Advancing water governance in the Lake of Palmas River Basin

POLICY BRIEF | JULY 2025

Summary

This policy brief synthesizes findings from participatory research conducted in the Lake of Palmas River Basin, Brazil, focusing on water governance challenges and opportunities. Using Water Flow Diagrams (WFD) and the Viable System Model (VSM), the study engaged stakeholders to co-diagnose systemic issues and co-design governance improvements.

This policy brief is designed for stakeholders in the Palmas Lake River Basin from both civil society and local government.

Context

The Lake of Palmas River Basin in Brazil's Tocantins-Araguaia Hydrographic Region is under growing pressure from climate variability, rapid urbanization, and expanding agriculture. These dynamics are increasing water demand while reducing availability, particularly during the dry season. The region, part of the ecologically vital Cerrado biome, plays a key role in food production, energy generation, and urban supply.

Despite its importance, the basin faces significant water management challenges. Water losses in irrigation and urban supply are high, and pollution from agricultural runoff and inadequate rural sanitation threatens water quality. Governance is fragmented, with limited coordination between agencies, weak enforcement of water rights, and insufficient data to support informed decision-making.

These issues are compounded by institutional gaps at the local level, where management units often lack the resources and authority to respond effectively. As water stress intensifies, there is an urgent need for improved monitoring systems, stronger inter-agency collaboration, and inclusive governance structures. Addressing these challenges is essential to ensure long-term water security, environmental sustainability, and equitable access for all users in the basin.

Key Messages

1. Diagnostic strengths of participatory diagraming

- The integration of WFD and VSM in a participatory process effectively identified systemic challenges in water governance.
- Visualizing water flows helped stakeholders understand issues in distribution, losses, and contamination risks.
- The participatory diagnostic process enabled inclusive discussion and co-design of potential solutions.

2. Governance and institutional gaps

- Strategic misalignments were revealed between environmental realities, operational practices, and policy frameworks.
- Weak coordination between local and higher-level institutions limits effective water management.
- Local management units require technical and financial support to fulfill their roles effectively.

3. Water use and risk management

- Imbalances in water rights allocation and enforcement contribute to overuse and illegal abstraction.
- Contamination risks from agriculture and inadequate sanitation remain unaddressed due to poor monitoring.

4. Data and information systems

- Strengthening inter-agency information sharing is critical to improving governance responsiveness.
- Real-time data platforms for hydro-meteorological conditions and water usage should be scaled up.

Partners: Eawag Sandec, Universidade Federal do Tocantins, Universidade Federal Fluminense, Instituto Tecnológico de Aeronáutica, OST Fachhochschule Ostschweiz, Universität St. Gallen

Participatory Approach

The study adopted a structured, step-by-step participatory process to assess and improve water governance in the Lake of Palmas River Basin. This participatory process fostered shared understanding, built trust among stakeholders, and laid the foundation for more resilient and inclusive water governance.

- **Initial Diagnosis**. The process began with a review of official documents, regulations, and qualitative interviews with representatives from key institutions. This helped identify preliminary governance challenges and informed the development of diagnostic tools.
- **Water Flow Visualization**. Several Water Flow Diagrams (WFD) were created to visualize seasonal water balances, usage patterns, and contamination risks. This provided a clear, accessible overview of the physical water system.
- **Governance Assessment.** The Viable System Model (VSM) was applied to analyze the structure and functioning of the water governance system. It highlighted systemic gaps such as weak coordination, limited monitoring, and unclear responsibilities.
- **Workshop 1 – Identifying Challenges.** The first co-creation workshop brought together stakeholders from federal and state agencies, municipal authorities, NGOs, civil society, indigenous groups, and the water utility. Participants reviewed the WFD and an initial outline of the VSM, discussed systemic governance issues, and proposed preliminary recommendations. Discussions were held in both plenary and breakout groups to ensure inclusive participation.
- **Workshop 2 – Refining Solutions.** The second workshop focused on refining the initial proposals, assessing their feasibility, and consolidating them into actionable steps. Participants also considered how to adapt strategies based on evolving governance dynamics and feedback from the first session.

Throughout both workshops, facilitators ensured balanced participation, managed speaking time, and helped resolve disagreements. This ensured that all voices were heard and that the outcomes reflected collective input.

Project Objectives

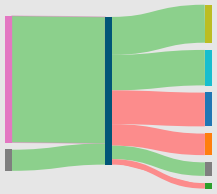
- Identify challenges in water supply and water quality management in Palmas, including areas of vulnerability for climate change related risks (scarcity, flooding, water contamination)
- Analyse governance of water services in the Lake of Palmas River Basin and identify challenges and potential fields for improvement using a participatory approach.

Participatory Diagramming Methods

Water Flow Diagram (WFD)

The Water Flow Diagram (WFD) is a visual which quantifies the movement of water through a defined system, such as a watershed or urban environment [2]. The diagram highlights sources, uses, losses and contamination risks. The diagram also illustrates the proportional volumes of water and a colour-code to distinguish problematic (red), appropriate (green), and unknown (grey) water management practices.

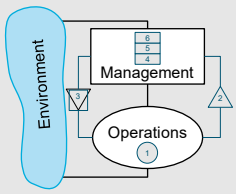
- Research teams partnered with local authorities to create and refine WFDs by compiling water flow data from different data sources



Viable Systems Model (VSM)

The Viable System Model (VSM) is a visual diagraming approach to analyse governance or organizational systems [3]. It is specifically designed to assess how systems adapt to complexity and change. It identifies five essential subsystems, 1) operations, 2) coordination, 3) management, 4) monitoring, and 5) policy that must function and interact effectively for a system to remain viable.

- Research teams partnered with local authorities to create and refine VSMs based on a review of documents and interviews with key stakeholders



This brief does not include the developed VSM, but instead includes a summary of identified challenges.

Diagnosis of Water Flows - Lake of Palmas Watershed

Water flows in millions of cubic meters (Mio m3).

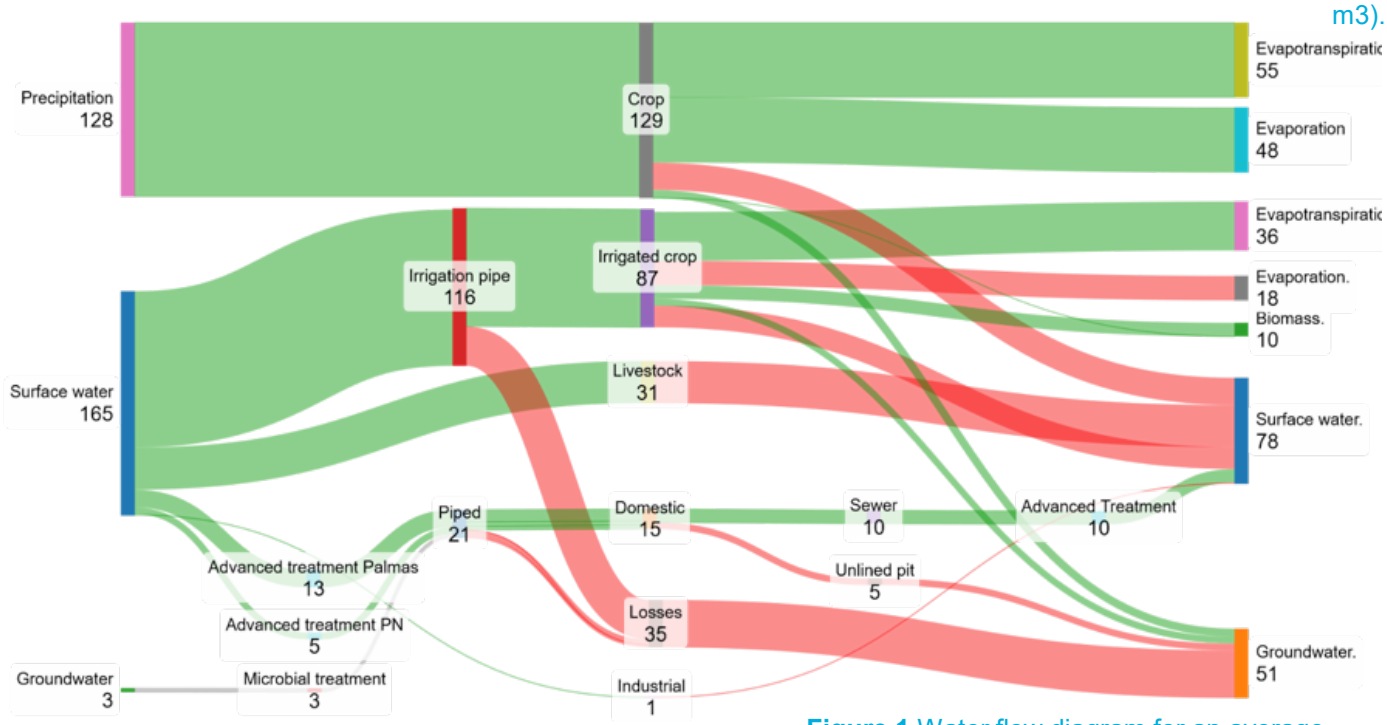


Figure 1 Water flow diagram for an average dry season (6 months) based on data from 1993-2023.

The WFD diagram highlighted various the outcomes of challenges in water service management in the Lake of Palmas River Basin (see **Figure 1**) which were particularly pronounced during the dry season when the area was affected by extended droughts during the past years. During the dry periods, large volumes of water were partially illegally abstracted for the irrigation of 2.7% of the agricultural area. During transit about 25% of the water used for irrigation was lost. In the urban water supply system, water losses amounted to 30-39%. Water losses in urban distribution systems above 30% are regarded as highly inefficient and problematic. Such losses often indicate poor system management or aging infrastructure, resulting in economic and resource inefficiencies [1].

Areas with a potential to contaminating surface water were identified in the run-off of pesticides from intensive agriculture and sewage from livestock production, while inadequate sanitation solutions in remote and rural areas may pose a risk to contaminating groundwater. Sanitation in the cities of Palmas and Porto Nacional was well-managed, with sewer connections for 80% and 60% of the population and treatment of effluents. The adequacy of drinking water and waste water treatment in remote communities remained unclear.

Not visualized in the diagram are the industrial use of water and the abstraction of groundwater as these water volumes are not documented in the case of industrial water use or not documented nor regulated in the case of groundwater abstraction.

Highlights

- Large volumes used to irrigate 2.7% of agricultural area
- 25% water loss for irrigation
- 30-39% water loss in urban area
- High contamination risks
- Inconsistences between actual water use and granted water use rights

Diagnosis of Water Governance - Lake of Palmas Watershed

1 Operations	• Weak local management units • Lack of technical capacity • Lack of decision making autonomy • Lack of access to data
2 Coordination	• Information silos, weak coordination of different levels of management
3 Executive Management and Monitoring	• Without information generated by operations, S3 lacks capacity to link legal requirements, supervision and implementation • Weak monitoring mechanisms on hydrometeorology, water demand vs availability and quality • Lack of compliance with water utilization permits
4 Strategy (Intelligence)	• Deficiencies in interoperability between federal and state level agencies • Struggles to implement key management instruments such as water use charges, water body classification and water rights allocation
5 Policy	• State Council of Water Resources resembles «registration chamber»

Figure 2 Summary of challenges within the governance system of water services in the "Lake of Palmas" River Basin

The governance structure of the Lake of Palmas River Basin was analyzed using the Viable System Model (VSM), which maps the roles and relationships of key stakeholders across five core subsystems. A diagnostic diagram illustrated the constellation of actors involved in water management and highlighted critical dysfunctions, particularly where components were missing or underperforming.

At the operational level (System 1), local management units were found to be weak. These units lacked decision-making autonomy, technical capacity, infrastructure, and access to reliable data. Their limited ability to implement regulations and communicate with higher levels of governance severely constrained their effectiveness. The absence of integrated data platforms further impaired coordination and responsiveness.

System 2, responsible for coordination, also showed significant weaknesses. Monitoring mechanisms for hydrometeorology, water demand, and water quality were underdeveloped. As a result, information exchange between key institutions—such as Naturatins, Semarh, ATS, BRK, and ANA—was fragmented, reducing the system's ability to respond to emerging challenges.

System 3, the executive management function, is led by the Palmas Lake River Basin Committee (CBHLP). While the committee includes representatives from government, civil society, and water users, it struggles with unbalanced stakeholder representation, high turnover, and limited technical and financial resources. Its current focus on regulatory compliance, such as water quality classification and water use charges, leaves little capacity for proactive governance.

System 3* (monitoring and auditing) is primarily the responsibility of Naturatins. However, the agency is overstretched, with broad environmental licensing duties across the state, limiting its ability to enforce water regulations effectively.

System 4 (strategic planning) is managed by Semarh, which develops state-level water policies. These must be approved by System 5, the State Water Resources Council (CERH). However, CERH often validates plans without thorough review or debate, leading to a disconnect between long-term strategies and operational realities. This misalignment undermines the system's ability to adapt to local needs and environmental pressures.

Reflections and Next Steps

The assessment of water governance in the Lake of Palmas River Basin, using the Water Flow Diagram (WFD) and the Viable System Model (VSM), revealed a significant gap between the regulated allocation of water use rights and actual, often illegal, water abstraction. This imbalance has been exacerbated by prolonged droughts, which increase pressure on already limited water resources. In a well-functioning system, water rights should align with available supply, but the current mismatch indicates that operational capacity is insufficient to manage this complexity effectively

Local management units are either weak or entirely absent in some areas. Where they do exist, they often lack the autonomy, infrastructure, and technical capacity needed to oversee daily operations. These deficiencies are compounded by poor data generation and monitoring systems, and by the absence of reliable platforms for sharing information between operational and higher-level governance bodies. As a result, coordination between legal mandates, supervision, and implementation is severely impaired.

A critical weakness is the lack of an “algedonic channel”—a feedback mechanism that alerts decision-makers to emerging threats such as water scarcity, overuse, or pollution. Without this, the system cannot respond proactively or adaptively. Strengthening data collection, real-time monitoring, and information-sharing platforms is essential to improve responsiveness and coordination.

The combined use of WFD and VSM in a participatory setting proved highly effective in identifying these challenges and co-developing mitigation strategies. The visualization of water flows and governance structures enabled stakeholders to pinpoint inefficiencies and risks. The process also highlighted the need to improve strategic alignment between environmental realities, operational needs, and policy frameworks. Strengthening inter-agency coordination and scaling up access to real-time hydro-meteorological and consumption data are key steps toward building a more resilient and equitable water governance system.

Existing reporting and Microsoft Copilot were used to support the development of this policy brief.

References

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