IWRM AND THE WATER–ENERGY–FOOD SECURITY NEXUS IN BELIZE

INTEGRATING RESOURCES FOR SUSTAINABLE DEVELOPMENT

National Hydrological Service

MINISTRY OF SUSTAINABLE DEVELOPMENT,
CLIMATE CHANGE & SOLID WASTE MANAGEMENT

OVERVIEW: IWRM AND THE WEF NEXUS IN BELIZE

Integrated Water Resources Management

IWRM coordinates water, energy, and food resources management for sustainable development and resilience.

Water-Energy-Food Nexus

The WEF Nexus highlights trade-offs and synergies between water availability, energy generation, and food production sectors.

Water as Foundational Resource

Water is the foundational resource enabling both food security and energy reliability, yet is vulnerable to climate and land use changes.

Integrated Resilience Approach

Belize is advancing integrated cross-sector resilience through improved coordination and sustainable development aligned with WEF principles

WHY WEF NEXUS MATTERS

Belize faces interconnected risks across **water, energy, and food systems**, driven by climate variability and development pressures.

Climate impacts include **droughts, floods, storms, and changing precipitation**, affecting agriculture, water supply, and infrastructure.

Agriculture is economically significant but highly climate-sensitive, contributing ~14% of GDP and supporting rural livelihoods.

The **WEF Nexus approach promotes integrated resource management**, planning, and resource efficiency recognizing interdependencies across sectors.

National adaptation and resilience planning increasingly require cross-sector coordination.

ROLE OF THE NATIONAL HYDROLOGICAL SERVICE

Water Monitoring and Data Collection

The NHS monitors surface water and rainfall and maintains hydrometric networks to provide accurate hydrological data. Discharge Program which maintains data on water availability over varied seasons.

Support for Agriculture and Energy

Hydrological data supports irrigation scheduling, crop selection, and hydropower operation decisions in Belize.

Disaster Risk Reduction

NHS enables early warning systems to reduce flood and drought risks, protecting lives and infrastructure.

Integrated Water Resource Management

NHS facilitates cross-sectoral water management, climate adaptation, and environmental protection planning.

WEF ACTIONS SUPPORTED BY ANNUAL BUDGET ALLOCATIONS

HYDROLOGICAL MONITORING NETWORK

Hydrological Monitoring Infrastructure

The network includes river gauge and rainfall stations collecting vital water data across major watersheds in Belize.

Supporting Agricultural Water Allocation

Accurate hydrological data aids farmers in irrigation planning by informing water allocation decisions to optimize crop production.

Enhancing Hydropower Management

River flow data are essential for hydropower generation, influencing energy production potential and operational safety.

Environmental Flow Protection

Monitoring helps identify ecological flow needs to sustain aquatic ecosystems and maintain environmental balance.

FLOOD FORECASTING AND EARLY WARNING SYSTEMS

Real-Time Data Integration

Systems use real-time rainfall and river level data combined with forecasting tools to issue timely flood warnings.

Risks to Agriculture and Energy

Floods damage crops, erode soils, disrupt food supply, and threaten hydropower and transmission infrastructure.

Preventive and Resilience Actions

Early warnings enable controlled dam operations, livestock evacuation, and protection of critical infrastructure.

IWRM for National Security

Integration of hydrological monitoring with disaster management enhances resilience and supports national development.

DATA INTEGRATION AND DECISION SUPPORT

Data Integration Platforms

NHS organizes hydrological data into accessible platforms supporting planners and policymakers.

Scenario Analysis and Risk Assessment

Integrated datasets enable scenario analysis and risk assessments considering multiple resource demands.

Actionable Knowledge for Governance

Transition from data collection to knowledge supports integrated governance under IWRM principles.

PROJECT 3: GEF 6 INTEGRATED WATERSHED MANAGEMENT

Watershed as Natural Unit

Watersheds integrate water, land use, agriculture, and ecosystems as natural units for management.

Impact of Poor Land Management

Poor land use increases runoff, sedimentation, and flood risks, harming irrigation and hydropower systems.

NHS Support in Planning

NHS provides data and technical input to reduce erosion and manage land impacts in watershed planning.

WEF Nexus Benefits

Effective watershed management secures water for farming, protects energy infrastructure, and sustains ecosystems.

PROJECT SUPPORTED INITIATIVE

GEF6 - CLIMATE RESILIENCE AND DROUGHT MONITORING

Drought Impact on Resources

Droughts reduce water availability for irrigation, domestic use, and hydropower, threatening food and energy security.

NHS Monitoring Activities

NHS monitors rainfall deficits, river flows, and seasonal trends to detect emerging drought conditions early.

Proactive Water Management

Using monitoring data, proactive water management adjusts irrigation, prioritizes usage, and plans energy production.

Integrated Climate Adaptation

Integrating climate data helps Belize adapt to climate impacts while sustaining the water-energy-food nexus.

Development of Planning Tools

Water Master Plan

Water Quality Control Plan

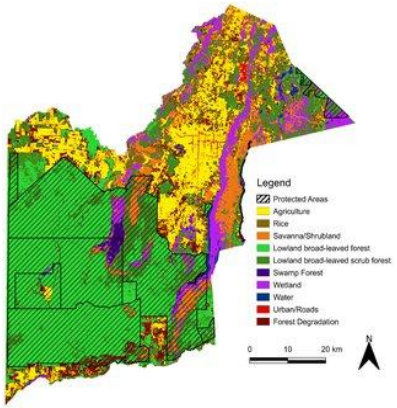
Mapping critical groundwater recharge areas

Determining Water Balance

Hydrological Drought Event in 2019 in the New River Watershed

New River watershed has the most intensified land use

- Geology mainly limestones
- Large lagoons completely dried up or partially dried up



Drought Damage to crops - 2019

Sapote Lagoon, 2019

BENEFITS OF THE WATER–ENERGY–FOOD NEXUS APPROACH

Improved Sector Coordination

The WEF Nexus approach reduces water use conflicts and enhances efficiency across water, energy, and food sectors.

Benefits to Agriculture

Farmers gain reliable water supplies and reduced climate risks, supporting food security and rural livelihoods.

Energy Sector Advantages

Hydropower planning improves and vulnerability to floods and droughts decreases, strengthening energy security.

Environmental and Social Gains

Ecosystem protection and watershed management support sustainability, community resilience, and reduced disaster losses.

KEY CHALLENGES FACING INTEGRATED WATER MANAGEMENT

Institutional Fragmentation

Water, agriculture, energy, and land-use sectors operate independently, limiting integrated management and trade-off optimization.

Data Gaps and Integration

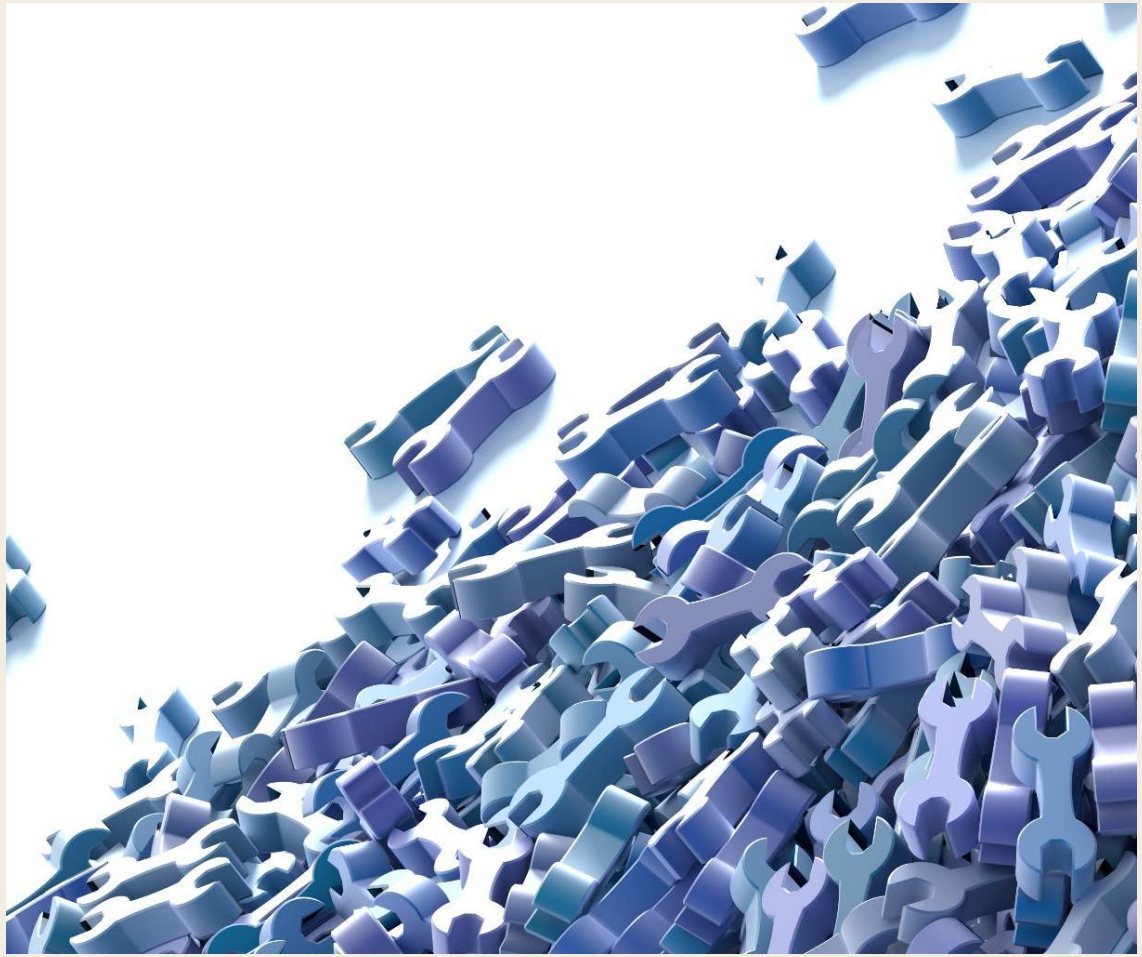
Lack of integrated hydrological, climate, and sectoral data weakens planning and decision-making processes.

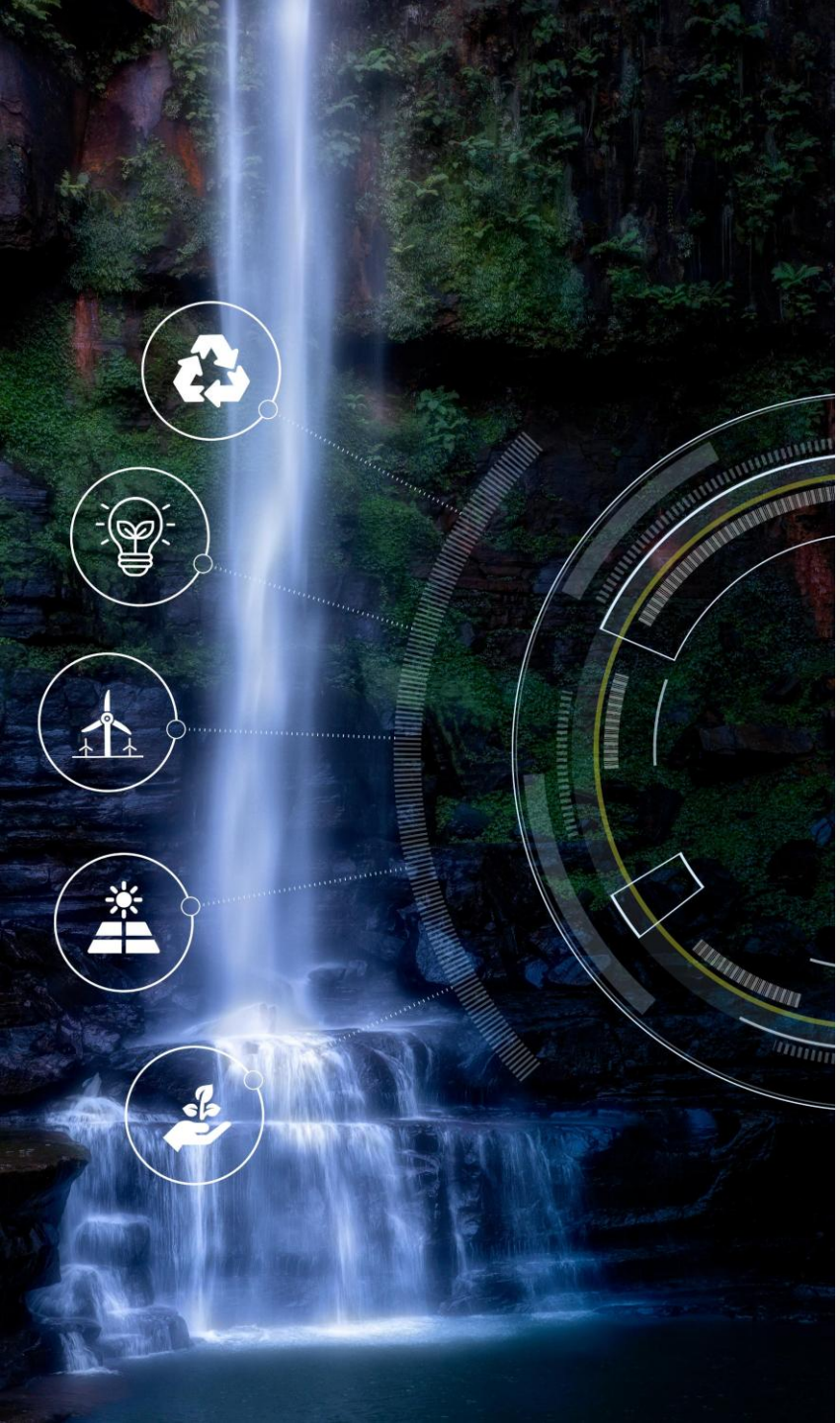
Climate Variability Risks

Climate variability increases uncertainty and risk, especially for drought-prone and flood-vulnerable regions.

Coordination Challenges

Project-based coordination limits long-term collaboration and shared accountability in resource management.





WEF NEXUS GAPS

Siloed Data Systems

Fragmented data hinders comprehensive analysis of water, energy, and food interactions, limiting effective decision making.

Weak Governance Coordination

Informal or weak governance arrangements reduce cross-sector collaboration needed for integrated nexus management.

Limited Integrated Planning

Lack of integrated planning tools at basin and national levels hampers strategic nexus investments and climate resilience.

Need for Formalized Nexus Approach

A formal nexus approach requires shared monitoring, joint planning, and clear mandates to improve investment outcomes.

MAINSTREAMING WEF APPROACHES ACROSS INSTITUTIONS

The NHS is strengthening hydrological monitoring networks and climate-informed water management tools to support decision-making.

- National Adaptation Plan for Integrated Water Resources Management
- National Integrated Water Resources Management Policy, Strategy and Action Plan

Belize continues expanding renewable energy generation, including hydro, biomass, and solar energy systems

- Partner with HydroBelize to operate a model for the Macal watershed used to inform their operations.

PRIORITY WEF ACTIONS

Integrated Water Information Systems

Develop systems that link hydrological, climate, agricultural, and energy data for informed decision-making.

Basin-Based Planning Approaches

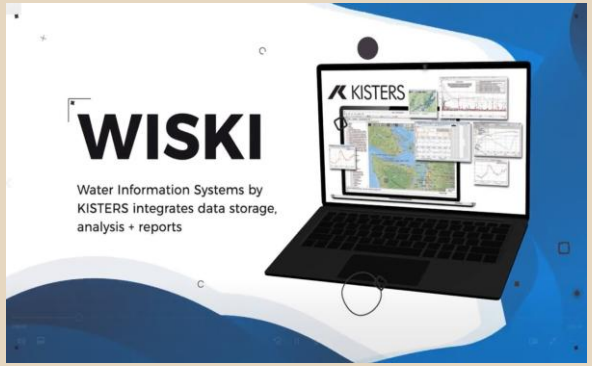
Adopt planning methods that consider multiple sector demands and ecosystem needs at the basin level.

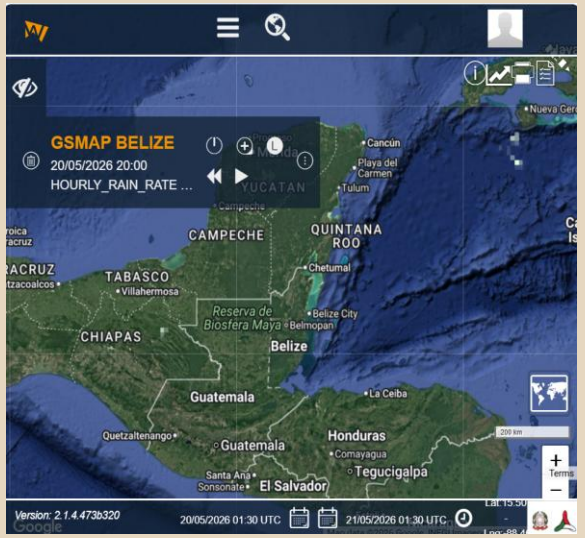
Mobilizing Climate Finance

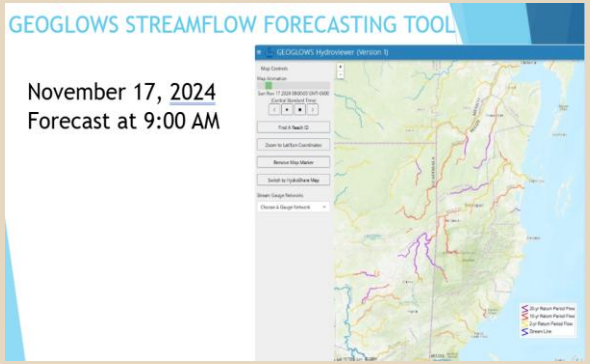
Secure funding to support cross-sector infrastructure and resilience investments addressing climate challenges.

Technical and Institutional Reforms

Implement tools, capacity building, and governance reforms to enable coordinated WEF Nexus actions.







WEF TECHNOLOGIES AND INTERVENTIONS

Modernization and Optimization (expansion) of hydrological monitoring stations and hydrological data management systems by the NHS.

Water Information Systems by Kisters International (WISKI)
GEOGLOWS Streamflow Forecasting Tool
DEWETRA Streamflow Forecasting Tool/Platform

WEF TECHNOLOGIES AND INTERVENTIONS

Drought monitoring and flood early warning initiatives supporting climate resilience and disaster preparedness.

- Generate Hydrological Outlooks quarterly for 1 watershed (scaling up to national)
- Partnered with Red Cross for Community Based Flood Early Warning Systems

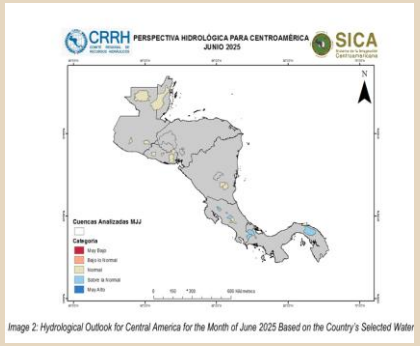


Image 2: Hydrological Outlook for Central America for the Month of June 2025 Based on the Country's Selected Water

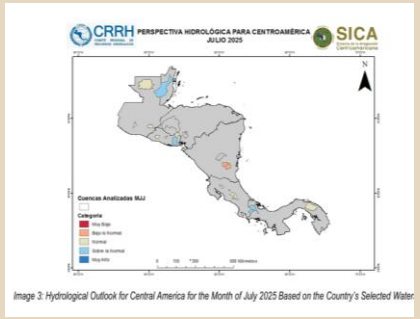
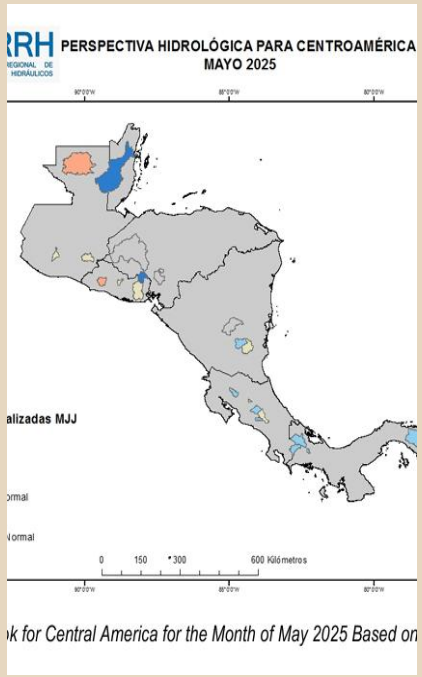


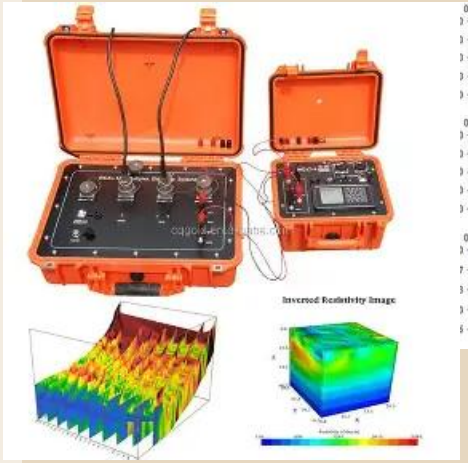
Image 3: Hydrological Outlook for Central America for the Month of July 2025 Based on the Country's Selected Water

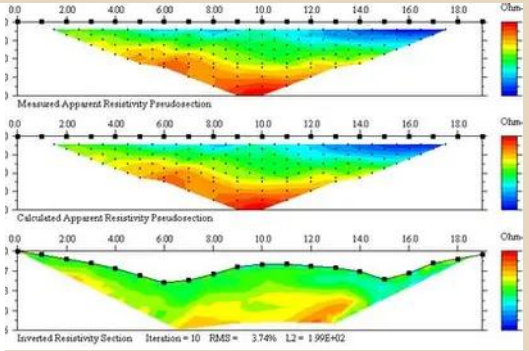


k for Central America for the Month of May 2025 Based on

Georesistivity Surveys

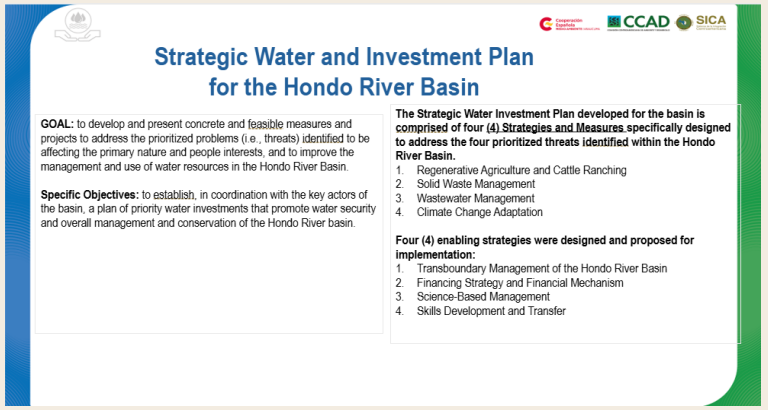
- Search for groundwater sources to reduce costs to users
- Increase information and knowledge on subterranean water resources
- Aid in better decision making for various sectors





WEF TECHNOLOGIES AND INTERVENTIONS

- **Financial Water Investments Plans developed for 1 watershed (Pilot)**



- **Watershed management and ecosystem-based adaptation initiatives to protect water supply and reduce erosion risks.**
  - Rapid Assessment of Sediment Transport on the Greater Monkey River Watershed
  - Partnering with CATIE to develop Watershed Management Plan for the Greater Monkey River Watershed (incl. updating flood hazard maps, erosion mapping, incorporation of Community inclusivity in hydrological monitoring)

SUPPORT NEEDED

Technical Assistance Needs

Support is needed for integrated planning and modeling tools to enhance WEF Nexus implementation.

Financing for Infrastructure

Funding is essential for climate-resilient, cross-sector infrastructure development and sustainability.

Capacity Building

Capacity building across ministries, utilities, and local institutions strengthens effective implementation and collaboration.

INVESTMENT PILLARS

Clear Investment Pillars

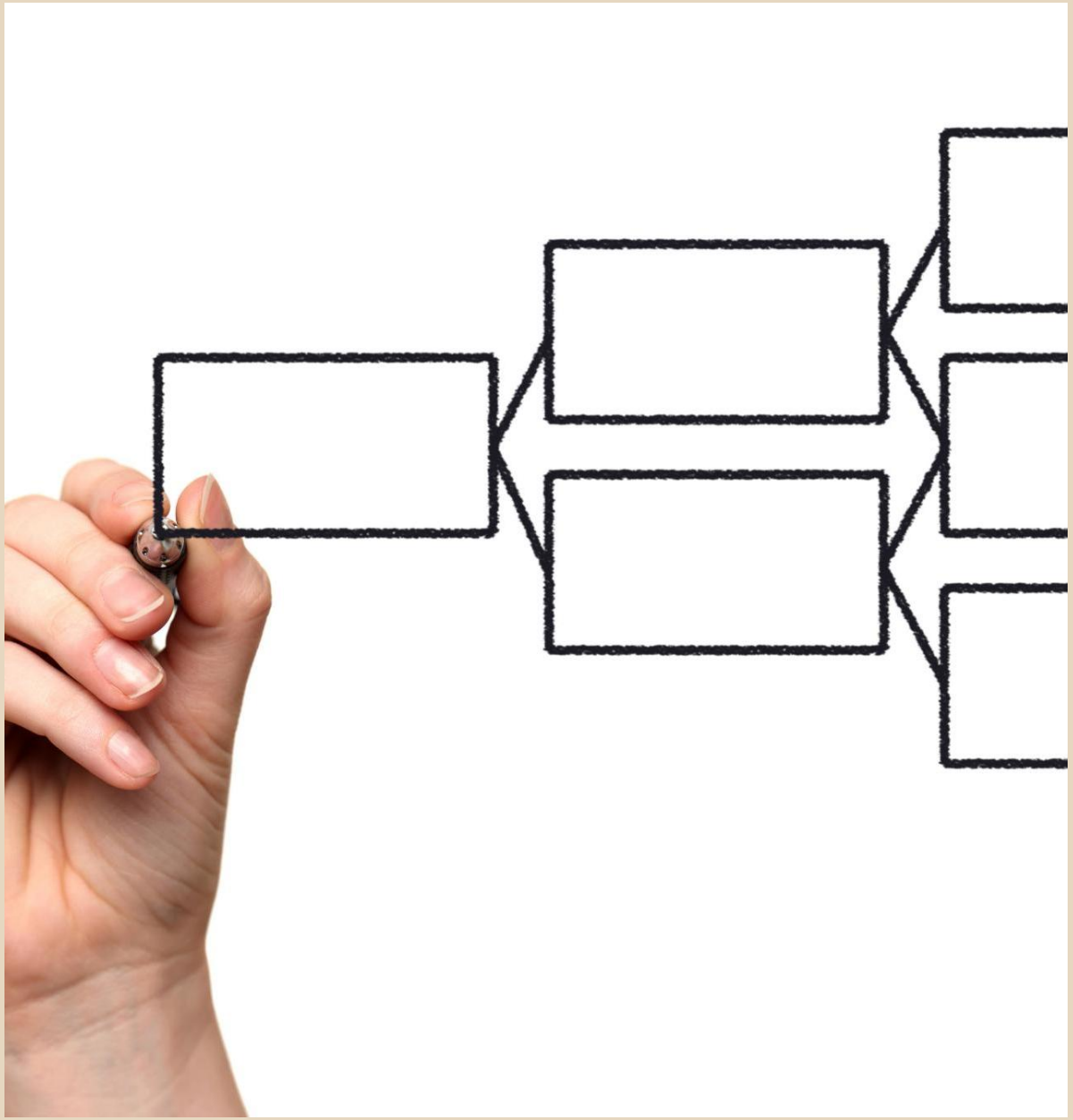
Grouping projects into pillars improves coherence and investor understanding for strategic alignment.

Multi-Sector Outcomes

Each pillar supports outcomes across water, food, energy, and ecosystem resilience simultaneously.

Strategic Coordination

Structured frameworks enable easier coordination, funding measurement, and communication of value.



PILLAR: TECHNICAL & INFRASTRUCTURE

Comprehensive Water Resources Inventory

- **Activity:** Nationwide hydrological assessment, groundwater mapping, abstraction inventory, water quality baseline
- **Budget Estimate:** USD 3–5M | 3 Years
- **Alignment With:** SDG 6.3.2, 6.4.1, 6.4.2, 6.5.1 | MTDS: Evidence-Based Governance | NDC 3.0: Climate Adaptation Planning
- **Beneficiaries:** National planners, utilities, agriculture sector, regulators
- **Project Outcomes:** National water baseline established; improved water accounting; informed allocation decisions
- **Project Impact:** Improved water security and climate-resilient national planning

PILLAR: TECHNICAL & INFRASTRUCTURE

Hydrological & Groundwater Monitoring Modernization

Activity: Telemetry stations; groundwater wells; sediment monitoring; national water information system

Budget Estimate: USD 4–6M | 5 Years

Alignment With: SDG 6.3.2, 6.4.2, 6.5.1 | MTDS: Digital Transformation | NDC 3.0: Hydro-Met Strengthening

Beneficiaries: National Hydrological Service, disaster agencies, farmers

Project Outcomes: Real-time data system; improved forecasting; strengthened decision-making

Project Impact: Data-driven climate adaptation and sustainable water management

Strategic Value: provides accurate, real-time data essential for improving water security, enhancing early warning systems, guiding climate-resilient planning, and supporting evidence-based management of national water resources.

PILLAR: TECHNICAL & INFRASTRUCTURE

Flood & Erosion Risk Reduction

- **Activity:** Hydrological & hydraulic modelling; flood hazard maps; erosion hotspot analysis
- **Budget Estimate:** USD 3–5M | 3 Years
- **Alignment With:** SDG 6.5.1, 6.6.1, 6.b.1 | MTDS: Disaster Risk Reduction | NDC 3.0: Climate Resilience
- **Beneficiaries:** Flood-prone communities, infrastructure sector, farmers
- **Project Outcomes:** Validated hazard maps; improved planning controls; reduced vulnerability
- **Project Impact:** Reduced disaster losses and climate risk exposure

PILLAR: TECHNICAL & INFRASTRUCTURE

Sediment Transport Assessment

Activity: Hydro-sediment data audit, sediment transport modelling, risk and hotspot mapping, monitoring system strengthening, stakeholder engagements, decision support, planning and knowledge products

Budget Estimate: USD $400,00 | 1-3 Years

Alignment With: SDG 6.5.1, 6.6.1, 6.b.1 | MTDS: Disaster Risk Reduction | NDC 3.0: Climate Resilience

Beneficiaries: Flood-prone communities, infrastructure sector, farmers

Project Outcomes: Reliable sediment rating curves and continuous SSC/turbidity datasets established. Identification of priority erosion hotspots and depositional zones. Sediment transport models developed and validated for target rivers/basins. Sediment management plan adopted by responsible institutions. Reduced disruption at water intakes due to improved sediment forecasting. Early warning triggers established for high-turbidity events. Staff trained in sediment sampling, QA/QC, and modelling

Project Impact: Improved water supply reliability; Extended reservoir lifespan, Reduced flood and erosion risk, Improved agricultural productivity; Sustainable sand mining practices; Healthier river and coastal ecosystems.

Strategic Value: Water security, Climate resilience, Infrastructure protection; Ecosystem integrity, Economic efficiency, Evidence-based regulation; Disaster risk reduction.

PILLAR: TECHNICAL & INFRASTRUCTURE

Water Vulnerability Profile

Activity: Baseline vulnerability assessment, Socioeconomic & Institutional Vulnerability Analysis, Risk Modelling and Climate Scenario Development, Vulnerability Mapping & Index Development, Stakeholder Engagement, Water Security & Resilience Action Plan, Capacity Building & Knowledge Transfer

Budget Estimate: USD $300,00 | 1-2 Years

Alignment With: SDG 6.5.1, 6.6.1, 6.b.1 | MTDS: Disaster Risk Reduction | NDC 3.0: Climate Resilience

Beneficiaries: Utilities, Local governments and disaster management agencies, Planning & finance ministries, Rural and urban households Farmers, agribusinesses, tourism operators, and industry Women, Indigenous communities, and other vulnerable populations, Environmental agencies, NGOs, Development partners Academic institutions Private sector investors

Project Outcomes: Clear understanding of water vulnerabilities across sectors, communities, and ecosystems. Spatially explicit maps identifying high-risk zones for supply, quality, and climate hazards. Water Vulnerability Index established and mainstreamed into planning. Strengthened water governance, with risk-informed decision making. Action plan with prioritized, costed interventions. Improved data collection, monitoring, and early warning capacity. Enhanced stakeholder awareness and participation in water risk management.

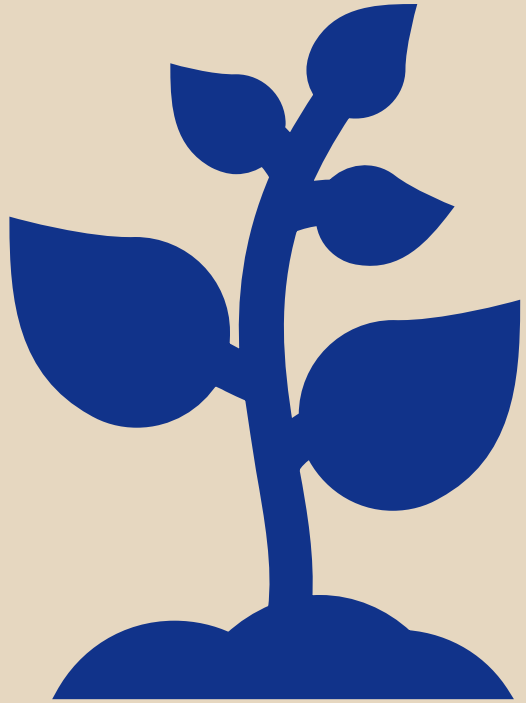
Project Impact: Increased water, Reduced vulnerability, Improved equity, Stronger governance, Climate-resilient infrastructure and service;. Health improvements; Economic resilience, with reduced losses from water stress.

Strategic Value: provides clear, actionable insight into where water risks are greatest, enabling targeted, climate-resilient decisions that protect people, ecosystems, and national water security.

PILLAR: POLICY

National Drought Management Framework

- **Activity:** Drought Management Policy, Strategy and Action Plan, Drought monitoring system; allocation contingency planning; early warning triggers
- **Budget Estimate:** USD 2–4M | 3–4 Years
- **Alignment With**: SDG 6.4.1, 6.4.2, 6.b.1 SDG 13| MTDS: Agricultural Resilience | NDC 3.0: Adaptation Targets,
- **Beneficiaries:** Farmers, water utilities, rural communities
- **Project Outcomes:** Operational drought framework; improved preparedness; water conservation mechanisms
- **Project Impact:** Enhanced national drought resilience and food security
- **Strategic Value:** delivers proactive, climate-resilient, and equitable water governance that protects people, the economy, and ecosystems from the escalating impacts of drought.
  - Shifts Belize's current drought response from:
  - Reactive drought response → Proactive drought risk management
  - Sectoral approaches → Integrated water resource management (IWRM)
  - Rainfall-focused systems → Full hydrological cycle management



KEY MESSAGES

Strong Policy Foundation

Belize has established solid policy and institutional foundations supporting WEF Nexus initiatives in the water sector.

Successful Pilots & Priorities

The country demonstrated successful pilots and identified clear priorities and gaps for scaling up efforts.

Call for Support & Investment

Sustained support, coordination, and investment are required to shift from pilots to national-scale impact.

Water's Central Role

Water is crucial for food security, energy reliability, and climate resilience, inviting broader collaboration.

Water is the entry point for the WEF Nexus in Belize

Integrated investment delivers resilience and growth

Questions?

Delivering Water Information for National Resilience

Thank You!

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