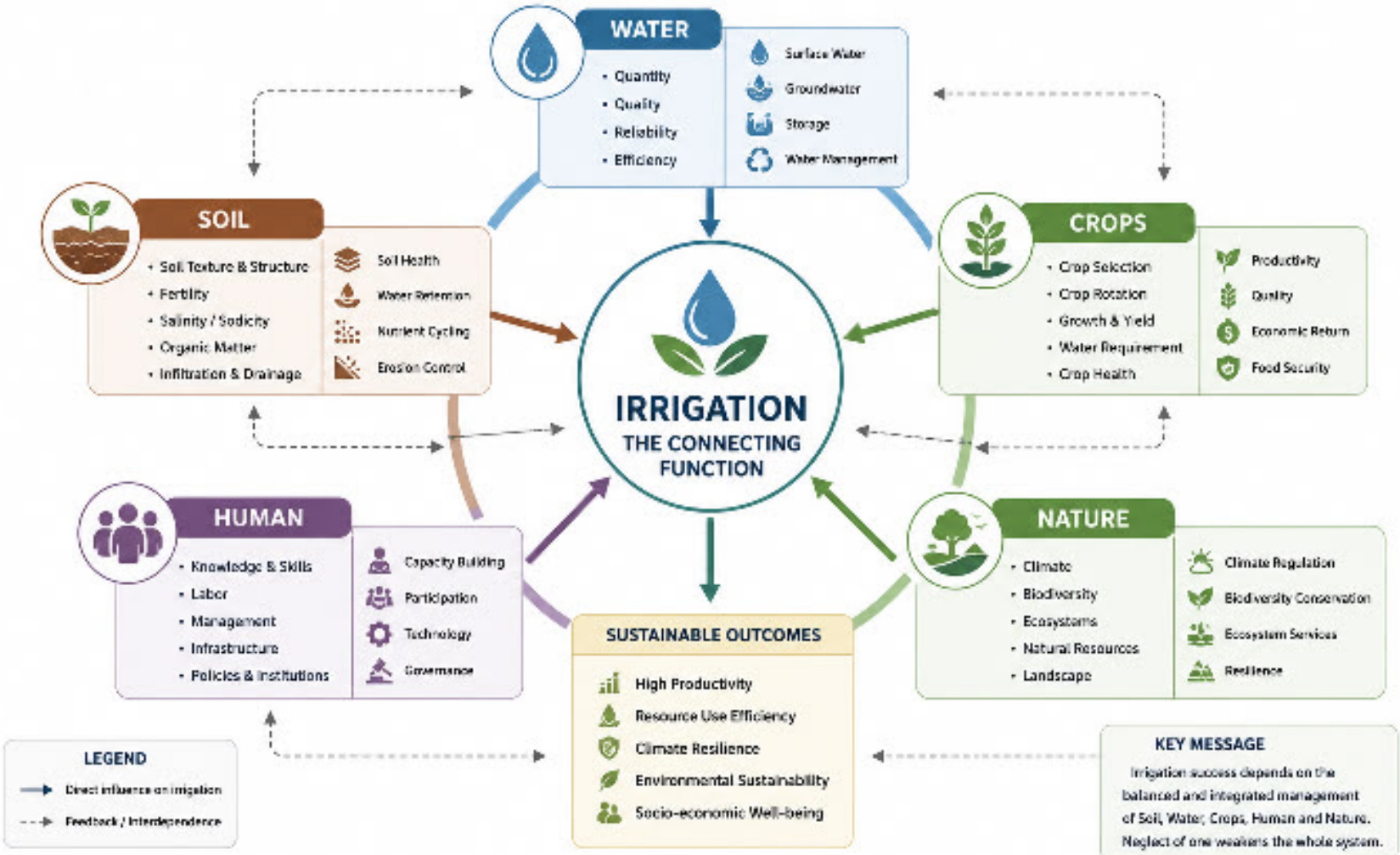
IRRIGATION AS A FUNCTION OF INTERCONNECTED PARAMETERS

Sustainable irrigation is the balanced interaction of five key parameters — Soil, Water, Crops, Human and Nature.
The goal is productivity, resilience and harmony.



BALANCE – INTEGRATION – PARTICIPATION – ADAPTATION = SUSTAINABLE IRRIGATION

ANCIENT CIVILIZATIONS OF THE WORLD BUILT ON IRRIGATION

Water Harnessed – Civilizations Flourished

1 MESOPOTAMIA
(Tigris–Euphrates Basin)
c. 5500 – 1500 BCE

- Cradle of urban civilization
- Canal irrigation from rivers
- Surplus food enabled cities, trade, writing & law
- Cities: Ur, Uruk, Babylon



2 ANCIENT EGYPT
(Nile River Valley)
c. 4000 – 1000 BCE

- Basin irrigation using Nile floods
- Shaduf and canals for water lifting
- Supported large population and monumental architecture
- Predictable floods = agricultural calendar



3 INDUS VALLEY CIVILIZATION
(Indus Basin)
c. 3300 – 1300 BCE

- Canals, reservoirs and flood management
- Advanced urban planning with drainage systems
- Agriculture: wheat, barley, cotton, pulses



4 YELLOW RIVER CIVILIZATION (CHINA)
(Huang He Basin)
c. 2000 – 1000 BCE

- Flood control and canal systems
- Dike construction and water distribution
- Millet farming supported early Chinese states



5 ANDES CIVILIZATIONS
(Peru – Coastal Valleys)
c. 2500 BCE – 1500 CE

- Mountain streams diverted through canals
- Terraces and aqueducts
- Crops: maize, quinoa, potato, beans
- Civilizations: Caral, Moche, Nazca, Inca



6 AEGEAN & MINOAN CIVILIZATION
(Crete & Aegean Islands)
c. 3000 – 1100 BCE

- Rainwater harvesting, cisterns and small-scale irrigation
- Olive, vine and garden agriculture
- Advanced hydraulic knowledge



7 PERSIAN EMPIRE
(Iranian Plateau)
c. 550 – 330 BCE

- Qanats (underground canals) to tap groundwater
- Efficient water distribution in arid regions
- Supported agriculture, gardens and settlements



8 SOUTHEAST ASIA CIVILIZATIONS
(Mekong, Chao Phraya, Java)
c. 1000 BCE – 1500 CE

- Irrigated rice agriculture
- Reservoirs, canals and water temples
- Sustained dense populations and trade



WHY IRRIGATION MADE CIVILIZATIONS

- **Food Security** – Enabled surplus production
- **Population Growth** – Supported large and stable societies
- **Cities & States** – Surplus led to cities, administration & law
- **Innovation** – Advanced engineering, calendar, measurement
- **Trade & Culture** – Exchanged goods, ideas and technologies
- **Legacy** – Many ancient irrigation systems still inspire modern solutions

DID YOU KNOW?

Over 40% of the world's food is still produced on irrigated land today.

SHARED FEATURES OF ANCIENT IRRIGATION CIVILIZATIONS

WATER MANAGEMENT – Harnessed rivers, floods, groundwater and rainfall through ingenious systems.

ENGINEERING INNOVATION – Canals, reservoirs, dikes, terraces, qanats, lifts and distribution networks.

AGRICULTURAL PRODUCTIVITY – Reliable water supply increased yields and crop diversity.

SOCIAL ORGANIZATION – Collective labor and governance were essential to build and manage systems.

CULTURAL & ECONOMIC IMPACT – Surplus enabled art, science, religion, monuments and long-distance trade.

LEGEND (Map Numbers)

1. Mesopotamia
2. Ancient Egypt
3. Indus Valley
4. Yellow River (China)
5. Andes
6. Aegean & Minoan
7. Persian Empire
8. Southeast Asia

> "Civilizations rise by water, flourish by water, and endure when they respect water."

THE ENDURING LESSON – *Where water flows wisely, life thrives. Ancient irrigation civilizations remind us that sustainable water management is the foundation of prosperity and resilience.*

THE EVOLUTION OF IRRIGATION ESTATES AND PLANTATION SYSTEMS THROUGH HISTORY

From Water Management to Sustainable, Climate-Resilient and Precision Agriculture

1 ANCIENT IRRIGATION ESTATES

c. 3000 BCE – 1000 BCE



- **Water Source & Technology:** Canals, reservoirs, wells, basin irrigation
- **Organization:** Early large estates managed by local elites and temples
- **Crops:** Cereals, dates, flax, legumes, vegetables
- **Labor:** Peasant and dependent labor
- **Focus:** Securing food surplus and supporting early civilizations

2 TEMPLE / ROYAL AGRICULTURAL ESTATES

c. 1000 BCE – 500 CE



- **Water Source & Technology:** Canals, tanks, water-lifting devices (shadūf, noria)
- **Organization:** Temples, palaces and royal estates
- **Crops:** Wheat, barley, rice, sugarcane, fruits, cotton
- **Labor:** Servants, tenants, corvée labor
- **Focus:** Supporting state, religion and urban centers

3 ROMAN LATIFUNDIA

c. 500 BCE – 500 CE



- **Water Source & Technology:** Aqueducts, canals, wells, cisterns
- **Organization:** Large private estates (latifundia)
- **Crops:** Olives, grapes, wheat, vegetables, wine & oil
- **Labor:** Enslaved people, tenants
- **Focus:** Large-scale production for markets and empire

4 ISLAMIC IRRIGATED GARDENS AND ESTATES

c. 7th – 15th Century



- **Water Source & Technology:** Qanats, canals, norias, reservoirs, terracing
- **Organization:** State lands, private estates, waqf (endowments)
- **Crops:** Citrus, pomegranate, rice, cotton, sugarcane
- **Labor:** Tenants, wage labor, sharecroppers
- **Focus:** Intensive irrigation, high value crops, landscape design and efficiency

5 ATLANTIC COLONIAL PLANTATIONS

15th – 17th Centuries



- **Water Source & Technology:** Canals, mills, reservoirs, water-diversion
- **Organization:** European-owned plantations
- **Crops:** Sugarcane, tobacco, indigo, cotton
- **Labor:** Enslaved Africans, indentured labor
- **Focus:** Export commodities for European markets

6 SLAVE-BASED PLANTATION ECONOMIES

17th – 19th Centuries



- **Water Source & Technology:** Extensive irrigation, drainage, mills
- **Organization:** Large estates, plantation complexes
- **Crops:** Sugarcane, cotton, coffee, rice, tobacco
- **Labor:** Enslaved labor systems
- **Focus:** Maximizing output and profit through coerced labor

7 COLONIAL EXPORT PLANTATIONS

19th – Early 20th Centuries



- **Water Source & Technology:** Irrigation canals, reservoirs, drainage, rail-linked water systems
- **Organization:** Colonial companies and estate management
- **Crops:** Tea, coffee, rubber, cocoa, banana, cotton
- **Labor:** Indentured labor, migrant labor
- **Focus:** Global export markets and colonial economic control

8 MECHANIZED AGRO-INDUSTRIAL PLANTATIONS

Mid 20th Century – 2000s



- **Water Source & Technology:** Large-scale irrigation, pumps, canals, sprinklers
- **Organization:** Corporate-owned, large farms, agro-industries
- **Crops:** Sugarcane, oil palm, soy, cotton, fruit plantations
- **Labor:** Wage labor, mechanization reduces labor intensity
- **Focus:** Efficiency, scale, and agro-industrial value chains

9 MODERN SUSTAINABLE / PRECISION-IRRIGATED PLANTATIONS

2000s – Present & Future



- **Water Source & Technology:** Drip/sprinkler, sensors, IoT, remote monitoring, recycled water, precision irrigation
- **Organization:** Sustainable businesses, cooperatives, certified producers
- **Crops:** High value fruits, nuts, coffee, cocoa, vegetables, specialty crops
- **Labor:** Skilled workforce, training, community inclusion
- **Focus:** Sustainability, water productivity, climate resilience, social equity

TIMELINE OVERVIEW

Early Civilizations (≈ 5000 years ago)	Ancient Kingdoms (≈ 3000 years ago)	Classical Empires (≈ 2500 years ago)	Medieval Innovation (≈ 1400 years ago)	Age of Exploration (≈ 500 years ago)	Colonial Exploitation (≈ 400 years ago)	Industrial & Colonial Expansion (≈ 200 years ago)	Industrialization & Globalization (≈ 70 years ago)	Sustainability & Innovation (Today & Future)

DRIVERS OF TRANSFORMATION

- Population Growth
- Technological Innovation
- Trade & Market Expansion
- Political Power & Empire Building
- Colonialism & Global Trade
- Labor Systems (From enslaved to wage labor)
- Industrialization & Mechanization
- Science, Data & Digital Technology
- Climate Change & Sustainability Imperative

EVOLVING GOAL

Survival & Food Security → Surplus Production for State & Religion → Empire Support & Market Supply → Efficiency, Diversity & Prosperity → New World Exploitation & Profit → Maximum Profit Through Coerced Labor → Export Growth & Economic Control → Efficiency, Scale & Agro-Industrial Value Chains → Sustainability, Resilience & Inclusive Prosperity

Across millennia, water management, technology and social organization have shaped irrigation estates and plantation systems—evolving from survival and surplus to global trade, industrial efficiency, and now toward sustainable, climate-resilient and people-centered agriculture.

EVOLUTION OF INTERNATIONAL FINANCING INSTITUTIONS IN THE IRRIGATION SECTOR

From Building Infrastructure to Building Resilient, Inclusive and Sustainable Irrigation Systems

TIMEFRAME

1 BUILD
1940s–1960s

Irrigation Infrastructure



- Post-war reconstruction and infrastructure
- Large dams, canals, drainage networks
- Engineering-led development
- Objective: increase agricultural production

2 IRRIGATE
1960s–1970s

Food Production & Green Revolution



- Irrigation + HYV seeds + fertilizer + mechanization
- Large-scale irrigation expansion
- Food security and rural economic growth
- IFIs support Green Revolution

3 REHABILITATE
1980s–1990s

O&M, Drainage & Institutional Reform



- Aging infrastructure and declining performance
- Rehabilitation, drainage and salinity control
- Operation & maintenance and cost recovery
- Water Users Associations and institutional reform

4 PARTICIPATE
1990s–2000s

Farmers, WUAs & Irrigation Management



- Participatory irrigation management
- Strengthening WUAs and local institutions
- Gender and social inclusion in water management
- Irrigation as a service

5 MODERNIZE
2000s–2010s

Efficiency, Automation & Water-Productivity



- Irrigation modernization and rehabilitation
- Canal lining, automation, SCADA, measurement
- Drip & sprinkler systems, improved drainage
- Asset management and water accounting

6 RESILIENCE & INTEGRATE
2010s–2020s and beyond

Climate Resilience & Integrated Water–Food–Energy Systems



- Climate-resilient infrastructure and drought management
- Environmental & social safeguards, gender equality
- Integrated Water Resources Management (IWRM)
- Water–Food–Energy–Environment nexus and digital solutions

KEY INTERNATIONAL FINANCING INSTITUTIONS (INCREASING ENGAGEMENT OVER TIME)

World Bank (IBRD)	IDA	ADB	AfDB	IsDB	IFAD	JICA (ODA)	EBRD	AIIB	NDB
1944	1960	1966	1964	1975	1977	1970s	1991	2016	2015
Pioneer in financing irrigation and agricultural infrastructure	Concessional finance for irrigation and rural development in low-income countries	Strong focus on irrigation, food production and rural development in Asia	Agriculture and water infrastructure for regional economic development in Africa	Irrigation, agricultural infrastructure and rural development in member countries	Small-scale irrigation, rural infrastructure and smallholder livelihoods	Major bilateral financing for irrigation in Asia, Africa and Middle East	Water & irrigation modernization, efficiency and institutional reform	Infrastructure and irrigation modernization, water resources management	Sustainable infrastructure and water-resource financing

EVOLUTION OF THINKING

Irrigation as **INFRASTRUCTURE** for economic development → Irrigation as a **DRIVER** of food security and agricultural intensification → Irrigation systems must **PERFORM** and be maintained sustainably → Irrigation management with **PEOPLE** at the center (participation & institutions) → Irrigation **MODERNIZATION** for efficiency and water productivity → Irrigation as part of an **INTEGRATED, CLIMATE-RESILIENT WATER–FOOD–ENERGY–ENVIRONMENT SYSTEM**

TYPICAL FOCUS OVER TIME

Dams, canals, large-scale infrastructure	Expansion of irrigated area & crop yields	Rehabilitation, O&M, drainage, institutional reform	Participation, WUAs, social inclusion & governance	Modernization, automation, water accounts, asset management	Climate resilience, environment, gender, digital solutions & integrated water resources management

OVERALL GOAL THROUGH TIME: Sustainable, inclusive and resilient irrigation systems that improve livelihoods, protect ecosystems and ensure water, food and energy security.

Kolkhoze and Sovkhoze System in Soviet Uzbekistan

State-controlled agriculture, cotton monoculture and large-scale irrigation

From collective farms to state farms — agriculture as a tool of Soviet economic and political policy.

What were Kolkhozes and Sovkhozes?

Kolkhozes (collective farms)

- Owned by farm members (collective ownership).
- Farmers worked collectively and received labor payments (in kind and cash).
- Managed by elected bodies, but tightly controlled by the state.

Sovkhozes (state farms)

- Owned and managed directly by the state.
- Employed wage labor (farm workers).
- Received inputs, plan targets and technical support from the state.

Why was this system established in Uzbekistan?

- To increase agricultural production, especially cotton, for the Soviet Union.
- To ensure state control over land, water and resources.
- To promote large-scale, mechanized farming and irrigation infrastructure.

Soviet Uzbekistan – Kolkhozes and Sovkhozes (1960s–1980s)



Monoculture of Cotton

- Cotton became the dominant crop (often >70% of sown area).
- Required large volumes of water, fertilizers and pesticides.
- Encouraged by the Soviet Union to earn foreign currency and supply the textile industry.

Result: a shift from diverse farming systems to cotton monoculture across much of Uzbekistan.

Impacts and Legacy

Environmental degradation
- Aral Sea shrinkage
- Soil salinization and waterlogging
- Loss of biodiversity

Social and economic effects
- Dependence on cotton exports
- Low crop diversification
- Labor shortages and low productivity

Long-term challenges
- Legacy of inefficient water use
- Need for reform and diversification after independence (1991)

Cotton Fields and Irrigation System

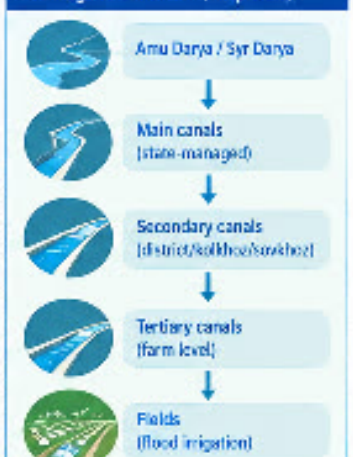
1 Water from rivers and canals
Amu Darya and Syr Darya provided water through a system of main canals, secondary canals and tertiary canals.

2 Irrigation method
Flood irrigation was widely used, with water released into furrows or basins.

3 Field layout
Large fields, often 10–50 ha, with cotton planted in rows (usually 6–10 plants per meter).



The Irrigation Network (simplified)





Cotton field in Soviet Uzbekistan (typical scene)

The kolkhoze–sovkhoze system, combined with massive irrigation projects, turned Uzbekistan into a major cotton producer — but at the cost of environmental stress, water overuse and long-term ecological consequences.

ARAL SEA DISASTER — SIX DECADES OF SHRINKAGE

From a thriving inland sea to a desert: the human and environmental cost of diverted rivers

1960
Vast, continuous water body



1950s–60s:
river diversion for irrigation

1989
North and South separated



late 1980s:
North/South separation

2000
Smaller, fragmented water body



2005:
Kok-Aral dam

2014
Eastern lobe disappears



2014:
eastern lobe disappears

2023
Extensive Aralkum exposed seabed



2023:
extensive Aralkum exposed seabed

Muynak — abandoned fishing fleet



Muynak — abandoned fishing fleet



FROM RIVER DIVERSION TO LASTING IMPACTS



DRASTIC DECLINE IN SURFACE AREA



~10% of original area remaining by 2023

IFI INVOLVEMENT FOR THE ARAL SEA:
FROM MITIGATION TO RESILIENCE AND REGIONAL TRANSFORMATION

VISION: A RESILIENT ARAL SEA BASIN – SUSTAINABLE WATER USE, PRODUCTIVE LANDSCAPES, PROTECTED ECOSYSTEMS, PROSPEROUS PEOPLE

THE ARAL SEA CRISIS – ROOT CAUSES AND IMPACTS



- Over-abstraction of Amu Darya and Syr Darya for irrigation
- Soil salinization, waterlogging, land degradation
- Dust storms and ecosystem degradation
- Declining agricultural productivity, food insecurity, health impacts
- Water scarcity and competition between sectors and countries

EVOLUTION OF IFI INVOLVEMENT IN THE ARAL SEA BASIN

1. EARLY RESPONSE (1990s – early 2000s)

Addressing the immediate consequences

- Drainage rehabilitation and groundwater control
- Salinity and waterlogging mitigation
- Land reclamation and pilot projects

KEY IFIs: WB, IsDB, UNDP, GEF

2. REHABILITATION (2000s)

Restoring deteriorated irrigation systems

- Canal and structures rehabilitation
- Pumping stations restoration
- Improved water delivery and measurement

KEY IFIs: WB, ADB, IsDB, JICA, EU, EBRD, SFD

3. INTEGRATED WATER MANAGEMENT (2010s)

From infrastructure to systems and institutions

- IWRM and basin planning
- Water allocation and water accounting
- WUAs and participatory irrigation management
- Strengthening institutions and data systems

KEY IFIs: WB, ADB, IsDB, EU, JICA, GEF

4. CLIMATE RESILIENCE (2015 – 2020s)

Adapting to climate change and increasing efficiency

- Irrigation modernization and water efficiency
- Salinity and water-quality management
- Drought and disaster risk management
- Climate-smart agriculture

KEY IFIs: ADB, WB, IsDB, GCF, GEF, EU, JICA

5. BASIN & REGIONAL TRANSFORMATION (2020s and beyond)

Cooperation, innovation and sustainable development

- Transboundary cooperation and water diplomacy
- Basin-wide programs and policy dialogue
- Digitalization, innovation and knowledge sharing
- Ecosystem restoration of the Aral Sea region

KEY IFIs: WB, ADB, EBRD, IsDB, UN, IFAD, GEF

HOW IFIs SUPPORT: INTEGRATED AREAS OF INTERVENTION

- **INFRASTRUCTURE** – Modernization of canals, structures, pumping stations, drainage systems
- **WATER MANAGEMENT** – Improved measurement of surface, operations, IWRM and basin modeling
- **LAND & SALINITY** – Salinity and waterlogging control, land reclamation, soil fertility improvement
- **AGRICULTURE & LIVELIHOODS** – Water productivity, diversification, climate-smart agriculture, rural income and food security
- **INSTITUTIONS & CAPACITY** – Institutional strengthening, WUAs, governance, regulation and capacity building
- **DATA & TECHNOLOGY** – Hydrometric data, remote sensing, digital tools, decision-support systems
- **ENVIRONMENT & ECOSYSTEMS** – Aral Sea ecosystem restoration, biodiversity protection, dust and salt-storm mitigation
- **FINANCE & PARTNERSHIPS** – Blended finance, public–private partnerships, co-financing

KEY IFIs AND PARTNERS

WORLD BANK · ADB – ASIAN DEVELOPMENT BANK · IsDB – ISLAMIC DEVELOPMENT BANK · EBRD – EUROPEAN BANK FOR RECONSTRUCTION AND DEVELOPMENT · JICA – JAPAN INTERNATIONAL COOPERATION AGENCY · GEF – GLOBAL ENVIRONMENT FACILITY

EU, UNDP, FAO, bilateral donors, Green Climate Fund (GCF), Civil Society, Private Sector

EXPECTED OUTCOMES / IMPACT

- **SUSTAINABLE WATER USE** – More crop per drop, reliable water supply
- **IMPROVED LAND AND AGRICULTURE** – Higher productivity, reclaimed land, better livelihoods
- **RESILIENT COMMUNITIES** – Reduced poverty, health risks and more secure lives
- **HEALTHY ECOSYSTEMS** – Restored landscapes, less dust and salinity, protected biodiversity
- **REGIONAL COOPERATION** – Stable, cooperative and climate-resilient Aral Sea Basin

COORDINATION, KNOWLEDGE SHARING AND LONG-TERM COMMITMENT ARE ESSENTIAL FOR A SUSTAINABLE FUTURE OF THE ARAL SEA BASIN

Pressure Relief Wells

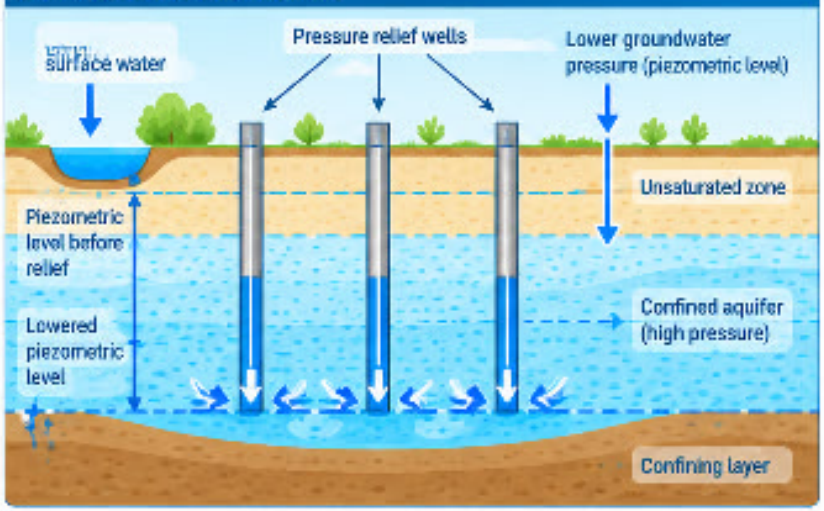
Reducing excess groundwater pressure for more sustainable and efficient water management

1 Theoretical Background

Pressure relief wells (PRWs) are vertical wells that intercept and release excess groundwater pressure from confined or semi-confined aquifers. By lowering the piezometric level, PRWs:

- prevent waterlogging and soil salinization,
- reduce land subsidence,
- improve the efficiency of water use and protect infrastructure and ecosystems.

How Pressure Relief Wells Work



2 Example: Fergana Valley (Central Asia)

In the Fergana Valley, intensive irrigation and poor drainage have led to rising groundwater levels and waterlogging. Pressure relief wells are used to discharge excess groundwater from the shallow confined aquifer, helping to:

- lower the water table and reduce soil salinity,
- improve soil conditions for agriculture,
- protect buildings, roads and infrastructure,
- support long-term water management.

Location in the Fergana Valley



Pressure relief wells in the Fergana Valley (example)



3 Key Design and Operation Elements

Well depth
- Intersects the confined aquifer
- Screens in target layer

Screen & filter
- Prevents sand inflow
- Ensures stable operation

Discharge system
- Gravity or pumped
- To canal or drainage network

Control & monitoring
- Measure water levels and discharge
- Adjust operation as needed

Benefits

- Prevents waterlogging and salinization
- Reduces land subsidence and infrastructure damage
- Improves irrigation and drainage efficiency
- Supports sustainable agriculture and livelihoods

Pressure relief wells are a simple but effective measure to manage groundwater pressure, especially in areas like the Fergana Valley, where intensive irrigation and limited natural drainage create high risks of waterlogging and salinization.

Managed Aquifer Recharge (MAR)

Storing water underground for a more resilient future

What is MAR?

Managed Aquifer Recharge (MAR) is the intentional and controlled recharge of water to aquifers, using natural or engineered methods, to store water for later use, restore groundwater levels and improve water quality.

Why is it important?

- Increases water supply reliability (drought buffer)
- Enhances climate resilience
- Supports ecosystems and baseflow
- Supports agriculture and livelihoods
- Improves water quality (by natural filtration)
- Helps manage floods and reduces runoff

How MAR Works – Main Methods

1. Infiltration basins

Surface basins where water infiltrates through the soil into the aquifer.

2. Spreading fields

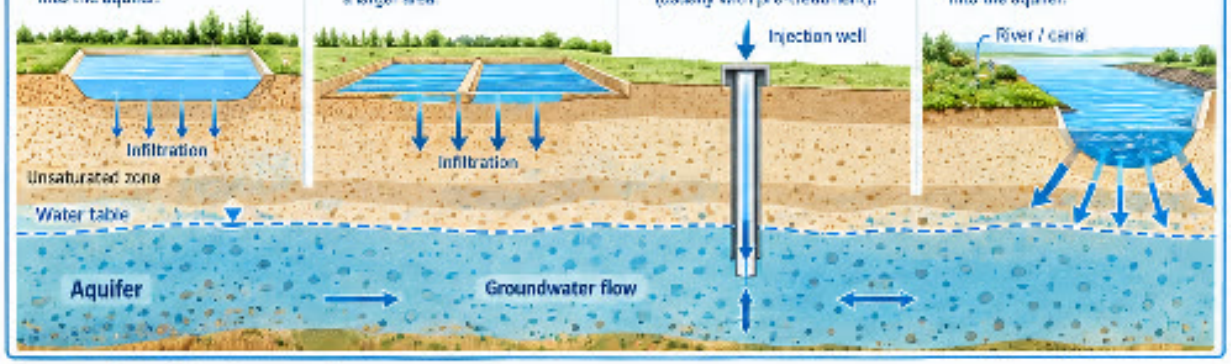
Shallow, unlined fields that allow water to infiltrate over a larger area.

3. Recharge wells

Direct injection of water into the aquifer through wells (usually with pre-treatment).

4. River/Canal bank filtration

Infiltration from rivers or canals through riverbed and banks into the aquifer.



Key Design and Implementation Considerations

- **Water quality**
  - Pre-treatment
  - Avoiding clogging
  - Monitoring
- **Site suitability**
  - Geological setting
  - Soil permeability
  - Aquifer capacity
- **Infrastructure**
  - Basins / wells / canals
  - Conveyance systems
  - Monitoring wells
- **Operation & management**
  - Recharge timing & volume
  - Water rights & agreements
  - Maintenance
- **Environmental & social**
  - Ecosystem impacts
  - Community engagement
  - Land use
- **Monitoring & evaluation**
  - Groundwater levels
  - Water quality
  - Performance assessment

Example: Fergana valley (Central Asia)

In the Fergana Valley, MAR is used to recharge groundwater from excess surface water, especially during the irrigation season, to support agriculture and mitigate water scarcity.



Key features in the Fergana Valley example

- **Source water:** excess irrigation water from canals and rivers (e.g. Syr Darya and its tributaries).
- **Techniques:** infiltration basins, spreading fields, and recharge wells.
- **Main aquifers:** shallow alluvial aquifers (unconfined) and deeper aquifers (confined).
- **Objectives:** increase groundwater levels, improve reliability of water supply, and support intensive agriculture.



Infiltration basin in the Fergana Valley (example)

Managed aquifer recharge turns seasonal surplus water into long-term groundwater resources — supporting people, agriculture and ecosystems.

INTERNATIONAL FINANCING INSTITUTIONS AND IRRIGATION IN TÜRKİYE

Evolution, Key Institutions, Major Contributions and Outlook

EVOLUTION OF IFI INVOLVEMENT IN IRRIGATION IN TÜRKİYE

1950s–1960s — FOUNDATION
Early support & technical cooperation for water resources and agriculture

1970s–1980s — BIG IRRIGATION ERA
Large dams, irrigation schemes and rural development projects

1990s — MODERNIZATION & INSTITUTIONAL REFORM
Rehabilitation, drainage, rural infrastructure and institutional capacity

2000s — INTEGRATION & EU ALIGNMENT
Water Framework alignment, efficiency, modernization, environment & safeguards

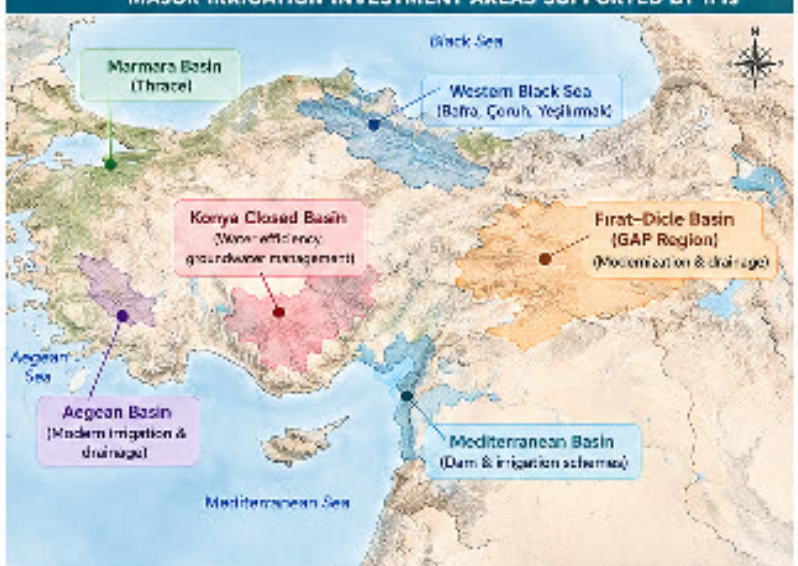
2010s — CLIMATE & RESILIENCE
Climate-smart irrigation, efficiency, water productivity, drought/flood management

2020s and beyond — SUSTAINABLE WATER & FOOD SECURITY
Integrated water management, digitalization, renewable energy, nature-based solutions

MAIN IFIs ACTIVE IN TÜRKİYE'S IRRIGATION SECTOR

IFI	Since	Focus Areas in Türkiye Irrigation / Water	Notable Examples
WORLD BANK (IBRD/IDA)	1960s	• Irrigation modernization • Water resources management • Rural development & climate resilience	• Water Resources Management Project • GAP Irrigation Modernization Project • DSI Performance Improvement Project
Asian Development Bank	1970s	• Irrigation & drainage • Regional rural infrastructure • Water productivity	• Cop Irrigation Support Project • Rural Infrastructure Development • SEENCA (energy-water efficiency)
EBRD (European Bank for Reconstruction and Development)	2009	• Water sector reform • Irrigation efficiency • Energy efficiency (pumping, WSS)	• Konya Plain Irrigation Modernization • DSI Energy Efficiency Program • Municipal water projects (PPP)
EIB (European Investment Bank)	1990s	• Water infrastructure & environment • Irrigation & flood management • Green transition	• Regional Water & Wastewater Projects • Irrigation Rehabilitation (various basins) • Climate-adaptation infrastructure
IsDB (Islamic Development Bank)	1980s	• Irrigation, dams, rural development • Food security & water efficiency	• Agricultural Irrigation Projects • Rural Infrastructure & Storage
IFAD (International Fund for Agricultural Development)	2000s	• Smallholder irrigation • Rural livelihoods & value chains • Women & youth inclusion	• PARD-like rural programs • Village-based irrigation support
JICA	1970s	• Technical cooperation • Irrigation & dam safety • Modernization & training	• Dam Safety & O&M • Irrigation Technology Cooperation • Capacity Building for DSI

MAJOR IRRIGATION INVESTMENT AREAS SUPPORTED BY IFIs



KEY IMPACTS

- **Increased Irrigated Area** — ~8.7 million ha today (2024)
- **Water Efficiency** — Improved through modernization and digitalization
- **Climate Resilience** — Addressing drought, floods, salinity and variability
- **Inclusive Development** — Gender, youth & local communities
- **Energy Efficiency** — Reduced energy use in pumping & conveyance

TURKEY & IFI PARTNERSHIP – KEY FEATURES

- Long-standing cooperation and trust
- Strong institutional partner: DSI (General Directorate of State Hydraulic Works)
- Shift from large-scale construction to modernization and efficiency
- Alignment with EU standards and environmental safeguards
- Digital tools, innovation & data-based water management

LOOKING FORWARD: 2030 AND BEYOND

- Smart irrigation & digitalization (sensors, SCADA, satellite)
- Integrated Basin Management
- Nature-based solutions & ecosystem protection
- Renewable energy for irrigation (solar pumping)
- Water–Food–Energy–Environment Nexus



THE BIG PICTURE

> "From building dams and canals to managing water wisely for a climate-resilient, productive and inclusive Türkiye."

Import and Export of Virtual Water

Agricultural and livestock products move water across borders

Virtual water is the amount of water embedded in goods and services. Through trade, countries import and export water in the form of agricultural and livestock products.

What is Virtual Water?

Virtual water = the volume of freshwater used to produce a good or service (agricultural or livestock products).

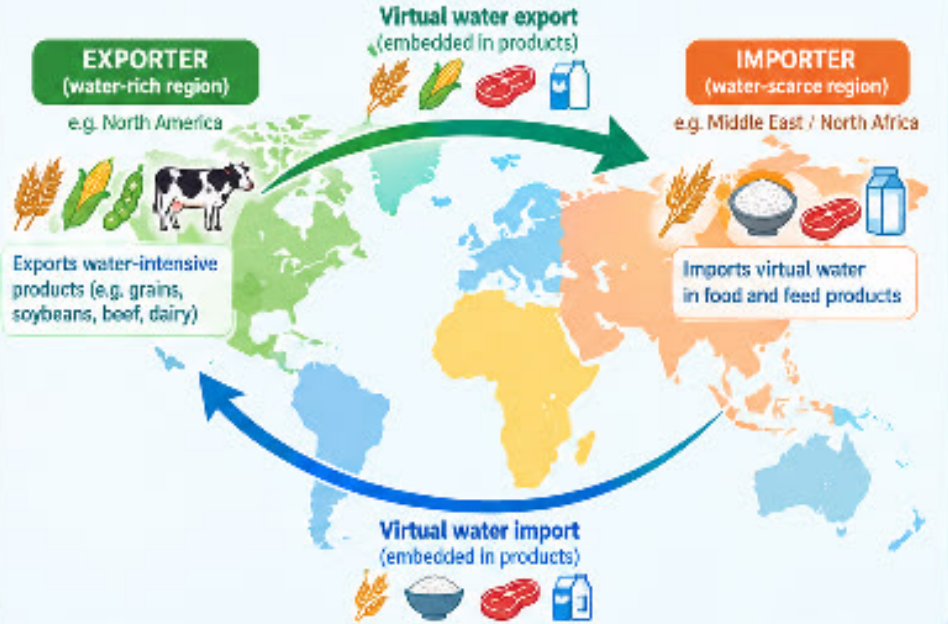
It is not physically traded, but it is embedded in products that cross borders.

Examples of Water Footprints

(approximate, varies by location and method)

- **Wheat** – ~ 1,300 m^3 per ton
- **Rice** – ~ 2,500 m^3 per ton
- **Maize** – ~ 900 m^3 per ton
- **Beef** – ~ 15,000 m^3 per ton
- **Milk** – ~ 1,000 m^3 per ton

How Virtual Water Moves Through Trade



From Farm to Market – Water Flows Across Borders



Production
Water is used for irrigation, livestock and processing (e.g. 1,300 m^3 per ton of wheat).

Processing & Packaging
Additional water for cleaning, processing and packaging.

Trade & Transport
Virtual water is embedded in traded goods.

Consumption
Water is used indirectly when products are consumed in the importing country.

Why It Matters

- Helps balance water availability and reduce pressure on local resources.
- **Supports food security** by enabling access to water-intensive products.
- Can increase water-use efficiency at the global level (when combined with sustainable production).
- May also create dependencies and transport-related emissions ("water and carbon footprint" trade-offs).

Key Considerations

- Water scarcity and resource limits in importing countries.
- Sustainability of production in exporting countries.
- Environmental and social standards (e.g. soil health, biodiversity, working conditions).
- Need for transparent data and consistent methodologies (for water footprint accounting).

Trade in agricultural and livestock products is a powerful way to move water resources — bringing benefits, but also new responsibilities for sustainable water management.

China's Future Role in the Irrigation and Agricultural Sector of Central Asia – My Assessment

Growing, Diversifying and Deepening – A Key Partner Alongside Traditional IFIs

Context: Why an Increasing Role for China?

- High demand for food security and water efficiency
- Urgent need for modernization of aging irrigation and water infrastructure
- Deepening economic and political ties through the Belt and Road Initiative (BRI)
- Rapid technological development and competitive cost of equipment and services
- Growing Chinese agricultural companies and global food supply strategy
- Increasing overseas land and agricultural investments



China's Likely Role in Central Asia – By Area

Area	Likely Chinese role	Illustrative level
Irrigation construction	Very high	■■■■■
Pumping/energy systems	Very high	■■■■■
Hydropower/water infrastructure	Very high	■■■■■
Agricultural machinery	Very high	■■■■■
Digital irrigation	High → very high	■■■■□
Agricultural investment	High	■■■□□
Land investment/leases	Selective rather than universal	■■□□□
Processing	Very high	■■■■■
Logistics	Very high	■■■■■
Climate-smart technology	Increasing rapidly	■■■■□
Financing	Increasingly equity/ commercial rather than only sovereign lending	■■■□□
WUA/institutional reform	Lower comparative advantage	■■□□□
Gender mainstreaming	Lower comparative advantage than IFIs	■■□□□
International environmental/ social safeguards	Improving, but important area for scrutiny	■■■□□
Governance/transparency	Potential area of tension with IFI approaches	■■□□□

Implications for Central Asia

- Accelerated modernization of irrigation and water infrastructure
- Rapid expansion of pumping, energy and water storage capacity
- Faster adoption of modern irrigation technology and equipment
- Integration of agriculture with processing and logistics value chains
- Increased investment in agriculture and agro-industry
- Greater access to climate-smart and digital solutions

Key Challenges

- Risk of over-dependence on one partner for technology, equipment and services
- Need for strong environmental and social safeguards
- Transparent, competitive and sustainable financing arrangements
- Balanced approach to land investment and local community interests
- Ensuring complementarity with IFI approaches on participation, gender and institutional reform

Overall: China will be a key and increasingly dominant partner in Central Asia's irrigation and agricultural transformation, especially in infrastructure, technology, equipment and investment — working in parallel and complementarity with IFIs to achieve water, food and energy security, climate resilience and sustainable rural development.

My Assessment for Turkey: China's Likely Future Role in the Water-

Turkey is unlikely to follow a China-led land + infrastructure model; instead, it can become a competitive platform linking Chinese technology,

TURKEY

China ↔ Turkey ↔ IFIs

AREA	LIKELY CHINESE ROLE	WHAT THIS LOOKS LIKE IN TURKEY
M Modernization of existing irrigation	★★★★★ VERY HIGH	• China enters a mature modernization market rather than creating irrigation capacity from scratch.
W Water efficiency / drought resilience	★★★★★ VERY HIGH	• Efficient conveyance, pressurized systems, drought management and water-saving technologies.
AI Digital & AI irrigation	★★★★★ VERY HIGH	• Sensors, IoT, telemetry, AI decision support, smart meters and automated irrigation.
C International irrigation contracting	★★★★☆ HIGH	• Turkish contractors remain strong; Chinese firms compete, partner or form joint ventures.
P Chinese technology partnerships	★★★★☆ HIGH	• Competitive Chinese equipment and digital technologies integrated into Turkish systems.
E Pumping & energy efficiency	★★★★☆ HIGH	• Efficient pumps, solar-powered irrigation and energy optimization, especially in water-stressed regions.
A Agricultural machinery	★★★★☆ HIGH	• Chinese machinery can expand competition in tractors, harvesters and precision agriculture.
G Greenhouses / controlled agriculture	★★★★☆ HIGH	• Potential technology and investment partnerships in controlled-environment agriculture.
P Processing / value chains	★★★☆☆ SELECTIVE	• Partnerships may extend from production toward processing, food industries and exports.
L Chinese land acquisition	★★☆☆☆ LOW / SELECTIVE	• Much less central than in some Central Asian scenarios; Turkish agriculture already has a strong private base.
E Chinese turnkey dominance	★★☆☆☆ LOW	• Less likely because DSİ, Turkish engineering and contractors already provide substantial domestic capacity.
I IFI-led climate / safeguards agenda	★★★★★ VERY HIGH	• IFI programs increasingly combine water efficiency, climate, governance and safeguards.
R Regional Turkish-led expansion	★★★★★ VERY HIGH	• Turkey can export irrigation engineering, contracting and IFI experience to Central Asia, Caucasus, MENA and Africa.

CONTEXT: WHY TURKEY IS DIFFERENT

MATURE DOMESTIC CAPACITY
DSİ, established irrigation experience, strong contractors, equipment manufacturers and agricultural institutions.

NEXT-GENERATION IFI MODEL
Current programs emphasize climate resilience, water efficiency, digitalization and safeguards.

WATER SCARCITY & CLIMATE
The focus is shifting from "build more irrigation" toward producing more with less water.

TECHNOLOGY ECOSYSTEM
AI, sensors, smart metering, automation and digital water accounting are emerging inside Turkey.

STRONG CONTRACTING BASE
Chinese firms are more likely to compete or partner with Turkish contractors than replace them.

REGIONAL CONNECTIVITY
Turkey can combine engineering, agriculture, IFI experience and regional access to serve third-country markets.

IFI / INTERNATIONAL STANDARDS
Turkey can bridge international safeguards and procurement requirements with Chinese equipment and technology.

SYSTEM-INTEGRATOR MODEL
Turkey can become the integrator: engineering + contractors + agriculture + IFI finance + selected Chinese technology.

OVERALL OUTLOOK

China is unlikely to displace Turkey's irrigation sector. More likely, it will increase technology competition and create partnership opportunities — while Turkey deve

ROLE / OPPORTUNITY	★★★★★ VERY HIGH	★★★★☆ HIGH	★★★☆☆ SELECTIVE	★★☆☆☆ LOW

Central Asia → potential China-led system integration | Turkey → Turkish-led integration with Chinese participation