Patterns in Transboundary Aquifer Governance
Unlocking Sustainable Development

Maya Velis[1], Kirstin I. Conti[2] & Frank Biermann[3] (2022) Patterns in transboundary aquifer governance: comparative analysis of eight case studies from the perspective of efficacy, Water International, 47:2, 278-296, DOI 10.1080/02508060.2022.2038925

[1] Houston Advanced Research Center [2] The World Bank [3] Utrecht University

Introduction

- Governance gaps leave transboundary sustainability risks unaddressed

- Untangling the efficacy of transboundary aquifer governance is key to unlocking sustainable development

→ Presenting a comparative analysis of eight case studies worldwide

Methods

Case studies

Transboundary Aquifer (TBA) selection criteria:
1) Included in IGRAC's database;
2) Governance issues in literature;
3) Dedicated codified mechanism.

Institutional Design Index

Empirically grounded, multi-dimensional index:
• Iteratively developed, based on literature review
• Coding statements for replicability

Pattern Analysis

Drivers of efficacy and explanatory factors:
• Institutional design
• Broader context: physical attributes, watershed change, political factors

Institutional design index

Calculated as weighted average of 25 criteria in 4 dimensions:

Normative foundations

Embodies relevant principles of international (water, environment) law

13 criteria

4 criteria

Objectives & Baselines

Reflects clear objectives, baselines, and indicators; shared knowledge of the resource and its use

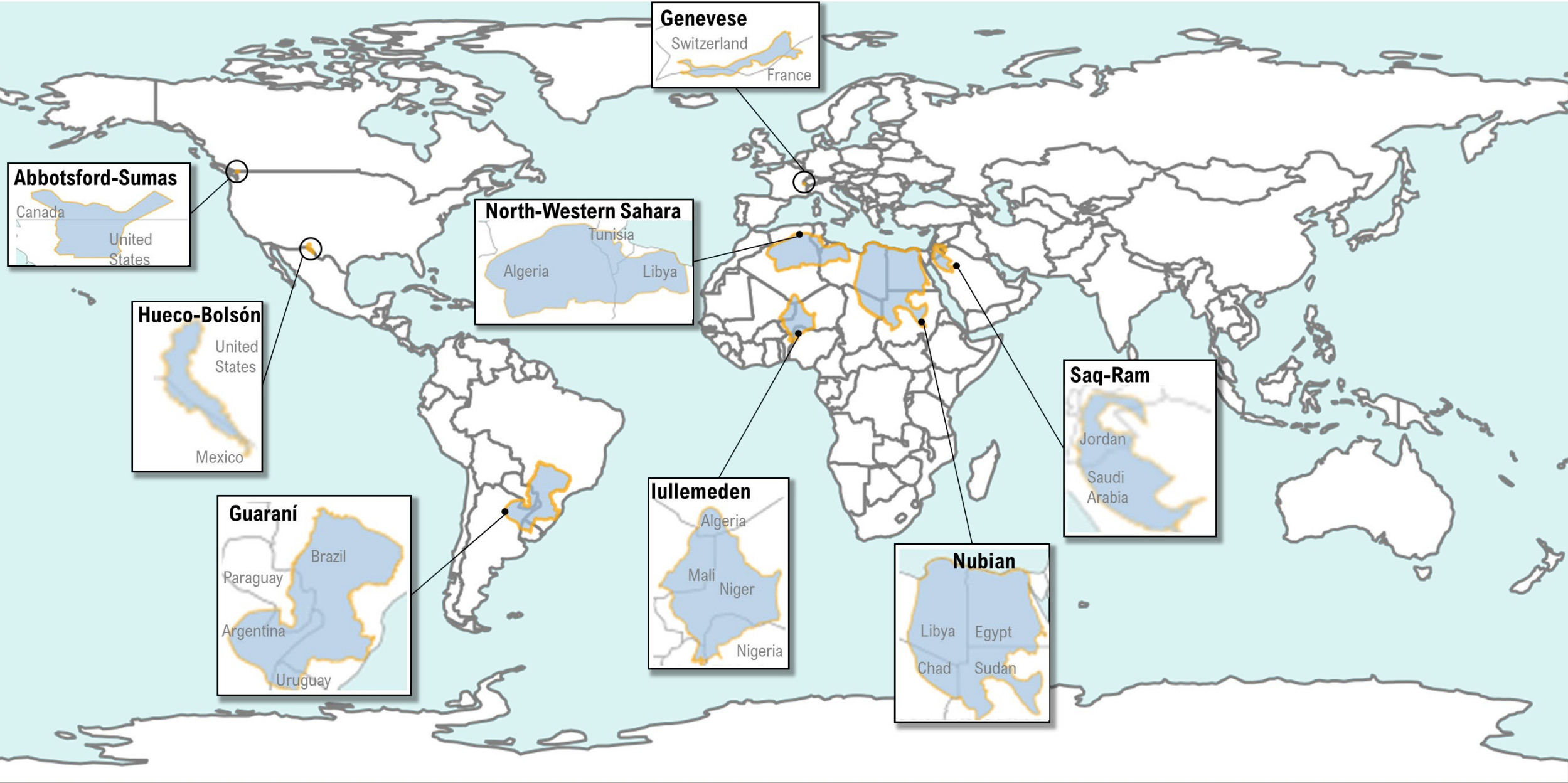**Monitoring & Adaptive capacity**

Sets out data and information infrastructure, flexibility mechanisms

5 criteria

3 criteria

Authority & Legality

Aligns towards shared objectives (e.g. via binding provisions, enforcement)

Eight case studies worldwide

Case studies by size
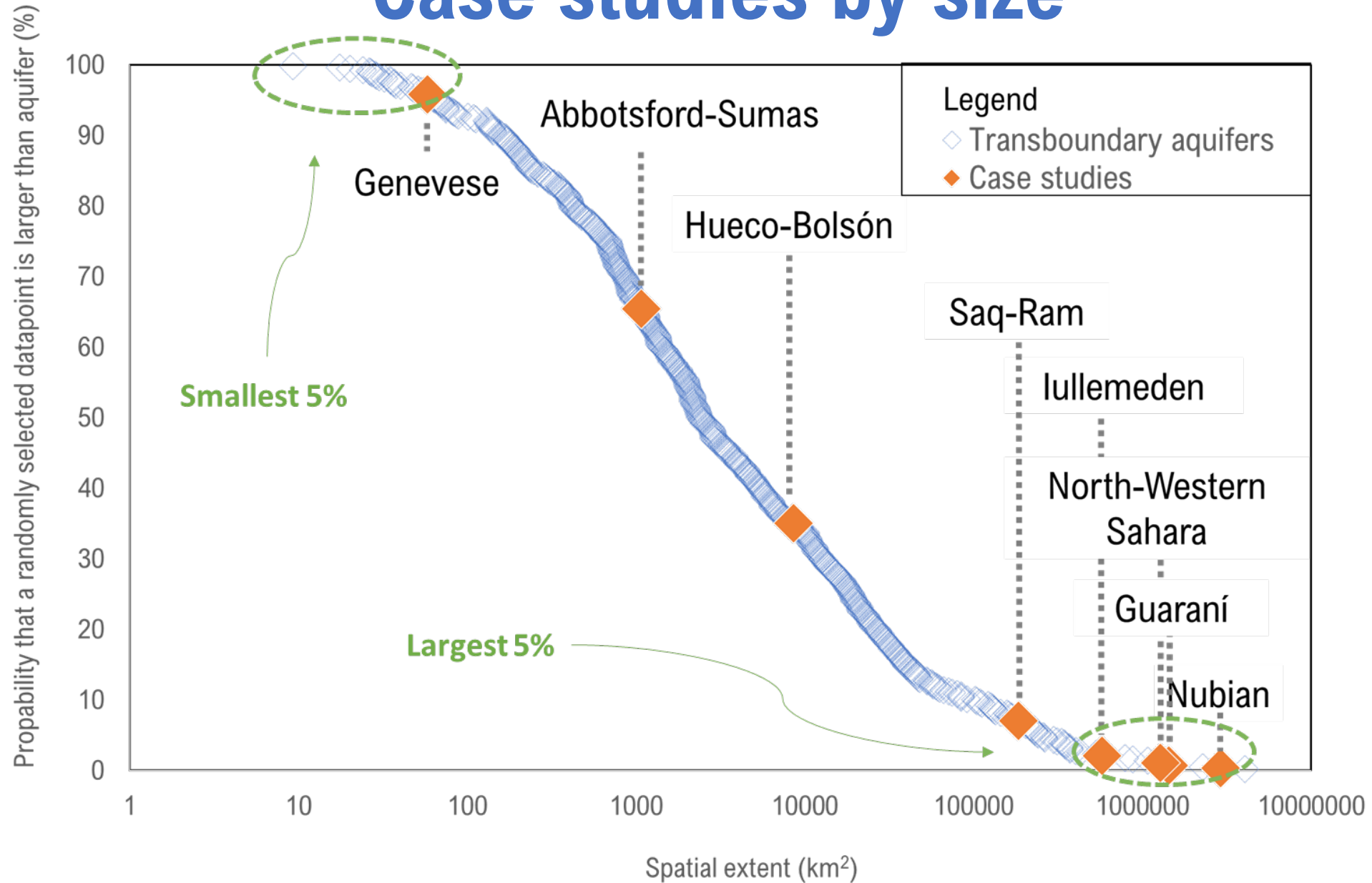
Case studies

Abbotsford-Sumas

Genevese
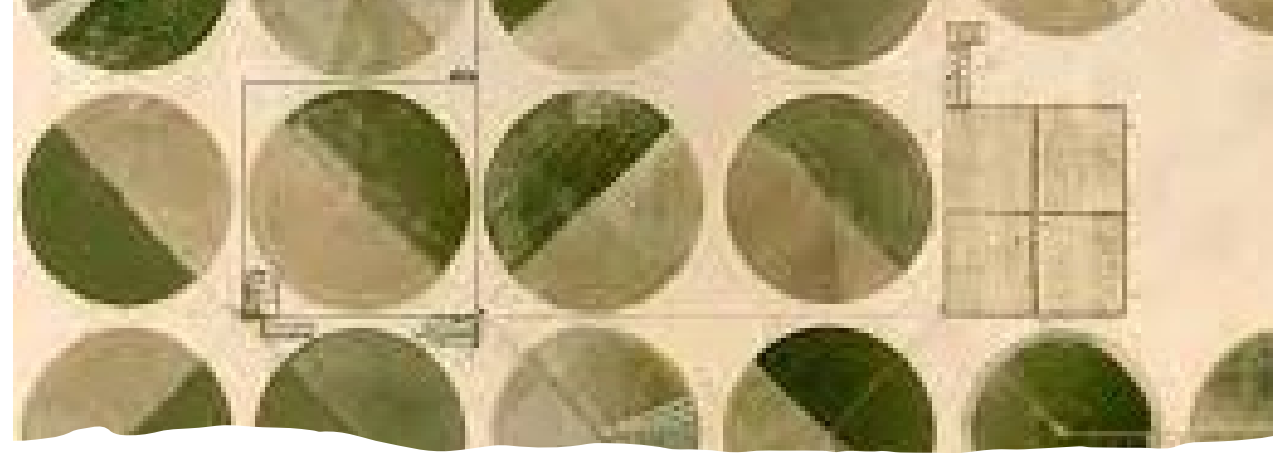
Guaraní

Hueco Bolsón

Iullemeden

North Western Sahara

Nubian Sandstone

Saq-Ram

Cases institutional design

	Multi-stakeholder mechanism	Institutional design index	Efficacy (defined objectives)			
			Conservation	Knowledge Development	Depletion	Pollution
Abbotsford-Sumas	Permanent committee	Low	n/a	High	n/a	Moderate
Genevese	-Intergovernmental mechanism -Permanent (local) committees	Medium	n/a	n/a	High	n/a
Guaraní	Multi-stakeholder mechanism	Medium-High	High	n/a	n/a	n/a
Hueco-Bolsón	Intergovernmental mechanism	Low	n/a	High	Moderate	n/a
Iullemeden	Intergovernmental mechanism	High	n/a	Moderate	Low	n/a
North-Western Sahara	Permanent committee	Low	n/a	Moderate	Low	n/a
Nubian Sandstone	Permanent committee	Medium	No data	Moderate	Low	No data
Saq-Ram	Multi-stakeholder mechanism	Low	n/a	n/a	No data	n/a

Differentials:
Groundwater exploitation capacity and –viability

(Nubian, Guaraní and Iullemeden)

Photos: Swiss Water Partnership, UNITAR, Pinterest
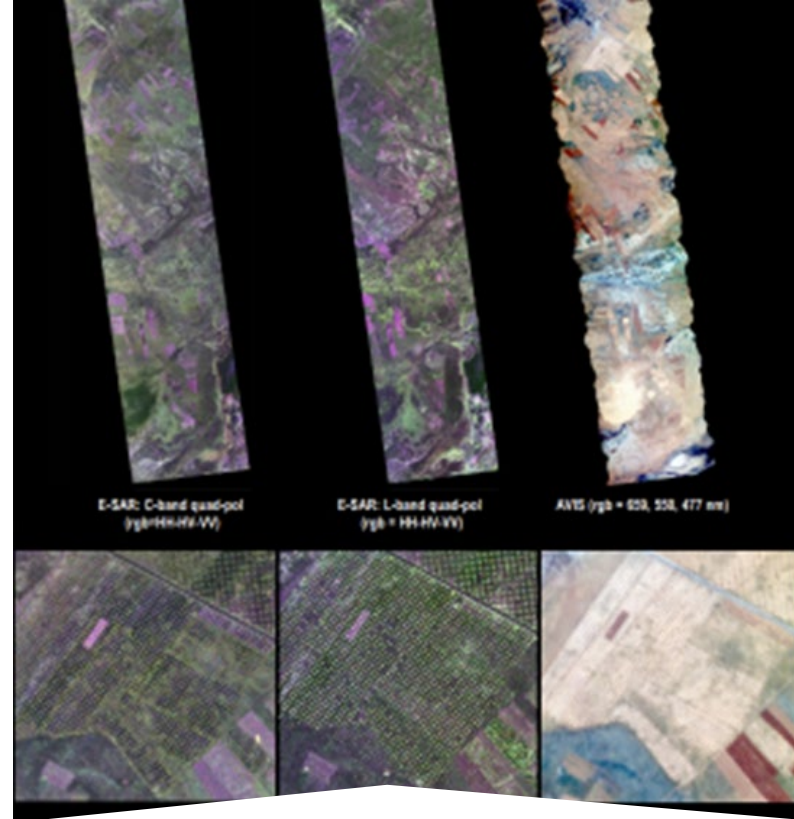
Tracing sustainability issues up to hundreds of kilometers away

(Nubian, Saq-Ram, Guaraní and Iullemeden case studies)

Photos: Wikimedia

International organizations shaping governance formality

(Guaraní, Iullemeden, Nubian and North-Western Sahara)

and emerging technologies deployed

(Iullemeden and North-Western Sahara)

Photos: Wikimedia, ESA Global Water Partnership

Effective institutions require tailored structures/mandates

To sustainability issues (Genevese, Hueco-Bolsón) or to geographic hotspots (Guaraní, Saq Ram)

Conclusions & Recommendations

Governance efficacy strongly depends on context (e.g. aquifer size, homogeneity), less dependent on mechanisms

1. Prioritize governance based on problem intensity and transboundary risks.

2. Foster innovation for adaptiveness, including scalable pilots w/ potential for benefit-sharing.

Thank You!

Contact: mvelis@harcresearch.org

Patterns in transboundary aquifer governance: comparative analysis of eight case studies from the perspective of efficacy

Maya Velis (ID) [a], Kirstin I. Conti (ID) [b], and Frank Biermann (ID) [c]

[a] Houston Advanced Research Center, The Woodlands, TX, USA [b] International Bank for Reconstruction and Development, Washington, DC, USA [c] Copernicus Institute for Sustainable Development, Utrecht University, Utrecht, the Netherlands

ABSTRACT
We performed a comparative analysis of eight case studies worldwide from the perspective of transboundary aquifer governance efficacy. First, we mapped variation in institutional design, applying institutional design criteria in four dimensions linked to The OECD Principles on Water Governance. We then identified explanatory factors: (1) physical variables, including aquifer size and hydrogeological characteristics; (2) watershed variables, including groundwater exploitation capacity and water transfer infrastructure; and (3) political factors, including international donor support. We found that transboundary aquifer governance efficacy is closely linked to problem structure and less attributable to institutional design in the presence of specific contextual variables.

KEYWORDS
Groundwater, institutional design, empirical analysis, international, regional environmental governance, water security, sustainable development, The OECD Principles on Water Governance

Introduction

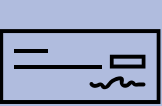Groundwater sustains lives, livelihoods, and ecosystems worldwide, yet groundwater resources are often overused and undervalued. Over the twentieth century, economic development has rapidly

Annexes

Case studies by physical properties

TBA Case study	Aquifer or aquifer system (A/AS); degree of confinement	Water body connections	Main lithology	Climate zone	Rainfall (mm/yr)
Abbotsford-Sumas	A – Unconfined, shallow	n/a	Sediment – gravel	Temperate	450
Genevese	A – Unconfined, shallow	Arve river	Sediment – gravel	Temperate	950
Guaraní	AS – Confined; Semi-confined	Paraná river	Sedimentary rock – sandstones	(Sub-)tropical, humid	1200
Hueco-Bolsón	AS – Unconfined	Rio Grande river	Sediment – Sand	(Semi) arid	240
Iullemeden	AS – Unconfined; Confined, non-recharging	Niger river; Chad basin aquifers	Sedimentary rock – sandstones	(Semi) arid, Tropical	550
North-Western Sahara	AS – Unconfined; Confined, non-recharging	Salt-fresh water interface	Sediment – Sand	Arid	59
Nubian Sandstone	AS – Confined, non-recharge, Unconfined	Nile river; Salt-fresh water interface	Sedimentary rock – sandstones	Arid	<10
Saq-Ram	AS – Confined, non-recharging; Unconfined	n/a	Sedimentary rock - sandstones	Arid	74

Contextual factors

TBA Case study	Selected contextual factors*					
	🌾	🏢	🌼	🌉	💳	👥
Abbotsford-Sumas	X		X			
Genevese	X		X			
Guaraní	X	X	X		X	
Hueco-Bolsón	X	X				
Iullemeden		X			X	X
North-Western Sahara	X	X	X		X	
Nubian Sandstone	X	X		X	X	X
Saq-Ram				X		

*Contextual factors (from left to right): **irrigated area** (50% of area equipped for irrigation is irrigated, FAO Global Map of Irrigation Areas v. 5.0 2013), **urban growth** (>1 million inhabitants AND >1% annual growth rate, U.N. World Urbanization Prospects (2018); a**gricultural fertilizer use** (>3kg/ha Nitrogen in fertilizer applied, Potter et. al. (2013), **water transfer infrastructure** (case studies in Velis et al. 2022); **international donor support**, and **competing development needs** (Multi-dimensional poverty index>0.4, Global MDI Databank 2021).