engineering, Far Western University, along with our teachers, for their continuous inspiration and knowledge.

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Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

Revitalizing Irrigation for Agri-Food Security in Koshi Province, Nepal

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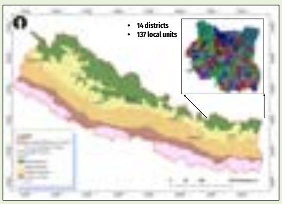
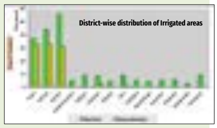
ID-04

1 Koshi Province at a Glance

Province Geographic, Demographic and Irrigation Profile





Total Area of Koshi Province= 25,90,500 Ha
Total Culturable Land= 7,83,595 Ha.
Total Irrigable Land=5,03,306 Ha
Total Irrigated Land= 3,15,287 Ha
(One-third by Groundwater)

	Nepal	Koshi Province	Percentage of Koshi Province
Area (sq.km.)	1,47,181	26,048	17.7%
Households (Nos.)	6,66,6937	11,91,556	17.9%
Population (Nos.)	2,91,64,578	49,61,412	17.0%

Annual Surface Water=40.44BCM
Annual Replenishable Groundwater=2.43 BCM

❑ **Major Irrigation Projects**

✔ **Under the Central Government**
- Sunsari Morang Irrigation Project, 68000 ha

✔ **Under Koshi Province**
- Kankai IMP, 8951 ha
- Chanda Mohana IMP, 1800 ha

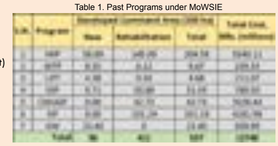
2 Programs for Irrigation Development

The line ministry responsible for agri-food system transformation in Koshi Province is the Ministry of Water Supply, Irrigation and Energy (MoWSIE).

Since the establishment of Koshi Province, the various programs being implemented by Koshi Province:

- Medium Irrigation Projects (MIP)
- New Irrigation Technology Projects (NITP)
- Lift Irrigation Projects
- ISIP (Irrigation System Improvement Project)
- CMIASP (Community Managed Irrigated Agriculture Sector Project)
- SIP (Small Irrigation Project)
- GW (Ground Water Irrigation Projects)

Table 1. Past Programs under MoWSIE



❑ **The new and innovative programs being implemented by MoWSIE:**

1. Solar lift shallow tubewell systems

The illustrated solar shallow tubewell was completed in Gauradaha-6, Jhapa in 2020. The command area covered is 10 ha. The solar system of rated power 3 kW was used for a rated flow of 17 m3/h at rated head of 40 m. The total construction cost of this system was NRs. 2.7 Million. The total number of such systems established were four in different locations of Jhapa district in 2020.

2. Canal Top Solar System in Kankai Irrigation Management System, Jhapa.

The tail end of Kankai Irrigation Systems experiences less water delivery during the early paddy period. To overcome this problem, MoWSIE has initiated a pilot project from this FY 2024/025, a conjunctive use of surface and ground water for tertiary no 19, 20, and 21 of Kankai IMP. A canal top solar system of 200kWp is being established to lift water from 4 deep borings with 30 lps discharge in each. (Under construction)

3. Solar Lift Systems, NITP, TCP-PIAT Programs at Kankai and Chanda Mohana IMO

Apart from the regular MIP programs to extend irrigation area for more yield of crops, the new technologies solar lift and NITP have great contribution for ensuring water to increase the crop productivity.

Irrigated Agriculture at Kankai IMO

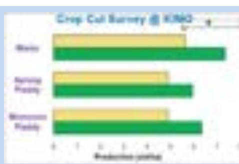
Irrigated Agriculture at Chanda Mohana IMO

Chiseni NITP, Ilam

3 Achievements

❖ **Crop Cut Survey**

❑ It has been found that by proper irrigation water management and supply, the productivity of monsoon paddy, spring paddy, and maize at KIMO has been increased in comparison to district-level productivity.



❖ **Public-Private Partnership**

❑ Coordination among farmers with Aarju Rice Mill, Jhapa, and Sagar Feed Industry, Itahari has been initiated for the direct sale of agricultural productivity at KMIO

❖ **Irrigation Service Fee Collection**

❑ Satisfactory ISF collection at KMIO is shown in the graph alongside. They collect NRs. 500 per bigha/year.

❑ In Khotang, at Tukure khola Bhasme Dobhan IP (50 ha), farmers collect NRs. 50/ropani since 2068 BS, and circulate the amount for repairs and as a cooperative for needy farmers in interest.

❖ **Entrepreneurship**

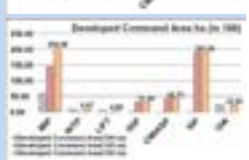
❑ Off-season farming is enabled by NITPs.

❑ Private enterprises and agro-vets are being boosted (solar-powered pumps, sprinklers, motors, and accessories).

❖ **Acts, Regulations, and Policies**

❑ To implement the programs efficiently, MoWSIE has formulated the following documents:

- Province Irrigation Act, 2076
- Province Irrigation Regulations, 2081
- Groundwater Irrigation Project Implementation Directives, 2081
- Koshi Province Renewable Energy Policy, 2081



❖ **External Financing**

- Irrigation Modernization Enhancement Project (IMEP)
- Kuwait Fund for Disaster Affected Irrigation Projects.
- Small Irrigation Project (SIP)

4 Key Message

✔ Modern, efficient irrigation systems are key to shifting from subsistence to commercial agriculture.

✔ Strategic irrigation drives higher yields, stable livelihoods, and regional food sovereignty.

✔ Entrepreneurship is evolving in water delivery, solar pumping, and irrigation services.

✔ Provincial policies must support water-user groups, climate-smart infrastructure, and sustainable financing.

✔ Strengthening farmer-managed irrigation systems and water-user associations is critical for long-term success.

Acknowledgements:

The authors would like to thank the Ministry of Water Supply, Irrigation and Energy (MoWSIE), Government of Province, Koshi Province, Nepal, for the permission to use progress datasets. The authors also acknowledge the use of datasets obtained from irrigation development/management offices. These datasets have been instrumental in supporting the analysis and interpretation of this poster.

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

Solar Irrigation Pumping: Clean Energy, Thriving Farms, No More Diesel

ID-05

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1 Context and objective

Nepal's agricultural sector is heavily reliant on irrigation for year-round productivity, but the high operating costs of diesel-based systems have limited farmer's access to reliable water sources. To address this challenge, the AEPC initiated a forward-looking solar energy initiative.

With the support of the German Federal Government through the KfW Development Bank, the '**Promotion of Solar Energy in Rural and Semi-Urban Regions of Nepal**' project aims to facilitate a clean energy transition by replacing diesel-powered irrigation systems with solar-powered alternatives. This project demonstrates Nepal's commitment to sustainable agriculture and climate change mitigation, aligning with global renewable energy and emission reduction goals.

- **Goal**: Increase solar electricity use and reduce CO2 emissions by installing solar irrigation pumping systems.
- **Implementation Year**: 2024
- **Subsidy**: Up to 60% of the investment (max. NPR 2 million) per unit under the Renewable Energy Subsidy Policy 2022

Fig 1: Study site and operation mechanism of solar pump

"Small-scale farmers remain vulnerable in the growing agribusiness economy. Projects like this must prioritize equity and inclusivity." — FAO

"Empowering rural farmers with clean energy is not just climate action— it's social justice." — UNDP

"Access to sustainable irrigation transforms agriculture from subsistence to resilience." — World Bank.

2 Project Implementation

Location: Jhapa District

1. Arjundhara Municipality (10 units)
2. Kankai Municipality (10 units)
3. Buddhashanti Rural Municipality (3 units)

Process:

1. Demand application and screening
2. Simplified feasibility and E & S assessment
3. Bid call and supplier selection
4. Installation, warranty (3 years), and post-installation monitoring

System Types Installed:

1. 7 systems of 2 kWp (2 HP)
2. 16 systems of 3 kWp (3 HP)

Fig 2: Subproject implementation cycle

Acknowledgements:
We thank the AEPC team, local governments, beneficiary farmers, DKTI Project staff, and implementing partners for making sustainable solar irrigation a reality in Jhapa.

3 Outcomes and Impact

- **Area Irrigated:** 32.99 hectares
- **Diesel replaced:** ~33,622 liters/year
- **CO2 emissions avoided:** ~90 metric tons/year
- **Water discharge capacity:**
  - 2 HP pump: 70,000 L/day
  - 3 HP pump: 100,000 L/day
- **Crops Supported:** Rice (July-Oct), Wheat (Dec-Mar)
- **Extended Use:** Vegetable farming and fisheries

Photo 1: DG set is used for the pumping of groundwater (before)

Photo 2: Diesel replaced after Solar PV pumping system

Photo 3: Happy beneficiary who is doing fishery nowadays

4 Key Message

Challenges & Way Forward

- Solar irrigation enhances productivity, lowers operational costs, and supports climate resilience.
- Transitioning from diesel to solar empowers farmers with reliable and sustainable water access.
- Farmers are adopting diversified agricultural practices with improved economic returns.

Barriers:

- Limited awareness of solar tech
- High upfront cost
- Small landholding structure

Need: Continued outreach, capacity building, and targeted financial support for small-holder farmers.

Photo 4: Installed SIP-S irrigation pumping system in Kankai Municipality, Jhapa

Impacts of Global Climate Modes on Seasonality of Major Rivers in Nepal

ID-06

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1 Introduction

- Climate modes are recurring, large-scale patterns of climate variability that influence weather and climate over wide regions and time scales ranging from months to decades (can have local, regional, or global impacts).
- A teleconnection is when a change in the climate or atmospheric condition in one part of the world affects the weather or climate in a distant region.

❖ Research Questions:

✔ How the Nepalese River Basins' discharge anomalies are related with climate modes?

❖ Objectives:

✔ To build a statistical predictive model for hydrologic cycles driven by climate modes.

✔ To quantify the strength of the global climate modes in each target river basin.

Table 1. Literature Review

[illegible]

2 Dataset and Methodology

- In-situ monthly river discharge for the period of [illegible] has been used.
- The simple form of statistical predictive model is given below:

$$Q_{predicted} = a \times DMI + b \times CP + c \times EP + d \times PDO + e \times AMO + f \times AO + g \times AMM + h \times NAO \quad (1)$$

Where, $Q_{predicted}$ = predicted standardized monthly discharge anomaly

a, b, c, d, e, f, g, h = standardized coefficients for respective indices

DMI = Dipole Mode Index, CP = Central Pacific type El-Niño, EP = Eastern Pacific type El-Niño, PDO = Pacific Decadal Oscillation, AMO = Atlantic Multidecadal Oscillation, AO = Arctic Oscillation, AMM = Atlantic Meridional Mode, NAO = North Atlantic Oscillation

- A partial correlation coefficient can be written in terms of simple correlation coefficients:

$$r_{XY,Z} = \frac{r_{XY} - r_{XZ} r_{YZ}}{\sqrt{(1 - r_{XZ}^2)(1 - r_{YZ}^2)}} \quad (2)$$

Where, X, Y, Z are three variables.

- The general form of partial correlation from a multiple regression is as follows:

$$r_k = \frac{t_k}{\sqrt{t_k^2 + DF}} \quad (3)$$

Where, t_k = the Student t-statistic for the k^{th} term in the linear model

r_k = partial correlation coefficient

DF = Degree of Freedom

Figure 1. A schematic statistical predictive model.

- A Three-month moving average is applied to smooth the time series.
- Standardization enables the actual variation comparison.
- Wet (dry) season corresponds to the long-term averaged high (low) flow month for each river basin.
- Lagged correlation upto 12-month window has been applied.
- Multivariate regression analysis was performed to identify a significant relationship.
- Climate modes from the Pacific, Indian, Atlantic, and Arctic oceans have been used.

Table 2. Description of Climate Modes considered in this study.

[illegible]

❖ Statistical predictive model is a linear combination of the eight climate modes sampled during those months of maximum correlation to predict the standardized discharge anomalies in respective wet or dry season.

Table 3. Location and Seasonal Flow Index

[illegible]

3 Results

- Koshi, Narayani and Karnali are snow-fed rivers while Bagmati is a non-snow-fed river.
- The natural flow in Bagmati river disturbed by human activities.
- In Figure 2, much (less) data is available in 25 to 75% range in observed (predicted) anomalies.
- In Figure 3, a significance test is performed at 80% and 90% confidence intervals and revealed that ~50% of predictions are significant.
- In Figure 4, the overall model performance underperforms in the Karnali River.

✔ DMI: negative (positive) influence in Koshi, Narayani (Karnali)

✔ CP: positive (negative) influence in Koshi (Bagmati, Narayani, Karnali)

✔ EP: absent in all rivers

✔ PDO: positively influencing in Koshi, Bagmati, and Narayani rivers but absent in the Karnali river.

✔ AMO: negative influence in the Bagmati river.

✔ AO: positively linked in the Koshi and Bagmati river

✔ AMM (NAO): negative (positive) in the Koshi and Narayani rivers.

❖ Lead times are shorter (longer) in Indian and Arctic (Pacific and Atlantic) ocean indices.

Figure 2. Box plot of observed and predicted discharge anomalies.

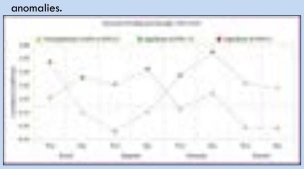

Figure 3. Seasonal Flooding and Drought.

Figure 4. Decomposition of Indices (Red, Blue, and Green colors represent positive, negative, and overall signal, respectively. Orange dots are lagged months).

Acknowledgements:

The authors would like to thank the Department of Hydrology and Meteorology (DHM), Government of Nepal, for the permission to use meteorological data. The authors also acknowledge the use of climate modes datasets obtained from various international sources. These datasets have been instrumental in supporting the analysis and interpretation of large-scale climate variability.

4 Key Message

- A statistical predictive model for each basin is developed, with wet and dry season discharge anomalies significant at the 95% confidence interval.
- Sub-seasonal analysis (wetter/drier) showed over 50% of predictions are significant at an 80-90% confidence interval.
- The strength and influence of climate modes vary across basins, with distinct signatures.
- Remote climate modes (e.g., from the Pacific and Atlantic Oceans) are tele-connected to the Nepalese river basins.
- Improved understanding of these teleconnections supports flood and drought risk prediction and an early warning system development.
- Human influence on river discharge variability requires further investigation.
- Integrating climate modes behavior with flood, drought, and fire activity can enhance multi-scale preparedness.
- Further validation against high-resolution dynamic models is recommended for operational use.
- Findings support climate-informed water resource planning for resilient agri-food systems in Nepal.

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

Promotion of Irrigated Agriculture in Kankai Irrigation System, Jhapa (Technical support provided by JICA TCP-PIAT Project)

ID-07

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1 Outline of JICA TCP-PIAT Project

❖ **Overall Goal**

- Develop successful **MODEL** Project that will be practiced in Terai Irrigated Area of Nepal
- **Formulation** of Guideline and Manual

❖ **Project Purpose**

Model of Irrigated Agriculture is formed by the **collaboration** among the Federal, Provincial, Local Governments and Water Users Associations (WUAs) and Private sectors.

❖ **Expected Outputs**

- **Formulation of Action plan** by the Stakeholders of Kankai Irrigation Scheme
- Establishment of **Equitable Water Distribution/ Improvement of O & M** of Irrigation Facilities
- Increase of Income of Farmers through practice of **Market Oriented Agriculture**
- Establishment of **Cooperation/ Collaboration system among stakeholders** for improvement of irrigated agriculture in KIS

❖ **Location of the Project/ Targeted Area**

JICA Technical Cooperation Project for the promotion of the Irrigated Agriculture (JICA, TCP-PIAT) in Terai Plain was located in **Kankai Irrigation System,** Jhapa managed by Kankai Irrigation Management Office under Ministry of Water Supply, Irrigation and Energy of Koshi Province, Biratnagar.

❖ **Duration of the Project**

March 2019 to March 2025 (**Five** years)

3 Results

Project has set **Ten** different **PDM Indicators,** based on that the following achievement were made

PDM Indicators	Target	Achievements
1. Formulation of Water Distribution Plan and Its Implementation	i) MC to SCs (22) ii) MC to DTOs (56) iii) SCs to TCs (181)	i) MC to SCs (22) Completed ii) MC to DTOs (56) iii) SCs to TCs (181)
2. Field Channel Construction	12 Km	12 Km (100%)
3. Formulation of Irrigation Facility Maintenance Plan and Its Implementation	i) MC (5) ii) SCs (8 model SCs & 14 Non model SCs) iii) Model TCs (13) and Non Model TCs (14)	i) MC (5) ii) SCs (8 model SCs & 12 Non model SCs) iii) Model TCs (9) and Non Model TCs (0)
4. Increase of Annual Irrigated Area	By 7%	End line survey will confirm the target
5. Increase of ISF Collection Amount	Increase by 1.5 times from that one before the project	i) Almost Achieved (NRs. 23,20,449/-) [NRs. 16,17,183/- in 2020/21 targeted amount NRs. 24,25,775/-]
6. Increase of Agriculture Incomes	Increase by 20%	i) Achieved (38%)
7. Preparation of Farm Business Plan	75% of farmers make Farm Business Plan	i) Achieved (more than 75% farmers)
8. Conducting Cooperation Activities	Conducting Four Cooperation Activities by stakeholders	i) Introduction of Laser Land Leveler technology ii) Establishment of Custom Hiring Service Center iii) Demonstration of Polyhouse for Market Orient production iv) Spring Rice Promotion Program v) Introduce Mechanical Rice Transplanter
9. Formulation of Guideline and Manuals	Preparation of Guidelines and Manuals	i) Completed
10. Conducting Training to Stakeholders	Two Irrigation Schemes in Terai area	i) Selection was completed (CMIS & Chandra Nahar IS)

Acknowledgements:

The author on behave of Kankai Irrigation Management Office, Jhapa would like to thank the Ministry of Energy, Water Resources and Irrigation, Federal Government, Ministry of Ministry of Water Supply, Irrigation and Energy (MoWSIE), Provincial Government, Koshi Province, Nepal, for the permission to use project achieved outputs and outcomes targeted by the project. These key activities carried during the project will definitely support in replicating the results in other Irrigation system of Terai Plain of Nepal through the interpretation of this poster.

2 Project Implementation

The slogan of the project was **"Maximum use of Water Grow for sale"**

❖ **Implementing Agencies**

i) Department of Water Resources and Irrigation (**DWRI**) under Ministry of Energy, Water Resources and Irrigation (**MOEWRI**)
ii) Department of Agriculture (**DOA**) under Ministry of Agriculture and Livestock Development (**MOALD**)
iii) Kankai Irrigation Office (**KIMO**) under Ministry of Water Supply, Irrigation and Energy (MOWSIE)
iv) Agriculture Knowledge Center (**AKC**) under Ministry of Industries, Agriculture and Cooperatives (**MOIAC**)
v) Kankai Irrigation Water Users Association (**WUA**)
vi) **Four Municipalities** of the Irrigation System

❖ **Output 2:**-Establishment of **Equitable & Efficient Water Distribution**

a) Formulation of Water Distribution Plan and its Implementation
b) Formulation of Irrigation Maintenance Plan and it's Implementation
c) Construction of Field Channel
d) Increase of Irrigated Area
e) Increase in Irrigation Service Fee Collection (ISF) amount

Increase in ISF collection

Gauge painting

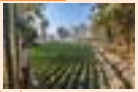
Emergency Maintenance

Field Channel Construction

Irrigated Area

❖ **Output 3:**- Increase of Income of Farmers through practice of **Market Oriented Agriculture**

a) Increase of Agricultural Income
b) Preparation of Farm Business Plan



Leader Farmer's in KIS

Real Time Telemetry System

❖ **Output 4:**- Establishment of **Cooperation/ Collaboration system among stakeholders**

The following seven cooperation activities are conducted:

1. Introduction of land leveling technology using Laser Land Leveler
2. Establishment of Custom Hiring Service Center
3. Demonstration of playhouse vegetable nurseries for market-oriented vegetable production (off-season production) to scale-up CAP
4. Spring rice promotion program
5. Introduction of mechanical rice transplantation program

Demonstration of Laser Land Leveler

Community Custom Hiring Center

Polyhouse Nursery

Mechanical Rice Transplanter in KIS

4 Key Message

- The project creates synergy by forming a common platform for joint action (*Coordination, Cooperation & Coexistence*) among the **three tiers of Government** with a common goal increase production and productivity through ***Equitable and Efficient water distribution*** and practicing ***Market Oriented Agriculture*** introducing mechanization & technology
- Providing a high priority on the ***Capacity Development of WUA*** (*Focal body of stakeholder*) is the must
- Developing agriculture as a agri-business attracting private and public sectors, direct linkage of farmers with the market and the industry, ensuring the returns

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

Towards Modernizing Irrigation Systems in Nepal for Informed Decision Making

ID-08

Santosh Nepal[1,], Jibesh KC[1], Anup Khanal[2], Dinesh Bhatt[3]*
[1]International Water Management Institute (IWMI), [2]Innovation Engineering Services (IES), [3]Department of Water Resources and Irrigation (DWRI)
Corresponding Author's Email: s.Nepal@cgiar.org

1 Background

The National Irrigation Policy 2023 emphasizes volumetric water allocation to boost agricultural productivity. Improving understanding of irrigation flow data is critical.

Nepal lacks systematic irrigation data collection, leading to inefficient water distribution, especially during dry seasons.

Poor water management and inadequate regulating structures exacerbate head-tail disparities in water access.

The International Water Management Institute (IWMI) and the Department of Water Resources and Irrigation (DWRI) through CGIAR's NEXUS Gains Initiative, introduced basic water measurements in the Babai Irrigation Project (BIP), Western Nepal, in 2023.

The project provides real-time data on water availability and usage, aiding in efficient water scheduling and allocation, ultimately reducing water conflicts and benefiting farmers and irrigation managers.

2 Methodology

FIELD SURVEY → SENSOR INSTALLATION → CAPACITY BUILDING → DATA COLLECTION → DATA VISUALIZATION

Field Survey

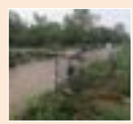
An initial field survey in July 2023 identified the need for irrigation flow measurements in Babai - Eastern irrigation canal system.

The eastern canal system and its 25 branch canals were selected for instrumentation.

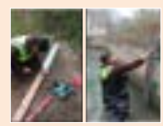
The B2 branch canal is selected for further soil moisture monitoring.

The field visit was supported by the Babai Irrigation Office, DWRI, DOA, and IWMI experts from Pakistan, South Africa, and Nepal.

Sensor and Instrument Installations



One automatic flow sensor and an array of meteorological sensors at head of eastern canal



25 manual gauges at each branch canal for flow measurements

Six soil moisture sensors at the command areas of the B2 branch canal

Training and Data Collection

10 gate operators learned to read and transfer flow level data via a web-based portal.

Gate operators are providing flow data through web portal

23 farmers (including 8 women) received training on using soil moisture sensors.

Six farmers are providing soil moisture and soil temperature data on a regular basis.

3 Outcomes

Babai Irrigation Information System (BIIS) dashboard

The BIIS dashboard provides real-time canal flow, meteorological, and soil moisture data on an online server for informed decision making.

- Real-time main canal flow level and velocity in 15 minutes duration.
- Flow level and velocity at the branch canals – two measurements a day.
- Soil moisture and soil temperature data at command areas in 2 hr. duration.
- Meteorological data: rainfall, temperature, and humidity in 10-minute duration.

Link to the web portal: https://www.stationlogin.com/bip/login

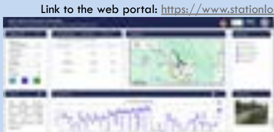


Figure 1: Babai Irrigation Information System Portal

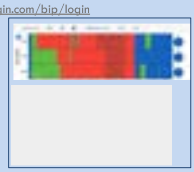


Figure 2: Soil moisture and soil temperature measured in a farmer's field at Bansgadhi, Bardiya in 2024

Data Insights

Real-time flow data helps irrigation managers understand water availability, aiding in informed decision-making.

Maximum flow observed in the eastern canal is 30.6 m^3/sec. Discharge drops frequently due to debris blockages and maintenance (Figure 1, discharge data).

220 MCM of water flowed through the eastern canals, irrigating 21,000 hectares of fields in a year, with an average flow of 6.21 m3/sec. Out of which 77 percent flows during the paddy growing season.

Soil moisture data from six farms in Bardiya district indicated positive impacts on crop management and irrigation scheduling.

Soil temperature trends showed significant soil dryness during the first two weeks of June, influenced by temperature increases and lack of irrigation or rainfall events (Figure 2).

4 Key Message

Irrigation instrumentation enhances data collection, visualization, and informed decision-making.

Seasonal flow variability and head-tail water distribution disparities highlight the need for improved system management.

Key future steps:

- Expand instrumentation system coverage
- Institutionalize data-driven practices
- Develop department-level management information systems
- Need for long-term data collection and analysis

Acknowledgements:
The authors would like to extend gratitude to the Department of Water Resources and Irrigation, CGIAR's NEXUS Gains Initiative, and Babai Irrigation Project.

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

AI-based National-Scale Rainfall-Triggered Landslide Nowcast System: From Data to Prediction

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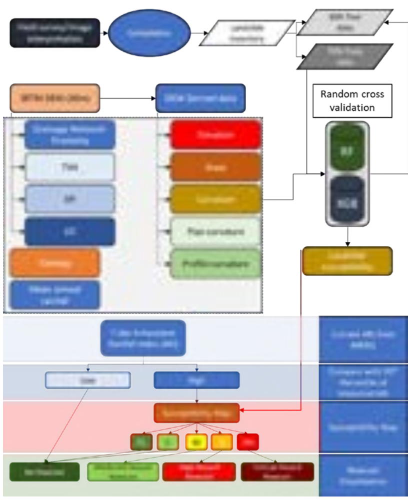
ID-09

1 Introduction

- Landslides are becoming increasingly common in Nepal, and their incidence is expected to grow as precipitation patterns become more severe and road-building increases. This poses a significant threat to the lives and livelihoods of people in the region. In this study, we developed an integrated approach that combines two modeling methods to predict the likelihood of landslide occurrences and develop a near-real-time landslide warning system.
- Predicting when and where landslides may occur and issuing warnings, accordingly, is an evolving area of research. Landslide models can either be designed to function as near real-time or forecasting systems.
- This study aims to evaluate the effectiveness of the Random Forest (RF) and Extreme Gradient Boosting (XGBoost) classifier models in assessing landslide susceptibility, and to compare their applicability in the Nepal Himalaya region. Additionally, it utilizes the Landslide Hazard Assessment for Situational Awareness (LHASA) model, which provides insights into rainfall-triggered landslide potential by identifying times and locations where landslides are more probable relative to other areas.

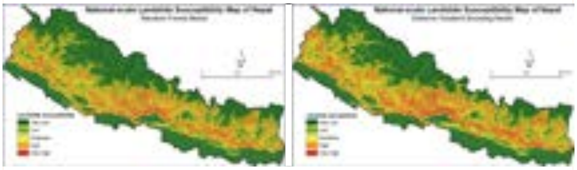
2 Methodology

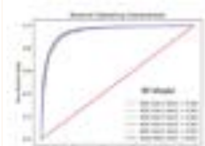


Firstly, 37096 landslides information from 1980 to 2023 were obtained through field investigation and satellite image interpretatioin, and a predictors database of 11 conditional factors had been constructed. Secondly, non-landslide points were selected to form a complete data set and RF and XGB models were established.

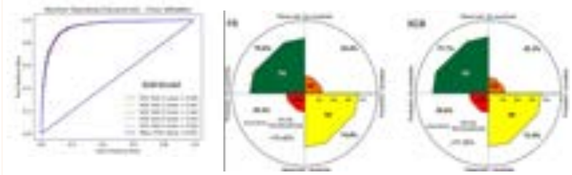
3 Results

Landslide Susceptibility Mapping

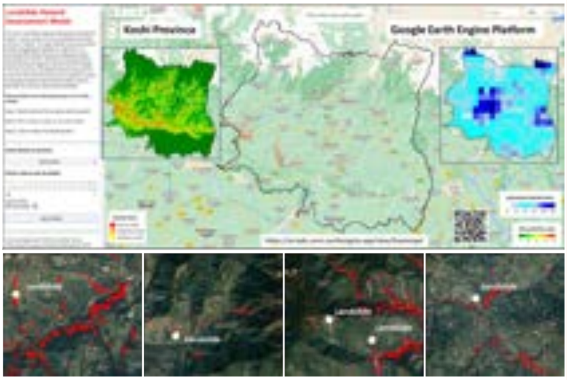




Classification generally reflects the original distribution of presence/absence landslide data, with the dominant class represented by True Positive (TP) and True Negative (TN). Overall, the predictive performance estimated via 5-fold random cross validation schemes achieves good results.



Landslide Nowcast



The true positive rate (TPR) was evaluated by verifying if each of the 116 landslide events (2019–2024) in Koshi Province was predicted by the Alarm Level nowcast. These events were selected based on their "location confidence".

4 Conclusions

- Landslide nowcasting serves as a vital early warning tool in the Nepal Himalaya, offering near real-time assessments of rainfall-triggered landslide potential.
- The nowcast system provides a synoptic-scale view of landslide susceptibility, enabling national and regional authorities to monitor potential hazards across large and inaccessible mountainous areas without the need for dense ground-based networks.
- When combined with local knowledge and field validation, the nowcast can support proactive disaster risk management

Acknowledgements:
The author is grateful to the WRRDC for their support in the formulation of the landslide nowcasting project. Sincere thanks are also extended to the Koshi Province Government and local authorities for their valuable assistance and coordination during the fieldwork and data collection phases.

Artificial Intelligence-Based Approach for Identifying Locations for Free-Flowing Wells

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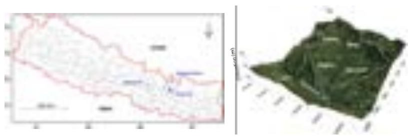
ID-10

1 Introduction

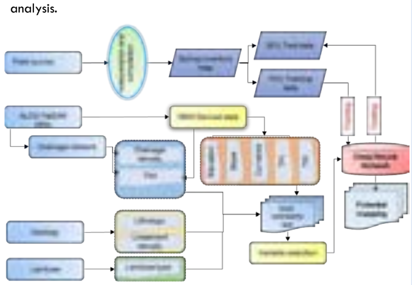
- The study area, Gopi khola watershed lies about 165 km east of Kathmandu, situated almost in the southwestern part of the Dolakha District with an area of 54.3 km^2. The study area has a gentle slope in most of the area and also has a steep slope in the northern and eastern parts.

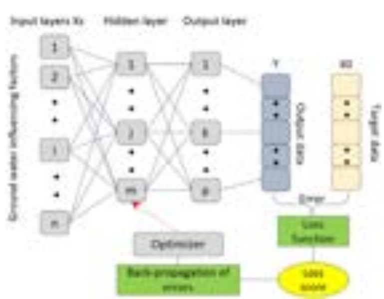


- The principal goal of this study is to analyze and resolve the probable distribution of groundwater occurrence and their spatial association in the mountainous terrain of Nepal Himalaya. This study efforts to capture suitable area for groundwater exploration in Gopi khola watershed using an integrated approach of deep neural network (DNN), GIS techniques and field survey.

2 Methodology

- The study comprised four phases: (1) collection and preparation of geospatial datasets—topographic, hydrological, land use, geological—and spring inventory data; (2) data preprocessing and modeling using a Deep Neural Network (DNN) framework; (3) geophysical exploration; and (4) drilling based on integrated analysis.



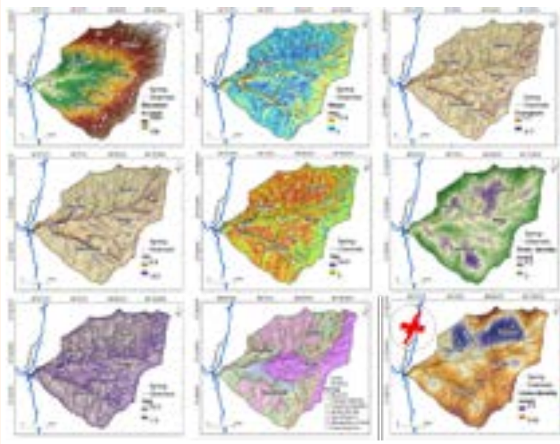


Architecture of the study

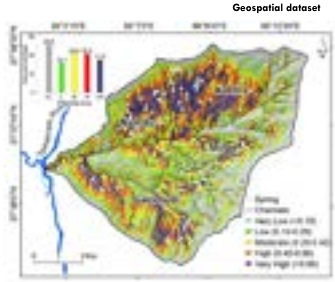
Acknowledgements:
The author is grateful to the WRRDC for their support in the formulation of this project.

3 Results

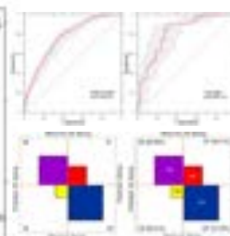
- **Spatial analysis**



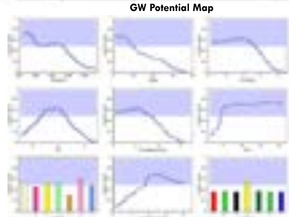
Geospatial dataset



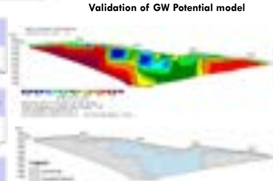
GW Potential Map



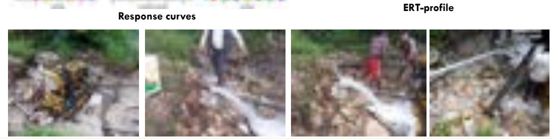
Validation of GW Potential model



Response curves



ERT-profile



Drilling site

4 Key Message

- The results confirm that AI-driven methodologies can significantly enhance decision-making in groundwater exploration, especially in complex hydrogeological settings.
- This approach not only improves efficiency and accuracy in site selection but also offers a scalable framework for similar applications in other data-scarce regions.

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

Evaluating the need and feasibility of micro-irrigation systems for sustainable irrigation

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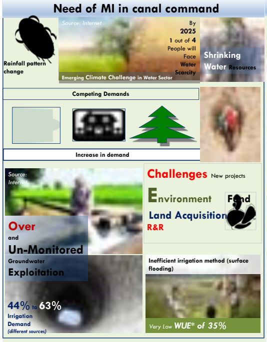
ID-11

1 Context and study region

Need of MI in canal command



Objectives

1. To evaluate the **current canal condition**
2. To evaluate the **techno-economic feasibility** of MI
3. **Sustainability** assessment of MI

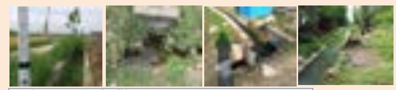
Study Area

Gadarjudda Minor
Deoband branch, UGC
Length :5.4km
Inlet: Non-gated
Design Q: 0.283 cumec
CCA: 485 ha

Financing

2 Methods

1. Canal Survey 2. Outlet Conditions 3. Control Devices 4. Conveyance efficiency



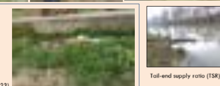
Seepage loss (I) = (Qinlet − Qoutlet)/A
Karad et al. (2013)
$E_c = \frac{Q_{outlet}}{Q_{inlet}} \times 100$
Sitaram and Singh (2018)

5. Maintenance & Mgt. Condition

Manning's roughness (n) $= \frac{R^{2/3} \times S^{1/2}}{V}$

$ACC = \frac{n(\text{projected})}{n(\text{actual})} \times 100\,\%$

Gebr et al. (2023)



6. Water Source

Discharge = (Wetted area) × (Velocity)
(Global Water's FP111) DVM

Tail-end supply ratio (TSR) $= \frac{N_s}{N_t}$
Nelson (2002)

7. Water Quality 8. Soil and Crop Characteristics 9. Crop Water Requirement (CWR)

pH, TDS, and EC measured by multi-parameter (Orion Star A325) and TSS by oven dry method

10. Water Use Performance Indicators

S.N.	Indicator	Detail	Reference
1	WDCI	act. capacity at the Head (m3/s) / Peak CWR at the Head (m3/s)	Jha et al., 2022 Bos et al., 2005
2	AVIWD	Annual volume of water delivered to the farmer's field (m³)	Bhat et al., 2024 Bos et al., 2005
3	AIWS/CA	AVIWD (m3) / Command Area (ha)	Bhat et al., 2024 Jha et al., 2022
4	RWS	Total water supply (irrigation + eff. rainfall) / Crop water demand	Bhat et al., 2024 Jha et al., 2022
5	RIS	Total irrigation supply / Irrigation demand (CWR − eff. rainfall)	Bhat et al., 2024 Jha et al., 2022

1. Necessity of MI

-Water Demand and Availability:
WDCI (Canal capability to meet peak

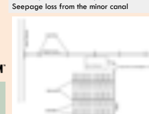
-Water Quality: (permissible limit)
pH < 7.0
TDS < 500 mg/L
EC < 250 µS/cm
TSS < 50 mg/L

-Water Distribution System
How well water is distributed from outlet

-Conveyance Efficiency
Seepage loss from the minor canal

2. Piped Irrigation Network

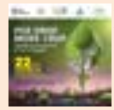
$$D_x = \left(\frac{2.215 \times 10^{12} \times Qx^{1.852}}{Chw^{1.852} \times Sxy}\right)^{\frac{1}{4.87}}$$



- Epanet 2.2 (Rossman, 2000)
- Head loss: H-W
- Pipe used: HDPE (C_{hw}=150)
- Velocity: 0.6-1.5 m/s
- Pressure: > 0.6 m at outlet
- Design CA: 485 ha (1.36 lps/ha)
- Design Discharge= 660 lps
- No.of outlets: 25 nos.

Head: 5 nos (× 13 ha)
Mid: 10 nos (× 22 ha)
Tail: 10 nos (× 20 ha)

Government Role



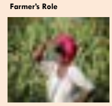
- Subsidy (up to 50-100%)
- Guidelines for Piped Irrigation Network & MI

Industry Role

NETAFIM

- Design and cost estimate
- Promote water-saving tech.
- Assistance to farmers
- Develop low-cost MI system
- Upgrade manufacturing capabilities
- Manufacturer outlets

Farmer's Role



- Interest and knowledge of farmer
- Farmer's participation
- WUA's presence

3. Social Survey

Table: Techno-economic feasibility of MI (Likert scale rating)

SN	Characters (Factors)	Nil	Low	Medium	High
1	Awareness				
2	Knowledge				
3	Attitude				
4	Willingness of adoption				
5	Purchase Capacity				

Score attributes: Nil (0), Low (1), Medium (2), High (3)

Table: Lower and Upper limit for Interpretation

Attributes	Interpretation	Score	Lower limit	Upper limit
Nil	Negligible	0	0	0.5
Low	Minimal	1	0.51	1.5
Medium	Moderate	2	1.51	2.5
High	Highest	3	2.51	3

3 Results

1. Canal Survey (L-X section)

2. Outlet Condition: Average discharge 27 lps

3. Control Devices

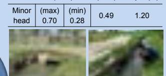
5. Maintenance and Management Conditions

Table: manning's roughness (n) and actual canal capacity (ACC)%.

Reach	manning (n)	ACC (%)
Head	0.035	51.1%
Mid	0.030	59.1%
Tail	0.040	44.6%

6. Water Source

Loc.	Measured Q (m³/s)		Avg. Q (m³/s)	Water Depth (m)
Minor head	(max) 0.70	(min) 0.28	0.49	1.20



4. Conveyance Efficiency

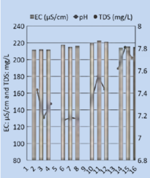
Reach	Ec (%)
Head (500-670 m)	88
Middle (2635-2970 m)	72
Tail (3500-4210 m)	77.56
Overall (500-3500 m)	57.6

Table: Soil properties in experimental plot

Soil Property	Value
Soil Texture	Loamy Soil
Bulk Density	1.54 g/cc
Infiltration Rate	12 mm/hr
Field Capacity	24.45 %
PWP	14.56 %

9. Cropped Area

7. Water Quality 8. Soil properties



11. Water Use Performance Indicators

WUP indicator	Unit	minor
WDCI	-	0.38
AVIWD	m³	756,000
AIWS/CA	m³/ ha	2,191.3

Table: Calculated value of RIS and RWS for Gadarjudda minor

Crop	Area (ha)	CWR (m³)	Irrigation (m³)	Eff. Rain (m³)	RIS	RWS
Sugarcane	207	2,514,636	1,500,871.68	1,474,461	1.44	1.18
Wheat	69	105,777	154,828.80	52,992	2.93	1.96
Paddy	59.75	488,261.25	139,345.92	289,075.5	0.70	0.88
Mustard	34.5	58,719	77,414.40	34,017	3.13	1.90

1. Necessity of MI

-Water Demand and Availability:
WDCI = 0.38 ; TSR = 0.33

-Water Quality: (permissible limit)
pH = 7.4 (< 7.0)
TDS = 106.4 < 500 mg/L
EC = 215.8 < 250 µS/cm
TSS = 24.1 < 50 mg/L

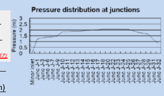
-Water Distribution System
Uneven distribution of water/ no control

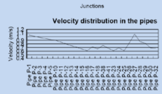
-Conveyance Efficiency
57% loss in seepage

2. Piped Irrigation Network

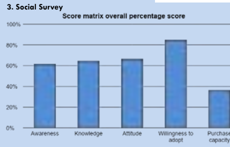
Full supply depth= 1.2 m
Pressure variation= 0.85 – 2.06 m
Velocity variation = 0.61 – 1.5 m/s
(MoWR, RD and GR, 2017)

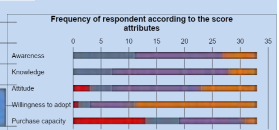
Diameter (mm)	Length (m)
900	2642
800	358
710	682
630	385
500	230
400	149
355	97
315	555
225	262
Total	5360





3. Social Survey





4 Key Message

Summary

- MI promising tool for water mgt.
- Need to promote MI in canal command
- Study in Gadarjudda minor of UGC
- Current canal conditions:
  - Canal survey, water quality, soil and crop, CWR, water use performance indicators
- Feasibility of MI:
  - Necessity, piped network design, social survey
- Sustainability of MI
  - Government-industry-farmers role

Conclusions

- Average canal profile 1:1600; The upward slope in (ch.750 Gadarjudda and ch. 3200 Nagla Aimad); Old brick masonry lining (n=0.35 > 0.018); WDCI = 0.38; TSR = 0.33; Conveyance Efficiency = 57%. Showing erratic supply and need of modernization of Gadarjudda minor
- Canal profile adequate for gravity pipe flow; replacement pipe network cost INR 83.43 million; willingness to adopt (85%); purchasing capacity (36%). Showing MI in minor command is feasible.
- Government subsidy available; MI vendors available (70 km); awareness among farmers; WUA non-existence. Showing need of WUA for project sustainability.

Future Scopes

- Expand to branch canal and whole UGC command
- WaterGEMS for modeling the Piped network and MI in the command
- Optimization of pipe size using machine learning and a genetic algorithm
- Extensive social survey for the precise requirements of the study area

Acknowledgements:

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National Water Mission (NWM), Department of Water Resources, RD&GR, Ministry of Jal Shakti, Government of India.
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Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

Integrated Assessment of Irrigation and Agriculture Management Challenges in Nepal's Flagship Irrigation Schemes

ID-12

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a: International Water Management Institute; b: Department of Water Resources and Irrigation; c: Water Resources Research and Development Centre; d: Department of Agriculture; e: Water and Energy Commission Secretariat; f: National Agricultural Policy Research Centre, Nepal Agricultural Research Council

1 Context and Objectives

- Agriculture remains the backbone of Nepal's economy, with irrigation playing a vital role in enhancing productivity, especially amid increasing climate variability. To support year-round farming, the government has invested in several large-scale irrigation schemes, including the Babai, Rani Jamara Kuleriya, and Mahakali systems—considered flagship projects in Western Nepal. Despite significant investments, these systems have underperformed due to recurring issues such as poor maintenance, delayed water delivery, and weak farmer participation. Governance challenges, including overlapping roles of agencies and limited capacity of water user associations (WUAs), further constrain effective management. This study systematically assesses and ranks the challenges across the three schemes to identify core barriers and inform policy and operational improvements in Nepal's irrigation sector.

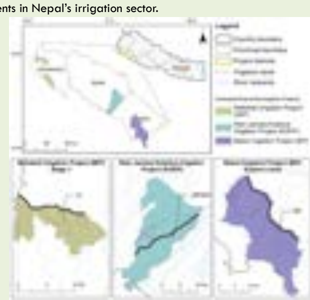

Fig 1: Map of the three irrigation systems (from west to east): Mahakali Irrigation Project (MIP), Rani Jamara Kulariya Irrigation Project (RJKIP), Babai Irrigation Project (BIP). The main canal in each systems is highlighted using parallel black lines.

3 Key Findings and conclusion

- The most significant category of challenges across the three irrigation systems is socio-economic and market conditions.
- The top-rated challenge is the timely unavailability of adequate fertilizer (score: 4.41 out of 5), spring water availability and unfair market prices for agricultural products.
- Babai Irrigation Project (BIP) Faces the Most Severe Challenges particularly the mid-section of the command area.
- Farmers struggle with fertilizer shortages, declining groundwater, and high dry-season water deficits.
- Geographic Location Affects Input Access and Market Dynamics. Proximity to the Indian border in RJKIP and BIP tail sections improves access to fertilizers (including via informal trade) but raises quality concerns.
- Nepali farmers face unfair competition due to lower Indian production costs and subsidies. In contrast, MIP farmers benefit from better product prices due to demand in hill regions.
- GESI (Gender Equality and Social Inclusion) and Governance Are Key Enablers. Despite national policies, subsidy access remains difficult, especially for smallholders.
- Gender challenges persist, with female farmers reporting less participation in WUAs and facing cultural/informational barriers. Male dominance is prevalent in WUA leadership, often resulting in token female representation.
- Water Availability, Especially in the Spring and Winter, Is a Major Concern. Water availability during dry seasons is a significant agricultural water management issue. Source-level deficit in BIP, structural conveyance issues in RJKIP, and distribution inequities in MIP hinder effective irrigation.
- Physical and Structural Issues Are Less Severe, but Still Notable. While canal capacity is largely sufficient, poor maintenance, leakages, canal slides, and urban encroachments (notably in MIP) are key issues.
- Maintenance challenges are worsened by ongoing construction in BIP and lack of stakeholder engagement. Challenges are interconnected and require holistic, nexus-based solutions. Problems in one domain (e.g., infrastructure) exacerbate others (e.g., water availability).
- Peripheral enabling conditions (e.g., input access, market prices) are beyond the control of farmers and require stronger government intervention. Emphasis on a holistic and integrated approach that considers socio-economic, environmental, institutional, and gender-related dimensions.
- A replicable, interdisciplinary methodology for ranking irrigation challenges and stresses the need for actions like regular canal flow measurement and groundwater management to support data-driven, adaptive solutions across systems.

2 Methodology and results

- This study identified and assessed irrigation and agriculture management challenges across three flagship irrigation schemes in Nepal based on literature on holistic irrigation and agricultural management.
- Thirty-three performance indicators were selected and grouped into four thematic categories:
  – Physical and Structural (9)
  – Agriculture and Water (10)
  – Socioeconomic and Market (7)
  – GESI and Governance (7)

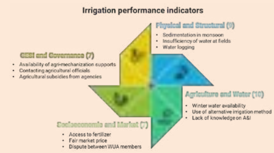

Fig 2: Irrigation performance indicators based on four thematic categories. Three indicators for each categories are listed as an example.

- Two field visits in August and October 2022 included consultations with farmers and Water User Associations (WUAs) to contextualize these challenges. For each irrigation scheme, one representative canal was purposively selected, and stratified into head, mid, and tail sections. This stratification allowed the study to capture variation in water availability and access.
- Likert scale classififcation (1–5) was used in household surveys yielding 449 responses. Respondents rated the severity of each challenge indicator. A weighted average score (Irrigation Challenge Score) was calculated using the number of respondents from each canal section.
- Stratified random sampling using the 'random walk' method was employed due to the absence of a comprehensive household roster.
- Validation meetings were held in July 2023 to verify findings with stakeholders. Ethics approval was obtained from IWMI, and informed consent was collected from all participants.

Physical and structural

- The three highest-ranked challenges for physical and structural are i) Insufficiency of water at fields (average challenge score: 3.6), ii) maintenance of irrigation canals (3.5), and iii) leakages from canals (3.4)

Agricultural water management

- The three highest-ranked challenges are i) spring water availability (average challenge score: 4.3), ii) intercultural operations due to lack of water (4.0), and iii) winter water availability (3.8)

Socioeconomic and market

- The three highest-ranked challenges are i) access to fertilizer (average challenge score: (4.4), ii) fair market price (4.2), and iii) access to input-output market (4.2)

GESI and governance

- The three highest-ranked challenges are i) agricultural subsidies from agencies (average challenge score: Male: 4.1 and Female 4.0), ii) contacting agricultural officials (male/female: 3.9) and iii) Agricultural mechanization support (male/female: 3.9)

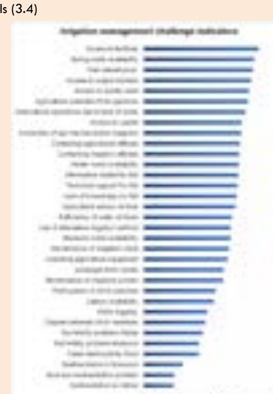

Fig 3: Indicators-wise combined challenge score in all 3 irrigation projects (Note: A&I – Agriculture and Irrigation, WUA- Water User Association)

Acknowledgements:
This research study is part of the NEXUS Gains initiative supported by CGIAR Trust Fund: cgiar.org/funders. We would like to express our gratitude to the WUAs of the three irrigation systems who assisted us in the data collection process. We would like to extend our appreciation to the Department of Water Resources and Irrigation (DWRI), and Mahakali, Rani, Jamara, Kulariya and Babai irrigation field offices for their continuous support throughout this research study.

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

Identification of Groundwater Potential Zones and Their Impact on Sustainable Crop Transformation: Insights from Banke, Nepal

ID-13

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**Corresponding Author's Email: ravi078lwe@ioepc.edu.np*

1 Introduction

- Groundwater is becoming important for irrigation in Nepal's Terai, particularly in the Banke district.
- Surface water sources are becoming unreliable due to seasonal variability.
- 95% of Banke's household depend on agriculture (mainly rice, wheat, and winter legumes; 55.8% cultivated)
- Unregulated groundwater use threatens long-term availability and quality.
- Mapping Groundwater Potential Zones (GWPZs), in conjunction with land use change analysis, supports sustainable water use and crop planning.
- These insights can help local governments implement evidence-based groundwater management and climate-resilient agricultural plans.

◆ **Research Question**

- How can the identification and utilization of GWPZs support sustainable crop transformation in Banke district, Nepal?
- Which regions of the Banke district have the **highest and lowest groundwater potential**, as determined by several drilling methods, and what are its implications for local water resource planning?

◆ **Research Objective**

- To identify and **map GWPZs** in Banke district
- To **compare groundwater potential** across the 8 local governments to identify high-potential and vulnerable areas.

3 Outcomes/Results

- Spatial interpolation showed that **shallow groundwater levels** are concentrated in Rapti Sonari and eastern Banke, whereas **deeper levels** are prevalent in Baijanath, Kohalpur, and Narainapur, indicating regional variation in groundwater availability.
- Thicker aquifers were found in **southern regions** such as Narainapur and Duduwa, indicating groundwater storage potential, whereas **northwestern locations** (e.g., Khajura) showed thinner aquifer zones.
- Significant land transitions were detected, particularly from **agriculture to built-up areas** in **central to western Banke**, reducing infiltration zones and contributing to groundwater stress.
- Combined interpretation of GWL, aquifer thickness, and LULC trends allowed preliminary identification of GWPZ, distinguishing **high potential areas with shallow water tables and thick aquifers from vulnerable zones characterized by deep GWL, thin aquifers, and rapid urban expansion**.
- **Rapti Sonari**, one of the eight local governments, showed **good shallow groundwater**, whereas Baijanath and Kohalpur experienced depth issues.
- These comparisons are helpful for focused drilling, conservation planning, and future recharge interventions.

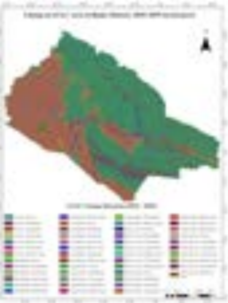

Fig.4 LULC change map of Banke District (2010 – 2019) highlighting major land transitions

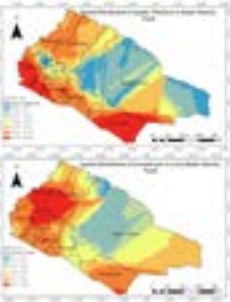

Fig.5 Spatial distribution of aquifer thickness (top) and groundwater level (bottom) in Banke District, Nepal

Acknowledgments

The Authors would like to thank the **Agriculture Knowledge Center (AKC), Government of Nepal, Banke**, for granting access to the groundwater exploration and installation dataset. We also acknowledge the **Groundwater Irrigation Development Division, Banke**, for their valuable technical support during the installation and study period.

2 Research Methodology

I. Site Selection & Preliminary Survey

- **400 sites selected** based on technical feasibility (soil type, depth, aquifer structure).
- Field teams and local technicians were educated to record soil profiles, aquifer depths, and water-bearing strata

II. Drilling Techniques

- **Rotary Drilling:** Used for deeper formation to reach confined aquifers.
- **Percussion (Cable Tool):** Preferred in semi-artesian zones (e.g. Rapti Sonari, Duduwa).
- **Manual Sludge Drilling:** Used in unconsolidated formations using MS pipe system.

III. GIS & Remote Sensing- Based Mapping

- Groundwater level and aquifer thickness were recorded at each site during the dry season.
- **Empirical Bayesian Kriging (EBK)** interpolation in ArcGIS Pro was used to generate spatial maps of GWL and aquifer thickness.
- Integrate **multiple layers**: DEM, LULC, soil, rainfall, geology, and drainage
- **AHP** method will be used for criteria weighting and overlay in ArcGIS, to determine GWPZ map.

Fig.1 Location of Banke District within Nepal and distribution of groundwater observation wells across its eight local governments.

Fig.2 Workflow for Groundwater Potential Zone (GWPZ) Mapping using ArcGIS Pro and AHP Methodology

IV. Land Use Land Cover (LULC) Change Analysis

- Land conversion trends were assessed for the period 2010 – 2019 using ArcGIS Pro.
- This provides information about how landscape change influences groundwater recharge and demand.

Manual Drilling | Cable Tool Drilling | Rotary Drilling

Fig.3 Field Photographs of Groundwater Observation Well Drilling in Banke District, Nepal

4 Key Message

- In fiscal year 2080/81, AKC Banke installed **364 bore wells** across all municipalities, supporting irrigation on ~40 hectares and benefiting over 2,000 farmers.
- Priority was given to marginalized areas like **Narainapur,** where bore success was high, and cropping intensity increased from two to three cycles annually.
- Regions like **Rapti Sonari** and **Duduwa** showed artesian aquifers at shallow depths (20 – 30 ft), indicating strong GWPZ potential.
- **Sikta irrigation project; National Pride project has only reached** ~ 21,000 of its planned 42, 766 ha coverage, leaving many areas dependent on groundwater.
- These trends, along with rising bore density, highlight the critical need for groundwater recharge strategies and evidence-based GWPZ planning in Banke to maintain long-term agricultural resilience.

5 Future Works

- Generate final GWPZ maps using AHP-based weighted overlay of DEM, LULC, soil, rainfall, geology, and drainage density layers.
- Engage local stakeholders in incorporating GWPZ outputs into irrigation planning, cropping calendars, and groundwater governance.

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

Assessment of Groundwater Storage Variation in Transboundary Aquifer of Nepal

ID-14

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1 Context and Objectives

Problem Statement:

Groundwater (GW) storage management is hindered by inadequate understanding of spatial heterogeneity in its distribution, due to lack of spatially distributed monitoring wells and long-term data. Although few reports claim GW depletion in Terai region, the state of GW storage has not been quantified. In lack of field data, several studies show potential application of remote sensing (RS) data such as GRACE in assessing the GW storage dynamics. Studies conducted using such data have quantified the GW loss in broader Ganga Basin, but fine-resolution data of Terai region is lacking.

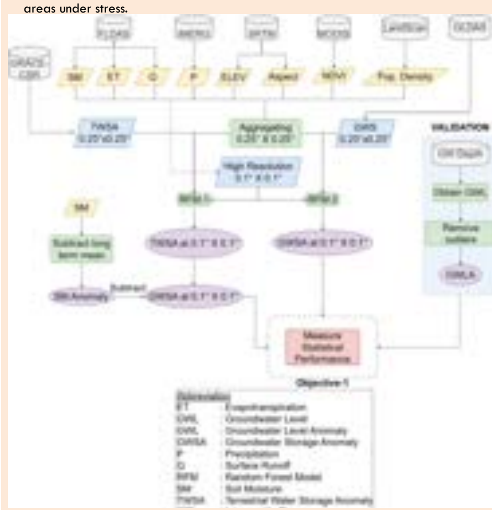
Objectives:

This research analyzes variation in GW storage in the transboundary aquifer of Nepal that extends from Terai region of Nepal to Northern India, and characterizes nature of variation in the Terai region of Nepal. Specific objectives are:

- Assess RS products for representing GW storage variation in Nepal's Terai
- Characterize spatial-temporal patterns of GW storage variation in the study area

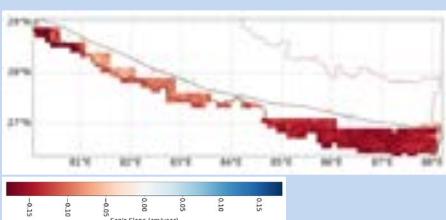
2 Methods

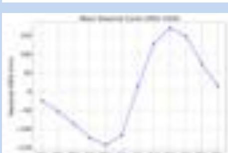
- **Assessing Suitability of RS Products:** Given coarser resolution of RS products, resolution enhancement was performed for improving local-scale applicability by downscaling coarse-resolution GRACE data using random forest technique. Groundwater Storage Anomaly (GWSA) was computed based on downscaled GRACE data and compared with in-situ observation of GW level at selected monitoring wells to verify accuracy in capturing groundwater fluctuations.
- **Spatial Hotspots and Temporal Trends:** Based on GWSA, areas/zones with notable gain loss in GW storage were mapped, to identify critical area for recharge and depletion. Spatial pattern in GW storage variation (hotspots) was characterized based on those zoning. For temporal trends, long-term increase/decrease in GW storage at the 95% confidence level was analyzed to highlight areas under stress.



3 Results

- Validation demonstrated a strong correlation between GRACE- and GLDAS-derived GW storage estimates and in situ observations.
- The transboundary aquifer exhibited a mean depletion rate of 1.06 cm yr^{-1}, a comparable results reported in literature.
- Within Nepal's portion of the transboundary aquifer, the results showed a decrease in GW storage at an average of 7.96 mm yr^{-1}—equivalent to a total storage loss of 50.66 km^3 from 2003 to 2020.
- A statistically significant depletion was detected in the Terai region, with the most pronounced hotspots located in Madhesh Province.
- Depletion peaked during the spring (March–May), coinciding with the annual minimum in groundwater storage.
- Cross-correlation analysis revealed that precipitation directly influences GW recharge, with no observable lag between rainfall and storage response.





4 Conclusions

- For proper spatial and temporal coverage of the data, remote sensing products such as GRACE provides good means to study the GWS at regional scale. However, by downscaling appropriately, they can also be considered for local-scale applicability.
- While downscaled products enhance resolution, there could still be limitation for capturing adequately local scale GW variability, both spatial and temporal. Therefore, results should be interpretated carefully.
- Regional analysis across Nepal reveals significant GW storage depletion, especially during the spring months. Continued reliance on GW heightens risks to agriculture as storage declines persist.
- The pervasive downward trend in GW storage underscores the need for coordinated transboundary aquifer management.

Acknowledgements:
The authors are grateful to Collaborative Research and Capacity Strengthening for Enhancing Water Security (CaREWaS) project, a partnership between Center for Water Resources Studies (CWRS) and Kathmandu Valley Water Supply Management Board (KVWSDB), for supporting this study.

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May 2025 [Thursday], Kathmandu, Nepal

Impact of Cryosphere Changes on Hydrological Drought and Agriculture in Nepal: A Case Study of the Gandaki Basin

ID-15

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1 Context & Objectives

A. Problem Statement:
Accelerated retreat of the Himalayan glaciers due to climate change (CC) are affecting the river flow patterns. The Gandaki Basin (**Figure 1**, Area- 36,650 km^2) relies on glacier and snowmelt for sustaining river flow. However, the role of glacier and snowmelt runoff in mitigating agricultural drought remains largely under-studied.

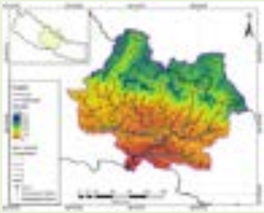

Figure 1: *Gandaki River Basin with distributed meteorological and hydrological stations*

B. Objectives

2 Methods

The methodology framework for quantifying the potential role of meltwater in agriculture and mitigating drought under changing climatic patterns is given in **Figure 2.**

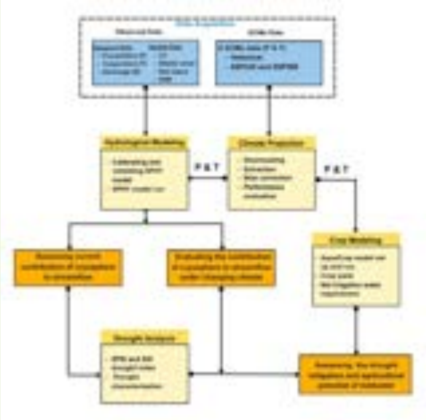

Figure 2: *Methodological Framework for the study*

A. Understanding the current hydrological regime:

Model Used: SPHY v2.0, suitable for glacierized basins.

Calibration and Validation: Manual calibration with data from the Devghat station. Performance evaluation using NSE, PBIAS, and R².

Outputs: Seasonal runoff components: glacial melt, snowmelt, rainfall runoff, base flow.

B. Climate change impacts on cryosphere:

Climate Projection: CMIP6 GCMs (SSP245, SSP585).

Data Processing: Bias correction using Quantile Mapping (precipitation) and linear transfer function (temperature).

Analysis: Projected changes in temperature, precipitation, and meltwater runoff to assess seasonal water availability.

C. Impacts of cryosphere on drought and agriculture:

Drought Assessment: SSI index to evaluate drought trends.

Agricultural Impact Assessment: AquaCrop model to estimate yield and irrigation need. Focused on Paddy and Wheat in Nawalparasi district (97,000 ha).

3 Results

A. Current hydrological regime

Figure 3: *Observed and Simulated Discharge vs. Time*

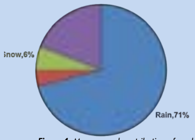

Figure 4: *Mean annual contribution of each runoff component to the total runoff*

B. Impact of CC on cryosphere

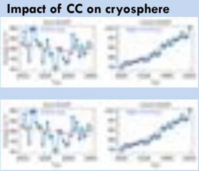

Figure 5: *Yearly trend of snowmelt runoff, glacier melt runoff & total runoff under SSP245 & SSP585*

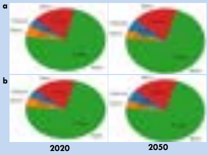

Figure 6: *Annual contribution of each runoff component to the total runoff under SSP 245(a) and SSP 585(b) for 2020(on left) and 2050 (on right)*

C. Impact on drought and agriculture

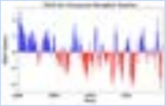

Figure 7: *SSI3 for Narayani Devghat Station*

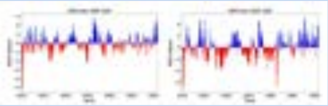

Figure 8: *SSI3 under SSP 245 and SSP 585 for outlet station*

Drought : At Narayani Devghat Station, severe droughts were observed in 2013, 2016, and 2019. Under SSP 2.45, extreme droughts occurred in 2020 and are projected for 2026, 2034, and 2035, with wet years in 2023, 2031, 2036, and 2037. Under SSP 5.85, dry months dominated, with extreme droughts in 2020 and 2041, and wet extremes in 2024, 2025, 2037, and 2047..

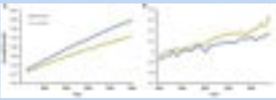

Figure 9: *Projections of dry yield for key crops under SSP245 and SSP585 scenarios: (a)Rice (b)Wheat*

Figure 10: *Mean yearly gross irrigation requirement & snow and glacier runoff under SSP585*

Agriculture: Wheat and rice yields are expected to rise from 2025 to 2050 under both SSP245 and SSP585, with higher gains under SSP585. Melt runoff from snow and glaciers exceeds irrigation needs, helping buffer short-term droughts in glacier-fed regions.

4 Conclusions

- Rising temperatures are increasing **glacier melt** while reducing **snowmelt,** altering the flow regime and leading to reduced dry season flow in the Gandaki Basin.
- Meltwater peaks during **summer,** supporting Kharif crop sowing and mitigating **pre-monsoon drought.** Rice and wheat yields are projected to increase.
- Climate change is projected to result **more frequent** and **severe droughts** in specific parts of the Gandaki Basin, revealing a need for **location-specific** management strategies.
- It is essential to implement **water storage and conservation strategies** to manage the increased pre-monsoon glacier meltwater, for Kharif sowing and agricultural security. Further, **studies** integrating **hydrological and agricultural** models to assess the **Water-Food-Energy** nexus should be prioritized to decide on optimal allocation and efficient use of resources.

Acknowledgements:
We would like to express our sincere gratitude to **Dr. Sonu Khanal, Dr. Nirman Shrestha,** and **MD Zuber** for their guidance and contributions to this research.

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

Solar Irrigation for Agricultural Resilience in South Asia (SoLAR-SA) Project

Shisher Shrestha[1,]; Manohara Khadka[1]; Darshan Karki[1]; Sumitra KC[1]; Anuj Mishra[1]*
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ID-16

1 Context and Objectives

- **Solar Irrigation for Agricultural Resilience in South Asia (SoLAR-SA)** is a Swiss Agency for Development and Cooperation (SDC) funded project that aims to sustainably manage the water-energy and climate interlinkages in South Asia through the promotion of solar irrigation pumps (SIPs).
- The main **goal** of the project is to contribute to **climate-resilient, gender-equitable, and socially inclusive agrarian livelihoods** in Bangladesh, India, Nepal and Pakistan by supporting government efforts to promote solar irrigation. This project responds to government commitments to transition to clean energy pathways in agriculture.

Key Objectives:

- Generating **improved empirical evidence** to support the development of climate-resilient, gender-equitable, socially inclusive, and groundwater-responsive solar irrigation policies.
- **Validating innovative** actions and approaches for promoting gender-equitable, socially inclusive, and groundwater-responsive solar irrigation.
- Increasing **national and global knowledge and capacity** for developing gender-equitable, socially inclusive, and groundwater-responsive solar irrigation policies and practices

2 Project Implementation

Impact Evaluation and GESI Case Studies of APEC's Solar Irrigation Program

A range of research methods have been employed, including:

Rapid Assessment of Renewable Energy Policy and Subsidy Delivery Mechanism for Solar Irrigation Pumps (SIPs) in Nepal

Household Survey (2021) 656 HHs in 7 districts in Koshi and Madhesh Province

- Farmers who applied & got SIPs (n=303);
- Farmers who applied but did not get SIP (n=205);
- Farmers who did not apply for SIP (n=148);

Phone Survey (2021) ~876 farmers in 19 Tarai districts

- Farmers who applied & got SIPs (n=479)
- Farmers who applied but did not get SIP (n=397)

Qualitative surveys (2021) of AEPC/ICIMOD/IWMI-ACIAR Models In-depth interviews (63 qualitative interviews, 9 key informant interviews, and 4 telephonic interviews)

Policy review (2021) of the Water-Energy-Food Policies of Nepal and Bangladesh using a gender continuum scale (39 WEF sectoral policies reviewed)

Qualitative surveys (2024-25 - ongoing) to assess the efficacy of RE subsidy policy changes

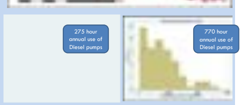
Publications

- Khadka, M., Uprety, L., Shrestha, G., Shakya, S., Mitra, A., & Mukherji, A. (2024). Can water, energy, and food policies in support of solar irrigation enable gender transformative changes? Evidence from policy analysis in Bangladesh and Nepal. Frontiers in Sustainable Food Systems, 7.
- Shrestha, G., Uprety, L., Khadka, M., & Mukherji, A. (2023). Technology for whom? Solar irrigation pumps, women, and smallholders in Nepal. Frontiers in Sustainable Food Systems, 7.
- Kafle, K., Uprety, L., Shrestha, G., Pandey, V., & Mukherji, A. (2022). Are climate finance subsidies equitably distributed among farmers? Assessing socio-demographics of solar irrigation in Nepal. Energy Research and Social Science, 91(August), 102756.
- Kafle, K., Balasubramanya, S., Stifel, D., & Khadka, M. (2024). Solar-powered irrigation in Nepal: implications for fossil fuel use and groundwater extraction. Environmental Research Letters, 19(8),

3 Results

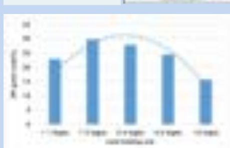
Finding 1 - SIPs reduce diesel use and improve income

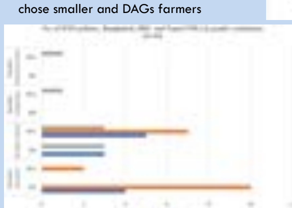
- Strong reduction in the use of diesel for SIP farmers compared to non-SIP farmers *(Phone Survey, 2021)*
- SIP farmers reduced diesel pump use by 64 and 33 percent for monsoon paddy and wheat, respectively *(HH Survey, 2021)*
- SIP Farmers earned 10% more crop revenue than non-SIP Farmers SIP farmers from the Disadvantaged group reported higher benefits



Finding 2 - Adoption of SIPs faced significant barriers. *(HH Survey, 2021)*

- ~20% of 9100 farmers who applied for SIPs received subsidized SIPs from AEPC
- Small and marginalized farmers are less likely to be SIP *applicants (Kafle et. al., 2022)*
- Among those who applied for SIPs, AEPC chose smaller and DAGs farmers





Finding 3 - Sectoral policies show variability in the understanding and embeddedness of gender and inclusion *(Khadka et al., 2024)*

- Agriculture policies show greater GESI responsiveness
- Energy policies show much lower GESI awareness, seeing energy as gender-neutral

Finding 4 - Unequal social and gender relations have skewed the adoption and benefits of SIP. *(Shrestha et al., 2023)*

- Women Friendly – YES
- Change in Gender Stereotypes – NO
- Change in Gender Relations – NO

4 Key Message

Key Takeaways

- SIP subsidy delivery process did not reach all categories of farmers, but AEPC used GESI-compatible criteria for the selection.
- SIP farmers, who tend to devote more land to vegetables, earn more revenue compared to non-SIP farmers, with mostly positive impacts overall, despite SIPs having an insignificant effect on crop yields.
- O&M and breakdowns remain an issue – need to allocate funds for capacity building of technicians.

Positive Policy Changes:

- Improved smallholder criteria (reduced land size requirements, acceptance of land-lease agreements, community-based systems).
- Increased accessibility for rural women (priority in subsidy allocation).
- Strengthened local government role (mandatory recommendations in the subsidy process).

Remaining Concern: The efficacy of these policy changes at the local level is yet to be seen.

Acknowledgements:
Swiss Agency for Development and Cooperation (SDC)
Alternative Energy Promotion Centre (AEPC)
Nepal Electricity Authority (NEA)
Chhipaharmai Rural Municipality, Parsa

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

Evaluation of Irrigation System Performance Using Remote Sensing and GIS: A Case Study of Nepal

ID-17

Lalan Baitha[1], Sandeep Kumar Chourasia[1], Dilip Barman[1,2], Ashish Pandey[1]
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1. Background & objectives

Efficient irrigation systems are pivotal for agricultural productivity and sustainability, but the lack of real-time information poses a significant challenge to evaluating their performance. Therefore, this study aims to assess irrigation system performance using a remote sensing-based approach. This study explores integrating remote sensing data with irrigation system performance evaluation to enhance water efficiency and sustainability. The proposed study area is the Kankai Irrigation System (KIS) in the Koshi Province, Nepal. It is located between the latitudes of 26° to 27° North and longitude of 87° to 88° East. The study area map is shown in Figure 1.

The specific objectives of the study are as follows:

1. To determine irrigation system operating performance by gathering necessary data and analyzing irrigation efficiency.
2. To evaluate the performance of the irrigation system using standard performance indicators.

2. Methodology and Materials and Methods

Table 1. Salient features of KIS

Name of the System	Kankai Irrigation System (KIS)
Location	Gainde, Jhapa, Koshi Province
Latitude	26° to 27° N
Longitude	87° to 88° E
Elevation	75 to 120 m above MSL
Source of the river	Kankai River
Total command area	8000 ha
Actual command area	7000 ha (Monsoon: 7000 ha; Winter:4000 ha; Spring:2500 ha)
Main Canal	36 km
Secondary Canal	74 km (22 numbers)
Tertiary Canal	110 km (287 numbers)

Study area and methodology

Fig 1. Study Area Map of KIS

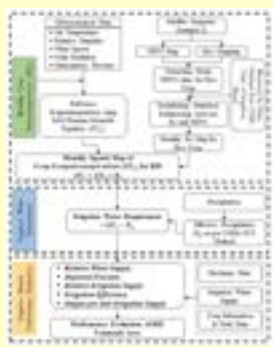

Fig 2. Flowchart of Methodology for Performance Evaluation

Table 2. Data Requirement for the study

Data/information	Type of data	Source
Cropping pattern, cropping area, and Crop yield	Cropping details	Kankai Irrigation Management Office (KIMO), Jhapa and reference reports
Design discharge, Supply discharge data, Command area, and Canal networks	Flow rates and field data	KIMO, Jhapa and reference reports
Climatic data (Rainfall, Max and Min Temp, Max. and Min. Relative Humidity, Sunshine Hour, Wind Speed)	Monthly data	CLIMWAT 2.0
NDVI maps (July to November 2022)	Sentinel-2 (10m, 10 days)	Google Earth Engine (GEE)
Crop Coefficients (K_c) Values of Rice	15-days interval	Department of Irrigation

Table 3. Performance Indicators used for the study

Performance Evaluation of the Kankai Irrigation System is determined by using the following indicators :

Water Delivery Performance Indicators:

$$\textbf{Relative Water Supply (Levine, 1992)} = \frac{\text{Total Water Supplied } (I + Pe)}{\text{Total Crop Water Demand}}$$

$$\textbf{Depleted Fraction (Molden, 1997)} = \frac{\text{Total Crop Water Demand}}{\text{Total Water Supplied } (I + Pe)}$$

$$\textbf{Relative Irrigation Supply (Perry, 1996)} = \frac{\text{Irrigation Water Supplied (I)}}{\text{Irrigation Water Requirements (CWR} - \text{Pe)}}$$

Physical Performance Indicators:

$$\textbf{Irrigation Efficiency (Bandara, 2003)} = \frac{\text{Total Irrigation Water Demand (CWR} - \text{Pe)}}{\text{Total Water Supplied (I)}}$$

Agricultural Performance Indicators:

$$\textbf{Output Per Unit Irrigation Supply} \left(\frac{\$}{m^3}\right) = \frac{\textit{Yield of Harvested Crop (\$)}}{\textit{Diverted Water Supplied}}$$

$$\textbf{Output Per Unit Water Consumed} \left(\frac{kg}{m^3}\right) = \frac{\textit{Yield of Harvested Crop (\$)}}{\textit{Water Consumed by Crop } (m^3)}$$

3. Results and Discussion

NDVI Map

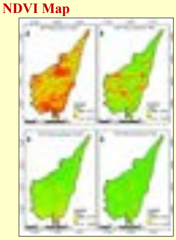

Fig 3. NDVI Map of July to November 2022

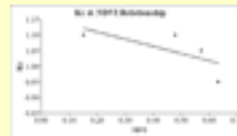

Fig. 4 Correlation between DoI Kc and NDVI

Table 4. PET from CROPWAT 8.0

Month	Eff rain	Min Temp	Max Temp	Relative Humidity	Wind Speed	Sunshine hours	Radiation	ETo
	mm	°C	°C	%	km/day	hours	MJ/m²/day	mm/day
June	222.78	25.10	33.00	77.00	130.00	5.30	18.10	4.38
July	163.09	25.30	32.20	82.00	121.00	4.20	16.30	3.87
Aug	168.53	24.90	32.30	84.00	104.00	4.60	16.40	3.75
Sep	168.82	24.00	31.70	86.00	95.00	5.70	16.60	3.62
Oct	105.17	21.70	31.40	74.00	86.00	7.10	16.20	3.51
							Average ET_o	3.83

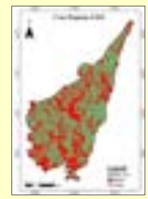

Fig. 5 Rice Mapping of KIS

Crop Coefficient (Kc) Map

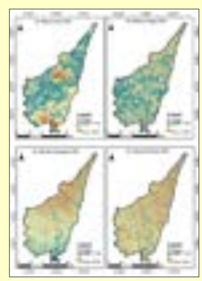

Fig 6. Kc Map of July to November 2022

Actual Evapotranspiration Map

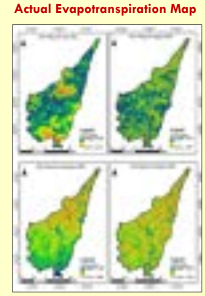

Fig 7. AET Map of July to November 2022

Table 5. Calculations of Different Indicators

Performance Indicators	Standard Value	Calculated Value	Remarks
Relative Water Supply	1	1.01	Beyribey et al. (1997)
Depleted Fraction	0.6-1.1	0.99	Bastiaanssen (2001)
Relative Irrigation Supply	1	1.02	Molten et al. (1998)
Irrigation Efficiency	100%	97.94%	Bandara (2003)
Output Per Unit Irrigation Supply (US\$/m^3)	0.04 to 0.10	0.19	Molden et al. (1998)
Output Per Unit Water Consumed (US\$/m^3)	0.10	0.20	Molden et al. (1998)

4. Conclusions

- Overall performance of the Kankai Irrigation System (KIS) is satisfactory, but there is scope for improving the irrigation efficiency of this project.

5. Recommendations

- Field data should be updated more frequently, i.e., cropping patterns, irrigated areas, irrigation potential details, etc.
- Water delivery should be based on the CWR and irrigation scheduling.
- The modern intervention of technologies like canal automation as a pilot project may be introduced by integrating remote sensing and GIS techniques in a computerized mechanism.
- Avoid field-to-field irrigation. Farmers should irrigate their fields by field channels.

6. Acknowledgements

- It is my great pleasure to express my sincere gratitude to the Department of Water Resources Development and Management, IIT Roorkee and Kankai Irrigation Management Office, Gainde Jhapa.

References:

1. Planning and Design of Strengthening Project, M.3 Hydrology and Agro-meteorology Manual(1990), Department of Irrigation (DoI), Nepal.
2. Narziev, J., Nikam, B., & Gapparov, F. (2021). Infrastructure mapping and performance assessment of irrigation system using GIS and remote sensing. E3S Web of Conferences, 264. https://doi.org/10.1051/e3sconf/202126403005.

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

Sustainability of Inter-Basin Water Transfer Under Climate Change: A Case Study of the Bheri Babai Diversion Project, Nepal.

ID-18

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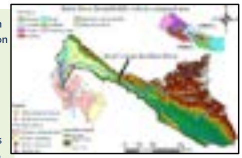
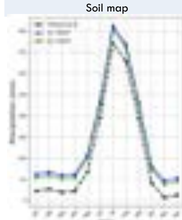
1 Context & Objectives

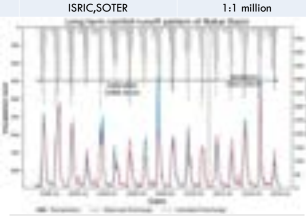
- The Babai Basin (BaRB), lying in Middle mountain Zone in Nepal, is crucial for agriculture production in Nepal, and faces water deficit conditions due to increasing irrigation water demand.
- Furthermore, the impacts of climate change on irrigation water resources have been drawing attention.
- Although the Inter-basin Water transfer project is ongoing to transfer water (40m^3/s) from Bheri to Babai River Basin, no comprehensive study exist to project the streamflow in BaRB considering both the impact of climate change and water diversion.
- This study assesses the impact of climate change on streamflow, crop water requirements (CWR), and irrigation water requirements (IWR) in BaRB using the Soil and Water Assessment Tool (SWAT) and CROPWAT 8.0, with climate data from three General Circulation Models (GCMs).



2 Data and Methodology

Dataset(unit)	Source	Spatial/Temporal Resolution
Observed daily precipitation (mm)	DHM Nepal	7 stations (1990-2015)
Observed daily max and min temperature (°C)	DHM Nepal	3 Stations (1990-2015)
Observed daily river discharge (m^3/s)	DHM Nepal	1 Station (1990-2015)
Digital elevation model (DEM) (m)	SRTM, USGS https://earthexplorer.usgs.gov	30m*30m
Land use map	ICIMOD	30m*30m (for 2010)
Soil map	ISRIC,SOTER	1:1 million





The water cycle in the SWAT model is based on the water balance equation

$$SW_t = SW_o + \sum\left(R_{day} - Q_{surf} - E_a - W_{seep} - Q_{gw}\right)$$

$$NSE = 1 - \left[\frac{\sum_{i=1}^{n}(Q_i^{obs} - Q_i^{sim})^2}{\sum_{i=1}^{n}(Q_i^{obs} - Q^{mean})^2}\right]$$

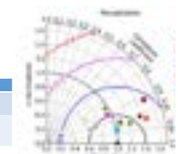
$$PBIAS = \left[\frac{\sum_{i=1}^{n}(Q_i^{obs} - Q_i^{sim}) * 100}{\sum_{i=1}^{n}(Q_i^{obs})}\right]$$

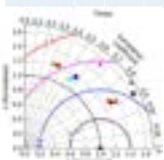
$$R^2 = \frac{\left[\sum_{i=1}^{n}(Q_i^{obs} - Q_{mean}^{obs})(Q_i^{sim} - Q_{mean}^{sim})\right]^2}{\sum_{i=1}^{n}(Q_i^{obs} - Q_{mean}^{obs})^2 (Q_i^{sim} - Q_{mean}^{sim})^2}$$

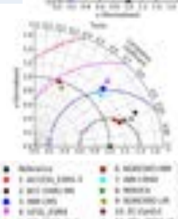
	NSE	PBIAS	R^2
Calibration (1999-2010)	0.87	-4.9%	0.87
Validation (2011-2015)	0.88	+10%	0.89

- CMIP6 climate model data were utilized for climate change projections in the basin
- To identify the most suitable General Circulation Model (GCM), a Taylor Diagram was employed
- Bias correction was done using Quantile Mapping (QMAP)
- Future projections are analysed across three time windows:

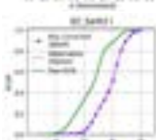
•Near Future (NF): 2025–2050
•Mid Future (MF): 2051–2075
•Far Future (FF): 2076–2100

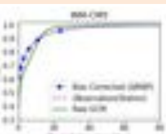


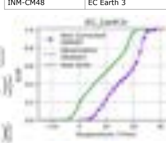




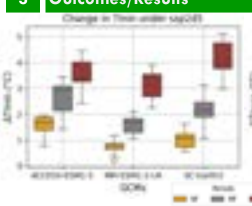
Precipitation GCMs	Temperature GCMs
INM-CM5	ACCESS_ESM1_5
MPI_ESM1_2 LR	MPI_ESM1_2 LR
INM-CM48	EC Earth 3



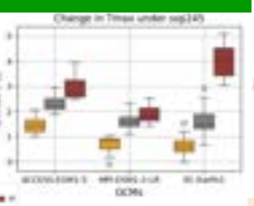




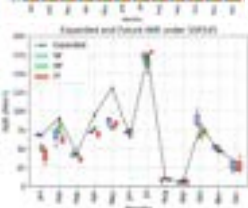
3 Outcomes/Results



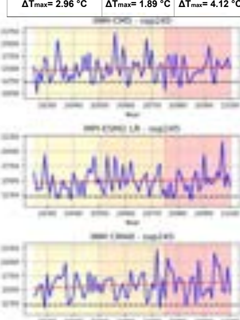
ACCESS ESM12 LR	MPI ESM12 LR	EC Earth 3
ΔT_{min}=2.96 °C	ΔT_{min}=1.89 °C	ΔT_{min}=4.02 °C



ACCESS ESM12 LR	MPI ESM12 LR	EC Earth 3
ΔT_{max}= 2.96 °C	ΔT_{max}= 1.89 °C	ΔT_{max}= 4.12 °C

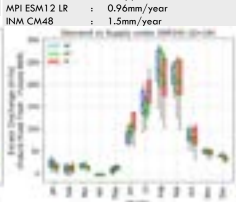


"Although CWR is projected to rise, increased precipitation will reduce the IWR."



Rising rate of precipitation by 3 GCMs (SSP245)

INM CM5	:	0.95mm/year
MPI ESM12 LR	:	0.96mm/year
INM CM48	:	1.5mm/year



4 Key Message

- The rise in temperature is projected to increase the Crop Water Requirement (CWR) in the Babai River Basin (BaRB) by around 10% in the future.
- Despite the increase in CWR, the Irrigation Water Requirement (IWR) is expected to decrease due to increased precipitation.
- If the diversion from the Bheri River Basin (BRB) is assured, the BaRB will no longer be a water deficit basin.
- However, a projected 40% reduction in BRB discharge, along with an equivalent reduction in diversion to BaRB, could lead to irrigation water stress in the BaRB—particularly in April.

Acknowledgements: I sincerely thank the ADB-JSP Program for the scholarship to pursue my master's at Tokyo Tech, and Prof. Tsuyoshi Kinouchi for his valuable guidance and support throughout this research."

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

IWMI International Water Management Institute

Brihat Bagmati Irrigation Project: Sustainable Irrigation Infrastructure for Agricultural Transformation in Madhesh

ID-19

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1 Context, Objectives & Financing

Location:

- *Bagmati Irrigation Project, Karmaiya Sarlahi (Madesh Province) Nepal.*

Context and Rationale:

Initial studies were conducted as early as 1967–1972 (UNDP-FAO), and major works began in the 1980s with foreign support.Inter-Basin Water Transfer (IBWT) through the Sunkoshi–Marin Diversion, supplementing Bagmati River flow.

Objectives:

✔ *provide year-round, reliable irrigation to 1,22,000 ha of land.*
✔ *enhance agricultural productivity and food security.*
✔ *modernize and expand the existing canal network.*

Duration:

- *Seven 7year (2082-2089) years of persistent hard work and on-going*

Financing Mechanism: GoN and DP

3 Outcomes/Results

1. Enhanced Irrigation Coverage: Irrigation service to 1,22,000 hectares

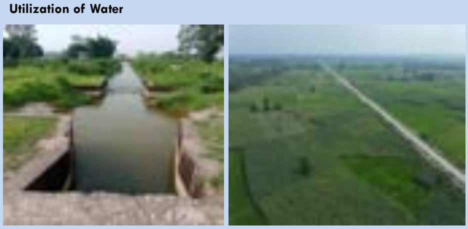
2. Increased Agricultural Production & Productivity: Per hectare return increases from Rs. 1.29 lakh to Rs. 2.86 lakh.

3. Economic Returns & Viability: Economic Returns & Viability: EIRR 17.32% and B/C ratio:1.79

4. Livelihood and Employment Benefits/Climate-Resilient Agriculture/Modernized and Sustainable Infrastructure/Institutional Strengthening

- **Rehabilitation of Existing System /Water Maangment**

- **Utilization of Water**



Acknowledgements:

- **Thanks to all who supported in the endeavor**

2 Project Implementation

Initiative:

Initial studies were conducted as early as 1967–1972 (UNDP-FAO), and major works began in the 1980s.

2.Phase wise Planning and Const:

Phase-2.

Stage-1

1) Sarlahi (West of Jhim River)
22,600 Ha./ 24.25 Km
2) Rautahat (East of Lalbakaiya)
23,000 Ha/ 28 Km
Total - 45,600Ha

Construction started in 2035/2036

Stage-2

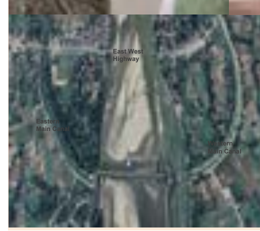
Bara (West of Lal Bakiya & East of Pasaha)
Total - 22,400 Ha.

High Dam Construction
1) Sarlahi (East of Jhim)
2) Mahottari
3) Dhanusha (Nagarain)
Additional - 54,000 ha

Grand Total=45,600+22,400+54,000 = 1,22,000 Ha
Eastern 76,400 ha (64.40 cumec) Western 45,400 ha (48.30cumec)

Key Activity:

1. Rehabilitation of Existing System of Existing 38,600 Ha
2. Command Area Development (CAD) of 7,600 Ha of Existing System
3. Extension of Irrigation Coverage: 76,400 Ha and Integration of IBWT Project.
4. Organizational Setup: Four offices under a central project directorate.



Key Message (Innovation and Significance)

✔ *Inter-basin water transfer for irrigation*
✔ *The project is a game-changer for water management in Nepal.*
✔ *It sets an example of large-scale, sustainable irrigation integrated with climate adaptation and economic upliftment.*

BABAI IRRIGATION PROJECT, BAIDI, BARDIYA

ID-20

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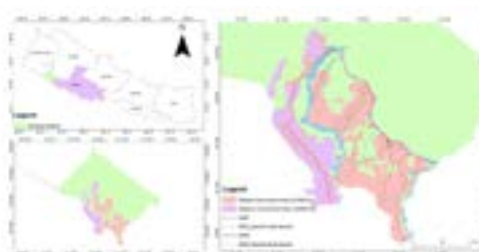
1 Context, Objectives & Financing

Rationale and Objective of the project

The Babai Irrigation Project started in fiscal year 2045/46 BS fully funded by the Government of Nepal, aims to provide year-round irrigation in Bardiya district to about 36,000 hectares of cultivable land across six local municipalities. The project features two main canal systems: the Eastern Main Canal, which irrigates 21,000 hectares, and the Western Main Canal, covering the remaining 15,000 hectares. Once completed, the project is expected to significantly boost agricultural productivity, improve food security, and uplift the livelihoods of thousands of farming households in the region and helps to achieve the national goal of Prosperous Nepal, Happy Nepali.

Location of the project



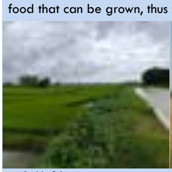
Duration and financing of the project:

The total estimated cost of the Babai Irrigation Project as per updated/revised master procurement plan is at NPR 18 arab 96 crore 30 lakh 44 thousand, with the target of completing the project by fiscal year 2082/083 BS. However, due to the impact of COVID-19 and the lack of budget allocation in previous fiscal years as projected by the approved master plan, both the cost and timeline of the project are expected to increase. As a result, preparations are underway to revise the master plan with a new target of completing the project by fiscal year 2085/086 BS. So far, NPR 14 arab 88 crore 67 lakh has been spent, and 76.50% of the total work has been completed.

3 Results

Major Activities	Targets set as per approved Master Plan	Achievements till date
Productivity (FY 2081/82, Paddy)		6.81 ton/ha
Syphon Construction (551 m long and 30 Cumecs capacity)	1 No	Completed
Land Acquisition	576.56 ha.	397.42 ha.
Eastern Main Canal	34.5 km	Completed
Western Main Canal	41.4 km	29.7 km
Branch/ Sub Branch Canals	454.2 km	312 km
Command Area Protection Works (CAP)	32.18 km	28.44 km
Command Area Development Works (CAD)	**36000 ha.**	**26500 ha.**

Completion of Construction of Canal Systems and CAD works is crucial for delivering water to farmland, which directly impacts agricultural productivity and the types of food that can be grown, thus transforming the food supply.


Paddy Cultivation


Wheat Cultivation


Mustard Cultivation

Acknowledgements

Babai Irrigation Project would like to thank the Department of Water Resources and Irrigation for organizing the Irrigation Seminar with the theme "Water for Agri-Food System Transformation" and providing the opportunity to present the poster about project.

2 Project Implementation

Phase I: Weir cum Bridge (315m) and Eastern Main Canal (28 km) –completed in 2058 BS


Weir Cum Bridge (315m)


Settling Basin

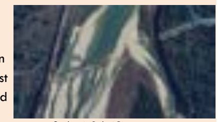

Eastern Main Canal

Phase II: Started with Syphon in Babai River.

Ongoing Works and Future Works

Eastern Canal System: Tender Award has been completed and construction work has just commenced for the final section construction and strengthening of B2 branch.

The study for the branch/sub-branch canals originating from the final section of the Eastern Main Canal (Ch. 28+000 - 34+000) and command area development work south of the Hulaki Sadak has been completed. Tendering can be done upon receiving source agreement on next FY.


Syphon in Babai River


Lining in Branch/ Sub-branch Canal (Eastern System)

Western Canal System: Construction work on the final section of the Western Main Canal (Ch. 28+000 - 41+400) and 4 branch canals is progressing rapidly under two awarded contract packages.

The study for the branch canals originating from the final section of the Western Main Canal (Ch. 32+000 - 41+400) and CAD work has been completed. tendering can be done upon receiving source agreement on next FY.


Suhelwa Branch

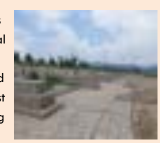

Covered Canal (Western Main)


Syphon in Western Main Canal


Drain Under Pass

CAD work is underway in areas where branch/sub-branch canal construction has been completed. Contract award has been completed and construction work has just commenced for the remaining **command area protection works.**


CAD Works


CAP Works

Challenges:

1.Balancing Water Demand & Supply and addressing the Year-Round Irrigation through trans-basin diversion (BBDMP).

2. Budget allocation as per MPP and timely completion of project with no cost overrun.

3. Preparedness for extreme flood events (flood in 2013 damaged road at headwork and prevented damage to headworks but syphon was washed away causing obstruction to supply of water towards Dhodhari and Jamti Bargada canals.)

4. Land acquisition is always challenging as locals demand either the provision of alternative land plots or high price for land.

5. Implementing project construction activities in line with canal operation plan and achieving targets set. Also, in National Park and its buffer zones, there is always delay in construction activities.

4 Key Message

- Budget as per Master Procurement Plan must be sanctioned to complete a project on time otherwise it would cause both time and cost overrun.
- Well organized and structured WUAs is mandatory for smooth implementation of any irrigation project.
- Irrigation and agricultural offices linkages at project implementation level is necessary for achievement of targets set.

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

CMIASP-AF: Towards Agri-Food System Transformation

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ID-21

1 Context, Objectives & Financing

LOCATION: **34 Districts**

FMIS:
Bagmati Province
Madhesh Province
Koshi Province
AMIS:

Batch I - 72 FMIS, 3 AMIS
Batch II - 56 FMIS, 2 AMIS
Batch III – 35 FMIS, 2 AMIS
Total – 169 ISPs

CONTEXT AND RATIONALE:

20,000 FMIS: 6,40,000 Ha → Great potential in farmers for revitalizing agricultural sector ← GoN Intervention

OBJECTIVES:

- To increase agricultural production with farmers participation;
- Rehabilitation of old systems to increase performance and minimize the losses of conveyance system;
- Enhance the participatory mechanism
- Institutional strengthening of farmers for appropriate O&M;
- Adoption of improved agricultural practices.

FINANCING MECHANISM
Total: $67.17 M

9 years (2014 to 2022)

2 Project Implementation

The **Community Managed Irrigated Agriculture Sector Project (CMIASP)** and its **Additional Financing (CMIASP-AF)** in Nepal aimed to reduce rural poverty and promote inclusive growth by improving farmer-managed irrigation systems (FMIS) and supporting agriculture and livelihoods.

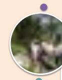
Challenges for Implementation and Remedies:

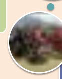
Challenge	Issue	Remedy
Overambitious design, poor feasibility, and site verification caused setbacks	**Design Delays**	Revised schedules and stakeholder consultations
Weak coordination and staff turnover	**Institutional Capacity**	Training, clearer roles, and policy reforms
Women's leadership and GESI integration weak despite targets	GESI Shortfalls	Training, policy reforms, and capacity-building
Non-functional MIS and data gaps, limited oversight	Monitoring Issues	Regular updates and MIS sustainability

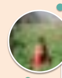
Programs only partially need-based → **Agriculture & ICWM** → Improved delivery with more field staff and alternative approaches

Non-functional MIS and data gaps, limited oversight → Monitoring Issues → Regular updates and MIS sustainability

TOWARDS SUSTAINABILITY

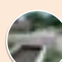

Socially inclusive and equitable development


Farmers and their Association Strengthened

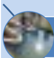

Increased food sufficiency

Increased Crop Yields & Crop production


Promoted Agricultural Extension

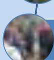

Improved Irrigation Facilities

3 Results

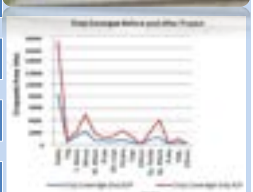

Rehabilitated 169 irrigation subprojects, benefiting 26,464 ha under Additional Financing

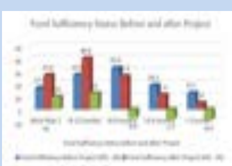

Exceeded irrigation coverage targets.

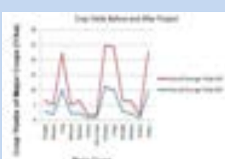

Significant gains in crop yield and cropping intensity.


Met Gender Equality and Social Inclusion (GESI) goals, with strong WUA participation.


Environmental and social safeguards were effectively handled using a voluntary land donation framework (Category C for resettlement).







4 Key Message

Community-driven approaches with strong institutional support improved irrigation, boosted agricultural productivity, and enhanced rural livelihoods sustainably.

Project exceeded goals, proving the value of empowering Water Users' Associations and social inclusion; increased irrigated land, crop yields, and community involvement make it a replicable model for rural agriculture and food security.

Acknowledgements:

Project Completion Report CMIASP-AF 2022
Irrigation Management Division

Mechanized Irrigation Innovation Project, Jawalakhel, Lalitpur

ID-22

Ajay Raj Adhikari[1,*]
Mechanized Irrigation Innovation Project, Department of Water Resources and Irrigation
**Corresponding Author's Email: miip.irrigation@gmail.com*

1 Context, Objectives & Financing

Location:

- *16 local levels of Sarlahi and Rautahat Districts*

Context and Rationale:

- *Ground Water Irrigation Schemes through deep tube wells (GWIS);*
- *Electric VSD/VFD pumps;*
- *Contribution to dry part of the country to enhance agriculture yield;*
- *Sustainability of irrigation system envisaged in MOM through PPP modality and establishment of irrigation management company;*
- *DBO modality: 1st of its kind in irrigation sector in Nepal ;*

Objectives:

- *To increase year-round access to irrigation water in the Terai by constructing a large-scale network of tube wells, pipe based distribution system and dedicated electricity distribution networks*
- *On-demand irrigation services will be provided to the farmers by the MOM operator against payment through prepaid metering systems*
- *Specific institutional and capacity development support for the water users to develop self-sustained and long-term crop intensification and diversification, and market support services.*

Duration:

- *Design build period four years followed by 10 years of O&M*

Financing Mechanism:

- *Asian Development Bank loan and grant (80%) and Government of Nepal (20%)*

3 Outcomes/Results

1. Improved Irrigation Access and Reliability

- Installation of about 500 GWIS to provide assured round the year irrigation services at the nearest control point.
- Dependency of monsoon rains is over and year-round farming is awaiting.

2. Innovation Through Prepaid Metering System and VFD

- Use of prepaid metering system using smart cards, allowing farmers to pay for water uses digitally, promoting efficient and equitable distribution;
- Reduced water wastage and improved irrigation efficiency among farmers.

3. Increased Agricultural Productivity

- Climate-resilient and diversified cropping practices established;
- Mechanized irrigation allows farmers to grow multiple crops per year, including high-value crops like vegetables and fruits and reduces the risk of crop failure significantly and,
- Crop yields improves significantly due to assured irrigation, resulting in better income and food security.

Fig: Increase in production due to irrigation

4. Empowerment of Farmers and Local Communities

- The project benefits over 121,000 farmers, many of whom were previously marginalized by lack of infrastructure.
- Strengthens the capacity of Water User Groups and encouraged women's participation in water governance.

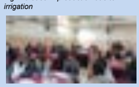


Fig: Involvement of local level during project planning phase

5. Enhanced Climate Resilience

- Reducing vulnerability to drought,
- Promote sustainable water management practices in the face of climate variability.

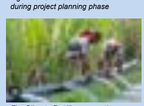


Fig: Climate Resilience practice.

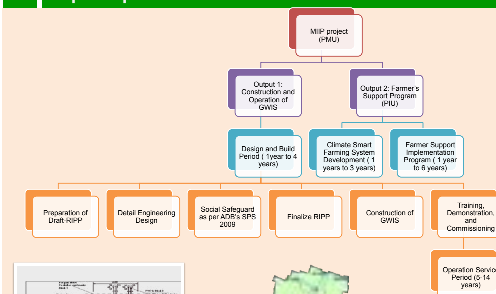
6. Sustainable Operation Through Public-Private Partnership

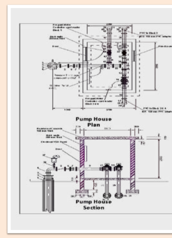
- Adopted the Design-Build-Operate (DBO) model, where private contractors not only construct the system but also operate and maintain the irrigation systems on behalf of irrigation management company ;
- Ensure long-term system reliability and reduced burden on government resources and,
- The collected irrigation tariff is deposited in Escrow account to cover the cost of management, operation and maintenance and remaining money will be fix deposited for Asset Replacement Fund.

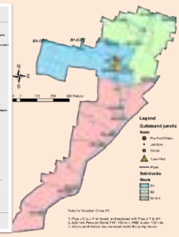
Acknowledgements:

We gratefully acknowledge the on going support of the Government of Nepal, Asian Development Bank and local communities in making the Mechanized Irrigation Innovation Project a successful one for sustainable and climate-resilient agriculture.

2 Project Implementation







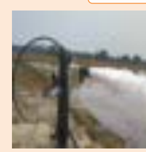


Fig: Testing of Tube-well

MIIP Pilot Scheme Design:

Fig: Variable Frequency Drive- to regulate the flow discharge

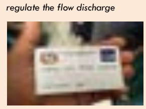


Fig: Pre-paid Card to Farmers

Fig: Tele-Prepaid Meter System (TPPM)

Fig: Variable Frequency Drive- to regulate the flow discharge

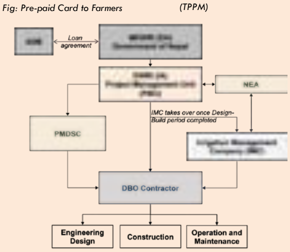


Fig: Project implementation arrangement

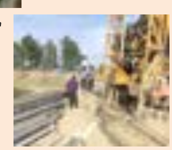


Fig: Tube-well Construction

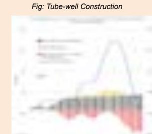


Fig: Economic model for MoM Sustainability

4 Key Message

- MIIP brings innovative irrigation technology ;
- It provide reliable year-round irrigation services through deep tube wells and prepaid metering system;
- It transforms lives of 1,21,000 people by increasing the income;
- Ensure smart water management with prepaid metering systems reduces waste and ensures fairness and,
- Ensures system sustainability through introduction of PPP modality in management, operation and maintenance.

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May 2025 [Thursday], Kathmandu, Nepal

Status of Sunsari Morang Irrigation Project

ID-23

Sunsari Morang Irrigation Project
Corresponding Enail: smip_Biratnagar@yahoo.com

1 Context, Objectives & Financing

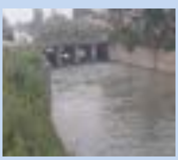
The Sunsari Morang Irrigation Project (SMIP), initially designated as the Chatara Canal Irrigation Project (CCP) with the objective of providing year- round irrigation facility to cultivable land of Sunsari and Morang district resulting food security, stands as the largest irrigation system in Nepal. Constructed under a bilateral agreement between Nepal and India, the Government of India undertook the project's construction, which commenced in 1964 and concluded in 1972.

Location map of SMIP head works

The Government of India formally handed over the operational and maintenance responsibilities to the Nepal Government in 1975, leading to the rechristening of the project as the Sunsari Morang Irrigation Project (SMIP). Encompassing a command area of 68,000 hectares, with 40,000 hectares situated in Sunsari District and 28,000 hectares in Morang District, SMIP boasts the Chatara Main Canal (CMC), diverting from the Koshi River at Chatara with a designed discharge of 45.3 cumecs, traversing a 53-kilometer southeast trajectory. The comprehensive gross command area of SMIP spans approximately 112,000 hectares, extending between the Koshi River in the west and the Bakra River in the east.

3 Outcomes/Results

Different Structures constructed during different Stages and Phases



Chatara Main Canal

New Side Intake

Old Intake

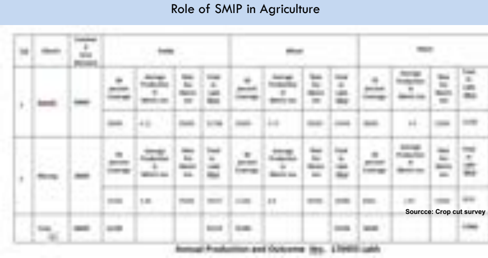
Dredger Machine

Desilting Basin

Budhi Aqueduct

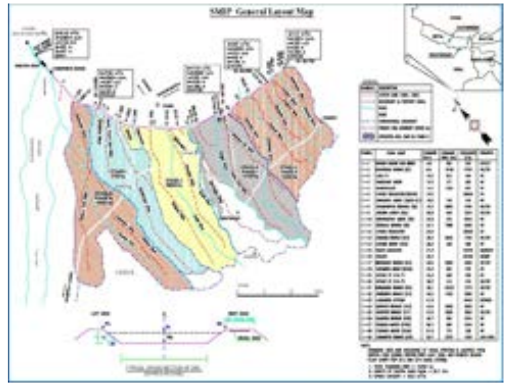
- After the different stages and phases, the water management problems have been greatly reduced by the adaptation of a simply structured irrigation system under the stage - II and stage - III, phase - I project and the participation of farmers from project design to system's operation and maintenance (O and M) resulting the following annual productivity.

Role of SMIP in Agriculture



Acknowledgements: All the members of the Sunsari Morang Irrigation Project, related stakeholder, Professionals and researchers.

2 Project Implementation



The Sunsari Morang Irrigation Project (SMIP) was originally implemented as Chatra Canal project (CCP) under the Grand Aid from the Government of India (1964 - 1975).

The initial infrastructure handed by the Government of India included a side intake (Now called as Old Intake), the 53-kilometer long Chatara Main Canal (CMC), 19 branch/distributary canals covering 203 kilometers, and 234 kilometers of minor canals.

The SMIP has been rehabilitated since 1978 by the financial assistance of International Development Association (IDA). The rehabilitation is divided into three stages of command area development and mitigation of siltation problem, namely Sunsari Morang Headwork Project (SMHP) as follow:

Stage -I : Development of Shankarpur Distributary and its adjacent area (9750 ha) including the Koshi river control and sediment control device. (April 1978 - June 1986).

Stage -II : Development of Sitagunj and Ramgunj Distributaries area (1600 ha) including improvement of Chatara Main Canal (CMC) and related structures (November 1988 - July 1994).

SMHP : Construction of a new intake, a desilting basin, electrically operated dredgers and micro hydro power station in the (March 1993 - November 1995).

Stage -III : It comprises three phases, with Phase I executed from 1997 to 2001, while Phase II includes cad work in 29000 ha of land and Phase III as per master plan are yet to be implemented. Phase I- Development of Biratnagar and Harinagara distributaries (15100 ha) including CMC restoration, Budhi aqueduct and Koshi flood embankment..

4 Key Message

- The existing condition of the Sunsari Morang Irrigation Project (SMIP) reveals a significant challenge in water extraction from the river. Despite initial developments covering 38,000 hectares in various stages, operational issues have surfaced within the system. The construction of a new side intake, boasting a capacity of 60 m3/sec, aimed to facilitate water intake into the Chatara Main Canal (CMC) under the SMHP program. However, the lack of a robust diversion structure to manage sedimentation has led to substantial morphological changes in the river, notably impacting the intake's discharge capacity.

- Downstream of Chatara, the Koshi River's flow across an alluvial fan has resulted in bifurcation into two channels at the head. While the main stream flows on the right side, a secondary channel supplies water to the CMC on the left bank. Due to water requirements and the system's disability to abstraction water during the dry season, a temporary diversion by earthen dam is constructed on an annual basis, resulting in a significant capital cost burden.

- This predicament underscores the pressing need for urgent intervention and modernization to address these operational challenges and ensure sustainable water management, thereby securing reliable year-round irrigation facilities for the command area which will secure food security.

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

Improved Irrigation and Agriculture Service Enhanced the Livelihood and Farm Production

ID-24

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1 Context & Objectives

Introduction & Background

- Nepal's oldest and largest Farmer Managed Irrigation Systems: Rani (1896), Jamara (1905), Kulariya (1915) were traditionally built and operated by the Tharu community.
- In 2010 the Government of Nepal merged them into the Rani Jamara Kulariya Irrigation Scheme (RJKIS) covering 14,300 ha.
- Recently the project has planned to cover 38 000 ha.

Challenges Prior to Project

- Unreliable supply. flood-prone intakes with high dry-season losses.
- Inequitable water distribution: head-tail conflicts.
- Low cropping intensity (~160%);
- Labor intensive constructions if intake every year.
- Women's participation in WUAs below 19%.

Project Finance (in USD millions)	
Government of Nepal	125
World Bank	66
Water Users Association	1.3

3 Results

Acknowledgements:

1. Mr. Devesh Belbase: Water Governance expert
2. Ms. Rubika Shrestha:Task Team Leader ,World Bank
3. Dr. Bhesh Raj Thapa: Water resource expert

2 Project Implementation

Interventions

Constructed permanent intake at Karnali and modernized canal networks

Strengthened WUAs with 33% women.

Multipurpose system: 4.71 MW hydropower generation for revenue generation and clean energy.

Introduced improved farming technology, farming equipment and machinery, fertilizers, and seeds

Implemented watershed conservation, erosion control flood protection, and dolphin-friendly embankments.

Built 250 km of rural roads and access to market .

4 Key Message

The Rani Jamara Kulariya Irrigation Project has revitalized a historic farmer-built system with modern engineering and robust institutions. It exemplifies how investing in irrigation infrastructure, linking agriculture, and community capacity can drive rural development: water is now equitably distributed to over 25,000 households, yields and incomes have surged, women and men share in governance. This success story offers a model for modernizing other farmer-managed irrigation schemes across South Asia – showing that with the right support, even century-old systems can be transformed into engines of inclusive growth for the future.

Mega Dang Valley Irrigation Project : Efficient Water Use Strong Harvests – Sustainable Irrigation for Agricultural Transformation in Dang Valley

ID-25

Top Bahadur Khatri Chhetri
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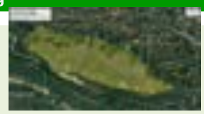
1 Context, Objectives & Financing

Location:



- *Mega Dang Valley Irrigation Project, Tulsipur,Dang, Nepal.*

Context and Rationale:

With the main objective of finding a direction towards economic prosperity by increasing the agricultural production , the Mega Dang Valley Irrigation Project has been implemented by the Government of Nepal on 2016 (2073 BS).

Objectives:

✔ *provide year-round, reliable irrigation to 56,000 ha of land in Dang Valley.*

✔ *Promote Sustainable Water Management.*

✔ *Improve Socio Economic Condition.*

Duration:

- *Ten 10 year (2074-2084) years of persistent hard work and on-going*

Financing Mechanism: GoN

3 Results

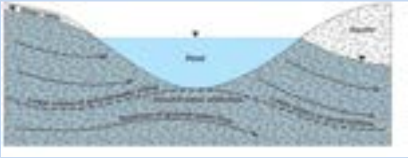
1. Enhanced Irrigation Coverage:

- *Rehabilitation/modernization and strengthening of existing surface irrigation systems- 6000 Ha*
- *Storage of water from rivers within the Dang valley- 2250 Ha, 35 nos. of storage has been constructed, Some Storage Distribution system is yet to be developed*
- *Groundwater Irrigation System- 730 Ha,22 no of Groundwater system(Deep Tubewell) has been completed including distribution system.*

Pic1- Happy Farmers-Irrigation from storage Component- Deserted Land turned into greenery

Pic 2 –Farmer's Review In Newspaper

Pic 3-Reservoir Tank of Storage Pond



Pic 4- Ground Water Recharge through storage pond

Acknowledgements:

- **Thanks to all who supported in the endeavor**

2 Project Implementation

Component

Surface Water → **Identification**

Storage

Ground → **Identification**

Identification

Survey, Design(Factors consideration Discharge, Command Area, Catchment Area, Soil Properties, Economic and Financial Analysis, Irrigation System)

If OKAY

Construction and Implementation

Storage
Soil Embankment-Spillway-Stone pitching-Lifting/Gravity-Reservoir Tank-Distribution

Groundwater
Boring-Pump house–Electrification-O/H tank-Pump Installation, fittings-Distribution

Challenges :

- **To provide sufficient Irrigation facilities during Dry Period**
- **Unavailability of suitable soil for construction of Embankment for Storage Pond**
- **Depletion of Ground Water Table**
- **Most of the River are Non-Perennial River.**

How are they being tackled:

storage pond projects

- **Helps in groundwater recharge.**
- **Impounding surplus water during the monsoon and irrigate during Dry period.**

Surface Irrigation System

- **Improves water efficiency, minimize water loss**

Ground Water Irrigation system

- **Reduces Dependency on Monsoon**
- **On-Demand Access**

4 Key Message (Innovation and Significance)

✔ *Use groundwater wisely— protect it, use it efficiently.*

✔ *Storage ponds: secure irrigation today, sustain water for tomorrow .*

✔ *Surface Irrigation: Efficiency Focused.*

Irrigation Management Information System in Nepal: Current Status, Opportunities & Challenges

ID-26

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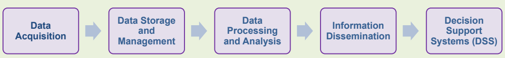
1 Background

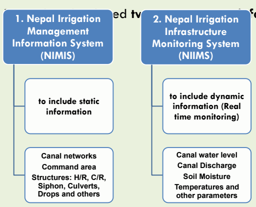
Irrigation Management Information System (IMIS) is a system that integrates **data, hardware, software, and people** to support **informed decision making** in the planning, operation, and management of irrigation systems.

It's a tool that helps to **optimize water use,** assist in **water balance** (supply/demand side), improve **irrigation efficiency ,** enhance **agricultural productivity,** ensure **equitable water distribution, real time monitoring** of irrigation systems, and better **planning and decision making.**

Typical Components of IMIS



- National Irrigation Policy 2080, **Strategy 9.10** has focused in **developing integrated management information system in irrigation sector** that would collect information and data about irrigation projects from **central, provincial and local level governments.**
- **Department of Water Resources and Irrigation(DWRI)** have been developing an **integrated management information system** for systematic collection of data and information relating to irrigation sector with the **goal to assist in decision making** in the field of irrigation water management and future infrastructural planning.



3 Opportunities

- **NIMIS and NIIMS** can be **developed as central database information system** integrating information and data from **central, provincial and local level governments.**
- **Optimization** of available water for irrigation use through **improved irrigation efficiency**
- **Enhancing agricultural productivity** (timely and adequate irrigation guided by the insights of Management Information System leads to better crop yields)
- Ensuring **equitable water distribution** (monitoring of water flow and distribution across the irrigation system)
- Increase **in transparency and accountability** (centralized data platforms ensures to make water management process transparent)
- Enable **Real-time Monitoring** (Integration of technologies such as telemetry that allow for continuous tracking of critical parameters like discharge, soil moisture, rainfall and others)
- Supports for **better planning and informed decision making** (accurate data enables informed decision making about water availability, crop water demand, irrigation scheduling, infrastructure maintenance plan and upgrades and policy development)
- Facilitate in **Climate Change Adaptation** (Data on changing weather patterns, water availability and demand can assist in managing irrigation under varying climatic scenarios)
- Better **Preparedness from Disasters** like flood and drought

Acknowledgements:
The authors would like to acknowledge everyone associated with NIMIS and NIIMS work at Department of Water Resources and Irrigation.

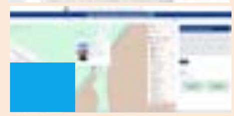
2 Current Status

NIMIS:

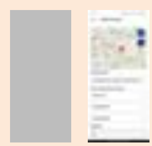
Main goal of NIMIS is to **develop and establish** an operational system to **integrate MIS database with GIS** and **online reporting systems** (includes developing a location-based information system for unlimited users with varying access rights and data / information needs which can publish results and managing database based on geo-spatial technology for a given region and sector/purpose)

At Present **NIMIS Database system** includes:

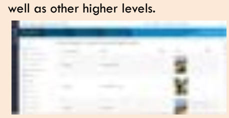
- inclusion of scattered **FMIS systems**
- detailing all the structures at the **AMIS systems**
- Basic information on **Groundwater and Non-conventional Irrigation Systems.**



- This System **demands continuous operation and update** of the existing database (**Asset Inventory data : Rating of structures** that contributes **to develop Asset Management and Maintenance Plan**)
- Provision of **NIMIS Mobile Application** to support and enhance at **different users' level** to assist in **viewing and updating the information** from the field level as well as other higher levels.



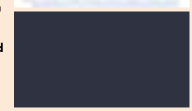
Addition of new FMIS into NIMIS database using NIMIS Mobile Application



Updating status of Asset Inventory of Irrigation Infrastructure in NIMIS database

NIIMS:

- A dynamic information system developed as a real time monitoring systems **Nepal Irrigation Infrastructure Monitoring System (NIIMS)** for monitoring the status of irrigation water flow through the main canals at various large irrigation systems across the country.
- Developed with a goal **to assist in operation and maintenance** of the irrigation system (assist in irrigation scheduling, water balancing, system management)



4 Challenges

- Limited Infrastructure and Connectivity
- Technical Expertise and Capacity Building
- Data Management and Interoperability
- Financial Constraints
- Institutional and Governance Issues
- Sustainability and Ownership

5 Key Message

- Developing NIMIS and NIIMS as a **Centralized Irrigation Database** can provide accurate data supporting water managers in **making accurate decisions for improving irrigation water management** (Less Conflict, Equitable Distribution).
- MIS can assist in **optimum agricultural production** from existing irrigation infrastructures with **improved irrigation efficiency through informed decision making**
- **Maximizing the return of scarce financial resources** invested in irrigation infrastructure as data driven approach help in **identifying and prioritizing the maintenance** need in the irrigation system

Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

Data-Driven Insights for Policy: Evaluating the Impact of Irrigated Areas on Crop Yields through Google Earth Engine and Statistical Data

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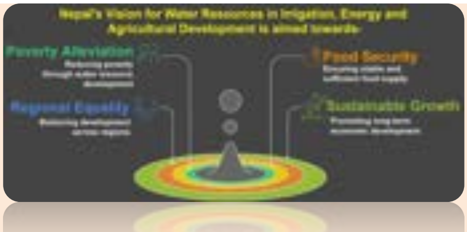
[1] Ministry of Water Supply, Irrigation and Energy, Koshi Province, [2] Nepal Development Research Institute, [3] Kathmandu Metropolitan City Office, [4] Institute of Engineering, [5] Water Resources Research and Development Center
**Corresponding Author's Email: sarojioe@gmail.com*

ID-27

1 Background and Objective

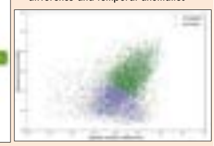


Ultimately, transforming Nepal into a prosperous and self-reliant nation

- Huge investment is pumped towards the development and expansion of irrigation and agriculture sector. Irrigation Master Plan, 2024 aims to expand and improve irrigation services to 2.26 MHa of command areas across Nepal.
- To evaluate the contribution of irrigated command areas, this study aims to first accurately map spatiotemporal dynamics of irrigated agricultural areas and hence, the subsequent crop yield from selected command areas.

2 Methodology

Scatter plot of spatial relative difference and temporal anomalies



- Using GEE and ICIMOD cropland data, MODIS Normalized Difference Vegetation Indices (NDVI)
- and applying the concept of temporal stability, its two indices, Spatial Relative Differences and Temporal Anomalies maps were generated considering of time of peak of NDVI
- And using the K-means algorithm, classification of irrigated and rainfed land was distinguished.
- Results were analyzed across selected irrigation projects to correlate irrigated areas vs crop yields.

3 Results and Implications

Results across Nepal

Average irrigated areas increased across all provinces except Gandaki.

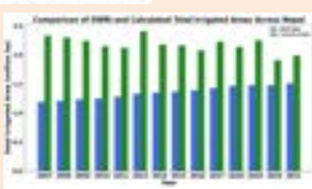
Madhesh and Karnali province depicted least irrigation coverage during the peak cropping season.

Koshi and Sudurpashchim Province showed highest increase over the past two decades.

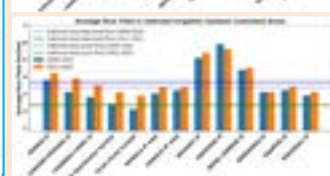
Province	Irrigated areas (%) (2000-2010)	Irrigated areas (%) (2011-2021)	% change
Koshi	63.4	67.3	3.97
Madhesh	51.8	52.4	0.52
Bagmati	62.5	62.8	0.27
Gandaki	69.0	68.0	-0.96
Lumbini	59.6	62.9	3.29
Karnali	53.9	56.6	2.65
Sudur Pashchim	56.04	59.8	3.74

Typically two cropping cycle was observed. In average, 60% crop areas were covered by irrigation in the main cropping season while about 45% during second cropping cycle in Terai and Siwalik.

Irrigation coverage across the country showed varying trends over the period of 15 years with notable differences between DWRI data and the calculated data. Unaccounted FMIS is likely to influence the data.



Results across selected irrigation Projects



- Irrigation coverage during peak cropping season varied (36-84%) significantly across irrigation systems.
- This variation can be linked to limited water availability in source river, reduced cropped areas.
- Although the yield in the selected irrigation projects is above the national average, there has been only a slight increase in crop yield over the past two decades.

4 Key Message

- In average, 60% of the crop areas was found to be irrigated over the last two decades.
- Inconsistencies in the spatial distribution of total irrigated areas among different agencies are expected to be narrowed by the output of this study.
- Yield is satisfactory but Expanding crop areas within irrigation command zones is vital for boosting production and maximizing project returns.
- Applying remote sensing and the GEE platform enhances our understanding of irrigated area dynamics and hence evaluating their impacts.

References

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Irrigation Seminar 2025: Water for Agri-Food System Transformation
15 May, 2025 [Thursday], Kathmandu, Nepal

Digitalization of Environmental Assessment Process

ID-28

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1 Context, Issues & Objectives

The environmental clearance process for development projects has been made mandatory, with the level of assessment determined by the nature and scale of the project. However, the current process is outdated, overly complex, and time-consuming. Due to the lack of clear guidelines on assessment levels, involvement of multiple agencies, and the need for repeated follow-ups, the process has become cumbersome for project proponents. As a result, there is growing reluctance among proponents to undertake environmental assessments. Furthermore, the credibility of these assessments is questionable, as they are often conducted merely to fulfill procedural requirements rather than to enhance environmental outcomes. There is also inadequate implementation, monitoring, and auditing of the recommended environmental management plans.

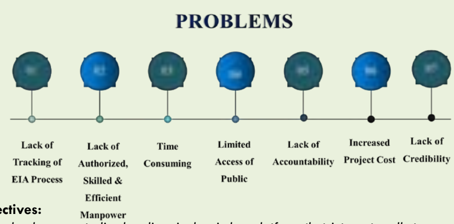
Where Our Environmental Assessment Process Stands?

Nijgadh Airport: Content was copied from a similar document prepared for a hydropower project

Pokhara Int'l Airport: Found only 28 species of birds while conservationists have counted more than 470 species of birds.

Prithvi Highway: Tree with a nest of griffon vulture, an endangered species was cut down despite the plea of Pokhara Bird Society.

Sikta Irrigation Project: Supplementary EIA initiated in 2078 has not been approved yet.



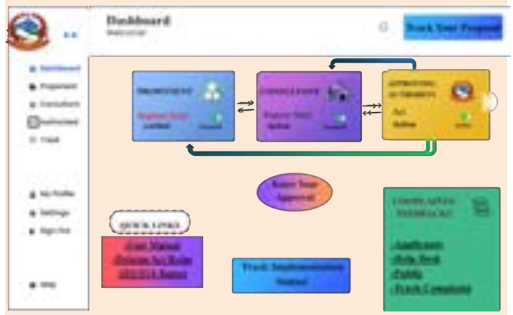
Objectives:

- *To develop a centralized, online single window platform that integrates all steps and stakeholders involved in the environmental clearance (EIA) process.*
- *To simplify and accelerate the clearance process by reducing procedural delays, minimizing manual coordination, and enabling real-time tracking and digital approvals.*
- *To promote transparency, consistency, and objectivity in decision-making, thereby enhancing trust and accountability in the environmental assessment process.*
- *To improve accessibility and user-friendliness of the system, encouraging greater compliance and proactive participation from project proponents, ultimately leading to more sustainable and environmentally responsible development projects.*

2 Project Intervention

Intervention:

The intervention aims to streamline the environmental clearance process by establishing a centralized, online single window platform that integrates all stakeholders, enhances transparency and efficiency, and encourages greater compliance through simplified, consistent, and result-oriented procedures.



Implementation Framework

Institutionalization

- *A department can be formed at MOFE to look after online EIA process.*
- *Environment Unit will be formed at each public office to handle any EIA related works.*

Cost for Implementation

- *Cost required to develop & maintain EIA portal*
- *Cost of Training to Public Officials (can be physical or virtual)*

Early Adopters

- *A specific type project of any province (e.g. Any Irrigation Project in Lumbini Province) can be taken as pilot project.*

3 Outcomes/Results

Challenges	Risks
Requires significant time and investment for digitizing environmental data.	*Potential manipulation of data by proponents.*
Involves complex transition from traditional to digital systems.	*Risk of reduced involvement from key regulatory agencies.*
Necessitates capacity-building and training for stakeholders.	*Possible neglect of on-site monitoring and auditing.*
Demands development of a secure and efficient online platform.	*Vulnerability to unauthorized access or system misuse.*

4 Key Message (Innovation and Significance)

Innovation:

The innovation lies in the creation of a centralized, online platform that streamlines the environmental clearance process, ensuring greater efficiency, transparency, and accessibility while improving coordination among stakeholders.

Significance:

The proposed innovation represents a significant shift in the environmental clearance process by introducing a centralized, online single window system that integrates all stakeholders and steps involved & enhances efficiency, transparency, and accessibility, ultimately leading to more environmentally responsible development projects.

Key Message:

Promoting sustainable development and good governance through the digitalization of environmental assessment process in order to develop sustainable and environment friendly development projects is is crucial for ensuring effective decision-making and a positive, lasting environmental impact.

Acknowledgements:

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Sub-Committees formation for Seminar

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   Member : Ms. Manju Kawan
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5. **Vehicle /Driver Management Sub-Committee:**
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Annex 4:

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	Retired / Special Guest / DGs					
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157	Mr. Laxman Sharma	Male	Executive Director	ADPC		
	Poster Presenter					
158	Mr. Lalan Baitha					
159	Prof Dr. Vishnu Pandey					
160	Narayan Krishna Ganesh		Ground Water Division,			

S.N.	Name	Gender	Name of Agency/Organisation	Position / Designation	Mobile	E-mail
161	IWMI (5)					
162	WRRDC					
163	Rajendra bir Joshi(1)					
164	Mahesh Yadav					
165	Ramesh Ranabhat					
166	Crimson Singh Negi					
167	Anish Pradahn					
168	Saroz Karki					

Annex 5:

Photos

Welcome Remarks by DDG Mitra Baral

Opening Session of Irrigation Seminar 2025

Inauguration by the Honorable Minister

Keynote by **Prof Dr. Shiva Raj Adhikari,** Honorable Vice Chairman, NPC, Government of Nepal

Keynote by **Dr. Mark Smith,** Director General, IWMI

Keynote by **Dr. Marco Arcieri,** President, ICID

Remarks of Opening Session by **Dr. Govinda Prasad Sharma,** Secretary, MoALD

Remarks of Opening Session by **Hon'ble Dipak Khadka,** Minister, MoEWRI

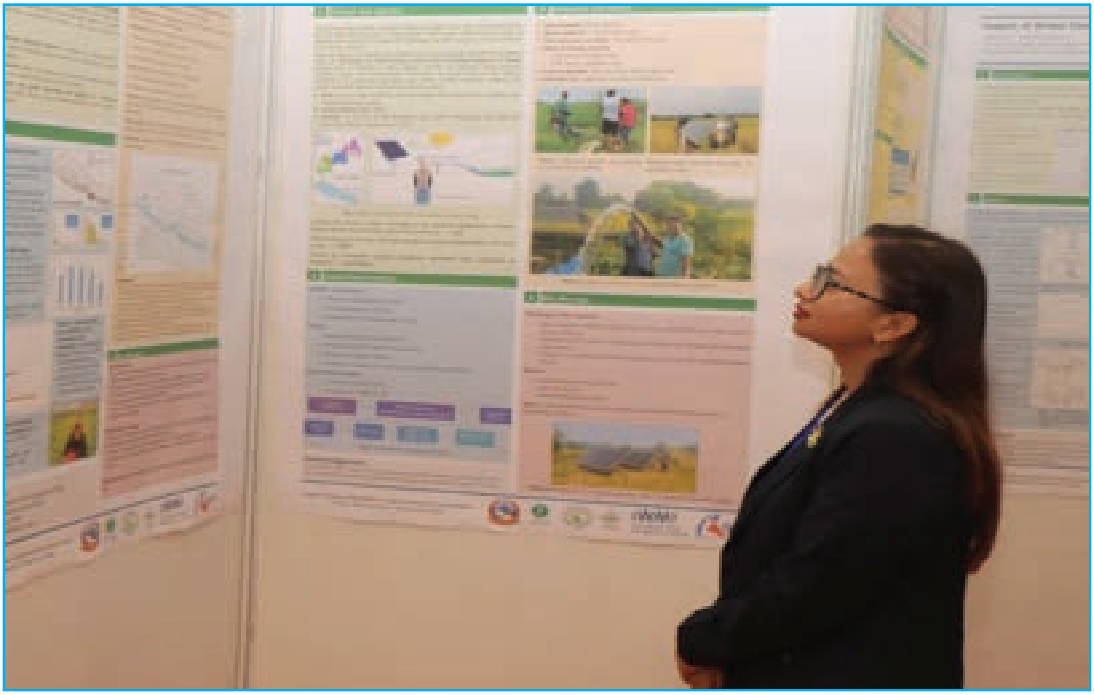
Remarks of Opening Session by **Ms. Sarita Dawadi,** Secretary, MoEWRI

Remarks of Opening Session by **Mr. Madhav Belbase,** Hon'ble Member

Closing Remarks of Opening Session by Session Chair, **Mr. Sanjeeb Baral,** Director General, DWRI

Token of Appreciation to the Keynote Speaker by **Mr. Sanjeeb Baral,** Director General, DWRI

Poster Presentation



Poster Presentation

Group Photo after the **Introduction of poster sessions**

Session 1 [Panel Discussion]

Primer presentation of Session 1 [Panel Discussion] by **Mr. Tika Ram Baral,** Joint Secretary, WECS

Panelist on Session 1 [Panel Discussion] Irrigation for Food Security: Key Practices and Bottlenecks [Facilitator: Mr. Nabin Chandra Adhikari]

Group Discussion during Session 2 [Group Work]

Group Discussion during Session 2 [Group Work]

Group Discussion during Session 2 [Group Work]

Session 2 [Group Work]: [Facilitator: Dr Santosh Nepal, IWMI

Session 3 [Panel Discussion]: Way Forward – Translating the Pathways (Developed in Group Work) into Action [Facilitator: Prof Dr Vishnu Prasad Pandey]

Panel discussion on Translating the Pathways (Developed in Group Work) into Action
Mr. Sanjeeb Baral, Director General, DWRI

Panel discussion on Translating the Pathways (Developed in Group Work) into Action
Panelists: **Dr. Sabnam Shivakoti,** Joint Secretary, MoALD

S.D.E. Birendra Yadv raising question during panel discussion

Participants raising question during panel discussion

Participants raising question during panel discussion

Participants raising question during panel discussion

Panelists and Facilatator of Session 3 after receiving Token of Appreciation Joint Secretary Shishir Koirala, MoEWRI

Remarks by Dr. K.Yella Reddy, Vice President , ICID

Reflections and Key Takeaways by Dr. Santosh Kaini, Deputy Director General, DWRI