National Water Security Strategy for Libya

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Title of the report: National Water Security Strategy.

Consultant: Hydroconseil (France)

Donors: 

Deep thanks and appreciation are extended to the National Water Security Committee, established pursuant to Resolution No. (87) of 2023 issued by the Prime Minister of the Government of National Unity, and to the supporting Technical Committee, established pursuant to Resolution No. (190) of 2024 issued by the Minister of Planning.

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Acronyms

Acronym	Definition
CAPEX	Capital Expenditures
FAO	Food and Agriculture Organization
GCWW	General Company for Water and Wastewater
GDC	General Desalination Company
GDP	Gross Domestic Product
GIS	Geographic Information System
HIB	Housing and Infrastructure Board
MAR	Managed Aquifer Recharge
MHI	Ministry of Housing and Infrastructure
MMRA	Man-Made River Authority (refers to the body)
MWR	Ministry of Water Resource
NRW	Non-Revenue Water
NSAS	Nubian Sandstone Aquifer System
NWSS	National Water Security Strategy
OPEX	Operational Expenditures
OSS	Sahara and Sahel Observatory
PM	Prime Minister
PPP	Public-Private Partnership
SDG	Sustainable Development Goals
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Program
USD	US Dollar
WEFE	Water, Energy, Food and Ecosystems
WHO	World Health Organization

A. Executive summary

A.1 Purpose and Status

This National Water Security Strategy (NWSS) sets a unified, country-wide course to secure Libya's water future, aligning institutions, investments, data systems, resource portfolios, and financing mechanisms behind a single long-term vision. It is the final version for approval, prepared under the UNDP Water Security Project and developed by Hydroconseil with extensive Libyan stakeholder input and technical review.

The Strategy is designed as an authoritative reference for all actors in the water sector – ministries, public companies, municipalities, and partners – so that projects, funds, and investments align with the NWSS priorities and contribute measurably to national goals.

A.2 The Case for Action

Libya faces severe water scarcity driven by aridity, climate trends, and overwhelming reliance on non-renewable fossil groundwater. Groundwater provides over 90% of use; coastal aquifers are increasingly saline; surface water potential is marginal. Core systems are underperforming: the Man-Made River Project (MMR) operates at less than half its design capacity; desalination assets deliver only 14% of their nominal output; and collected wastewater is discharged untreated.

Demand is misaligned with resource realities. Agriculture is reported to consume 80-85% of water yet contributes to lees than 2% of Libyan GDP and suffers high losses (35-40%). Municipal services face 30-50% Non-Revenue Water (NRW) and frequent disruptions.

Climate risks amplify fragility: rising temperatures, declining rainfall, sea-level rise and extreme events (e.g., Storm Daniel, 2023) threaten aquifers, infrastructure, and coastal cities. Without reform, Libya risks systemic shortages, ecosystem degradation, and escalating socio-economic tensions.

A.3 Vision 2050 and Commitments

In the absence of a separated policy document for the water sector, this national water security strategy is based on the following vision for year 2050:

Water security and climate resilience are ensured through a sustainable equilibrium between renewable resources and rational demand, under the leadership of a single public authority for the entire water sector. Decisions are data-driven, coordinated across sectors, and ensure fair, efficient service delivery. By 2050, the target is to curb down consumption below 150 l/c/d[1] for municipal water, reach 75 % of renewable sources in the resource mix, and contain NRW below 25% with infrastructure operating at 80% of design capacity.

[1] This target focuses only on urban municipal water, excluding water for agriculture. It is defined as the final consumption at household level, this is not a design standard, which must account for peak capacity and technical losses. Similarly, national production per inhabitant will be much higher to cover other demands, such as agriculture and account for technical losses.

This NWSS is also based on the following principles:

- It covers the water sector from resource to consumption across municipal, agricultural, industrial, and livestock uses.
- It is intended as a binding sector reference for policies, programs, and financing decisions of main actors of the sector.
- It orientates efforts towards making the best use of available water rather than meeting demand at any cost. Regain control over the demand and aim for efficiency.
- It fosters integrated water-energy-agriculture planning while protecting ecosystems.
- It recognizes the essential role of tariffs and incentives, to curb down the demand, reflect cost and value, with social protection.
- Under conditions of structural scarcity, Libya should optimize water productivity, reserving scarce conventional water for high-value and essential uses and relying more on imports of water-intensive commodities (virtual water) rather than domestic production that would draw heavily on finite aquifers at high cost.

A.4 Five axes to implement the change

A.4.1. Axis 1, institutional enabling environment

Goal: an enforced regulatory system to facilitate the NWSS. Priorities include establishing a single leading government body ("Water Board") coordinating resources, planning, ownership, operations, service delivery, and demand management; creating an independent regulator to oversee compliance, service quality, and tariff fairness; and clarifying functions across ministries and operators.

A.4.2. Axis 2, sector alignment

Goal: a truly integrated WEFE approach (Water-Energy-Food-Ecosystems) and coordinated investment planning across actors. The Water Board leads top-down strategy setting, consolidates utility investment plans into a single national program, and anchors Libya's transboundary water engagement.

A.4.3. Axis 3, develop a knowledge base

Goal: operational data collection, management, and interpretation systems. Establish a National Data & Analytics Unit (NDAU) and a centralized National Water Information System (NWIS); standardize KPIs; expand operational monitoring (SCADA, telemetry, metering); and launch the National Water Research & Technology Center (NWRTC).

A.4.4. Axis 4, optimize water usage & adapt water sources

Goal: supply from resilient, effectively managed sources. Core moves: demand management (especially agricultural), groundwater master-planning and modelling, and a roadmap to diversify supply (rehabilitated surface water systems, desalination for coastal cities, treated wastewater reuse, managed aquifer recharge), with energy efficiency integrated throughout.

A.4.5. Axis 5, seek financial sustainability

Goal: reduced reliance on subsidies. Centralize asset ownership with the Ministry of Housing & Infrastructure (MHI); apply transparent, evidence-based investment prioritization; implement a fair, volumetric tariff system (with pro-poor blocks and wastewater charges), smart metering, and

a clear regulatory tariff process; and mobilize innovative finance (PPP under Resolution 507/2025, blended finance, climate funds, green/blue bonds).

✓ THE BIG SHIFTS

- Leadership & accountability: Water Board and independent regulator fully operational.
- From fragmented data to decisions: NDAU + NWIS enable shared, quality-assured data and predictive analytics.
- From meeting the demand to managing the demand: systematic controls on groundwater abstraction, agricultural efficiency, and NRW reduction.
- From large volume transfers to a more balanced source mix: basin-specific groundwater frameworks and national/city master plans for diversification.
- Tariffs & finance that work: transparent tariff-setting, smart metering, and diversified financing instruments.

A.5 Implementation Roadmap (2026–2050)

A.5.1. Phasing

Step 1 (2026), **build the enablers**: Water Board operational; initiate regulator; start NWIS.

Step 2 (2027), **operationalize coherence and informed decisions**: NWIS live; regulator active; abstraction permitting in place.

Step 3 (2028–2030), **transform operations**: NRW quick wins; metering; tariff reform; utilities on commercial basis.

Long-term (2030–2050), consolidate transition: renewable share >75%; NRW <27%; subsidies <15% by 2040.

A.5.2. Bottom Line

The NWSS replaces reactive, fragmented responses with a proactive, coherent, data-driven, and financially credible pathway to water security. It sequences governance, alignment, and knowledge first (2026–2027), then scales efficiency and diversification (2028–2030), and consolidates resilience and sustainability to 2050.

B. Preamble

B.1 Presentation of the document

B.1.1. The partnership between UNDP and the Ministry of Planning

Under the patronage of the Prime Minister and in collaboration with the United Nations Development Program (UNDP), the Ministry of Planning has begun the process of formulating the National Water Security Strategy, based on an integrated water resources total management approach. This strategy aims to ensure sustainable solutions to water security amid the growing impacts of climate change and increased demand for this resource.

The formulation of this strategy, *which is developed within the framework of the National Water Security Committee chaired by the Ministry of Planning with UNDP's high-level technical expertise and broad stakeholder engagement*, represents a vital major step toward achieving sustainable water resource total management in Libya, when finished and implemented.

This strategy is part of the UNDP Water Security Project, funded by the Governments of Italy and Denmark. These efforts demonstrate the Ministry's commitment to securing Libya's future through strategic planning, evidence-based policymaking, and comprehensive collaboration with national and international partners.

The strategy is scheduled for completion in the fourth quarter of 2025 and is planned to address Libya's heavy reliance on groundwater, inefficient water use, and the increasing risks posed by extreme weather patterns. It is to identify actionable steps to manage demand, enhance resilience, explore unconventional water sources, and integrate the water-energy nexus for long-term sustainability.

B.1.2. The assignment commissioned to Hydroconseil

Hydroconseil has been tasked by UNDP with the development of this National Water Security Strategy (NWSS). The contract was signed in December 2023 and Hydroconseil was formally endorsed by the PM office in July 2024. An event was held in December 2024 to formally launch the assignment, in the presence of the PM Office.

This assignment is overseen by the National Water Security Committee, comprising representatives from the Ministry of Water Resources, the Ministry of Housing and Infrastructure, the Desertification Control Committee, Man-Made River Authority, Ministry of Finance, Ministry of Interior and the Libyan Central Bank. It is chaired by the Ministry of Planning, and a technical committee has been established to be the interlocutor of the consultant, and is hosted at the Ministry of Planning, comprising two technical resource persons from the water sector and representatives of Ministry of Planning and UNDP.

B.1.3. Stakeholder engagement

Due to logistical and visa issues limiting international experts to meet stakeholders in Libya, the methodology was adjusted to:

- Organize online meetings with the help of a local team of experts facilitating contact with institutions.

- Rely more significantly on literature review (which has been intensively fed by many institutions).
- Organize a specific workshop in Tunis to engage a core team of representatives of the major entities of the sector.
- Strengthen the local team with a senior expert of the water sector to facilitate stakeholder engagement.
- Establish bi-weekly online meetings with the participants of the Tunis workshop.
- Present the main axes proposed for the strategy document for validation by the Technical Committee (late September).
- Organize working sessions in Tunis to review the document in session and make most of the desired amendments on screen.
- Submit a final draft before the 31st of December.

B.1.4. Structure of the document

To keep it concise and easy to read, the present document is structured in the following way:

Section	Purpose
A Executive summary, page 6	Summarizes the entire document and highlights the main take aways
B Preamble, page 10	Describes the context of the preparation of the document and its structure
C The main directions of the strategy, page 12	Rationales the fundamentals of the proposed strategy (goals, perimeter, methods)
D The five strategic axes of the strategy, page 23	Details the content of the strategy, axis by axis, with the same format: goal, objectives, rationale, strategic approaches.
E Implementation action plan, page 50	Provides insight into the necessary phasing of actions.
F Annexes, page 56	Gathers all further details to avoid long detailed description in the main body of the document.

The above section names are clickable to directly reach the given section in the document (Ctrl + click on the page number).

A synthetic table is given (Table 1, page 22) to see all the axes and their objectives at a glance. Names of the objectives and axis are also clickable for a direct reach.

C. The main directions of the strategy

C.1 Current situation of the water sector

C.1.1. Situation analysis

Libya faces one of the most severe water scarcity challenges globally, shaped by its arid climate, limited renewable resources, and heavy dependence on non-renewable fossil groundwater. Over 95% of the country is desert, with average annual rainfall of only 26 mm and evaporation rates reaching 6,000 mm/year in southern regions. Climate trends show rising temperatures (+1.9°C since 1950), declining precipitation, and increasing evapotranspiration, amplifying stress on already fragile water systems.

Water Resources Profile

Groundwater dominates Libya's water supply, accounting for over 90% of total use. Renewable shallow aquifers in the north provide only 20% of groundwater and are highly vulnerable to saline intrusion and pollution. Deep fossil aquifers in the south (Murzuq, Kufra, Sarir) supply the bulk of water but are finite and increasingly costly to exploit. Coastal aquifers face irreversible salinization, worsened by over-abstraction and sea-level rise.

Fossil reserves are widely believed to remain extensive and are likely to be available for at least decades to come. However significant uncertainty exists regarding how long the exploitable fossil reserves will last and how wellfield operating conditions are likely to become increasingly complex and costly over time. The most recent Libyan numerical model simulations date from before 2015 meaning that there is an urgent need to review and update these simulations to improve confidence levels in the exploitable reserve estimates and enable informed water resource planning.

Surface water resources are negligible, limited to seasonal wadis and springs in the northern highlands. Dams exist but suffer from poor maintenance, high evaporation losses, and unclear operational status. Even optimistic projections estimate only 40~70 Mm^3/year of usable surface water, confirming its marginal role in national supply.

Infrastructure and Service Delivery

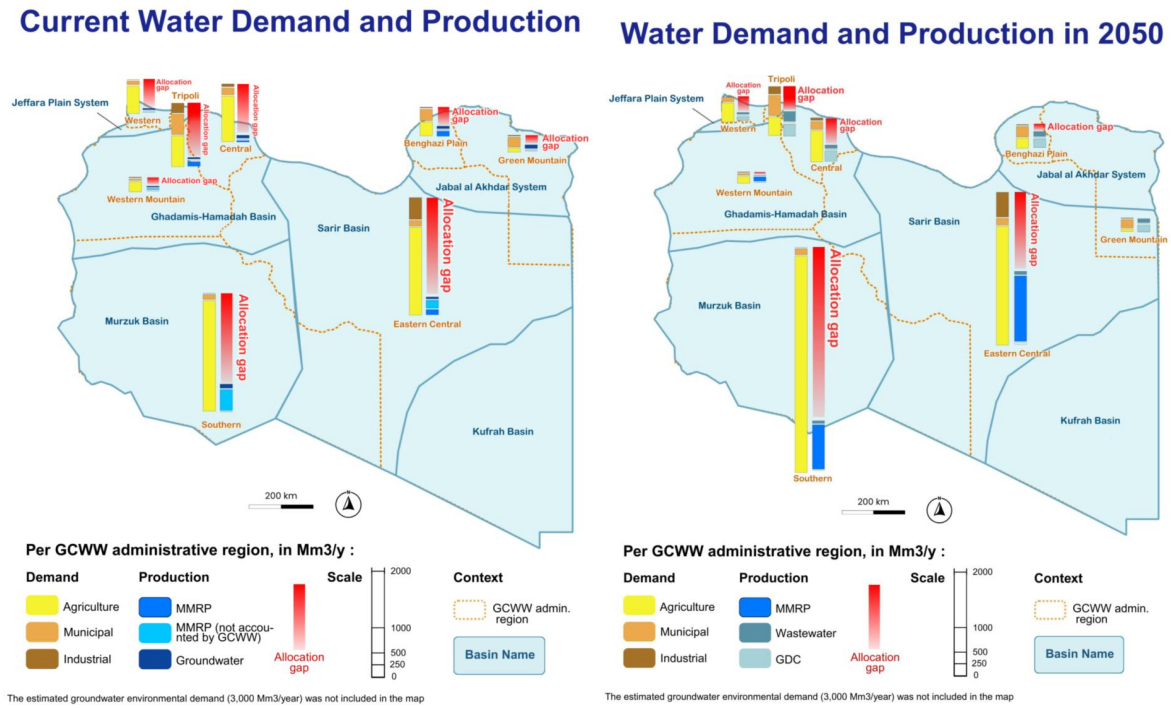
Libya's water infrastructure is deteriorating. The Man-Made River Project (MMR), designed to transfer fossil groundwater to coastal cities, operates at less than half its planned capacity due to aging pipelines, power outages, and conflict-related damage. Desalination plants, once numbering over 20, now function at less than 14% efficiency, producing only 15.8 Mm^3 in 2024 versus a design capacity of 360,000 m^3/day. Wastewater treatment is virtually non-existent: over 90% of collected wastewater is discharged untreated, posing severe environmental and health risks.

Municipal water supply coverage has declined, with frequent service disruptions and losses estimated at 30–50%. Rural areas remain underserved, relying on private wells and rainwater harvesting. Non-revenue water and illegal connections further undermine resource management.

Demand and Allocation Gaps

According to many sources (most of them referring to a study in 2014) agriculture has been consuming 80–85% of Libya's water, mostly through unregulated private wells. Yet, this very high

consumption contributes less than 2% to GDP. Inefficient irrigation and high losses (35–40%) exacerbate pressure on aquifers. Municipal demand is rising with urbanization, while industrial use – dominated by oil production – adds further strain. Current estimates indicate a national water deficit exceeding 4,000 Mm³/year, with up to 82% of demand met by uncontrolled private abstraction.



Climate and Environmental Risks

Projected temperature increases (+2.2–2.7°C by 2100), declining rainfall, and sea-level rise (up to 0.6 m) threaten water security, agriculture, and coastal infrastructure. Extreme events, such as Storm Daniel in 2023, highlight vulnerabilities in flood management and dam safety. Desertification affects 80% of pasturelands and accelerates rural migration, compounding socio-economic instability.

C.1.2. The risks for Libya if no action is taken

Libya faces severe water security risks if it continues on its current path. The country relies overwhelmingly on non-renewable fossil groundwater, which supplies over 90% of its water needs. These deep aquifers (Murzuq, Sarir, and Kufra) are finite and already showing alarming declines, jeopardizing municipal supply and agricultural production. These concerns are all the more serious given that the data required to assess how long these reserves may last are either insufficient or too outdated to be reliable. There is an urgent need to update the last comprehensive study on this issue, which dates back to 2014. Coastal aquifers are under even greater stress: over-abstraction and rising sea levels are causing irreversible saline intrusion, threatening drinking water quality for millions.

Infrastructure fragility compounds these risks. The Man-Made River Project operates at barely half its planned capacity due to aging pipelines, power outages, and conflict-related damage. Desalination plants function at less than 14% of initial capacity, and wastewater treatment has virtually collapsed, with over 90% of collected wastewater discharged untreated, polluting ecosystems and coastal zones. Meanwhile, the agricultural sector is unable to translate its dominant share of water consumption into a meaningful contribution to GDP. Inefficient irrigation and losses of up to 40% accelerate depletion.

Climate change amplifies these vulnerabilities. Rising temperatures, declining rainfall, and extreme events such as Storm Daniel increase pressure on already fragile systems. Without urgent reforms, Libya risks systemic water shortages, food insecurity, ecosystem collapse, and escalating social tensions over resource allocation, undermining economic stability and national resilience.

C.2 The future vision of the water sector in Libya

C.2.1. Horizon 2050

Libya's water sector has currently no standalone policy document as such to define the situation aimed for the 2050 horizon, and serve as a basis for the development of this national water security strategy.

However, Libya has been repeatedly producing sector documents in an effort to pose strategic principles or plans. Some of these documents, released before 2011, belong to another era when the conditions and knowledge were too different to remain relevant for the current situation. But the elements of the vision on which this strategy is based can be collected from the following documents:

1. The National Water Security Strategy for Libya (2015-2050), prepared by the National Planning Committee (2014)
2. The Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025)
3. Libya's Water Resources Sector Development Plan 2020–2024 (Ministry of Planning, 2019)
4. Several investment plans or strategic action plans developed by each of the main utilities (MMRA, GCWW, GDC…)

Among these documents, the following elements can be drawn to serve as a basis for the 2050 vision of the water sector:

- A sector where water resources are managed in an integrated manner across all water usages (integrated water resource management), considering water resources as economic assets for development and long-term water and food security.
- The development of the water sector contributes to the broader development goals aimed at achieving prosperity and sustainability.
- A sustainable water supply for the population (priority 1), balancing available renewable water resources and realistic demand.
- Water is considered as an economic input in the agricultural sector while it is a common good of all the population of Libya, with a strong value.
- The water sector is effectively led and monitored, decisions are informed and the leader of the sector is accountable to the government.
- Groundwater resources are efficiently used and protected from depletion and pollution

The proposed vision guiding the water sector development for 2050 is:

✓ VISION 2050

Water security and climate resilience are ensured through a sustainable equilibrium between renewable resources and rational demand, under the leadership of a single public authority covering all aspects (integrated water resource management, infrastructure and service delivery) of the water sector.

This authority implements an integrated, data-driven approach that accounts for cross-sectoral strategies, coordinates investment planning among all concerned parties, optimizes resource management at national level, and oversees fair service delivery.

This equilibrium relies on a diversified and sustainable mix of groundwater, desalination, surface water, and water reuse. Sector governance is founded on knowledge and data sharing, centralized monitoring, and coordinated planning, ensuring that every decision safeguards water for people, agriculture, energy, and ecosystems, without compromising the needs of future generations.

A rational demand in 2050 should be under 150 liters per day per capita in urban areas.

Optimized resource management in 2050 shall achieve 75% of renewable water resources

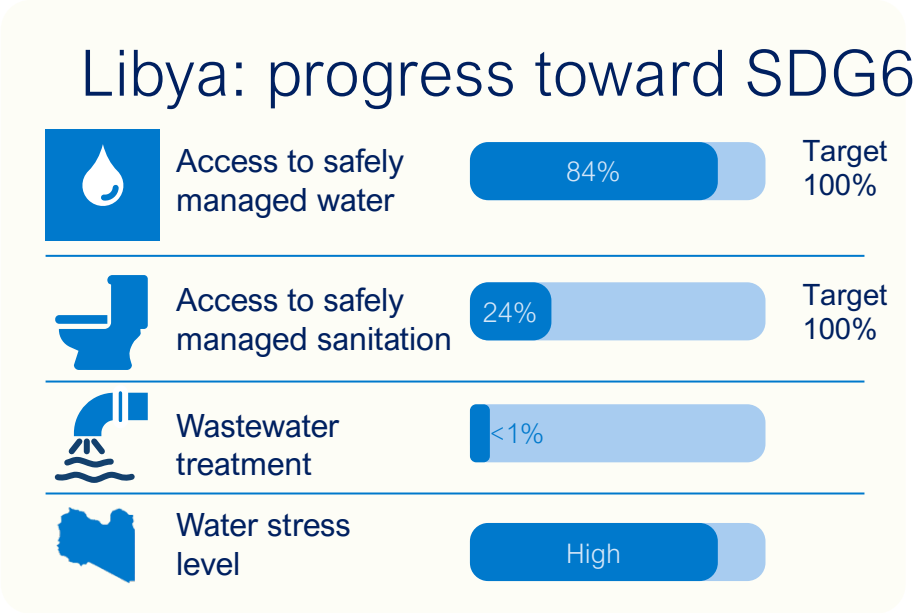
Infrastructure efficiency in 2050 shall translate into less than 25 % of Non-Revenue Water and operation at 80 % of the design capacity.

C.2.2. Libyan water sector commitments

Sustainable Development Goals

The Sustainable Development Goals (SDGs) provide a global framework for addressing critical challenges by 2030. SDG 6 focuses on ensuring universal access to safe drinking water, sanitation, and hygiene, while promoting sustainable water resource management and ecosystem protection. Globally, water scarcity affects over 40% of the population and is worsening, while more than 80% of wastewater is discharged untreated, causing severe pollution. Libya ranks among the most water-stressed countries, facing acute scarcity and inadequate wastewater treatment. Progress toward SDG 6 remains limited, with significant geographic disparities in water stress and a strong difference in access to safe water between urban areas (more than 90% access) and rural areas (very low level of access to improved facilities).

Figure 1: current status of progress towards SDGs



Source: UN SDG reports, 2024

Other "sector documents"

This section consolidates forward-looking commitments inferred from the following documents:

- Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025),
- Libya's Water Resources Sector Development Plan 2020–2024 (Ministry of Planning, 2019).

1. Water Resources Management (supply, protection, diversification)

- Ensure a sustainable balance between water supply and demand through an integrated, data-driven approach that aligns cross-sectoral strategies (WEFE nexus).
- Mobilize a diversified water mix: renewable and non-renewable groundwater, Man-Made River, surface water via dams, seawater desalination, and safe wastewater reuse. [Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025)]
- Protect and develop groundwater resources, including coastal aquifer salinity management, pollution control, and national monitoring networks (levels, salinity, intrusion). [Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025)]
- Rehabilitate, maintain, and expand surface water infrastructure (dams, diversion structures), undertake valley mapping, and deploy early-warning systems for droughts, floods, and pollution. [Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025)]
- Restore and secure the MMRP systems (infrastructure rehabilitation, maintenance, anti-illicit connections, capacity recovery) to meet targeted flows. [Libya's Water Resources Sector Development Plan 2020–2024 (Ministry of Planning, 2019)]
- Scale up desalination capacity: rehabilitate existing MED/MSF plants; add large RO plants (~2,000,000 m³/day total) and small RO units (5,000–10,000 m³/day) for smaller cities; ensure reliable energy supply (transformer stations, cables) and transition to cleaner energy (natural gas and solar PV). [Decadal Plan 2024-2034 for the Management of Water Resources in Libya

(Ministry of Water Resources 2025)]; [Libya's Water Resources Sector Development Plan 2020–2024 (Ministry of Planning, 2019)]

- Expand safe wastewater reuse for agriculture and industry; build/rehabilitate treatment plants (including mobile units for mountainous areas) and use treated water to reduce pressure on groundwater and enable artificial recharge. [Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025)]

2. Use Prioritization (urban, agriculture, industry, ecosystems)

- Guarantee prioritized access to safe drinking water and essential services for citizens, under normal and emergency conditions, aligned with WHO standards.
- Optimize agricultural demand: raise irrigation efficiency (drip, sprinklers), promote lower-water crops, and substitute non-conventional resources (treated wastewater, desalination) to reduce groundwater/MMR use for irrigation. [Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025)]; [Libya's Water Resources Sector Development Plan 2020–2024 (Ministry of Planning, 2019)]
- Secure industrial demand using fit-for-purpose water (including desalination and reuse) supported by appropriate pricing. [Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025)]
- Protect ecosystems by reducing untreated discharges, managing pollution, and mitigating droughts/floods in line with WEFE nexus principles.

3. Climate Resilience and Risk Management

- Implement a dedicated climate adaptation pillar: address droughts, water stress, and extremes through preparedness and diversified sources.
- Deploy early-warning systems (drought, flood, pollution), enhance strategic storage (dams, reservoirs, aquifers), and diversify coastal supplies (desalination and reuse) to counter seawater intrusion. [Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025)]
- Integrate Water-Energy-Food-Environment (WEFE) and strengthen energy efficiency and renewable energy in water utilities (desalination plants and pumping stations).

4. Demand Management (efficiency, economic instruments)

- Reduce total demand and improve water productivity across urban, agricultural, and industrial sectors.
- Cut urban losses via network rehabilitation and better service quality; strengthen monitoring and control. [Libya's Water Resources Sector Development Plan 2020–2024 (Ministry of Planning, 2019)]
- Introduce/revise water pricing for industrial, agricultural, and domestic uses to support financial sustainability and equitable access. [Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025)]; [Libya's Water Resources Sector Development Plan 2020–2024 (Ministry of Planning, 2019)]
- Promote awareness and behavioral change on water and environmental conservation. [Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025)]

5. Institutional Landscape and Governance

- Establish clear leadership by a dedicated government authority to coordinate cross-sectoral strategies and investment plans; set up a ministerial committee to oversee plan execution. [Libya's Water Resources Sector Development Plan 2020–2024 (Ministry of Planning, 2019)]
- Update legislative and regulatory frameworks: sustainable and equitable water use, aquifer protection, transboundary basin cooperation, PPP, and cost-recovery mechanisms. [Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025)].
- Centralize monitoring, enable data sharing, and publish performance indicators (KPIs) for strategy implementation.
- Strengthen human capacities through training and qualification; mobilize international expertise and academic partnerships. [Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025)].
- Ensure financial sustainability via phased investments (2020–2024, 2024–2034) and improved revenue collection. [Libya's Water Resources Sector Development Plan 2020–2024 (Ministry of Planning, 2019)]

6. Water Security for Citizens (Quality, Continuity, Equity)

- Restore continuity of service through rehabilitation of wells, pumping stations, reservoirs, and ~16,000 km of urban networks; secure reliable power for plants and pumping. [Libya's Water Resources Sector Development Plan 2020–2024 (Ministry of Planning, 2019)]
- Enhance water quality through treatment, lab testing, and chlorination; recommission wastewater plants to curb pollution and public health risks. [Libya's Water Resources Sector Development Plan 2020–2024 (Ministry of Planning, 2019)]; [Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025)]
- Advance equitable distribution and service coverage, including small and medium coastal cities via new RO units and network extensions. [Decadal Plan 2024-2034 for the Management of Water Resources in Libya (Ministry of Water Resources 2025)]

C.3 Founding principles

C.3.1. Scope of this strategy

This National Water Security Strategy covers the following perimeter:

Water from its natural origin (groundwater, seawater, surface water, reused water) to its consumption (municipal water, water for agricultural purposes, commercial and industrial purposes and livestock breeding). Excludes drought management (for which another strategy[2] exists) as well as marine and river water for transport.

C.3.2. A strategy to guide all actors

This sectoral strategy document constitutes an authoritative reference, binding on all actors operating within the water sector. This means that any project, program, development fund, international financing, or investment initiative must align with the priorities and approaches set forth in this strategy, thereby contributing to progress towards its stated ultimate objective (cf. C.2.1 Horizon 2050, page 14).

[2] Draft National Drought Management and Mitigation Strategy and Action Plan, June 2025, UNDP.

C.3.3. Prioritizing efficient water use over increased production

Libya faces a challenge where the limited water resources availability is compounded by an unregulated demand, for agriculture as well as high levels of per capita consumption in major towns. This challenging equation has been tentatively solved in the past through massive investments in infrastructure for mobilizing, transporting and delivering water from remote and finite aquifers. This strategy emphasizes the change of paradigm that is necessary to reach a long-term water security: the priority is no longer producing more water, but using it in a more efficient manner.

The Libyan water sector must shift from a paradigm of 'meeting demand at any cost' to one of 'reducing demand to fit within the volume that can be sustainably produced, while mobilizing all viable alternative water resources.

This shifts the focus from infrastructure planning to most promising leads for demand optimization:

- Improving efficiency of service delivery (from technical efficiency to fighting against non-revenue water, including regulation by tariffication)
- Reducing the demand for irrigation water by implementing strategic choices of crops at national level (including "water footprint prioritization" and "virtual water" approach to encourage the local production of low-water consuming goods and importing highly water-consuming goods, see Annex 4 Virtual Water as a tool for water security, page 63)
- Distinguishing demand and need, and exploiting demand elasticity against price, particularly through setting guiding principles on tariff structure for both municipal water and water for agriculture to discourage overconsumption.
- Introducing the concept of "water utilization" (where water is not consumed but serves a first utilization while remaining usable for another usage), reserving the "water consumption" for the final usage.

C.3.4. Climate change preparedness

Climate change poses profound risks to Libya's water resources, amplifying existing vulnerabilities in land use and agriculture. With over 95% of national water supply drawn from non-renewable fossil groundwater, the country's arid to semi-arid climate already faces severe stress. Rising temperatures, increased evapotranspiration, and declining precipitation will intensify scarcity, particularly in coastal plains and interior regions. These shifts will reshape agricultural land suitability, undermining food security and economic resilience.

Agriculture, consuming more than 80% of Libya's water, is highly climate-sensitive. Reduced groundwater recharge and growing salinization of coastal aquifers will render irrigated farming increasingly unsustainable. Inefficient traditional irrigation will exacerbate pressure on aquifers, accelerating land degradation, desertification, and abandonment of marginal lands—especially in the Jafara Plain and Jabal Akhdar. Such changes risk triggering feedback loops of groundwater depletion and ecological decline, as vegetation loss further reduces infiltration and soil moisture retention.

Urban expansion compounds these challenges. Uncontrolled groundwater abstraction for cities and farms, notably around Tripoli, threatens water availability for other sectors, weakens ecosystem services, and heightens subsidence risks in coastal zones. Without integrated planning that links climate-resilient water management to sustainable land use and agricultural practices, Libya faces escalating exposure to systemic environmental and socio-economic shocks.

To address these interconnected risks, this strategy proposes to adopt an integrated, cross-sectoral approach that embeds water efficiency, land-use planning, and climate-smart agriculture into national and regional adaptation strategies. This would include promoting the use of treated wastewater, enhancing soil and water conservation measures, improving irrigation technologies,

and implementing policies. Upgraded meteorological, hydrological, and hydrogeological long-term monitoring systems are essential for providing data to inform resource planning, as well as the development of early warning systems related to drought, saline intrusion, and land degradation.

C.3.5. Water as an economic value

Water may be considered as a basic need and a common good of the entire population of Libya (and often claimed as free by nature), but in the conditions of aridity and limited renewable water availability in Libya, production, transport and distribution of water have an increasing cost.

Water also has a significant value in terms of economic potential or social need. This is particularly the case for agriculture (economic value of the crops compared to the value of water used for agriculture).

This strategy advocates restructuring the tariff in accordance with both cost and economic value of each cubic meter of water.

C.3.6. This strategy will introduce several significant changes

The paradigm shift outlined in section C.3.3 (Prioritizing efficient water use over increased production), requires a fundamental transformation in sector governance. Implementation must be phased, combining short-term measures to mitigate current impacts with longer-term actions to enable resource transition. The plan should anticipate resistance to change through robust communication and awareness strategies and must be underpinned by strong political commitment and endorsement at all levels. Capacity development is essential to engage stakeholders, while institutional restructuring is a prerequisite to steer and sustain this transition.

C.4 Five strategic axes

This national water security strategy is based on 5 identified axes that support each other.

1) The first foundation block is to adapt the **institutional framework** to enable the desired changes. Clear leadership must emerge from this reorganization, to steer the implementation of the strategy.
2) Then, the first steering action is to create the forums and methods to **align all the actors** with an overarching sector strategy
3) Another fundamental base needed is a **solid knowledge** of resources, infrastructure, demand and environmental threats.
4) The core of the strategy lies in the **transition towards the most sustainable mix** of water resources, sized for reasonable demand.
5) The last axis consists in achieving a sustainable balance in the way **water services are financed**, from operating expenses to capital investment.

Each of these 5 axes is described in chapter D, page 23.

Figure 2: the five axes of the National Water Security Strategy

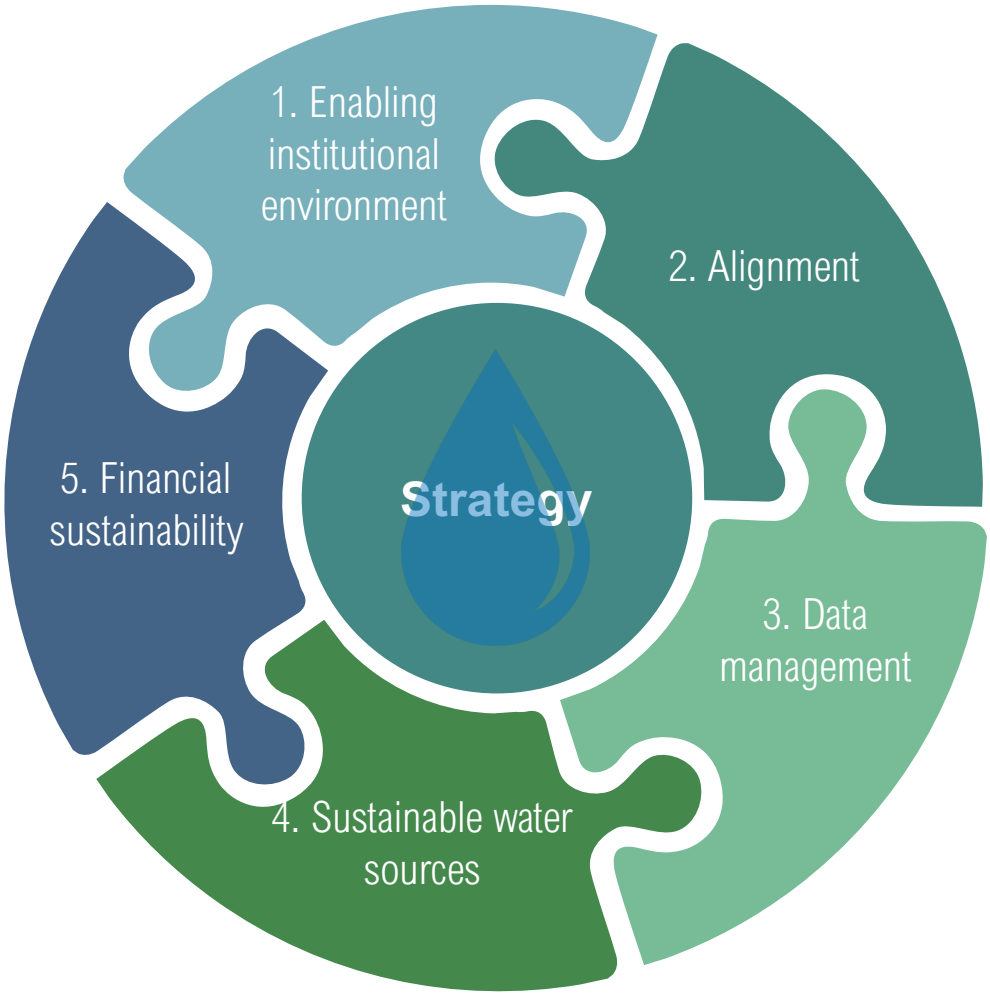


Table 1: synthetic view of the 5 axes and their objectives

Axis 1 Institutional enabling environment, page 23	Axis 2 Sector alignment, page 30	Axis 3 Develop a knowledge base, page 33	Axis 4 Optimize water usage & adapt water sources, page 38	Axis 5 Seek financial sustainability, page 44
Objective 1.1 Define and empower the legitimate national authority to lead, coordinate and oversee the sector	Objective 2.1 Water, Energy, Food and Ecosystems stakes are addressed in an integrated approach	Objective 3.1 Centralize and integrate water data management	Objective 4.1 Reduce water consumption and improve efficiency across all sectors	Objective 5.1 Centralize asset ownership and investment prioritization
Objective 1.2 Define, formalize and implement institutional functions, mandates and relationships among all sector entities	Objective 2.2 Investment planning is coordinated across main actors	Objective 3.2 Establish reliable and integrated operational monitoring systems	Objective 4.2 Long-term strategic water supply decision making is based on the understanding of the long-term availability of groundwater resources	Objective 5.2 Implement an equitable and financially sustainable tariff system that promotes efficiency, conservation and social protection
Objective 1.3 Translate the national water strategy into a coherent and enforceable regulatory framework	Objective 2.3 The contribution of Libya in international cooperation (transboundary water resources) is defined in consultation with the Libyan actors of the water sector	Objective 3.3 Strengthen data analysis, interpretation & accessibility for informed decision-making	Objective 4.3 Establish a road map to diversify renewable and non-conventional water resource supplies across sectors	Objective 5.3 Operating companies capable of covering operation and maintenance costs and reducing commercial losses
Objective 1.4 Develop and implement a comprehensive and coordinated program for public and institutional awareness raising on water resources management		Objective 3.4 Establish a National Water Research and Technology Centre	Objective 4.4 Protect water resources against increasing risks of climate change and anthropogenic water	Objective 5.4 Enhance innovative financing mechanisms to support capital investment in the water sector

D. The five strategic axes of the strategy

Axis 1. Institutional enabling environment

Goal: an enforced regulatory system to facilitate the NWSS

Establish a coherent, empowered and accountable institutional and legal framework for the water sector to enable effective implementation of the NWSS and ensure sustainable management of the nation's water resources and services

Objective 1.1	OBJECTIVE 1.2	OBJECTIVE 1.3	OBJECTIVE 1.4
Define and empower the legitimate national authority to lead, coordinate and oversee the sector	Define, formalize and implement institutional functions, mandates and relationships among all sector entities	Translate the national water strategy into a coherent and enforceable regulatory framework	Develop and implement a comprehensive and coordinated program for public and institutional awareness raising on water resources management

A strong institutional framework is the foundation for achieving national water security and ensuring implementation of the NWSS. Overlapping mandates, fragmented responsibilities and limited enforcement capacity have historically weakened governance and hindered investment in the sector. Consolidating institutional roles and functions, strengthening legal and regulatory frameworks and clarifying accountability across all entities, underpinned by awareness raising among both sector institutions and the wider public, will establish the legal and social conditions necessary for efficient coordination.

Objective 1.1. Define and empower the legitimate national authority to lead, coordinate and oversee the sector

✓ RATIONALE

Most activities in the water sector were driven by the main public institutions and companies, each according to their respective mandate, without a higher level of planning, coordination and regulation. The establishment of a single leading governmental body is critical for eliminating this fragmentation and strengthening accountability.

Similarly to the existing Energy and Water Board, which board of directors includes representatives of several ministries (Water Resources, Housing and Infrastructure, Agriculture, Planning, national energy company, etc.) a Water Board must be created to cover the most important aspects of the water sector: resources, planning, infrastructure construction and operation, service delivery and demand management. A water board would be in capacity to take the lead of the entire water sector to:

- Set a policy, a vision for the development of the sector, including the endorsement of the National Waters Security Strategy.
- To animate, with the concerned ministries, the process to establish the associated strategies and plans for these ministries to implement the NWSS.
- Ensure the alignment of long-term planning across water sector actors with national development goals, climate adaptation strategies, and UN SDG.
- Establish a gapless role sharing among the companies and other actors of the sector.
- Centralize the reporting of all actors to monitor the progress.

Beside an environment and water resource department (in charge of interacting with the Ministry of Water Resources), the Water Board must include a planning department (liaising with both the Ministry of Planning and the Ministry of Housing and Infrastructure) and service delivery department, in charge of supervising the ownership missions trusted to the Ministry of Housing and Infrastructure, including the supervision of operational functions of utilities (production, transfer, distribution, treatment, etc.) and possible future private operators. The Ministry of Housing and Infrastructure will act as a contracting authority, to establish performance contract with utilities and reinforce their reporting obligations, organize the role sharing and the contractual relations between them, or with the customers.

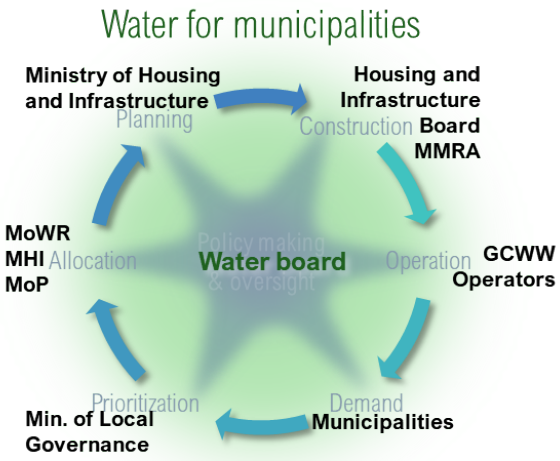
An independent regulatory body, with a strong mandate and clear responsibilities, must be created to:

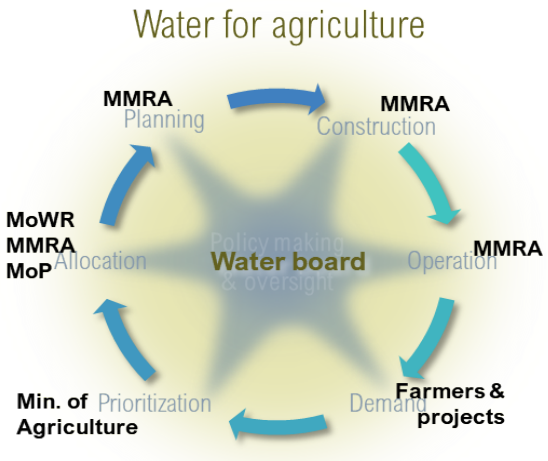
- monitor, benchmark and certify compliance of operators (public or private) to both the public service of water and the production/distribution contracts signed with the Ministry of Housing and Infrastructure, feeding into a centralized information system;
- ensure fairness and transparency of tariff policies against the quality of service;
- build public confidence and policy transparency;
- enforce regulation mechanisms to manage the intervention of main companies and possible future private operators.

In addition, MMRA would include its plan for the completion of the project, into the master plan of the sector to address the demand and the challenges of the resources.

Figure 3: institutional functions to address the demand

The central role of policy making and oversight requires an institutional player which is, at the same time, not directly involved in one of the six functions, and in close connection with the other players implementing these functions. Depending on the usage of water (municipalities or agriculture), different players implement the six functions, in connection with the Water Board:





Strategic approaches

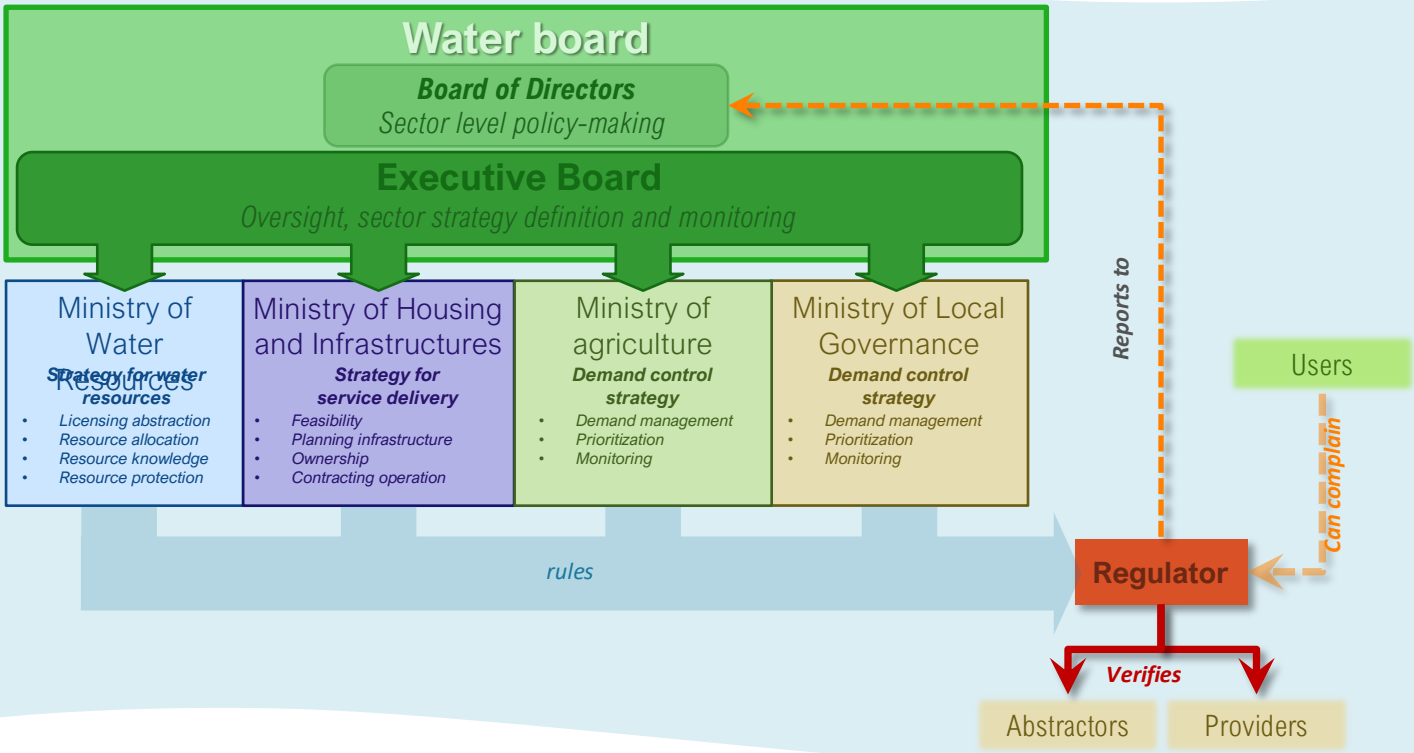
1. **Designate a national lead institution:** formally assign the Water Board as the central body responsible to guide policy making with the relevant ministries, supervise strategic planning and define governance of the water sector in Libya.
2. **Clarify institutional relationships and mandates:** define the roles and reporting lines between the Ministries, the Water Board, the water operators and the Regulator to eliminate overlaps and ensure coherent governance.
3. **Clarify the Water Board functional scope**: ensure the perimeter of the Water Board covers the full watercycle (including water resources, water supply, infrastructure ownership, service delivery, demand management – including municipalities, agriculture, industries – and wastewater treatment and reuse). Appoint and task the non-executive members of the Water Board to ensure seamless cooperation with their respective ministries:
   - Ministry of Water Resources (technical standards, water quality norms, resource protection regulation, abstraction permitting),
   - Ministry of Housing and Infrastructures (technical design standards, asset management protocols, works and construction processes),
   - Ministry of Agriculture (demand management, wastewater reuse standards),
   - Ministry of Local Governance (demand management),
   - Ministry of Planning (national planning and finance allocation),
   - GECoL (connections with energy strategy),
   - Ministry of Environment (norms, wastewater disposal),
   - Ministry of Health (water quality norms, user sensitization).

   Also include MMRA during the completion of the MMR project (infrastructure planning in accordance with the municipal and agriculture demand).

   The Well Drilling Authority must be included in the Ministry of Water Resources, to coordinate resource allocation, drilling control and abstraction licensing).
4. **Strengthen the legal and institutional framework:** develop or amend the legal basis (through a new Water Law or a presidential / prime-ministerial decree) to formalize the mandates, functions and coordination powers, ensuring long-term legitimacy and stability.
5. **Ownership and investment initiation:** public service infrastructures for water are owned by the Ministry of Housing and Infrastructures, unless a formal transfer protocol has been implemented to give ownership to a municipality. The Water Board master plans the priority investments at national level and sets prioritization criteria for investment planning see Objective 5.1, page 45). Ministry of Housing and Infrastructures implements these prioritization criteria to the demands received from municipalities or agriculture, as well as proposals made by donors and international agencies, to size a national water supply program of investments, and search the necessary funds. The completion of MMR project must contribute to this national investment plan.

   The regulator reviews the investment plans to ensure the compliance of investments with the standards.

Figure 4: Policy-making, strategy definition and regulation of the water sector



Objective 1.2. Define, formalize and implement institutional functions, mandates and relationships among all sector entities

✓ RATIONALE

Role clarity is essential to understand and fulfil the objectives effectively. Functions and scope of activities shall be clearly defined and communicated to all stakeholders and duplication of tasks and mandates with other public institutions must be avoided. The success will depend on the breadth and depth of the powers granted by legislation and other defining texts and practices.

Strategic approaches

1. **Define and formalize institutional functions:** clearly delineate the mandates, responsibilities and boundaries of the Water Board, the Ministry of Water Resources, the Ministry of Housing an Infrastructures, MMRA, the Ministry of Agriculture, the Ministry of Local Governance the operating companies and the Regulator, ensuring full coverage of all sector functions and avoidance of duplication (see Annex 1 Sector entity functions, page 57).
2. **Adopt an appropriate regulatory model:** establish a regulatory framework tailored to Libya's water sector context, defining the regulator's independence, powers, scope (economic, service and environmental) and accountability mechanisms (see Annex 2 Regulation models, page 59).

3. **Clarify institutional relationships and coordination mechanisms:** specify and formalize the operational, reporting and coordination relationships between policy, operational and regulatory entities to separate policymaking, service delivery and enforcement functions.
4. **Operationalize a sector monitoring and evaluation system:** a complete M&E system includes the performance of water utilities and service providers; access and audit operational, technical, and financial data; and publish annual sector performance reports to ensure transparency. It is the responsibility of the Water Board to set and use the M&E system, while its implementation strongly relies on the Regulator for reliability and transparency.
5. **Build the necessary capacity:** the Ministry of Housing and Infrastructures must be supported to build its capacity to encompass water service delivery, operation contract management and asset management. The capacity of both ministries must be reinforced in policy making and development of standards and rules.

Objective 1.3. Translate the national water strategy into a coherent and enforceable regulatory framework

✓ RATIONALE

Regulation (laws, bylaws, rules, standards, and procedures) should be designed to achieve the objectives of the national water strategy. The regulation should not only define rights, obligations and performance requirements, but also ensure compliance through clear mechanisms for enforcement to protect water resources, public health and ecosystems. In addition, creating a predictable and transparent legal environment – including clear PPP legislation and dedicated institutional capacity – will enhance investor confidence and enable donor and private sector participation in financing and operating water infrastructure.

Strategic approaches

1. **Develop and harmonize water sector regulations:** translate the NWSS into a coherent regulatory framework covering water resource management, service delivery, wastewater reuse and infrastructure standards, ensuring alignment across all related laws and decrees.
2. **Implement and enforce permitting mechanisms:** establish and operationalize systems for licensing water abstraction, drilling and wastewater discharge, supported by monitoring, inspection and sanction mechanisms to ensure compliance and protect groundwater and surface resources.
3. **Set and enforce technical and quality standards:** develop national standards for materials, construction, treatment technologies and water quality (including treated wastewater) to ensure safety, efficiency and sustainability of water and sanitation infrastructure.
4. **Strengthen enforcement and accountability systems:** define clear institutional mandates and mechanisms for regulatory enforcement, including inspection powers, penalties and judicial recourse, supported by transparent reporting and data systems.

5. **Create an enabling legal framework for private participation:** operationalize the 2025 PPP Resolution by issuing accompanying regulations, developing standardized contractual models and establishing a dedicated PPP unit or committee to manage water-sector PPP and facilitate innovative financing mechanisms.

Objective 1.4. Develop and implement a comprehensive and coordinated program for public and institutional awareness raising on water resources management

✓ RATIONALE

Effective implementation of the National Water Security Strategy requires not only strong institutions and infrastructure to lead the transition, but also informed and engaged citizens, stakeholders, and professionals to adhere. Raising awareness about water scarcity, conservation, pollution prevention, and the value of water services strengthens behavioral change and supports long-term sustainability. Equally, internal awareness within the sector – through staff engagement, training, and communication – builds a shared understanding of the strategy's goals and enhances institutional performance. A coordinated, well-resourced communication program, led by a designated national entity (and with the possible assistance of private sector and donors) will ensure consistent messaging, promote collaboration across ministries and media, and foster a culture of water stewardship nationwide.

Strategic approaches

1. **Assign coordination and accountability:** designate a lead institution (e.g. the communication department of the Ministry of Water Resources) to coordinate awareness initiatives, align efforts across institutions and ensure consistency of messages.
2. **Assess current awareness levels and gaps:** conduct a comprehensive baseline assessment of public and institutional awareness on water management, conservation and service responsibilities to inform campaign design and resource allocation.
3. **Define target groups and tailored communication strategies:** identify key audiences – households, farmers, industries, schools, local governments and sector professionals – and develop targeted messages and tools for each.
4. **Develop and implement a national awareness plan:** establish a mutli-year plan with clear objectives, key messages, and outreach channels (media campaigns, social media, school curricula, community engagement, professional workshops)
5. **Secure sustainable resources and capacity:** define financial and human resource needs, and build communication skills within sector institutions to sustain awareness programs and reinforce internal alignment with strategy goals.

Axis 2. Sector alignment

Goal: establish a truly integrated approach across stakeholders

This strategic axis aims to enhance the respective efforts of main institutions in the sector through coordination with connected sectors. Aligned efforts yield more than the sum of all efforts

Objective 2.1	Objective 2.2	Objective 2.3
Water, Energy, Food and Ecosystems stakes are addressed in an integrated approach	Investment planning is coordinated across main actors	The contribution of Libya in international cooperation (transboundary water resources) is defined in consultation with the Libyan actors of the water sector

Objective 2.1. Water, Energy, Food and Ecosystems stakes are addressed in an integrated approach

✓ RATIONALE

Water, energy, food, and ecosystems are deeply interconnected. Decisions in one sector inevitably affect the others – solving a water issue can create new challenges for energy. The current reliance on public companies in water, energy, and agriculture increases the risk of fragmented approaches, leading to unintended cross-sector impacts. Effectively addressing these challenges requires acknowledging and modeling these strong interdependencies. By adopting an integrated perspective on Water, Energy, Food, and Ecosystems, Libya can transform interdependence into strength and enable decision-makers to design policies that deliver balanced benefits across all sectors - building resilience and ensuring progress without adverse effects.

Strategic approaches

1. **Play a leading role in Libya's WEFE initiative:** by its composition, the Water Board should take the lead in driving policy coherence – particularly in sectors where strategies are shaped by operating companies rather than government bodies – and support decision-makers in planning smarter investments through an integrated, cross-sector perspective.
2. **Coordination across sectors:** the Water Board (which non-executive board would include representatives from the Ministry of Water Resources, the Ministry of Housing and Infrastructure, the National Company of Electricity, the Ministry of Agriculture, the Ministry of Local Governance and the Ministry of Planning) should also be expanded to include the environmental sector.

3. **Coordinated Investment planning:** the Water Board, with its comprehensive understanding of dynamics across the nexus sectors, will develop a sector-wide investment plan (at the master-plan level) that accounts for the challenges identified in the energy and agriculture master plans, while ensuring the protection of ecosystems.
4. **Top-down strategy:** overall goals and specific objectives will be defined by the Water Board in accordance with the overall cross-sector stakes. These strategic elements will help each sector to define or adapt its own strategy in accordance with the stakes of other sectors (i.e. the energy strategy will consider the demands of the water strategy).

Objective 2.2. Investment planning is coordinated across main actors

✓ RATIONALE

Within Libya's water sector, investment decisions are often made independently by different operators, focusing on immediate infrastructure needs rather than long-term strategic alignment. This fragmented approach fails to account for cross-sector policies and can lead to unintended impacts on agriculture, energy, or ecosystems. Coordinating investment planning among water sector actors – while aligning with broader intersectoral priorities - is essential to ensure the sector follows a clear strategic direction. A shared vision and integrated programming will make every investment strengthens water security without creating new challenges elsewhere.

Strategic approaches

1. **Strategic goals for each utility in the water sector:** the Water Board tasks the Ministry of Housing and Infrastructure to develop a strategic master plan that covers all current public companies (and possible future private operators) in the sector. Deriving from Objective 2.1, this master plan must align with national water priorities while integrating intersectoral considerations and assign strategic goals to each utility to contribute to the general dynamics of the sector.
2. **Bottom-up planning from utilities:** utilities and operating actors plan their infrastructure investment priorities according to the strategic goals that are assigned to them, using the investment prioritization model developed in Objective 5.1, page 45.
3. **Centralization of investment plans:** Utility investment plans are consolidated by the Water Board to ensure alignment, set priorities, and determine possible allocations across utilities. The Water Board liaises with the Ministry of Planning and the Ministry of Finance to secure resource allocations and to prepare potential funding requests for donors and international agencies.
4. **Informed investment decisions:** sector-wide reliable data are used for informed decisions (see Axis 3 Objective 3.3, page 36).

Objective 2.3. The contribution of Libya in international cooperation (transboundary water resources) is defined in consultation with the Libyan actors of the water sector

✓ RATIONALE

Libya shares vast fossil aquifers with neighboring countries, including the Nubian Sandstone and Northwest Sahara systems – critical reserves that underpin water security for millions. Yet, legal frameworks and coordination mechanisms remain weak, and exploitation often occurs without harmonized monitoring or joint planning. This fragmented approach risks accelerating depletion, increasing salinity, and fueling regional tensions over scarce resources. Establishing a clear national policy on transboundary water management (and asserting it in international forums) is essential to safeguard Libya's interests, promote equitable use, and ensure that shared aquifers are managed sustainably for future generations.

Strategic approaches

1. **Establish a dedicated coordination unit** within the Waer Board to manage international engagement and data exchange.
2. **Use the knowledge base developed in Axis 3** (especially monitoring and modeling systems for shared aquifers) to provide reliable data for negotiations and joint planning.
3. **Develop a national transboundary water policy** that defines clear principles for sustainable use, monitoring, and cooperation, for the dedicated coordination unit to engage in negotiations and joint planning.
4. **Actively participate in regional and global platforms** (e.g., OSS, NSAS Joint Authority) to advocate Libya's position and align with international best practices.

Axis 3. Develop a knowledge base

Goal: operational data collection, management and interpretation systems

Operational data is collected, managed and interpreted to enable effective, transparent and sustainable management of water sources

Objective 3.1	Objective 3.2	Objective 3.3	Objective 3.4
Centralize and integrate water data management	Establish reliable and integrated operational monitoring systems	Strengthen data analysis, interpretation & accessibility for informed decision-making	Establish a National Water Research and Technology Centre

Libya's water sector runs on fragmented, delayed, and non-standardized data, both on technical data (groundwater, surface flows, production and distribution infrastructure, quality control) and financial data (financial performance, investment requirements, customer consumption patterns, affordability, etc.). Operational decisions are often made reactively rather than being grounded in comprehensive, current evidence. Strategic planning and operational decision-making should be underpinned by accurate, accessible, updated data. The need for reliable and shared data is so acute and cross-cutting at national level, that it requires building a unified national data ecosystem.

Objective 3.1. Centralize and integrate water data management

✓ RATIONALE

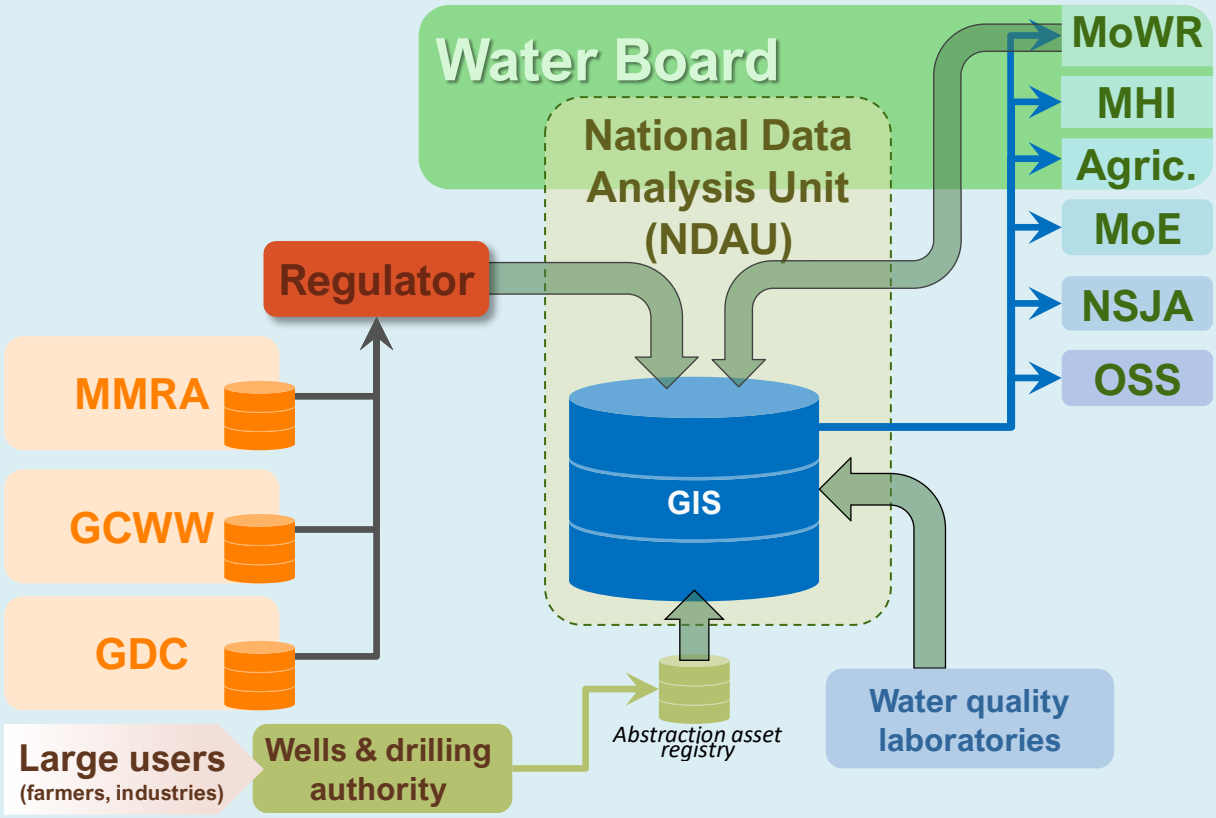
Fragmented and inconsistent data across institutions hinders effective planning, monitoring and decision-making. A unified data management system will ensure that water-related information is accurate, interoperable and accessible to authorized stakeholders. It will also support the digital transformation across the water sector.

Strategic approaches

1. **Establish a National Data and Analytics Unit (NDAU):** create a dedicated inter-institutional entity responsible for data governance, analytics, reporting and maintaining system interoperability across the water sector. It should be anchored in the leading entity covering the entire water sector, the Water Board.

2. **Develop a centralized National Water Information System (NWIS):** build a secure, cloud-based system permitting the integration of all water-related datasets – including hydrological, infrastructure, abstraction and water quality data – with clear QA/QC protocols, cybersecurity standards and role-based access).
3. **Standardize indicators and performance metrics:** define and harmonize national Key Performance Indicators (KPI) for water resource management, utilities and regulatory oversight, ensuring consistency across agencies. A long-term and short-term target for each KPI should be set and agreed upon with all stakeholders.
4. **Implement a GIS-linked asset and abstraction registry:** maintain a georeferenced, auditable registry of all abstraction assets (groundwater basins, surface water infrastructure, licensed and high-volume wells or drillings), updated regularly by each institution within the NWIS.
5. **Mandate institutional data updating and integration:** require all relevant institutions (public utilities, regulatory bodies, private operators) to maintain and routinely update GIS-based registries of their production, treatment, and distribution assets within the NWIS framework.

Figure 5: strategic reorganization of the water sector



Objective 3.2. Establish reliable and integrated operational monitoring systems

✓ RATIONALE

Reliable, real-time monitoring is essential to maintain safe abstraction levels, protect groundwater and surface water resources, enhance energy efficiency, improve supply and distribution systems, and ultimately ensure sustainable water resource management. Strengthening technical monitoring and data collection equipment will enhance the accuracy and timeliness of information used for decision-making. Modern technologies – including telemetry, SCADA and digital analytics – will enable proactive management of droughts, intrusions and system inefficiencies, while advancing the digital transformation of the water sector.

Strategic approaches

1. **Equip priority water assets with advanced monitoring systems:** install calibrated telemetry, SCADA and automated sensors on priority wells, reservoirs and treatment plants to enable continuous data collection, real-time operational decision-making and support safe abstraction thresholds.
2. **Expand metering and monitoring across the entire water cycle:** introduce and maintain standardized metering systems for water production, treatment and distribution to ensure comprehensive tracking of water flows and losses.
3. **Develop templates for periodical collection and review of financial and commercial data** regarding revenues, costs, investments, consumption, collection rates, staff, customers and debts and set systems to audit and review accuracy of data supplied.
4. **Develop and implement national monitoring programs:** design and enforce regular monitoring programs for infrastructure performance, water quality and resource conditions, integrating them within the NWIS.
5. **Deploy digital dashboards and decision-support tools:** create integrated dashboards that consolidate key metrics – including drought and flooding indicators, saline intrusion, non-revenue water (NRW), energy use and resource availability – with automated alerts and predictive analytics to support evidence-based management
6. **Adopt modern technologies to improve operational efficiency:** strengthen leakage detection and pressure management, optimize pumping and treatment performance and improve energy efficiency using advanced technologies such as smart sensors, automation and drones equipped with thermal imaging tools for agricultural networks.

Objective 3.3. Strengthen data analysis, interpretation & accessibility for informed decision-making

✓ RATIONALE

Reinforced and appropriately scaled monitoring systems, integrated with a modern centralized data management platform, will turn raw data into insight and decision support. Enhanced data analysis will support refined aquifer assessments, informed operational decisions (such as wellfield rotation) and more accurate planning for sustainable abstraction. Linking analytical outputs with operational and financial decisions will enhance efficiency, system reliability and compliance, while the incorporation of climate data will strengthen the sector's resilience. Improved data integration and sharing will also facilitate cooperation with regional and international partners, supporting both transboundary water management and donor confidence.

Strategic approaches

1. **Develop an operational data platform accessible to decision-makers:** create a user-friendly, role-based interface within the NWIS that provides real-time operational data and analytical tools to water managers, regulators and policy-makers to support evidence-based planning and responses, and link to external data (e.g. climate forecasts, flood warnings, land use, electricity consumption) for coordination across sectors.
2. **Enhance analytical and interpretive capacity for resource management:** strengthen analysis of groundwater and surface water data through improved monitoring networks, increased measurement frequency and advanced modelling tools to refine aquifer resource evaluations, monitor depletion rates and manage coastal and fossil aquifer systems sustainably.
3. **Leverage global and regional digital platforms for integrated analysis:** utilize and integrate existing analytical tools such as FAO's WaPOR, GAEZ, GIEWS and the Agricultural Stress Index (ASI) to enhance drought mapping, water use efficiency and agricultural planning, ensuring alignment with regional and global water information initiatives.
4. **Facilitate transboundary data exchange and cooperation:** strengthen partnerships and data sharing with regional initiatives such as the Nubian Sandstone Joint Authority (NSJA) and the Sahara and Sahel Observatory (OSS) to promote coordinated management of shared aquifers in line with SDG6.5.
5. **Promote energy-efficient and digitally optimized operations:** apply data-driven efficiency and energy management practices to optimize performance across the water cycle – from production and transmission to reuse – while linking budgets, incentives and planning priorities to verified outcomes (e.g. cubic meters saved, compliance days achieved, uptime maintained).

Objective 3.4. Establish a National Water Research and Technology Centre

✓ RATIONALE

Libya's water challenge is not just about infrastructure – it is about knowledge, innovation, and sustainability. For decades, Libya has been developing an impressive capacity to move fossil water from the south to the north. But, as these aquifers are finite, it is time to pair infrastructure with innovation, ensuring solutions that address the real challenge. Libya has strong scientific expertise; the next step is to connect it with the engineering power of national companies. A National Water Research and Technology Center will bridge this gap, turning research into solutions and ensuring that every investment secures the country's future. The choice is clear: innovate, or run dry

Strategic approaches

1. **Establish and operationalize the National Water Research and Technology Centre (NWRTC):** create a dedicated national institution to conduct applied research, steward national water datasets, and serve as a hub for collaboration among government, academia and the private sector.
2. **Promote research, piloting and scaling of innovative technologies:** invest in the testing and deployment of innovative water management techniques (such as Managed Aquifer Recharge (MAR), groundwater protection zones, seawater intrusion sentinels and flood- or stormwater-based recharge pilots) and modern treatment technologies (desalination, wastewater), particularly across coastal and vulnerable aquifer systems).
3. **Strengthening partnerships and knowledge exchange:** foster collaboration between the water sector, research institutions, environmental organizations and technology provides to promote the adoption of modern technologies and data-driven solutions in water treatment and management, facilitate joint research initiatives and enhance national technical and scientific capacity.

Axis 4. Optimize water usage & adapt water sources

Goal: supply from resilient and effectively managed water sources

Ensure that water source selection is optimized to maximize long term water availability.

Objective 4.1

Water demand management: improving efficiency across all sectors to reduce water consumption

Objective 4.2

Long-term strategic water supply decision making is based on the understanding of the long-term availability of groundwater resources

Objective 4.3

Establish a road map to diversify renewable and non-conventional water resource supplies across sectors

Objective 4.4

Protect water resources against increasing risks of climate change and anthropogenic water contamination

Libya's water portfolio is dominated by non-renewable groundwater abstraction and stressed coastal aquifers, with limited reuse, intermittent desalination capacity, and high physical and commercial losses. The abstraction of these resources will become increasingly challenging as aquifer levels continue to deplete and that groundwater quality will likely deteriorate with long term abstraction.

Optimizing the current water supply sources while rationalizing extraction and demand is essential to stabilize supplies, protect critical aquifers, allocate resources for priority uses and ensure water security.

Objective 4.1. Water demand management: improving efficiency across all sectors to reduce water consumption

✓ RATIONALE

The Situation Analysis clearly shows that increasing water supply is not sufficient to achieving SDG6.1 (universal access to safe & affordable drinking water) – there is an urgent need to reduce demand, particularly in the agricultural sector, to protect conventional water resources from over-abstraction, seawater intrusion and pollution in line with SDG6.6, while maintaining water security during the gradual transition toward more renewable water sources. Reducing demand requires coordinated regulatory reform, economic incentives, technological adoption and behavioral change to promote the efficient use and equitable allocation of water. Demand reduction measures will not only preserve water resources but also improve economic returns per cubic meter of water used, enhance energy efficiency and strengthen resilience to future water scarcity.

Strategic approaches

1. **Regulate and control groundwater abstraction through integrated licensing and metering systems:** implement groundwater abstraction controls by linking groundwater modelling, drilling permitting, metering and consumption, to enforce safe abstraction thresholds. Introduce phased regularization and amnesty programs for unlicensed wells, followed by graduated penalties for non-compliance, with linkages between water and electricity consumption for agricultural projects.

2. **Promote water-efficient crop patterns and agricultural practices:** align agricultural policies to gradually shift production from high-consumption staple crops to low-water, high-value crops, particularly those with export or urban market potential. Encourage adoption of water-saving crops through the introduction of concepts such as virtual water, the economic value of water and the water footprint.

3. **Enhance irrigation efficiency through modern technologies and precision agriculture:** improve water-use efficiency at the farm-level by promoting efficient irrigation systems (e.g. drip, sprinkler, automated systems) and precision agriculture tools (e.g. soil moisture sensors, weather-based irrigation scheduling, satellite monitoring), providing technical support and incentives for adoption.

4. **Reduce non-revenue water and losses across municipal and agricultural systems:** develop and implement NRW reduction programs in municipal and irrigation networks, using metering and telemetry data to identify leakages, illegal connections and inefficiencies. Make NRW reduction a key mandate of any institution abstracting, transferring or distributing water. Deploy modern technologies such as drones with thermal imaging and smart sensors for real-time leak detection.

5. **Improve industrial water use efficiency:** encourage industrial facilities to adopt technologies and machinery that minimize freshwater use (such as air-cooled systems and local wastewater reuse and treatment of industrial wastewater before pumping it to the network) and establish benchmarking standards and incentive schemes for water-efficient industrial processes. Gradually complete the incentive schemes with a penalty schedule.

6. **Promote water conservation awareness:** align internal sector incentives with performance-based outcomes (e.g. reduced abstraction, improved efficiency, higher value per cubic meter), while encouraging responsible consumption amongst municipal users and farmers through awareness campaigns (see Objective 1.4, page 29), tiered tariffs, rebates for water-efficiency and recognition programs.

Objective 4.2. Long-term strategic water supply decision making is based on the understanding of the long-term availability of groundwater resources

✓ RATIONALE

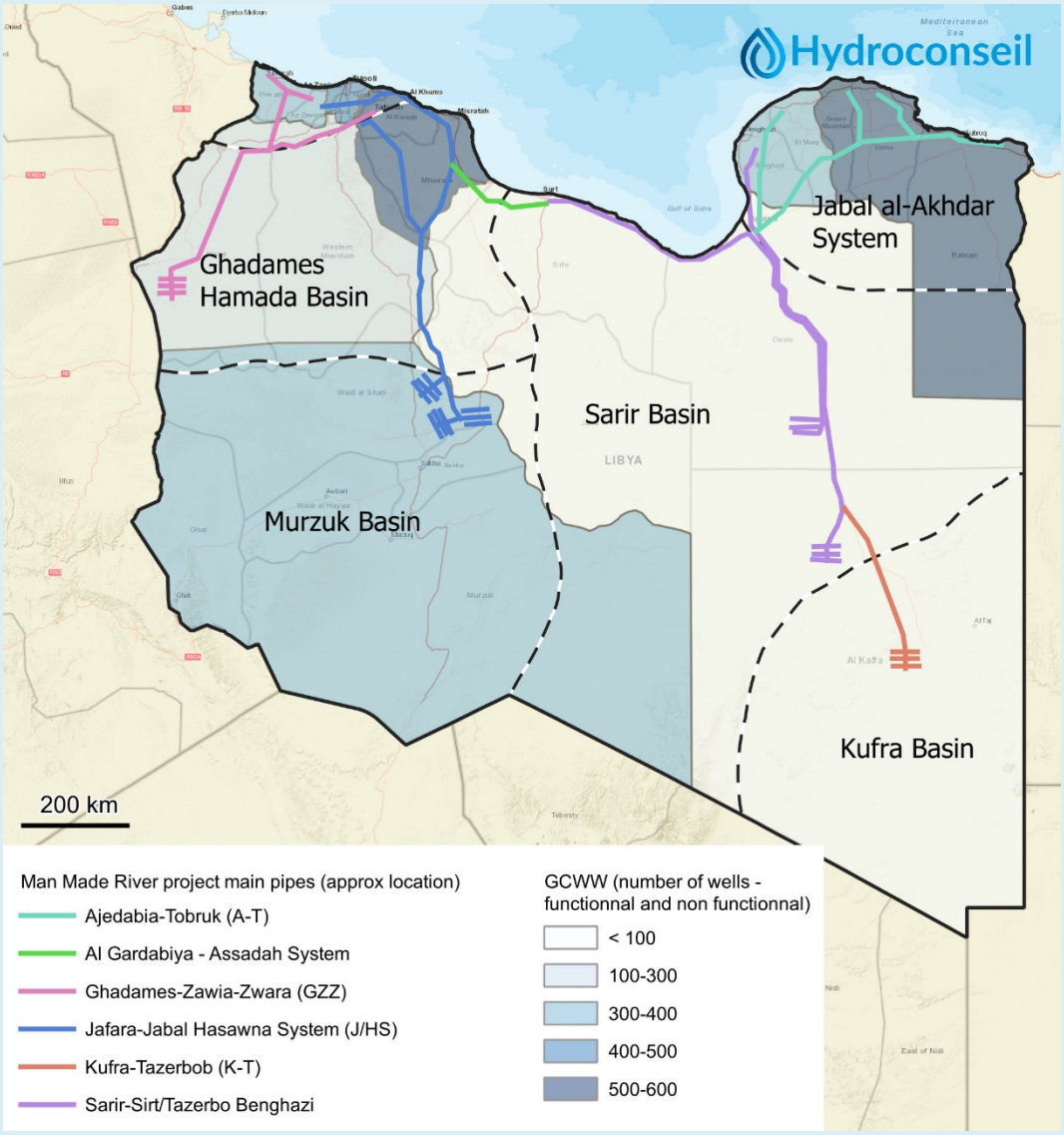
There is, and will continue to be, heavy reliance on groundwater supply, particularly from fossil aquifers, with the largest non-renewable groundwater reserves located in the Murzuq, Kufra, and Sarir basins. Long-term plans reported by the National Planning Council in 2014 presented studies, including modelling, that indicate that continued over-extraction will exhaust Libya's non-renewable aquifers within decades unless urgent measures are taken to reduce consumption and develop alternative water sources. Similarly, over extraction of the coastal aquifer systems, especially in Tripoli and Benghazi needs to be limited to sustainably manage saline intrusion and excessive drawdown.

Long-term transition from finite to more sustainable water resources is therefore essential to maximize the lifespan of the finite sources while developing the alternatives. This requires further investigation and updating the exploitable reserves estimates for the different aquifer systems to inform the development of focused, regional water supply master plans. In addition, the use of different water sources has been managed across various utilities in Libya, based on their own mandates. The Libyan water sector requires a structured, higher-level master plan, across all utilities, that implements the transition to more renewable water resources and likely realigns roles and responsibilities across public companies.

Strategic approaches

1. **Develop basin-specific groundwater management frameworks:** prepare detailed water resource management plans for each major basin inclusive of "safe yield" estimates and dynamic pumping plans per basin, informed by modern regional and local groundwater models to enable both fossil aquifer and coastal aquifer resource estimations. This is essential to inform long-term strategic planning such as redesigning pumping schedules and the rotation of wellfield and should include specific models for:
    - Sarir Basin
    - Kufra Basin
    - Murzuq Basin
    - Ghadames – Hamada Basin
    - Jafara Plain shallow coastal aquifer
    - Al Jabal al Akhdar coastal fracturer aquifer
2. **Integrate updated groundwater modelling into strategic water supply planning:** embed the results of groundwater assessments into long-term water balance planning, linking them with infrastructure investment decisions, desalination and reuse expansion strategies, and climate change adaptation scenarios to ensure a balanced, sustainable resource mix. Groundwater models will also enable Libya to contribute effectively to regional cooperation on shared water resources, fostering coordinated basin management.

Figure 6:distribution of GCWW wells and MMRA pipes across the water basins



Objective 4.3. Establish a road map to diversify renewable and non-conventional water resource supplies across sectors

✓ RATIONALE

While groundwater will remain the principal source of water supply in Libya for the foreseeable future, particularly for the agricultural sector and inland regions, its current exploitation is unsustainable. To ensure long-term water security and reduce pressure on aquifers, the country must progressively expand the contribution of non-conventional and renewable water sources – including surface water capture, desalination, treated wastewater reuse and managed aquifer recharge – while rehabilitating and optimizing existing infrastructure. This diversification requires a national and regional water and sanitation master plan to guide the transition toward a balanced, resilient and sustainable water supply portfolio, monitored through a clear roadmap. Such master plans can be designed with support from the private sector/donors, both nationally and internationally, harnessing innovative financing mechanisms.

Strategic approaches

1. **Develop a national master plan:** prepare a comprehensive national water and sanitation master plan defining the optimal mix of water sources by sector and geography, informed by groundwater models and updated data systems and incorporating climate scenarios aligned with the National Climate Change Strategy.
2. **Develop harmonized master plans for principal cities**: elaborate city-level master plans aligned with the national framework, identifying priority infrastructure projects, investment requirements and phased implementation timelines.
3. **Align institutional and financial planning frameworks:** require all water companies and institutions to prepare investment plans consistent with the national and city-level master plans, integrating budgeting for rehabilitation and replacement of critical infrastructure. These plans should be prioritized at centralized level, by the Water Board, based on predefined sets of criteria, as detailed in Axis 5, Objective 5.1, page 45.

These plans should consider the following aspects:

- **Maintain, modernize and expand surface water systems for local and drought resilience:** rehabilitation and upgrading of dams, flood diversion structures and wadi retention systems to capture seasonal flows for non-potable local demand, aquifer recharge and drought buffering, implementing protective measures against flood damage and sediment.
- **Invest in desalination for urban supply in coastal regions:** modernization of existing desalination plants and planning for phased expansion to meet urban demand in coastal areas.
- **Increase wastewater treatment and reuse for agricultural use and aquifer recharge:** rehabilitate and upgrade wastewater treatment infrastructure and expand sanitation coverage to increase the availability of treated wastewater for irrigation and managed aquifer recharge, ensuring treated effluent meets quality standards for safe reuse in line with SDG6.3.

- **Promote Managed Aquifer Recharge (MAR) schemes:** scale-up piloted MAR programs, particularly in coastal and drought-prone areas, using treated wastewater, stormwater or floodwater to replenish aquifers and counter seawater intrusion.
- **Select critical groundwater infrastructures that need to be reinforced or rehabilitated to meet the future resource mix:** plan and finance the rehabilitation of critical components of the MMR that are relevant to the needs of the future resource mix, whilst developing a long-term investment plan.
- **Expand water supply and sanitation coverage, particularly in rural areas:** although Libya has a relatively high urban water supply coverage, expanding sanitation coverage nationwide and extending safe water supply coverage in rural communities – considering cost-effective decentralized solutions and PSP with existing operators – is essential to maximize wastewater availability for treatment, improve financial sustainability of water utilities and achieve SDG 6.1 and 6.2 by encouraging the use of package waste treatment units and make available to the public or small municipalities on easy loan bases.
- **Establish a national laboratory network for water quality monitoring:** establish and equip a national network of laboratories for comprehensive water quality monitoring, ensuring that both drinking water and treated wastewater consistently meet health and environmental standards for safe and diverse uses.

All new and rehabilitation projects must also incorporate energy efficiency and renewable energy solutions, ensuring environmental and financial sustainability. Plans should also promote private sector participation (PSP) where financially and operationally viable.

Objective 4.4. Protect water resources against increasing risks of climate change and anthropogenic water contamination

✓ RATIONALE

Climate change is intensifying pressures on Libya's water resources through increasing temperatures, prolonged droughts, erratic rainfall and rising sea levels. At the same time, pollution from industrial effluents, inadequate sanitation and poor waste management practices continues to degrade water quality, threatening human health, ecosystems and water supply quality. In addition to the integration of climate data and risk management detailed under Axis 3, reinforcing early warning systems, modernizing drought and flood management, protecting aquifers and mitigating contamination will enhance the long-term sustainability of surface and groundwater systems.

Strategic approaches

1. **Operationalize storm, flood and drought early warning protocols:** make use of the databases developed in axis 3, to enable proactive management of extreme events, improve preparedness and reduce the socio-economic impacts.
2. **Develop and implement seasonal operating plans for coastal aquifer abstraction:** establish dynamic abstraction schedules and recharge plans for coastal aquifers, guided by real-time monitoring data and groundwater models, to mitigate seawater intrusion and maintain long-term aquifer stability.

3. **Implement measures to reduce evaporation losses and improve water storage efficiency:** where technically and economically viable, introduce measures to minimize surface water evaporation, such as covering open reservoirs or deploying floating baffles or roofing systems.
4. **Strengthen pollution control mechanisms:** reduce point-source contamination from industrial, agricultural and municipal sources by mandating industrial pre-treatment and hazardous waste control, and spill prevention measures, as well as enhancing regulation and monitoring of water treatment facilities, to prevent contamination of surface and groundwater resources and protect ecosystems in line with SDGs 6.3 and 6.6.

Axis 5. Seek financial sustainability

Goal: reduced reliance on subsidies

Build a financially sustainable water sector capable of funding its operations and maintenance, justifying its investment needs and mobilizing diverse financial resources to ensure reliable, efficient and inclusive water services

Objective 5.1	Objective 5.2	Objective 5.3	Objective 5.4
Centralize asset ownership and investment prioritization	Implement an equitable and financially sustainable tariff system that promotes efficiency, conservation and social protection	Operating companies capable of covering operation and maintenance costs and reducing commercial losses	Enhance innovative financing mechanisms to support capital investment in the water sector

Long-term water security depends not only on sound resource management but also on the financial viability of the institutions that deliver water and sanitation services. In Libya, decades of underinvestment, poor cost recovery and fragmented management have constrained the sector's ability to maintain operation and maintenance cost-recovery as well as expand critical infrastructure. To address these challenges, it is essential to establish the financial foundations for sustainability by improving asset management and investment prioritization, introducing a transparent and equitable tariff framework, strengthening the operational and financial performance of service providers, and enabling access to innovative sources of finance. Together, these measures will allow the sector to gradually achieve full cost recovery for operations, justify and attract capital investment, and deliver efficient, climate-resilient and socially equitable services in line with national development goals.

Objective 5.1. Centralize asset ownership and investment prioritization

✓ RATIONALE

Fragmented or unclear ownership of water sector assets and ad-hoc investment decisions have undermined accountability, efficiency and the effective allocation of scarce financial resources. The financial management and prioritization framework must be revised. Centralizing asset ownership under a single national water authority (the Ministry of Housing and Infrastructures) will enable coherent infrastructure planning, standardized maintenance and renewal, and transparent performance monitoring. At the same time, investment prioritization must be guided by the national and regional water and sanitation master plans (Axis 4), ensuring that funding decisions are consistent with national objectives, resource sustainability and service delivery targets. This alignment will enhance governance, improve cost efficiency and strengthen confidence among government and development partners in the sector's financial management.

Strategic approaches

1. **Centralize asset ownership:** transfer, where necessary, ownership of all water and sanitation assets to the Ministry of Housing and Infrastructures, with a delegation contract to public or private companies for operation and maintenance, in line with Axis 1, page 23.
2. **Align investment planning with master plans:** base investment prioritization on the sector roadmaps and master plans developed under Axis 4, aligning all capital projects with long-term resource sustainability and service delivery goals as they are set in coordination with other sectors (alignment to the top-down strategy developed under Axis 2).
3. **Adopt transparent investment selection criteria:** establish a clear, evidence-based framework for ranking and approving projects using predefined economic, social, environmental and technical criteria to ensure efficient allocation of public funds.
4. **Develop an integrated asset and investment database:** the Water Board should incorporate the value, condition and performance of all sector assets into the NWIS (see Objective 3.1 Centralize and integrate water data management, page 33), enabling data-driven investment planning, cost benchmarking and lifecycle management.
5. **Strengthen financial justification and donor coordination:** use the roadmaps, master plans and investment justifications to prepare costed investment pipelines aligned with national priorities, improving the sector's ability to justify budget requests and attract external financing.

Objective 5.2. Implement an equitable and financially sustainable tariff system that promotes efficiency, conservation and social protection

✓ RATIONALE

Water tariffs play a central role in achieving financial sustainability, promoting conservation and ensuring social equity. The tariff-setting process, led by the sector regulator, should define clear methodologies for determining tariffs based on cost of service, affordability and conservation objectives. It should institutionalize regulatory review, stakeholder consultation and period adjustment mechanisms, ensuring that tariffs evolve in response to changing costs, inflation and consumption trends. Furthermore, the introduction of smart metering at customer level (ref. Axis 3) will further strengthen billing accuracy, revenue collection and enforcement, thereby enhance the sector's financial performance and reduce dependency on public subsidies.

Strategic approaches

1. **Develop a comprehensive tariff-setting framework:** institutionalize a transparent, evidence-based process for tariff setting and adjustment (that accounts for inflation, service costs and changing consumption patterns). This mechanism should be based on a proposal from operating companies, reviewed by the regulator, then approved by the government, within regulatory oversight and stakeholder consultation. Annex 5 Tariff setting mechanism, page 68 provides more details on the tariff setting mechanism by the regulator.
2. **Establish a national tariff system for domestic and industrial use:** this tariff must be volumetric with a flexible structure for gradual adaptation (recommended to be an increasing block tariff with values reviewed on regular basis), approved by the Regulator, ensuring cost recovery, affordability and incentives for efficient water use across domestic, industrial and agricultural sectors. Annex 6 Tariff model, page 69 provides recommendations on the categories/structures for domestic and industrial use that should be included in the tariff model.
3. **Introduce agricultural water tariffs:** gradually introduce area or input-based tariffs for agricultural users (see Annex 6) to encourage conservation and improve cost recovery, while safeguarding food security and rural livelihoods. Develop a system for applying tariff to private extraction from underground water through municipalities and connecting them to the wastewater system
4. **Deploy customer-level smart metering:** implement smart metering systems to improve billing accuracy, reduce collection costs and enhance revenue reliability – linking financial performance with operational efficiency and service quality, as detailed in Annex 6 Tariff model, page 69).
5. **Strengthen public communication and acceptance:** conduct outreach and communication campaigns to raise awareness about tariff reform objectives (included in the awareness raising program to be developed under Axis 1 Objective 1.4, page 29), emphasizing fairness, transparency and the link between payment, service reliability and long-term water security.

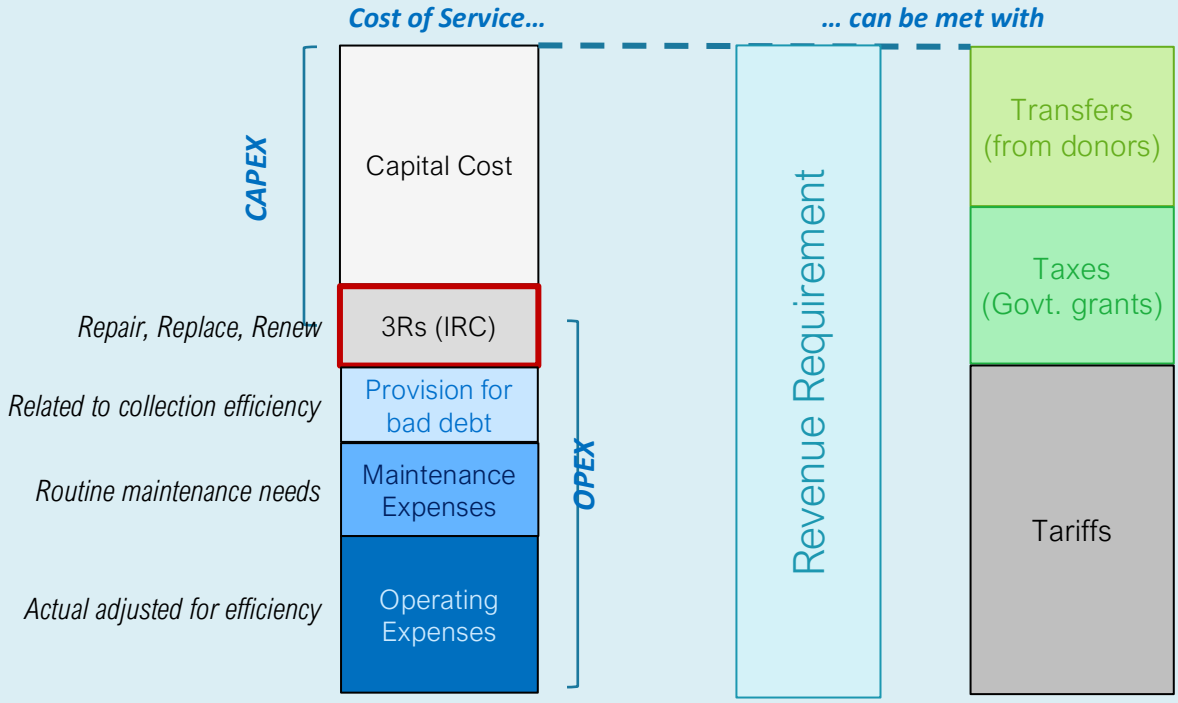
Objective 5.3. Operating companies capable of covering operation and maintenance costs and reducing commercial losses

✓ RATIONALE

A first step to achieving financial sustainability is improving recovery for operation and maintenance costs from internal revenues. Through systematic cost analysis, performance benchmarking and the adoption of digital and preventive maintenance systems (in coordination with the data and monitoring initiatives under Axis 3 Develop a knowledge base, page 33), companies can reduce inefficiencies, lower energy consumption and improve billing accuracy. Further, building managerial and technical capacity, alongside clear performance indicators and accountability mechanisms (set by the Water Board), will enable utilities to progressively finance their own operations and strengthen overall sector resilience.

Cost recovery means ensuring that the revenues generated by a water utility are sufficient to cover the full costs of providing water and wastewater services, including operation expenses, routine maintenance, replacement and rehabilitation and capital investments. As shown in the diagram below there a different level of cost coverage that can be achieved over the strategy period.

Figure 7: cost recovery components



Strategic approaches

1. **Assess and optimize O&M expenditure:** conduct comprehensive assessments of O&M costs across companies to identify inefficiencies, establish performance baselines and allocate investments to improve energy efficiency, maintenance practices and material use.
2. **Establish performance-based management systems:** based on the KPI defined under Axis 3 – including energy use per cubic meter, staffing ratios, cost-recovery benchmarks – introduce regular performance reviews and incentive mechanisms to drive continuous improvement. Set gradual targets for operating companies to cover O&M costs from internal revenue during specific number of years.
3. **Reduce commercial losses and strengthen revenue protection:** implement systematic programs to detect and address meter inaccuracies, unauthorized connections and billing errors, supported by smart metering, digital monitoring and enforcement mechanisms. Reduce illegal connections by design projects to be fully integrated to include production, force main, networks and housing connections along all distribution lines.
4. **Digitalize operations and asset monitoring:** deploy smart meters, SCADA and GIS tools to improve real-time monitoring of network flows, optimize pumping schedules, detect anomalies, install remote controlled valves on heavy consumers (enabling quotas) and support data-driven operational decisions.
5. **Build institutional and human capacity:** strengthen technical, financial and managerial capabilities of water utilities through structured training, adoption of standard operating procedures and performance-linked capacity development programs.

Objective 5.4. Enhance innovative financing mechanisms to support capital investment in the water sector

✓ RATIONALE

While the goal is for public investment to fund water and sanitation infrastructure, innovative financing mechanisms can complement government funds to accelerate capital investment, expand service coverage and deliver resilient, climate-smart infrastructure. Although Libya has already taken initial steps to encourage PPP projects (some PPP companies are already established), and while the regulatory framework for tariff setting and performance monitoring (proposed under Axis 1), reliable data and performance indicators (Axis 3) and laws and regulations for guarantees, subsidies and risk sharing (Axis 1) should create enabling conditions, further efforts are required complement these reforms. Furthermore, additional mechanisms are needed to broaden and diversify sources of capital investment beyond PPP (see Annex 7 Main innovative financing instruments, page 70). By leveraging blended finance, PPP, climate finance, green bonds, output-based aid and other instruments, the sector can mobilize additional resources, improve financial efficiency and achieve results.

Strategic approaches

1. **Promote blended financing and Private Sector Participation (PSP):** facilitate structured partnerships with private investors, development finance institutions and donor agencies to co-finance infrastructure projects, leveraging guarantees and risk-sharing mechanisms. Explore the pros and cons of various PSP options (service delegation, PPP, etc.) according to project nature. Start with small scale pilot projects that can be upscaled based on lessons learned.

2. **Diversify financing instruments:** explore innovative capital sources, including green/blue bonds, climate finance, microfinance for household sanitation, pooled financing mechanisms and output-based aid (see Annex 7, page 70). Some international examples of innovative financing projects that could be adopted in Libya:

   - **PPP** for wastewater treatment and reuse (Jordan),
   - **Green bonds** for desalination and water reuse (Morocco),
   - **Blended finance** for small-scale water providers (Kenya),
   - **Microfinance schemes** for household sanitation (Philippines),
   - State Revolving Funds (SRF) and WIFIA programs for low-cost infrastructure loans (USA).

3. **Capacity building for project structuring and monitoring:** establish a PPP unit with specialized skills within the Water Board or Ministry of Planning and develop staff capacity to design, contract and manage PPP projects, including monitoring performance indicators and reporting to investors and stakeholders.

Public-private partnerships in Libya were regulated by Resolution n° 507 of 2025, that issued specific regulations governing public-private partnership contracts. The resolution aims to establish the legal framework for implementing infrastructure and public service projects, define project tendering mechanisms, and prepare indicative contract models and their oversight by the competent authority. This resolution constitutes a legal basis and a solid foundation for future private sector participation in water projects in Libya.

E. Implementation action plan

E.1 Axis 1 to 3: preparation of the necessary conditions

E.1.1. Laying the first building blocks of Libya's national water strategy

There are 3 fundamental building blocks:

1. Leadership and authority
2. Coherence
3. Knowledge

Leadership and authority

Implementing a strategy requires clear institutional leadership. This leading institution must combine three essential qualities:

- Legitimacy: all stakeholders must recognize the institution's role and authority to guide and coordinate actors across the sector.
- Responsibility: the institution must assume responsibility for the results achieved, even if it does not directly implement all actions itself but enables other actors to do so. It therefore needs a clear mandate from the State of Libya and must operate at an institutional level that inspires confidence in its ability to carry such responsibility.
- Capacity: the institution must possess both high-level institutional capacity (e.g., a board of directors capable of strategic oversight) and operational management capacity (executive members with comprehensive knowledge of all aspects of the water sector).

The establishment of such an institution, utilizing the existence of the national Water Board, is the first priority in 2026, as it may take a significant institutional time to reach a fully staffed and mandated institution to launch the implementation of the strategy.

Required steps

1. Advocacy for the redefinition of the mandate and composition of the Water Board
2. Preparation of a presidential decree for the new mandate (extended to the entire water sector and including participation from agriculture, energy and environment)
3. Nomination (completion) of the board of directors (current + agriculture and environment)
4. Staffing of the executive board (at least four directors general, for water resources, investment planning, service delivery and agriculture demand, plus necessary divisions and staff)

✓ MILESTONE

By the end of 2026, the Water Board must be fully operational (mandated, staffed and equipped).

Together with the establishment of the leading institution for the sector, the first steps to create a regulator must be initiated.

Required steps

1. Advocacy for the creation of an independent regulator, appointed by the parliament
2. Staffing of the regulator
3. Nomination (completion) of the board of directors (current + agriculture and environment)
4. Preparation of a presidential decree fixing the mandate, the composition and the authority of the independent regulator (its scope of regulation can be larger than the water sector)

✓ MILESTONE

By the end of 2027, the water sector regulator must start its first control activities with the existing public companies of the water sector.

By the end of 2027, the mechanisms for abstraction permitting must be in place.

Coherence

Required steps

1. Preparation of guidelines for policy setting in connected sectors (energy, agriculture)
2. Completion of sector policies and strategies for energy and agriculture, with a strong integration in the NWSS.
3. Appointment of (dedicated unit in) the Energy and Water Board to the international organizations in charge of transboundary resources management (e.g., OSS, NSAS Joint Authority).

✓ MILESTONE

By the end of 2026, coordinated policies are defined for water, energy and agriculture, giving the long-term goals for each sector to build or update its strategy.

By mid-2027, the dedicated unit in the Water Board is sitting in all the necessary international organizations for transboundary resource management.

By the end of 2027, the mechanism for coordinated planning is in place.

Knowledge development

Required steps

1. Securing funds to launch necessary technical studies for a comprehensive audit of all existing databases connected to the water sector
2. Build the capacity at central level to host and regulate the NWIS.
3. Connect the universities and research actors to the NWIS

✓ MILESTONE

By the end of 2026, creation of the NDAU within the Energy and Water Board

By mid-2027, operationalization of the NWIS (a central database gathering all updated data available about aquifers, infrastructure is in place and fed with data coming from public companies and ministries).

Establishment of the NWRTC by the end of 2027.

By 2030, the NWIS is regularly updated (every 3 months) with all the water sector data (from public companies, private producers, surface water, groundwater, infrastructure, demand, consumptions).

E.1.2. Transforming the sector

The transformation of the functioning rules and habits in the water sector relies on the gradual implementation of new mechanisms, under the guidance (and pressure) of the Water Board.

Required steps

1. Building the capacity of the executive departments of the Water Board through technical assistances
2. Definition of comprehensive operation manuals for:
   - Abstraction permitting
   - Investment planning and prioritization
   - Information collection, storage and availability
   - Contracting with production or distribution companies
   - Tariff definition
   - Reporting by the regulator
3. Master planning of water resource allocation and investment needs

✓ MILESTONE

By the end of 2027, all operation manuals must be completed and disseminated.

During 2026, 2027 and 2028, dedicated technical assistances must be provided to the Water Board (in the form of thematic assignments or in the form of permanent technical assistant).

By the end of 2028, a comprehensive master plan for resource allocation (resource mix), and investment priorities (type of production facilities, location, size) must be validated.

E.2 Axis 4 and 5: gradual implementation in the longer term

E.2.1. KPIs and milestones for transition to a more sustainable water sector

The implementation of axis 4 requires the following conditions to be implemented effectively:

1. A strong leadership of the sector
2. A master plan on water resources and infrastructure (which requires the NWIS to provide relevant date for informed planning decisions)
3. A regulator in place to monitor progress and enforce the mechanisms to manage the demand and the abstraction

Axis 4 is essentially a gradual implementation of:

- Curbing down the demand through efficiency improvement and demand management
- Transitioning to a more sustainable mix of water resources
- Protecting water resources

✓ MILESTONE

By the end of 2027, all wells and drillings are censed into the NWIS.

2026-2028: all public utilities identify and address “quick-wins” in the management of NRW

2026-2030: install meters on all public infrastructure. NRW rate in the public companies is contained under 40%.

2028-2030: license priority wells; implement coastal intrusion controls.

2030-2050: retire/deep-convert stressed wellfields; mainstream seasonal operating plans; tighten abstraction caps with verified data.

2050: NRW rate is below 27%.

2050: the share of renewable water (sustainable aquifers, surface water, desalination, wastewater reuse, rainwater harvesting) reaches 75%.

E.2.2. Seeking financial sustainability

Implementation of Axis 5 requires 4 main ingredients:

1. progress on the adaptation of the legal framework to facilitate the private sector participation;
2. introduction of metering at end-user connections (and bulk supply connections);

3. massive public communication to raise awareness on the real cost of water;
4. the investment prioritization criteria derived from the sector master plan.

✓ MILESTONE

By the end of 2026, all connections for bulk water selling are metered (data reliability is verified, remote data collection is ready) and data is fed into the NWIS (initiated, half-way to completeness).

By mid-2027, an institutional dialogue has been established with all the municipalities of Libya about the cost and price of water.

By mid-2027, the per capita consumptions of all the municipalities in Libya are benchmarked.

By end of 2027, all the utilities (public or private) benefit from a cost-recovery audit from the Regulator.

By the end of 2030, all public utilities are operating on a full-commercial basis, in contract with the Ministry of Housing and Infrastructures (including clauses on staggered revision of the balance subsidy coming from the State).

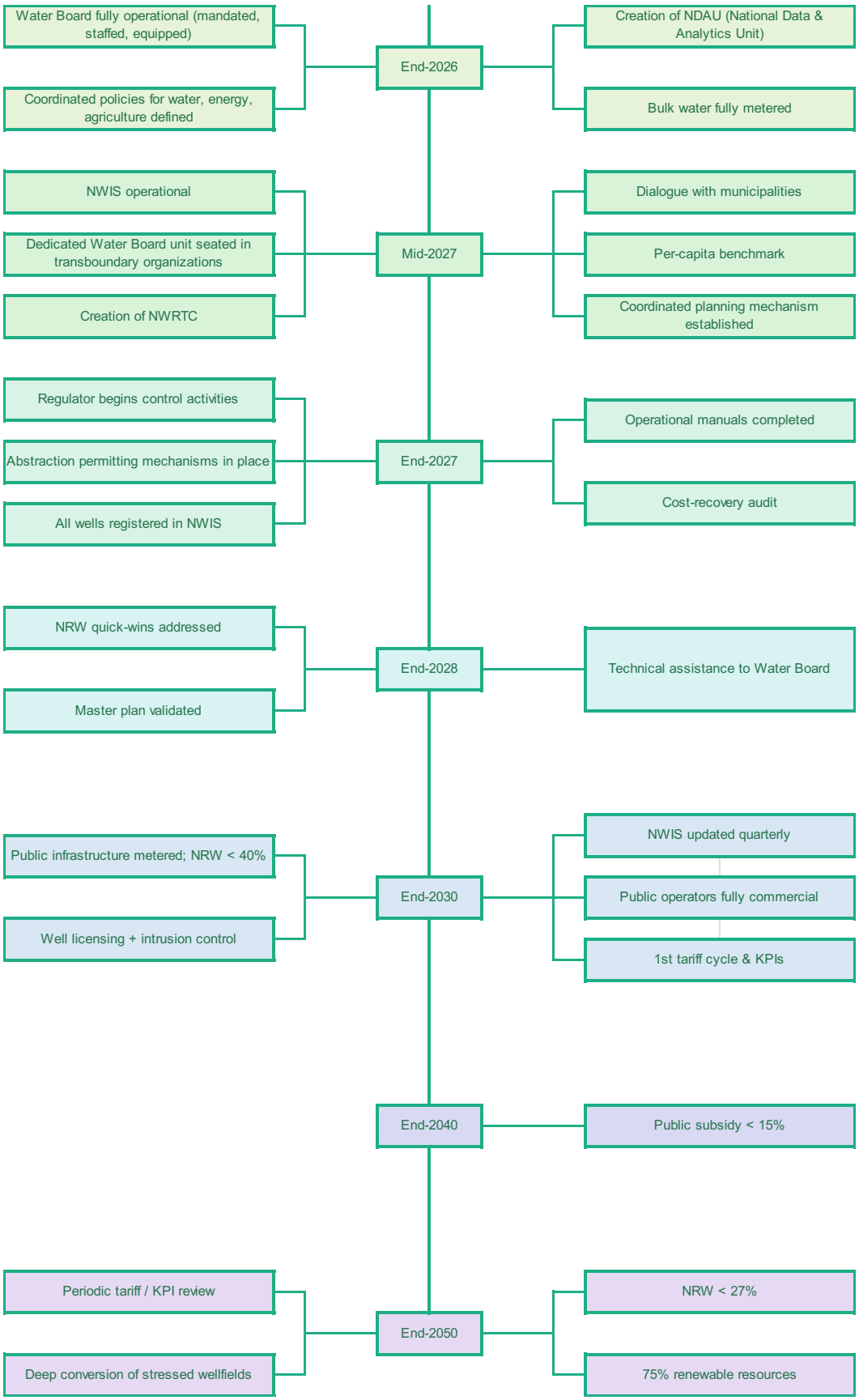
2027-2030: start implementing the prioritization model and develop plans for asset management and KPI for cost efficiencies. Start the first round of tariff setting mechanism with the regulator.

In 2040, public subsidy for municipal water service delivery is under 15%.

2030-2050: periodical review of tariffs, cost recovery KPI and finding sources for investment plans.

E.3 Timeline

Figure 8: roadmap timeline



F. Annexes

Annex 1. Sector entity functions

Table 2: role sharing among the 3 national bodies

Entity	Functions
Ministry of Water Resources	• Policy formulation for water resources use. • Establishment of sector regulation documents (water act, laws, bylaws, etc.) • Planning and Allocation of Water Resources • Provide technical advice to the Water Board. • Public Awareness and Stakeholder Engagement • Definition of standards and norms for water protection, drinking water quality, wastewater for reuse and wastewater rejections (in collaboration with Ministry of Environment, Ministry of Health and Ministry of Agriculture)
Ministry of Housing and Utility	• Policy formulation for service delivery • Contracting authority for operation companies • Technical and Operational Supervision of delegation contracts (to public or future private operators) • Provide technical advice to the Water Board. • Data Collection and reporting • Mobilizing financing for renewal and extension.
MMRA	• For the specific purpose of completing the MMR project, coordinates with the Ministry of Housing and Infrastructure to include MMR project in the investment planning • Implements the construction of the infrastructure
Water Board	• Institutional Coordination and Sector Governance • Monitoring, Evaluation, of the NWSS implementation. • Capacity Development and Institutional Strengthening • Sector financing • Coordination and Integration between the ministries, operators and agencies. • Investment planning coordination • Setting incentives for efficient investment • Promoting innovative technologies • Promoting demand management • Data, Information, and Research Management

Entity	Functions
Regulator	• Tariff regulation • Monitoring of water quality for drinking water • Monitoring of quality for wastewater for reuse • Monitoring of service delivery performance and benchmarking operators • Arbitration between contracting authorities and operators (public and private) • Improving standard delegation contracts and service delivery standards • Information and data gathering • Verification of abstraction permits compliance • Customer engagement • Consumer protection and dispute resolution • Advice and advocacy
Ministry of Local Governance	• Assit municipalities in fulfilling their mandate concerning the public services (in particular the water supply service and wastewater service) • Collect demands from the municipalities (in particular demands for water supply infrastructure) • Manage and coordinate the demands at national level (in terms of priorities and structure of the financing) • Transfer eligible demands to the Water Board, for feasibility and investment coordination • Serve as an interface between Municipalities and the Water Board during the process

Annex 2. Regulation models

- Regulation by government;
- Regulation by contract, which specifies the regulatory regimes in legal instruments (usually referred to as the French model);
- Independent regulation where independence has three dimensions: independence of decision making, of management and of financing (usually referred to as the Anglo-American model), or
- Outsourcing regulatory functions to third parties, which makes use of external contractors to perform activities such as tariff reviews, benchmarking, dispute resolution.

In the first model, the public sector is responsible for the management of the water services and owns the assets. The provision of the WWS is usually delegated to public water operators while the regulatory functions are carried out directly by the State at its different levels (central, regional, municipal). This organizational model prevails in the Netherlands and to a lesser extent in Germany.

In the second model, public authorities are responsible for WWS regulation but the provision of water services can be delegated to private operators through contract agreements. The contract agreements establish the set of rights and obligations for each contracting authority. The provision of WWS is awarded to private companies following public tenders. WWS infrastructure remains within the public domain. The "French model" of regulation by contract originated in France in the nineteenth century and expanded rapidly across countries to become one of the dominant models, especially in countries where municipalities are responsible for WWS management.

In the third model, also called the "English model", the regulatory framework for WWS is organized around the establishment of dedicated agencies with regulatory functions. The dedicated water agency supervises and regulates the water sector independently from the private operators, the government and the consumers. This model allows separation of powers between the regulator and the line Ministers. This separation concentrates the regulatory functions into a single body and limits potential conflicts between policy formulation and enforcement. While it initially originated in the United Kingdom, this model has spread in other countries, including for instance recently to Italy.

The Egyptian Experience (recommended):

The Egyptian Water, Wastewater and Consumer Protection Regulatory Agency (EWRA) was established as an independent entity, by Presidential Decree No. (136) of 2004, aiming to regulate, monitor, and control all aspects related to drinking water and wastewater activities. The regulatory agency aims to achieve a balance between service providers and consumers. The vision for restructuring the sector focuses around the separation of ownership and management (the holding company and the New Urban Communities Authority), operation and maintenance (subsidiary companies and city authorities), and oversight and regulation (the regulatory agency).

The agency's responsibilities include:

- Ensuring that the treatment, desalination, transportation, distribution, and sale of drinking water, as well as the collection, treatment, and safe disposal of wastewater and industrial wastewater, are all carried out within the framework of laws and regulations, particularly those related to quality and environmental protection.
- Periodically reviewing plans for the consumption, treatment, desalination, transportation, and distribution of drinking water, as well as plans for the collection, treatment, and safe disposal of sewage and industrial wastewater, including the necessary investments, to ensure their availability and achieve state policy in this area.
- Providing technical assistance to service providers in preparing studies to determine the targeted technical, commercial, economic, and financial performance levels.
- Periodically monitoring and verifying that the costs of treating, desalinating, transporting, distributing, and selling drinking water, and the costs of collecting, treating, and safely disposing of sewage and industrial wastewater, safeguard the interests of service providers and consumers.
- Ensuring that service providers adhere to technical, commercial, financial, and economic performance standards and adhere to the tariff schedules approved by the Council of Ministers.
- Studying requests to determine and amend tariffs to ensure financial and economic balance for service providers, taking into account consumption segments and patterns, for approval by the Council of Ministers.
- Reviewing and approving contract and agreement models that regulate the relationship between service providers and consumers.
- Monitoring the availability of administrative, technical, financial, and economic competencies for service providers.
- Ensuring the quality of technical and administrative services provided by service providers and providing technical assistance.
- Publishing information, reports, and recommendations that help service providers and consumers understand their rights and obligations and inform them of the nature of the Authority's role.
- Investigating subscriber complaints to ensure a balanced protection for service providers and consumers and working to mitigate any disputes that may arise in this regard.

Annex 3. Regulation enforcement

- Licensing and permitting powers to determine how activities are controlled (e.g. abstraction licenses, wastewater discharge permits).
- Inspection and Monitoring to guarantee how compliance is verified (field inspections, data audits, reporting systems).
- Sanctions and remedies (e.g. warnings, fines, license withdrawal).
- Judicial recourse (appeals to administrative or judicial bodies)
- Transparency and accountability.

To ensure that regulation serves the strategy:

- The Water Board sets strategy goals and ensures that all regulations support them.
- The Water Board shall implement strategy through executive department and Ministry of Water Resources and Ministry of Housing and Infrastructure.
- The Regulator shall verify compliance to the rules set by the ministries, monitor performance, and apply sanctions fairly and transparently.

Ministries enforcement functions are:

The Ministries (of Water Resources and Ministry of Housing and Infrastructure) are the policy-makers, their main role with regard to legislative and regulatory Framework is to:

- Ensure consistency with national law and international commitments.
- Oversee the work of the government body and the regulator to ensure alignment with strategy priorities.
- Supervision of Utilities and Service Providers
- Reports progress and performance indicators to the Ministry and the Regulator
- Technical Enforcement

The Independent Regulator enforcement functions are:

- Regulatory Framework Implementation
- Licensing Oversight
- Tariff Regulation
- Standards and Compliance
- Sanctions and Dispute Resolution

Accountability: There are three groups of stakeholders to which regulators are generally accountable:

1. Ministers and the legislature
2. regulated entities
3. the public.

The regulator is usually tasked with protecting consumers' interests and receives delegations and powers from the government to act on this objective. An important aspect of this relates to the mechanisms available to regulators to monitor and disseminate information about the level and quality of services provided by the operators. Subjecting the activities of the regulator to scrutiny is important to enhance the integrity of the regulatory process and ultimately to secure the trust and respect of all constituents.

Countries have a number of mechanisms to ensure that water regulators are held accountable. The regulator may be required to report regularly and publicly to the legislature on its objectives and activities or/and be submitted to periodical evaluation to ensure that it is meeting its responsibilities with integrity, honesty and objectivity. Accountability can be safeguarded through transparency requirements on regulatory decisions and the possibility of revision and appeal. The Governance of Regulators highlights the following:

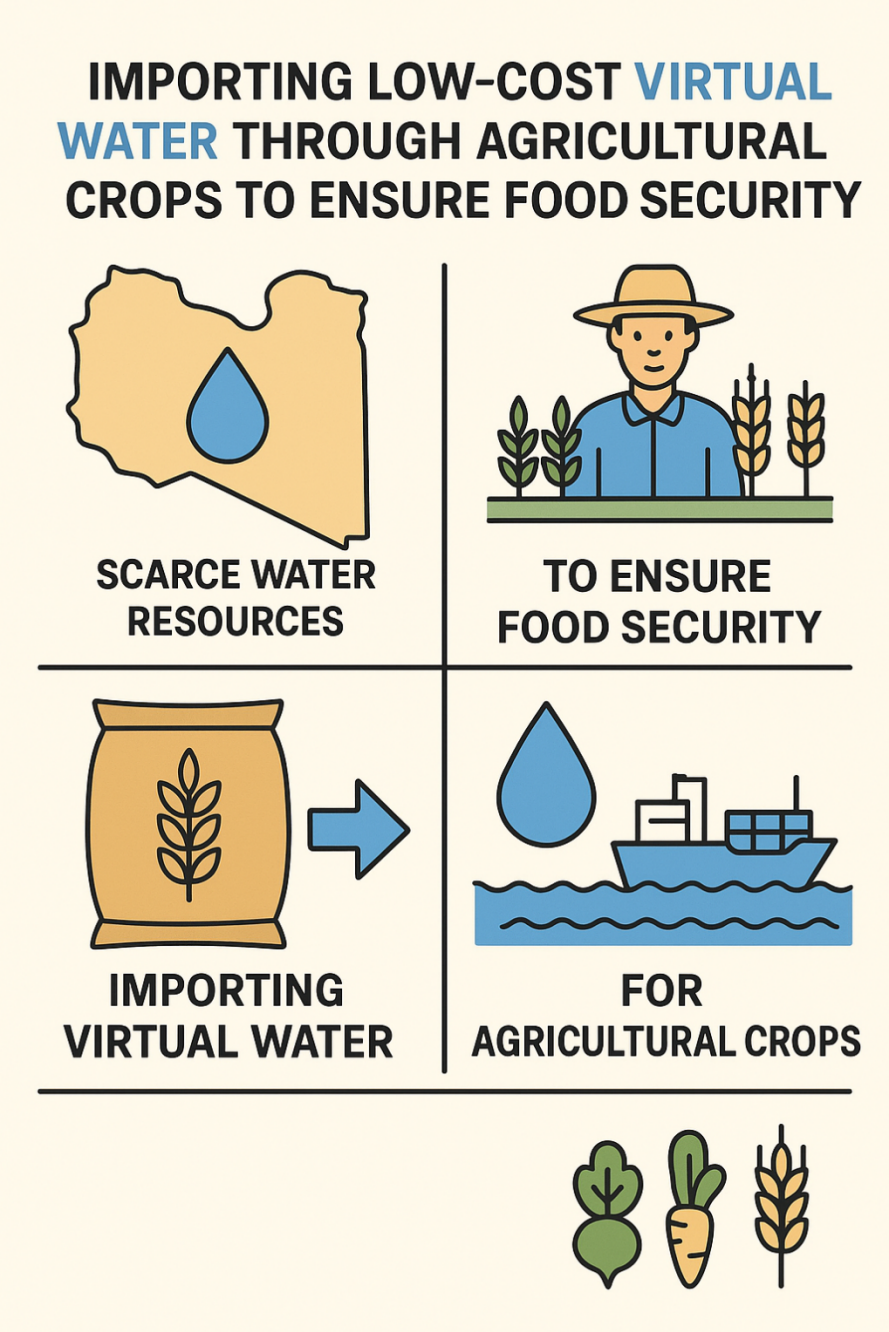
- Regulators should report to ministers or legislative oversight committees on all major measures and decisions on a regular basis and as requested;
- Key operational policies and other guidance material, covering matters such as compliance, enforcement and decision review, should be publicly available;
- Regulated entities should have the right of appeal of decisions that have a significant impact on them, preferably through a judicial process.
- Formal accountability, where regulators are accountable by law to the government or to the parliament.
- When regulators report that their actions may be challenged by courts.
- Accountability vis-a-vis the regulated entities.
- Regulators report being accountable by law to the public via their annual report or other communication means such as on their website.

Annex 4. Virtual Water as a tool for water security

Importing goods that require a high volume of water for their production equals to saving the consumption of this water in Libya, reallocating this unconsumed water to lower water-consuming productions. In that sense, the choice of goods to be produced locally and those to be imported can significantly impact on the water balance of the country.

Therefore, the quantities of water consumed in producing imported goods (mostly agricultural ones) can be considered as "virtual water" that can be imported instead of being consumed in Libya.

Figure 9: virtual water concept



The reasoning starts by estimating the volume of water embedded in goods (Virtual Water) in cubic meters:

$$S.W.D = W.R / Y$$

Where:

- W.R = Water requirement (m^3/ha)
- Y = Productivity (tons/ha)

Calculation of the transferred (embedded) Virtual Water: V.W = Gi * S.W.D

Where:

- G_i = Quantity of the imported commodity (tons)
- V.W = Volume of water embedded in imported goods (m^3)

Calculation of the required area to produce the imported commodity locally: A = Gi/ Y

Where:

- A = Area required to produce the imported commodity locally (hectares)
- G_i = Quantity of the imported commodity (tons)
- Y = Productivity (tons/ha)

Estimation of the water volumes required to produce imported commodities locally: Q = A * W.R

Where:

- Q = Volume of water required to produce imported commodities (m^3)
- A = Area required to produce the imported commodity (hectares)
- W.R = Water requirement (m^3/ha)

Estimation of the unit price of water required to produce imported commodities locally: P = PC/ Q

Where:

- P = Price per cubic meter of water (USD/m^3)
- P_C = Value of the imported commodity (USD)
- Q = Quantity of water required to produce the imported commodity locally (m^3).

The following table shows the total quantities of virtual water (VW) embedded in imported goods, in millions of cubic meters, from countries of origin during the period (1998–2002).

Commodity	1998	1999	2000	2001	2002	Total
Oil	128	87	277	131	574	1198
Tomatoes	69	11	120	181	183	564
Wheat	1,900	1,500	1,800	1,500	2,000	8,700
Legumes	23	30	6	—	—	59
Feed	981	118	345	292	222	1,958
Total	1,201	247	749	604	980	3,780

This second table shows the total cultivated areas for imported commodities, if produced locally, in hectares during the period (1998–2002).

Commodity	1998	1999	2000	2001	2002	Total
Oil	23,240	20,081	24,713	16,856	7,956	92,846
Tomatoes	931	1,306	763	1,309	2,167	6,476
Wheat	372,329	225,575	336,250	289,000	366,022	1,589,176
Legumes	1,830	580	200	—	—	2,610
Feed	156,485	26,957	33,086	75,919	17,539	572,986
Total	554,815	274,499	395,012	383,084	393,684	1,748,383

Note: The figures are expressed in hectares, and the dash (—) indicates that data for those years are not available.

The following table shows the volumes of water that would have been required to produce locally the equivalent quantities of some imported commodities. Results are distributed by geographic regions, in millions of cubic meters, for the entire quantity imported during the 1998–2002 period. For example, in 1998, the volume of imported wheat is such that, if Libya had to produce it locally, it would have consumed 1,850 millions cubic meters of water. The following year, it dropped down to 1,271 millions because much less wheat was imported.

Area	Wheat	Tomatoes	Corn Oil	Legumes	Feed	Total
Tripoli						
1998	1,851	8.3	238	5.6	1,028	3,132
1999	1,271	11.5	206	1.8	276	1,764
2000	1,671	6.4	253	0.7	678	2,610
2001	1,436	11.5	128	—	529	2,104
2002	1,839	19.2	94	—	204	2,156
Sabha						
1998	5,034	19.8	545	17.9	2,044	7,661
1999	4,414	27.8	471	3.6	632	5,549
2000	4,626	16.2	580	2.0	1,477	6,700
2001	3,939	27.8	395	—	1,113	5,475
2002	4,947	46.0	215	—	877	6,084
Sirte						
1998	2,934	8.7	216	10.2	983	4,152
1999	2,004.1	12.1	169	3.2	250	2,438
2000	2,649.5	7.1	229	1.1	640	3,527
2001	2,276.7	12.1	59	—	508	2,856
2002	2,176.3	20.2	85	—	314	3,295
Benina						
1998	2,524.5	12.0	301	6.7	1,248	4,523
1999	1,724.3	15.5	273	2.1	350	2,365
2000	2,279.6	9.1	320	0.7	858	3,467
2001	1,958.8	15.7	219	—	666	2,858
2002	2,508.84	25.7	119	—	5,407	3,060

Note: the values are expressed in millions of cubic meters, and the dash (—) indicates that data for those years are not available.

The next table shows the average cost per cubic meter of water required to produce imported commodities if produced locally, in US dollars.

	1998	1999	2000	2001	2002	Average
Wheat						
Tripoli	0.18	0.17	0.18	0.22	0.60	0.27
Sabha	0.07	0.05	0.06	0.08	0.23	0.10
Sirte	0.13	0.10	0.10	0.16	0.45	0.19
Benina	0.14	0.12	0.10	0.17	0.39	0.18
Average	0.13	0.11	0.11	0.16	0.41	0.19
Tomatoes						
Tripoli	4.62	5.70	5.21	5.80	14.90	7.25
Sabha	1.90	2.40	2.10	2.42	6.29	3.02
Sirte	4.40	5.60	4.80	5.56	14.40	6.95
Benina	3.47	4.30	3.75	4.33	11.20	5.41
Average	3.60	4.50	4.00	4.53	11.70	5.67
Corn Oil						
Tripoli	0.62	0.63	0.56	0.63	1.71	0.83
Sabha	0.28	0.26	0.25	0.28	0.72	0.36
Sirte	0.68	0.65	0.61	0.71	1.83	0.90
Benina	0.50	0.48	0.43	0.50	1.30	0.64
Average	0.52	0.51	0.46	0.53	1.39	0.68
Legumes						
Tripoli	0.70	0.87	0.64	—	—	0.73
Sabha	0.27	0.28	0.22	—	—	0.26
Sirte	0.47	0.52	0.38	—	—	0.46
Benina	0.75	0.78	0.68	—	—	0.70
Average	0.43	0.61	0.46	—	—	0.53
Feed						
Tripoli	0.10	0.07	0.09	0.11	0.39	0.13
Sabha	0.04	0.03	0.04	0.05	0.23	0.08
Sirte	0.10	0.08	0.10	0.17	0.45	0.18
Benina	0.09	0.06	0.07	0.07	0.42	0.14
Average	0.08	0.06	0.07	0.10	0.37	0.13

In light of the foregoing, virtual water, defined as the volume of water embedded in the production of imported agricultural commodities, can be regarded as an indirect yet strategically significant water resource. By substituting domestic production with imports, virtual water helps reduce pressure on groundwater reserves that are increasingly stressed by growing food demand.

Estimates suggest that the water embodied in imported goods amounts to millions of cubic meters annually, thereby contributing indirectly to the strengthening of national water security.

Conversely, local production of these commodities faces several structural constraints, most notably the limited availability of arable land, estimated at only a few thousand hectares, and the difficulty of securing the substantial water volumes required for cultivation. Meeting these needs domestically could consume millions of cubic meters of water, posing a tangible risk to already vulnerable groundwater reserves.

Economic indicators further reinforce this concern. The average cost of water required to produce imported grains locally is approximately $0.19 per cubic meter, whereas water supplied through the Great Man-Made River Project (MMRA) costs about $0.24 per cubic meter roughly (26%) higher. While this difference may appear modest, it becomes economically consequential when applied across large-scale irrigation systems. Given that a significant share of these high-cost water resources is allocated to agriculture, directing them toward low-value crops yields limited economic returns on a strategically critical input.

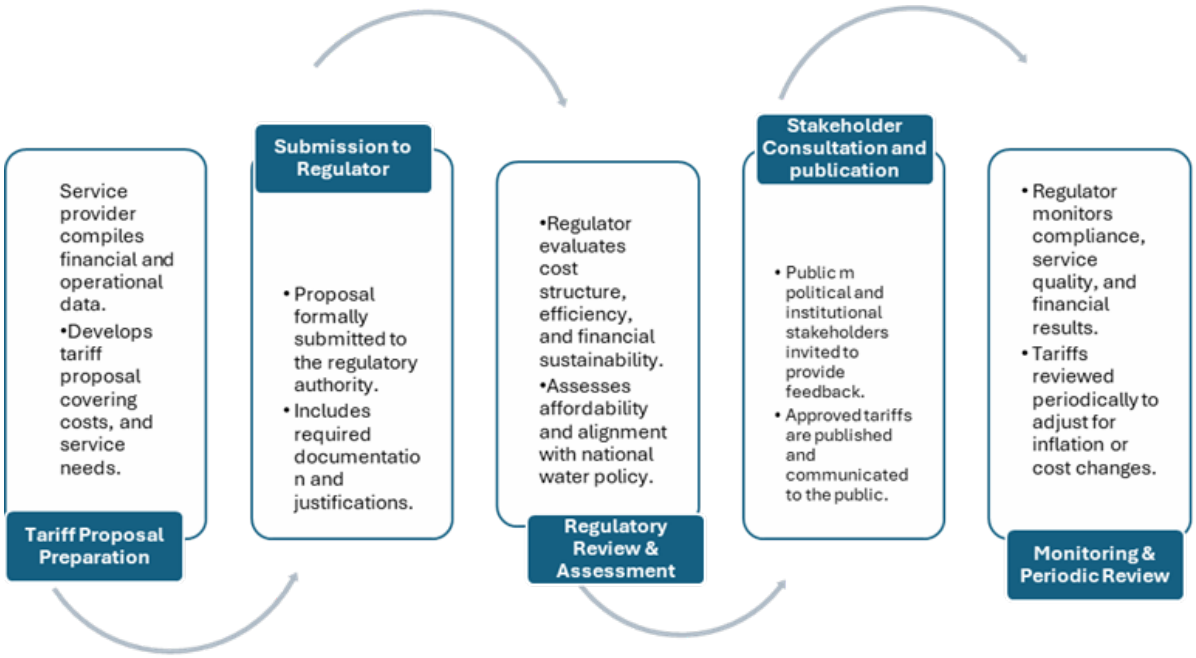
In water-scarce contexts, these dynamics strengthen the rationale for adopting virtual water strategies that import water-intensive commodities rather than producing them domestically, thereby enhancing economic efficiency while supporting the long-term sustainability of water resources. The case of tomato production illustrates this imbalance clearly: the water cost required to produce one ton locally is estimated at $5.67, more than 23 times the cost of a cubic meter supplied by MMRA ($0.24). Such disparities signal inefficient resource use and economically suboptimal decision-making under conditions of scarcity.

However, if a degree of domestic grain production is deemed necessary to maintain a minimum threshold of food security, it should be carefully aligned with available water resources and adapted to prevailing scarcity conditions. Priority should be given to crops that generate higher economic value per unit of water consumed, thereby improving overall water productivity.

Taken together, these findings point to a fundamental conclusion: unsustainable water use in the agricultural sector, combined with limited prospects for expanding conventional and non-conventional water resources, necessitates the adoption of virtual water as a strategic instrument for water resource management. By enabling the conservation of potentially billions of cubic meters of water through the import of water-intensive goods, this approach can help safeguard groundwater reserves at risk of depletion while simultaneously reducing pressure on constrained agricultural lands.

Annex 5. Tariff setting mechanism

Figure 10: tariff setting mechanism



Annex 6. Tariff model

Table 3: domestic and industrial considerations for the tariff model

Suggested tariff structure	Benefits	Requirements
An increasing block tariff with different rates for domestic and non-domestic water consumption (e.g. 0-10, 10-20,20-30, > 30 m^3/month)	The blocks value covers O&M costs for operating companies with target to cover part of investment in the future	Collection of historical data of O&M cost of all operating companies in a centralized location. A thorough data analysis to identify areas of inefficiencies and methods for reduction
Wastewater tariff linked to water consumption (e.g. percentage of water value)	No additional billing system for wastewater (and no unpopular effect of a "new invoice")	Coverage of wastewater services
A social tariff block for essential domestic needs (e.g. 10 m3/month)	The block will be protection for the poor	A study for affordability and willingness to pay steered by the Regulator
Charge for connection	A fixed charge for connection. Can start with subsidized value or incentive to encourage reduction of illegal connections	Field surveys to determine illegal connections
Charge for ground water drilling	This charge helps regulate the number of wells and discourages excessive or unplanned abstraction, protecting aquifers from over-exploitation and depletion	Collection of data on wells used by private customers
Polluter Pays Principle	users to pay for the negative externalities they initiate (pollution of water source, over utilization of underground sources, industrial discharge to wastewater networks)	

Table 4: agricultural tariff types

Tariff Type	Description	Examples of Application
Area-based Tariffs	Farmers pay a fixed fee per hectare of irrigated land, regardless of actual consumption.	Common in South Asia (India, Pakistan), parts of North Africa (Egypt's traditional surface irrigation).
Volumetric Tariffs	Charges are based on the actual volume of water consumed, measured through meters or flow devices.	Widely used in developed countries (Spain, France, USA, Australia) and increasingly in Middle East pilot projects (Jordan, Morocco).
Block Tariffs (Increasing or Decreasing)	Tariffs increase with higher consumption levels to encourage conservation (increasing block), or decrease to support larger farms (decreasing block).	Spain and Israel use increasing block tariffs for irrigation water.
Flat Tariffs	A uniform fixed annual charge, often used where metering is not feasible.	Common in developing regions with limited infrastructure or smallholder systems.
Input-based Tariffs	Linked to energy or pumping costs rather than water volume.	Observed in countries using groundwater irrigation, e.g., India and Iran.

Annex 7. Main innovative financing instruments

Instrument	Description	Examples / Applications
Blended Finance	Combines **public or concessional funds** with **private capital** to make projects financially viable.	Donor grants blended with development bank loans for wastewater treatment.
Output-Based Aid (OBA)	Funds disbursed only when **specific results** (like new connections) are achieved.	Utilities receive payments after proving new low-income households were connected.
Public–Private Partnerships (PPP)	Long-term contracts where private firms finance, build, and operate water assets.	BOT (Build-Operate-Transfer) wastewater plants, desalination facilities.
Green Bonds / Blue Bonds	Debt instruments financing **environmentally sustainable** water projects.	"Blue bonds" for coastal and marine water protection.
Climate Finance	Accessing funds from global **climate funds** (e.g., Green Climate Fund) for adaptation/resilience projects.	Drought resilience, wastewater reuse, and desalination projects.
Microfinance & Community Funds	Small-scale financing for local water or sanitation projects.	Rural water kiosks, community-managed boreholes.
Pooled Financing Mechanisms	Aggregating projects from multiple utilities or municipalities to access better loan terms.	State-level water funds or regional infrastructure pools.
Impact Investing & ESG Funds	Investors seeking both financial and social/environmental returns.	Investments in smart metering, water efficiency, or reuse projects.
Tariff Reform & Credit Enhancement	Adjusting tariffs to improve revenue reliability; using guarantees to reduce lending risk.	Partial risk guarantees, escrow accounts, performance-based subsidies.

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