Southern Africa's shared water systems are under increasing strain from climate change, rising demand, and uneven institutional capacity. As governments and development partners explore Artificial Intelligence (AI) and blockchain to improve data systems, forecasting, and accountability, an urgent policy question emerges: **can digital technologies strengthen cooperation, or will they deepen existing inequalities and tensions?**

POLICY BRIEF

Ethical Governance of AI and Blockchain in Shared Water Systems in Southern Africa

This policy brief examines how artificial intelligence and blockchain are reshaping governance, authority, and decision-making in Southern Africa's shared water systems.

Keywords:
Shared water systems · Artificial Intelligence · Blockchain · Ethics · Water governance · Southern Africa

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Key Message

AI and blockchain have the potential to transform transboundary water governance by enhancing transparency, coordination, and adaptive decision-making. However, without clear ethical safeguards, inclusive data governance, and robust institutional oversight, these technologies may deepen mistrust, reinforce existing inequalities, and destabilise already fragile shared water systems.

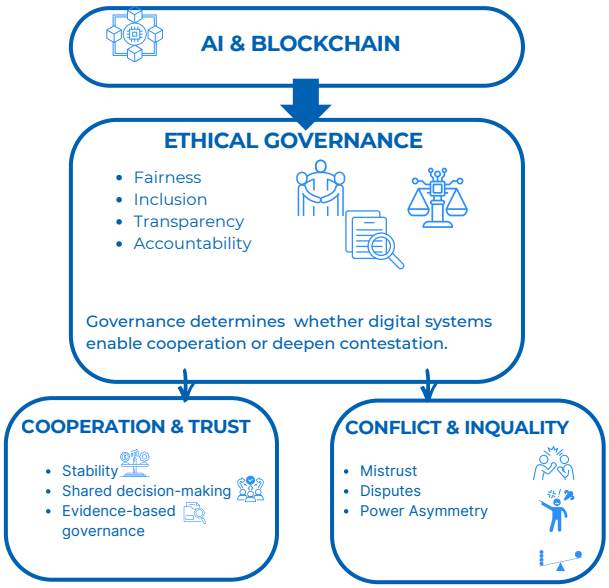
Why This Matters?

Across Southern Africa, shared water systems underpin economic development, food security, and climate resilience. Yet increasing climate stress, population growth, and competing demands are intensifying pressure on these systems.

Digital technologies are often presented as solutions to improve forecasting, transparency, and coordination. However, in politically sensitive transboundary contexts, they are frequently introduced into environments shaped by unequal power relations, fragmented governance, and limited institutional capacity.

Without ethical governance, digital innovation risks amplifying these structural challenges rather than resolving them.

Ethical Governance as a Missing Link



The Policy Problem

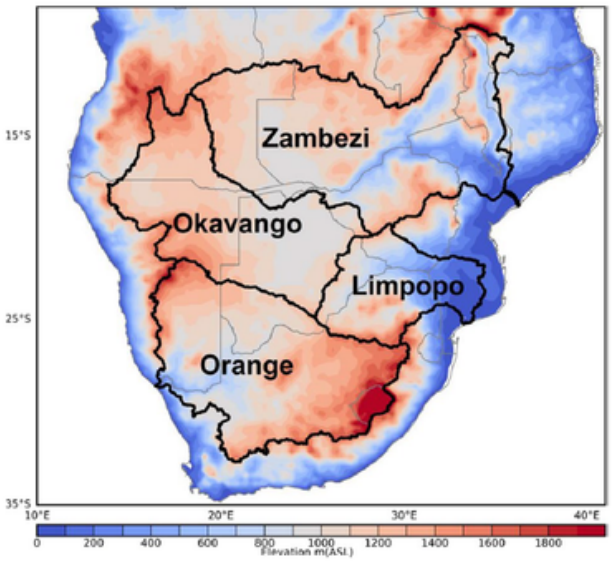


Figure 1: four major river basins (Limpopo,Okavango, Orange and Zambezi) in southern Africa (Samuel et al., 2023)

Southern Africa depends heavily on shared rivers, lakes, and aquifers for livelihoods, agriculture, and regional stability (Ayuba et al., 2025; Nhamo et al., 2018). These systems are increasingly strained by: -

- Climate variability and hydrological uncertainty
- Extreme events, including droughts and floods
- Population growth and urbanisation
- Expanding irrigation and energy demands
- Fragmented governance across national boundaries

At the same time, digital technologies such as AI and Blockchain are being deployed and explored to support monitoring and decision-making (Kanyama et al., 2023, 2025). However, the central challenge is whether states and institutions have the ethical, legal, and institutional capacity to govern these systems fairly.

At a glance

- Shared water systems are critical for regional stability and development
- Digital tools are advancing faster than governance frameworks
- Data, algorithms, and infrastructure are not neutral
- Poorly governed technologies can increase contestation rather than cooperation

The Core Governance Challenge

Balancing Equity, Sovereignty, and Cooperation in a Digital Era

The central challenge facing transboundary water governance in Southern Africa is not the pace of digital innovation, but the conditions under which it is introduced. While AI and blockchain are increasingly promoted as tools to improve monitoring, transparency, and coordination, their deployment is outpacing the development of shared ethical, legal, and institutional frameworks required to govern them effectively (Akpobome, 2024).

In transboundary contexts, digital systems are not neutral instruments. They do more than process and transmit information. They shape authority, redistribute power, and determine whose knowledge is recognised in decision making processes. The design of algorithms, the control of data infrastructures, and the rules governing access and interpretation all influence how water is measured, allocated, and contested across borders.

When introduced into fragile or uneven governance environments, these technologies can unintentionally reinforce existing asymmetries. States or institutions with greater technical capacity may gain disproportionate influence over data production and interpretation, while others remain dependent on systems they cannot fully verify or contest. This can deepen mistrust, heighten political sensitivities around water allocation and compliance, and undermine the legitimacy of shared decision making.

As a result, digital tools intended to support cooperation may instead exacerbate contestation.

Without deliberate governance design, digitalisation risks embedding inequality into the very systems meant to promote transparency and coordination. The challenge is therefore not simply to adopt new technologies, but to ensure they are governed in ways that uphold equity, respect sovereignty, and enable meaningful cooperation.

Digital technologies in transboundary water systems do not only generate data. They shape power, legitimacy, and cooperation.

The Ethical Gap in Digital Water Governance

The growing use of AI and blockchain in transboundary water systems is introducing new forms of decision making that existing governance arrangements are not equipped to address (Feldman, 2026; Kim & Glaumann, 2011).

While traditional water agreements focus on allocation, infrastructure, and cooperation mechanisms, they provide little guidance on how digitally generated knowledge should be governed. Questions surrounding algorithmic decision making, data ownership, and the legitimacy of digital evidence remain largely unresolved.

This creates a new layer of governance complexity (Rosso, 2025). Decisions are increasingly shaped by data models, automated systems, and digital infrastructures, yet there is no shared understanding of how these systems should be evaluated, contested, or trusted across borders.

In practice, this means that two states may rely on the same digital system but interpret its outputs differently, or question the assumptions embedded within it. Without agreed standards for transparency, verification, and accountability, digital systems can introduce ambiguity rather than clarity into transboundary decision making.

The ethical gap therefore lies not in the absence of cooperation, but in the absence of agreed rules governing how digital knowledge is produced, validated, and used in shared water systems.
Addressing this gap is essential to ensure that digital technologies strengthen, rather than destabilise, transboundary cooperation.

Governance Limitations in Practice

Why Existing Arrangements Are Not Fit for Digital Systems

Current transboundary water governance arrangements in Southern Africa were designed for a different era of water management (Anghileri et al., 2024; Jacobs & Nienaber, 2011; Mndzebele, 2025). They are largely built around negotiated agreements, periodic reporting, and state-led data exchange mechanisms. While these approaches have supported cooperation over time, they are not fully equipped to manage the speed, scale, and complexity of digitally mediated decision making.

Digital systems introduce continuous data flows, automated analysis, and new forms of evidence that challenge existing institutional processes. However, governance structures have not evolved at the same pace. In many cases, data sharing remains fragmented, standards are inconsistent, and institutional mandates for managing digital information are unclear.

A key limitation lies in the absence of harmonised rules for digital data governance across borders. While countries may collect increasingly sophisticated data through smart technologies, there is often no shared agreement on how this data should be validated, interpreted, or used in joint decision making. This creates space for conflicting interpretations and weakens the role of digital systems as a common evidentiary base.

Institutional capacity also varies significantly across countries and agencies. Differences in technical expertise, infrastructure, and analytical capability can result in unequal influence over how digital information is produced and applied. Where some actors are better equipped to generate or interpret data, digital systems may unintentionally reinforce existing power imbalances.

Legal and regulatory frameworks further constrain effective governance. Many existing agreements do not explicitly address issues such as digital data ownership, cross border data flows, algorithmic decision making, or accountability for automated systems. As a result, governance arrangements remain incomplete, particularly in relation to emerging technologies.

These limitations mean that digital systems are often layered onto existing governance structures without being fully integrated into them. Rather than strengthening cooperation, this can introduce new uncertainties and tensions, particularly where trust in data and institutions is already fragile.

AI and Blockchain as Governance Technologies

From Technical Tools to Instruments of Power and Coordination

The growing integration of AI and blockchain into water management is often framed in technical terms, as tools to improve efficiency, accuracy, and transparency. However, in transboundary water systems, these technologies perform a far more consequential role. They function as governance technologies that shape how decisions are made, validated, and enforced across political boundaries.

AI is increasingly used to analyse hydrological data, forecast water availability, optimise allocation, and detect anomalies in water use (Devineni et al., 2023; Kanyama et al., 2024; Kim & Ahmad, 2025). These capabilities position AI systems as influential actors in decision making processes. The outputs generated by predictive models and optimisation algorithms can inform allocation decisions, compliance assessments, and infrastructure planning. Yet these systems are not neutral. They are shaped by the data on which they are trained, the assumptions embedded in their design, and the objectives defined by those who deploy them.

In transboundary contexts, this raises critical concerns. If underlying data are incomplete, biased, or unevenly distributed across states, AI driven decisions may privilege certain actors while disadvantaging others. Similarly, where algorithmic models are not transparent or cannot be independently assessed, their outputs may be contested, particularly in politically sensitive allocation negotiations.

Blockchain technologies are often presented as mechanisms for enhancing trust through immutable and transparent records. In water governance, they are proposed for tracking water use, managing allocation rights, and facilitating data sharing across institutions. While blockchain can strengthen traceability, it also introduces new governance questions.

Decisions regarding who operates the system, who validates transactions, and how access is controlled become central to how authority is exercised.

In shared water systems, blockchain does not eliminate the need for trust. Rather, it redistributes it. Trust shifts from institutions to technological architectures, raising questions about accountability, control, and inclusion. If governance arrangements are not clearly defined, blockchain systems may concentrate control in the hands of a few actors or exclude those with limited technical capacity.

Taken together, AI and blockchain reshape the governance landscape of transboundary water systems. They influence how knowledge is produced, how decisions are justified, and how compliance is monitored. Their impact extends beyond technical performance to the political and institutional dynamics that underpin cooperation.

Recognising these technologies as governance instruments rather than neutral tools is essential. Without this shift, their deployment risks reinforcing existing asymmetries, introducing new forms of contestation, and complicating already fragile governance arrangements.

Ethical Governance Framework for AI and Blockchain in Transboundary Water Systems

Governing Digital Authority, Knowledge, and Control

The integration of AI and blockchain into transboundary water systems requires a deliberate rethinking of governance. These technologies do not simply support existing institutions. They reshape how authority is exercised, how knowledge is produced, and how decisions are legitimised across borders.

An ethical governance framework is therefore necessary to ensure that the deployment of these technologies does not undermine cooperation or reinforce asymmetries, but instead supports fair, accountable, and legitimate decision making.

The framework proposed here identifies the core governance conditions required to regulate how AI and blockchain systems operate within shared water contexts.

Core Governance Dimensions

1. Governance of Algorithmic Authority

AI systems increasingly influence decisions related to water allocation, forecasting, and compliance. Ethical governance requires that the authority exercised by these systems is clearly defined, limited, and subject to oversight.

This includes establishing:

- institutional responsibility for algorithmic outputs
- transparency in model design and assumptions
- human oversight in critical decision making processes

The central concern is whether their authority is legitimate and appropriately governed.

2. Governance of Distributed Ledger Control

Blockchain systems introduce new forms of decentralised data management and record keeping. However, decentralisation does not eliminate control. It reconfigures it.

Ethical governance must define:

- who operates and maintains the ledger
- who validates transactions and sets rules
- how access and participation are structured

Without clear governance, blockchain systems risk concentrating control in ways that are less visible but equally powerful.

3. Governance of Data Hierarchies and Bias

AI systems depend on data, and data are never neutral. Differences in data availability, quality, and representation across countries can shape outcomes in ways that favour certain actors.

Ethical governance must address:

- unequal data infrastructures across states
- biases embedded in datasets and models
- the exclusion of local or non digitised knowledge

The objective here is to prevent digital systems from reproducing or amplifying existing inequalities.

4. Governance of Cross Border Digital Jurisdiction

AI and blockchain systems operate across national boundaries, often without clear legal alignment. This creates uncertainty regarding which laws apply and who is accountable.

Ethical governance requires:

- agreed frameworks for cross border data flows
- clarity on jurisdiction over digital systems
- alignment between national and transboundary regulations

This is essential for ensuring that digital systems operate within recognised legal and institutional boundaries.

5. Governance of Contestation and Dispute Resolution

Digital systems introduce new forms of evidence into transboundary negotiations. However, without mechanisms to challenge or interpret this evidence, they can become sources of conflict.

Ethical governance must ensure:

- the right to contest algorithmic outputs
- procedures for disputing digital records
- institutional pathways for resolving technology driven disagreements

This ensures that digital authority remains accountable and open to scrutiny.

6. Governance of System Evolution and Long Term Responsibility

AI models evolve, and blockchain systems persist over time. Their impacts are not static. Ethical governance must account for how these systems change and who remains responsible for their consequences.

This includes:

- periodic review of system performance and impacts
- mechanisms for updating governance arrangements
- long term accountability for digital system outcomes

From Governance to Cooperation

These governance dimensions provide a structured basis for ensuring that AI and blockchain systems support rather than undermine transboundary cooperation. By explicitly addressing authority, control, knowledge, and accountability, this framework shifts the focus from technological capability to governance legitimacy.

Without such a framework, digital systems risk becoming sources of ambiguity, contestation, and imbalance. With it, they can contribute to more transparent, equitable, and resilient forms of cooperation in shared water systems.

The question is no longer whether AI and blockchain can improve water governance, but who governs them, under what rules, and in whose interest.

Policy Priorities for Ethical Governance of AI and Blockchain

From Framework to Action

Translating ethical governance into practice requires targeted action by governments, regional institutions, and development partners. The following priorities outline the key steps needed to ensure that AI and blockchain systems support fair, legitimate, and cooperative transboundary water governance.

1. National Governments

National governments play a central role in shaping how digital technologies are adopted and governed within transboundary water systems.

Priority actions include:

- Establish legal recognition of digital water data and algorithmic outputs within national regulatory frameworks to ensure their legitimacy in decision making
- Develop national guidelines for the ethical use of AI in water management, including standards for transparency, human oversight, and accountability
- Define clear policies on data ownership and cross border data sharing, ensuring alignment with transboundary obligations
- Invest in institutional and technical capacity to reduce dependence on external systems and strengthen national participation in digital governance

2. River Basin Organisations and Regional Institutions

River basin organisations are critical for coordinating cooperation and providing neutral platforms for shared governance.

Priority actions include:

- Develop joint protocols for AI and blockchain governance, including rules for data validation, algorithmic transparency, and system oversight.

- Establish shared digital platforms or observatories that are governed collectively rather than controlled by individual states
- Create independent verification mechanisms to assess digital data and algorithmic outputs used in transboundary decision making
- Facilitate inclusive dialogue among member states to build consensus on the ethical use of digital technologies

3. Development Partners and Donors

Development partners have significant influence over how digital systems are designed and implemented through funding and technical support.

Priority actions include:

- Shift from technology-driven projects to governance-driven investments, ensuring that ethical frameworks are embedded from the outset
- Require governance safeguards as part of funding conditions, including transparency, accountability, and inclusive participation
- Support regional capacity building initiatives to address disparities in technical and institutional capability
- Fund pilot projects that integrate AI and blockchain with governance design, generating practical lessons for scaling.

4. Cross-Cutting Priorities

Certain actions cut across all actors and are essential for coherent governance.

These include:

- Developing shared regional standards for digital water governance, particularly for AI use, blockchain implementation, and data interoperability
- Ensuring that digital systems remain subject to human oversight, particularly in high-stakes decisions such as water allocation
- Embedding dispute resolution mechanisms specifically designed to address digital evidence and algorithmic decisions
- Promoting transparency in system design and operation to build confidence among stakeholders

Digital innovation must be matched by governance innovation. Without this alignment, technological progress will not translate into cooperative outcomes.

Conclusion and Strategic Outlook

Governing Digital Transformation for Shared Water Futures

The integration of AI and blockchain into transboundary water systems marks a significant shift in how water governance is practiced. These technologies are not simply enhancing existing processes. They are redefining how knowledge is produced, how decisions are made, and how authority is exercised across borders.

This brief has shown that the central challenge is not technological adoption, but governance readiness. While digital systems offer new opportunities for monitoring, coordination, and adaptive management, their effectiveness depends on the institutional conditions within which they operate. Without clear ethical frameworks, aligned legal systems, and inclusive governance arrangements, these technologies risk reinforcing existing inequalities, introducing new forms of contestation, and undermining cooperation.

The ethical governance of AI and blockchain is therefore not an optional consideration. It is a prerequisite for ensuring that digital transformation contributes to equitable and sustainable water management in shared basins.

Looking ahead, the trajectory of transboundary water governance will increasingly be shaped by how digital systems are governed. Decisions made today regarding data ownership, algorithmic authority, system control, and accountability will define whether these technologies become tools for cooperation or sources of division.

The future of transboundary water governance will not be determined by the technologies that are deployed, but by the rules and institutions that govern them.

For Southern Africa, where shared water systems are central to economic development, climate resilience, and regional stability, the stakes are particularly high. Strengthening governance frameworks for digital systems offers an opportunity not only to manage water more effectively, but to build more resilient and cooperative institutional relationships across borders.

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