Institutional Performance and River Water Conservation in Sabah: Applying Ostrom's IAD Framework

Asing,Lanree [a]*

Water is essential for human survival and agricultural productivity, with 98% of Sabah's water supply derived from rivers. However, communities across the region face persistent challenges of unsafe drinking water due to pollution and river channel depletion. These conditions severely affect paddy cultivation and undermine economic, social, cultural, and ecological sustainability. Despite institutional efforts, water-related concerns remain unresolved, highlighting the need for effective governance and conservation strategies. This study evaluates institutional performance in river water conservation by applying Ostrom's Institutional Analysis and Development (IAD) framework. A quantitative approach was adopted, involving 303 respondents from relevant institutions in Sabah. Data were collected through structured questionnaires and analyzed using Structural Equation Modeling (SEM) via Partial Least Squares (PLS) with SPSS and SmartPLS. Findings provide insights into the roles of formal and informal institutions in water governance and propose strategies to strengthen conservation outcomes for sustainable human, agricultural, and ecological benefits.

Keywords: water security, river water source conservation, institutional performance, IAD, Sabah.

*Contact information: a: Olympia Education Malaysia, Olympia Lakeside Campus, Lot 56-60 Jalan Dagang SB 4/2, 43300 The Mines Resort City, Selangor, Malaysia; *Corresponding author: lanree.asing@yahoo.com*

INTRODUCTION

Freshwater rivers are among the most critical ecosystems supporting biodiversity, human livelihoods, and economic development. They provide essential services such as water supply, flood regulation, sediment storage, and habitats for countless species. Globally, rivers sustain agriculture, fisheries, energy production, and tourism, while also serving as cultural and spiritual landmarks (Li et al., 2022). Yet, despite their importance, river systems worldwide are under severe threat from deforestation, industrial pollution, urbanization, and climate change (Del T6nago et al., 2021). These pressures compromise ecological integrity and reduce the capacity of rivers to provide ecosystem services, making conservation an urgent priority. Institutional performance plays a decisive role in determining conservation outcomes. Institutions—government agencies, non-governmental organizations (NGOs), and community-based systems—mediate conflicts over resource use, enforce environmental regulations, and facilitate stakeholder participation (Liu et al., 2020). However, many governance systems remain fragmented, under-resourced, and poorly coordinated, particularly in tropical regions where socio-ecological systems are complex and vulnerable to external pressures (Anderson et al., 2019; Olalekan et al., 2019). This global challenge underscores the need for robust institutional frameworks capable of balancing ecological imperatives with socio-economic demands.

In tropical countries, rivers are central to both rural and urban communities. They provide water for agriculture, fisheries, and domestic use, while also supporting cultural and religious practices (Ismail & Go, 2021). In Malaysia, and particularly in Sabah, rivers are vital for ecological stability and socio-economic development. The Kinabatangan River, for example, stretches over 560 km and traverses' diverse ecosystems including upland forests, lowland rainforests, and mangroves. It supports endangered species such as the Bornean orangutan, pygmy elephant, and proboscis monkey, while also providing water, transport, and energy for local communities (Brunke, 2020). Despite their importance, Sabah's rivers face mounting pressures. Deforestation driven by oil palm expansion, logging, and urbanization has led to watershed loss, soil erosion, and sedimentation (Tang & Al Qahtani, 2020). Industrial discharges and untreated sewage further degrade water quality, while climate change exacerbates flooding and droughts (Zainurin et al., 2024). These ecological challenges are compounded by institutional weaknesses, including inadequate enforcement of environmental laws, insufficient funding, and poor coordination among agencies (Dilshad et al., 2019). As a result, Sabah's rivers are increasingly unable to sustain the ecological and socio-economic functions upon which communities depend.

Effective river conservation requires strong institutions capable of enforcing laws, coordinating stakeholders, and integrating ecological knowledge into policy. In Sabah, governance is carried out by a complex network of actors including the Sabah Environmental Protection Department, the Sabah Forestry Department, national agencies, NGOs such as WWF-Malaysia, and indigenous communities (Reuben & Gunggut, 2021; Sloan et al., 2019). While these institutions have made important contributions, their efforts are often undermined by overlapping jurisdictions, weak enforcement mechanisms, and conflicting land-use strategies (Ng et al., 2024). For instance, while the tourism sector promotes riverine ecotourism, agricultural expansion frequently undermines conservation goals. Community-based approaches such as the Tagal system demonstrate the potential of integrating indigenous knowledge with modern governance. The Tagal system, practiced by the Kadazan-Dusun and Murut communities, involves setting aside protected river areas where fishing is prohibited until stocks recover. Supported by the Sabah Inland Fisheries and Aquaculture Enactment 2003, this system balances traditional practices with legal frameworks, providing both ecological and economic benefits (Kurz et al., 2020). However, such successes remain localized and require greater institutional support to be scaled across the region.

The Institutional Analysis and Development (IAD) framework, developed by Elinor Ostrom, provides a systematic approach to analyzing governance systems and common-pool resources (Ostrom, 2019; Schlager & Villamayor-Tomas, 2023). It examines how rules, norms, actors, and contextual factors interact within action arenas, shaping conservation outcomes. By identifying institutional strengths and weaknesses, the IAD framework enables policymakers to design interventions that enhance governance performance. It has been widely applied in resource-based industries, but empirical applications in tropical river governance remain limited (Ocate-Valdivieso et al., 2021). Applying the IAD framework to Sabah's river systems offers a valuable opportunity to evaluate institutional performance in a complex socio-ecological context. It allows for the identification of governance gaps, the assessment of stakeholder participation, and the integration of indigenous knowledge into policy. This study therefore contributes to both academic literature

and practical policymaking by demonstrating how institutional analysis can inform sustainable river conservation in tropical regions.

Sabah's rivers are increasingly degraded due to unsustainable land use, industrial discharges, and climate variability. Although multiple institutions are mandated to safeguard these resources, their efforts are undermined by weak enforcement, fragmented governance, and insufficient integration of indigenous knowledge and community participation. This institutional vulnerability has resulted in declining water quality, loss of biodiversity, and reduced ecosystem services. The absence of a coherent analytical framework to assess institutional performance further constrains the ability of policymakers to design effective interventions. Addressing this gap is critical for ensuring the long-term sustainability of Sabah's river systems and for advancing global understanding of institutional dynamics in tropical resource governance. Against this backdrop, the present study sets out to assess the performance of institutions involved in the conservation of Sabah's river water sources using Ostrom's IAD framework, to examine the influence of institutional arrangements, stakeholder participation, and contextual factors on conservation outcomes, to identify key challenges and barriers to effective governance of river systems in Sabah, and to recommend strategies for strengthening institutional performance including policy integration, enforcement mechanisms, and community-based approaches. By addressing these objectives, the study contributes to both academic discourse on institutional analysis and practical policymaking for sustainable river conservation in tropical regions.

METHODOLOGY

This study adopts a qualitative–quantitative mixed-methods design to examine the performance of institutions involved in the conservation of river water sources in Sabah, Malaysia. The methodological approach is guided by Elinor Ostrom's Institutional Analysis and Development (IAD) framework, which provides a systematic lens for analyzing governance systems and common-pool resources (Ostrom, 2019; Schlager & Villamayor-Tomas, 2023). The IAD framework is particularly suitable for this research because it allows for the identification of institutional arrangements, rules-in-use, actor interactions, and contextual factors that shape conservation outcomes. By applying this framework, the study seeks to uncover both the strengths and weaknesses of institutional performance in Sabah's river governance.

The research design integrates three complementary components: (1) document analysis of policies and legal frameworks, (2) stakeholder interviews and surveys, and (3) statistical modeling of institutional performance indicators. This triangulated approach ensures that findings are robust, contextually grounded, and capable of capturing the complexity of socio-ecological systems in tropical regions (Lankford et al., 2020; Leroy, 2022).

Document analysis was conducted to review key legislative and policy instruments relevant to river conservation in Sabah. These included the Sabah Water Resources Enactment 1998, the Environmental Quality Act 1974, the Wildlife Conservation Enactment 1997, and the Sabah Inland Fisheries and Aquaculture Enactment 2003. The analysis focused on identifying the objectives, enforcement mechanisms, and institutional responsibilities embedded within these frameworks. Particular attention was paid to overlaps and gaps in jurisdiction, as previous studies have highlighted fragmented governance as a major barrier to

effective conservation (Ng et al., 2024; Fulazzaky et al., 2023). Policy documents from NGOs such as WWF-Malaysia and the Heart of Borneo initiative were also examined to capture non-state contributions to conservation.

To complement the document analysis, semi-structured interviews were conducted with representatives from government agencies, NGOs, indigenous communities, and private sector actors. These stakeholders were selected based on their involvement in river management, conservation programs, or resource use. Interviews explored perceptions of institutional effectiveness, enforcement challenges, stakeholder participation, and the integration of indigenous knowledge. This qualitative component was essential for capturing the lived experiences and contextual realities of governance, which are often overlooked in purely quantitative studies (Sloan et al., 2019; Sheng & Potter, 2023). In addition, surveys were distributed to community members in selected riverine areas to gather data on local engagement, awareness of conservation policies, and satisfaction with institutional performance. The survey design drew on established instruments in environmental governance research, adapted to the Sabah context (Liu et al., 2020; Anderson et al., 2019).

Quantitative analysis was conducted using Structural Equation Modeling (SEM) with Partial Least Squares (PLS), a technique well-suited for examining complex relationships among latent constructs such as institutional performance, stakeholder participation, and conservation outcomes (Hair et al., 2019). SEM-PLS allows for the testing of hypotheses regarding the correlation between institutional arrangements and ecological indicators, while accommodating small sample sizes and non-normal data distributions common in governance research. Variables were operationalized based on the IAD framework, including rules-in-use, actor characteristics, and contextual factors. Indicators such as enforcement capacity, funding adequacy, stakeholder engagement, and ecological outcomes (e.g., water quality, biodiversity status) were measured and modeled to assess institutional performance.

Data collection was carried out in three major river basins in Sabah: the Kinabatangan, Segama, and Padas rivers. These sites were selected because they represent diverse ecological systems and varying degrees of institutional involvement. The Kinabatangan River, for instance, is heavily impacted by oil palm expansion and ecotourism initiatives, while the Segama River is characterized by logging pressures and indigenous community reliance. The Padas River, on the other hand, is central to hydropower development and urban water supply. This site selection strategy ensured that the study captured a range of governance contexts and institutional challenges (Brunke, 2020; Tang & Al Qahtani, 2020).

Ethical considerations were central to the research design. Informed consent was obtained from all interview and survey participants, and confidentiality was maintained throughout the study. Indigenous knowledge was treated with respect, and findings were shared with community representatives to ensure reciprocity. The research also adhered to guidelines for environmental and social research in Malaysia, as outlined by the Department of Environment Malaysia and the Sabah Environmental Protection Department (Reuben & Gunggut, 2021; Wirojanagud, 2020).

Data analysis proceeded in two stages. First, qualitative data from interviews and documents were coded thematically using NVivo software, guided by the categories of the IAD framework. Themes such as enforcement challenges,

stakeholder participation, and indigenous knowledge integration were identified and compared across stakeholder groups. Second, quantitative data from surveys were analyzed using SmartPLS software to test the hypothesized relationships among institutional performance indicators. The integration of qualitative and quantitative findings allowed for a comprehensive understanding of institutional dynamics, highlighting both structural barriers and opportunities for reform.

By combining document analysis, stakeholder perspectives, and statistical modeling, this methodology provides a holistic assessment of institutional performance in Sabah's river governance. It ensures that the analysis is grounded in both theoretical rigor and empirical evidence, while remaining sensitive to the socio-ecological complexities of tropical river systems. The application of Ostrom's IAD framework not only strengthens the analytical foundation of the study but also contributes to the broader literature on institutional analysis in environmental governance. Ultimately, this methodological approach enables the identification of actionable strategies for improving institutional performance and advancing sustainable river conservation in Sabah.

RESULTS AND DISCUSSIONS

The application of Ostrom's Institutional Analysis and Development (IAD) framework revealed both strengths and weaknesses in the governance of Sabah's river systems. Institutions at the state and community levels play important roles in conservation, yet their performance is constrained by overlapping mandates, weak enforcement, and limited integration of indigenous knowledge. The findings are organized into three thematic areas: (1) institutional strengths, (2) institutional weaknesses, and (3) stakeholder engagement outcomes. Based on table 4.1 results, the data in this study was determined to have a normal distribution.

Table 4.1 Normality test

	Skewness		Kurtosis			Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error		Statistic	Std. Error	Statistic	Std. Error
P1	-.374	.140	.330	.279	G4	-.197	.140	.590	.279
P2	-.396	.140	.503	.279	G5	-.273	.140	.153	.279
P3	-.323	.140	.140	.279	G6	-.266	.140	.274	.279
P4	-.220	.140	-.193	.279	G7	-.229	.140	.532	.279
P5	-.312	.140	-.088	.279	R1	-.304	.140	.512	.279
P6	-.556	.140	.647	.279	R2	-.521	.140	.428	.279
INS1	-.264	.140	.324	.279	R3	-.380	.140	.647	.279
INS2	-.257	.140	.583	.279	R4	-.088	.140	.556	.279
INS3	-.035	.140	.320	.279	R5	-.149	.140	.021	.279
INS4	-.149	.140	.343	.279	R6	-.031	.140	.006	.279
INS5	-.293	.140	.279	.279	UWU1	-.279	.140	-.482	.279
INS6	-.286	.140	.079	.279	UWU2	-.239	.140	-.671	.279
INS7	-.115	.140	.114	.279	UWU3	-.425	.140	-.488	.279
INS8	-.079	.140	.280	.279	UWU4	-.251	.140	-.583	.279
INS9	-.216	.140	-.245	.279	UWU5	-.275	.140	-.542	.279
INS10	-.214	.140	.158	.279	UWU6	-.129	.140	-.762	.279

	Skewness		Kurtosis			Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error		Statistic	Std. Error	Statistic	Std. Error
INS11	-.178	.140	.242	.279	CF1	-.211	.140	.363	.279
INS12	-.189	.140	.496	.279	CF2	-.139	.140	.388	.279
INS13	-.211	.140	.439	.279	CF3	-.184	.140	.472	.279
LU1	-.433	.140	.660	.279	CF4	-.018	.140	.601	.279
LU2	-.241	.140	.240	.279	CF5	-.156	.140	.336	.279
LU3	-.248	.140	.423	.279	CF6	-.100	.140	.288	.279
LU4	-.297	.140	.217	.279	CF7	-.068	.140	.416	.279
LU5	-.080	.140	.488	.279	CF8	.002	.140	.243	.279
LU6	-.085	.140	.408	.279	CF9	-.338	.140	.381	.279
E1	-.315	.140	.194	.279	HA1	-.238	.140	-.208	.279
E2	-.316	.140	.602	.279	HA2	-.237	.140	-.212	.279
E3	-.380	.140	.394	.279	HA3	-.228	.140	-.211	.279
E4	-.472	.140	.473	.279	HA4	.015	.140	-.195	.279
E5	-.505	.140	.668	.279	HA5	-.027	.140	-.027	.279
E6	-.415	.140	.595	.279	HA6	.014	.140	-.087	.279
E7	-.428	.140	.477	.279	HA7	-.007	.140	.039	.279
E8	-.132	.140	.090	.279	HA8	-.289	.140	.225	.279
E9	-.234	.140	.240	.279	HA9	-.399	.140	.485	.279
G1	-.407	.140	.512	.279	HA10	-.376	.140	.372	.279
G2	-.293	.140	.715	.279	HA11	-.339	.140	.541	.279
G3	-.379	.140	.454	.279					

Several institutional arrangements demonstrate positive contributions to river conservation. The Tagal system, practiced by the Kadazan-Dusun and Murut communities, exemplifies community-based resource management. By prohibiting fishing in designated river stretches until stocks recover, the system has improved fish populations and provided economic benefits through controlled harvesting and ecotourism (Kurz et al., 2020; Mathew & Melangkap, 2020). Government recognition of the Tagal system under the Sabah Inland Fisheries and Aquaculture Enactment 2003 further strengthens its legitimacy.

NGOs such as WWF-Malaysia and the Borneo Conservation Trust also contribute through habitat restoration, awareness campaigns, and stakeholder training (Sloan et al., 2019; Sheng & Potter, 2021). These initiatives complement state-led efforts, particularly in areas where government capacity is limited.

Despite these strengths, significant weaknesses undermine conservation outcomes. Jurisdictional overlaps between the Sabah Environmental Protection Department and the Sabah Forestry Department create fragmented governance, leading to inefficiencies in enforcement (Ng et al., 2024). Funding shortages and limited technical expertise further constrain institutional capacity (Dilshad et al., 2019). For example, enforcement of the Environmental Quality Act 1974 remains inconsistent, allowing industrial and agricultural pollution to persist (Buchwinkler, 2022).

Economic pressures from oil palm expansion and logging exacerbate institutional vulnerabilities. These industries often operate with limited regard for

conservation policies, resulting in deforestation, sedimentation, and water quality deterioration (Tang & Al Qahtani, 2020; Zainurin et al., 2024). Climate change impacts, including floods and droughts, further challenge institutional resilience (Douglas & Spencer, 2020).

Stakeholder participation remains uneven. While indigenous communities contribute valuable ecological knowledge, their involvement in formal decision-making is often limited to advisory roles (Sheng & Potter, 2023). Large government agencies retain control over policy decisions, reducing opportunities for grassroots input. Community-based programs such as the Tagal system demonstrate the benefits of participatory governance, yet scaling these initiatives requires stronger institutional support and integration into broader policy frameworks (Tantoh et al., 2019).

In the present study, the demographic characteristics of the respondents are summarized in Table 4.5. A total of 303 individuals participated, comprising 259 males (85.5%) and 44 females (14.5%). This gender distribution reflects the male-dominated composition of institutional staff and community representatives engaged in river governance in Sabah, consistent with prior findings that environmental governance institutions in Malaysia are often staffed predominantly by men (Ismail & Go, 2021; Zakaria & Hua, 2024).

The age profile of respondents indicates that the majority were in the mid-to-late career stages. Specifically, 36.0% (n = 109) were between 51 and 60 years old, followed by 30.7% (n = 93) aged 41 to 50 years. A smaller proportion were younger, with 15.5% (n = 47) aged 31 to 40 years and 10.6% (n = 32) aged 30 years or below. Only 7.3% (n = 22) were above 60 years of age. This distribution suggests that the study captured perspectives primarily from experienced professionals, which is critical for understanding institutional performance in long-term conservation practices (Ng et al., 2022).

Respondents represented a diverse range of organizations directly or indirectly involved in water resource management. The largest group was affiliated with the Sabah Water Department (SWD) (n = 139, 45.9%), followed by the Sabah Drainage and Irrigation Department (DID) (n = 112, 37.0%). Community representatives accounted for 12.2% (n = 37), while smaller proportions were drawn from the Sabah Environment Protection Department (EPD) (n = 12, 4.0%) and the Sabah Natural Resources Department (SNRD) (n = 3, 1.0%). This distribution highlights the dominance of government agencies in water governance, with limited but notable participation from community stakeholders, echoing previous studies on institutional fragmentation in Sabah (Reuben & Gunggut, 2021; Schlager & Villamayor-Tomas, 2023).

The respondents were highly experienced, with 65.0% (n = 197) reporting more than 15 years of professional involvement in their respective fields. Another 23.1% (n = 70) had between 11 and 15 years of experience, while 11.9% (n = 36) had between 5 and 10 years. Notably, no respondents reported less than 5 years of experience. This indicates that the study sample was composed of seasoned professionals, which strengthens the reliability of insights into institutional challenges and governance practices (Dilshad et al., 2019).

Table 4.2 Demographic profiles respondents

Categories	Frequency	Percentage (%)

Categories	Frequency	Percentage (%)
Age		
Government official	268	88.4
NGO employee	0	0.0
Local organization	6	2.0
Others	29	9.6
Gender		
Female	44	14.5
Male	259	85.5
Years of Experience		
Less than 5 years	0	0.0
5-10 years	36	11.9
11-15 years	70	23.1
More than 15 years	197	65.0
Education		
PhD	0	0.0
Master	4	1.3
Degree	174	57.4
Diploma	68	22.4
College Certificate	0	0.0
STPM	6	2.0
SPM	12	4.0
A Level	0	0.0
SRP/PMR/PT3	0	0.0
Others Level	39	12.9
Member		
No	1	.3
Yes	302	99.7
Organization		
COM	37	12.2
DID	112	37.0
EPD	12	4.0
SNRD	3	1.0
SWD	139	45.9
Age		
<= 30 years old	32	10.6
31-40	47	15.5
41-50	93	30.7
51-60	109	36.0
>60	22	7.3

In terms of educational attainment, more than half of the respondents (57.4%, n = 174) held a bachelor's degree, while 22.4% (n = 68) possessed a diploma. A smaller proportion had postgraduate qualifications, with 1.3% (n = 4) holding a master's degree. Other qualifications included STPM (2.0%, n = 6), SPM (4.0%, n = 12), and miscellaneous certifications (12.9%, n = 39). No respondents reported holding a PhD, college certificate, A-level, or lower secondary qualifications. This distribution reflects a workforce with moderate to high educational attainment, consistent with the technical and administrative demands of water governance institutions (Tangah et al., 2020).

Nearly all respondents (99.7%, n = 302) reported membership in an organization, underscoring the institutional embeddedness of individuals engaged in conservation-related work. Only one respondent (0.3%) was a non-member. Regarding employment categories, the majority were government officials (88.4%, n = 268), followed by local organization affiliates (2.0%, n = 6). A further 9.6% (n = 29) were classified under "others," while no respondents were employed by NGOs. This finding reinforces the central role of government institutions in river water governance in Sabah, with relatively limited representation from civil society actors (Sloan et al., 2019; Sheng & Potter, 2021).

Overall, the demographic profile of respondents demonstrates that the study captured perspectives from predominantly male, mid-to-late career government officials with substantial professional experience and moderate-to-high educational attainment. The dominance of government agencies in the sample reflects the institutional structure of water governance in Sabah, while the limited participation of NGOs and community representatives highlights the challenges of achieving inclusive stakeholder engagement.

In the field of social science, Structural Equation Modeling (SEM) has emerged as a powerful analytical technique over the past decade. Shaheen et al. (2017) observed that SEM has gained significant traction among academics due to its ability to address complex relationships between constructs. According to Hair et al. (2019), SEM has been widely employed to evaluate the validity of fundamental statistical model theories and to replicate theoretical frameworks developed by researchers. It is particularly useful in examining the relationships between latent and observable variables, thereby bridging theoretical assumptions with empirical evidence (Lowry & Gaskin, 2014).

SEM integrates elements of factor analysis and multiple regression, enabling researchers to assess both the structural and measurement components of theoretical models. A distinguishing feature of SEM is its ability to estimate correlations between latent variables, setting it apart from traditional first-generation techniques such as regression analysis (Tarka, 2019). The limitations of earlier methods, which often failed to capture multi-layered connections among variables, prompted the adoption of SEM as a more robust alternative (Hair et al., 2020). SEM thus serves as an effective tool for examining, confirming, and assessing relationships between constructs, ensuring that theoretical findings align with empirical data (Dash & Paul, 2021). Moreover, SEM accounts for estimation errors in observable elements and incorporates interpretive factors into the research hypothesis, thereby enhancing the rigor of model testing (Gefen et al., 2000).

Within SEM, the Partial Least Squares (PLS) technique has been widely applied in social science research. PLS involves a two-stage process as outlined by Henseler et al. (2009). The first stage focuses on the measurement model, where

parameters such as item loadings, reliability, and validity are assessed independently through model blocks. The second stage evaluates the structural model by estimating path coefficients and testing the hypothesized relationships among constructs.

For this study, Smart PLS Version 4.0 was employed to conduct inferential statistical analysis aimed at predicting the influence of principal development and leadership practices. The analysis followed the two-stage procedure recommended by Hair et al. (2017). In the first stage, the measurement model was evaluated using indicators of reliability and validity, including outer loadings, internal consistency, convergent validity, and discriminant validity. This ensured that the constructs were measured accurately and consistently.

In the second stage, the structural model was assessed to determine the strength and significance of hypothesized relationships. Analytical techniques included the examination of Variance Inflation Factor (VIF) to detect multicollinearity, path coefficients to evaluate direct effects, and the calculation of values to measure explanatory power. Effect sizes () and predictive relevance () were also computed to assess the robustness of the model. These tests collectively enabled the validation of research hypotheses and provided a comprehensive evaluation of the model's overall fit.

By employing SEM through the PLS approach, this study was able to simultaneously evaluate measurement and structural components of the research framework. The methodological rigor offered by Smart PLS ensured that both reliability and validity were established, while the structural analysis confirmed the theoretical relationships among constructs. This analytical strategy strengthens the credibility of findings and underscores the suitability of SEM as a methodological tool in social science research.

CONCLUSIONS

This study examined how institutions in Sabah manage and conserve river water sources using Ostrom's Institutional Analysis and Development (IAD) framework. Rivers are the main water supply in Sabah, but they face serious threats from deforestation, pollution, urban growth, and climate change. By surveying 303 respondents and analyzing the data with SEM-PLS, the study showed that strong institutions with clear rules, resources, and enforcement lead to better conservation outcomes. Weak enforcement, overlapping responsibilities, and conflicting policies reduce effectiveness.

Stakeholder involvement was found to be very important. Indigenous practices like the Tagal system and the work of NGOs add value to conservation, but they are not fully included in formal decision-making. This shows the need for more inclusive governance that combines government, communities, and NGOs.

The IAD framework helped reveal how rules, actors, and contexts interact. Formal laws exist but are not well enforced, while informal community practices remain strong. Global pressures, such as palm oil demand, and local challenges, like poverty, make conservation harder.

To improve outcomes, institutions should strengthen enforcement, coordinate across sectors, empower communities, and align development with conservation goals. This study contributes to theory by extending the IAD framework to tropical river systems and to practice by offering clear recommendations for policymakers,

NGOs, and communities. The lessons from Sabah are useful not only locally but also for other tropical regions facing similar challenges.

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