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# Assessing Institutional and Governance Frameworks in Sub-Basin Water Management: A Multi-Level Comparative Case Study

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**Abstract:**
Integrated Water Resources Management aims to promote sustainable, equitable, and efficient water use, especially in regions facing scarcity, pollution, or institutional fragmentation. This study examined the effectiveness of sub-basin governance in three cases: Nawuni Sub-Basin in Ghana, São Francisco and Paraíba do Sul Basin in Brazil. The objective was to assess how institutional structures, coordination mechanisms, and stakeholder participation shape governance outcomes. A qualitative comparative case study approach was used, drawing on government documents, basin management plans, research publications, and international policy assessments. The findings show that strong legal frameworks alone do not guarantee effective water governance. The São Francisco Basin benefits from a decentralized and participatory structure but struggles with coordination, enforcement, and equitable resource allocation. Paraíba do Sul applies scenario-based planning but faces fragmented administration, inconsistent instruments, and limited technical and financial capacity. The Nawuni Sub-Basin reflects cooperation between national agencies and traditional authorities, yet is constrained by weak legislation, overlapping mandates, limited funding, and poor enforcement. The study concludes that governance performance depends on institutional capacity, coordination across levels, stakeholder empowerment, and sustainable financing. It recommends legal harmonization, stronger vertical and horizontal coordination, targeted capacity-building, improved enforcement, and continued empirical research to guide long-term IWRM implementation.

**Keyword**: Integrated Water Resources Management, Stakeholder Empowerment, Sustainable, Institutional Capacity, Stakeholder Empowerment, São Francisco River Basin, Nawuni Sub-Basin, Paraíba do Sul River Basin, Ghana, Brazil.

## 1. INTRODUCTION

Integrated Water Resources Management has become the main framework for sustainable, equitable, and efficient water use in different ecological and governance settings. It focuses on coordinated planning and decision making at river basin level (where competing social, economic and environmental demands are most visibly present) (Benson et al., 2020). Sub-basins are operational units through which national water

policies are translated into practical actions (Mees et al., 2017). Governance arrangements of sub-basins are usually a mix of state institutions, basin committees, local governments, private actors and community stakeholders. The effectiveness of arrangements depends on clear legal mandates, properly functioning coordination mechanisms, and the financing and participation of affected water users. Because countries adopt IWRM in different political, institutional and cultural contexts sub-basin governance outcomes differ considerably so comparative analysis is both relevant and necessary.

Although IWRM principles are widely accepted, many sub-basins still face fragmented institutions, overlapping responsibilities, weak technical and financial capacity and weak community involvement (Duda & Hirji 2025; Liambila 2017). Federal systems like Brazil have decentralization so basin committees are participatory but they lack strong legal authority and coordination across levels of government is inconsistent (Abers & Keck 2013); Ghana is transitional governance context where national water policies coexist with customary institutions whose roles are not always clear (Atampugre et al. 2016). São Francisco and Paraíba do Sul Basins were chosen because they show a mature but imperfect decentralized system while Nawuni Sub-Basin shows how IWRM works in a setting where institutional consolidation is still emerging. Though the basins are politically and ecologically different they can be compared since it helps understand how institutional design functions under different governance environments. Empirical research on sub-basin governance in federal and transitional settings is sparse so there is a gap in our understanding of conditions that enable or constrain effective IWRM implementation. The aim of this study is to examine the institutional and governance frameworks of São Francisco, Paraíba do Sul and Nawuni sub-basins with a multi-level comparative case study approach. Specifically, we want to look at legal and institutional arrangements, coordination processes and participatory mechanisms; challenges, strengths and determinants of effective sub basin water governance so that insights can be generated for IWRM implementation in federal and transitional governance contexts.

## 2. RELATED RESEARCH WORK

This study focuses on three selected sub-basins: the São Francisco River Basin and the Paraíba do Sul River Basin in Brazil, and the Nawuni Sub-Basin in Ghana. These cases were purposively selected because they represent different stages of development and implementation of Integrated Water Resources Management (IWRM), providing contrasting institutional and governance experiences for examining how institutional arrangements influence water management outcomes. The São Francisco River Basin represents a relatively mature decentralised governance model, while the Paraíba do Sul River Basin reflects a partially integrated institutional system. In contrast, the Nawuni Sub-Basin represents a transitional governance context characterised by the interaction of formal institutional structures and customary water management arrangements. The selection of these cases is intended to capture a broad range of governance conditions that would not be adequately represented by examining basins with similar institutional characteristics. Comparing these contrasting contexts provides an opportunity to identify institutional features that consistently contribute to effective IWRM implementation, distinguish context-specific governance practices, and generate broader, transferable lessons for strengthening sub-basin water management across different institutional and administrative settings.

**Nawuni Sub-Basin, Ghana**

The Nawuni Sub-Basin, located within the White Volta River system in northern Ghana, is an essential hydrological unit that supports domestic water supply, irrigation, small-scale fisheries, and livelihoods across surrounding communities (Tahiru et al., 2020). It serves as a major raw water source for the Ghana

Water Company Limited, making it a critical resource for both urban and rural populations (Banda, 2023). As mandated by Ghana's National Water Policy, the basin falls under the jurisdiction of the Water Resources Commission (WRC), which oversees planning, regulation, and the coordination of water-related activities (Frimpong et al., 2021).

Institutional processes such as IWRM planning, community forums, and stakeholder engagement platforms are central to governance in the Nawuni Sub-Basin. These processes help guide resource allocation, support monitoring activities, promote dialogue between customary authorities and government institutions, and enhance accountability in water use (Obuobie, 2008). They also contribute to creating an enabling environment where basin-level structures can function effectively within Ghana's decentralization framework.

Ghanaian studies, including those by Mul et al. (2015), show that agencies such as the Water Resources Commission, district assemblies, and traditional councils endorse these IWRM processes because they facilitate coordinated planning and strengthen the integration of local knowledge into water management. Their support provides technical direction, regulatory oversight, and collaboration channels that help address management gaps. Despite these institutional efforts, achieving effective vertical coordination between national agencies, district authorities, and community-level actors remains challenging (Dirwai et al., 2021). Key constraints include overlapping mandates among institutions, inconsistent enforcement of regulations, limited financial and technical capacity at district levels, weak data collection systems, and irregular stakeholder engagement. These challenges restrict the basin's ability to operationalized IWRM principles consistently, thereby reducing the effectiveness of policy implementation on the ground.

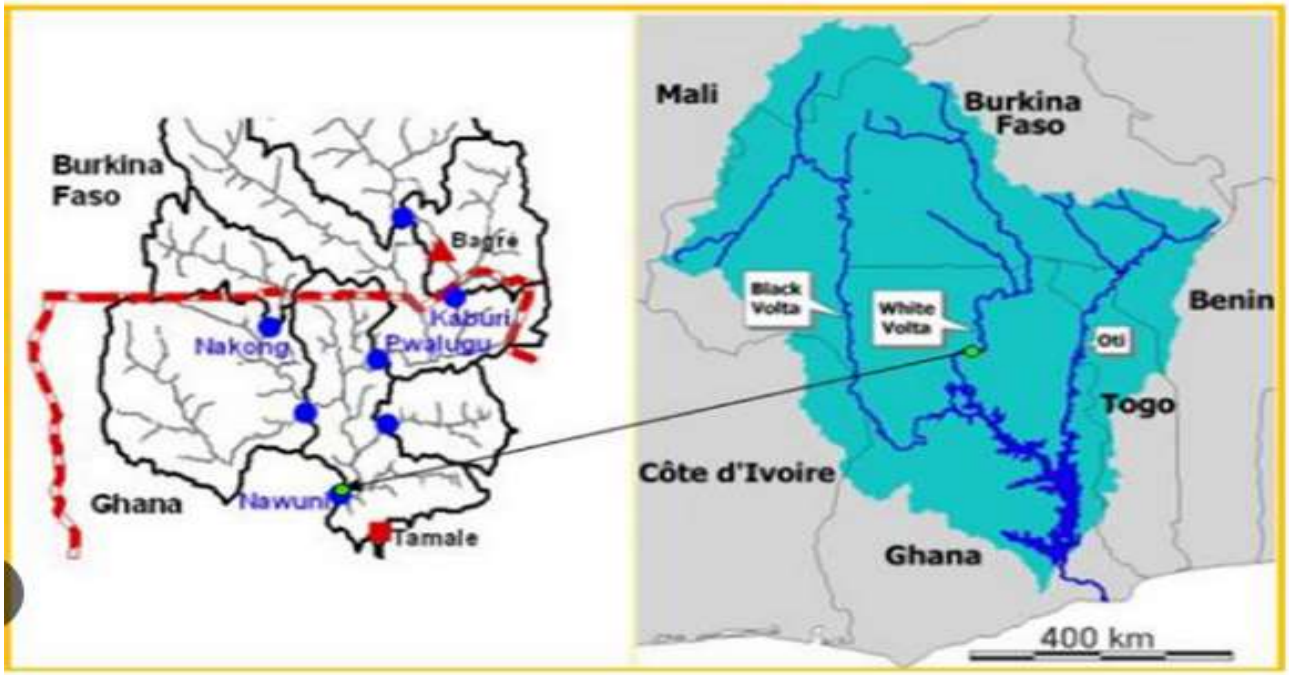



**Figure 1 Nawuni River Basin on the Left (adopted from** Alhassan et al., 2023)

**São Francisco River Basin, Brazil**

The São Francisco River Basin (SFRB) is a significant watershed in Brazil, as shown in Figure 2. The basin encompasses approximately 636,920 km² across seven states in Brazil and fulfils multiple functions, such as agriculture, hydroelectric power generation, fishing, and domestic water supply (Santos et al.,

2023 and Andrade et al., 2024). Brazil's National Water Resources Policy asserts that the basin falls under its jurisdiction. The Committee for the Basin of the São Francisco River (CBHSF) is responsible for the planning and allocation of water resources (Bouckaert et al., 2020). River basin plans, user-pays principles, and stakeholder forums are institutional processes that strengthen basin governance by guiding decision making, improving accountability, and ensuring that water users contribute to the cost of management (Delipınar & Karpuzcu, 2017). These mechanisms are not only procedural tools, but they also help create a stable institutional environment where basin committees can operate effectively.

Bouckaert et al. (2020) show that agencies such as the Agência Nacional de Águas (ANA) and Agência Peixe Vivo support these processes because they promote coordinated planning and reinforce the implementation of IWRM principles. In practice, their endorsement means that basin organizations receive technical backing, regulatory guidance, and financial mechanisms that help bridge gaps in local capacity. The attainment of efficient vertical coordination among federal, state, and local levels, aimed at ensuring the inclusion and active participation of all stakeholders, remains hindered by numerous challenges (Schmeier, 2012). These challenges commonly include fragmented administrative structures, poor harmonization of data and monitoring systems, insufficient technical capacity at sub-national levels, and limited mechanisms for sustained stakeholder participation. Together, these constraints weaken the ability of basin organizations to translate national IWRM principles into effective action on the ground (Baatuuwie, 2015).

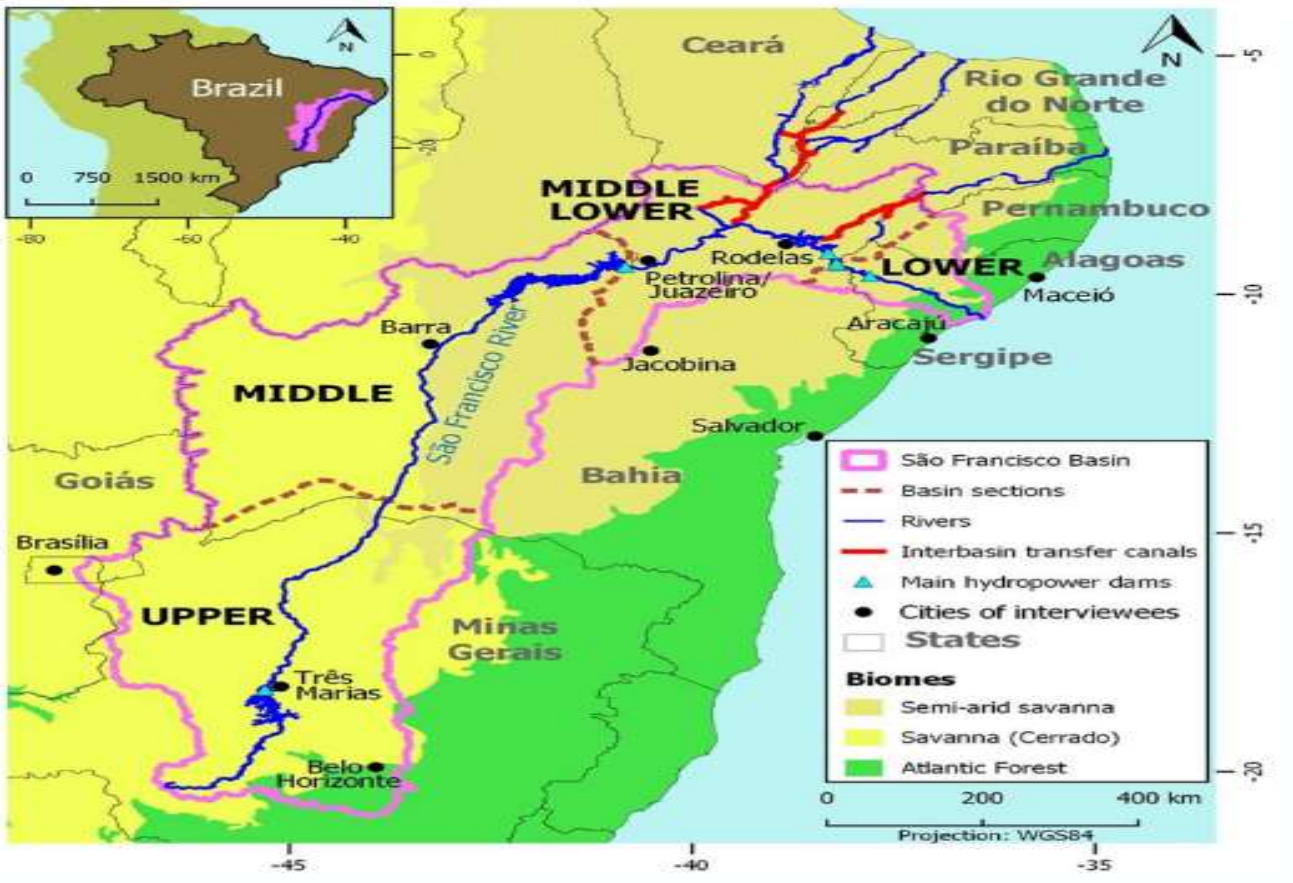



**Figure 2 São Francisco River Basin sections (upper, middle, middle-lower, and lower). (Adopted from Bouckaert et al., 2020)**

**Paraíba do Sul River Basin, Brazil**

The Paraíba do Sul River Basin, spanning parts of Rio de Janeiro, São Paulo, and Minas Gerais, is a strategically important watershed that supports industrial activities, agriculture, hydropower, and domestic water supply for major urban centres (da Encarnação Paiva et al., 2020). Governed under Brazil's National Water Resources Policy, the basin is managed through the Comitê para Integração da Bacia Hidrográfica do Rio Paraíba do Sul (CEIVAP), which oversees planning, allocation, and monitoring activities (de Oliveira et al., 2023).

Institutional tools such as basin plans, scenario-based modelling, and user-pays mechanisms guide decision-making and enhance the accountability of water users. These governance processes help CEIVAP coordinate actions across federal and state levels while promoting participatory approaches in line with IWRM principles (da Encarnação Paiva et al., 2024). Support from entities like the Agência Nacional de Águas (ANA) and the regional executive agency AGEVAP further strengthens basin operations by providing technical and financial assistance (Fico et al., 2022).

However, studies highlight that vertical and horizontal coordination remains constrained by fragmented administrative responsibilities, inconsistent planning instruments, and limited financial and human resources (Bouckaert et al., 2020). These challenges reduce the basin's ability to fully integrate stakeholder inputs and implement IWRM measures effectively (Schmeier, 2012).

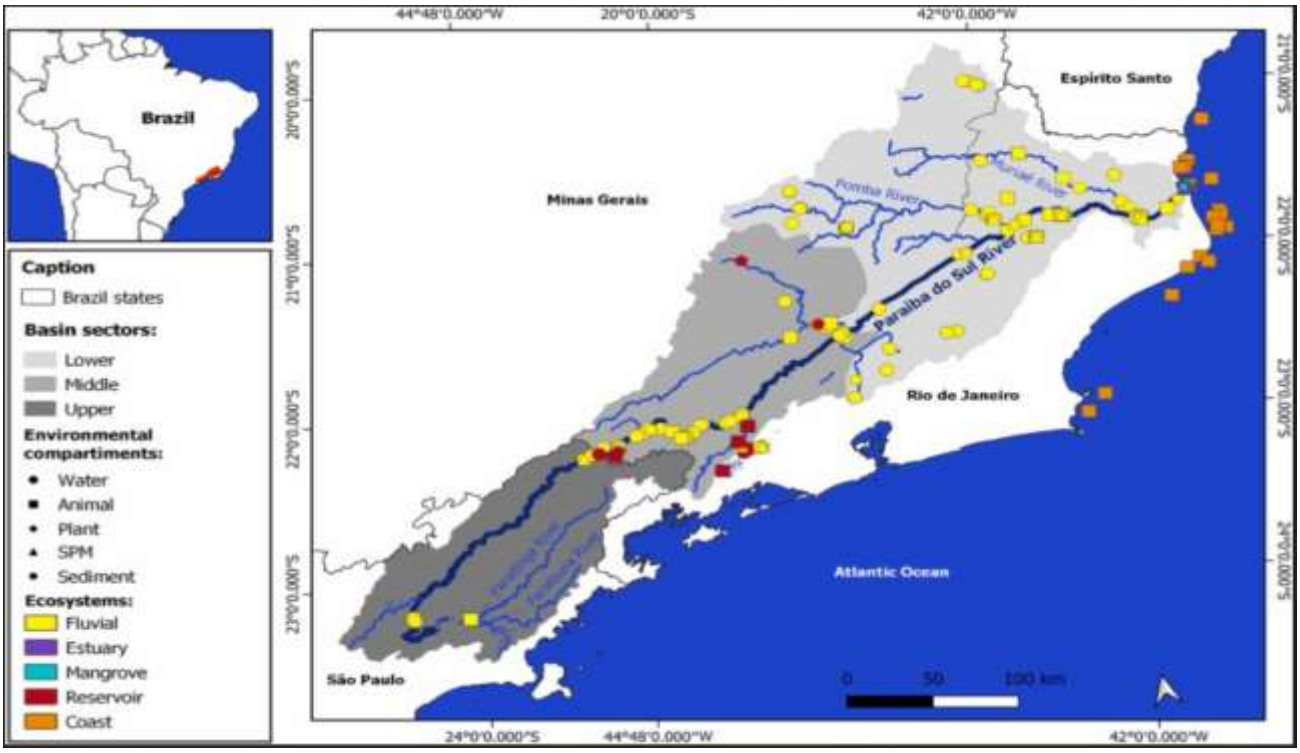



**Figure 3 Paraíba do Sul River Basin, Brazil (adopted from** Araújo et al., 2024**).**

## 3 METHODOLOGY

This study employed an explanatory case study design to examine how institutional structures, coordination mechanisms, and stakeholder processes influence Integrated Water Resources Management across the São Francisco, Paraíba do Sul, and Nawuni sub-basins. An explanatory case study is suitable for understanding how and why governance outcomes occur within real-life settings where multiple actors

and policies interact (Robert, 2018). The design is appropriate because water governance is complex, context-dependent, and shaped by relationships among legal frameworks, basin agencies, and local stakeholders. This approach allows the study to link observed patterns to underlying institutional factors rather than simply describing basin characteristics (Yin, 2009). Using secondary data, including policy documents, basin plans, and scholarly sources, the explanatory case study supports triangulation and strengthens the credibility of findings. It also enables meaningful cross-case insights into the conditions that promote or hinder effective IWRM implementation.

Two analytical frameworks guided the study. The Institutional Analysis and Development (IAD) Framework was used to explore rules-in-use, actor behaviour, and institutional processes influencing basin governance. The IAD has been widely applied in water governance studies, including Assis et al. (2020) and Bouckaert et al. (2020), because it helps reveal how formal and informal rules shape coordination and decision-making. Its main advantages are its systematic structure and ability to analyse complex institutional settings. A limitation, however, is that it requires rich institutional data and may overlook cross-scale power dynamics if used alone.

To complement this, the Multi-Level Governance (MLG) perspective was applied to examine how authority, responsibilities, and coordination occur across national, regional, and local levels. MLG has been used in studies such as Domorenok (2017) and Pahl-Wostl (2021) to explain governance fragmentation and institutional overlaps. Its strength lies in highlighting vertical and horizontal interactions in decentralized systems, though it offers fewer tools for analysing actor incentives. Using both frameworks strengthened the study because the IAD clarified how basin institutions function internally, while MLG helped interpret coordination challenges across governance levels. Together, they provided a coherent basis for comparing Brazil's mature decentralized basins with Ghana's evolving governance system. This combined approach made it possible to capture the institutional complexity and multi-level interactions that influence Integrated Water Resources Management across the three study sites

**Data Collection**

Data for this study were gathered entirely from secondary sources to enable a structured examination of water governance arrangements across the São Francisco, Paraíba do Sul, and Nawuni sub-basins. The collection process focused on obtaining documents that were authoritative, current, and directly relevant to institutional analysis. These included national water policies, river basin management plans, legislative instruments, institutional reports, and peer-reviewed academic publications.

Credibility was determined using three yardsticks. First, the document had to originate from a recognized regulatory or technical institution, such as the Agência Nacional de Águas e Saneamento Básico (ANA), the Comitê da Bacia Hidrográfica do Rio São Francisco (CBHSF), the Comitê para Integração da Bacia Hidrográfica do Rio Paraíba do Sul (CEIVAP), the Associação Pró-Gestão das Águas da Bacia Hidrográfica do Rio Paraíba do Sul (AGEVAP), and the Water Resources Commission (WRC) of Ghana. Documents from institutions with legal mandates or basin oversight responsibilities were prioritized because they reflect official governance processes (Bouckaert et al., 2020). Second, the document needed to demonstrate transparency by clearly presenting its objectives, methods, or institutional procedures. Transparency is an important indicator of reliability since it strengthens traceability and minimizes interpretive bias (Assis et al., 2020). Third, recency was considered. The review focused on materials published between 2018 and 2024 to ensure the analysis captured current governance realities, particularly considering recent reforms in Brazil and Ghana (Schmeier, 2012).

Peer-reviewed academic literature was also collected to complement policy documents and provide analytical depth. Articles were sourced from reputable databases such as ScienceDirect, SpringerLink, MDPI, and ResearchGate. Only studies that directly examined river basin governance, Integrated Water Resources Management (IWRM), institutional capacity, or multi-level coordination were included. Peer-review status and the presence of empirical or conceptual grounding served as additional markers of credibility (Benson et al., 2015).

Inclusion and exclusion criteria guided the selection process. Sources were included if they:

1. addressed institutional arrangements, governance frameworks, stakeholder participation, or coordination processes in Brazil or Ghana,
2. were published between 2018 and 2024,
3. provided sufficient detail to support thematic analysis, and
4. were produced by recognized academic, governmental, or international organizations.

Sources were excluded if they:

1. lacked methodological clarity or did not provide enough information to support analysis,
2. were outdated, especially documents published before major policy reforms,
3. consisted of opinion articles, media summaries, or informal commentaries without institutional credibility, or
4. focused solely on hydrological or engineering dimensions without offering governance-related insights.

All selected documents were downloaded, read carefully, and cross-verified with at least one additional independent source. This triangulation step strengthened accuracy and helped confirm recurring themes related to institutional authority, coordination, stakeholder engagement, and resource constraints. Secondary document analysis was appropriate for this study because the objective was to interpret existing governance frameworks rather than collect new field data.

**Data Analysis**

Data analysis followed a structured qualitative approach that made it possible to interpret governance arrangements across the three sub-basins in a consistent and comparative manner. All secondary documents, including basin plans, national policies, legal texts, and academic publications, were reviewed in detail. Relevant information was coded manually, with attention to themes such as institutional roles, legal authority, coordination processes, stakeholder participation, enforcement capacity, and resource constraints. This thematic coding helped organize the material and allowed the study to remain focused on the elements most connected to the research objectives. After coding each basin separately, the study applied a cross-case comparison. This involved examining where the São Francisco, Paraíba do Sul, and Nawuni Sub-Basin shared similar governance characteristics and where they differed. The comparison centered on core governance functions such as the clarity of legal mandates, the strength and autonomy of basin institutions, the level of stakeholder involvement, and the quality of coordination across administrative levels. This step helped reveal how institutional maturity, political structure, and resource availability contributed to the variations seen in governance performance.

The OECD Water Governance Principles served as an interpretive guide rather than a scoring tool. These principles provided a consistent lens for understanding whether each basin demonstrated transparency, accountability, effective participation, adequate capacity, and strong coordination. Using this framework helped ensure that findings remained grounded in recognized governance standards without introducing numerical indicators that the dataset could not support. Throughout the analysis, triangulation was used to

improve the credibility of interpretations. Insights from policy documents were checked against academic studies, institutional reports, and publicly available basin assessments. When multiple sources confirmed the same patterns, the interpretations were strengthened. Where inconsistencies appeared, they were examined to determine whether they reflected institutional gaps, differences in policy implementation, or variations in local capacity

## 4. RESULTS AND DISCUSSION

### Institutional Structures Across Sub-Basins

A comparative review of the institutional and governance frameworks in the São Francisco, Paraíba do Sul, and Nawuni sub-basins demonstrates significant discrepancies in the impact of legal mandates, decentralization, and stakeholder participation on the effectiveness of water governance at the sub-basin level.

The National Water Resources Policy of Brazil, formalized by Law 9433 in 1997, provides a robust legal foundation for decentralized management in the São Francisco Basin. The CBHSF (Comitê da Bacia Hidrográfica do São Francisco) is a crucial entity for decision-making. It possesses the authority to vote on initiatives and financial allocations and is mandated by law to engage all stakeholders. The institutions have attained a significant level of maturity; yet, numerous issues persist, particularly around ineffective enforcement instruments, incompatible data systems, and inadequate international coordination. Bouckaert and Vasconcelos (2020) assert that these issues complicate the basin's government's ability to implement programs consistently at both state and local levels.

In addition to adhering to Law 9433/1997, the Paraíba do Sul Basin also has a distinct governance model that places a greater focus on scenario-based planning and technical foresight tools. CEIVAP, which stands for the basin committee, is an organization that brings together individuals from a variety of fields and employs theme working groups to assist them in making choices. However, in actual fact, planning models are not utilized nearly as frequently as they might be, and coordination with actors at the municipal level is not always successful. Despite the fact that decentralization is rather robust, the integration between the basin committee and local government units is still in the process of being worked on, which results in the governance framework being less responsive [(AGEVAP, 2016)].

In the Nawuni Sub-Basin, governance operates within Ghana’s National Water Policy (2024) and the IWRM Act of 2016, overseen by the Water Resources Commission (WRC) and the White Volta Basin Board. While the policy framework supports decentralization, actual implementation is constrained by limited financial and technical resources. Decision-making is shared between district assemblies and basin boards, with inputs from traditional authorities. However, stakeholder participation especially from civil society and user groups is still evolving, and data systems remain underdeveloped. Weak institutional capacity, fragmented mandates, and low monitoring frequency challenge the sub-basin’s ability to operationalize IWRM principles effectively (Water Resources Commission, 2008 and Tahiru et al., 2020).

All of these scenarios demonstrate that the institution exhibits varying degrees of development and collaboration. Despite São Francisco's increased decentralization, it continues to face challenges regarding intergovernmental collaboration and regulation. The Paraíba do Sul region exhibits significant technical innovation and effective stakeholder integration; yet, it also faces several practical challenges. The Nawuni Sub-Basin possesses a robust policy objective; yet, it faces significant challenges regarding its data infrastructure, capability, and stakeholder engagement. The findings directly reinforce the primary objective of the study by demonstrating how institutional architecture, comprising stakeholder

engagement, decentralization frameworks, and legislative stipulations, influences the governance efficacy of sub-basin water management systems.

**Table 1. Institutional Structures Across Sub-Basins**

| Feature / Basin | São Francisco (Brazil) | Paraíba do Sul (Brazil) | Nawuni (Ghana) |
|---|---|---|---|
| **Governing Framework** | National Water Resources Policy (Law 9433/1997); IWRM implementation via ANA and CBHSF | Law 9433/1997; integrated into National Water Plan; scenario-based IWRM planning | Ghana National Water Policy (2024); IWRM Act 2016; Water Resources Commission oversight |
| **Main Basin Authority** | CBHSF (Comitê da Bacia Hidrográfica do São Francisco) | CEIVAP (Comitê para Integração da Bacia do Rio Paraíba do Sul) | Water Resources Commission (WRC) of Ghana; White Volta Basin Board |
| **Decision-Making Body** | Basin Committee with elected representatives from users, civil society, and government | Basin Committee (CEIVAP) with multi-sectoral representation and technical chambers | Basin Board and District Assemblies; decisions co-informed by traditional authorities |
| **Stakeholder Participation** | Strong participatory model; legal provision for stakeholder voting and budget decisions | Formalized stakeholder involvement; use of working groups and public consultations | Mixed participation; formal engagement through basin board, but limited civil society involvement |
| **Decentralization Level** | High – basin-level committees with funding authority and planning powers | Medium-High – active sub-basin structures but reliant on federal coordination | Moderate – decentralized in structure, but constrained by resource and data limitations |
| **Institutional Challenges** | Overlapping mandates; funding gaps; limited inter-agency data sharing | Scenario tools underused in practice; low coordination with local authorities | Fragmented mandates; weak enforcement; limited financial and technical resources |
| **Monitoring and Data Systems** | Managed by ANA and HidroWeb; robust but siloed across sectors | Nationally supported by ANA; technical tools available but integration uneven | Sparse hydrological data; low monitoring frequency; weak data sharing infrastructure |

**Governance Scorecard Analysis**

The radar chart (Figure 4) illustrates a comparative assessment of governance performance across six fundamental dimensions: Roles & Responsibilities, Financial Mechanisms, Legal/Institutional Framework, Monitoring & Data, Coordination Across Levels, and Stakeholder Engagement. This visual representation provides a comprehensive and clear overview of institutional strengths and weaknesses across the three subbasins. The São Francisco Basin has the best overall governance performance. The

assessment indicates strong performance in the areas of Legal/Institutional Framework and Stakeholder Engagement, highlighting the developed institutional structure of Brazil's National Water Resources Policy and the CBHSF's role in facilitating participatory planning. Nonetheless, its performance in Financial Mechanisms and Monitoring & Data is moderate, indicating disparities in technical capacity and difficulties in maintaining basin-wide coordination and enforcement (Bouckaert & Vasconcelos, 2020). The Paraíba do Sul Basin exhibits a balanced yet marginally lower profile in comparison to the São Francisco Basin. The entity exhibits robust performance in its legal framework, monitoring & data, and stakeholder engagement, supported by scenario-based planning facilitated by the CEIVAP committee and technical assistance from AGEVAP. Coordination across levels and financial mechanisms is only moderately effective, which means that there are sometimes gaps in integration between federal and local authorities (AGEVAP, 2016). The Nawuni Sub-Basin (White Volta, Ghana) exhibits markedly lower scores in most dimensions. The primary deficiencies lie in monitoring and data, as well as financial mechanisms, with the water highlighting inadequate infrastructure, insufficient funding, and ineffective enforcement systems. Despite the definition of roles and responsibilities in Ghana's IWRM Act, institutional fragmentation and data limitations continue to exist. Stakeholder engagement is still evolving, especially within civil society and user associations, and is deficient in the structured mechanisms found in Brazil's basins. The studies by Tahiru et al. (2020) and the Water Resources Commission (2008) provide relevant insights.

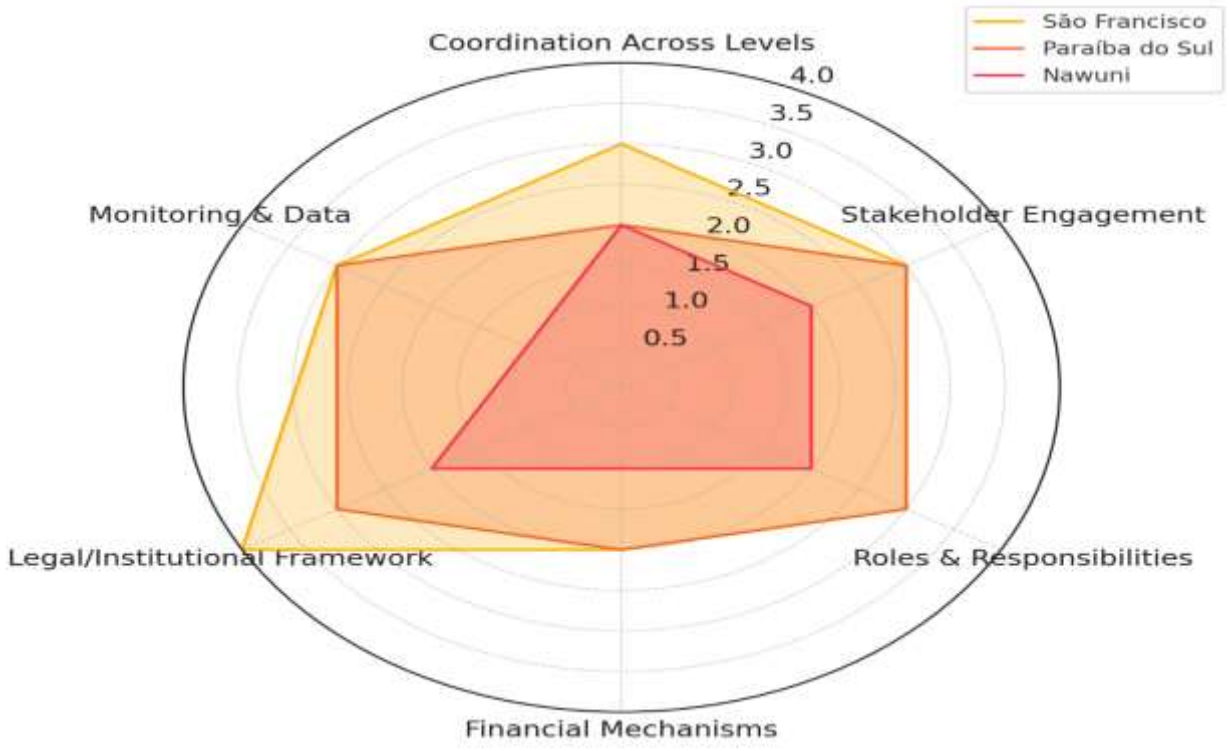



**Figure 4 Governance Scorecard Across Sub-Basins Based on Six Core Institutional Dimensions.**

**Stakeholder Participation Landscape**

Figure 5 shows a radar chart that compares governance performance across six key areas: roles and responsibilities, financial mechanisms, legal/institutional framework, monitoring and data, coordination across levels, and stakeholder engagement. This picture provides a full and clear picture of the strengths and weaknesses of institutions in the three sub-basins. The São Francisco Basin has the best overall

governance performance. The assessment shows that Brazil's National Water Resources Policy has a well-developed institutional structure and that the CBHSF has helped with participatory planning. This is shown by the strong performance in the areas of Legal/Institutional Framework and stakeholder engagement. The performance in Financial Mechanisms and Monitoring & Data is average, which shows that there are differences in technical skills and problems with keeping basin-wide coordination and enforcement (Bouckaert & Vasconcelos, 2020). The Paraíba do Sul Basin has a profile that is balanced but slightly lower than that of the São Francisco Basin. The organization does very well in legal framework, monitoring & data, and stakeholder engagement. This is made possible by scenario-based planning done by the CEIVAP committee and technical help from AGEVAP. The coordination across levels and financial mechanisms is still only moderate, which means that there are sometimes gaps in integration between federal and local authorities (AGEVAP, 2016). The Nawuni Sub-Basin (White Volta, Ghana) has scores that are much lower in most areas. The main problems are with monitoring & data and financial mechanisms, which show that the infrastructure is poor, the funding is insufficient, and the enforcement systems are weak. Even though Ghana's IWRM Act clearly defines roles and responsibilities, there are still problems with institutional fragmentation and limited data. Stakeholder engagement is changing, especially in civil society and user groups. It is not as well-organized as it is in Brazil's basins. Tahiru et al. (2020) and the Water Resources Commission (2008)




**Figure 5 Stakeholder Participation Network in the São Francisco River Basin**

Figure 6 shows the stakeholder organization in Ghana's Nawuni Sub-Basin as part of the Integrated Water Resources Management framework. The White Volta Basin Board works with people from districts, communities, and institutions, while planning and building are the jobs of District Assemblies. The Ghana Water Company Ltd. (GWCL) is integral to water supply management, whereas Community Water and Sanitation Agencies oversee rural and small-town water systems. In rural areas, traditional authorities control how land and water are used. Water User Associations (WUAs) and NGOs are important for getting people involved in their communities and helping them learn new skills. But these groups often have problems like decentralization and not having enough money. The stakeholder map suggests that governance should be open to everyone, but problems with coordination and technical skills are slowing its progress. Improving this base could make participatory water governance better.

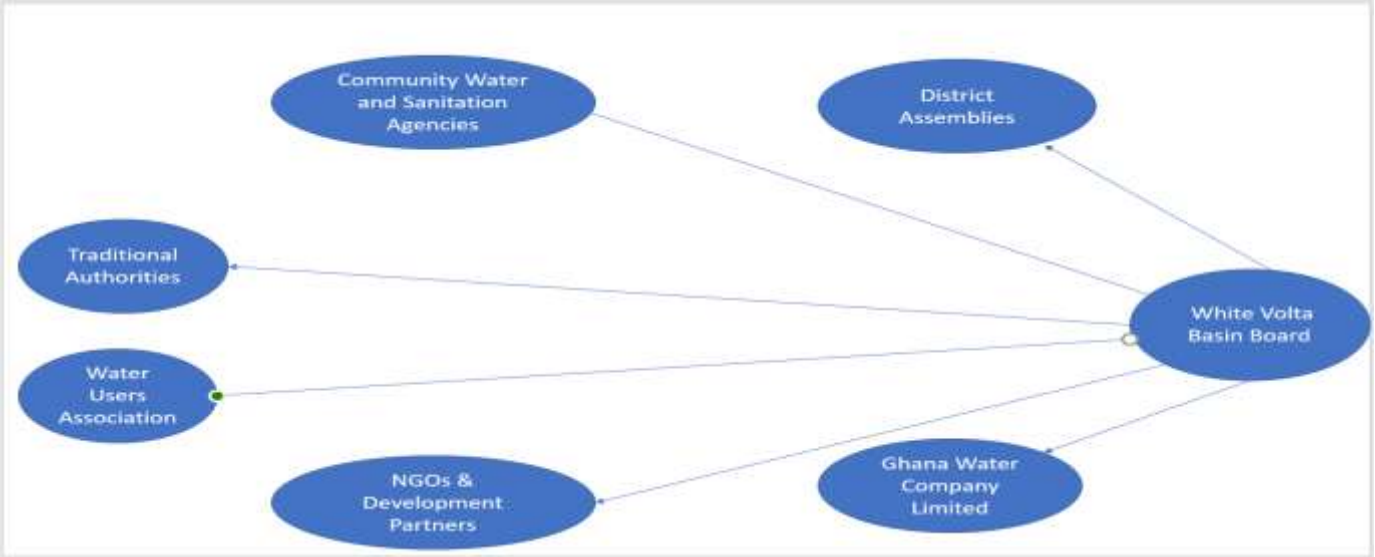



**Figure 6. Stakeholder Participation Network in the Nawuni Sub-Basin (Ghana)**

Figure 7 shows the people who have a stake in the Paraíba do Sul Basin. This is a large river basin in southern Brazil that is managed by a decentralized and participatory water management system. The CEIVAP Coordination Committee (Comitê para Integração da Bacia Hidrográfica do Rio Paraíba do Sul) is in charge of planning and making decisions for the whole basin. AGEVAP is the technical-executive agency that makes sure that plans are carried out, money is handled, and projects are completed. AGEVAP and CEIVAP work very closely together. Local governments help make and carry out rules for how water is managed in their areas. The state environmental agency INEA in Rio de Janeiro is an example of an agency that makes and enforces rules in its own area. Including civil society and NGOs, who provide advocacy and local knowledge, as well as water users, such as industrial and agricultural operators who pay for services through user-pays methods, makes stakeholder engagement even better. Academic and research institutions also help by doing technical studies, effect assessments, and coming up with new ideas for managing the basin. This stakeholder network is a good example of a participatory framework that is already well-known. Everyone knows what they need to do, and there are systems in place to make sure that policies are followed and work is done correctly. But it's not always simple to put them into action all the time because institutions in different municipalities don't always do their jobs well, and state-level policies don't always work together. The Paraíba do Sul Basin is a well-organized but always-changing example of how to get everyone in Brazil to take part in the management of water. The Nawuni Sub-Basin has a more broken-up structure, and the Odra Basin has a more complicated international structure.

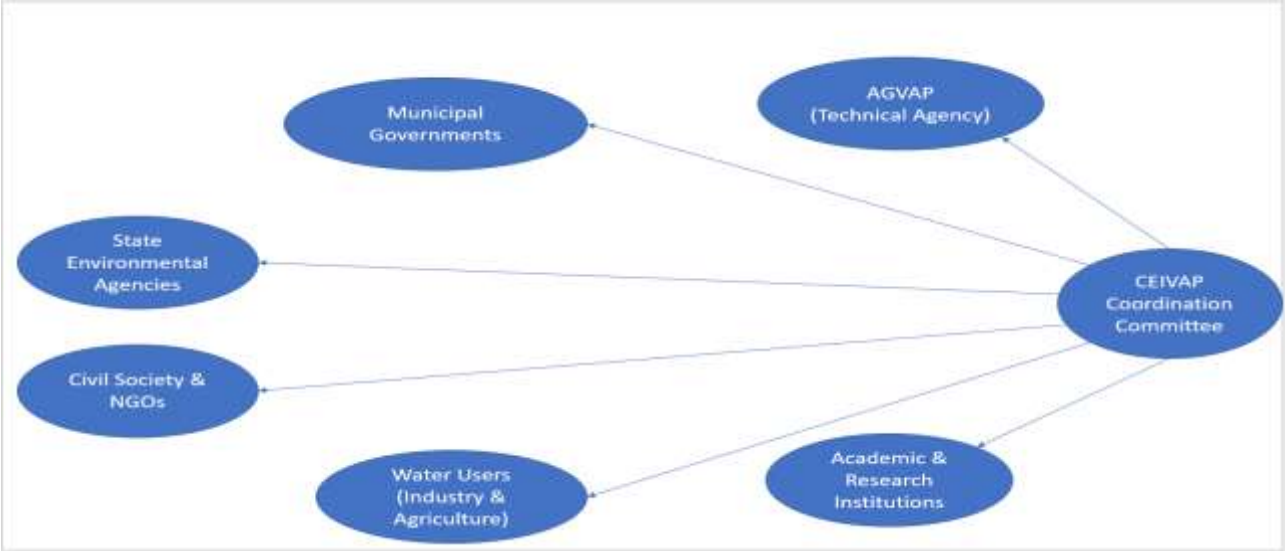



**Figure 7. Stakeholder Participation Network in the Paraíba do Sul Basin (Brazil)**

**Comparative Assessment of Institutional Integration**

The National Water Resources Policy of Brazil (Law 9433/1997) has made it considerably easier for groups to work together in the São Francisco River Basin. The São Francisco River Basin Committee (CBHSF) is tasked with ensuring the National Water Agency (ANA) fulfills its responsibilities. State Water Resources Councils (CERHs) collaborate with CBHSF to strategize programs across various regions, thereby increasing public participation at the state level. Through CBHSF participation frameworks, civil society and water customers in the region contribute to decision-making processes. The implementation of binding basin plans and the allocation of water use charges facilitate integration; nonetheless, coordination remains problematic due to the lack of collaboration among agencies and the disparate capacities of institutions.

The São Francisco River Basin Committee (CBHSF) is responsible for overseeing the National Water Agency (ANA) in the execution of its duties. The State Water Resources Councils (CERHs) partner with CBHSF to devise programs across diverse regions, thereby enhancing public engagement at the state level. People in the region's civil society and water consumers help make decisions within the CBHSF frameworks. The use of binding basin plans and the charging of water consumption fees help bring people together, but coordination is challenging because agencies don't work together well and institutions have different skills.

In the Paraíba do Sul River Basin (Brazil), institutional integration is generally robust and reflects the federal framework of São Francisco, albeit with unique governance systems. CEIVAP (Committee for the Integration of the Hydrographic Basin of the Paraíba do Sul River) supervises basin planning, with the assistance of AGEVAP, a designated technical agency responsible for project implementation and basin management. INEA (Rio de Janeiro State Environmental Institute) and other state agencies make rules for the whole region. Municipalities and user groups also work together in formal participatory forums. Even though binding basin plans help with vertical alignment, it's difficult to coordinate and manage things because ANA, CEIVAP, and state players all have overlapping roles.

The integration of institutions in the Nawuni Sub-Basin (Ghana) is now happening as part of Ghana's national Integrated Water Resources Management (IWRM) framework. The Water Resources Commission (WRC) provides suggestions for the whole country, but it doesn't have much power at the

sub-basin level. District Assemblies are in charge of organizing events in their areas, but they don't always do a good job because they can't enforce rules and don't know enough about technology. The White Volta Basin Board is a group that brings together local Water User Associations (WUAs) and traditional leaders to work together. Programs funded by donors have made vertical coordination better, but basic issues like unclear institutional mandates, tight budgets, and broken data systems still make it difficult for different levels of government to work together well.

**Table 2. Comparative Analysis of Multi-Level Institutional Integration in the São Francisco, Paraíba do Sul, and Nawuni River Basin**

| Governance Level | São Francisco (Brazil) | Paraiba do Sul (Brazil) | Nawuni Sub-Basin (Ghana) |
|---|---|---|---|
| **National** | ANA and National Water Policy (Law 9433/1997); CBHSF provides basin-level oversight | ANA and National Water Policy (Law 9433/1997); oversight via CEIVAP | WRC under national IWRM policy; sub-basin planning lacks legal autonomy |
| **Regional** | State environmental agencies participate through CERHs and coordinate with CBHSF | State agencies (e.g., INEA) coordinate implementation with CEIVAP and AGEVAP | District Assemblies play a limited role in enforcement and coordination |
| **Local** | Local water users and civil society represented in CBHSF; municipalities involved via local forums | Municipalities and user groups participate in basin committee processes | Traditional authorities and Water User Associations engaged through basin board meetings |
| **Integration Mechanisms** | CBHSF facilitates vertical coordination with binding basin plans and use of water charges | CEIVAP supports vertical coordination through binding plans and AGEVAP operational role | WRC basin boards offer coordination platforms; donor support is critical to integration |
| **Barriers** | Fragmentation between federal, state, and local mandates; capacity disparities | Overlapping roles among ANA, CEIVAP, and state actors; resource limitations | Limited legal mandates, data infrastructure gaps, and low sub-national capacity |

**Source: Source:** Compiled by authors using secondary data from WRC (2008), ANA (2024), CBHSF (2023), CEIVAP (2023), AGEVAP (2023), Bouckaert & Vasconcelos (2020), and relevant IWRM implementation documents.

**Stakeholder Participation Effectiveness**

Anyone interested in the São Francisco River Basin can formally become involved through the São Francisco River Basin Committee (CBHSF). The group members advocate for the establishment of an inclusive panel of indigenous peoples, water consumers, governmental bodies, and civil society representatives. The basin plan and participatory budgeting methods empower it to make decisions. These strategies foster inclusive leadership, which aligns with the study's objective: to evaluate the efficacy of

participatory approaches. Persistent challenges, including excessive municipal involvement, insufficient representation of underrepresented groups, and inadequate commercial engagement, underscore the necessity for further capacity building and outreach initiatives.

The Paraíba do Sul River Basin has a participatory framework that is similar in structure but somewhat less powerful. AGEVAP provides technical support to the CEIVAP basin committee, which brings together people from government, academia, and user groups. The basin committee is responsible for making long-term plans, but the federal government still makes most of the final decisions. The participatory framework in the Paraíba do Sul River Basin is structurally similar but has slightly less power. AGEVAP provides technical assistance to the CEIVAP basin committee, which comprises representatives from academia, user groups, and government. Although the basin committee is responsible for developing plans for the future, the majority of the ultimate choices are still made by the federal government.

In contrast, the Nawuni Sub-Basin operates within a less defined and weaker participatory structure. The White Volta Basin Board, which reports to Ghana's Water Resources Commission (WRC), encourages stakeholder engagement, including representatives of traditional authority, non-governmental organizations (NGOs), and district assemblies. However, stakeholders typically view involvement as a consultative role with limited decision-making power. Difficulties include insufficient digital access to governance tools, minimal stakeholder capability, and no legislative mandates for basin boards. The entire system is a perfect example of the persistent problem of getting people to really get involved when resources are limited, even while donor-funded organizations have procedures in place to help with this.

**Table 3. Comparative Assessment of Stakeholder Participation Effectiveness in the São Francisco, Paraíba do Sul, and Nawuni River Basins**

| Indicator | SÃ£o Francisco (Brazil) | ParaÃba do Sul (Brazil) | Nawuni Sub-Basin (Ghana) |
|---|---|---|---|
| **Formal Participation Mechanisms** | CBHSF Basin Committee with multi-sector representation; participatory budgeting and project planning | CEIVAP Basin Committee with multi-sector reps; AGEVAP supports technical implementation | Basin boards under WRC; stakeholder meetings; district-level consultations |
| **Inclusivity (Actors Represented)** | Broad: government, civil society, private sector, indigenous groups, water users | Broad: government, private sector, civil society, academia, water users | Moderate: traditional leaders, water users, NGOs, and district assemblies |
| **Decision-Making Power** | High: CBHSF approves basin plans and allocates funds via water charges | Moderate: shared planning influence but final approvals influenced by ANA | Low: advisory influence with limited decision-making authority |

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|---|---|---|---|
| **Transparency & Accessibility** | High: public access to documents and meetings via ANA and CBHSF platforms | High: CEIVAP publishes reports, holds public forums, and uses a transparent website | Low to moderate: limited documentation; low digital access |
| **Stakeholder Capacity** | Medium: some training support; disparities among local stakeholders | Medium: training provided, but municipal capacity varies | Low: limited funding and technical skills among local actors |
| **Challenges Noted in Literature** | Coordination gaps among federal/state levels; inconsistent engagement by private actors | Reliance on AGEVAP; uneven municipal participation | Unclear mandates; inconsistent participation and weak legal frameworks |

**Source:** Compiled by authors using secondary data from WRC (2008), ANA (2024), CBHSF (2023), CEIVAP (2023), AGEVAP (2023), Bouckaert & Vasconcelos (2020), and IWRM implementation reports for Ghana and Brazil.

**Legal Authority and Enforcement Capacity**

Table 4 provides a comparative analysis of the legal frameworks and enforcement capabilities regulating water resources in the São Francisco, Paraíba do Sul, and Nawuni basins. While all three basins function under national water policies, their legal authority, institutional integration, and enforcement capabilities differ markedly.

In the São Francisco Basin, Brazil's National Water Resources Policy (Law 9433/1997) provides a definitive legal framework, empowering the CBHSF (basin committee) to formulate basin plans and administer water use fees. Enforcement systems, primarily supervised by the National Water and Sanitation Agency (ANA) and state entities, facilitate permit regulation and sanctions; however, enforcement is applied inconsistently across regions. Coordination difficulties between federal and state mandates create persistent challenges, undermining implementation consistency despite the robustness of the legal framework. Brazil's National Water Resources Policy (Law 9433/1997) establishes a legislative framework for the São Francisco Basin, allowing the CBHSF (basin committee) to create basin plans and collect water use fees.

CEIVAP and its administrative branch, AGEVAP, are responsible for Brazil's national water policy, which benefits the Paraíba do Sul Basin. As the official body responsible for determining water use rates and approving basin plans, CEIVAP receives technical assistance from AGEVAP. Although there is a robust legal framework, enforcement is heavily dependent on state environmental authorities such as the Iowa Environmental Agency (INEA). According to São Francisco, the overall effectiveness of enforcement is not very high due to the dispersion of institutions and variances in the capacity of local implementation.

The Nawuni Sub-Basin in Ghana, on the other hand, works within a changing set of laws. Even though the WRC Act (1996) gives the Water Resources Commission (WRC) nationwide power, sub-basin laws are still not clear or complete. Basin boards can give advice, but they can't administer water programs or handle finances. The majority of the oversight comes from programs that are supported by donors. The legal system's lack of power and the insufficiency of funding for institutions and enforcement

organizations reduce the overall effectiveness of laws and regulations. The Paraíba do Sul Basin is a beneficiary of Brazil's national water program. AGEVAP and CEIVAP are accountable for it. Programs financed by donors predominantly supply the oversight.

**Table 4. Comparative Assessment of Legal Authority and Enforcement Capacity in the São Francisco, Paraíba do Sul, and Nawuni River Basin**

| Indicator | Sao Francisco (Brazil) | Paraiba do Sul (Brazil) | Nawuni Sub-Basin (Ghana) |
|---|---|---|---|
| **Legal Framework** | Established under Brazilians National Water Resources Policy (Law 9433/1997); CBHSF created via federal decree | Also governed under Law 9433/1997; CEIVAP created by federal resolution; linked with ANA | Guided by the Water Resources Commission Act (1996); supports IWRM but lacks basin-specific legal instruments |
| **Basin Committee Legal Mandate** | CBHSF legally mandated to approve basin plans, manage water use charges, and oversee implementation | CEIVAP has authority to draft basin plans and allocate funds; executed through AGEVAP | Basin boards have advisory status only; no formal authority over budgeting or enforcement |
| **Enforcement Mechanisms** | Enforced by ANA and state agencies; mechanisms in place but enforcement varies regionally | Enforcement led by ANA, INEA (RJ), and other state agencies; implementation varies by state | WRC leads permitting and compliance but is under-resourced; enforcement remains limited |
| **Monitoring & Compliance** | Monitoring coordinated by ANA and HidroWeb; supported by state agencies; data integration remains fragmented | Monitoring is coordinated among ANA, AGEVAP, and state bodies; robust but not fully harmonized | Minimal monitoring infrastructure; relies on donor programs and district support |
| **Legal Gaps & Limitations** | Overlap in mandates between federal and state agencies; inconsistent enforcement | Coordination and role clarity between CEIVAP and state actors can be weak | Lack of legal clarity and authority at sub-basin level; weak institutional mandates |
| **Overall Capacity** | Moderate to high: strong legal base and planning tools but uneven implementation | Moderate: legal mandate exists but administrative and financial dependence on technical agencies | Low: existing legal structure lacks sub-basin enforcement power and resourcing |

**Source:** This table is based on secondary data from institutional and policy documents, including ANA, CBHSF, CEIVAP, and AGEVAP reports for Brazil, and the WRC's IWRM Plan and Ghana National Water Policy for Ghana. These sources provided insights into legal frameworks, enforcement capacity, and institutional mandates across the São Francisco, Paraíba do Sul, and Nawuni basins.

**Budgetary and Human Resource Constraints**

Table 5 provides a comparative analysis of the São Francisco, Odra, and Western Bug basins concerning funding mechanisms, budgetary stability, human resources, training systems, and administrative constraints. Evidence indicates that resource availability directly impacts the institutional capacity of governance systems, significantly affecting policy implementation and sustainability.

The CBHSF administers water usage taxes that constitute the majority of the revenue for the São Francisco Basin in Brazil. ANA further provides funding for the initiative. This structure ostensibly advocates for local financial autonomy, but, in fact, financing is vulnerable to political changes, and many state-level institutions cite personnel deficiencies and coordination difficulties. Capacity-building programs exist, although their utilization is often limited, particularly in underdeveloped sub-regions. The issues indicate that the governance model has decentralized funding authority, although institutions are often ill-prepared to manage it. The Odra Basin possesses a highly developed financial and human resource landscape, particularly in Germany, where national and EU support, such as the Cohesion Fund and the LIFE program, ensures budget stability and facilitates continuous professional development. Poland continues to require assistance from the EU, while its financing sources remain relatively stable. Both nations possess robust administrative capabilities, with skilled personnel operating at the regional level. The primary issue is the disparity in funding between state agencies and NGOs, which may impede the implementation of the strategy in communities. The Odra instance demonstrates substantial operational capacity due to its integrated financial and professional systems. Conversely, the Western Bug Basin, particularly in Ukraine, faces significant challenges with the resources of its institutions. Economic fluctuations may significantly constrain national funding. The quality of human resources is inadequate due to a deficiency of effective training programs and educational institutions. EU-funded initiatives like Twinning and UNECE have addressed certain issues, but their solutions are ephemeral and applicable to only select projects. On the other hand, Poland's institutions function more efficiently because they comply with EU regulations and receive consistent external assistance.

**Table 4. Comparative Assessment of Budgetary and Human Resource Constraints in the São Francisco, Paraiba do Sul, and Nawuni River Basins**

| Indicator | São Francisco (Brazil) | Paraíba do Sul (Brazil) | Nawuni Sub-Basin (Ghana) |
|---|---|---|---|
| **Funding Mechanisms** | CBHSF collects water use charges; ANA supports projects through transfers | CEIVAP collects water use charges; ANA and AGEVAP support project funding | WRC receives limited government funds; reliant on external donor projects |
| **Budget Stability** | Moderate stability; reliant on ANA transfers and basin contributions | Moderate stability; dependent on federal transfers and user contributions | Unstable and insufficient; periodic donor injection, but no predictable flow |
| **Human Resource Capacity** | Variable technical capacity across states; basin institutions support staff development | Variable technical capacity across states and municipalities; AGEVAP supports planning | Low technical staffing in districts and WRC regional offices |

| | | | |
|---|---|---|---|
| **Training & Support** | Occasional training by ANA and basin institutions; not fully institutionalized | Occasional capacity building from ANA and CEIVAP; not systematically institutionalized | Donor-funded training programs exist; lack continuity and national ownership |
| **Administrative Limitations** | Overlap between CBHSF, ANA, and state agencies creates coordination issues | Fragmentation between CEIVAP, AGEVAP, and state/municipal levels creates overlap | Limited coordination between WRC, districts, and traditional authorities |

**Source:** The data in Table 5 is based on secondary information from official agencies managing the São Francisco and Paraíba do Sul basins in Brazil (ANA, CBHSF, CEIVAP, AGEVAP) and the Nawuni Sub-Basin in Ghana (WRC). These documents provided insights into funding mechanisms, staffing capacity, and administrative coordination challenges within each basin.

## 5. DISCUSSION

An analysis of the governance frameworks in the São Francisco, Paraíba do Sul, and Nawuni sub-basins uncovers significant institutional disparities that influence water management outcomes. The findings illustrate that resource availability, enforcement strategies, stakeholder engagement, and legal obligations collectively enhance governance effectiveness.

The National Water Resources Policy of Brazil (Law 9433/1997) promotes institutional integration within the São Francisco Basin and enables decentralized planning via the CBHSF. Significant issues persist in the cooperation between federal and state entities, despite the legal framework advocating for basin-level planning and participatory decision-making. Bouckaert and Vasconcelos (2020) assert that dispersed duties, unequal enforcement powers, and insufficient data integration hinder the implementation of integrated water resources management. The implementation of integrated water resources management**.**

The Nawuni Sub-Basin in Ghana illustrates the structural constraints of an emerging governance framework. Despite the backing of a national IWRM policy and the Water Resources Commission Act (1996), implementation is hindered by ambiguous mandates at the sub-basin level, limited legal authority for basin boards, and resource limitations (Water Resources Commission, 2008). Participation by district assemblies, traditional authorities, and user groups is primarily consultative rather than decision-making, indicating a broader context of institutional underdevelopment. Monitoring systems demonstrate fragmentation, and staffing levels are insufficient, heavily depending on donor initiatives for technical support (Tahiru et al., 2020).

Stakeholder involvement strategies vary in structure and aim throughout the three basins. The São Francisco and Paraíba do Sul basins have legally authorized entities for participatory budgeting and project planning. However, discrepancies in fair representation and local capability remain significant challenges (Assis et al., 2020). The stakeholder framework in the Nawuni Basin comprises traditional leaders, district governments, and non-governmental organizations (NGOs); however, interactions are devoid of legal enforceability and are often influenced by donor interests. There are also variations in the effectiveness of legal enforcement and compliance measures. Brazil's federal structure allows national (ANA) and state agencies to implement laws; however, overlapping jurisdictions and insufficient interagency coordination reduce efficacy. The WRC in Ghana has national power but limited capacity at the basin level, with inconsistent enforcement due to resource shortages and administrative turmoil. Financial and human

resource competencies are critical in determining institutional effectiveness. Although both Brazilian basins benefit from water user fees and state funding, administrative challenges and political dependency threaten long-term stability. In Ghana, the implementation of Integrated Water Resources Management (IWRM) faces challenges due to a lack of adequate personnel and unreliable funding. Securing resources, fostering stakeholder engagement, and effectively aligning legal mandates with enforcement mechanisms are crucial in this situation.

## 6. CONCLUSION

The study examines water governance frameworks in Brazil's São Francisco and Paraíba do Sul Basins, as well as Ghana's Nawuni Sub-Basin, analyzing essential governance elements.

The São Francisco Basin, regulated by Brazil's National Water Resources Policy and the CBHSF, possesses robust legal authority and a variety of stakeholders; however, it faces challenges in coordination, enforcement of regulations, and equitable distribution of resources.

The Paraíba do Sul Basin, regulated by Law 9433/1997, employs scenario-based planning with the support of AGEVAP; yet, it encounters issues of partial administrative integration, inconsistent planning instruments, and constrained financial and human resources.

The Water Resources Commission of Ghana oversees the Nawuni Sub-Basin, executing a national Integrated Water Resources Management framework aimed at decentralization and participatory objectives. Challenges include inadequate legislation, fragmented institutional responsibilities, limited funding, and weak enforcement mechanisms.

The findings suggest that while robust legal frameworks are necessary, they are not sufficient for effective water governance. Effective governance is contingent upon institutional capacity, inter-level coordination, stakeholder empowerment, and sustainable financing. The three situations differ, highlighting the necessity of employing context-specific approaches that integrate the legal, technical, and participatory aspects of governance.

## 6. Recommendation

Strengthening coordination among local, regional, and national institutions through effective horizontal and vertical collaboration is essential for improving policy consistency and facilitating effective implementation. Institutions and relevant stakeholders should be assigned clear mandates, defined responsibilities, and adequate decision-making powers to promote inclusive and participatory water governance. Furthermore, governments should establish collaborative mechanisms for data collection, sharing, and analysis to support transparent, evidence-based decision-making. Adequate financial resources, technical capacity, and qualified personnel should also be allocated to basin and district-level institutions to support long-term planning, strengthen institutional performance, and improve operational effectiveness. Collectively, these recommendations provide valuable guidance for policymakers seeking to strengthen institutional and governance frameworks for integrated water resources management across diverse administrative and institutional contexts.

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