Revista Brasileira de Ciências Ambientais
Brazilian Journal of Environmental Sciences

Water governance and public policy evaluation: an analysis of the Upper Iguaçu basin plan

Governança hídrica e avaliação de políticas públicas: uma análise do plano de bacias do Alto Iguaçu

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ABSTRACT

This article analyzes aspects of water governance and water resources management within the Alto Iguaçu Basin Plan in the Curitiba Metropolitan Region. The research focused on evaluating this plan, with the aim of understanding how its instruments, guidelines and actions influence water management. The methodological approach integrated the analysis of data from the implementation assessment of the National Water and Basic Sanitation Agency (ANA) with an evaluation of the governance guidelines of the Federal Court of Accounts (TCU). The analysis revealed implementation limitations, including a lack of data systematization, unclear targets, limited monitoring capacity and insufficient communication among stakeholders. Furthermore, the analysis highlights that, although a parity-based committee exists, its performance is hindered by poor coordination with municipal governments. The study concludes that there is a need to improve coordination across different administrative levels, strengthen information systems and promote greater transparency and accountability.

Keywords: Water security; Basin committees; Environmental monitoring; Territorial planning; Stakeholders.

RESUMO

Este artigo analisa aspectos da governança e da gestão de recursos hídricos no Plano de Bacias do Alto Iguaçu na Região Metropolitana de Curitiba. A pesquisa concentrou-se na avaliação deste plano, com o objetivo de compreender de que modo seus instrumentos, diretrizes e ações influenciam a gestão hídrica. A abordagem metodológica mesclou a análise de dados, a partir da avaliação da implementação da Agência Nacional de Águas e Saneamento Básico (ANA), com a avaliação das diretrizes de governança do Tribunal de Contas da União (TCU). As análises revelaram limitações na implementação, como a falta de sistematização dos dados, a ausência de metas claramente definidas, a baixa capacidade de monitoramento e a comunicação insuficiente entre os atores. Destaca-se, ainda, que, embora exista um comitê paritário, sua atuação é prejudicada pela escassa articulação com os governos municipais. Conclui-se que há necessidade de aprimorar a coordenação entre os diferentes níveis de administração, fortalecer os sistemas de informação e promover maior transparência e accountability.

Palavras-chave: Segurança hídrica; Comitês de bacias; Monitoramento ambiental; Planejamento territorial; Partes interessadas.

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Received on: 03/26/2026. Accepted on: 07/03/2026.

https://doi.org/10.67790/rbciamb.026.3056

Introduction

Policy analysis examines what governments do, why they do it and what impacts their actions generate (Dye, 2012). In the field of water resources, this perspective is particularly relevant given the increasing complexity of water governance systems and the need to strengthen water security under conditions shaped by climate change, urban expansion and anthropogenic pressures on aquatic ecosystems (Gesualdo et al., 2021; Getirana et al., 2021). Among the instruments established by the *Política Nacional de Recursos Hídricos* (PNRH) [National Water Resources Policy] Federal Law No. 9,433/1997 (Brasil, 1997) and the *Política Estadual de Recursos Hídricos do Paraná* (PERH-PR) [Paraná State Water Resources Policy – State Law No. 12,726/1999] (Paraná, 1999), watershed management plans stand out; their implementation should be monitored by River Basin Committees and other entities within the National Water Resources Management System.

Evaluating the implementation of water resources plans constitutes a strategic mechanism for the continuous improvement of water management, enabling the identification of barriers to the execution of planned actions, strengthening monitoring processes and generating information capable of supporting decision-making and institutional learning (Bezerra et al., 2021; Costa and Neto, 2023). Despite the central role of these instruments within the Brazilian water governance framework, studies that comprehensively examine the relationships among planning, implementation and governance remain limited. Most evaluations focus on plan content or compliance with specific targets, whereas the institutional mechanisms conditioning operationalization and effectiveness remain relatively underexplored (Bouckaert et al., 2022; Santos et al., 2025). This limitation has also been identified in water security research, which indicates that approaches excessively focused on infrastructure, water availability or physical indicators tend to underestimate factors related to governance, institutional coordination and social participation, elements that are fundamental to the effectiveness of public water policies (Ferreira et al., 2025).

This gap becomes particularly relevant in metropolitan contexts subjected to intense pressure on water resources. Recent studies demonstrate that water insecurity in Brazilian metropolitan regions results from the interaction among climate variability, urban expansion, institutional weaknesses and governance system constraints, requiring integrated and multilevel approaches to its understanding and management (Ventura et al., 2026). In the Curitiba Metropolitan Region, the 2020 water crisis exposed limitations associated with water security, institutional coordination and water governance (Cassilha et al., 2020). Within this context, the *Plano de Bacias do Alto Iguaçu e Afluentes do Alto Ribeira* (PBAIAR) [Upper Iguaçu and Upper Ribeira Tributaries River Basin Plan], approved in 2013, represents an important instrument for understanding how planning guidelines are translated into concrete water management actions.

Against this background, this study seeks to answer the following research question: to what extent does the PBAIAR establish effective mechanisms for planning, implementation, monitoring and evaluation capable of strengthening regional water governance? To address this question, the general objective of this research is to evaluate the implementation of the PBAIAR from a water governance perspective, examining the consistency between planning and implementation, the definition of institutional responsibilities, the operationalization of planned programs and the capacity of monitoring and evaluation mechanisms to generate information that feeds back into decision-making processes.

The relevance of this study lies in the need to understand how water planning instruments operate within complex, highly urbanized territorial contexts. Furthermore, the research seeks to address a methodological gap in the literature by integrating technical implementation criteria proposed by the *Agência Nacional de Águas e Saneamento Básico* (ANA) [National Water and Basic Sanitation Agency] with governance and public auditing guidelines developed by the *Tribunal de Contas da União* (TCU) [Federal Court of Accounts]. In doing so, it proposes an evaluative approach capable of expanding understanding of the institutional factors influencing the effectiveness of water policies. Finally, the article offers a methodological contribution by developing a formative and internal evaluation model for public policy implementation analysis, integrating environmental planning instruments with governmental auditing tools applied to the context of river basin management.

Theoretical framework

Attributes of water governance

Water governance has become one of the main analytical frameworks for understanding water resources management in contexts characterized by multiple actors, scales and competing interests. Although the concept has been interpreted in different ways, there is a relative consensus that governance encompasses the institutional arrangements, decision-making processes and coordination mechanisms that guide the formulation and implementation of public policies related to water resources (Bakker and Morinville, 2013; Aguirre and Paredes Cuervo, 2023).

In the context of water resources, governance extends beyond the exclusive role of the State and encompasses interactions among governmental agencies, water users, civil society organizations and other actors involved in decision-making processes. It constitutes a polycentric and multilevel system in which responsibilities and competencies are distributed across different institutional levels (Ménard et al., 2018; Pahl-Wostl and Knieper, 2023). Recent studies emphasize that the effectiveness of these arrangements depends not only on their formal structure but also on the capacity for coordination,

meaningful participation and stakeholder engagement in decision-making processes (Bouckaert et al., 2022; Santos et al., 2025).

The literature also highlights the importance of adaptive governance in addressing complex problems characterized by high levels of uncertainty. From this perspective, more resilient management systems are those able to foster continuous learning, incorporate new information and adjust strategies in response to environmental and social changes, while adopting polycentric approaches to power distribution and decision-making (Pahl-Wostl et al., 2012; Pineda-Morales et al., 2025). Evidence from river basin committees in South America nevertheless indicates that institutional constraints, excessive centralization and leadership weaknesses frequently hinder the adaptive capacity of these organizations in responding to water crises (Trimble et al., 2022).

The relevance of governance to water management gained international prominence following the United Nations World Water Development Report (UN WWDR), which identified the global water crisis as fundamentally a crisis of governance (WWAP, 2003). This interpretation remains highly relevant in light of contemporary challenges associated with water security, climate change and increasing competition among water uses (Gesualdo et al., 2021; Brown et al., 2025).

Several studies applied to the Brazilian context have identified persistent weaknesses in water governance arrangements, including poor integration across management scales, limited institutional capacity and difficulties in implementing participatory governance principles (e.g., Bezerra et al., 2021; Costa and Neto, 2023). Furthermore, research conducted with Brazilian river basin committees has revealed deficits in technical knowledge, information asymmetries and limitations in accountability mechanisms, factors that compromise the quality of deliberative processes and the effectiveness of shared water management (Rothberg and Garde-Hansen, 2021; Matos et al., 2022).

Accountability and public policy evaluation

Within public administration, increasing demands for transparency and social oversight have strengthened accountability as a central element of governmental evaluation processes. The concept is associated with the obligation of public managers to report on their actions, justify decisions and remain subject to institutional and social accountability mechanisms (Friedrich, 1940; Brasil, 2014). From this perspective, public policy evaluation moves beyond merely measuring outcomes and assumes a strategic role in generating information for organizational learning, institutional improvement and for strengthening the legitimacy of public decisions (Trevisan and Van Bellen, 2008).

In the field of water resources, evaluating the implementation of river basin plans is particularly relevant because it enables assessment not only of the execution of planned actions but also of the capacity of responsible institutions to coordinate stakeholders, monitor outcomes and promote adjustments throughout the implementation process. Thus, evaluation and accountability mechanisms become essential components of water governance, contributing to the transparency, effectiveness and legitimacy of public policies (Matos et al., 2022; Costa and Neto, 2023).

The absence of accountability among decision-makers constrains the development of adaptive water governance, since adaptive systems depend on clearly defined responsibility among the actors involved (Nkhata, 2024). Therefore, there is a clear theoretical relationship: the ability of a governance approach to safeguard accountability is fundamental to its effectiveness, whereas failures in accountability prevent governance systems from achieving their intended objectives, particularly in complex issues such as water security (Julio et al., 2021).

Methods

This study adopts a qualitative approach structured as an instrumental case study, using the PBAIAR, an instrument of the PNRH, as the unit of analysis. The research is situated within the field of policy analysis, with emphasis on the evaluation stage of the public policy cycle, following the approaches proposed by Dye (2012) and Wu et al. (2014) and focusing on the analysis of implementation and the institutional mechanisms associated with the plan (Table 1).

Data collection was conducted between March 2024 and March 2026 and relied exclusively on publicly available secondary documentary sources retrieved from the COALIAR website (Paraná, 2013), including the Diagnostic Report, Technical Report and Executive Report of the PBAIAR. Based on these documents, the analytical scope was delimited to the Basin Action Plan, which organizes programs, subprograms and actions, as systematized in Table 1. This delimitation enabled the analysis to focus on the policy's operational dimensions, with the potential to generate empirical evidence on governance and implementation capacity. It should be noted that content analysis was conducted based on the categories presented in Figure 1, following the framework developed by the TCU.

As a systematization procedure, a synthesis matrix was developed based on Step 1 of Stage 1 of the methodology for evaluating the implementation of Water Resources Plans proposed by the ANA (2021), applied to the six PBAIAR programs. The synthesis matrix organized information regarding objectives, targets, planned activities, deadlines, responsible institutions and estimated costs, enabling verification of the internal consistency of the planning process and its adherence to results-oriented management criteria. Table 2 illustrates the application of this instrument to Program 1 – Water Resources Management. This systematization considered the relevance of information transparency and the existence of institutional interest in policy evaluation, an attribute associated with the concept of accountability (Brasil, 2014), as well as the importance of oversight and continuous policy improvement (Cassiolato and Gueresi, 2010).

Table 1 – Programs and subprograms included in the PBAIAR Action Plan

Upper Iguaçu and Upper Ribeira Tributaries Basin Plan	
Program	**Subprograms**
1 – Water resources management	1.1 Studies and surveys to support the Decision Support System for Water Resources Management. 1.2 Integrated Water Resources Management. 1.3 Qualitative and quantitative monitoring of surface and groundwater. 1.4 Development of regulatory instruments for groundwater quality protection. 1.5 Monitoring of domestic and industrial effluent discharges, as well as regularization of corresponding water permits. 1.6 Monitoring of diffuse pollution sources from urban areas and agricultural inputs.
2 – Recovery of water body quality	2.1 Treatment of urban effluents, water treatment plant (WTP) and wastewater treatment plant (WWTP) effluents, final disposal of sludge generated by WTPs and WWTPs and urban solid waste final disposal systems.
3 – Conservation and protection of water bodies	3.1 Feasibility studies and improvement of legislation for the protection of current and future water sources. 3.2 Restoration of riparian vegetation and vegetation cover and land-use regulation.
4 – Promotion of rational water use	4.1 Rationalization of water use in urban water supply systems. 4.2 Support for industrial activities.
5 – Prevention and protection against extreme hydrological events	5.1 Establishment and support of non-structural measures and Civil Defense activities. 5.2 Operation of warning systems, meteorological radar and telemetry networks. 5.3 Dredging projects and works, river channel rectification, watercourse canalization and flood control structures. 5.4 Monitoring of prolonged drought indicators.
6 – Technical training, environmental education and social communication	6.1 Training and capacity building of Committee members and the River Basin Management technical staff. 6.2 Support and training for municipalities in project preparation and fundraising.

Source: Adapted from Paraná (2014, p. 58).

Table 2 – Synthesis of plan information for governance assessment

Program	Program 1 – Water Resources Management (WRM).
Subprogram	Water Resources Information System.
Objectives	Assist in verifying the updating of the classification of water bodies.
Targets	Short, medium and long term.
Planned activities	Development and implementation of a Decision Support System (DSS) for Water Resources Management, aimed in particular at assisting in verifying the classification of watercourses and in analyzing applications for water use permits.
Expected timeframe for completion of program/ action activities	By 2017; by 2027; by 2036.
Responsible agency	Water and Land Institute.
Estimated cost	Information not available.

Source: Adapted from ANA (2021).

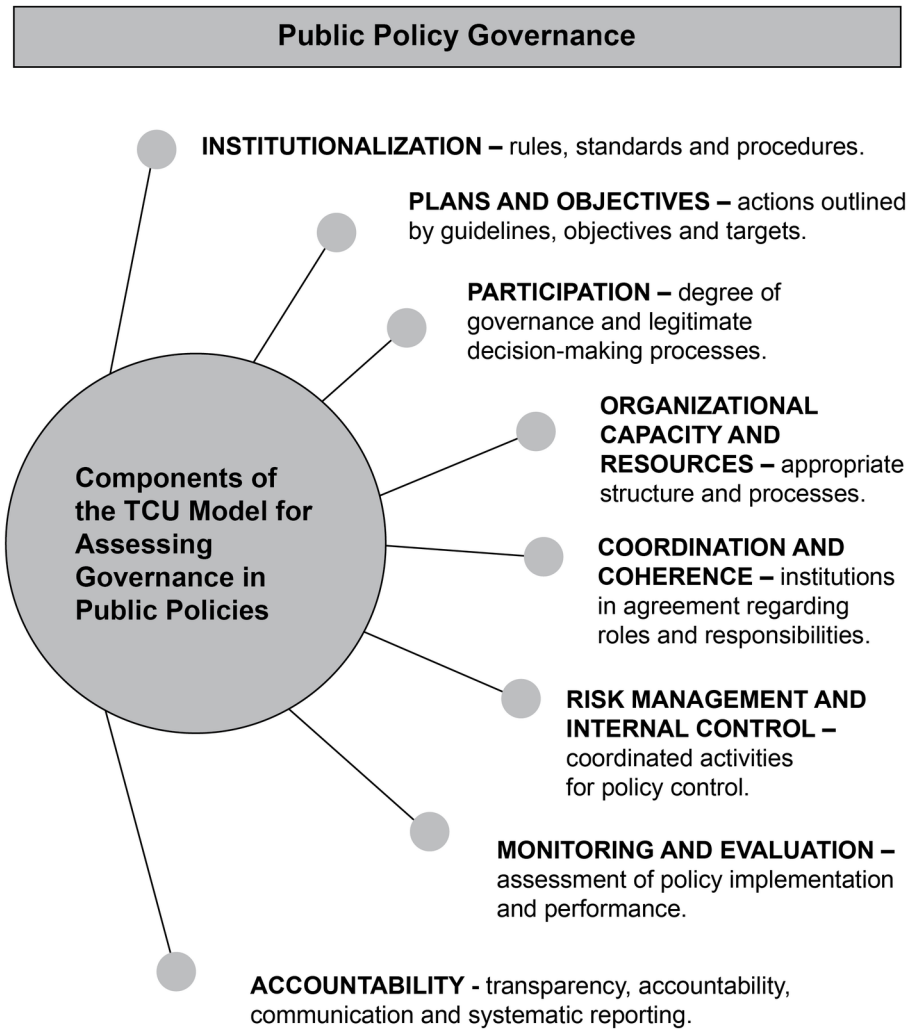

Figure 1 – Components of the TCU Public Policy Governance Evaluation Model.
Source: Adapted from Brasil (2014).

To define the analytical criteria for governance assessment, this study adopted the Public Policy Governance Evaluation Model developed by the TCU (Brasil, 2014). Among the eight components included in the model and presented in Figure 1, this study selected the components "Plans and Goals" and "Monitoring and Evaluation" because they align with the objective of examining the planning structure and monitoring mechanisms of the PBAIAR. Within the "Plans and Goals" component, the analysis examined whether implementation timelines were structured into manageable stages to reduce risks and identify interdependencies and barriers to implementation (Brasil, 2014) and whether key indicators had been defined to measure progress. Within the "Monitoring and Evaluation" component, the analysis examined the definition of the scope, purpose and intended users of the monitoring system from the policy formulation stage onward; the availability of reliable and relevant data to support performance reporting; and the regularity with which results were communicated.

To examine the structure of monitoring and evaluation mechanisms, the documentary corpus was expanded to include committee resolutions and deliberations, the committee's Internal Regulations (COALIAR, 2005, 2024) and federal and state legislation concerning the competencies of River Basin Committees (Brasil, 1997; Paraná, 1999). Institutional documents produced by agencies involved in policy implementation or oversight were also analyzed, including the *Instituto Água e Terra* (IAT) [Water and Land Institute], the *Secretaria de Estado do Desenvolvimento Sustentável* (SEDEST) [State Secretariat for Sustainable Development], the *Agência de Assuntos Metropolitanos do Paraná* (AMEP) [Paraná Metropolitan Affairs Agency] and the *Tribunal de Contas do Estado do Paraná* (TCE-PR) [State Court of Accounts of Paraná]. The analysis focused on identifying elements

such as implementation schedules, indicator definitions, resource allocation, assignment of responsibilities and control mechanisms to assess the coherence between formal planning and effective operationalization. Figure 2 summarizes the stages of the study.

The evaluation conducted in this study is classified as internal because one of the authors participates in the committee as a municipal representative, which provides privileged access to decision-making arenas (Rua, 2009). Although the literature acknowledges potential limitations related to impartiality in evaluations conducted by actors directly linked to the policy under analysis (Arretche, 2003), this condition also expands access to institutional information unavailable in public databases. Moreover, the literature recognizes that absolute neutrality is unattainable in public policy evaluation (Trevisan and Van Bellen, 2008; Jannuzzi, 2025). To mitigate potential bias, priority was given to formal documentary analysis and the use of criteria previously defined in the TCU framework.

As a documentary research study, this investigation presents limitations associated with the exclusive use of secondary sources. The analysis depends on the quality, completeness and currency of administrative records provided by the responsible institutions. No interviews or primary data collection procedures were conducted, restricting the analysis to the formal dimension of public policy. Potential informational gaps may affect the scope of inference; however, the adoption of previously defined analytical criteria grounded

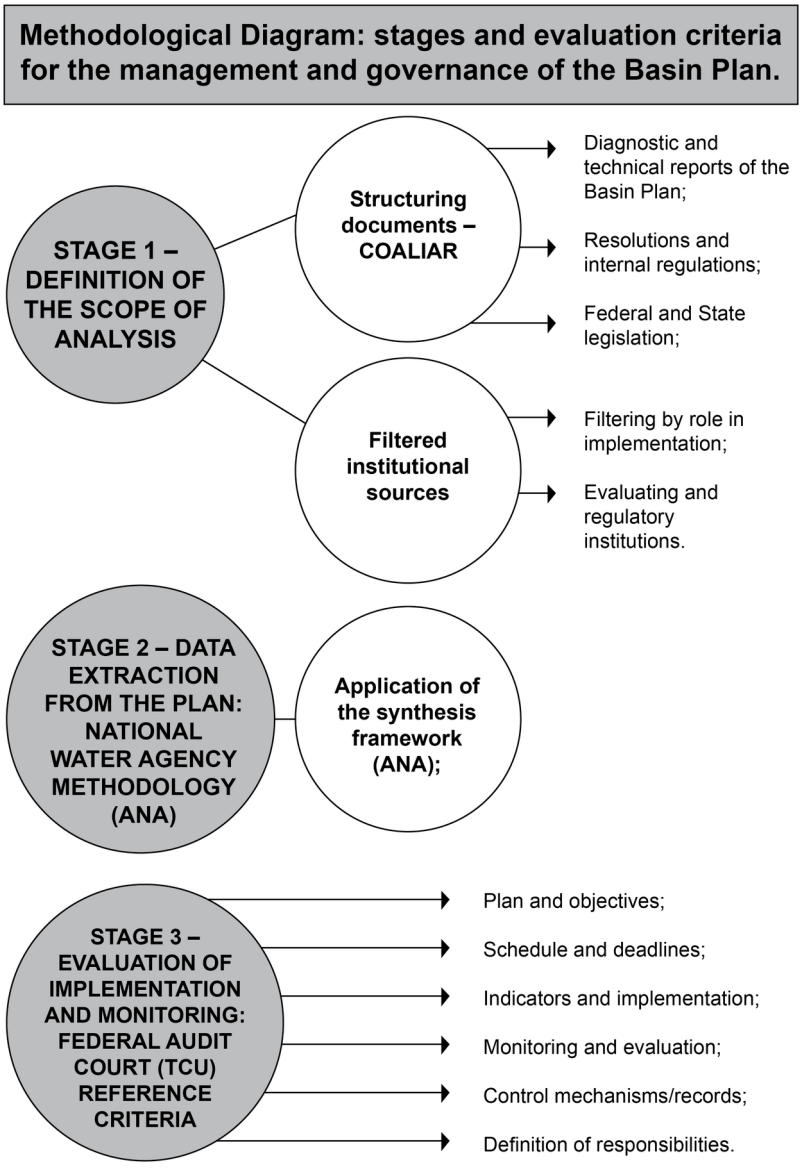

Figure 2 – Summary of the study methodological stages

in consolidated institutional frameworks contributes to ensuring the consistency and reliability of the evaluation.

Regarding the evaluative framework, absolute performance standards were adopted, consistent with the targets formally established in the River Basin Plan. Concerning the timing of the evaluation, the study is classified as intermediate or formative, as it was conducted during the implementation process of the plan, considering the temporal horizon established for its targets (Trevisan and Van Bellen, 2008).

Results and discussion

The results are presented according to the two central components of the analytical framework adopted: (i) **Plans and Goals**; and (ii) **Monitoring and Evaluation**. First, the empirical findings derived from the documentary analysis are presented, followed by their interpretation in light of the specialized literature on water governance and public policy evaluation.

Plans and goals: structuring planning and implications for operationalization

The analysis of the reports comprising the PBAIAR revealed structural fragmentation of information regarding targets, responsible actors, deadlines and actions. Although these elements are formally included in the plan, they are distributed across different documents, making systematic monitoring difficult and reducing the of the evaluation as understood in the guidelines of the ANA (2021). More than an operational limitation, this fragmentation affects the plan's ability to function as a coordination instrument among the multiple actors involved in basin management. Recent studies suggest that the effectiveness of water governance instruments depends not only on the formal existence of targets and agreements but also on the clarity of the mechanisms that enable their implementation, monitoring and accountability over time (Santos et al., 2025). In this sense, information dispersion reduces transparency in decision-making processes and hinders the development of shared references among the actors responsible for policy implementation.

The actions proposed under the subprograms should present explicit links to objectives, targets, responsible institutions and deadlines. However, the dispersion of information reduces decision traceability and hinders monitoring. The plan establishes short-term (up to 2017), medium-term (up to 2027) and long-term (up to 2036) targets aimed at improving water body quality and revising water quality classification (Paraná, 2013), yet the actions do not present explicit connections to the targets detailed in the Executive Report (Paraná, 2014). In polycentric and multilevel governance arrangements, such as those underlying water resources policy (Bakker and Morinville, 2013; Pahl-Wostl and Knieper, 2023), failures in information coordination increase inefficiency risks, exacerbate asymmetries among actors and compromise planning effectiveness.

The complexity and multiplicity of actors and institutional arrangements in water governance create challenges for policy coordination and monitoring (Carvalho and van Tulder, 2022), which become even more pronounced in contexts characterized by fragmented information for decision-making, as observed in the PBAIAR. This finding converges with evidence reported by Matos et al. (2022), who identified accountability deficits, knowledge asymmetries and difficulties in understanding management instruments within Brazilian river basin committees, factors that undermine qualified participation and the capacity to monitor decisions. Similarly, Rothberg and Garde-Hansen (2021) found that lack of clarity regarding the role of committees may weaken their legitimacy in the eyes of society, highlighting the importance of institutional mechanisms that foster transparency and improve understanding of actor responsibilities.

The plan classifies targets into structural and non-structural actions and, in some cases, defines responsible institutions and objectives, but it does not establish systematic correspondence across all programs. In the case of the Program for prevention and protection against extreme hydrological events deadlines, objectives and responsible institutions are specified for only three of the 18 planned actions. Therefore, despite the formal existence of indicators, the absence of clearly defined targets and responsibilities compromises performance assessment and limits results-oriented monitoring. A recent study on water governance in public administration indicates that target-based accountability mechanisms ensure that all participants are evaluated against expected outcomes, thereby promoting transparency and effectiveness and ensuring that water management targets are actually achieved (Wang et al., 2025).

Furthermore, recent studies have shown that the increasing complexity of water security challenges requires governance structures capable of integrating planning, implementation and monitoring in a continuous and adaptive manner (Gesualdo et al., 2021; Ballarin et al., 2023). When such integration does not occur, institutional bottlenecks become more difficult to identify, implementation strategies become harder to adjust and responses to crisis scenarios or environmental changes become less effective. Accordingly, the weaknesses identified in the PBAIAR represent not merely documentary limitations but potential barriers to adaptive capacity and the effectiveness of basin water governance.

Of the total of 92 actions identified, only 48 – those linked to water quality classification – simultaneously define targets, responsible actors and objectives. The remaining 44 actions lack absolute performance benchmarks, preventing effectiveness from being measured. According to the OECD (2020), clear and specific targets are a necessary condition for outcome evaluation and efficient allocation of public resources. Performance evaluation requires establishing reference standards that enable evaluators to make informed judgments (Costa and Castanhar, 2003). That is, adopting an absolute benchmark means that the original targets established by a program are treated as the sole standard to be

achieved; consequently, outcome evaluation becomes a direct comparison between what was planned during formulation (the target) and what was achieved during implementation.

In the case of the PBAIAR, effectiveness measurement is restricted to a limited subset of planned actions, weakening its capacity to induce allocative efficiency. Moreover, the absence of clearly established targets reduces actors' ability to monitor commitments, prioritize resources and develop accountability mechanisms throughout implementation, elements recognized as fundamental to effective water governance (Costa and Neto, 2023; Santos et al., 2025). In contexts characterized by increasing pressure on water resources, the absence of verifiable benchmarks also hinders the generation of information capable of supporting adaptive adjustments and strengthening water security (Gesualdo et al., 2021; Ballarin et al., 2023).

Considering the similarity between the data systematization adopted in this study and the logical model methodology (Cassiolato and Gueresi, 2010), it became evident that, during policy formulation, the core elements of the policy must be made explicit so that evaluation and monitoring processes can be adequately guided and redesigned if implementation adjustments become necessary (Trevisan and Van Bellen, 2008). It can therefore be argued that the mere existence of the Plan as a legal instrument, together with supporting tools (such as indicators and targets), does not guarantee implementation, efficacy or effectiveness in water resources management, as observed in South Africa (Pahl-Wostl et al., 2012) and in the *Comitê de Bacias Hidrográficas do Litoral Norte da Paraíba* [North Coast River Basin Committee of Paraíba] (Costa and Fonseca, 2022).

Recent evidence indicates that the effectiveness of management instruments depends on the existence of institutional arrangements able to transform formal objectives into coordinated actions that are monitored and subject to revision throughout implementation (Bouckaert et al., 2022; Santos et al., 2025). Likewise, studies on water governance in Brazil demonstrate that accountability deficits, technical limitations and difficulties in understanding management instruments may compromise the ability of basin committees to fulfill their deliberative and monitoring functions, even where formal instruments have already been established (Matos et al., 2022). Consequently, the findings suggest that the mere existence of planning mechanisms does not ensure effectiveness; rather, institutional capacities must be developed to translate normative guidelines into concrete management outcomes.

Integration with economic instruments of water policy

A strategic instrument for implementing the plan is the water use charge, regulated by State Decree No. 7,348/2013 and approved through COALIAR Resolution No. 05/2013 (COALIAR, 2013). The Investment Program projected the allocation of collected revenues between 2014 and 2017 (Paraná, 2014). However, the TCE-PR (2021) found that the IAT does not maintain consolidated information regarding revenue collection and charging criteria. The agency also failed to establish clear procedures for assessment, payment and registration of overdue debts. As a result, no investments were made in the planned short-term actions, revealing a disconnect between physical planning and financial execution. More than an administrative limitation, this disconnect undermines the capacity of the economic instrument to fulfill its intended role of supporting the implementation of actions agreed upon in the river basin plan. Recent studies emphasize that the effectiveness of management instruments rests not on formal regulation alone but on institutional mechanisms capable of ensuring operationalization, monitoring and allocation of financial resources in accordance with agreed objectives (Costa and Neto, 2023; Santos et al., 2025).

Another important issue neglected in the implementation of the charging mechanism is the lack of clear regulation governing payment procedures and debt collection, identified by the TCE-PR (2021). This limitation reduces the effectiveness of the charging system, creates financial management difficulties and ultimately leads to revenue losses, weakening both the capacity to finance water resources management actions within the basin and the incentive structure for rational water use. The literature highlights that economic instruments only achieve their intended outcomes when embedded within institutional arrangements capable of ensuring predictability, regulatory certainty and accountability mechanisms for users (Moraes et al., 2021). In the absence of these conditions, revenue collection decreases and the charging mechanism loses its potential to induce behaviors aligned with water policy objectives.

Analysis of committee resolutions suggests that the collected revenues were never effectively applied. Following the establishment of the charging mechanism in 2013, decisions were approved to modify the allocation percentages of collected funds established in the Basin Intervention Plan (COALIAR Resolution No. 07/2014) and to develop Call for Proposals No. 01/2016, which defined prioritization criteria for resource allocation (COALIAR Resolution No. 09/2016). Although approved, the proposal was not advanced within the committee and revisions to Call No. 01/2016 were resumed only in 2023 through COALIAR Deliberation No. 01/2023, in accordance with the Guidance Manual for the Allocation of Revenues from Water Use Charges. Thus, although formally established, the instrument was not implemented for its intended purpose, namely, financing the programs contained in the basin plan itself. From an economic–institutional perspective, this disconnect compromises the principle of performance-based budgeting, reduces intertemporal predictability and weakens the credibility of the economic instrument as a mechanism for behavioral induction and public policy financing. In addition, experiences from other river basin governance contexts demonstrate that stakeholder engagement and coordinated implementation of planning instruments are essential conditions for transforming planning objectives into concrete management outcomes (Bouckaert

et al., 2022). In this context, the failure to allocate the collected revenues indicates that the formal existence alone was insufficient to generate the expected effects on policy implementation.

Furthermore, the revision of water body classification (*enquadramento*) is directly linked to the implementation of the charging mechanism, since collected revenues provide financial support for improving knowledge of watershed characteristics and for pollution control programs that contribute to watershed restoration (Souza and Pizella, 2021). In the Alto Iguaçu case, the plan links targets to the Program for Implementation of the Proposal for Updating the Integrated Water Body Classification, approved through COALIAR Resolution No. 04/2013. Since the charging mechanism was formally implemented but never operationalized, as discussed above, this constitutes another planning instrument that failed to materialize, despite its potential to support implementation of water body classification targets (Souza and Pizella, 2021). This situation suggests a cumulative (cascade) effect among institutional weaknesses, whereby the inoperability of one instrument compromises the execution of dependent mechanisms. Research on water security has emphasized that the effectiveness of water policies depends on coordination among planning, financing and implementation instruments, and that failures in coordination and operationalization are among the main factors associated with governance challenges across different contexts (Gesualdo et al., 2021; Ferreira et al., 2025).

Monitoring, evaluation and accountability

Internal Regulations are essential in water governance bodies for identifying competencies, composition and other structural aspects, while also serving as a criterion for evaluating civil society participation (Vitória and Pizella, 2024). The committee's Internal Regulations provide for monitoring of the basin plan (COALIAR, 2005); however, a dedicated working group was only established in 2024, 11 years after plan approval (COALIAR, 2023, 2024). Moreover, this working group has a temporary character, which contradicts the permanent nature of monitoring established in the plan itself. The PBAIAR establishes the preparation of evaluation and implementation monitoring reports; however, the review of resolutions and deliberations found no reports produced during the period analyzed, thereby limiting policy feedback and compromising institutional learning processes. The same review identified Resolution No. 11/2017, which extinguished both the *Câmara Técnica de Planejamento* (CTPLAN) [Technical Chamber for Monitoring Plan Development] and the *Câmara Técnica de Cobrança pelo Uso dos Recursos Hídricos* (CTCOB) [Technical Chamber for Water Use Charges], consolidating their functions into the *Câmara Técnica de Instrumentos de Gestão* (CTINS) [Technical Chamber for Management Instruments] (COALIAR, 2017). Although this resolution established a formal definition of roles, competencies and institutional responsibilities for producing evaluative information in alignment with public governance guidelines (Brasil, 2014), this normative structure did not translate into effective operational practice. The PBAIAR itself includes the "Preparation of Evaluation and Monitoring Reports on Basin Plan Implementation" as one of the actions under the Water Resources Management Program; nevertheless, a monitoring report was produced only in 2025 (COALIAR, 2025).

Regarding information production, the PBAIAR includes a dedicated subprogram, the Water Resources Information System. Currently, the environmental agency operates the *Sistema de Informações para Gestão Ambiental e de Recursos Hídricos* (SIGARH) [Environmental and Water Resources Management Information System], a corporate platform implementing the *Sistema Estadual de Informações sobre Recursos Hídricos* (SEIRH/PR) [Paraná State Water Resources Information System]. This structure comprises three systems: the *Cadastro de Recursos Hídricos* (CRH) [Water Resources Registry], the Sistema de Informações Hidrológicas (SIH) [Hydrological Information System] and SIGARH itself. The assessment conducted by the TCE-PR (2021) identified the following weaknesses: (a) lack of integration between the manually updated CRH and SIGARH; (b) absence of integration between CRH and SIGARH water permitting systems and the Environmental Management System associated with environmental licensing; (c) deficiencies in the control of estimated water demands, disaggregated by surface and groundwater basin and by user sector, for the purpose of estimating allocable quantity and quality; (d) lack of alignment between municipal environmental licensing systems and IAT systems, considering that water permits are issued exclusively by the Institute, thereby weakening environmental licensing processes for projects requiring water permits; and (e) absence of monitoring of applications for well drilling corresponding to preliminary water permits.

These adjustments in information production should be implemented by the Institute itself, since one of IAT's official responsibilities is to "administer and update the State Water Resources Information System and maintain records of water uses and users, in addition to disseminating data and information," which constitutes the purpose of SIGARH (IAT, 2020). Therefore, the availability of reliable and relevant data needed to support reports on plan performance remains below expected standards. Similar challenges were identified in the Jundiaí River Basin in São Paulo (Puga et al., 2020). Governance assessment revealed limitations in information integration, particularly concerning information generated at the basin management scale, namely the information systems of the Piracicaba, Capivari and Jundiaí (PCJ) river basins, which pose difficulties for access and use at the local scale. Such information frequently remains confined to technical circles and fails to translate into concrete actions or more participatory and informed decision-making among stakeholders (Mancini and Jacobi, 2020; Puga et al., 2020).

It is also important to revisit the lack of monitoring of revenues generated by water use charges discussed in the previous section.

TCE-PR (2021) analyses demonstrated that, although a dedicated tab exists on the Committee's website, the generated report remains restricted to the agency and is insufficient to address concerns regarding transparency. These limitations reduce the quality of information available for decision-making and performance assessment. According to the OECD (2020), integrated information systems constitute a necessary condition for adaptive governance and efficient resource allocation.

Participation, coordination and accountability

The TCU model (Brasil, 2014) recognizes the interdependence among monitoring, participation and accountability. The TCE-PR (2021) identified difficulties faced by COALIAR members in monitoring the financial and physical execution of actions, particularly because the IAT provides information only during committee meetings. Accountability, understood as responsibility and systematic reporting (Brasil, 2014), remains limited, as evidenced by the absence of public committee reports and systematic communication by actors responsible for information disclosure, thereby reducing transparency and significantly compromising policy learning.

Studies clearly demonstrate the consequences of impaired learning processes (Pahl-Wostl, 2009; Empinotti et al., 2021), both in terms of deficits and institutional constraints (when learning processes fail or are blocked) and in terms of active engagement of society and the State in political and social learning. When learning is compromised or neglected, governance systems experience severe impacts that may lead to systemic failures such as stagnation in *single-loop learning* (Pahl-Wostl, 2009). Without an environment that fosters critical learning, governments remain confined to refining established routines without questioning the underlying assumptions of the problem. Empirical analysis of river basin committees in South America (Brazil, Argentina and Uruguay) during water crises concluded that although crises created opportunities for information sharing (a basic level of learning), institutions remained trapped in *single-loop learning*, focusing on short-term responses and technical adjustments. These findings demonstrate that the absence of deeper learning processes (*triple-loop learning*) prevents governance from becoming genuinely adaptive under conditions of climatic extremes (Trimble et al., 2022).

Regarding municipal participation in basin water governance, only five out of the 26 municipalities within the basin hold seats on the committee (COALIAR, 2005, 2024). This limited representation compromises intergovernmental coordination, particularly considering that many actions depend on municipal implementation (Puga et al., 2020). Despite normative provisions linking municipalities to the integration of water resources, environmental and urban policies, the institutional reality reveals the exclusion of these actors. This restricted participation highlights a governance gap in intersectoral basin management (Nicollier et al., 2022).

Beyond the limited inclusion of stakeholders, the lack of technical training among committee members (TCE-PR, 2021) also reduces deliberative and oversight capacity, weakening governance. These impacts clearly affect social effectiveness (Costa and Fonseca, 2022) due to constraints on members' decision-making capacity and performance. Insufficient training of committee members, particularly civil society representatives, combined with difficulties in systematically monitoring implementation of Basin Plan actions (TCE-PR, 2021), undermines the participatory and decentralized nature of water resources management. Given its polycentric and multilevel character, effective governance also requires social learning and therefore depends on monitoring and transparency. Overall, structural deficits were identified in the integration among planning, financing, monitoring and institutional learning, limiting the adaptive capacity of the system.

Methodological contributions

Beyond the specific contributions to evaluating the Alto Iguaçu Basin Plan in the Curitiba Metropolitan Region, the results of this study offer simple and readily replicable methodological contributions.

Integration of Frameworks (ANA and TCU): The study stands out for adopting a hybrid approach that integrates instruments from different institutional sectors. The methodology proposed by the ANA (2021) was employed to systematize and structure basin plan data and integrate them into the Governance Assessment Model of the TCU (Brasil, 2014). This integration enables a comprehensive analysis of both planning robustness (including targets, deadlines and costs) and governance quality (monitoring, evaluation and transparency).

Mitigation of Biases in Internal Evaluations: This study proposes a methodological alternative applicable when researchers actively participate in the policies under analysis (as in the present case, in which one author serves as a municipal representative on the committee). The approach transforms the potential bias of internal evaluations into an advantage by leveraging privileged access to restricted information while ensuring scientific rigor and neutrality through exclusive reliance on official documents and institutionally defined criteria established by the TCU.

Potential replications

Standardized Tool (Synthesis Matrix): By developing a synthesis matrix to map programs according to objectives, targets, activities, deadlines, responsibilities and costs (see Program 1 – Water Resources Management), this study provides a structured and easily adaptable instrument for results-oriented management in other contexts.

Feasibility through Documentary Analysis: Since the methodology relies exclusively on secondary documentary sources (diagnostic, technical and executive reports, together with legislation and institutional resolutions), it can be readily replicated by public managers and researchers in different regions without requiring costly primary data collection or interviews.

Governance Assessment in Other Public Policies: The selection of specific components from the TCU model, namely "Plans and Goals" (emphasizing manageable timelines and indicators) and "Monitoring and Evaluation" (prioritizing reliable data and performance reporting), offers a ready-to-use analytical framework for governance and accountability assessments across other public policy domains.

Use of Absolute Performance Standards: The model adopts standards based on targets formally established by the evaluated instrument itself, enabling formative application to any policy containing documented targets and implementation schedules and allowing adjustments and interventions during policy execution.

Conclusions

Evaluation of the management and governance dimensions of the PBAIAR demonstrated that the mere existence of planning instruments does not guarantee effective regional water governance. The study revealed structural deficits in the integration among physical planning, financial support and performance monitoring.

The main findings indicate: (1) operational disconnection resulting from the absence of deadlines, targets and clearly defined responsibilities for a substantial portion of actions, making the assessment of policy effectiveness unfeasible; (2) financial inoperability, as failure to apply revenues generated by water use charges interrupted the investment cycle required to implement planned programs; (3) monitoring inertia, due to the absence of systematic monitoring reports for more than 10 years, preventing institutional learning and transparency toward society; (4) fragility in multilevel governance, reflected in low municipal representation and insufficient technical capacity among committee members, compromising deliberative and adaptive capacity; and (5) development of an analytical model that is readily replicable.

In summary, transitioning from a merely formal plan to an operational management instrument fundamentally depends on alignment among planning, budgeting and integrated information systems. This finding underscores the importance of designing robust plans capable of supporting monitored implementation and generating tangible outcomes for water security. The present evaluation provides evidence to support managers in reorienting committee actions and strengthening water security in the Curitiba Metropolitan Region in the face of recurring water scarcity events.

Authors' Contributions: Giordani, A.C.: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing; Affonso, I.P.: Formal Analysis, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Conflicts of interest: the authors declare no conflicts of interest.

Funding: none.

Declaration on the use of generative artificial intelligence: The authors declare that they did not use AI in the preparation of the manuscript.

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