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Kingdom of Morocco



Ministry of
Equipment and Water

Towards Integrative and Transformative Research on Water and Societies

From Gaps to New Demands

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Water Challenges of the Anthropocene

- **Societal Dynamics**
 - Drivers such as GHG emissions, urbanization, and intensified agriculture (e.g., Kuang et al., 2024).
 - Pressures such as pollutants, sealed surfaces, and water withdrawals (e.g., Oswald et al., 2023).
- **Changes to the global water cycle**
 - E.g., global currents and circulations, ice melt, precipitation and evapotranspiration patterns, seasonality, loss of global wetland areas (e.g. Fluet-Chouinard et al., 2023).
- **Changes to the regional and local freshwater**
 - E.g., river basins experiencing hydrological, morphological and water quality changes) such as alterations in river flow regimes accompanied by reduced connectivity (e.g., Grill et al., 2019).

→ Effects on the freshwater are strongly non-linear and potentially irreversible once certain thresholds are exceeded (Armstrong McKay et al., 2022).



Water Challenges of the Anthropocene

Anthropogenic activities leading to shifts in precipitation patterns, heatwaves, pollution, and hydrological extremes causes significant impacts on ecosystems and societies. The impacts are dependent on the degree of **ecological** and **social vulnerabilities** (e.g., Myrntinen et al., 2018).

Impacts on Ecosystems

- Disrupting habitats and food webs
- Altering water quality and quantity
- Shifting species ranges
- Increases the risks of diseases
- Biodiversity loss

(e.g., Blumenfeld et al., 2009; Zhang et al., 2021; van Vliet et al., 2023)

Impacts on Societies

- Water, energy, and food securities
- Public health
- Infrastructure and economy
- Migration and non-migration
- Intensifying conflicts and injustice

(e.g., Gubbens, 2021; IPCC, 2022; Rabbani et al., 2022; Campbell-Lendrum et al., 2023)

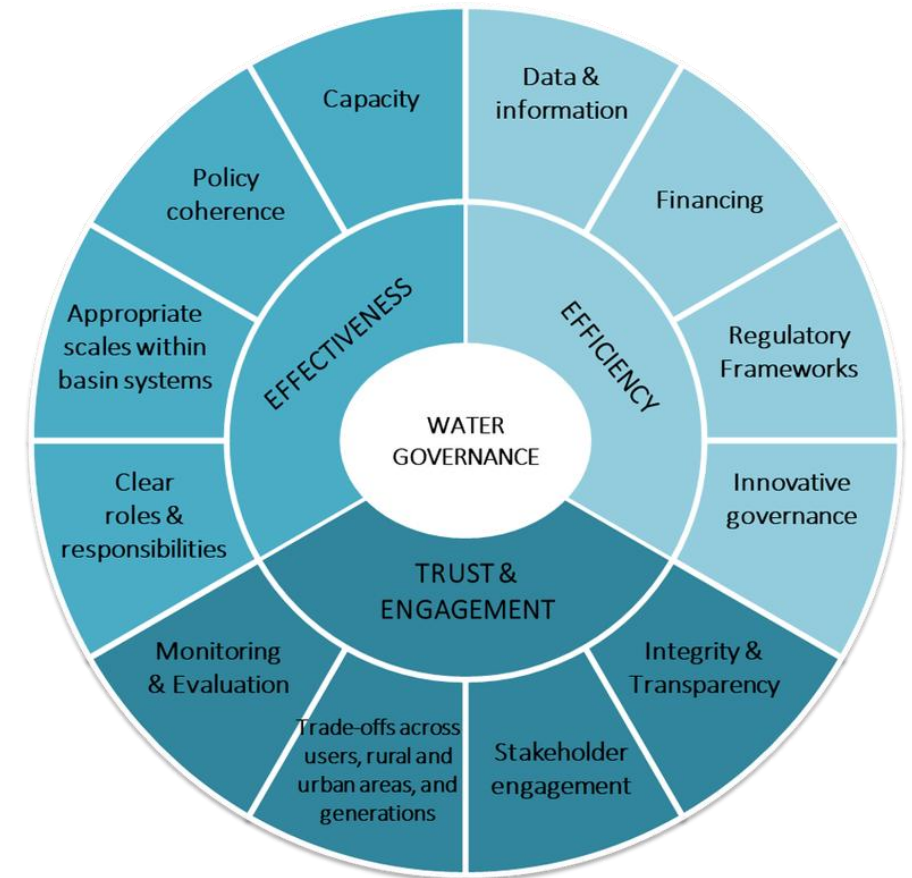


Water Challenges of the Anthropocene

Water Governance

Existing institutional arrangements are present for water governance with increasing challenges

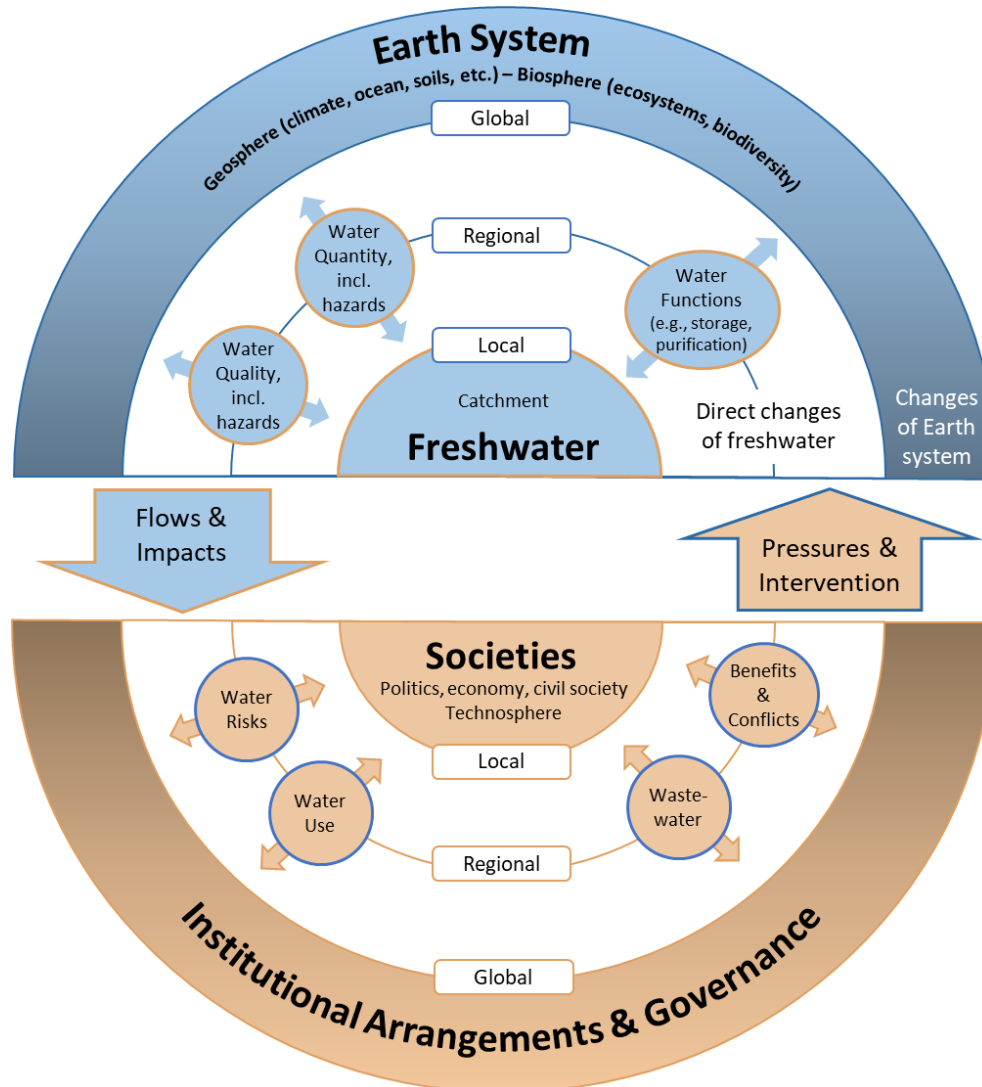
- Managing and regulating water **sustainably** and **equitably** across geographical, political, social, and climate settings
- **Competition** on water between sectors and users
- **Integration** vs fragmentation of institutional arrangements
- **Regulations and institutions**
 - Global institutes, international law, and framework treaties (e.g., UN-Water, Global Water Partnership, IWRA, World Water Forum)
 - Regional and bilateral treaties and regulations (e.g., EU Water Framework Directive, Nile treaties)



Overview of the 12 OECD principles on water governance (OECD, 2015)

Water Challenges of the Anthropocene

Cross-scale interlinkages of Freshwater & Societies



Societal pressures and interventions in the Earth's freshwater subsystem alter water flows and cause impacts on societies, depending on institutional arrangements and governance.

Current Research Landscape

Key examples from natural sciences

Global Water Assessments/ Water models

(Concept/Approach)

Quantity and quality of water resources considering anthropogenic change and impacts on humans

Freshwater Biodiversity Research

(Research field)

Identifying links between freshwater biodiversity, ecosystem functioning, and services to society, accounting for multiple stressors

IAHS Scientific Decades

(Research Program)

Hydrological processes, water challenges, societal aspects



Current Research Landscape

Key examples from social sciences

Water Vulnerability/ Resilience Research

(Research field)

Social characteristics and markers that make societies/individuals vulnerable to water-hazards, considering interventions and governance

Water Conflict Research

(Research field)

Water challenges and socio-political instability across scales

Water footprint

(Research topic)

Quantities of (blue, green, and grey) water used by countries, companies, or individuals, for different products/activities



Current Research Landscape

Key examples from integrated research

Socio-hydrology & social water cycle

(Research field)

Dynamics of coupled human-water systems. Focusing on the human-impacted water cycle

IWRM

(Concept/Approach)

Interdependencies between water resources and societies including different stakeholders.

Water Security

(Concept/Approach)

Capacity of societies in sustainably managing water-related aspects under changing socio-political, economic, and environmental conditions

Nexus (WEF/WEFE)

(Concept/Approach)

To understand the interconnections between the sectors (or resources). Includes assessments, support governance, and interventions



Key Gaps in Addressing Water in the Anthropocene

- **Cross-scale** analyses of feedback between water and societies in both directions considering the specificities and the spatial distribution of the natural and societal dynamics.
- While biophysical parameters are often addressed, the derivation of **regional and global freshwater boundaries** with their societal context of **well-being and justice** is missing.
- We still need to gain the understanding of **societal capacities** to govern water as an Earth system component and the understanding of **societal water impacts and risks**.



New Demands



New Demands

Demand 1



Multisystemic approaches for studying water & societies considering their interlinkages

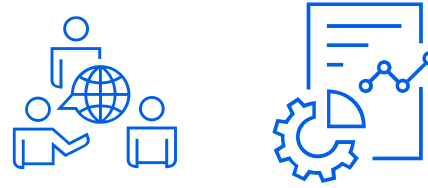
(e.g., climate change, hydrology, groundwater, users, demands, green/blue water, wastewater)

- Agreeing on the overall aims and principles (e.g., sustainability, boundaries, justice and equity)
- Delineating the systems identifying their relevant interlinkages and endpoints (elements, processes)
- Defining characteristics describing the endpoints (descriptors and attributes)
- Assigning potential indicators for each descriptor
- Analyzing the indicators for overlaps (synergies and tradeoffs).



New Demands

Demand 2

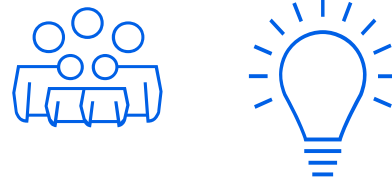


System-based references: regional and global boundaries & evaluation frameworks

- System-based scientific rationales related to insights from the system analysis supporting possible societal goals and targets.
- References can be derived from critical limits (e.g. tipping points) of
 - (i) the considered biophysical water systems (e.g., green freshwater boundary by Wang-Erlandsson et al., 2022)
 - (ii) and immaterial societal systems (e.g. equity for water resources management by Higgs et al., 2024),and can be assigned to sustainability goals.
- Setting in place institutional arrangements for negotiation, implementation and monitoring of these boundaries and goals on various levels of politics.

New Demands

Demand 3



Systemic innovations to enable societal transformation in the water sector

- Systemic innovations to address levers and capacities which support the sustainability transformations to decrease societal pressures on freshwater and reduce water-related impacts and risks (e.g., Schot & Kanger, 2018; McPhearson et al., 2021)
- Technological, economic, social and political innovations.
- Covering the four levels of leverage points (e.g., Meadows, 1999)
 - Parameters, feedbacks, design, and intent.



InTRES

Platform for *Integrative and Transformative Research on Earth & Societies*

Working Group 4

Freshwater and Societies within the Earth System

The WG aims to provide scientific pathways to address those key challenges through developing and testing concepts, frameworks and approaches.

As part of the InTRES Platform

InTRES is established to foster inter- and transdisciplinary research on the interlinkages between the Earth system and societies. The platform is open to all interested researchers and facilitates collaboration between international colleagues. It currently includes 21 institute members and 9 working groups.





Image Credit
Oliver Guhr



InTRES

Integrative and Transformative
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Thank you!

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