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LAND MANAGEMENT
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AKHMET YASSAWI
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MICRO-CREDENTIAL

CLIMATE CHANGE FOR SUSTAINABLE LAND MANAGEMENT IN CENTRAL ASIA

4.- Water, Cryosphere and Climate in Central Asia

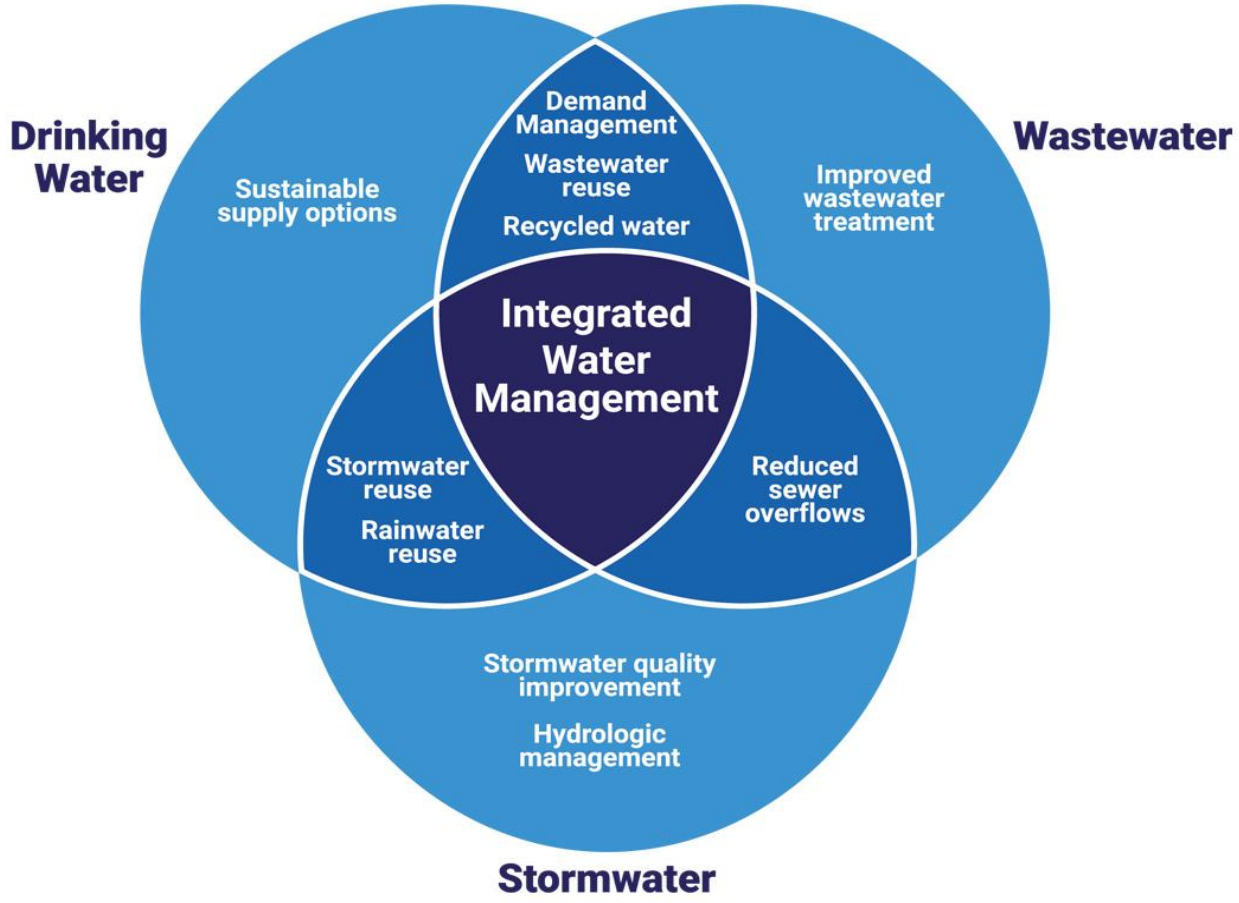
Integrated Water Resources Management and SLM

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Introduction

Regional Context and Challenges

Central Asia, comprising countries such as Kazakhstan, Uzbekistan, Kyrgyzstan, and Tajikistan, is characterized by arid and semi-arid climates, limited water availability, and a strong dependence on irrigated agriculture. The region's natural resource systems are deeply interconnected, with water and land forming a tightly coupled system that supports both ecosystems and human livelihoods. Historical patterns of resource use, particularly those established during the Soviet era, have left a legacy of large-scale irrigation, monoculture agriculture, and environmental degradation. Today, these challenges are compounded by climate change, population growth, and increasing demand for water and land resources.

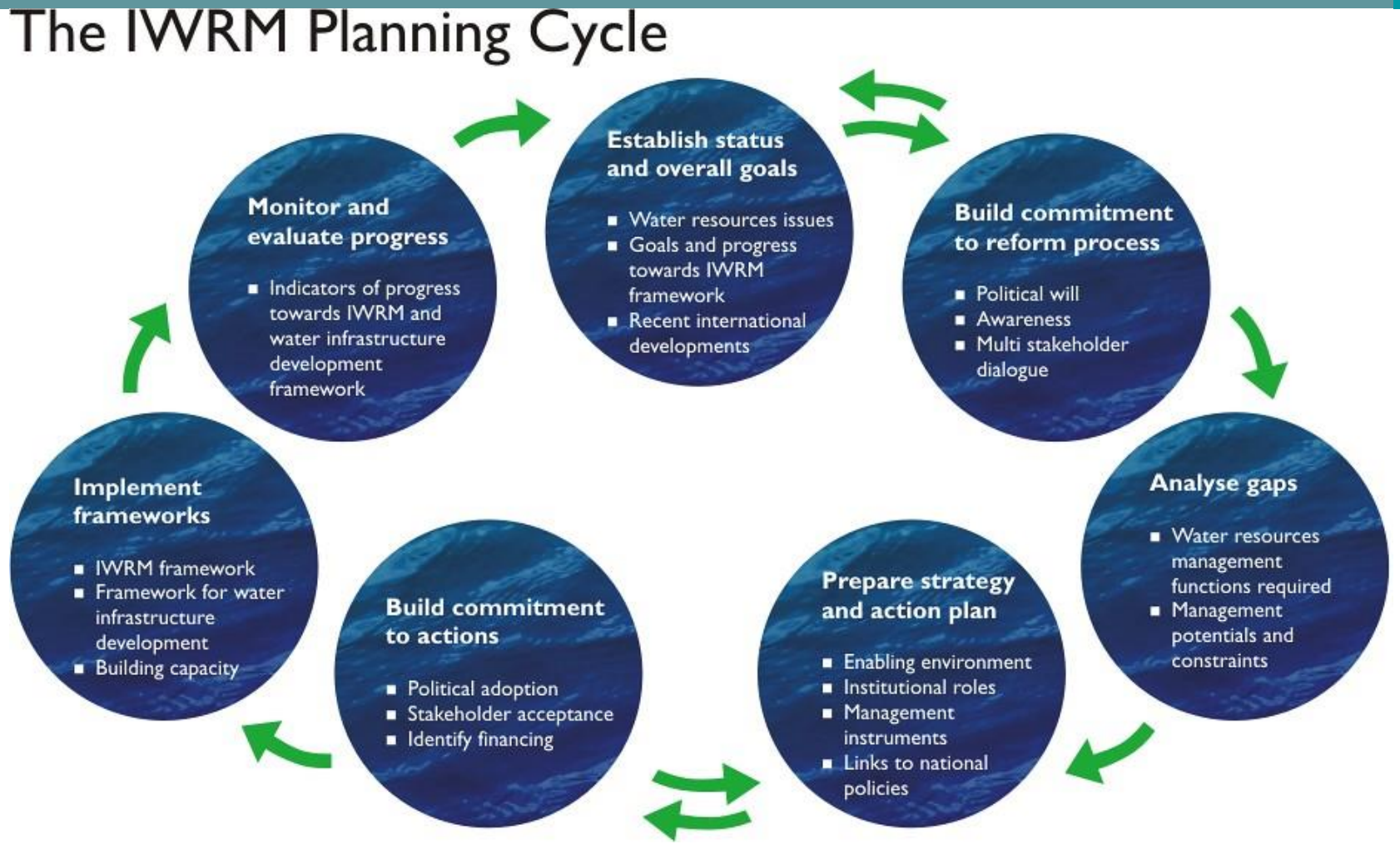


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Concept of Integrated Water Resources Management (IWRM)

Integrated Water Resources Management (IWRM) represents a holistic approach to managing water resources in a way that balances economic, social, and environmental objectives. Rather than addressing water issues in isolation, IWRM emphasizes the integration of surface water, groundwater, land use, and ecosystem dynamics within a unified framework. In Central Asia, this approach is particularly relevant due to the transboundary nature of major river systems such as the Amu Darya and Syr Darya, which connect upstream mountainous regions with downstream agricultural zones.

IWRM promotes basin-level management, where decisions are made based on hydrological boundaries rather than political borders. This helps align water allocation with natural processes and encourages cooperation between countries that share water resources. The approach also highlights the importance of equitable access, efficient use, and the protection of aquatic ecosystems.



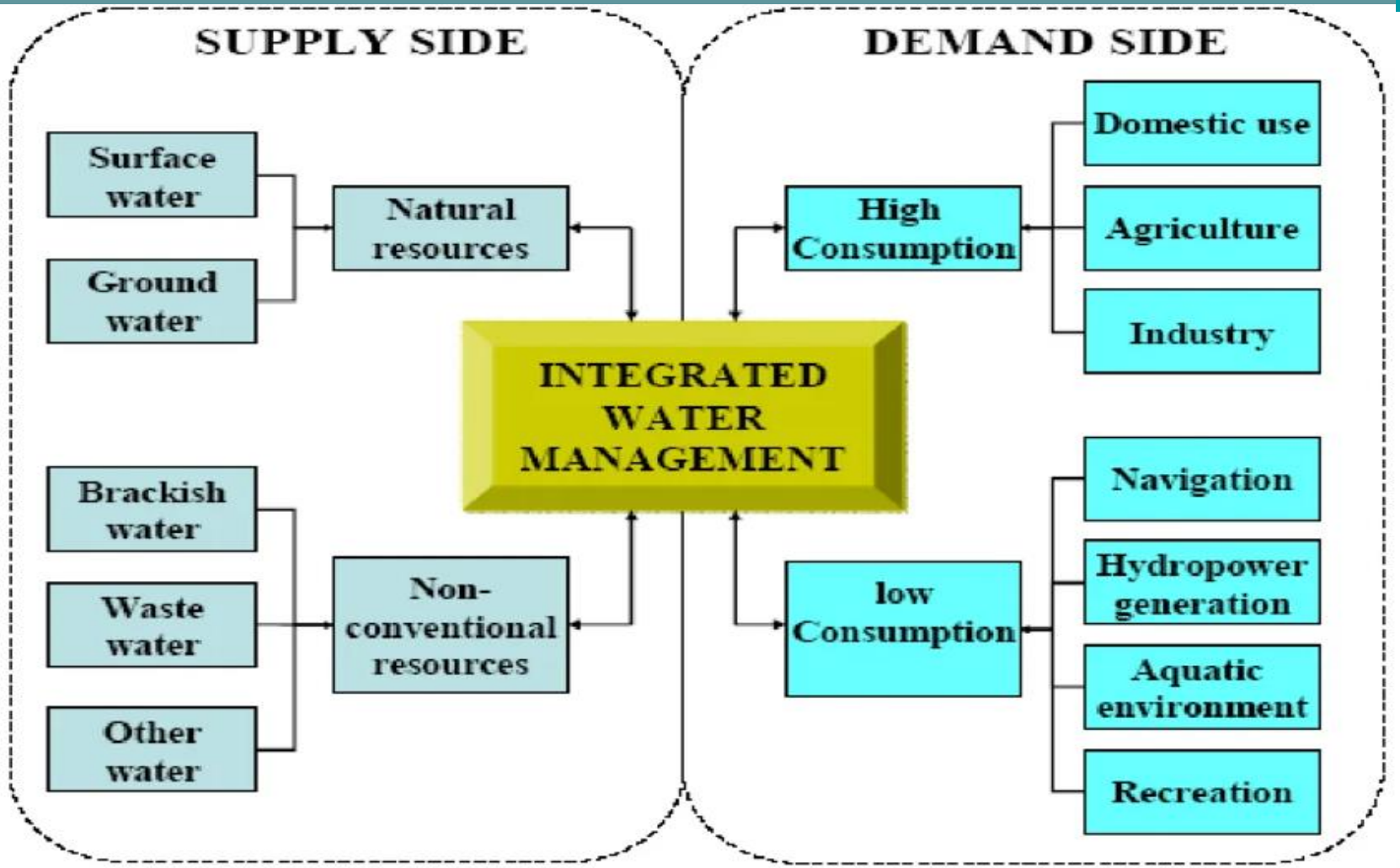
Graphics about water and IWRM Flickr
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Concept of Sustainable Land Management (SLM)

Sustainable Land Management (SLM) focuses on the responsible use and conservation of land resources to maintain their productivity and ecological functions over time. In Central Asia, land degradation is a major concern, driven by unsustainable agricultural practices, overgrazing, and deforestation. These processes lead to soil erosion, salinization, and desertification, all of which reduce the capacity of land to support agriculture and natural ecosystems.

SLM seeks to address these challenges by promoting practices that enhance soil health, improve water retention, and maintain vegetation cover. By stabilizing soils and increasing infiltration, SLM also plays a crucial role in supporting water resources, demonstrating the close link between land and water management.



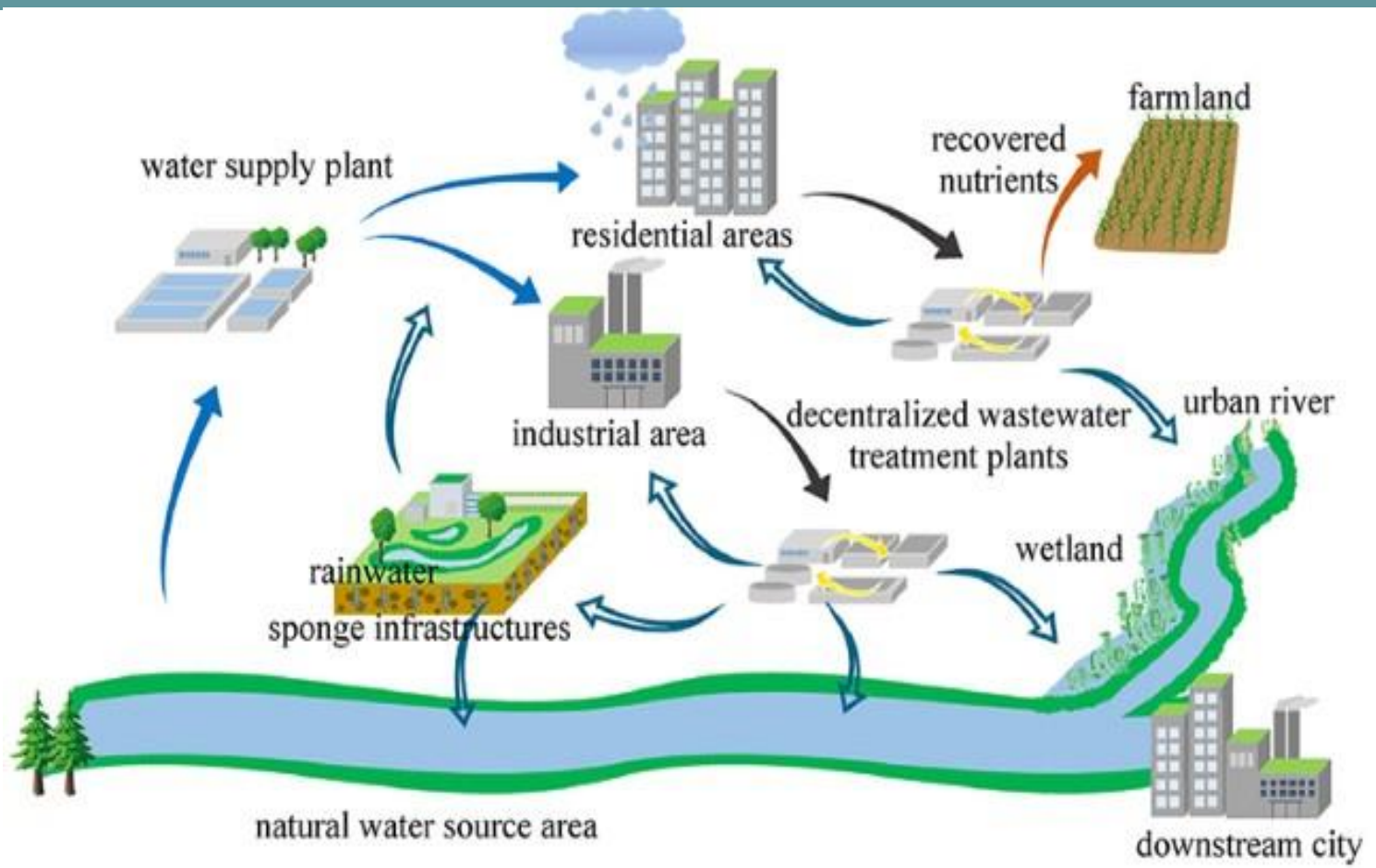
Integrated Water Resource Management (IWRM) mechanism based on integration of water demand and supply, Source: Ragab, 2004, p. 12

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Interconnections Between Water and Land Systems

The relationship between water and land in Central Asia is particularly evident in irrigated agriculture, which accounts for the majority of water use in the region. Inefficient irrigation practices have historically led to significant water losses and contributed to soil salinization. This not only reduces agricultural productivity but also affects the broader hydrological system by altering groundwater recharge and increasing runoff.

The environmental consequences of mismanaged water and land resources are exemplified by the degradation of the Aral Sea. Large-scale diversion of water from the Amu Darya and Syr Darya for irrigation caused a dramatic decline in the sea's water level, leading to ecosystem collapse and widespread socio-economic impacts. This case highlights the need for integrated approaches that consider both water and land in decision-making processes.



Upgrading to urban water system 3.0 through sponge city construction ENGINEERING **link.springer.com**

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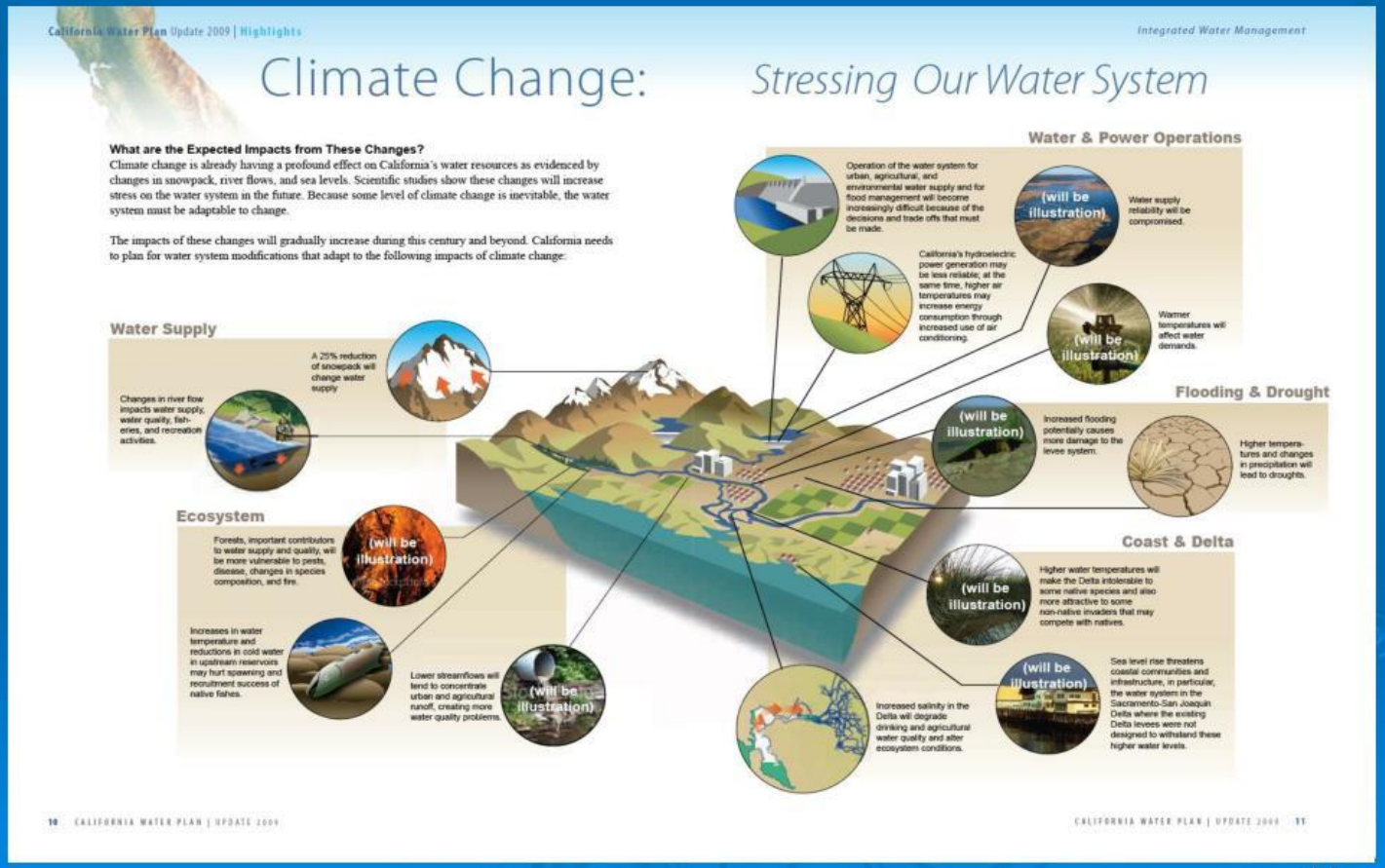
Climate Change and the Need for Integration

Climate change is intensifying existing pressures on water and land systems in Central Asia. Rising temperatures, shifting precipitation patterns, and the retreat of mountain glaciers are altering the timing and availability of water resources. These changes affect river flows, soil moisture, and groundwater recharge, making resource management more complex and uncertain.

In this context, the integration of IWRM and SLM becomes essential. Adaptive strategies must address both hydrological and land-based processes simultaneously, ensuring that water management decisions account for land conditions and vice versa. This integrated perspective enhances resilience to climate variability and supports long-term sustainability.

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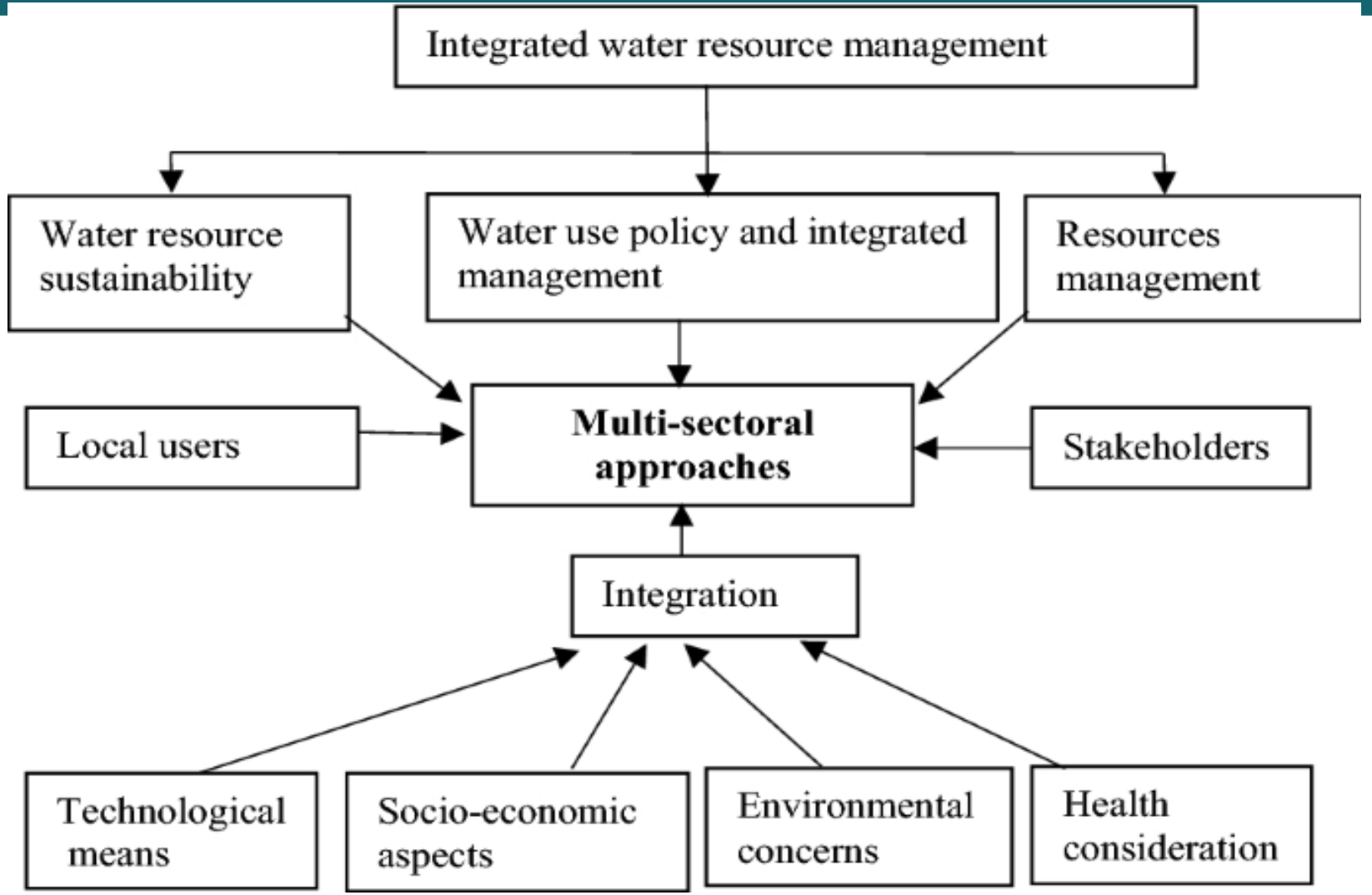
Climate Change: Stressing Our Water System (2)



PPT - INTEGRATED WATER MANAGEMENT PowerPoint Presentation, free download - ID:38
slideserve.com

Integrated Water Resources Management (IWRM) is a systems-based framework that aligns water, land and related resources management to support equitable development, ecosystem health and climate resilience.

This presentation unpacks the drivers of the water crisis, the philosophy and principles of IWRM, practical catchment-level implementation, links to Sustainable Land Management (SLM), and real-world initiatives that demonstrate how coordinated governance and participation deliver measurable, long-term benefits.



Towards integrated water resources management considering hydro-climatological s
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The Growing Water Crisis: More Than Just Scarcity

Scarcity and Demand Pressure

Global freshwater availability is under pressure from population growth, urbanisation and rising per-capita water consumption. Many basins now face competing demands from households, agriculture, industry and energy production, creating structural scarcity even where absolute water volumes remain stable.

Pollution and Quality Decline

Water quality deterioration—from industrial effluents, untreated sewage and agricultural runoff—reduces usable supplies, increases treatment costs and undermines human health and food safety. Contamination also damages aquatic ecosystems that underpin livelihoods.

Fragmented Governance

Poor governance and siloed sectoral management (water, land, agriculture, environment) limit coherent planning. Fragmentation leads to conflicting policies, inefficient investments and missed opportunities for cross-sectoral solutions.

The combined impact accelerates risks to development, food security and public health. Any credible response must therefore treat water as an interconnected resource rather than as isolated uses.

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IWRM: A Paradigm Shift for Water Governance

Coordinated Management

IWRM promotes coordinated development and management of water, land and related resources to maximise social and economic welfare while protecting vital ecosystems. It explicitly links policy, planning and on-the-ground management across sectors and scales.

Equity and Efficiency

The goal is to balance competing demands—ensuring efficient allocation, prioritising basic human needs and supporting equitable access for communities that are often marginalised or under-served.

From Sectors to Systems

IWRM replaces fragmented, sectoral decision-making with a holistic systems approach that considers upstream-downstream linkages, land-water interactions and the role of ecosystems in regulating flows and quality.

Adopting IWRM requires policy alignment, institutional reform, financing strategies and sustained stakeholder engagement; it is as much about governance transformation as technical solutions.

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The Core Principles of IWRM

Water as Finite & Vulnerable

Recognise freshwater limits; protect recharge zones, aquifers and ecological flows to maintain long-term availability and resilience.

Participatory Approach

Inclusive decision-making brings government, civil society, private sector, indigenous peoples and communities into planning and management. Local knowledge improves outcomes and legitimacy.

Role of Women

Women often manage household water and agricultural labour—ensuring their meaningful participation improves relevance, efficiency and equity in water governance.

Economic Value of Water

Recognise water's economic dimension to inform pricing, cost-recovery, incentive design and investment decisions—while safeguarding affordability for basic needs.

These principles are mutually reinforcing: treating water as a finite good drives conservation; participation and gender equity ensure fair outcomes; economic recognition supports sustainable financing and efficient use.

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IWRM in Practice: The Catchment Approach

The catchment (or basin) is the natural unit for IWRM because it captures hydrological linkages—surface water, groundwater, land use and ecosystem services. Operationalising IWRM at catchment scale enables integrated planning of water supply, flood control, irrigation, conservation and urban water services.

Assessment & Diagnostics

Baseline hydrology, water quality, ecological condition, socio-economic uses and institutional mapping identify pressures, vulnerabilities and opportunities.

Stakeholder-driven Planning

Co-design management plans that set objectives (allocation, abstraction limits, environmental flows), specify interventions and define roles across agencies and communities.

Integrated Interventions

Combine nature-based solutions (riparian buffers, reforestation), engineering (storage, treatment), demand management (efficiency, meters) and governance reforms.

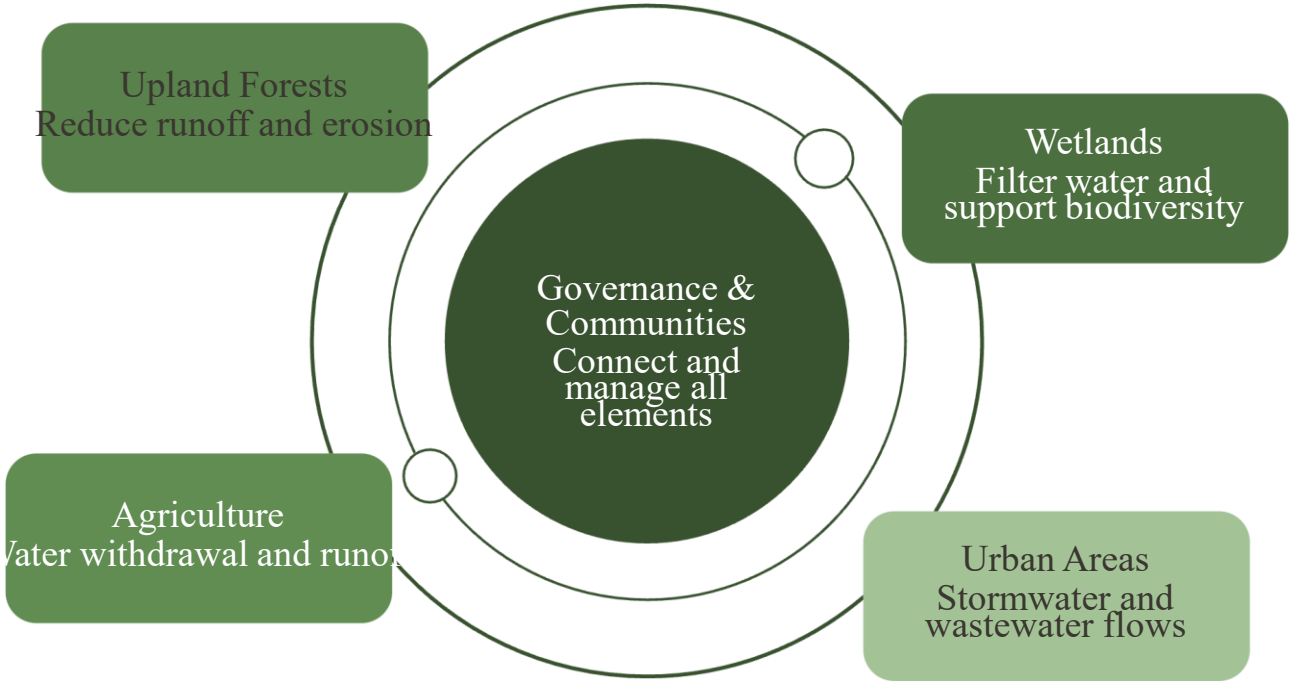
Monitoring & Adaptive Management

Continuous monitoring of flows, quality and social outcomes informs adaptive changes—building resilience to climate variability and shocks.

Cross-sector integration with land planning, agriculture, forestry and urban development is essential: interventions upstream (forest protection, erosion control) create downstream benefits (water quality, reduced flood risk).

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Water is Not an Island: The IWRM Ecosystem



This diagram highlights how land cover, ecosystem services, human activities and governance interact. Protecting upstream ecosystems reduces sediment and pollutant loads, improving storage and treatment efficiency downstream. Groundwater and surface waters are interconnected; mismanaging one degrades the other. Effective governance wraps around these physical links, coordinating actions and conflict resolution.

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Benefits of Integrated Water Resources Management

Fair and Efficient Distribution

Coherent allocation frameworks ensure essential domestic supply while optimising use in agriculture and industry. Efficiency measures reduce waste and delay costly infrastructure expansions.

Conflict Prevention & Cooperation

Shared basin management and transparent data foster dialogue, reduce tensions over resources and create joint investment opportunities—transforming disputes into cooperative action.

Climate Adaptation & Resilience

Integrated planning builds redundancy (diverse sources, storage, nature-based solutions) and reduces vulnerability to extreme events such as droughts and floods.

Sustainable Development

Healthy watersheds support livelihoods, food security and biodiversity, contributing to economic growth that does not erode environmental capital.

When implemented well, IWRM yields multiple co-benefits across sectors and scales, improving outcomes for people and nature while lowering long-term costs.

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The Interplay with Land Management (SLM)

Sustainable Land Management (SLM) and IWRM are tightly linked: land use decisions directly determine runoff, infiltration, sedimentation and pollutant loads. Integrating SLM into watershed planning safeguards water resources while improving agricultural productivity and livelihoods.

Consequences of Poor Land Management

Deforestation, overgrazing and unsustainable tillage accelerate erosion, reduce infiltration and increase sedimentation of reservoirs and waterways, raising treatment costs and lowering storage capacity.

SLM Solutions that Protect Water

Practices such as contour farming, terracing, reforestation, agroforestry and conservation agriculture reduce erosion, enhance soil moisture retention and recharge groundwater—delivering tangible downstream benefits.

Synergies: Productivity & Conservation

Integrating water-saving irrigation (drip, deficit irrigation), nutrient management and landscape restoration increases yields per water unit and reduces pollutant runoff—improving food security while conserving water.

Coordinated planning and investment, supported by incentives and extension services, help scale SLM practices that reinforce basin resilience and the long-term availability of clean water.

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Real-World Application: Blue Peace Initiative

The Blue Peace Initiative (BPI) is an example of applying IWRM principles at regional scale: it promotes water diplomacy, transboundary cooperation and integrated basin management to prevent conflict and foster sustainable development. BPI activities include capacity building, support for legal and institutional frameworks, basin planning, and convening multi-stakeholder dialogues to turn shared water challenges into pathways for peace.

Water Diplomacy

Negotiated agreements and joint institutions enable equitable sharing, data exchange and coordinated investments across borders.

Institutional Strengthening

Strengthening basin organisations, monitoring systems and financing mechanisms is central to scaling integrated approaches.

Cross-Sector Networks

Facilitating connections among government, civil society, academia and private sector accelerates innovation and implementation on the ground.

BPI demonstrates that coupling technical planning with diplomacy and inclusive governance can convert shared water dependencies into platforms for regional stability and development.

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The Future of Water: Coordinated, Participatory, Sustainable

Commit to Integrated Planning

Embed IWRM into national and basin-level policies with clear mandates, funding lines and cross-sector coordination mechanisms to align investments and priorities.

Scale Nature-Based Solutions

Invest in catchment restoration, wetlands protection and green infrastructure as cost-effective measures that deliver co-benefits for water, climate and biodiversity.

Empower Communities & Women

Strengthen local institutions, promote gender-inclusive participation and support community-led monitoring to ensure solutions are equitable and durable.

Finance & Data for Adaptive Management

Mobilise blended finance, introduce targeted incentives for SLM, scale monitoring networks and use data to guide investments and adapt policies in the face of uncertainty.

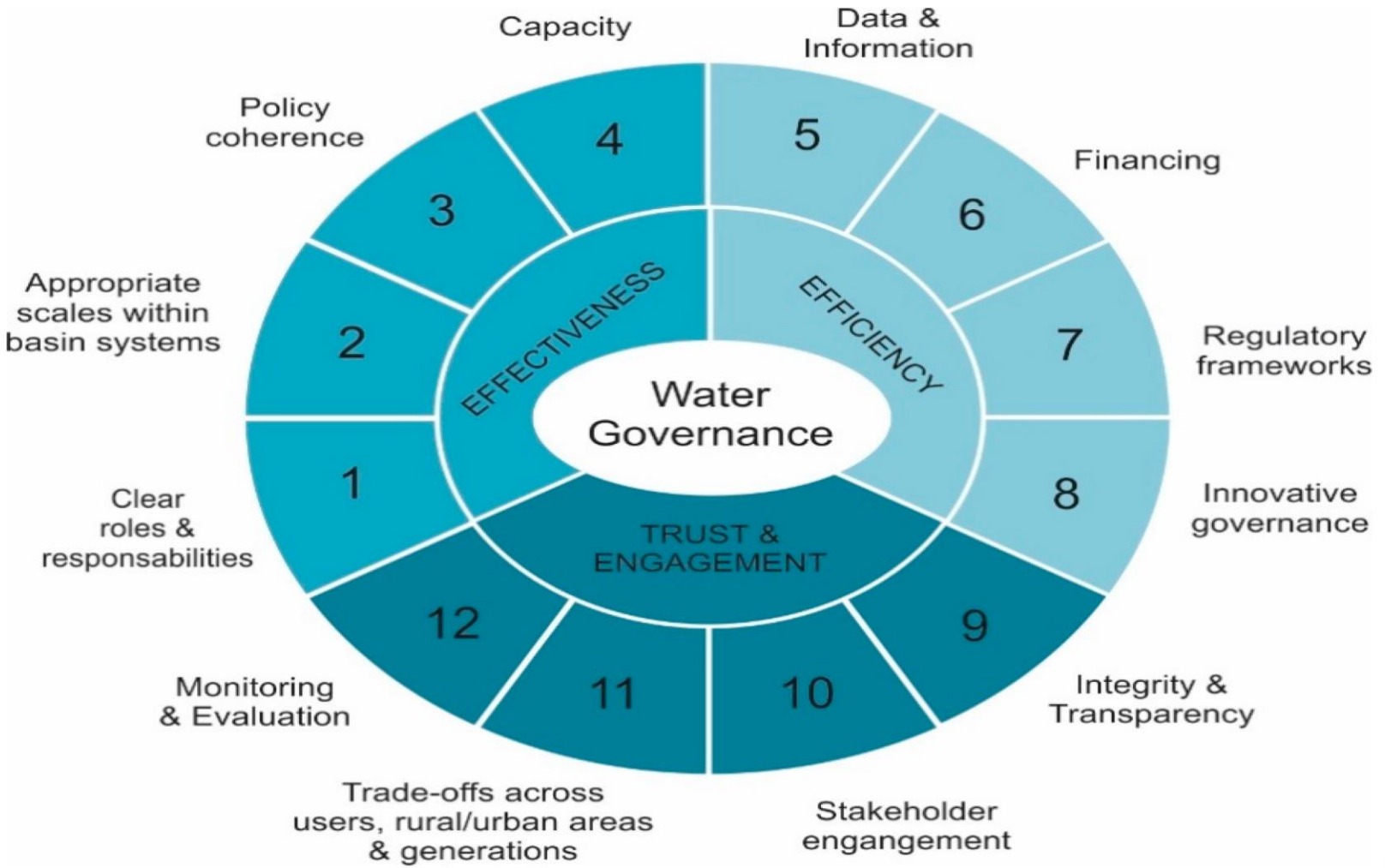
IWRM is not a single technology but a governance and design paradigm that requires long-term commitment, cross-sector collaboration and a willingness to balance trade-offs. By integrating water, land and human needs within a shared governance framework, we can secure water resources for people and ecosystems now and for future generations.

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Governance and Institutional Challenges

Despite the recognized benefits of IWRM and SLM, their implementation in Central Asia faces significant institutional and governance challenges. Water and land management responsibilities are often fragmented across different sectors and administrative levels, leading to a lack of coordination. Transboundary water management is further complicated by differing national priorities, particularly between upstream countries that emphasize hydropower and downstream countries that rely on irrigation.

Existing agreements and institutional frameworks are not always well-suited to address the uncertainties associated with climate change. Limited data sharing and weak monitoring systems also hinder effective decision-making. Strengthening institutions and improving cooperation are therefore critical for successful implementation.



Water Resources Management in Mexico, Chile and Brazil: Comparative Analysis of mdpi.com

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Conclusion

The integration of water and land management in Central Asia represents a critical pathway toward sustainability in a region facing significant environmental and socio-economic challenges. IWRM and SLM provide complementary frameworks that, when applied together, can address the complex interactions between water availability, land use, and climate change.

Achieving this integration requires not only technical solutions but also institutional reform, regional cooperation, and long-term commitment. By aligning policies and practices across sectors and scales, Central Asian countries can enhance resource efficiency, reduce environmental degradation, and improve resilience to future uncertainties.

Emerging Approaches and Regional Cooperation

In recent years, there have been increasing efforts to promote integrated resource management in Central Asia. Regional initiatives and international organizations are supporting capacity building, data exchange, and pilot projects that demonstrate the benefits of combining IWRM and SLM approaches. These efforts emphasize stakeholder participation, recognizing that local communities, farmers, and water users are key actors in managing resources sustainably.

By fostering collaboration across sectors and borders, these initiatives aim to build trust and develop more flexible and adaptive management strategies. The integration of scientific knowledge with local experience is also seen as an important component of effective resource management.