GOPA AFC GOPA MetaMeta

Managing irrigation systems

A fresh perspective

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This paper sets out GOPA MetaMeta's perspective on the future of irrigation system management. It is grounded in decades of practical experience in large-scale and smallholder irrigation, drainage, land and water management, and climate adaptation across Africa, Asia, Europe, and the Middle East.

Drawing on field practice, applied research, and system-level advisory work, the paper reframes irrigation as critical public infrastructure within the wider water cycle. It outlines the core challenges facing irrigation systems today and proposes a set of principles and practical pathways to improve performance, resilience, and governance under growing climate pressure.

This position paper is intended to inform governments, development partners, irrigation authorities, and financiers seeking integrated, implementable solutions that go beyond isolated technical upgrades.

The challenge

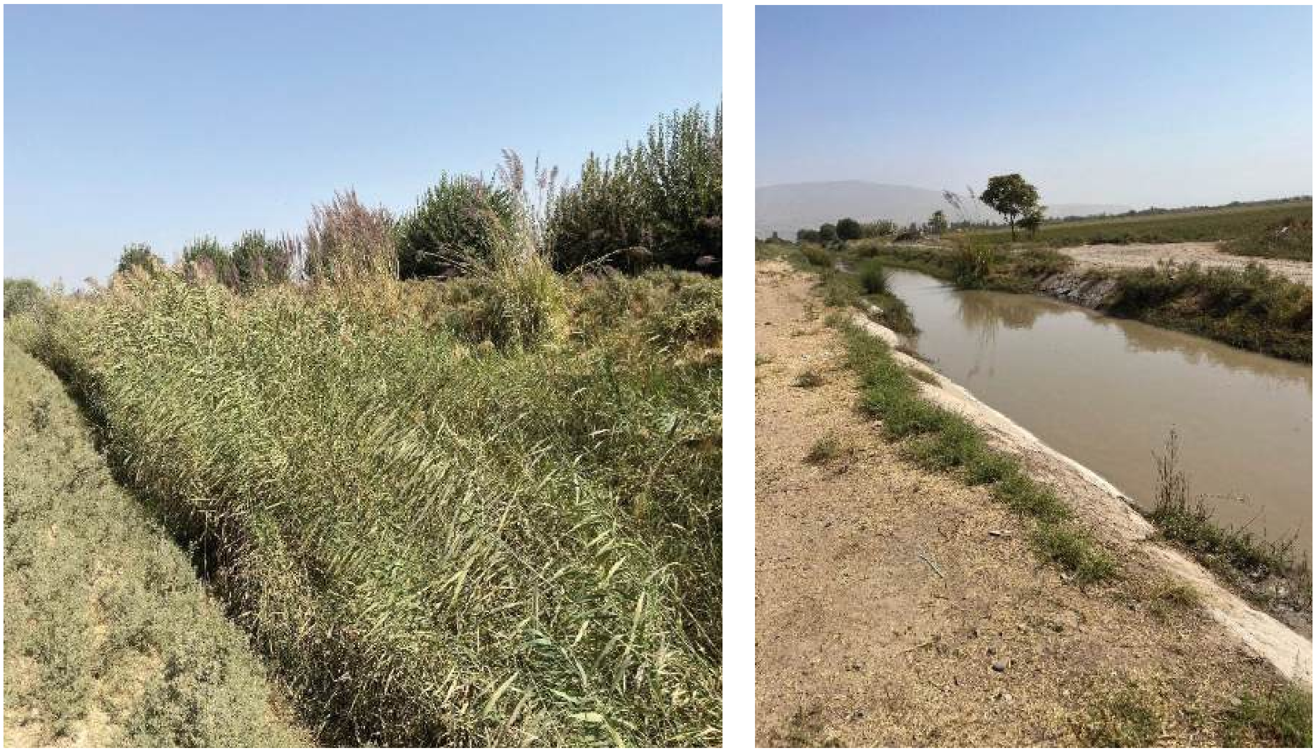
Irrigation sustains nearly half of global food production and supports the livelihoods of billions, while accounting for around 70 percent of global freshwater withdrawals[1]. As the irrigated area has expanded almost sixfold over the past century to approximately 3 million square kilometres[2], irrigation has become the largest human intervention in the water cycle and a major force within the Earth system[3], altering both land energy balances and hydrological processes. Studies demonstrate that large-scale evapotranspiration in one region can induce precipitation responses elsewhere, leading to increased rainfall in some areas and reduced rainfall in others, and thereby reshaping the spatial distribution of water resources. Accounting for these land–atmosphere interactions is therefore essential when assessing the impacts of irrigation expansion on water availability and long-term water security[4].

How global water resources are managed, how water scarcity is addressed, how food availability is secured is therefore closely linked to how irrigation systems are designed, operated, and governed. There is high urgency to make the most out of the existing land and water resources under irrigation to address water scarcity and food security. The next agricultural transformation must focus on achieving higher productivity per drop while maintaining soil health and moisture, combined with sustainable farming practice: positioning irrigation as a driver of local soil and water restoration rather than depletion. As land use change and degradation increasingly disrupt local water cycles, irrigation's role in restoring and stabilising these cycles moreover becomes central to climate resilience and water security. Irrigation must be rethought as part of the broader water cycle rather than solely as a means of supplying water to crops. Priority should be given to retaining water longer within landscapes by slowing runoff, enhancing infiltration, and rebuilding soil moisture and groundwater reserves. Among others this requires recognising the value of green water, the moisture stored in soils and vegetation, and integrating it more explicitly into land-use and agricultural planning

However, irrigation is managed below potential in many countries. In many intensively irrigated regions, yields are suboptimal, water storage in soils and landscapes, and overall soil health, are all declining. And thus, despite its critical importance, irrigation in most countries is performing far below what is possible now and both long-term productivity and food security are undermined. Water use keeps increasing, often depleting strategic

[1] Zhang, K., Li, X., Zheng, D., Zhang, L., & Zhu, G. (2022). Estimation of global irrigation water use by the integration of multiple satellite observations. Water Resources Research, 58(3), e2021WR030031.
[2] Source: Yao, Y., Ducharne, A., Cook, B.I. *et al.* Impacts of irrigation expansion on moist-heat stress based on IRRMIP results. *Nat Commun* **16**, 1045 (2025). https://doi.org/10.1038/s41467-025-56356-1
[3] Cook, B., Shukla, S., Puma, M. & Nazarenko, L. Irrigation as an historical climate forcing. *Clim. Dyn.* 44, 1715–1730 (2015).
[4] Yao, Y., Thiery, W., Ducharne, A. *et al.* Irrigation-induced land water depletion aggravated by climate change. *Nat Water* (2025). https://doi.org/10.1038/s44221-025-00529-1

groundwater reserves and compromising environmental flows, while crop yields show only marginal improvement. System efficiency, productivity, and governance remain weak, failing to match the scale and importance of the sector.



Poorly managed drainage canal and irrigation canal in poor shape in Tajikistan

The four core challenges in Irrigation System Management

1. **Enormous water use -** Irrigation consumes most of the world's freshwater, mainly from rivers and canals, with about a quarter from groundwater. Because shallow groundwater often originates from surface seepage, irrigation functions not only as a major water user but also as a regulator of surface water and groundwater systems, with direct implications for regional water availability.

2. **Strong landscape impact -** Irrigation systems shape entire regions, influencing land use, water flows, and local climates, as well as settlement patterns, public health, flood risk, and biodiversity. In many areas, irrigation systems are the backbone of regional development and water supply. Yet these broader functions are rarely recognised or managed in an integrated way, limiting the contribution of irrigation systems to resilience and sustainable area development.

3. **Suboptimal performance -** Large and mega-irrigation schemes, often spanning 50,000 to more than 1 million hectares, are among the world's largest water users but frequently perform below their narrow production potential. Ageing infrastructure, weak maintenance, and allocation frameworks designed for past crop patterns and climates result in uneven water distribution, low water productivity, and persistent problems such as salinity and waterlogging. The Gezira Scheme

in Sudan illustrates how outdated allocation rules continue to constrain system performance and resilience (see Box 1). Investment responses tend to prioritise large rehabilitation programmes, while smaller, targeted improvements are overlooked.

4. **Little is done about it -** Despite their strategic importance, irrigation systems receive limited investment in governance and performance management. Agencies often face understaffing, limited mandates, narrowly focussed capacities, and chronic funding shortages. Weak Water User Associations, poor coordination, and limited access to reliable data further undermine the ability to perform and accountability. At the same time, human capital has eroded (see Box 2). Declining technical capacity, loss of institutional memory, and insufficient training have reduced the ability to monitor, measure, and manage water delivery. Without skilled people and clear governance structures, even technically well-designed systems fail to perform effectively.

Box 1 - Outdated water allocation in Mega-Schemes (Gezira, Sudan)

In the Gezira Scheme, covering approximately 1,000,000 hectares, irrigation allocation systems were designed under British colonial rule for cotton as the dominant crop and have not kept pace with changes in water availability, crop diversification, or climate variability. As a result, inefficiencies, head–tail inequities, and soil salinisation have become widespread, undermining system productivity and resilience. At the same time, there is substantial potential to redesign allocation frameworks to reflect current realities. Integrating climate data, soil conditions, and diverse cropping patterns could enable more equitable and efficient water deliveries, while small-scale water storage and flexible scheduling would support adaptive management under variable rainfall and drought conditions. Revisiting allocation rules also creates opportunities to move away from monocultures towards more diverse and profitable cropping systems, while protecting soils and supporting groundwater recharge.

Box 2 - Recognizing human capital in irrigation water supply management: the case of Uzbekistan

In Uzbekistan, as in many countries, the human capital that once sustained irrigation systems has declined sharply. The professional workforce of engineers, hydropost operators, and mobile guards responsible for day-to-day water control and delivery has been substantially reduced due to budget cuts, shifting institutional mandates, and the hastily transfer of responsibilities to Water User Associations. These changes weakened public oversight and disrupted the operational chain needed for effective irrigation management. Following the Soviet period, declining public investment led to asset deterioration, limited operation and maintenance, and loss of institutional knowledge. The former irrigation service structure, which enabled close monitoring and rapid field response, gradually eroded as staff were underpaid or phased out. Donor-driven decentralisation reforms, while well-intended, often reinforced this trend by prioritising administrative restructuring over workforce development. The result has been weaker day-to-day operation, reduced monitoring and control, and limited decision support. The Uzbekistan experience underscores that infrastructure and technology alone are insufficient. Skilled and motivated personnel remain essential to irrigation performance and rebuilding technical and institutional capacity must be a core focus of public investment to ensure systems function reliably and remain resilient.

A new perspective

Addressing today's irrigation challenges requires a fundamental shift in how irrigation systems are understood and managed. They are not simply networks of canals, drains and pumps, but complex systems where water infrastructure, farming practices, governance, ecosystems, and local economies interact. Performance depends on coordinated decisions across the entire system; farm-level improvements alone cannot deliver durable results.

The way forward is total system management. Irrigation must actively support sustainable water use, soil health, climate resilience and local area development, not only crop production. Future gains will come from using water and land more intelligently rather than more intensively. Measures such as decentralised storage, flexible scheduling, and landscape interventions that manage runoff, wind, and evapotranspiration can stabilise local conditions and increase resilience under climate variability.

From this perspective, irrigation systems are critical public infrastructure and multifunctional drivers of the landscapes that they are part of. Alongside food production, they provide flood buffering, groundwater recharge, climate regulation, and ecological benefits. For better or worse canal systems are often used for multifunctional water supply, waste disposal, transport and they provide water fronts for local property. When managed in an integrated way, irrigation systems can add tremendous social and economic value, secure water resources, reduce risk and strengthen resilience at regional scale.

This shift demands a corresponding change in investment and policy. Instead of focusing narrowly on technical efficiency upgrades. Strategies must combine infrastructure modernisation with strong governance, daily operational capacity, and multifunctional and climate-adaptive management. Only integrated approaches can ensure irrigation systems meet future demands while protecting water resources, soils, and livelihoods.

One such concept is the Smart Polder approach, which applies system-level design to landscapes where irrigation, drainage, flood risk, and salinity interact (Box 3).

Box 3 - The Smart Polder concept: integrated water-level management for resilient lowland agriculture

A Smart Polder is a fully integrated water and land management system that combines drainage, irrigation, flood protection, salinity control, monitoring, agroecology, and governance within a single operational framework. Its core objective is year-round water table optimisation. Instead of rapid drainage, the system maintains the right water level at the right time to protect crops, strengthen soils, support farm operations, improve public health, and sustain ecological functions. By aligning irrigation and drainage, Smart Polders reduce peak pumping, avoid unnecessary discharge, and improve equity between head and tail areas.

Smart Polders apply conjunctive water management by coordinating surface water, shallow groundwater, rainfall, incidental flows, and internal storage as one system. Real time information from satellite monitoring, field sensors, and operator routines supports daily water scheduling, early stress detection, and adaptive operation under variable climate conditions.

The Smart Polder is designed as a multifunctional landscape. Water level management and spatial layout support agricultural production while enhancing recharge, water quality, biodiversity, and microclimate stability. Wetlands, vegetated canals, buffer zones, and shelterbelts help retain moisture, reduce evaporation and heat stress, and strengthen soil biology. Agroecological practices such as permanent soil cover, crop diversification, hedgerows, biological pest and rodent management, salt tolerant crops, and selective biological drainage reinforce system resilience and productivity.

Flood safety is an integral part of the design. Embankments protect against floods while also supporting transport, access, evacuation routes, and wider spatial development, contributing to both water security and disaster preparedness.

A Smart Polder is also a governance and operations model. Performance depends on coordinated behaviour and shared operational rules that prevent conflicting actions such as excessive pumping or drainage. Clear mandates, capable operators, shared data systems, and functioning local institutions enable collective operation, asset management, and timely maintenance, supported by realistic operation and maintenance financing.

Financial sustainability is strengthened through value creation linked to multifunctionality, including aquaculture, vegetation management, and land value improvements. In peat and organic soils, Smart Polder water management also reduces carbon emissions by avoiding over drainage and enabling selective rewetting combined with appropriate cropping systems.

Overall, the Smart Polder approach offers a practical and transferable model for total system management in lowland and flood prone irrigated landscapes. By integrating infrastructure, daily operation, land use, monitoring, and governance into one coherent system, Smart Polders provide a robust pathway towards climate adaptive and economically sustainable irrigation systems.

7 Principles for improving irrigation system management

To transform irrigation systems into drivers of resilience and sustainability, we propose a comprehensive approach built around seven core principles:

1. Manage irrigation systems as an integrated water resource system

Managing irrigation as a collection of individual farms misses the system reality. Effective irrigation management requires system-level control, aligning water allocation and scheduling from headworks to tail ends to ensure equity, avoid over-irrigation, and reduce losses across the network.

Resilience depends in many irrigation systems on conjunctive water use that combines surface water and groundwater and makes use of all available sources. This includes canal water, rainfall, seasonal floods, and tributaries entering irrigation schemes. Managing these flows together improves recharge and buffering capacity, increases operational flexibility, and strengthens overall system stability.

System management must also respect hydraulic design. Canals are engineered for specific flow ranges, and abrupt operational changes without structural adaptation can lead to sedimentation and loss of capacity. Flexibility therefore depends on combining sound engineering with adaptive operation.

In practice, performance gains often come from targeted, incremental improvements rather than large rehabilitation programmes alone. Interventions such as upgrading local pumping infrastructure, improving gate operation, or restoring tertiary canals can significantly improve reliability and equity at relatively low cost when embedded in a coherent system management strategy (see Box 4).

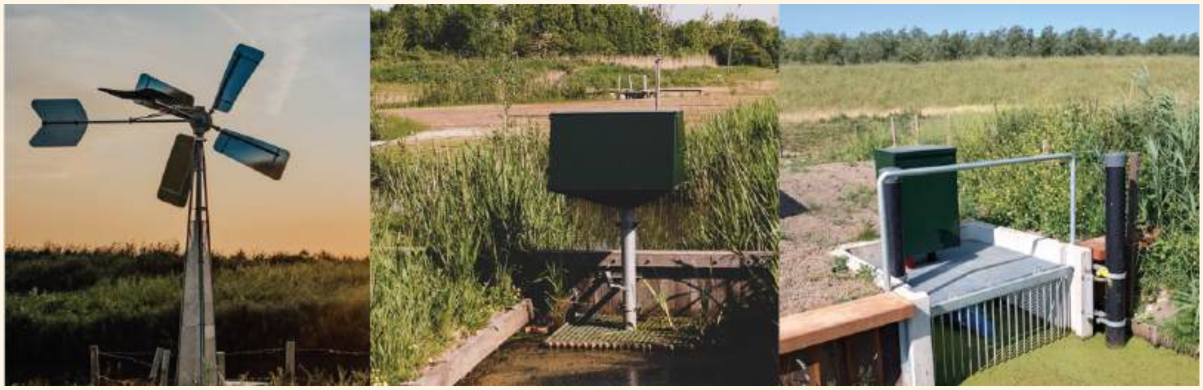
When managed as integrated water resource systems, irrigation schemes move beyond static infrastructure and function as climate-resilient landscapes that sustain productivity, water security, and ecological balance.

Box 4 - Irrigation and drainage management innovations

Small-scale innovations can deliver big improvements in irrigation and drainage system performance. Across many schemes, traditional materials and outdated infrastructure - such as heavy steel gates, corroded sluices, and poorly maintained valves - remain in use. These systems are maintenance-intensive, vulnerable to rust, and prone to failure, often leading to water loss or flooding. Their rigid design limits flexibility and makes adaptation to modern water management needs difficult.

Bosman Watermanagement and ROwat Water Control are showing how quick, modular upgrades can change this. By replacing old iron and steel structures with lightweight, corrosion-resistant HDPE or stainless-steel components, ROwat reduces maintenance needs and enables automation and precise control. Bosman complements this with solar- and wind-driven pumping systems that automatically regulate water levels, improve local water balance, and operate energy-efficiently.

These innovations show that incremental upgrades (such as modernized local pumping and drainage infrastructure) can significantly enhance water delivery, reduce energy use, and strengthen resilience, often at a fraction of the cost of large-scale rehabilitation projects. They are practical, scalable examples of how focusing on smaller, smarter improvements can deliver immediate and lasting system gains.



Irrigation and drainage solutions (B4 Windwatermill, BCK Pump, Vision MV) by Bosman Watermanagement

Spindle Valves, Water level control weirs, and storage systems by ROwat Water Control

2. Recognize and optimize multifunctionality

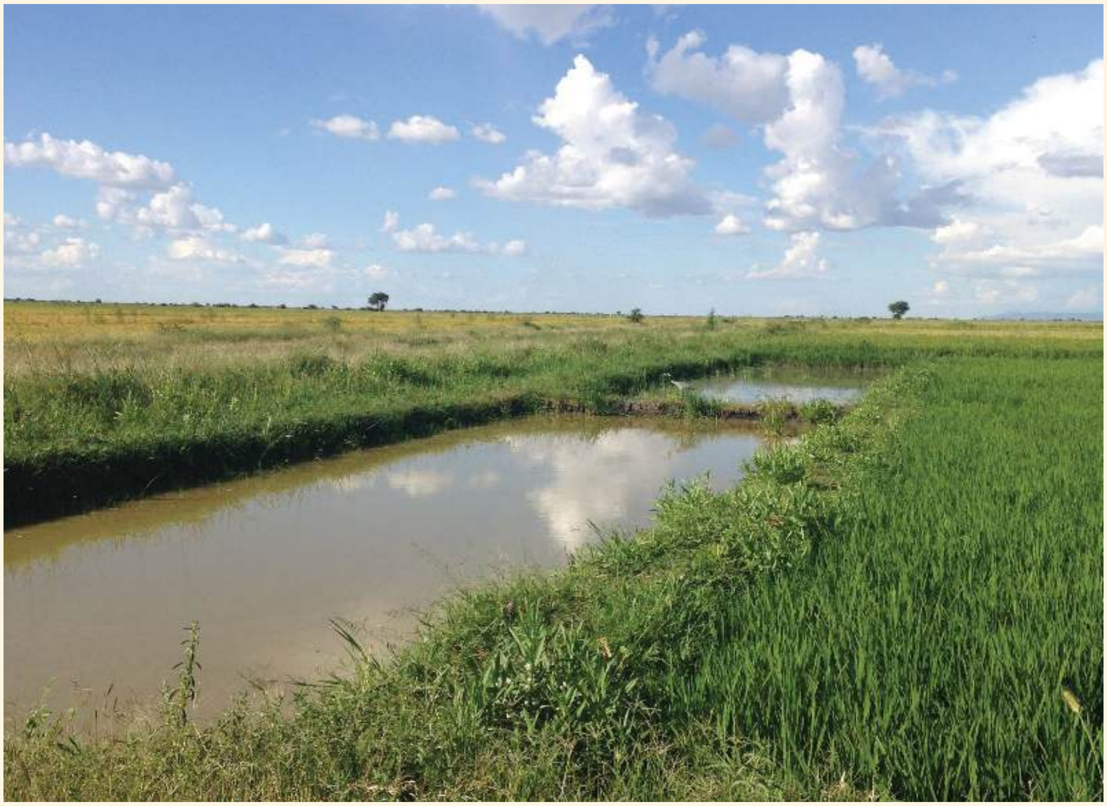
Large irrigation systems do far more than supply water to crops. They shape entire landscapes and provide essential services such as flood regulation, groundwater recharge, local climate control, biodiversity support, domestic water supply, navigation, waste disposal and even recreation. In many regions, canals also serve for livestock watering, household use, fishing, and aquaculture - yet these multiple roles are rarely recognized or managed strategically.

Recognising multifunctionality enables more effective and cost-efficient planning by generating social, environmental, and economic benefits simultaneously. Wetlands and vegetated canals can improve water quality, reduce flood peaks, and create biodiversity corridors while supporting agricultural production. Shelterbelts and hedgerows reduce evaporation, moderate temperatures, and protect crops and workers from heat stress. Retention ponds and selectively unlined canals enhance groundwater recharge and provide buffering capacity during dry periods.

Experience shows that integrating such measures can significantly improve overall system performance. Community-managed water storage ponds, for example, often evolve into valuable multi-purpose assets that combine irrigation supply with aquaculture, recreation, and ecological functions (see Box 5). Scaling these approaches allows irrigation systems to move beyond single-purpose infrastructure and become drivers of climate adaptation and resilient rural development.

Box 5 – Multifunctional water storage as a driver of local resilience

Water storage ponds are increasingly evolving from single-purpose irrigation assets into multifunctional landscape features. Beyond supplying water for agriculture, well-designed and community-managed ponds can support aquaculture and fisheries, providing food and additional income, while also creating opportunities for recreation and eco-tourism such as boating, picnicking, or birdwatching. These water bodies enhance local biodiversity by providing habitats for aquatic species, birds, and pollinators, and can contribute to higher land values by creating attractive "waterfront" areas for communities and local investment. By integrating ecological design principles with water storage, such ponds deliver multiple benefits simultaneously. They strengthen local livelihoods, improve water buffering capacity under variable climate conditions, and foster community ownership and stewardship. As a result, multifunctional water storage can become a practical entry point for economic diversification, climate resilience, and long-term landscape restoration.



Rice cultivation combined with tilapia fish farming, Igunga, Tanzania

3. Embed real-time evidence in decision-making

Effective irrigation management depends on accurate, timely data. Advances in remote sensing now make it possible to monitor key parameters in real time (evapotranspiration, soil moisture, crop water stress, and climate trends) (see Box 6). These insights can pinpoint inefficiencies, guide irrigation scheduling, and improve planning at both system and field levels.

Remote sensing is now available at high resolutions – even below field level. Results help explain agronomic variation within irrigated landscapes and within farms. Differences in biomass accumulation and water consumption can reveal underlying factors such as water delivery. soil properties, nutrient conditions, salinity occurrence, fertiliser application, crop rotation, and crop stress. In irrigation schemes, this information can be used to assess irrigation performance by analysing uniformity at field level and equity and adequacy at tertiary, secondary, or scheme level. It can also guide individual farm operations. When combined with measured abstractions from surface water and groundwater, these datasets provide a comprehensive picture of total water consumption, including head–tail differences within systems.

Box 6 - Using satellite intelligence for smarter irrigation: the Hydrosat–IrriWatch platform

The Hydrosat–IrriWatch platform demonstrates how satellite data can fill a long-standing gap in irrigation management: the lack of timely, system-level information on how water is actually used. By combining thermal infrared, optical, and climate model data at 10×10 meter resolution, the platform provides daily insights into evapotranspiration, soil moisture, crop stress, and water use efficiency. These datasets, validated through more than 30 years of SEBAL-based experience, allow irrigation agencies to see where water is overapplied, underused, or lost within large systems. Data is accessible through a web portal, API, and mobile interface, offering a practical tool for both field operators and decision-makers. The platform's historical archive (extending back to 1984) supports long-term performance assessments and planning, while real-time monitoring enables more adaptive irrigation scheduling and crop management. This illustrates how systematic, spatially detailed data can make irrigation management more evidence-based.

Web portal and mobile application of the IrriWatch platform

Data alone, however, are not sufficient. Information must be translated into decisions that farmers, operators, and institutions can act on. This includes adjusting water delivery schedules, refining crop calendars, aligning operations with infrastructure capacity, and anticipating climate-driven shifts in water availability. When agronomic and irrigation performance indicators are linked to crop yields and production outcomes, land and water productivity can be quantified, compared against targets, and used to inform management priorities and policy objectives.

4. Rethink financial models and incentives

Most irrigation systems are financed through water service fees that rarely cover the true costs of operation, maintenance, and renewal. This structural gap undermines system performance and long-term viability and is a major factor. Sustainable irrigation therefore requires financial models that combine cost recovery with incentives aligned to environmental, social, and economic outcomes.

Financing should move beyond narrow volumetric or "water-saving" approaches and focus instead on system performance, reliability, and service quality. Budgets and revenue mechanisms need to reflect the full value irrigation systems generate, not only for agriculture, but also through flood buffering, groundwater recharge, and ecosystem services that benefit surrounding communities.

Diversified income streams can strengthen financial resilience. Canal bank forestry, recreation and eco-tourism, aquaculture, water delivery to towns and industries and land value capture around irrigated "waterfront" areas can generate additional revenues while reinforcing local ownership. These revenues should be transparently reinvested in operation, maintenance, and performance improvement.

Payment systems also need to be simple, fair, and enforceable. Community-based collection, digital payments, or prepaid water cards can improve transparency and compliance. At the same time, incentives should reward practices that improve soil health, reduce emissions, and increase water productivity, directly linking financial performance to sustainability outcomes.

Secure land tenure and supportive policy frameworks are essential to enable farmer investment in long-term improvements and climate-smart practices. When financial models recognise and reinvest the multifunctional value of irrigation systems, they can evolve from fiscally fragile utilities into resilient public assets that sustain livelihoods, ecosystems, and water security.

Irrigated Rice Fields in Indonesia

5. Integrate agroecology into irrigated agriculture

Irrigated agriculture can place heavy pressure on soils and water resources when managed intensively, but agroecological approaches offer practical pathways to reverse these impacts. Practices such as alternative wetting and drying, crop diversification, fodder rotations, permanent ground cover, green manures, hedgerows, and agroforestry improve soil structure, enhance infiltration, and strengthen natural nutrient and pest regulation.

Healthy soils are central to climate resilience. Soils with higher organic matter retain more water, buffer temperature extremes, and sustain yields under drought and flood stress. The use of biofertilizers and composts – often also preferable because of cost and local availability – can reverse the soil depletion that characterizes systems with decades use of synthetic agro-chemicals.

Soil life can moreover be stimulated by proper moisture management in irrigation system, rather than blanket field inundation that suffocates soil biota, including rain works and healtny bugs. Selective wetting and drying of farm fields can also break agricultural pest cycles, reducing the need for pesticides.
Agroecological practices – in particular alternate wetting and drying – moreover also contribute to climate mitigation by reducing methane emissions in paddy systems and increasing carbon storage in soils and biomass.

Embedding agroecology within irrigated systems shifts them from extractive production to regenerative management. When soil health, water efficiency, and biodiversity are addressed together, irrigated landscapes become more productive, more stable under climate variability, makes larger contribitions to health and nutrition and are better able to sustain livelihoods over the long term.

6. Address salinity and waterlogging issues

Salinity and waterlogging remain among the most persistent constraints in irrigated agriculture. Overirrigation, inefficient or malfunctioning drainage, and inappropriate field water management practices reduce yields, degrade soils, cause public health hazards, such as malaria, dengue, schistosomiasis or liver fluke. In history they have forced farmers to abandon productive land.

Effective strategies combine well-tuned surface water delivery, use of shallow groundwater and selective drainage with adaptive cropping systems, and the introduction of salt-tolerant and deep-rooted crops. Productive use of marginal and saline lands with selected varieties and appropriate fertilizer application can generate income while soil structure and fertility are gradually restored. These measures reduce pressure on high-quality land and help stabilise water tables across the system.

Experience from Sindh, Pakistan illustrates how combining technical interventions with adaptive farming practices can rehabilitate saline soils and strengthen rural livelihoods (see Box 7). When drainage, crop choice, and water management are addressed together, farmers can reclaim degraded land, improve resilience to long-term water stress, and restore productivity in challenging environments.

Box 7 - Restoring saline soils through integrated management in Pakistan

In Sindh, Pakistan, large areas of irrigated land have been affected by rising groundwater tables and soil salinity. In response, farmers and support programmes have applied a combination of drainage improvement, controlled water management, and adaptive cropping to stabilise water tables and restore productivity. Salt-tolerant crops and fodder systems were introduced to make productive use of saline fields, allowing cultivation to continue while soils gradually recovered. These measures were supported by field-level monitoring and practical incentives that helped farmers adjust practices and manage risks. The experience demonstrates that salinity is not an irreversible condition: when water management, crop choice, and soil restoration are addressed together, degraded land can be brought back into use, yields stabilised, and rural incomes protected, even under severe salinity stress.

Salt-tolerant potato varieties under the "Salt Tolerant Potato to Feed the World" project in Punjab and Sindh, Pakistan

7. Strengthen governance for integrated management

Technical upgrades alone cannot deliver reliable irrigation services without effective governance. In many large schemes, operation and maintenance of main and secondary networks depend on public institutions that lack sufficient resources, field presence, or coordination. Strengthening governance is therefore essential to ensure dependable water delivery and coherent system management.

Irrigation governance centres on allocation and use: who receives water, in what quantity, when, and under which conditions. These decisions shape livelihoods, economic activity, and equity, and require clear mandates, transparent rules, and inclusive participation. Governance also extends beyond main systems to on-farm water management, where daily operational decisions directly affect efficiency and sustainability.

Operation and maintenance are central to this challenge. Water User Organisations typically manage tertiary networks and on-farm distribution, including scheduling, routine maintenance, and local rule enforcement, but their effectiveness depends on supportive institutional frameworks and Water User Organisations being part of overall system governance and not temporary project constructs. Irrigation authorities must provide clear asset responsibilities, technical backstopping, and support when maintenance needs exceed local capacity.

Asset management links governance to long-term performance. Without asset inventories, condition monitoring, and maintenance planning, irrigation infrastructure deteriorates rapidly. Embedding asset management within governance frameworks ensures timely maintenance, predictable financing, and sustained functionality across system levels.

Effective governance also requires coordination across sectors. Fragmentation between irrigation, agriculture, and water resource authorities undermines planning and implementation. Shared data systems, coordinated investment planning, and horizontal learning platforms support accountability and adaptive management.
Experience from long-standing governance arrangements shows that local legitimacy and ownership are critical for sustained performance (see Box 8). Future-oriented governance frameworks must therefore link water, soil, and climate objectives, address land tenure constraints, and empower Water User Associations with real authority and technical support. When governance is strong, irrigation systems function as integrated, accountable institutions capable of maintaining productivity and resilience under increasing climate pressure.

Central to all of this is also the 'capacity to do' within the irrigation agencies. They need not be understaffed – but have adequate person power to deal with system operation and maintenance as well as effective water allocation and multifunctional water use.

Box 8 - Good water governance in Spain - irrigator associations and tribunals

In Valencia, water management has been guided for centuries by a unique tradition of participatory governance. At the heart of this system is the Tribunal de las Aguas de la Vega de Valencia (Water Court), one of the world's oldest water institutions, with roots dating back to the al-Andalus period. Even today, the court meets every Thursday at noon outside the Puerta de los Apóstoles of Valencia Cathedral, where elected trustees from each Irrigation Community gather to settle water disputes. These oral hearings, conducted in Valencian, are swift, public, and deeply embedded in local culture.

The Water Court is more than a historical curiosity. Recognized in 2008 by UNESCO as part of the Intangible Cultural Heritage of Humanity, it reflects Valencia's long-standing commitment to the sustainable use of water for its fertile orchards. This enduring system embodies key governance principles: representation of diverse interests, professional autonomy, decentralized decision-making, and effective conflict resolution. As celebrated in the medieval epic El Cantar de Mio Cid, it symbolizes a harmonious relationship between people and nature, lessons still relevant to irrigation management today.

Solutions and service offering

We help governments, irrigation authorities, and farming communities transform irrigation systems into drivers of productivity, resilience, and sustainability. Our integrated service package combines technical, institutional, and ecological expertise along four interconnected pathways:

1. System-level strategy and design: future-proofing irrigation systems

We work with public agencies and irrigation communities to develop and implement climate-smart and multifunctional systems that are ready for future water, land, and climate challenges. Our work includes:

1. **Irrigation system assessments**: Evaluating system performance, water productivity, and governance structures to identify opportunities for improvement: mapping where decisions are made, analysing staffing levels (such as hectares managed per engineer), and detecting key bottlenecks in operation and allocation. Using rapid system scans and satellite data, we build a clear picture of how the system functions and where it can be improved, forming the basis for smarter and more adaptive management.
2. **Redesigning water allocation frameworks**: Updating outdated systems to reflect shifting water resources, crop patterns, soil conditions, and climate variability.
3. **Combine irrigation management with other functions for area developmen**t: secure drinking water supply, industrial process water, improved water fronts, enhanced public health
4. **Conjunctive water management** – Balancing surface water with shallow groundwater recharge and use, while deploying drainage strategies to combat waterlogging, salinization, and enhance multifunctionality.
5. **Climate-smart infrastructure planning** – Integrating green infrastructure (wetlands, vegetated canal banks, nature-based solutions) with grey infrastructure (pumps, gates, reservoirs) to enhance resilience and multifunctionality.
6. **Local climate management solutions** – Using hedgerows, shelter belts and landscape interventions to regulate wind, reduce evaporation, manage solar exposure, and buffer local climates, creating more stable growing conditions in the face of climate variability.
7. **Smart Polder design and implementation** – Applying integrated water–land system design to irrigated lowlands and flood-prone landscapes, combining irrigation, drainage, flood protection, salinity management, monitoring, agroecology, and governance into a single operational framework.

2. Field-level innovation and support: Building climate-resilient farming systems

We support farmers and institutions to adopt agroecological and water-efficient practices that enhance productivity, restore soil health, and build resilience to climate extremes. Our approach includes:

1. **Water productivity enhancement** – Maximizing "crop per drop" efficiency while increasing economic and social returns from water use.
2. **Salinity and waterlogging management** – Applying controlled drainage, stormwater harvesting, and introducing saline agriculture with salt-tolerant crops.
3. **Agroecology in irrigated systems**:
    - Use of biofertilizer to improve soil structure and water retention capacity
    - Alternative Wetting and Drying (AWD) and precision irrigation to save water, manage pests, improve soil life and reduce methane emissions.
    - Crop diversification, fodder rotations, permanent crop cover, cover cropping, green manures, and agroforestry for improved soil fertility and biodiversity.

4. **Pest and nutrient management** – Promoting ecologically based solutions like Ecologically-Based Rodent Management (EBRM), biofertilizers, and biopesticides to reduce reliance on chemicals and strengthen ecosystem services.
5. **Soil health diagnostics and restoration** – Assessing soil moisture, texture, and carbon levels to guide investments that secure long-term fertility and water retention.

3. Governance, capacity building, and financing: Enabling long-term sustainability

We support the development of **institutional and financial frameworks** that ensure irrigation systems are well-managed, inclusive, and financially sustainable. This includes:

1. **Institutional strengthening** – Prepare institutional development plans and staff capacity strengthening. Train staff of Irrigation Authorities and train Water User Associations, to improve leadership, coordination, asset management, use of improved farm practice and enforcement of allocation rules, while scaling proven approaches – in management, operation and maintenance, to fit local contexts.
2. **Water tenure - supply and demand management** – Supporting the (re)configuration of water allocation agreements and operational arrangements, linking water resources availability with irrigation rights and distribution rules. This includes aligning surface water, groundwater, and storage management with actual demand, seasonal variability, and system capacity.
3. **Stakeholder facilitation** – Building trust among landowners, tenants, and water managers to address land tenure issues and create incentives for long-term farmer investment.
4. **Horizontal learning platforms** – Facilitating peer-to-peer exchanges and communities of practice to spread innovations, strengthen accountability, and drive continuous improvement across irrigation schemes.
5. **Innovative financing models** – Embedding realistic cost-recovery systems alongside performance-based incentives, and exploring alternative revenue streams such as canal bank forestry, eco-tourism, and reservoir-based recreation.
6. **Policy support** – Advising governments on integrated approaches that align irrigation, agriculture, and water resource management with national climate and development goals.

4. Infrastructure

We design and implement irrigation infrastructure that is robust, cost-effective, and aligned with long-term operational realities. This includes:

1. **Value for money engineering** – designing durable, low-maintenance irrigation and drainage infrastructure that reduces lifecycle costs and remains functional under potentially low O&M budgets. Solutions prioritise simplicity, modularity, and the use of corrosion-resistant materials suited to local capacities and conditions.
2. **Build-in energy options** – Incorporating renewable energy options such as solar-powered pumping and assessing opportunities for low-head hydropower generation within canals and control structures, reducing dependence on diesel and grid electricity while improving energy security and operational resilience.
3. **Multifunctional infrastructure design** – Integrating fish-friendly pumping systems, fish passages, and fish ladders to maintain ecological connectivity and reduce environmental impacts, enabling irrigation systems to support both agricultural production and ecosystem functions, whilst also reducing overall clogging of systems.
4. **Precision water management –** combining reliable hydraulic structures and gates with accurate flow control to enable predictable and equitable water distribution across schemes, improving system performance and compliance with allocation rules.
5. **Efficient field-level irrigation** – linking system-level water regulation with low-pressure, high-efficiency field irrigation technologies to reduce water losses, improve efficiency, and increase agricultural water productivity.

A complete partnership for smarter irrigation systems

We work together as a partnership that combines complementary expertise to deliver a complete service package for irrigation system improvement:

GOPA MetaMeta	**GOPA MetaMeta** – System design, field-level innovation, and governance reform, integrating technical, ecological, and institutional solutions to make irrigation systems efficient, resilient, and sustainable.
ROwat WATER CONTROL	**ROwat Water Control** – Water storages options, advanced, corrosion-free hydraulic structures and gates that ensure precise, reliable water regulation.
bosman WATERMANAGEMENT	**Bosman Watermanagement** – Modular and low-maintenance pumping and drainage systems that improve water control and energy efficiency.
Hydrosat	**Hydrosat (IrriWatch platform)** – Real-time satellite monitoring of evapotranspiration, soil moisture, and crop stress to guide adaptive water management.

Together, we offer an end-to-end approach - linking technology, data, and governance to help modernize irrigation systems for today's challenges and tomorrow's climate realities.

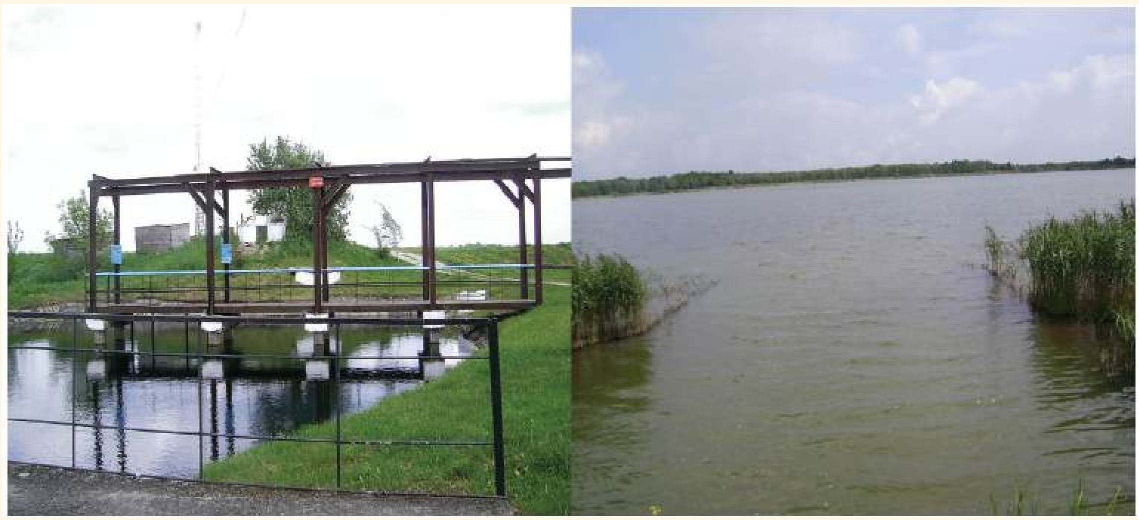
Towards future – proof irrigation systems

Irrigation systems are at a crossroads. Meeting the growing demand for water and food while navigating climate uncertainty and land degradation requires more than technical fixes. The future lies in holistic, adaptive, and inclusive management that connects water, soil, climate, and governance: across every level, from canals to communities and from systems to individual plots.

Our approach embraces the complex dynamics of large-scale irrigation systems to ensure they are ready for the challenges of today and the uncertainties of tomorrow.

Box 9 - Potential pilot: Integrated Water Supply and Irrigation Modernization in Volyn, Ukraine

The Volyn Integrated Water Supply and Irrigation Modernization Project aims to combine a technical and governance approach that revitalizes the deteriorating water systems. Covering 3,549 hectares in northwestern Ukraine.



Old pump station in need of modernization (left) and Krychevychivska water reservoir (right)

In the Volyn region, decades of underinvestment have left drainage and irrigation systems fragmented, energy-intensive, and poorly coordinated. Pump stations are outdated, canals are silted, and water distribution no longer meets current agricultural and domestic needs. The separation of irrigation, drainage, and water supply management causes both flooding and seasonal shortages, highlighting the need for a more integrated approach.

The pilot proposes a modernization strategy combining infrastructure renewal, monitoring, and institutional reform: installation of a Bosman modular pump station, rehabilitation of 60 km of canals, groundwater monitoring at 10 points, and capacity building for local authorities and Water User Organizations (WUOs).

Once implemented, the Volyn pilot would demonstrate how incremental modernization, and better governance can transform outdated water infrastructure into a climate-resilient, multifunctional system that supports both agriculture and rural livelihoods. It represents a scalable model for cost-effective improvements in other irrigation and drainage networks across Ukraine and beyond.

GOPA AFC GOPA MetaMeta