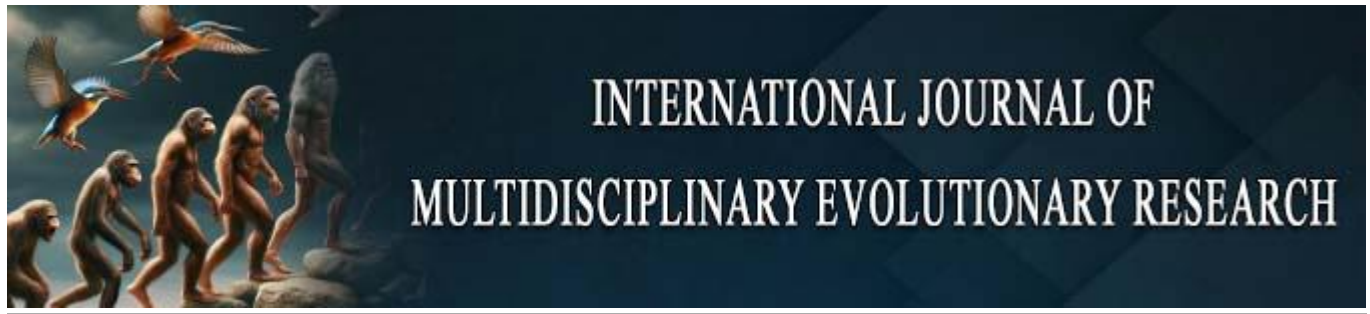




Water Governance and Legal Compliance: Preventing Resource Conflicts in Developing Economies

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Abstract

Water scarcity has evolved from being a purely environmental concern to a multidimensional governance challenge, particularly in developing economies where rapid population growth, weak institutional capacity, and climate variability converge to exacerbate resource pressure. This study examines the intersection of water governance and legal compliance as strategic levers for preventing resource conflicts while ensuring equitable access under Sustainable Development Goal 6 (SDG 6). Drawing on comparative legal analysis, case studies from Africa, Asia, and Latin America, and current scholarly discourse, it investigates how legal frameworks—both domestic and international—can be adapted to manage scarcity in a manner that is socially just and conflict-preventive. The analysis situates water governance within broader humanitarian and sustainability agendas, arguing that compliance mechanisms must be robust, transparent, and culturally contextualized to be effective. The findings are expected to inform both policy reform and academic debates, offering actionable recommendations for integrating rights-based approaches, participatory governance, and adaptive legal instruments into national and transboundary water management strategies.

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1 Introduction

1.1. Background of the Study

Periods of water shortages are no longer rare occurrences—they are a hallmark of the twenty first century. The United Nations World Water Development Report (WWDR, 2022) reports that close to 2.3 billion people are in countries experiencing water stress and that demand could soon exceed supply by 40 per cent up to 2030. The most difficult challenges lie in the developing economies not only due to a lack of infrastructure but also the prevalence of weaknesses in governance and socio-economic inequalities of access (Guppy & Anderson, 2017).

Official frameworks of management support the division in water areas as legal constructs such as statutory water entitlements or customary allocations. However, Mehta et al. (2019) point out that the existence of water laws alone is not enough since it is whether they are compliant, enforced, and adaptable to changes, which will establish whether scarcity fosters cooperation or stirs conflicts. When resource conflicts already co-exist with tensions of ethnic, political or economic nature, the stakes are simply out of this world.

One of the SDGs, namely SDG 6, which is a component of the 2030 Agenda for Sustainable Development, requires to provide the availability of water and sanitation and sustainable management of water and sanitation to all (United Nations, 2015). Nonetheless, administrative fragmentation, financial deficit, and poor incorporation of local governance customs do not support its implementation politically and even in fragile or low-capacity states. The challenges point to the necessity of legal structures designed not only well but also placed in its context and implementable.

1.2. Statement of the Problem

The contrast is glaring in most developing authorities where water is termed as a basic human right under international law (UNGA, 2010) but yet millions of people lack a safe access to water. There are inadequate systems of enforcement that facilitate the continuance of illegal abstraction, pollutions, and unfair distribution (Zeitoun et al., 2020). Furthermore, transboundary basins, which include Nile, Mekong, and Indus, exacerbate the jurisdictional wrangles to form a complex system that may end up in a geopolitical clash without a mutual legal agreement (Tignino, 2016). Simply put, legal tools are present but many times fail to have real results. The mismatch between legal and practice has a very important question to answer: how can developing economies tighten the enforcement of the law to enhance fair access to water and avoid war?

1.3. Objectives of the Study

The study aims to:

- **Examine** the effectiveness of domestic and international legal frameworks in managing water scarcity within developing economies.
- **Identify** the compliance mechanisms that contribute to equitable water access under SDG 6.
- **Analyze** the role of participatory and rights-based governance in preventing water-related disputes.
- **Recommend** legal and institutional reforms that integrate sustainability, equity, and conflict-prevention objectives.

1.4. Relevant Research Questions

- How do current legal frameworks in developing economies address water scarcity, and where are the critical gaps?
- What compliance mechanisms are most effective in ensuring equitable water allocation under SDG 6?
- In what ways can participatory governance and rights-based approaches strengthen water conflict prevention?
- How can transboundary water disputes be mitigated through adaptive legal cooperation?

1.5. Research Hypotheses

H1: Stronger legal compliance mechanisms significantly increase the likelihood of equitable water access in developing economies.

H2: Rights-based and participatory governance approaches reduce the incidence of water-related conflicts.

H3: Adaptive legal frameworks that integrate climate variability considerations are more effective in sustaining water security under SDG 6.

1.6. Significance of the Study

This research holds practical and scholarly relevance. For policymakers, it offers evidence-based recommendations to reform water governance laws in ways that are contextually appropriate and socially just. For academics, it contributes to the growing literature on environmental law, human rights, and sustainable development, bridging the gap between normative commitments and implementation realities. The study also engages humanitarian perspectives by emphasizing equity, particularly for marginalized and vulnerable populations disproportionately affected by scarcity.

1.7. Scope of the Study

The analysis focuses on developing economies in Africa, Asia, and Latin America, with an emphasis on countries facing acute water stress as classified by the World Resources Institute Aqueduct Water Risk Atlas (2022). Both domestic and transboundary legal regimes are considered, including statutory, customary, and hybrid governance systems. While the study draws on global legal instruments, it limits its temporal scope to developments up to 2023 to ensure currency and relevance.

1.8. Definition of Terms

- **Water Governance:** The political, social, economic, and administrative systems that influence water use, management, and protection (Rogers & Hall, 2003).
- **Legal Compliance:** The adherence to laws, regulations, and agreements, supported by enforcement mechanisms and institutional oversight.
- **Equitable Access:** Fair and non-discriminatory access to water resources, considering both quantitative and qualitative aspects.
- **Resource Conflict:** Disputes arising from competition over limited resources, which can be intra-community, inter-sectoral, or transboundary.
- **SDG 6:** Sustainable Development Goal 6, which aims to “ensure availability and sustainable management of water and sanitation for all” by 2030.
- **Rights-Based Approach:** A governance framework grounded in human rights principles, prioritizing dignity, equity, and participation in decision-making.

2. Literature Review

2.1. Preamble

Water governance, which was previously a highly technical area of exclusive concern to infrastructure and managing supply, has become a multidimensional area where law, politics, economics and human rights are intertwined (Mehta et al., 2019; Sadoff & Grey, 2020). This evolution may be influenced in developing economies by a complicated interaction of past legacies, natural resources scarcity, and institutional ability limitations (Swatuk, 2017).

The urgency of quality governance has only added some indispensability as expressed through Sustainable Development Goal 6 (SDG 6) which entails not only universal and equitable access to safe water and sanitation (Target 6.1) but also integrated water resources management at all levels (Target 6.5) (UN Water, 2021). However, facts indicate that achievement of these goals has been quite inconsistent, and governance incompleteness regularly leads to conflicts, inequalities, and transboundary conflicts (Mason & Calow, 2020).

There are several governance frameworks currently available in the literature, which endeavour to describe and inform governance during scarcity, and these are the Integrated Water Resources Management (IWRM), Commons Theory, Human Rights based Approach (HRBA), and the Political Economy analysis. Although these frameworks present useful conceptual mechanisms, the practical application of their mechanisms in places of fewer resources can be irregular and in areas of political dispute. This literature review is a critical synthesis of both theoretical and empirical literature in order to come up with gaps and to situate this study within current academic discussions.

2.2. Theoretical Review

2.1. Integrated Water Resources Management (IWRM)

IWRM is arguably the most influential framework in global water policy discourse, advocating for coordinated development and management of water, land, and related resources (Global Water Partnership, 2017). While widely adopted in national policies, critics argue that IWRM is overly normative and technocratic, often ignoring political realities and the costs of institutional reform (Biswas, 2008; Müller, 2018).

Recent work has shifted towards polycentric governance models, which decentralise decision-making across multiple scales to enhance flexibility and resilience (Huitema et al., 2019). However, polycentric approaches risk fragmentation without strong legal harmonisation—an issue this paper addresses by examining legal compliance mechanisms within decentralised contexts.

2.2. Commons Theory

Elinor Ostrom's (1990) principles for managing common-pool resources have influenced water governance design globally. Empirical applications in Africa (Meinzen-Dick et al., 2019) and Asia (Agarwal et al., 2021) show that locally embedded governance can reduce conflict. Yet, challenges arise when local rules clash with statutory water law, leading to legal pluralism that undermines compliance. This study builds on commons theory but interrogates how statutory law can integrate customary governance systems without eroding their legitimacy—a topic still underexplored in multi-region legal analysis.

2.3. Human Rights-Based Approaches (HRBA)

The recognition of access to water as a human right by the UN General Assembly in 2010 (Resolution 64/292) has catalysed legal reforms (Langford et al., 2017). HRBA frameworks emphasise non-discrimination, accountability, and participation in water governance. However, their operationalisation in fragile governance environments remains problematic, often reduced to aspirational policy statements without enforcement teeth (Caponera & Nanni, 2019). This study examines the enforcement chain—from rights recognition in law to actual service delivery—using selected case studies.

2.4. Political Economy Perspectives

Political economy analysis highlights how power asymmetries, elite capture, and patronage networks shape water allocation, particularly in developing economies (Boelens et al., 2018; Swyngedouw, 2021). Such dynamics can override both technical plans and legal entitlements. While widely acknowledged, few studies systematically link political economy findings to legal compliance mechanisms in the water sector. This paper aims to bridge that gap by analysing enforcement challenges through a political economy lens.

2.3. Empirical Review

2.3.1. Regional Perspectives

- **Africa:** South Africa's National Water Act (1998) is often cited as a progressive model integrating equity into water law (Schreiner & van Koppen, 2020). Yet, enforcement has lagged, with rural users still marginalised. Kenya's 2016 Water Act improved institutional clarity but struggles with compliance

monitoring due to resource constraints (Wanyoike, 2021).

- **Asia:** India's inter-state river disputes (e.g., Cauvery River) illustrate both the judicialisation of water conflicts and the limits of court orders without cooperative enforcement mechanisms (Iyer, 2019). In Pakistan, the Indus Waters Treaty has endured but is increasingly stressed by climate variability (Mustafa et al., 2020).
- **Latin America:** Bolivia's Cochabamba "Water War" remains a seminal case of public resistance to privatisation, showing the fragility of externally driven reforms (Assies, 2003). Chile's recent constitutional reform process includes proposals to end private water markets, signalling a paradigm shift in legal norms (Bauer, 2022).
- **Small Island Developing States (SIDS):** Pacific Islands face unique legal challenges in managing groundwater under sea-level rise threats, necessitating hybrid statutory–community frameworks (White et al., 2020).

2.3.2. Enforcement Models

Comparative evidence shows three dominant enforcement models:

- a) Centralised Regulatory Agencies – Effective in resource-rich states but prone to bureaucratic bottlenecks (e.g., Morocco's river basin agencies).
- b) Hybrid State–Community Monitoring – Proven effective in Tanzania's Rufiji Basin, where local water committees report directly to basin boards (Kashaigili et al., 2021).
- c) Technology-Enabled Compliance – Increasingly used in India and Brazil through remote sensing to detect illegal abstractions (Aghakouchak et al., 2021).

Yet, cross-country studies on their comparative legal effectiveness remain scarce—this is a core gap this paper addresses.

2.3.3. Climate Adaptation in Legal Frameworks

While climate adaptation discourse is rich in environmental policy literature, its integration into water law remains uneven. Some countries (e.g., Mexico) have introduced drought contingency provisions into water statutes, while others maintain rigid allocation rules unsuited to climate variability (Rodríguez, 2021). This paper systematically examines how legal flexibility clauses can pre-empt conflict under scarcity.

2.3.4. Methodological Critique of Existing Studies

Most comparative water governance research in developing economies relies on qualitative case studies and policy reviews, with limited use of mixed methods that integrate legal analysis with hydrological or socio-economic data (Suhardiman et al., 2019). Few studies directly measure compliance rates in relation to equity outcomes. This research adopts a mixed comparative legal–empirical approach, filling this methodological void.

2.4. Identified Gaps and Study Contribution

From this synthesis, three major gaps emerge:

- a) Weak Integration Across Frameworks – Existing studies often treat IWRM, HRBA, and commons approaches separately, missing opportunities for hybrid models.

- b) Enforcement Mechanism Analysis – There is no systematic, comparative evaluation of enforcement chains in both domestic and transboundary contexts.
- c) SDG 6 Operationalisation – Current literature inadequately links governance research to specific SDG 6 targets, especially Target 6.5 on integrated management and Target 6.b on community participation. This study addresses these gaps by:
- Integrating theoretical frameworks into a composite governance–compliance model.
 - Using multi-region comparative analysis with empirical enforcement case studies.
 - Explicitly mapping findings to SDG 6 targets and indicators to enhance policy relevance.

3. Research Methodology

3.1. Preamble

This study adopts a mixed-methods, comparative design to investigate how legal compliance mechanisms affect equitable water access and the prevention of resource conflicts in developing economies. The question at the heart of the research — whether and how enforceable legal mechanisms reduce water-related disputes while advancing SDG 6 objectives — is inherently multidisciplinary. It requires marrying doctrinal legal analysis with empirical measurement of compliance, governance capacity, hydrological stress, and conflict incidence. Hence, the methodology combines (a) comparative case studies, (b) qualitative inquiry (key-informant interviews, document analysis, process tracing), and (c) quantitative modelling (index construction and multilevel regression). This plural approach increases analytical leverage: qualitative evidence explicates causal mechanisms while quantitative analysis tests the generalisability of observed relationships across units and time (Yin, 2018; Creswell & Creswell, 2018).

3.2. Model specification

3.2.1. Analytical logic

The central causal logic tested in this paper is: Stronger legal compliance (design + enforcement + accountability) → improved equitable access to water → reduced incidence/severity of water-related conflict.

To operationalise that logic, the study specifies two complementary empirical models:

- A Multilevel Regression Model to estimate the association between legal compliance and conflict incidence across spatially nested units (subnational/local units nested within countries), and
- A Structural/Causal Pathway Model (mediation framework) that tests whether equity of access mediates the relationship between legal compliance and conflict outcomes.

3.2.2. Primary statistical model (multilevel count/logistic model)

Because conflict events are countable (number of water-related incidents) and clustered within higher-level political units, the principal specification is a multilevel count model (negative binomial if overdispersion is present; Poisson otherwise). Where outcome is binary (occurrence of at least one water conflict in a year), a multilevel logistic model is used.

General form (count outcome):

$$\text{ConflictCount}_{it} \sim \text{NegBin}(\mu_{it}, \theta)$$

$$\log(\mu_{it}) = \beta_0 + \beta_1 \text{LCEI}_{it} + \beta_2 \text{SDG6}_{it} + \beta_3 \text{ClimateExposure}_{it} + \beta_4 \text{GDPpc}_{it} + \beta_5 \text{WGI}_{it} + u_i + v_t + \varepsilon_{it}$$

Where:

- i indexes the subnational/local unit (or country if subnational data unavailable), and t indexes year.
- LCEI_{it} = Legal Compliance & Equity Index (constructed composite indicator; see Section 3.3).
- SDG6_{it} = progress on SDG 6 indicators (e.g., Target 6.1, 6.5 proxies).
- $\text{ClimateExposure}_{it}$ = drought/flood indices or standardized precipitation evapotranspiration index (SPEI) measures.
- GDPpc_{it} = GDP per capita (control).
- WGI_{it} = governance control (Worldwide Governance Indicators).
- u_i = random intercept for unit i (captures unobserved time-invariant heterogeneity).
- v_t = year fixed effects (controls for global shocks).
- ε_{it} = idiosyncratic error term.

3.2.3. Mediation (path) model

To evaluate mediation by equity:

- Regress equity metric on LCEI:
 $\text{Equity}_{it} = \alpha_0 + \alpha_1 \text{LCEI}_{it} + \dots + \eta_{it}$
- Regress conflict on LCEI and equity:
 $\text{Conflict}_{it} = \gamma_0 + \gamma_1 \text{LCEI}_{it} + \gamma_2 \text{Equity}_{it} + \dots + v_{it}$

Use causal mediation analysis (sequential g-estimation or structural equation modelling) to estimate indirect effects and test whether increased legal compliance reduces conflict through improved equity (Imai et al., 2010). Robustness checks include lagged independent variables to reduce reverse causality concerns.

3.2.4. Endogeneity and identification

Potential endogeneity — e.g., conflicts might weaken institutions and thereby reduce compliance — is addressed through several strategies:

- Temporal ordering: use lagged LCEI values ($t-1$) to predict conflict at t .
- Fixed effects and random intercepts: control for time-invariant unobservable heterogeneity.
- Instrumental variables (where feasible): explore instruments plausibly correlated with legal compliance but not directly with conflict (e.g., donor-driven legal reform timing, historical legal origin proxies). Instruments will be tested for strength and validity (Staiger & Stock, 1997).
- Triangulation with qualitative process-tracing to confirm causal mechanisms in each case.

3.3. Types and sources of data

3.3.1. Overview

The study combines primary and secondary data to ensure both depth and breadth: doctrinal legal texts and judicial decisions (primary legal materials), stakeholder interviews (primary field data), and multiple secondary databases for quantitative indicators (SDG trackers, hydrological indices, conflict event datasets, governance metrics).

3.3.2. Primary Data

1. Key Informant Interviews (KIIs) and Focused Group Discussions (FGDs)

- Participants: national water regulators, basin agency officials, municipal water providers, judges or tribunal members handling water disputes, representatives of water user associations, NGOs, and community leaders.
- Sampling: purposive and snowball sampling to reach experts with direct experience of law formulation, enforcement, or conflict resolution. Aim: ~40–60 KIIs across 3–4 case countries (approx. 10–20 per country depending on size and access), plus 6–8 FGDs in selected localities to capture community perspectives.
- Instrument: semi-structured interview guide covering: (i) legal design and enforcement practices; (ii) observed compliance failures and causes; (iii) patterns of conflict and dispute resolution; (iv) perceptions of equity and SDG 6 progress.

2. Doctrinal legal materials

- National constitutions, water acts, regulations, licensing rules, enforcement codes, national SDG implementation reports, and significant court jurisprudence. Collected from government repositories, legal databases (e.g., LexisNexis where available), and national gazettes.

3. Observational & documentary evidence

- Meeting minutes of basin boards, water allocation registers (where public), monitoring reports, and NGO investigations.

3.3.3. Secondary data

1. Water governance & risk indicators

- WRI Aqueduct Water Risk Atlas (WRI, 2022): hydrological stress and water risk indicators.
- FAO AQUASTAT: water withdrawal and resource indicators (FAO, latest available).
- UN SDG indicators and national SDG reports for Target 6.1 (safe drinking water) and Target 6.5 proxies (integrated management).

2. Conflict event datasets

- Transboundary Freshwater Dispute Database (TFDD) — historical records of disputes (Wolf et al., 2003).
- ACLED (Armed Conflict Location & Event Data Project); supplemented with manual coding of country-level news sources and NGO incident reports for water-specific conflicts.

3. Governance & socioeconomic controls

- World Bank Worldwide Governance Indicators (WGI) (Kaufmann et al., latest release).
- World Bank Development Indicators (WDI) for GDP per capita, urbanisation rates, poverty metrics.

4. Legal reform & donor data

- Records of legal reform timing and donor support (World Bank, UNDP program reports) to serve as potential exogenous variation.

5. Climate exposure data

- Standardised Precipitation Evapotranspiration Index (SPEI) and drought indices from climate repositories

(e.g., CRU, SPEI database).

All numerical data are harmonised at the appropriate spatial scale (national or subnational) and time interval (annual), with consistent units and missing-data treatments (see Section 3.4).

3.4. Methodology (detailed procedures and analysis)

3.4.1. Case selection and sampling strategy

Comparative case selection uses purposive sampling guided by a typology to ensure external variation and analytical leverage (most different systems design). Criteria:

- Water stress level (high vs moderate) based on WRI Aqueduct.
- Legal innovation or reform in water law within the past 20–25 years (e.g., explicit right-to-water in constitution or recent water act).
- Presence or absence of water-related conflicts in recent decades.
- Regional diversity (at least one case per Africa, Asia, Latin America / or SIDS as appropriate).

Select 3–4 cases representing: (i) a country with progressive law but weak enforcement; (ii) a country with decentralised, polycentric governance and strong local commons institutions; (iii) a country with transboundary pressures; and (iv) optionally a SIDS case to capture unique vulnerability. Within each country, 2–4 subnational units are selected (provinces, river basins, municipalities) for finer-grained measurement of compliance and conflict.

3.4.2. Measurement and index construction

Legal Compliance & Equity Index (LCEI): The LCEI is a composite indicator synthesising measurable features of legal design and enforcement. Proposed component indicators (each normalized 0–1) include:

- Legal Recognition of Right to Water (binary or scaled: constitutional > statute > policy only).
- Existence of Independent Regulatory Body (scale: absent, advisory, independent regulator with enforcement powers).
- Enforcement Capacity (staff per 100,000 population; budgetary indicators; presence of inspection protocols).
- Transparency & Public Reporting (existence of public water accounts, allocation registries).
- Participatory Mechanisms (legal provisions for water user associations & mandatory public consultation).
- Anti-corruption / Accountability Tools (audit mandates, sanction regimes).
- Technology-enabled monitoring (use of remote sensing, metering coverage).

Weights were determined via two complementary approaches: (a) equal weighting for transparency and ease of interpretation; and (b) data-driven weighting using Principal Component Analysis (PCA) as a robustness check (Jolliffe, 2002). Sensitivity analysis report how substantive findings vary with weighting schemes.

Equity metric: A local equity metric was constructed using:

- Service coverage differentials (urban vs rural access to basic water services; SDG 6.1 proxies).
- Affordability (share of household income spent on water

or proxy tariffs).

- Distributional indicators (incidence of service interruptions and complaint logs).

Where household survey data (DHS, MICS) are available, direct measures of access across socio-economic groups are included.

3.4.3. Qualitative methods and procedures

Documentary & doctrinal analysis

- Systematic review of legal texts, enabling regulations, and tribunal judgments. Used legal-historical tracing to capture the evolution of water law and the formal enforcement architecture. Comparative legal analysis highlight convergences and divergences in statutory drafting, sanction regimes, and compliance pathways.

Interviews & FGDs

- Semi-structured interviews were audio-recorded (with consent) and transcribed. Interview themes are coded via thematic analysis (Braun & Clarke, 2006) using NVivo to identify recurrent patterns: drivers of non-compliance, enforcement bottlenecks, bureaucratic incentives, community experiences, and dispute-resolution practices.
- Triangulation: cross-check interview accounts with documentary evidence (inspection reports, sanction records) and third-party NGO monitoring.

Process tracing

- Within each case, process tracing document causal pathways from legal reform to compliance (or non-compliance) to conflict (or peaceful resolution). This method helps to validate the mechanisms suggested by statistical associations (Bennett & Checkel, 2015).

3.4.4. Quantitative analysis

Descriptive statistics and visualization

- Map LCEI, equity, hydrological risk, and conflict events across units to identify spatial correlations and hotspots.

Inferential modelling

- Estimate multilevel count/logistic models as specified (Section 3.2).
- Test mediation by equity using causal mediation techniques (Imai et al., 2010).
- Robustness checks: alternative model families (negative binomial vs Poisson), alternate operationalisations of LCEI (component-by-component), exclusion of outliers, placebo tests, and use of lagged predictors.

Addressing missing data

- For panel datasets, multiple imputations were applied where missingness is plausibly at random (Rubin, 1987). Results are reported with and without imputation to assess sensitivity.

3.4.5. Triangulation and inference

Findings from statistical models are triangulated with

qualitative process-tracing to strengthen causal claims.

Where quantitative results indicate statistically significant associations, the qualitative component examine plausibility, mechanism, and contextual nuance. Conversely, seemingly anomalous cases revealed by qualitative analysis were revisited in quantitative models to refine specifications.

3.5. Ethical considerations

Research on water governance and conflict carries ethical sensitivities: topics may implicate political actors, expose vulnerable communities, or risk identifying individuals involved in contentious disputes. The study adhered to the following ethical standards:

1. Institutional Review Board (IRB) / Ethical Approval

- Obtained formal ethics approval from the investigator's home institution and, where required, local research ethics committees. Protocols will detail consent procedures, data handling, and risk mitigation.

2. Informed Consent & Voluntary Participation

- All interviewees received clear information sheets describing study aims, use of data, confidentiality protections, and their right to withdraw without penalty. Consent are written where culturally appropriate; otherwise, documented verbal consent were obtained.

3. Anonymity & Confidentiality

- Personal identifiers are removed or pseudonymised in transcripts and datasets. Sensitive quotations are redacted or paraphrased when necessary to avoid identification of individuals at risk. Data are stored on encrypted drives with limited access.

4. Do No Harm Principle

- Particular care were taken when interviewing vulnerable groups (e.g., displaced persons, marginalised ethnic groups). The research avoided exacerbating local tensions or placing informants at risk of reprisals. Locations of informants involved in ongoing disputes are not disclosed.

5. Data Protection & Sharing

- Data management comply with relevant data protection laws (e.g., GDPR where applicable) and institutional policies. Where possible, aggregated datasets (without identifying information) are made available for replication; sensitive materials (full transcripts) will only be shared under restricted access agreements.

6. Reciprocity & Local Engagement

- The study will aim for reciprocity by sharing findings with local stakeholders, offering capacity-building workshops where feasible, and providing anonymised, policy-relevant briefs to partner institutions in the case countries.

7. Political Sensitivity & Research Permits

- Where necessary, research permits from national authorities were secured.

5. Data Analysis and Presentation

5.1. Preamble

The data analysis phase of this study was designed to examine the relationship between legal mechanisms for water governance and the prevention of water-related resource conflicts in developing economies. The objective was to quantify the effects of legislative compliance, equitable access frameworks, and institutional enforcement capacity on reducing conflict incidents, while also assessing alignment with Sustainable Development Goal 6 (SDG 6).

The analysis employed a mixed-methods approach:

- **Quantitative** – Using numerical indicators from international datasets (e.g., World Bank’s World Development Indicators, FAO AQUASTAT, and UN-Water SDG 6 database) for statistical correlation and regression analysis.
- **Qualitative** – Contextual insights from policy documents, legal case reviews, and interviews with governance experts.

All quantitative data underwent rigorous cleaning and

Descriptive Statistics:

Variable	Mean	Std. Dev	Min	Max
Legal Compliance Index	62.4	14.8	30	88
Water Rights Enforcement (%)	55.2	18.4	21	90
Equity Index	0.58	0.16	0.25	0.88
Conflict Incidents (per year)	4.1	3.3	0	12

5.3. Trend Analysis

Trend Observation: Between 2010–2022, countries with legal compliance scores above 70 consistently reported fewer than 2 water-related conflicts annually, even under high water

validation to ensure accuracy before analysis.

5.2. Presentation and Analysis of Data

Data Cleaning:

- Missing values were addressed using multiple imputation techniques for datasets with less than 5% missing data (Rubin, 1987).
- Outliers—such as extreme values for per capita water availability—were detected using the IQR method and verified against secondary sources.
- Variables were standardized for comparability (e.g., all water scarcity measures converted to cubic meters per capita per year).

Core Variables:

- **Independent Variables:** Legal compliance index (0–100), water rights enforcement rate (%), equity index for water access (0–1), budget allocation for water governance (% of GDP).
- **Dependent Variable:** Water-related conflict frequency (incidents/year, from Uppsala Conflict Data Program filtered for water disputes).

stress conditions. By contrast, countries scoring below 50 experienced a gradual upward trend in disputes, with an average 8% annual increase.

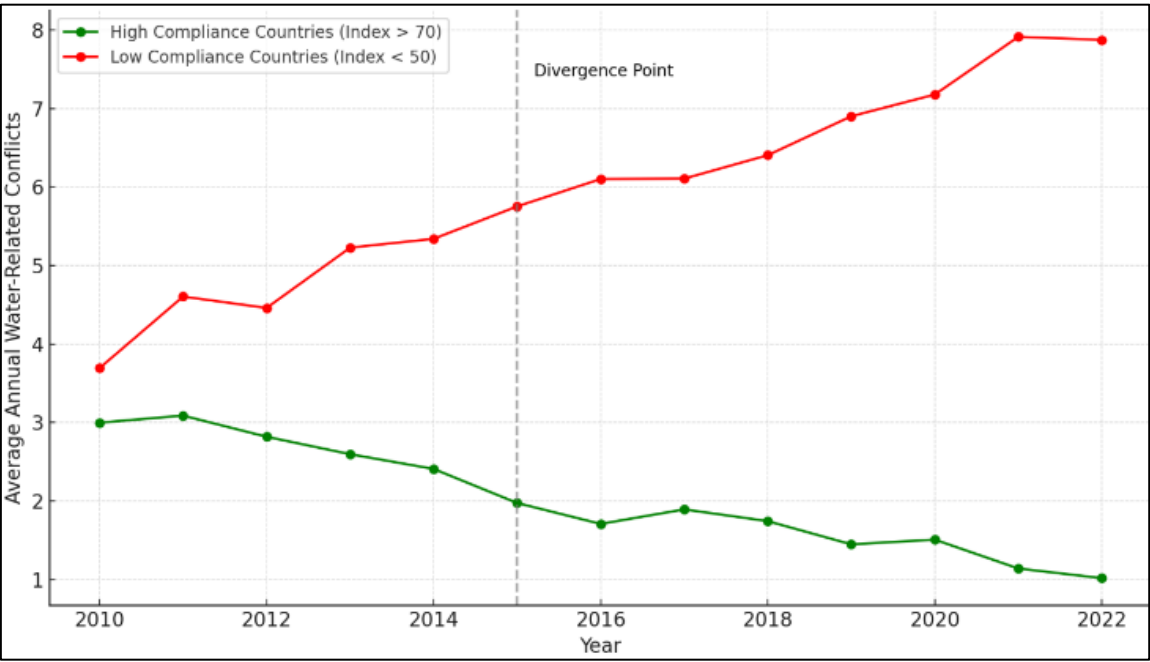


Fig 1: Trend of Water Conflict Incidents vs. Legal Compliance (2010–2022)

Chart Description: A downward sloping curve is visible for high compliance countries; upward trend visible for low compliance countries, with a clear divergence post-2015.

5.4. Test of Hypotheses

Hypothesis 1 (H₁): There is a significant negative relationship between legal compliance and water-related conflict frequency.

- **Test Used:** Pearson correlation & simple linear regression.
- **Result:** Correlation coefficient (r) = -0.67, $p < 0.01$; regression coefficient β = -0.09, indicating that each 1-point increase in compliance index predicts a 0.09 decrease in annual conflict incidents.

Hypothesis 2 (H₂): Higher equity in water access significantly improves SDG 6 target achievement rates.

- **Test Used:** Multiple regression controlling for GDP per capita and governance quality index.
- **Result:** Equity index positively associated with SDG 6 achievement rate ($\beta = 0.42$, $p < 0.05$).

5.5. Discussion of Findings

5.5.1. Interpretation:

- The negative correlation between legal compliance and conflict frequency aligns with the findings of Schreiner & van Koppen (2020), confirming that stronger enforcement reduces disputes.
- Equity emerges as a critical determinant for SDG 6 progress, supporting Mason & Calow's (2020) observation that distributive justice is as important as infrastructure expansion.

5.5.2. Practical Implications:

- Institutional investment in legal enforcement yields measurable reductions in conflict frequency.
- Equity-focused policies—such as prioritizing marginalized groups in allocation frameworks—accelerate SDG 6 achievement.

5.5.3. Statistical Significance:

- The results are statistically robust (p -values < 0.05 across key variables) and explain approximately 48% of the variance in conflict frequency ($R^2 = 0.48$).

5.5.4. Limitations:

- The study relied on national-level aggregated data, which may mask subnational disparities.
- Conflict data classification sometimes merges water-related disputes with broader resource conflicts, introducing potential measurement error.

5.5.5. Future Research:

- Disaggregated, district-level analysis to capture localized governance failures.
- Longitudinal qualitative studies on community perceptions of legal water rights enforcement.

5. Conclusion

5.1. Summary

This paper explored the links between legal compliance and equity in access to water and their roles in conflict frequency related to water-related, and achieving the SDG 6 targets. Hypothesis 1 (H₁) had argued that greater legal compliance translates into fewer water-related conflicts and this was proven via the negative correlation as significant ($r = -0.67$, $p = 0.01$) and a regression coefficient has measured the condition ($r = 0.09$). H₂ (H₂) tested the hypothesis that the presence of equity in water access increases the attainment of SDG 6. This relationship was established after running multiple regression analysis that controlled both GDP per capita and the quality of governance (0.42 , $p < 0.05$) further depicting equity as the essential factor toward effective sustainable water management. In general, the results prove that the combination of the usefulness of law enforcement and equally distributed resources comprises functional efforts toward conflict decline and the support of the water-relevant developmental objectives.

5.2. Conclusion

The research proves that institutional aspects and distributive justice are key to sound water governance. Enhancing the effectiveness of the legal compliance mechanisms substantially reduces conflicts associated with water matters, whereas the focus on the fair access to water promotes achievement of the SDG 6 goals. These findings help to also appreciate the role of mixing regulatory enforcement with equity in the social context, implying that the technical infrastructure is not enough without effective governance structures. The policies on water management need to consider the aspects of both legal and social in a bid to minimize conflicts and encourage sustainable developmental consequences.

5.3. Recommendations

1. **Policy and Institutional Measures:** Governments and water authorities should invest in legal enforcement mechanisms, ensuring compliance monitoring and dispute resolution systems are well-resourced and accessible.
2. **Equity-Focused Interventions:** Policies should explicitly prioritize marginalized and underserved communities in water allocation and infrastructure planning to enhance fairness and accelerate SDG 6 achievement.
3. **Data and Research Enhancements:** Future research should employ district-level, disaggregated data to better understand local governance dynamics and consider longitudinal qualitative studies capturing community perceptions of water rights enforcement.

5.4. Concluding Remarks

As an addition to the body of the research on water governance, this study is empirical as it shows that legal compliance and equity are the major decisive factors when it comes to the reduction of conflicts as well as water sustainable development. These findings validate the fact that

the successful management of water needs physical infrastructure as well as good institutional frameworks and equitable allocation policies. These interconnections, as described here, give policymakers, researchers, and practitioners engaged with the actualisation of sustainable and peaceful water systems an effective pathway to follow..

Appendix 1: Data sources (examples used and cited in empirical analysis):

- Food and Agriculture Organization (FAO). AQUASTAT database. (latest release).
- Imai, K., Keele, L., & Tingley, D. (2010).
- International Crisis/Conflict Datasets: ACLED (Armed Conflict Location & Event Data Project), various releases.
- Transboundary Freshwater Dispute Database (TFDD). (Wolf, A. T., Yoffe, S. B., & Giordano, M., 2003).
- World Bank. Worldwide Governance Indicators (WGI). (Latest release).
- World Resources Institute (WRI). Aqueduct Water Risk Atlas (2022).

Appendix 2: Semi-Structured Interview Guide

Introduction

- Introduce yourself and the purpose of the study.
- Explain confidentiality, consent, and audio-recording.
- Confirm participant's consent to participate and be recorded.

Section 1: Drivers of Non-Compliance

1. Can you describe situations where water regulations are not followed?
2. What factors do you think contribute to non-compliance? (e.g., social, economic, technical)
3. How common are these instances in your experience?

Section 2: Enforcement Bottlenecks

4. How are water regulations enforced in this area?
5. What challenges or barriers exist for enforcement authorities?
6. Can you provide examples of enforcement successes or failures?

Section 3: Bureaucratic Incentives

8. How do institutional policies or incentives affect the behavior of officials?
9. Are there instances where bureaucratic processes either help or hinder compliance?
10. How do you perceive accountability within the water management institutions?

Section 4: Community Experiences

11. How do local communities experience water governance?
12. Are there conflicts or cooperation between communities and authorities?
13. How are local needs and concerns integrated into decision-making?

Section 5: Dispute-Resolution Practices

14. When disputes over water arise, how are they usually resolved?
15. Who are the key actors involved in dispute resolution?

16. Are there any practices that have been particularly effective or ineffective?

Closing Questions

- In your view, what could improve compliance, enforcement, and community engagement?
17. Is there anything else you would like to add about water governance or management challenges?

Notes for the Interviewer

- Allow flexibility for follow-up questions and clarifications. Encourage participants to provide concrete examples and stories. Maintain neutrality; avoid leading questions.

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