SEI Initiative on the Water-Energy-Food Security Nexus

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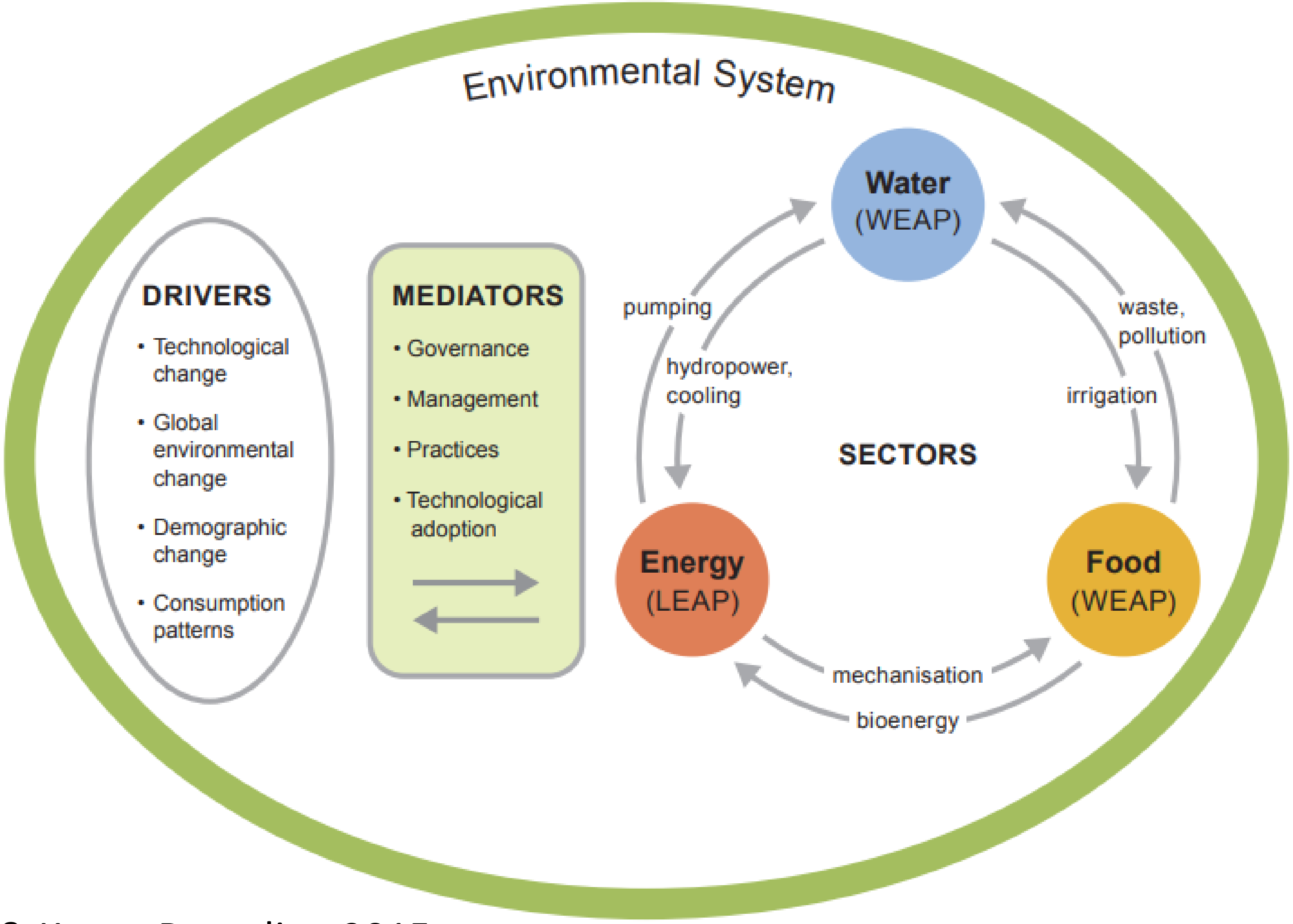
Stockholm Environment Institute

March 5, 2025

A Conceptual Framework for the Water-Energy-Food (WEF) Security Nexus



Huber-Lee & Kemp-Benedict, 2015

SEI's WEF Nexus Initiative is organized under three thematic areas that run through a set of case studies

CASE STUDY 1:	CASE STUDY 2:	CASE STUDY 3:	CASE STUDY 4:
Kenya (Theme 2)	**Kenya (Theme 2)**	**Kenya (Theme 1)**	**Kenya (Theme 3)**

THEME 1
Governing the nexus
Draws on SEI's extensive experience in environmental governance, including critically examining institutions and proposing alternatives that better contribute to policy coherence.

THEME 2
Understanding the nexus
Builds on two decades of SEI's work developing analytical and planning tools for water and energy that represents key features of energy, water, and food production

THEME 3
Managing and innovating the nexus
Work closely with stakeholders to identify which policies and institutional arrangements currently work well & technical innovations to better manage the processes at the interface of water, energy food, and ecosystems

Huber-Lee & Kemp-Benedict, 2015

Theme 2:
Understanding the Nexus in Kenya

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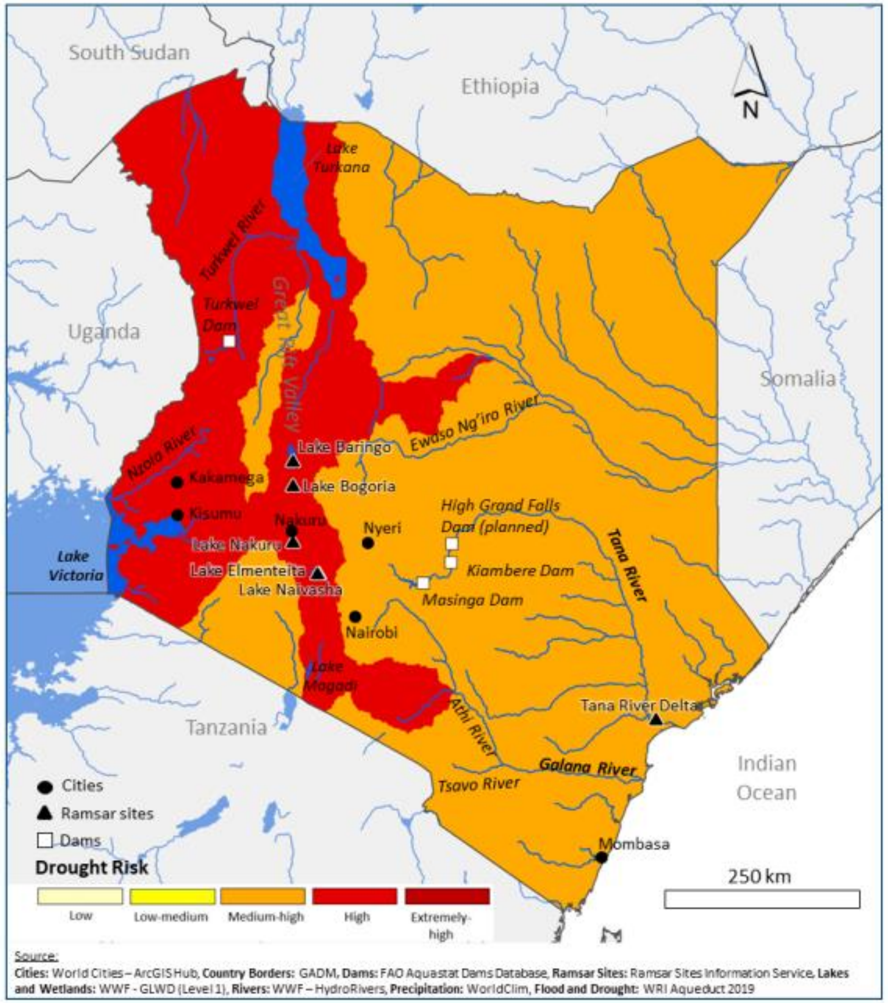
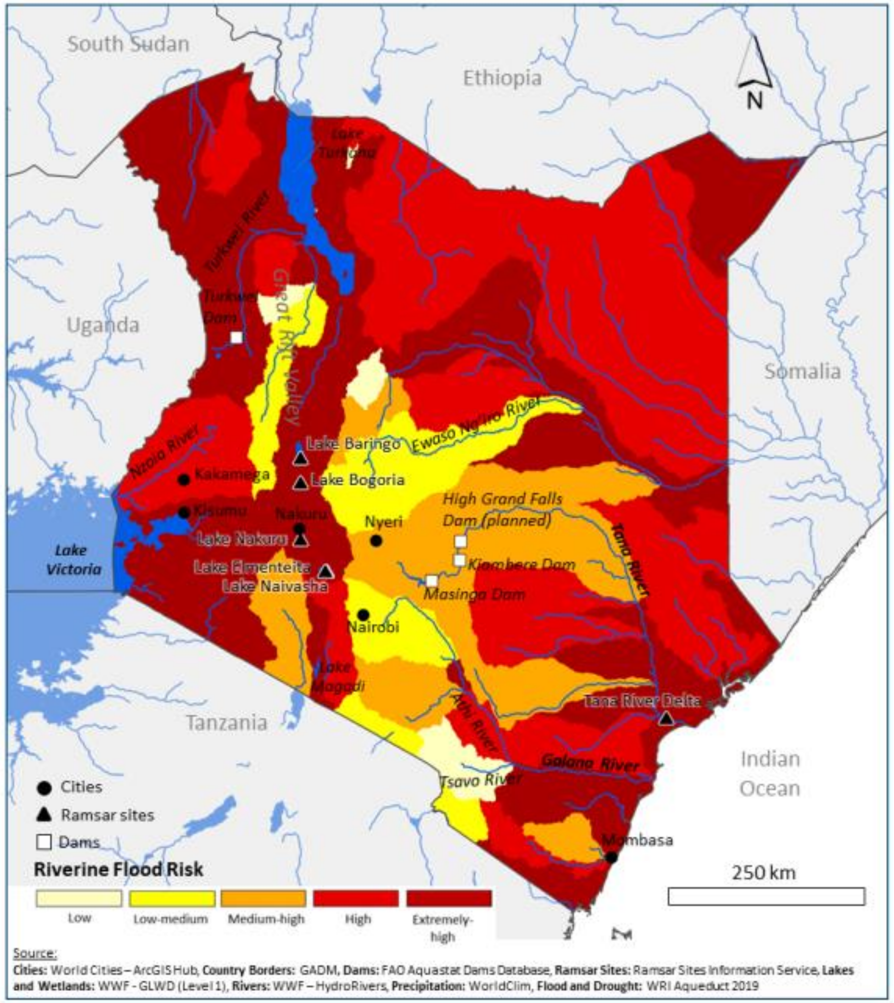
Context and Challenges: Climate Impacts on Kenya

- ❖ Kenya faces many complex and interconnected challenges including mediating climatic drivers such as:
  - ✓ Increased frequency of extreme droughts and severity of flooding, posing significant threats to livelihoods and food security



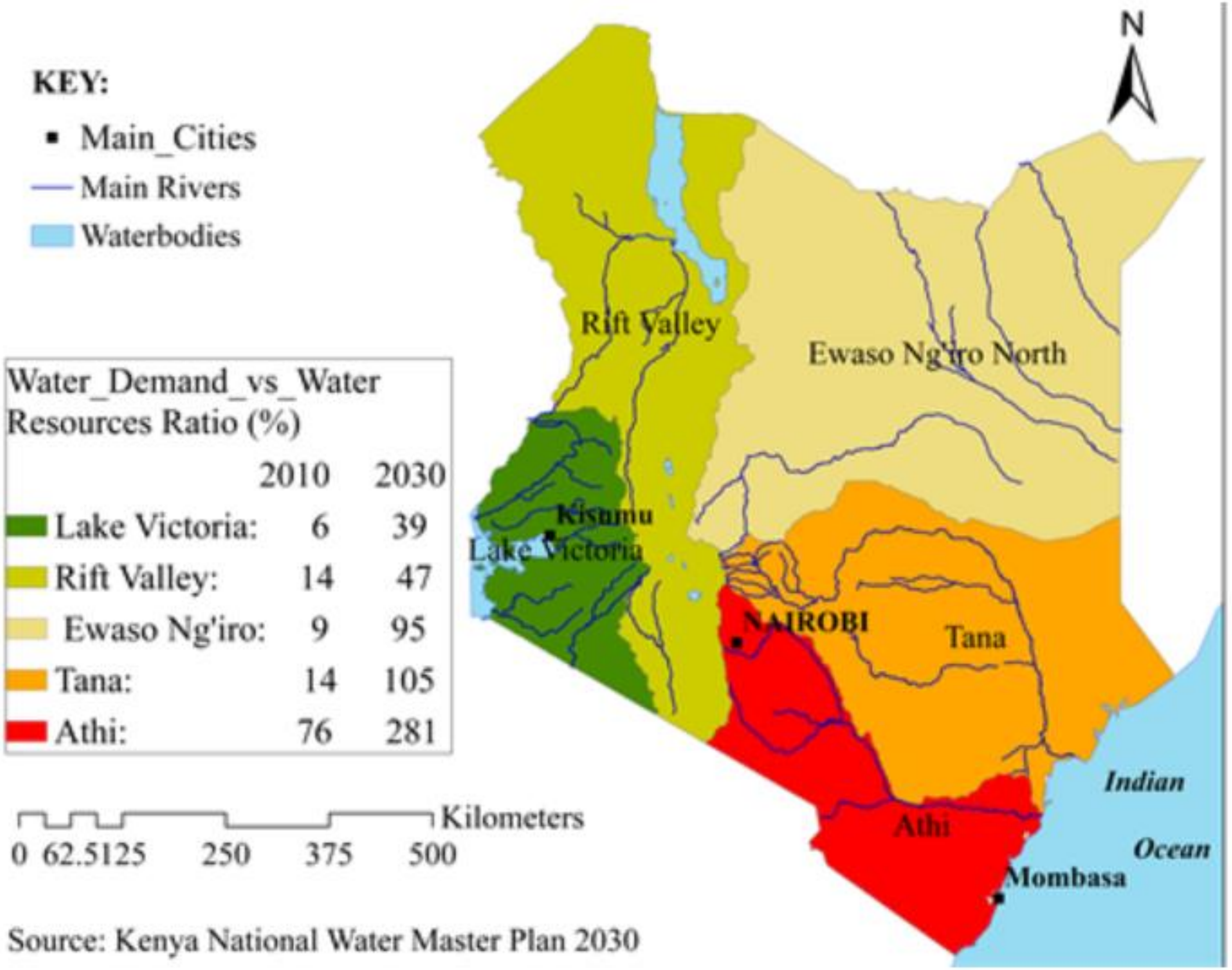


SWP, 2021

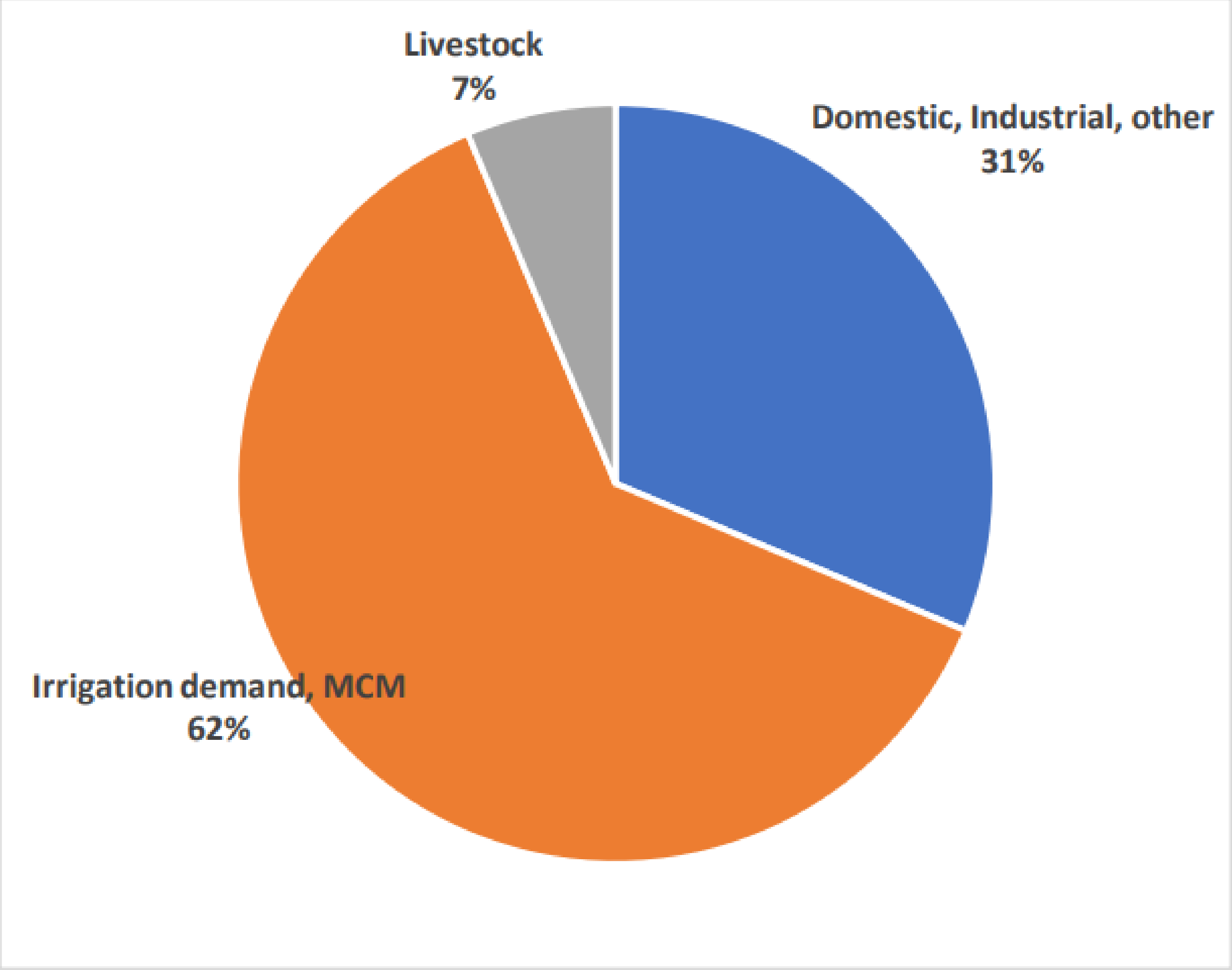
Context and Challenges: Water Demand and Use

- By 2030, Lake Victoria and Rift Valley are projected to have enough water to meet demand, with water supply exceeding demand by 61% and 53% respectively.

- In contrast, water demand in Athi and Tana is projected to exceed supply by 181% and 5% respectively with Ewaso Ng'iro's water demand almost equaling supply.



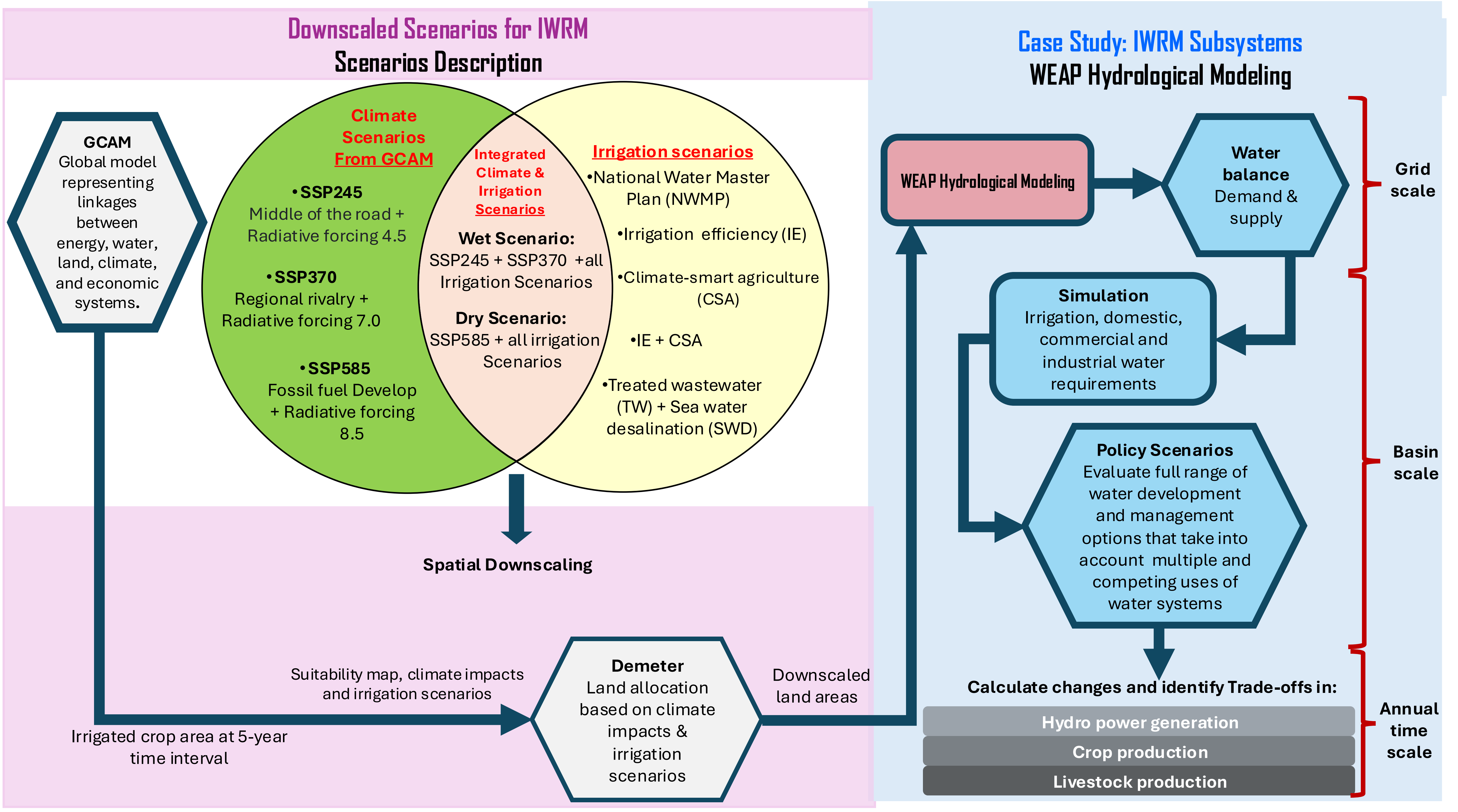
Scenario Analysis Vis-a-Vis Kenya's Water Use by Sector, 2018



World Bank, 2020

Potential Future Scenarios:

- National Water Master Plan (Expansion of irrigated land)
- Irrigation Efficiency plus reduced domestic/commercial and industrial demand losses
- Climate-smart Agriculture
- Irrigation Efficiency plus Climate-smart Agriculture
- Recycled wastewater and seawater desalination

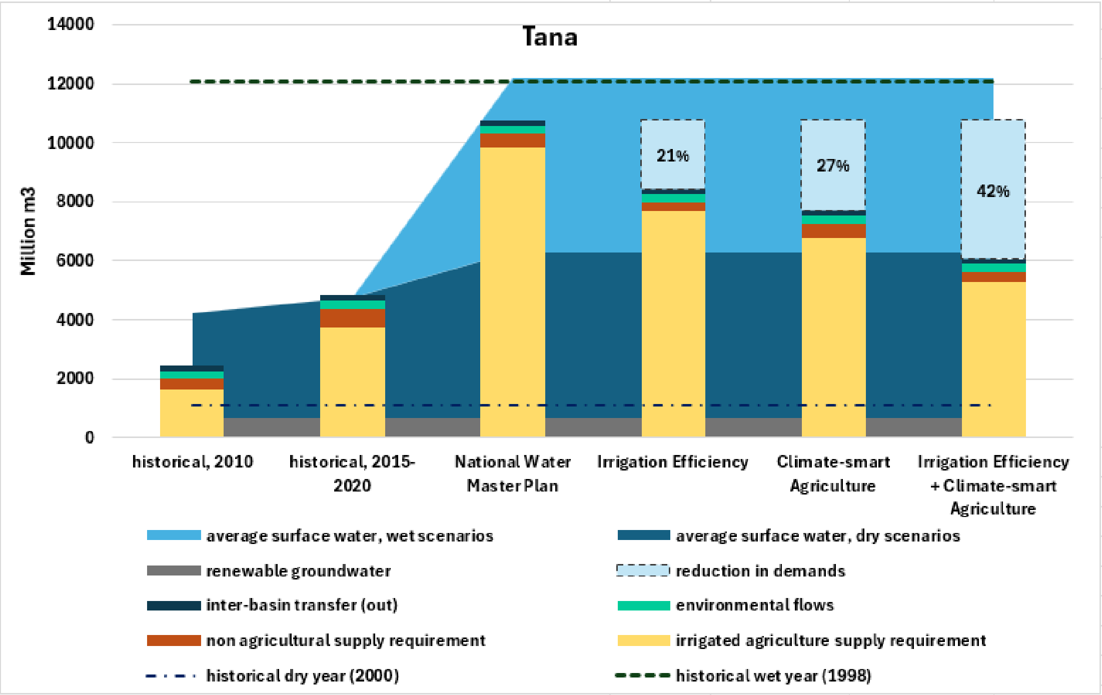


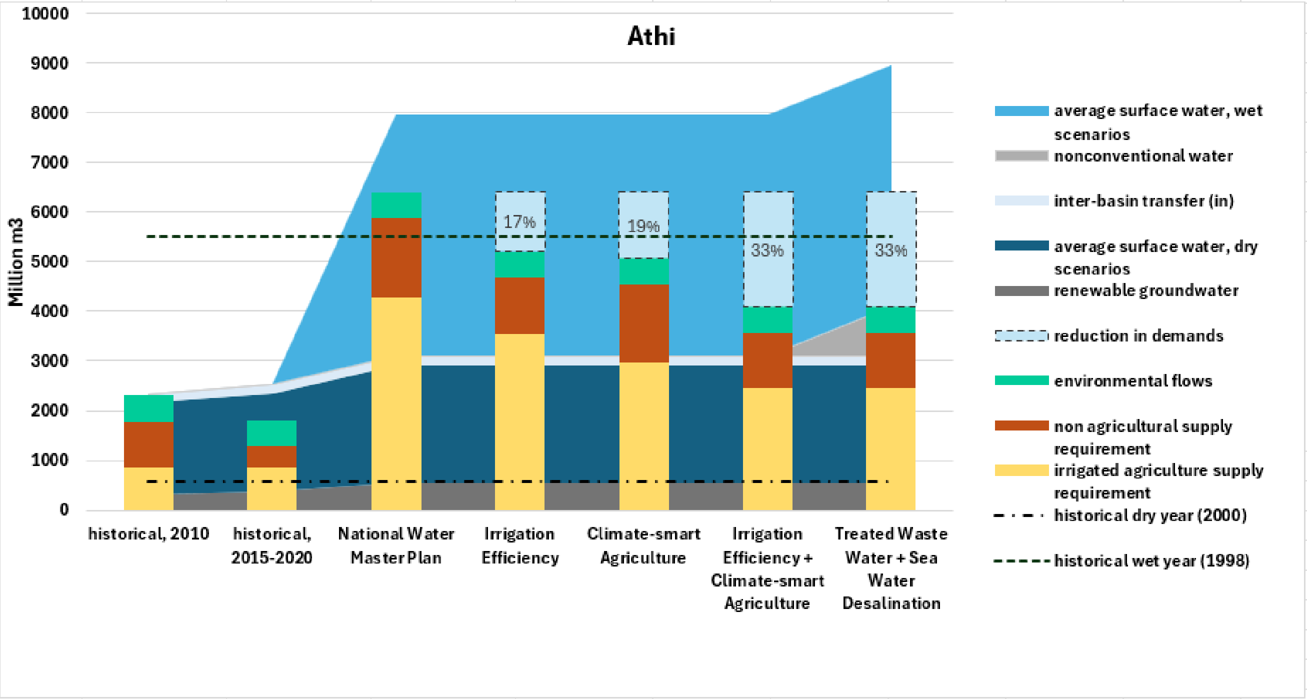
Downscaled Scenarios for IWRM
Scenarios Description
GCAM
Global model representing linkages between energy, water, land, climate, and economic systems.
Climate Scenarios From GCAM
•SSP245
Middle of the road + Radiative forcing 4.5
•SSP370
Regional rivalry + Radiative forcing 7.0
•SSP585
Fossil fuel Develop + Radiative forcing 8.5
Integrated Climate & Irrigation Scenarios
Wet Scenario:
SSP245 + SSP370 +all Irrigation Scenarios
Dry Scenario:
SSP585 + all irrigation Scenarios
Irrigation scenarios
•National Water Master Plan (NWMP)
•Irrigation efficiency (IE)
•Climate-smart agriculture (CSA)
•IE + CSA
•Treated wastewater (TW) + Sea water desalination (SWD)
Spatial Downscaling
Suitability map, climate impacts and irrigation scenarios
Irrigated crop area at 5-year time interval
Demeter
Land allocation based on climate impacts & irrigation scenarios
Downscaled land areas
Case Study: IWRM Subsystems
WEAP Hydrological Modeling
WEAP Hydrological Modeling
Water balance
Demand & supply
Simulation
Irrigation, domestic, commercial and industrial water requirements
Policy Scenarios
Evaluate full range of water development and management options that take into account multiple and competing uses of water systems
Calculate changes and identify Trade-offs in:
Hydro power generation
Crop production
Livestock production
Grid scale
Basin scale
Annual time scale

Main characteristics of the plausible future water demand-supply scenarios

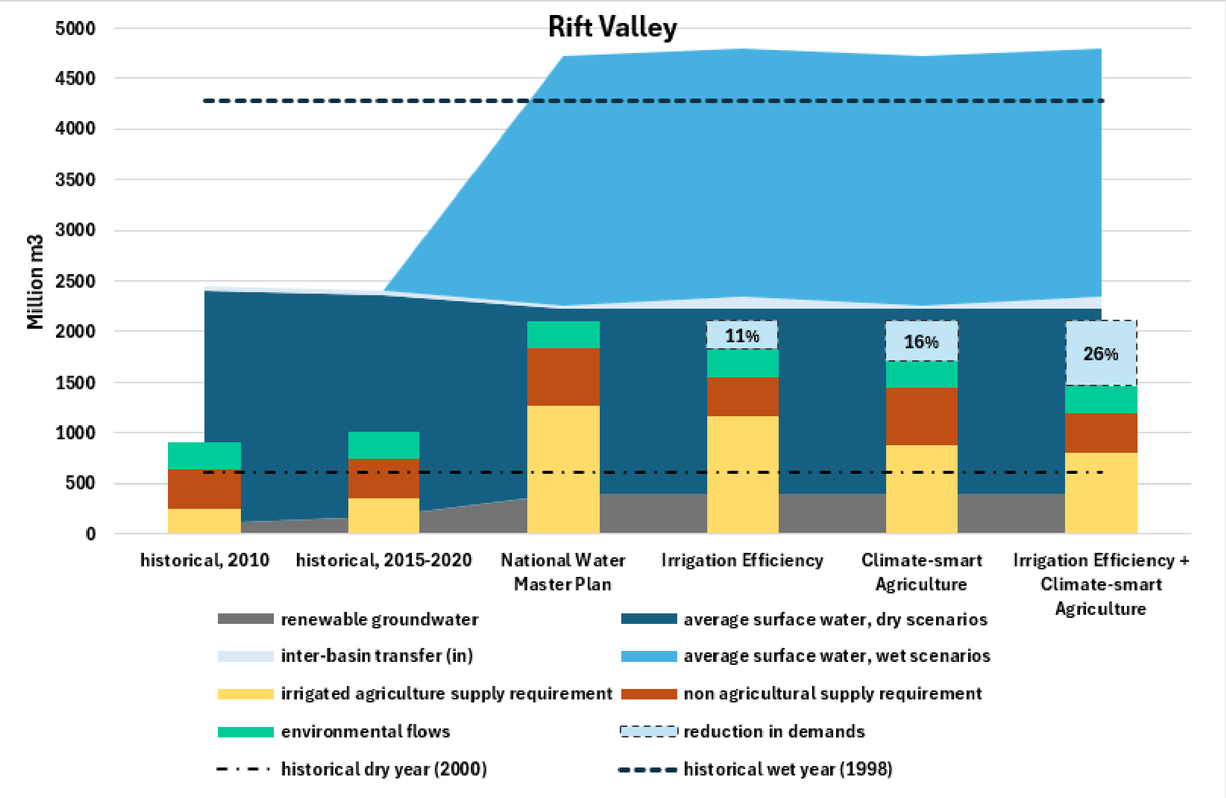
Water Security Indicator Drivers	Scenarios				
	National Water Master Plan	Irrigation Efficiency	Climate-smart Agriculture	Irrigation Efficiency Plus Climate-smart Agriculture	Treated Wastewater Plus Seawater Desalination
Crop yield Improvements	None	None	45%	45%	None
Irrigated area (Ha)	1,341,899	1,341,900	925,911	925,911	1,341,899
Irrigation efficiencies	65%	74%	65%	74%	65%
Domestic/commercial and industrial demand losses	43%	20%	43%	20%	43%
Inter-basin transfers (MCM)	LVS-> Rift: 41	LVS -> Rift: 123 LVN -> LVS: 189	LVS-> Rift:41	LVS -> Rift: 123 LVN -> LVS: 189	LVS-> Rift: 41
Storage capacity in large dams (MCM)	2604	8736	2604	8736	2604
Storage capacity in small dams and pans (MCM)	338	624	338	624	338

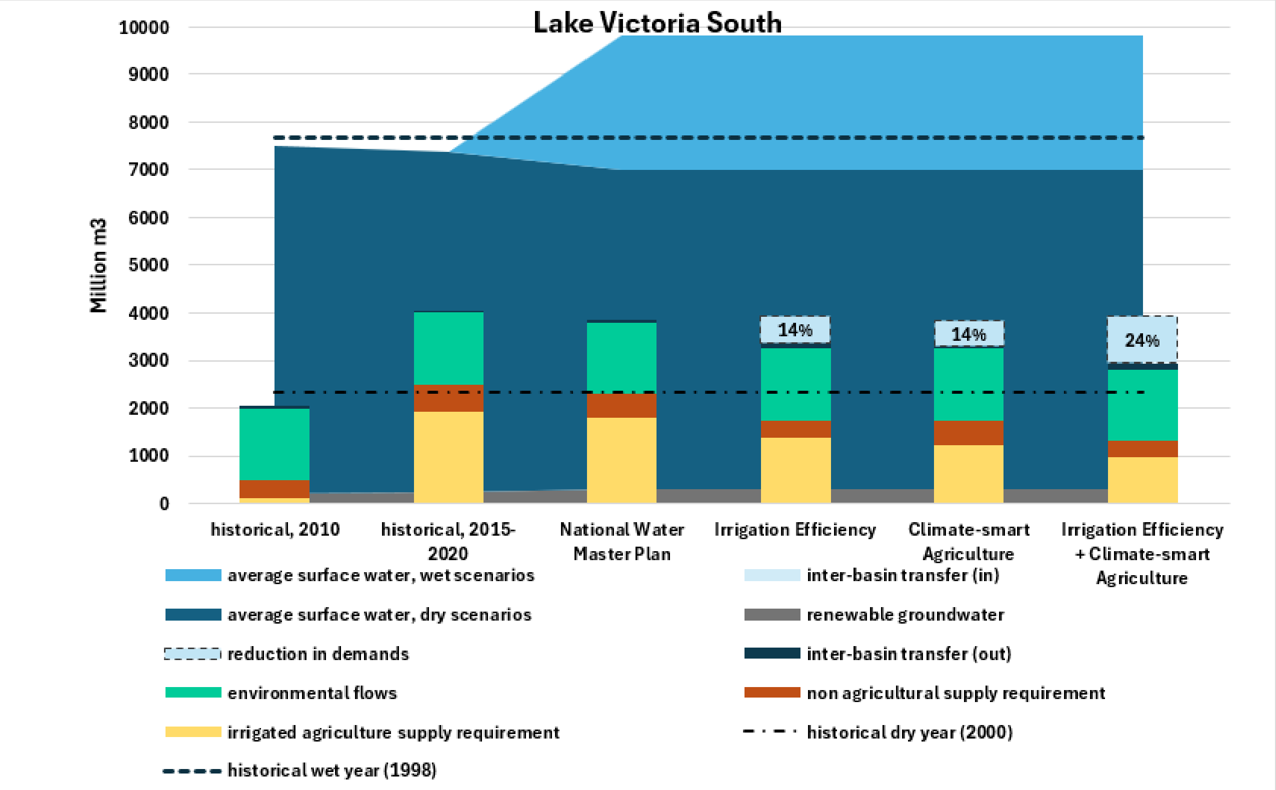
Water Supply and Demand Trends In Tana and Athi (2010 -2030)



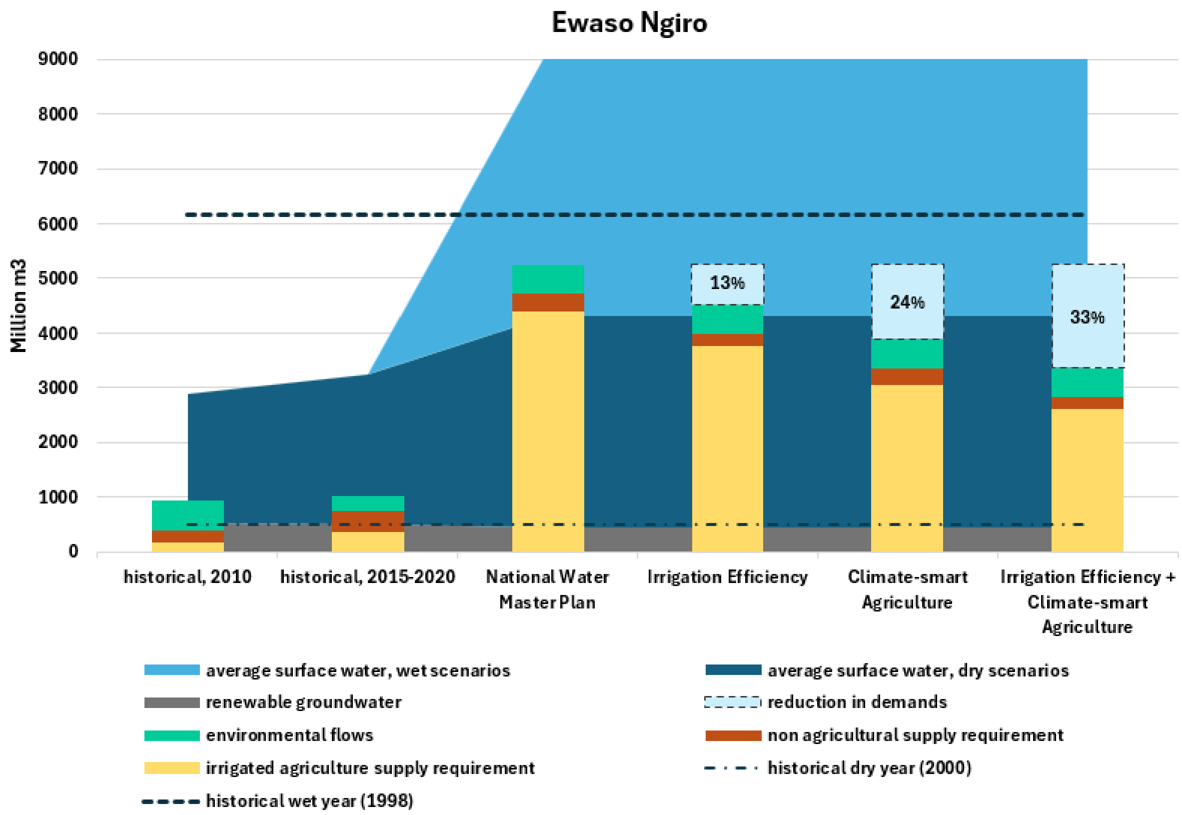


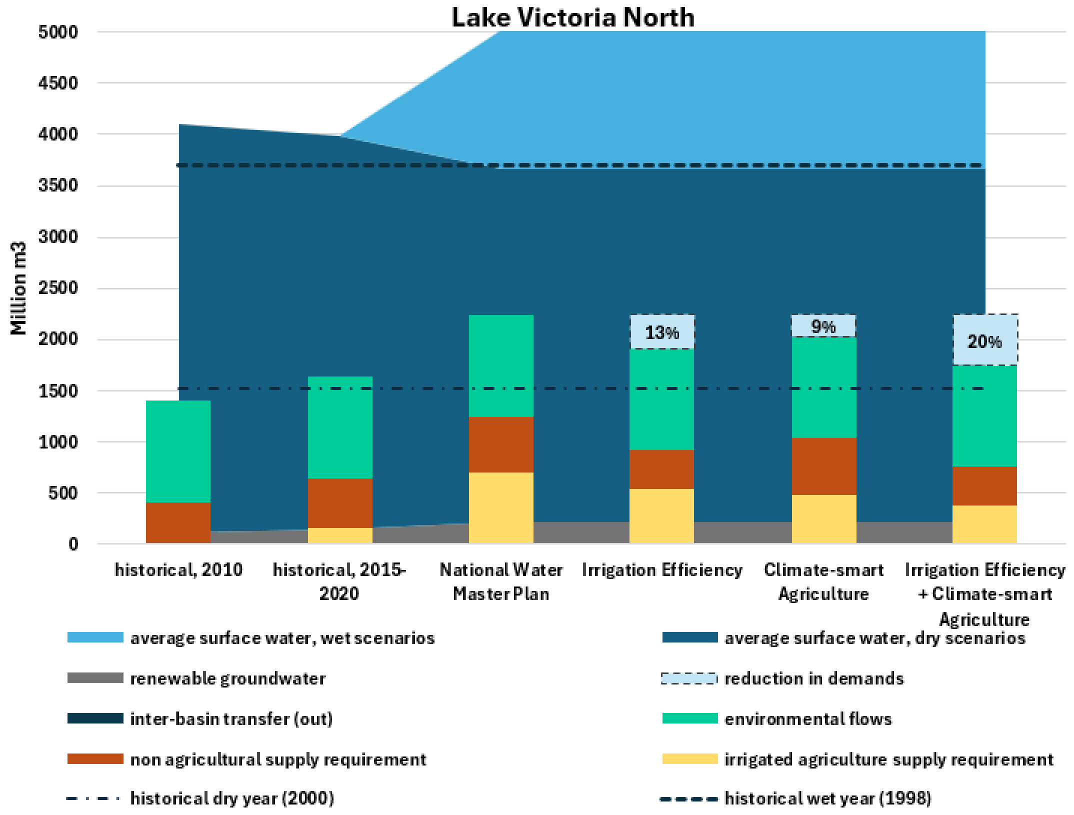
Water Supply and Demand Trends In Rift Valley and Lake Victoria South (2010 -2030)





Water Supply and Demand Trends In Ewaso Ngiro and Lake Victoria North (2010 -2030)





Synergies and Trade-offs of Integrated Water Resources Management in Kenya

Trade-offs and synergies between the water-energy-food security nexus (Adapted from Jonson et al., 2018)

Theme 1:
Governing the Nexus in Kenya

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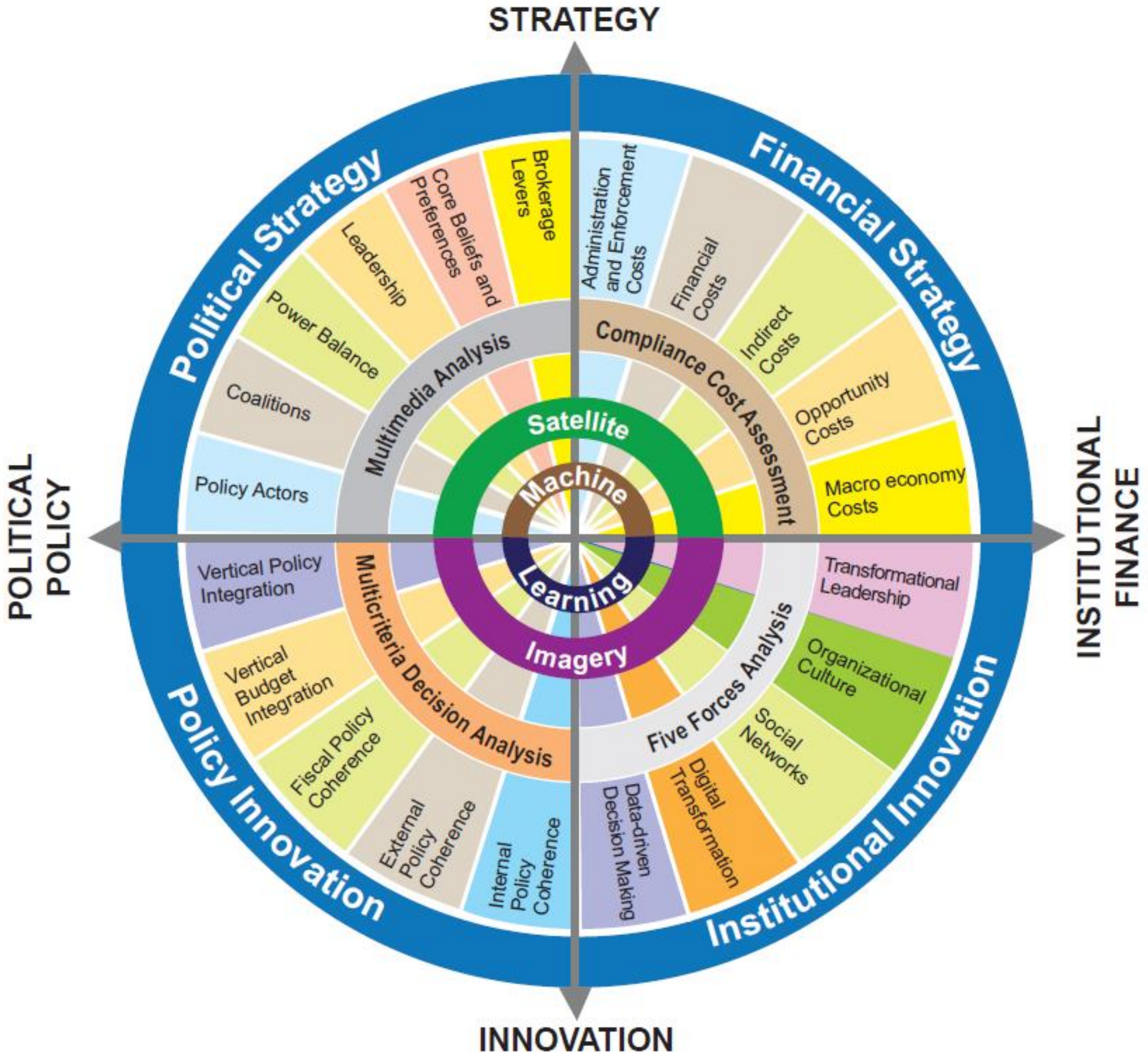
A Framework for Evaluating the Coherence of Natural Resources Policies



Research Outcome:

❖ A model that integrates mass media, economic valuation, satellite imagery, machine learning & agenda 2030 to optimize climate policy design & assessment

Research Output:

❖ Algorithmic machine-driven user Interface implemented through an online application

Research Impacts:

❖ Machine-driven algorithm allows for seamless integration of new scientific findings into existing and new policies

❖ Seamless integration allows existing policies to adapt to new realities and response to changing environment

5.0 Policy Coherence of the Forest-Water-Energy-Food Security Nexus in Kenya

Sustainability Indices

Policy Performance Scores	
8.1-10	Very High Performance
6.1-8.0	High Performance
4.1-6.0	Partial Performance
2.1-4.0	Low Performance
0.0-2.0	Very Low Performance

Standard Deviation Scores	
0.0-1.0	Very High Policy Coherence
1.1-2.0	High Policy Coherence
2.1-3.0	Partial Policy Coherence
3.1-4.0	Low Policy Coherence
4.1-5.0	Very Low Policy Coherence

Sustainability Indices	ASTGS	NFP	NWMP	NEP	NCCAP	MEAN (Performance across policies VERY POOR)	STDEV. (Coherence across policies)
(1) Policy Support Schemes	*3.9*	*3.3*	*3.9*	*4.5*	*3.8*	*3.9*	0.4
(2) Democratic Governance	*4.1*	*4.6*	*3.2*	*3.8*	*3.7*	3.9	0.5
(3) Social Safeguards (Very Poor)	*1.9*	*0.8*	*0.6*	*0.5*	*1.0*	0.9	0.5
(4) Environmental Protection	*1.8*	*2.6*	*2.4*	*1.2*	*4.6*	*2.5*	1.1
(5) Ecological and Genetic Intensification	*3.8*	*4.1*	*3.5*	*0*	*1.6*	2.6	1.6
(6) Socio-economic Intensification	3.1	3.8	3.2	3.3	2.3	3.1	0.5
(7) Economic Valuation	0.9	1.3	10	0.1	0.5	2.6	3.7
(8) Monitoring and Evaluation	2.6	2.6	2.6	0.5	2.6	2.2	0.9
Mean (Average Policy Performance across Indices) (Very Poor)	***2.8***	***2.9***	***3.7***	***1.7***	***2.5***	***2.7***	**0.6**
Standard Deviation (Policy Coherence across Indices)	**1.1**	**1.3**	**2.8**	**1.8**	**1.4**	**1.7**	**0.6**

Theme 3:
Managing and Innovating the Nexus in Kenya.

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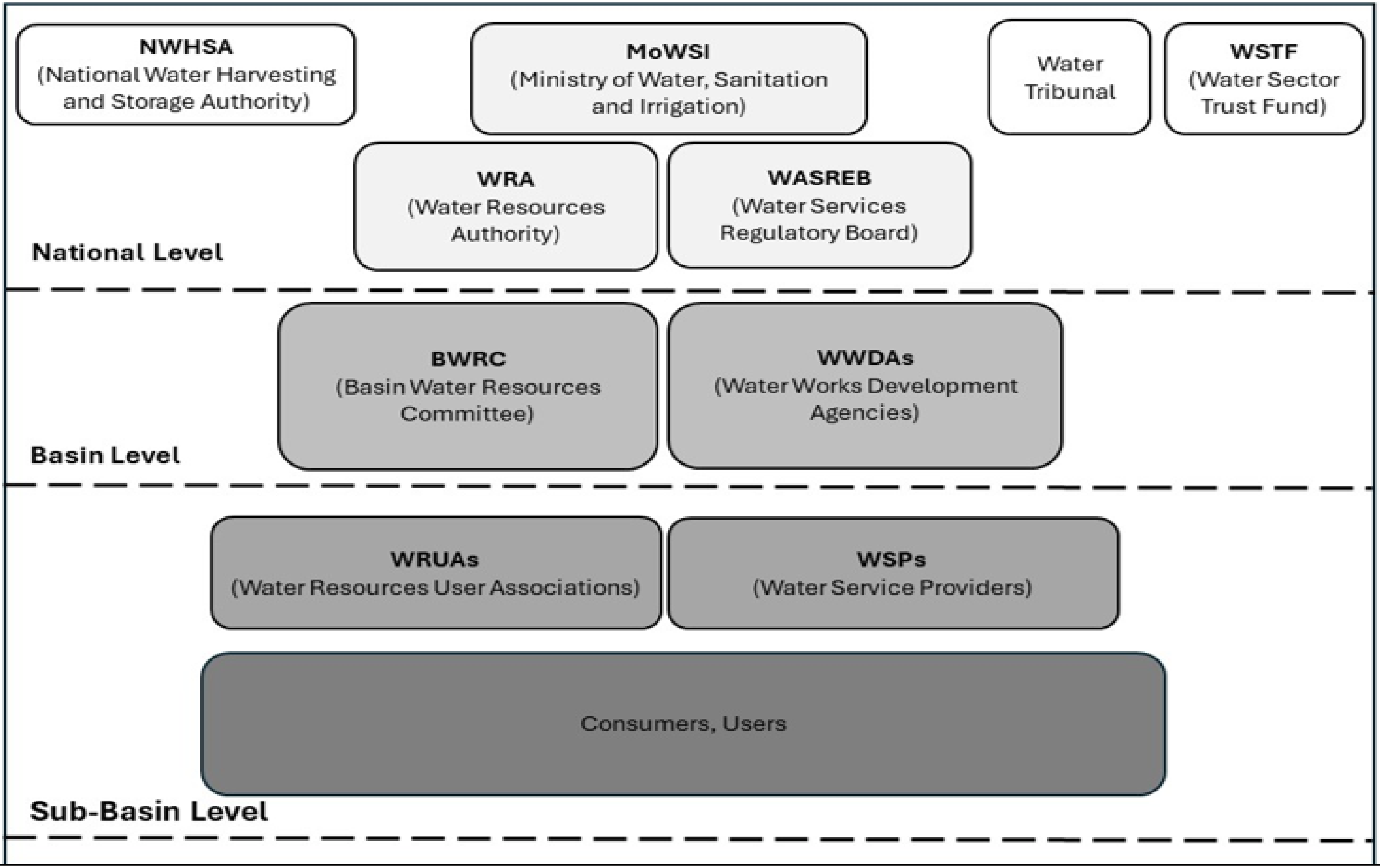
State of Integrated Water Resources Management Implementation in Kenya

National Challenge: A disconnect between national policy development and local needs, cumbersome nature of navigating national government bureaucracy, scarcity of skilled government personnel, and lack of coordination among diverse agencies present formidable obstacles to IWRM in Kenya

Sub-Basin Challenge: Despite the formation of over 750 WRUAs covering over 1200 sub-catchment areas, only 550 Sub-Catchment Management Plans (SCMPs) have been developed due to lack of funding



Basin-level Challenge: Lack of operationalization of BWRCs hinders stakeholder participation, data collection and analysis, and conflict resolution – all critical aspects of effective basin-level management.

Finding ways to incorporate bottom-up approaches, streamline bureaucratic processes, and ensure that national policies consider local contexts is crucial for achieving truly integrated and effective water resource management across the country.

Stakeholders' Perspectives on the State of Integrated Water Resources Management in Kenya (SDG Indicator 6.5.1)

(b) Overall National Score (53.7%)

Degree of Implementation: (0-100)

Very low (0)

Low (20)

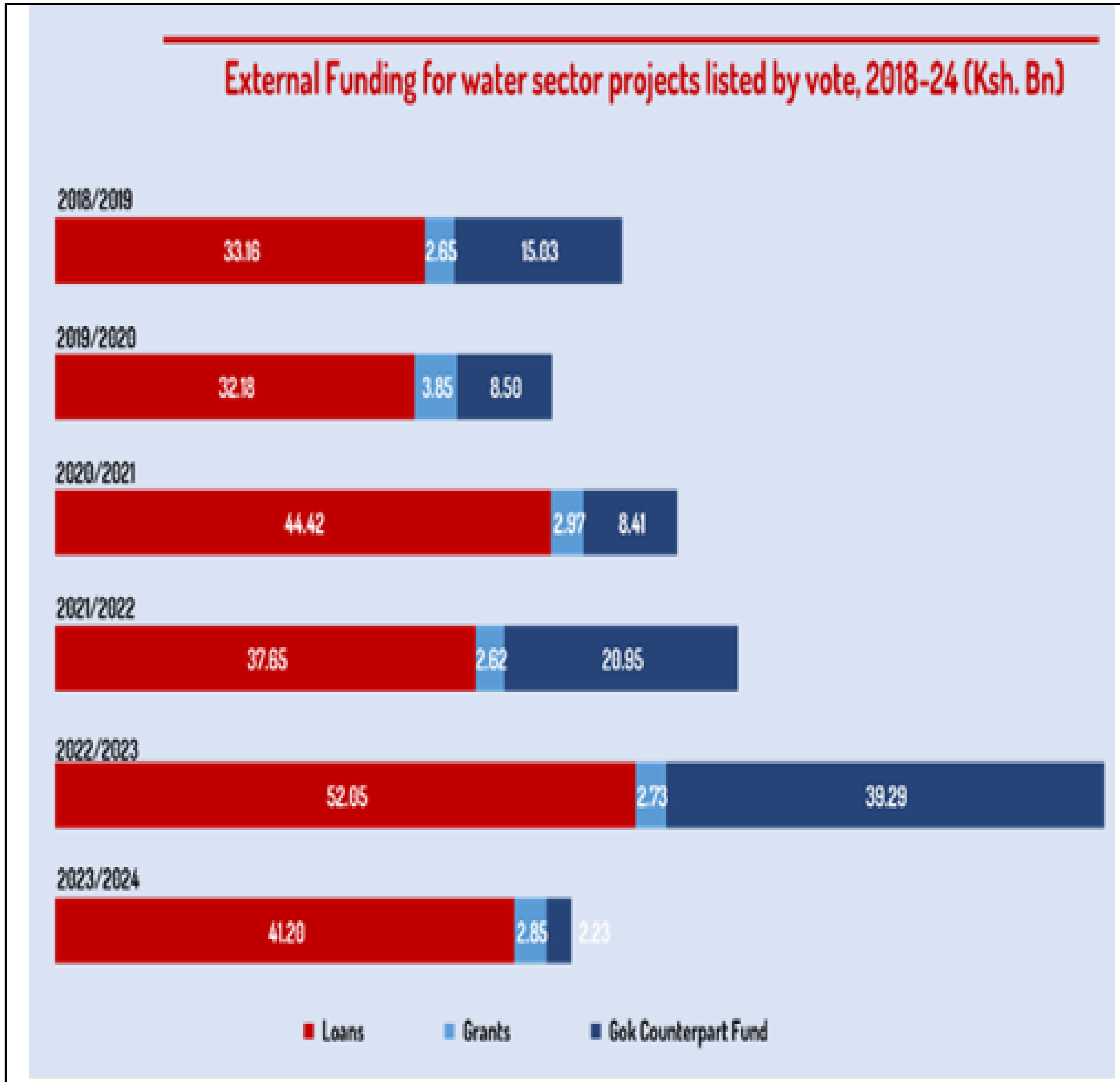
Medium-Low (40)

Medium-high (60)

High (80)

Very High (100)

The Funding Landscape of Integrated Water Resource Management in Kenya



(a)

- ❖ Total development budget between 2018-24 = 352.74 Khs. (National Treasury, 2018-2024).
- ❖ Development Partners contribution = Ksh. 258.32 billion (73.2%)
  - ❑ Loans = Ksh. 240.66 billion (93.2%)
  - ❑ Grants = Ksh.17.66 billion (6.8%)
- ❖ Grants by GoK = Ksh. 94.41 billion (26.8%)

Study Findings: Sustainability Initiatives of Bulk Water Users

Thematic areas	Del Monte Kenya Ltd	EABL	Bohemians Flowers	Bidco Africa
Water sourcing and usage	70% surface water, 10% groundwater, 20% recycled water	Recycled wastewater, representing 13% of the total water abstraction	Water sourced primarily from Lake Naivasha	Surface water, groundwater, and rainwater harvesting
Water use efficiency	Improved water efficiency by 30% since 2020	Water performance of 2.86L/per litre of product produced versus a target of 2.7 L/per litre of product produced Invested in state-of-the-art water recovery plants which have yielded significant water recovery results equivalent to 31%.	Drip irrigation minimizes leakages, employs mulching and cover crops, and schedules irrigation to reduce evaporation.	Advanced metering and data logging technologies, along with leak detection systems and high-efficiency fixtures, to optimize water efficiency.
Wastewater management	Treats wastewater for irrigation & industrial processes through settling tanks, biological treatment, filtration & disinfection	Improved Water Recovery Plant (WRP) rates from 45% to 49%	Treats wastewater with septic tanks, constructed wetlands, recycling it through fertilizer tanks and reservoirs with rubber linings	Multi-stage wastewater treatment processes to meet regulatory standards before reuse or discharge
Regulatory compliance	Conducts daily, weekly, and monthly water quality testing to comply with standards.	Inspects effluent turbidity and residual chlorine concentration	Inspects effluent and tests water quality weekly and quarterly.	Regular water quality testing and engaging in regular reporting
Community Engagement/Social Responsibility	Engages in outreach programs to raise awareness about water conservation and collaborates with environmental groups	Replenished up to 43,210m3 of water by sinking boreholes to provide water-stressed communities, from which the company sources local raw materials, with access to clean water	Works with the Rotaract Club of Naivasha to promote water conservation	Collaborates with local communities and environmental organizations to support water conservation efforts

Strategic Interventions for integrated water resource management in Kenya

Strategic Intervention 1: Sustainable Market-based Irrigation Systems and Financing Models	
Challenge	**Opportunity**
Inefficient irrigation systems leading to high water losses	Efficient irrigation systems coupled with reduced industrial, commercial, and domestic demand losses present a huge opportunity to reduce overall basin water demands in Ewaso Ng'iro, Athi, and Tana by 13%, 17%, and 21% by 2030, respectively. Thus, co-developing and demonstrating sustainable market-based irrigation systems and financing models to boost the adoption and use of efficient irrigation and water harvesting-storage technologies is critical to conserving water resources while increasing productivity and income for small and medium-sized farmers.

Strategic Interventions for integrated water resource management in Kenya

Strategic Intervention 2: Climate-smart Agriculture	
Challenge	**Opportunity**
Under dry climate change scenarios, Athi, Tana, and Ewaso Ng'iro basins will not be able to meet demands if the significant expansion of irrigated agriculture outlined in the Water Master Plan of 2013 is achieved at current irrigation efficiency and non-water levels	Designing and demonstrating climate-smart cropping systems, comprising high-yielding drought-resistant cultivars, conservation tillage, and nutrient management has great potential to increase crop yield by 45%, leading to a decrease in irrigated cropland, and consequently a reduction in irrigation water demand in Athi, Ewaso Ng'iro and Tana by 19%, 24% and 27% by 2030, respectively

Strategic Interventions for integrated water resource management in Kenya

Strategic Intervention 3: Water Circularity	
Challenge	**Opportunity**
By 2030, Athi's water demand is expected to surpass its supply, even with efficient irrigation systems, reduced industrial, commercial, and household demand losses, and climate-smart farming practices.	Study results revealed that non-conventional irrigation water supply, including treated wastewater and seawater desalination both have the potential to supplement any surplus irrigation water demand in Athi by 2030. Thus, conducting feasibility studies to evaluate the costs and benefits of wastewater reuse and seawater desalination options for irrigation water supply is critical to meet potential surplus irrigation water demand in Athi by 2030.

Thank you for your Attention