Digital transformation is changing how shared water is monitored and managed. Yet many cross-border digital systems underperform because states do not fully trust the data, the rules, or the institutions behind them. This brief sets out a practical framework to help international and regional actors build trust into digital water governance from the start.

POLICY BRIEF

Digital Trust for Transboundary Cooperation: Lessons from Smart Metering

Why this brief matters:

Shared river basins need real-time data, but data alone does not build cooperation. This brief shows why digital trust is the missing link between smart water technologies and effective transboundary governance.

Keywords:

Smart Metering · Digital Trust · Transboundary Cooperation

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Executive Summary

Globally, more than *280 transboundary river basins* cross national borders, supporting *nearly 40%* of the world's population and accounting for *over 60%* of global freshwater flows. Yet many of these shared systems are under increasing pressure from climate change, rising demand, and competing development priorities, while cooperation remains uneven.

In Africa, where the majority of freshwater resources are transboundary, these pressures are particularly acute. Shared river basins underpin food systems, energy production, and regional integration, but are increasingly strained by climate variability, population growth, and institutional fragmentation.

In Southern Africa, and in countries such as Namibia where water scarcity is structural and dependence on shared rivers is high, effective transboundary cooperation is essential for long-term stability and development.

In response, governments and development partners are accelerating investments in digital water technologies, including smart metering, remote sensing, artificial intelligence, and shared data platforms. These tools promise to enhance monitoring, transparency, and coordination across borders.

Yet technology alone does not create cooperation.

This brief argues that the primary constraint to digitally enabled transboundary water governance is not technical capacity, but the *absence of digital trust:* the confidence among states and institutions that shared digital systems generate credible data, are governed through fair and legitimate arrangements, and will not be used to reinforce asymmetries or undermine sovereignty.

Drawing on lessons from smart water metering research, the brief introduces a Digital Trust Framework for Transboundary Cooperation, structured around five core principles:-

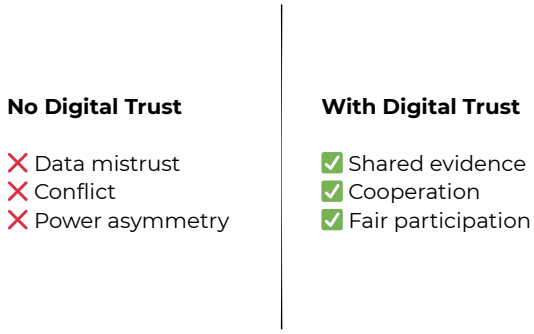
- Transparency by design
- Data sovereignty with shared stewardship
- Verifiability and traceability
- Equity and capacity parity
- Accountability with avenues for redress

Together, these principles reframe digital systems not as neutral technical tools, but as governance infrastructures that shape power, legitimacy, and cooperation in shared water systems.

The policy implication is clear: digital transformation in transboundary water governance must be approached as a governance challenge, not only a technological one. Investments in digital water systems must be matched by investments in institutional arrangements, verification mechanisms, and capacity development that make cross-border data systems *trusted, equitable*, and *effective*.

Without such foundations, digitalisation risks intensifying mistrust rather than enabling cooperation. With them, it can support more adaptive, transparent, and resilient transboundary water governance.

WHEN DIGITAL TRUST IS ABSENT VS PRESENT



The Policy Challenge

Transboundary water cooperation depends fundamentally on the exchange of reliable, timely, and mutually accepted information (McCracken, 2022; UN Water, 2008). States must share data on river flows, water abstraction, infrastructure operations, and climate conditions in order to coordinate decisions, manage risks, and uphold agreements.

However, in many shared basins, data systems remain fragmented across national boundaries. Monitoring technologies are often developed within domestic jurisdictions using different standards, formats, and reporting practices, limiting interoperability and the creation of a shared evidentiary base. At the same time, disparities in technical and institutional capacity mean that some actors are better positioned than others to generate, interpret, and use digital data.

These challenges are compounded by political and institutional sensitivities surrounding data (Lonzetta & Hayajneh, 2021; Prasad et al., 2025). Concerns over data ownership, misuse, surveillance, and loss of sovereignty can constrain willingness to share or rely on information generated beyond national borders. In such contexts, digital systems do not automatically enhance cooperation. Instead, they can amplify existing asymmetries and reinforce mistrust.

The rapid expansion of digital water technologies has therefore exposed a critical gap in current approaches to transboundary governance (Pichis-García & Cueva-Rodríguez, 2026). While investments have focused primarily on improving data generation and technical infrastructure, far less attention has been given to the governance arrangements required to ensure that shared digital systems are trusted, legitimate, and usable across jurisdictions.

As a result, many digital initiatives underperform in practice. Increased data availability does not necessarily translate into shared understanding or coordinated action, particularly where actors lack confidence in how data are produced, validated, and used.

This points to a central policy challenge: **how to design digital systems that not only generate data, but also build trust among the actors who depend on them for collective decision-making.**

A Digital Trust Framework for Transboundary Cooperation

To address the limitations of technology-driven approaches, this brief proposes a Digital Trust Framework for Transboundary Cooperation. The framework positions digital trust not as a technical feature of data systems, but as a governance condition that determines whether digitalisation supports cooperation or reinforces contestation.

Rather than focusing on specific technologies, the framework identifies the institutional principles required to ensure that shared digital systems are credible, legitimate, and usable across jurisdictions. It provides a practical lens for designing and evaluating digital water initiatives in transboundary contexts.

The framework is structured around five interrelated principles:

1. Transparency by Design

Digital systems should make data generation processes, assumptions, and limitations visible to all participating actors. Transparency must be embedded at the design stage, enabling a shared understanding of how data are produced and reducing informational asymmetries.

2. Data Sovereignty with Shared Stewardship

While states retain legitimate interests in nationally generated data, transboundary cooperation requires jointly agreed arrangements for data access, use, and governance. Trust emerges when sovereignty is balanced with shared stewardship.

3. Verifiability and Traceability

Confidence in shared data depends on the ability to independently verify information and trace its origin. Audit mechanisms, metadata standards, and validation procedures are essential for ensuring data integrity and limiting disputes.

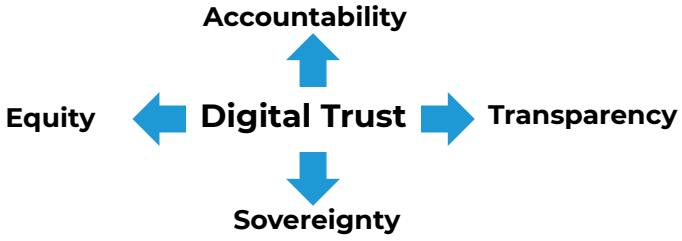
4. Equity and Capacity Parity

Digital systems must not reinforce existing inequalities. All participating actors should have sufficient technical and analytical capacity to access, interpret, and use shared data. Addressing disparities is critical for ensuring fairness and sustained cooperation.

5. Accountability and Redress

Clear accountability mechanisms and accessible pathways for resolving disputes are essential for maintaining trust over time. Defined responsibilities, transparent procedures, and formal avenues for redress strengthen the legitimacy of shared digital systems.

Together, these principles reframe digitalisation as a governance challenge rather than a purely technical one. When embedded within transboundary arrangements, they enable digital systems to support shared decision-making, reduce uncertainty, and strengthen cooperation.



Policy Implications: Building Digital Trust in Practice

Translating digital innovation into effective transboundary cooperation requires a shift in how digital water systems are designed, financed, and governed (Arebu et al., 2025; Expósito & Díez Cebollero, 2025). The Digital Trust Framework highlights that investments in technology must be matched by investments in institutions, rules, and capacity that enable trust across borders.

1. Embed Digital Trust in Transboundary Institutions

River basin organisations and regional bodies should move beyond ad hoc data-sharing arrangements toward formalised digital governance protocols. These should clearly define data access, stewardship, verification procedures, and dispute resolution mechanisms.

Positioning basin institutions as neutral stewards of shared digital systems can reduce politicisation of data and strengthen confidence among member states.

2. Align National Frameworks with Transboundary Data Governance

National governments play a critical role in enabling or constraining digital cooperation. Domestic legal and regulatory frameworks should be aligned with transboundary requirements, including provisions for:

- Cross-border data sharing
- Recognition of digital evidence
- Shared data governance arrangements

Ensuring interoperability and legal clarity strengthens the legitimacy and enforceability of shared digital systems.

3. Invest in Capacity to Ensure Equity

Disparities in technical and analytical capacity remain a major barrier to digital trust. Development partners and governments should prioritise:

- Shared analytical tools and platforms
- Regional technical support mechanisms
- Long-term capacity development

Addressing these asymmetries is essential to ensure that digital transparency is perceived as fair rather than coercive.

4. Shift from Technology-Centred to Trust-Centred Investment

Development partners, including multilateral institutions, should move beyond funding hardware and digital platforms alone. Instead, investments should support:

- Governance design and institutional coordination
- Verification and audit mechanisms
- Inclusive stakeholder engagement

Embedding trust considerations into project design and evaluation can improve the long-term effectiveness of digital water investments.

5. Institutionalise Verification and Accountability Mechanisms

Sustained trust depends on credible systems for verifying data and resolving disputes. Transboundary arrangements should include:

- Independent validation procedures
- Clear responsibilities for data stewardship
- Accessible mechanisms for redress

These measures reduce reliance on informal trust and strengthen institutional resilience over time.

Policy Priorities for Building Digital Trust

To translate digital innovation into effective transboundary cooperation, governments and development partners should prioritise the following:-

- **Institutionalise digital governance frameworks** within river basin organisations, including clear rules for data access, verification, and dispute resolution.
- **Align national legal and regulatory systems** with transboundary data-sharing requirements, ensuring interoperability and recognition of shared digital evidence.
- **Invest in capacity** to reduce asymmetries, including shared analytical tools, regional technical support, and long-term institutional strengthening.
- **Shift from technology-centred to trust-centred investments**, embedding governance design, verification mechanisms, and stakeholder inclusion into digital water projects.
- **Establish accountability and redress mechanisms**, including independent validation procedures and transparent processes for resolving disputes.

Conclusion

Digital technologies are rapidly transforming how water systems are monitored and managed. In transboundary contexts, they offer significant potential to improve transparency, coordination, and evidence-based decision-making.

However, this brief has shown that digitalisation alone does not guarantee cooperation.

The effectiveness of shared digital systems depends fundamentally on **digital trust**: confidence in the data, the rules that govern them, and the institutions that manage them. Where such trust is absent, digital technologies may deepen mistrust, reinforce asymmetries, and intensify contestation. Where it is present, they can enable more adaptive, transparent, and resilient forms of cooperation.

The Digital Trust Framework presented in this brief provides a practical foundation for aligning digital innovation with the governance requirements of transboundary water systems. By embedding transparency, shared stewardship, verifiability, equity, and accountability into digital infrastructures, policymakers can ensure that investments in technology translate into collective benefit.

Call to Action

For governments, regional institutions, and development partners, the priority is not only to digitise water systems, but to design them for cooperation.

This requires:

- Integrating governance frameworks into all digital water investments
- Strengthening institutional capacity for shared data management
- Embedding verification, accountability, and fairness into system design
- Supporting inclusive and transparent cross-border data arrangements

Without trust, digital systems risk becoming sources of dispute.
With trust, they can become foundations for cooperation, resilience, and shared water security

References

Arebu, B. A., Adem, E., Alzahrani, F., Alamri, N., & Elhag, M. (2025). Enhancing Transboundary Water Governance Using African Earth Observation Data Cubes in the Nile River Basin: Insights from the Grand Ethiopian Renaissance Dam and Roseries Dam. Water (Switzerland), 17(13). https://doi.org/10.3390/w17131956.

Expósito, A., & Díez Cebollero, E. (2025). How the digital revolution is reshaping water management and policy: A focus on Spain. Utilities Policy, 96. https://doi.org/10.1016/j.jup.2025.102020

Lonzetta, A. M., & Hayajneh, T. (2021). Challenges of Complying with Data Protection and Privacy Regulations. EAI Endorsed Transactions on Scalable Information Systems, 30, 1–13. https://doi.org/10.4108/eai.26-5-2020.166352

McCracken, M. (2022). Defining Effective Transboundary Water Cooperation. https://doi.org/https://doi.org/10.4324/9781003126249
Pichis-García, R., & Cueva-Rodríguez, M. (2026). Trends and Challenges in Water Governance Systematic Review and Bibliographic Study of Scientific Publications (2018–2025). World Water Policy, 12(2). https://doi.org/10.1002/wwp2.70069

Prasad, N., Diro, A., Warren, M., & Fernando, M. (2025). A survey of cyber threat attribution: Challenges, techniques, and future directions. Computers and Security, 157. https://doi.org/10.1016/j.cose.2025.104606
UN Water. (2008). Transboundary Waters: Sharing Benefits, Sharing Responsibilities.