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COMPARATIVE GOVERNANCE AND POLICY EFFECTIVENESS IN DROUGHT MANAGEMENT: LESSONS FROM TWO REGIONS IN ECUADOR AND SPAIN

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ABSTRACT. Climate change and increasing climatic variability have intensified droughts, rising temperatures, and rainfall uncertainty, placing growing pressure on water resources and spatial planning systems. In this context, governance structures play a central role in shaping how societies anticipate, respond to, and adapt to water scarcity. This study presents a qualitative comparative case analysis of drought governance in two climate-vulnerable regions: the lower Segura, Alicante basin (Spain) and the upper and middle Mira River basin (Ecuador–Colombia border). Although both regions experience recurrent water stress, they differ in institutional arrangements, governance capacities, and levels of stakeholder coordination. Using document-based qualitative analysis and interpretive comparison of policy and institutional frameworks, the study identifies structural and operational governance weaknesses conceptualized as systemic "glitches" that affect coordination, adaptive capacity, and participatory water management. Rather than measuring performance, the study focuses on how governance processes function in practice and how institutional configurations shape drought response. The analysis addresses three interconnected dimensions: (1) the structural factors shaping drought vulnerability, (2) the institutional configurations that condition climate risk governance, and (3) the governance patterns that influence adaptive capacity at the regional scale. The findings indicate that southern Alicante exhibits strong formal institutional capacity but limitations in operational coordination, while the Ecuadorian case shows more pronounced structural constraints affecting planning and implementation. By comparing these two governance contexts, the study contributes to a deeper understanding of how institutional design and policy coherence influence drought management outcomes. The results highlight the importance of flexible, integrated, and multi-level governance systems for improving resilience in water-scarce regions.

Gobernanza comparada y eficacia de las políticas en la gestión de la sequía: lecciones de dos regiones en Ecuador y España

RESUMEN. El cambio climático y el aumento de la variabilidad climática han intensificado las sequías, el incremento de las temperaturas y la incertidumbre en las precipitaciones, ejerciendo una presión creciente sobre los recursos hídricos y los sistemas de ordenación del territorio. En este contexto, las estructuras de gobernanza desempeñan un papel central en la forma en que las sociedades anticipan, responden y se adaptan a la escasez de agua. Este estudio presenta un análisis comparativo cualitativo de la gobernanza de la sequía en dos regiones vulnerables al clima: la cuenca baja del Segura (Alicante, España) y la cuenca alta y media del río Mira (frontera Ecuador–Colombia). Aunque ambas regiones experimentan estrés hídrico recurrente, difieren en sus pactos institucionales, capacidades de gobernanza y niveles de coordinación entre actores. Mediante un análisis cualitativo basado en documentos y una comparación interpretativa de los marcos normativos e institucionales, el estudio identifica debilidades estructurales y operativas de la gobernanza, conceptualizadas como "fallos sistémicos" que afectan a la coordinación, la capacidad adaptativa y la gestión participativa del agua. Más que

medir resultados, el estudio se centra en cómo funcionan los procesos de gobernanza en la práctica y en cómo las configuraciones institucionales condicionan la respuesta a la sequía. El análisis aborda tres dimensiones interrelacionadas: (1) los factores estructurales que configuran la vulnerabilidad a la sequía, (2) las configuraciones institucionales que condicionan la gobernanza del riesgo climático y (3) los patrones de gobernanza que influyen en la capacidad adaptativa a escala regional. Los resultados indican que el sur de Alicante presenta una sólida capacidad institucional formal, pero limitaciones en la coordinación operativa, mientras que el caso ecuatoriano muestra restricciones estructurales más acusadas que afectan a la planificación y la implementación. Al comparar estos dos contextos de gobernanza, el estudio contribuye a una comprensión más profunda de cómo el diseño institucional y la coherencia de las políticas influyen en los resultados de la gestión de la sequía. En conjunto, los resultados destacan la importancia de sistemas de gobernanza flexibles, integrados y multinivel para mejorar la resiliencia en regiones con escasez de agua.

Key words: Governance, drought, climate variability, adaptive capacity, water management, institutional analysis.

Palabras clave: Gobernanza, sequía, variabilidad climática, capacidad adaptativa, gestión hídrica, análisis institucional.

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1. Introduction

Water is a critical and finite resource that underpins ecosystems, economies, and human well-being. As one of the most sensitive components of the natural environment, it is directly affected by climate variability and long-term environmental change through intensified droughts, rising temperatures, and rainfall variability (Hurlimann and March, 2012; Olcina Cantos, 2024; Suárez-Almiñana *et al.,* 2020). These shifts are already transforming how societies govern water, revealing the limitations of conventional planning approaches. Where drought risk is explicitly integrated into land use and water governance frameworks, management systems tend to display stronger adaptive capacity (Meza *et al.,* 2020). Conversely, disjoined or reactive planning often increases vulnerability and reinforces water scarcity dynamics (Doorn, 2015; Gober and Wheater, 2014).

In many regions, population growth, agricultural expansion, and urbanization have intensified water demand, exacerbating tensions between users and territories (Karamidehkordi *et al.,* 2024). The challenge is not only hydrological but fundamentally institutional. Effective drought governance depends on the capacity of institutions to coordinate actions, integrate policies across sectors, and sustain adaptive decision-making under uncertainty. In this study, this capacity is understood as institutional coordination and adaptive governance capability. When such capacity is weak or inconsistent across levels of governance, systemic mismatches emerge, which we conceptualize as governance "glitches." These glitches produce gaps in planning, coordination, and social inclusion that constrain adaptive responses. In this context, "disruption" refers to moments when such mismatches interrupt established governance processes, revealing structural weaknesses while also opening opportunities for institutional learning and adjustment.

1.1 Climate Change, Extreme Events, and Drought Vulnerability

Human activities such as deforestation, unsustainable land use, and overextraction of water intensify extreme events, particularly in arid and semi-arid environments (IPCC, 2022; UNESCO, 2024). Among these, droughts are especially complex and socially disruptive, as their impacts are shaped not only by climatic conditions but also by inequality, infrastructure distribution, and governance arrangements (Wilhite and Buchanan-Smith, 2005; Wilhite and Pulwarty, 2017). Although the United Nations' Sustainable Development Goal 6 recognizes water as a human right, uneven access and political prioritization of water uses often undermine its implementation (Schubert-Zunker and Knappe, 2024).

Scientific research emphasizes that water security cannot be achieved through infrastructure or technological solutions alone. It requires governance systems capable of integrating environmental, social, and institutional dimensions in a coordinated way (Boccaletti, 2022; Rosso, 2025). This perspective shifts attention toward qualitative governance processes, highlighting collaboration, coordination, and stakeholder engagement as key elements for adaptive water management (Bakker, 2012; Di Vaio *et al.,* 2021; Pahl-Wostl, 2015). Within this broader governance perspective, climate risk is commonly conceptualized following the IPCC framework as the interaction between hazard, exposure, and vulnerability (IPCC, 2014). Reviews confirm that this triad underpins drought and climate risk assessments (Carrão *et al.,* 2016; Hagenlocher *et al.,* 2019), while governance research highlights that institutional arrangements mediate these components, particularly by shaping exposure and vulnerability (Hurlbert and Gupta, 2016). Accordingly, drought vulnerability is understood here as the outcome of interactions between environmental stressors and institutional arrangements, rather than as a purely physical phenomenon**.**

1.2. Comparative Perspective: Governance and Drought Vulnerability

A comparative approach provides an opportunity to understand how different governance systems shape drought resilience across diverse socio-environmental contexts. This study examines two contrasting regions: southern Alicante (Spain) and the upper and middle Mira River basin (Ecuador–Colombia). Both face increasing water scarcity, yet they differ in institutional capability, planning traditions, and social structures. This study adopts a qualitative comparative case study design, examining two regions exposed to recurrent water stress: the lower Segura territory in Alicante (Spain) and the upper and middle Mira River basin (Ecuador–Colombia border). Both territories face increasing water scarcity, but differ significantly in institutional arrangements, governance traditions, and planning capacities.

In southern Alicante, dependence on the Tajo–Segura water transfer system and a supply-oriented planning model illustrate the risks of rigidity in resource management. Infrastructure such as inter-basin transfers and desalination plants has alleviated scarcity but also reinforced consumption patterns and institutional dependency (Cañizares *et al.,* 2022). In the Mira River basin, Ecuadorian area, deforestation, weak institutional coordination, and transboundary governance asymmetries heighten exposure to drought, particularly among rural and Indigenous communities. While the Mira River Basin is transboundary, this study focuses on the Ecuadorian portion (upper and middle basin) to examine governance dynamics in depth, based on data availability and institutional access.

These contrasting contexts show that drought vulnerability is shaped not only by hydrological conditions but also by institutional coherence, coordination capacity, and planning integration. Vulnerability emerges where governance systems are misaligned, producing what this study conceptualizes as systemic "glitches" that affect policy implementation and adaptive response capacity.

Table 1 summarizes the main drivers of drought vulnerability in both regions, highlighting differences in environmental exposure, socio-economic conditions, and governance structures. While

Alicante presents strong institutional frameworks but operational rigidity, the Ecuadorian case reflects more structural limitations in coordination and planning capacity.

The Figure 1 presents the comparative study areas: Lower Segura territory (Alicante, Spain) and the Mira River Basin (Imbabura–Carchi, Ecuador), illustrating their contrasting hydroclimatic and socio-institutional contexts

Table 1. Causes of Vulnerability to Drought in the Study Areas.

Region	***Climate Category***	***Causes of Vulnerability***
Northern Ecuador	Temperate highland with dry winters and warm summers. The high and middle parts of the Mira River Basin (Climate in the Köppen-Geiger classification)	- Deforestation and land degradation reducing natural water retention capacity. - Weak institutional coordination and limited financial and technical resources for drought preparedness. - Socioeconomic marginalization of rural and indigenous communities, reducing adaptive capacity. - Limited access to reliable water supply and sanitation services in rural areas. - Transboundary governance challenges affecting coordinated water management between Ecuador and Colombia. - Climate variability increasing frequency and severity of drought events. - Lack of integrated drought risk management plans and early warning systems. |
Southern of Alicante	Semiarid climate (BSh, in Koppen-Geiger climatic classification)	- Increased agricultural water demand due to expansion of irrigation (since 1970s) - Increased urban-tourism water demand due to growing urbanized areas. - Heavy reliance on the Tajo-Segura water transfer system, with decreasing volumes due to climate change. - Absence of alternative plans to replace Tajo-Segura water with unconventional resources (reuse and desalination). - Social context resistant to change (politically conservative)

Note: The data come from the Ecuadorian portion of the Mira River Basin.
Note*:* The Köppen-Geiger climate classification is a widely used system that categorizes the world's climates based on average temperature and precipitation patterns (available on: https://koeppen-geiger.vu-wien.ac.at/present.htm).

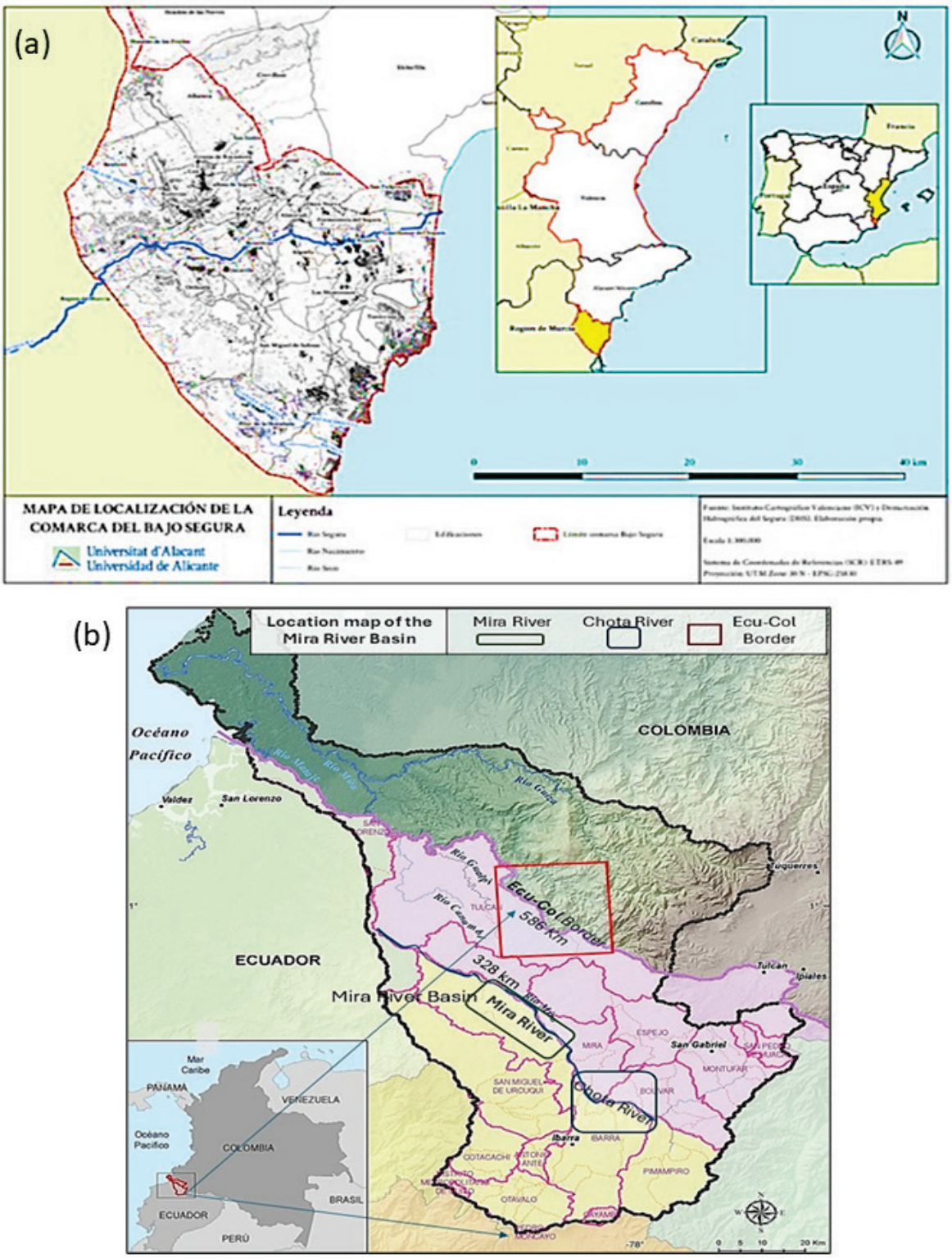

Figure 1. Illustrates the two Comparative study areas, highlighting their contrasting hydroclimatic and socio-economic contexts. (a) Lower Segura territory (Alicante, España). (b) Mira River basin (Imbabura-Carchi, Ecuador). Source: Valencian Cartographic Institute (ICV) and Segura Hydrographic Demarcation (DHS), and the Hydrographic Mira Basin (DHM).

1.3. Research Objectives, Questions, and Rationale

This study examines how governance arrangements shape drought management and adaptive capacity in two climate-vulnerable regions with distinct institutional and planning traditions: southern Alicante (Spain) and the upper and middle Mira River basin (Ecuador–Colombia border). Rather than assessing performance in quantitative terms, the research adopts a qualitative comparative case study approach to explore how institutional structures, policy frameworks, and coordination mechanisms influence drought governance outcomes.

The comparison is grounded in the recognition that both cases operate under different planning paradigms. In Spain, territorial planning refers to an integrated spatial governance framework that combines land use regulation, regional development, and environmental policy coordination. In Ecuador, land use planning is more closely associated with the regulation of productive activities and localized land allocation processes. As discussed in Section 2.2, distinguishing these conceptual approaches is essential for analytical consistency.

This study is guided by three research questions:

1. What socio-environmental and territorial factors shape drought vulnerability in southern Alicante and the Mira River basin?
2. How do governance arrangements and planning systems influence institutional responses to drought conditions?
3. What comparative insights can be derived to improve governance coherence and adaptive capacity in drought-prone regions?

To address these questions, the study pursues the following objectives:

- To identify and describe the main socio-environmental and institutional factors that contribute to drought vulnerability in both regions, including exposure conditions, land use dynamics, and governance constraints.
- To analyze the role of governance and planning frameworks in shaping drought response processes, focusing on coordination mechanisms, institutional interactions, and policy integration.
- To derive context-sensitive and analytically transferable insights aimed at strengthening institutional coordination and adaptive capacity in drought governance systems.

The study adopts an interdisciplinary qualitative framework that links socio-environmental vulnerability with governance structures and institutional dynamics. In this context, governance is understood as the set of formal and informal arrangements through which decisions on water and drought management are negotiated, implemented, and coordinated across multiple levels of authority.

Resilience is interpreted as the capacity of socio-ecological systems to anticipate, respond to, and adjust under conditions of climate variability and water stress, without relying on measurable performance indicators, but rather on observable governance processes and institutional interactions.

By integrating these dimensions, the analysis allows the identification of both context-specific governance constraints and shared structural patterns that influence drought management in different institutional environments. The comparison is based on a most-similar systems logic, where regions with comparable climatic exposure are contrasted to understand how differences in governance architecture shape adaptive outcomes.

Ultimately, comparing Spain and Ecuador provides insight into how governance systems, rather than climatic differences alone, determine drought vulnerability and resilience outcomes. This cross-contextual perspective contributes to ongoing debates on environmental governance by revealing how institutional "glitches" emerge and how they can be mitigated through more coherent, inclusive, and adaptive planning.

1.4. Conceptual contribution

This comparative perspective reinforces that drought vulnerability is shaped not only by climatic conditions, but by how governance systems are structured and operate in practice. Building on this, the study uses the notion of governance "glitches" as a heuristic to identify misalignments and operational constraints that limit coordinated and adaptive responses. By contrasting Spain and Ecuador, the analysis highlights how differences in institutional organization influence drought governance outcomes and reveals common challenges in translating formal frameworks into effective practice. The following section develops the theoretical foundations that underpin this analytical approach.

2. Theoretical Framework

2.1. Governance, Institutions, and Water Management

Effective drought management depends on integrating technical, institutional, and political dimensions within governance systems. Water security arises not only from infrastructure but from institutions capable of coordinating across sectors and scales (Boccaletti, 2022; Pahl-Wostl, 2019). In this study, governance is understood as the set of structures and processes through which collective decisions on water allocation and risk management are made, emphasizing transparency, participation, and adaptive capacity.

To better capture variations in governance performance, this research distinguishes between institutional capacity and institutional capability. Institutional capacity refers to the structural potential of governance systems, including formal mandates, available resources, and organizational arrangements. Institutional capability, by contrast, refers to the ability to effectively operationalize these resources in practice, including technical skills, coordination mechanisms, and responsiveness to changing conditions. This distinction helps to explain why governance systems that appear robust on paper may still underperform during drought events.

Fragmented governance structures often lead to reactive and uneven responses, as coordination gaps constrain anticipatory planning and equitable water allocation. In contrast, more integrated and inclusive arrangements can enhance resilience by linking scientific knowledge, social priorities, and institutional action (Bakker, 2012). From this perspective, governance is conceptualized as a relational process involving interactions among state, market, and community actors, where outcomes depend not only on institutional design but also on participation and legitimacy.

Adaptive learning and social inclusion contribute to sustaining water governance by enabling feedback between institutions and communities, especially during water stress. For example, local water boards in northern Ecuador incorporate experiential knowledge into allocation decisions, while participatory platforms improve trust and coordination among stakeholders (Pahl-Wostl *et al.,* 2010; Rosso, 2025). These processes are inherently complex, involving multiple actors, competing interests, and diverse knowledge systems.

Building on this, participatory governance literature argues that complexity and conflict are not merely constraints to be managed, but can also function as drivers of learning, innovation, and democratic transformation (Fung and Wright, 2001). However, in practice, governance systems often attempt to simplify these dynamics, limiting their adaptive potential. This study complements that

perspective by examining how institutional misalignments, conceptualized here as "governance glitches", constrain the effective translation of capacity into capability, particularly under environmental stress such as drought.

2.2. Land Use and Territorial Planning in Socio-Environmental Vulnerability

Land use and territorial planning play a decisive role in shaping water availability and drought vulnerability. Integrated planning aligns spatial development with sustainable resource management, while sectoralized governance systems amplify scarcity by disconnecting water supply from agricultural, urban, and industrial needs (Hurlimann and March, 2012).

In southern Alicante, reliance on the Tajo–Segura transfer system and a supply-oriented planning model demonstrate how infrastructural dependency can perpetuate vulnerability. Although desalination and transfers have temporarily offset scarcity, they have also stimulated demand, reinforcing unsustainable cycles of consumption (Cañizares *et al.,* 2022). In contrast, in Ecuador's Mira River Basin, deforestation, weak coordination, and transboundary governance asymmetries increase exposure to drought and constrain adaptive responses.

While closely related, territorial planning and land use planning differ across contexts. In Spain, territorial planning (ordenación del territorio) provides a comprehensive framework linking land regulation, environmental management, and regional development. In Ecuador and Colombia, land use and territorial planning (ordenamiento territorial y uso del suelo) focuses more narrowly on local zoning and productive land allocation. To ensure conceptual clarity, this study employs territorial planning when referring to overarching spatial governance frameworks and land use planning when discussing specific instruments or practices.

Addressing water scarcity therefore requires integrating planning processes with governance effectiveness and social inclusion. The analytical framework adopted here links socio-environmental vulnerability to institutional performance, examining how land use and governance arrangements jointly shape communities' capacity to adapt to drought. Water, as the core element of this analysis, supports ecological stability, livelihoods, and social cohesion, yet climate change and unsustainable management are disrupting these interdependencies, intensifying both droughts and floods (Kundzewicz *et al.,* 2019; Ward *et al.,* 2020). Adaptive, cross-sectoral governance that reconciles environmental, social, and institutional priorities is thus essential.

2.3. Conceptualizing "Glitches" in Governance

To analyze systemic weaknesses in drought management, this study introduces the concept of a "glitch" as an analytical metaphor. Borrowed from technology, a glitch denotes a malfunction within a system that otherwise functions as designed. In governance terms, it represents a disruption or misalignment, between policy intent, institutional capability, and social realities, that hampers coordinated and equitable responses to drought.

Unlike notions of outright failure, glitches highlight partial dysfunctions that expose institutional blind spots: decentralized authority, inconsistent enforcement, or the exclusion of vulnerable groups. Identifying these misalignments clarifies why drought governance often fails despite significant technical capacity (Bakker, 2012). While this assessment is based on qualitative institutional and comparative analysis rather than quantitative modelling, it consistently highlights gaps between formal capacity and operational performance.

Governance "glitches" can occur across technical, institutional, and social dimensions. Dispersed and poorly coordinated institutional responsibilities, characteristic of complex governance systems (Healey, 2006), delay responses; unintegrated data hinder decision-making; and political inertia

blocks reform. Examining these disruptions provides a nuanced understanding of how governance systems perform under stress and why adaptation remains constrained.

Applied comparatively, the glitch framework illuminates how governance systems in Spain and Ecuador diverge in coordination and coherence. In Spain, glitches emerge within established but compartmentalized institutions, where sectoral interests and policy objectives often conflict. In Ecuador, particularly in the Mira Basin, glitches stem from institutional weakness, limited data systems, and transboundary asymmetries, leading to reactive management.

By conceptualizing these disruptions as glitches, the study offers both a diagnostic and comparative tool, revealing how similar governance challenges manifest differently depending on institutional context. This approach moves beyond normative evaluation to examine how structures, power relations, and historical path dependencies shape resilience adaptive capacity. As Folke *et al.* (2003), Gupta *et al.* (2010), and Pahl-Wostl (2015) note, even well-resourced systems struggle when coordination and learning mechanisms remain rigid.

2.4. Governmentality and Interpretive Frameworks for Drought Governance

Complementing the glitch lens, the concept of governmentality, drawn from Foucault's notion of governing through rationalities and techniques, offers an interpretive framework for understanding how power, knowledge, and regulation intersect in drought governance. It highlights how decisions over water control, allocation, and benefit distribution reflect broader political and social dynamics.

This perspective clarifies why drought management outcomes differ across contexts. In Spain, governance surrounding the Tajo–Segura transfer illustrates how infrastructure and policy decisions are entangled with regional politics and economic interests. In Ecuador's Mira Basin, overlapping jurisdictions and limited technical capacity similarly reveal the political nature of water management, where asymmetries in power and knowledge shape institutional outcomes.

Combining the glitch and governmentality perspectives allows this study to explore both *how* governance fails and *why* those failures persist. While the glitch metaphor identifies operational and institutional misalignments, governmentality situates them within broader power relations and decision-making rationalities. Together, they provide a comprehensive framework for analyzing drought governance as a multi-scalar, socio-political process rather than a purely technical challenge.

Ultimately, strengthening water resilience to climate changes requires institutions that can learn, adapt, and coordinate across scales (Adger *et al.,* 2005; Dewulf *et al.,* 2019). By combining the diagnosis with interpretive understanding, the study reveals how systemic "glitches" are produced and maintained, and how governance reform can move toward more inclusive, adaptive, and equitable management of drought impacts.

3. Methodology

In this study, we adopt a qualitative comparative case study design to examine drought governance in two climatically and institutionally contrasting regions: southern Alicante (Spain) and the upper and middle Mira River Basin on the Ecuadorian side of the Ecuador–Colombia border. While the Mira River Basin is transboundary, we focus the empirical analysis exclusively on the territory, where data availability, institutional access, and case study development allowed for a systematic examination of governance structures and drought management processes. The Colombian side of the basin is therefore not included in the analysis, representing a limitation and an avenue for future research. This approach is well established in comparative governance research (Bartlett and Vavrus, 2017; George and Bennett, 2005; Ragin, 2014).

3.1. Research Design and Data Collection

We base the analysis exclusively on secondary qualitative data, including peer-reviewed academic literature, policy reports, institutional documents, and official planning instruments related to drought governance, land use planning, and water management.

The main methodological tool is document-based qualitative analysis, which allows for the systematic interpretation of governance arrangements, institutional coordination mechanisms, and policy responses to drought conditions (Bowen, 2009). This approach is particularly suitable for comparative governance research where direct fieldwork is not conducted, as it enables the reconstruction of institutional dynamics through publicly available sources.

The Ecuadorian case draws on previously developed and partially published case studies that form part of an ongoing doctoral research project. Due to the scope and publication status of this broader research, additional primary data from the Colombian side could not be incorporated, and the analysis remains focused on the Ecuadorian upper and middle basin. This ensures consistency in data sources and analytical depth across the selected cases.

3.2. Analytical Procedures

We combine qualitative content analysis and interpretive comparison to identify patterns of governance structure and institutional behavior across the two cases (Braun and Clarke, 2006; Pahl-Wostl, 2019). The focus is not on quantification, but on understanding *how governance systems function in practice under conditions of water stress.*

We apply a structured comparative framework to examine three key analytical dimensions:

1. Socio-environmental vulnerability, including exposure to drought, land use pressures, and environmental constraints.
2. Governance and planning arrangements, including institutional coordination, policy integration, and decision-making structures.
3. Adaptive governance capacity, understood as the ability of institutions to respond, adjust, and coordinate under climate variability and uncertainty.

These dimensions guide our systematic analysis of documentary sources across both cases, ensuring consistency in the variables examined despite differences in geographic scope (Spain at basin/regional level; Ecuador at basin level within national territory). Table 2 summarizes this analytical framework and the dimensions used to guide cross-case comparison.

Table 2. Analytical Framework for Achieving the Research Objective.

Framework Element	Description / Key Factors	Methodological Notes
Core Concepts	- Climate change impacts & extreme events (droughts, floods) - Governance and land use planning - Resilience & sustainable development	Define key terms clearly; reference IPCC and governance literature; emphasize interconnections.
Key Factors of Vulnerability	- Socioeconomic causes (livelihood dependency, poverty, marginalization) - Environmental impacts (ecosystem degradation, water scarcity) - Institutional capability and coordination gaps	Use mixed methods: socio-economic data analysis, content analysis; environmental reports on monitoring data.

Governance & Planning Role	- Policy frameworks addressing drought and climate risks - Land use planning integration with climate resilience - Social inclusion and stakeholder engagement	Conduct content analysis of policy documents and planning frameworks; stakeholder mapping and interviews to assess engagement.
Objectives	1. Assess vulnerability of rural and urban livelihoods to drought 2. Evaluate territorial [land use] planning and governance effectiveness 3. Proposing comparative, context-specific resilience measures	Organize study design around these objectives; develop indicators for vulnerability and governance performance; compare findings.
Adaptive Capacity & Resilience	- Institutional flexibility - Community preparedness - Inclusion of vulnerable groups - Long-term sustainability	Apply resilience frameworks (e.g., social-ecological systems theory); examine adaptive governance models; explore community case studies.
Methodological Approach	- Comparative case study - Qualitative content analysis - Stakeholder interviews - Policy document review - Socioeconomic and environmental data analysis	Ensure triangulation of data sources; incorporate participatory methods; possibly GIS or remote sensing for environmental aspects.

3.3. Data Sources and Validation

The study integrates multiple qualitative sources, primarily related to the Ecuadorian portion of the Mira River Basin, including academic publications, governmental reports, international assessments, and official policy documents such as national water plans, drought management protocols, land use regulations, and cross-border cooperation frameworks.

This triangulation of documentary sources ensures empirically grounded qualitative assessment by combining scientific literature with institutional and policy-based evidence. It also allows for cross-validation of governance interpretations across different types of sources, strengthening the reliability of the comparative analysis. Table 3 presents the main categories of sources used and their relevance for interpreting governance structures, planning systems, and adaptive capacity in both case studies.

Table 3. Key Consultation Sources and Official Documents Reviewed.

Region	Key Sources and Documents
Northern Ecuador (Mira River Basin)	- Hydrological Plan of the Mira Hydrographic Demarcation - National Water Secretariat (SENAGUA) reports on water governance and hydrological planning - Ecuadorian Agricultural Policies (towards Sustainable Rural Territorial Development 2015-2025) - Regional Development and Territorial Planning Plans for Imbabura and Carchi Provinces; Territorial Planning Development Plans - National Drought Plan (2021-2025) - National Water Plan - National Irrigation and Drainage Plan - Academic studies on drought, water governance, and cross-border cooperation in the Mira basin. (WWF, UNDP, EUROCLIMA+) - National Disaster Response Plan - Agenda and reports from the Ecuadorian Risk Management Secretariat (SGR) on drought and disaster risk management

Southern Spain (Alicante)	- Plan Hidrológico de la Demarcación Hidrográfica del Segura (2021–2027) Main reference for water resource planning and allocation - Segura Special Drought Plan - Drought-specific management strategy - Plan de Acción Territorial de la Vega Baja - Territorial planning for climate risk adaptation - Plan Vega Renhace (Generalitat Valenciana) - Regional plan for climate resilience- Urban Planning Database (Consellería de Medio Ambiente, Generalitat Valenciana) - Reference for municipal land use planning - Agricultural Sector Reports (Consellería de Agricultura, Generalitat Valenciana) - Data on agricultural water demand and risk - Water Management Reports (Mancomunidad de los Canales del Taibilla) - Information on water supply and drought contingency - Academic and technical studies on drought impacts in Alicante Province.

Note: The Mira River Basin analysis is based on documentary sources from the Ecuadorian side (upper and middle basin). Colombian institutional frameworks were not systematically analyzed due to data and access limitations, representing a limitation of the study.

*Secretaría de Gestión de Riesgos (SGR) (2023). *Informe de gestión de emergencias por sequía 2023*. Quito, Ecuador: Presidencia de la República del Ecuador. https://www.gestionderiesgos.gob.ec

3.4. Synthesis and Analytical Framework

We synthesize the findings from both case studies are synthesized through a comparative interpretive framework that distinguishes between two analytical categories: First, the Governance structures ("governance facts"), referring to formal institutional arrangements, policy frameworks, and planning instruments. Second, governance "glitches" are conceptualized as systemic misalignments, coordination constraints, or institutional gaps that limit effective drought response and adaptive capacity.

This dual analytical perspective allows for the identification of both structural strengths and operational constraints in drought governance systems across different socio-political and environmental contexts.

Figure 2 illustrates the interaction between governance structures, planning instruments, and governance glitches, showing how similar coordination and inclusion challenges emerge in both regions despite their contextual differences.

By relying exclusively on documentary and institutional sources, this methodology enables a systematic qualitative comparison without primary fieldwork, while maintaining analytical rigor through structured interpretation and triangulation. The integration of academic literature and policy documents ensures that findings are grounded in both empirical evidence and institutional practice, supporting the development of context-sensitive insights for improving drought governance.

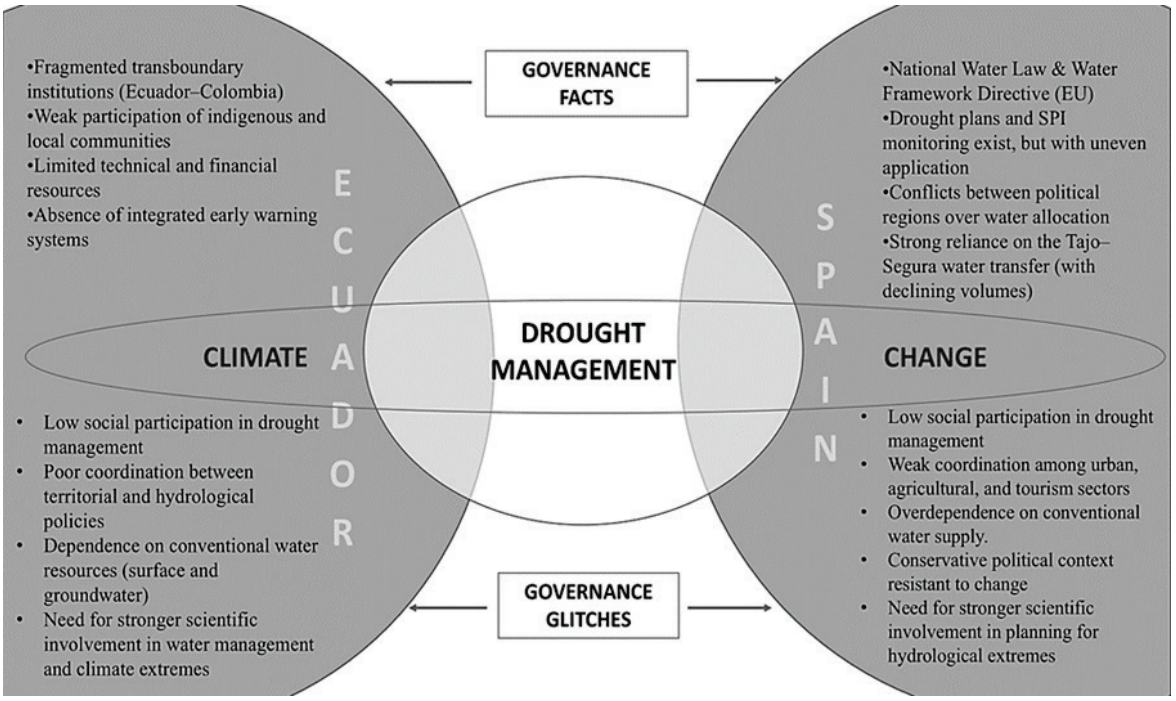

Figure 2. Governance Dynamics in Drought Management: Facts and Glitches.

4. Results

This study examines drought governance in two climatically and institutionally distinct regions: the Ecuadorian portion of the Mira River Basin, and southern Alicante in Spain. Both regions are drought-prone, yet they differ in institutional structures, planning frameworks, and operational capacities, providing a basis for comparative insights into governance effectiveness and systemic vulnerabilities.

4.1. Governance Structures and Institutional Responses

In Ecuador, the analysis focuses on the northern provinces of Imbabura and Carchi, particularly the upper and middle part of the Mira River Basin, which extends across the Colombian, and the border is highly vulnerable to both hydrological and governance-related stress. Covering approximately 6,880 km², the basin is organized into two zonal centers: (a) the Ibarra Zonal Center, which includes the lower, middle, and upper sections of the Mira River as well as the Lita, Ambi, and Chota rivers; and (b) the Tulcán Zonal Center, encompassing the San Juan and Carchi river basins. Imbabura Province plays a crucial role as the upper and middle catchment of the Mira River Basin, where many local water systems originate and drought risks are most acute.

The country's governance framework remains relatively centralized, with the National Water Secretariat (SENAGUA), now integrated into the Ministry of Environment, Water and Ecological Transition (MAATE) overseeing national water regulation under the 2014 Water Law. Provincial governments are responsible for irrigation management, while local governments (Gobiernos Autónomos Descentralizados, GADs) handle drinking water services. Water governance is organized around hydrological demarcations such as the Mira River Basin, which serves as a planning unit for integrated water resource management and drought contingency efforts. However, coordination across institutional levels remains limited, technical capacity at the local scale is weak, and infrastructure deficits continue to restrict effective response. Meteorological monitoring conducted by the National Institute of Meteorology and Hydrology (INAMHI), which provides SPI-based drought assessments, yet these are not consistently translated into actionable institutional protocols. Although the 2021

National Drought Plan aims to strengthen coordination between monitoring, water management, and resilience-building measures, its implementation is still constrained by financial, technical, and administrative challenges.

In Spain, drought governance is organized through hydrographic districts, managed at the basin level by River Basin Authorities such as the Segura (CHS), operating under the oversight of the Ministry for Ecological Transition (MITECO). The Segura Basin Authority coordinates across multiple autonomous communities, using the Special Drought Management Plans (*Planes Especiales de Sequía*, PES), which establish legal triggers, phased responses, and multi-level coordination. Indicators include the Standardized Precipitation Index (SPI), reservoir storage, groundwater levels, streamflow anomalies, and water demand stress. This framework allows anticipatory governance, linking hydrological monitoring to operational responses.

Table 4 summarizes the institutional and technical instruments in both contexts. Spain exhibits structured integration of planning, monitoring, and enforcement, whereas Ecuador demonstrates poorly coordinated governance arrangements and reactive approaches, with local adaptation efforts often disconnected from national directives.

Table 4. Comparative overview of drought definition instruments and protocols in Spain and Ecuador.

Country	***Spatial scale / Focus Area***	***River basin/ territorial unit***	***Lead institutions***	***Drought indicators used***	***Key protocols / frameworks***	***Drought declaration process***
Spain	Basin-level (Segura River Basin District, Valencian Community (Alicante focus)	Segura River Basin (southern Alicante within the Segura Basin District)	Confederación Hidrográfica del Segura (CHS); Ministry for Ecological Transition and Demographic Challenge (MITECO)	Standardized Precipitation Index (SPI); reservoir storage levels; streamflow anomalies; groundwater levels; water demand stress indicators	Special Drought Management Plans (Planes Especiales de Sequía, PES) (for each basin); EU Water Framework Directive;National Drought Observatory	CHS continuously monitors indicators (monthly/seasonal). Phased system: Normal → Pre-alert → Alert → Emergency, activated at basin level and coordinated with MITECO
Ecuador	Basin-level focus within national jurisdiction (Northern border: Zone 1 – Ecuadorian portion of Mira River Basin system)	Mira River Basin (Ecuadorian upper and middle basin); Carchi River sub-basin; connected transboundary rivers (San Miguel, Putumayo)	National Institute of Meteorology and Hydrology (INAMHI); Secretariat for Risk Management (SGR); Decentralized Governments (GADs); SENAGUA (dissolved, functions transferred to MAATE)	Rainfall anomalies / SPI (produced by INAMHI); dry spell duration; crop loss reports; Community - level water shortages (reported by GADs or local actors)	National Risk Management Framework (SGR); Early Warning Bulletins (INAMHI); Emergency Operations Committees (COE); no dedicated national drought policy	Predominantly reactive declarations at provincial/cantonal level (GAD/COE). National coordination activated by (N)SGR only during multi-territorial impacts

Note: The Ecuadorian case refers exclusively to the Ecuadorian portion (upper and middle basin) of the Mira River system. The Colombian side of the transboundary basin is not included in the empirical analysis.

4.2. Planning Instruments: Land Use vs Territorial Planning

The distinction between land use planning and territorial planning is relevant for understanding governance approaches in the two regions. In Ecuador, land use and territorial planning is operationalized at municipal and provincial scales, regulating zoning, productive activities, and local infrastructure. In the Ecuadorian portion of the Mira River Basin, land use planning primarily focuses on agricultural and irrigation development, but integration with hydrological risk management and drought preparedness is limited (Arias-Muñoz *et al.,* 2023; Maldonado-González et al., 2019; Megens and Warner, 2025). The planning tools often lack enforcement capacity, and overlapping responsibilities among GADs, INAMHI, and SGR generate coordination gaps.

In Spain, territorial planning (*ordenación del territorio*) operates at a basin and regional scale, integrating spatial planning development (Faludi, 2000), environmental management, and climate adaptation objectives. Plans such as the Plan Vega Renhace exemplify multi-scalar coordination between land use, water allocation, and infrastructure, linking legal, technical, and operational instruments (Hurlimann and March, 2012; Morote *et al.,* 2019). While the term "territorial planning" may not appear explicitly in operational drought protocols, the framework aligns with basin-scale planning to harmonize multiple land and water uses, reflecting higher institutional integration than in Ecuador.

Thus, the distinction is primarily conceptual: Ecuador emphasizes local land use planning instruments, whereas Spain implements territorial planning frameworks that coordinate multiple sectors across scales. Importantly, this difference is drawn from planning literature and institutional design rather than direct empirical comparison; observed variations in practice should be interpreted cautiously.

4.3. Institutional and Policy Instruments for Drought Management

This section compares the institutional instruments and policy frameworks used to define and respond to drought in Alicante (Spain) and northern Ecuador, drawing on the synthesis presented in Table 4. To support this comparison, the analysis distinguishes between institutional capacity (formal structures and resources) and institutional capability (their effective implementation), allowing for a clearer interpretation of governance gaps.

For our case in Spain, drought management is structured through formal policy instruments, particularly the Special Drought Plans (*Planes Especiales de Sequía*, PES), implemented by the Segura River Basin Authority (*Confederación Hidrográfica del Segura*, CHS) under the Ministry for the Ecological Transition and the Demographic Challenge (*Ministerio para la Transición Ecológica y el Reto Demográfico*, MITECO, 2023). These instruments establish legally defined thresholds, integrate hydro-climatic indicators, and link monitoring systems to predefined management actions. This enables coordinated responses across basin authorities, regional governments, and water users. For example, in September 2023, drought indicators in the Segura Basin reached "alert" levels, triggering irrigation restrictions and emergency measures coordinated by CHS and supported by the European Drought Observatory (CHS, 2023).

In contrast, Ecuador's drought governance framework is less institutionalized, historically characterized by weakly coordinated, reactive management rather than a systemic, proactive, and operationalized policy. It relies primarily on decentralized local governments (*Gobiernos Autónomos Descentralizados*, GADs), with technical input from the National Institute of Meteorology and Hydrology (*Instituto Nacional de Meteorología e Hidrología*, INAMHI) and coordination by the Secretariat for Risk Management (*Secretaría de Gestión de Riesgos*, SGR). Although policy instruments such as the National Drought Plan (*Plan Nacional de Acción frente a la Sequía*, DNP) and the Standardized Precipitation Index (SPI) exist, they are not comprenhensively connected to decision-making protocols or legally defined triggers. As a result, responses in the Mira River Basin during the

2023 drought were largely reactive, with provincial governments in Carchi and Imbabura implementing uncoordinated measures. Field reports documented water shortages and agricultural losses weeks before national actions were activated (INAMHI, 2023; MAATE, 2022).

A key difference between the cases lies in how institutional instruments connect data, decisions, and coordination. In Spain, monitoring systems combine climatic indicators (e.g., SPI) with reservoir storage, groundwater levels, and water demand metrics, allowing early warning systems to directly inform management actions. In Ecuador, monitoring tools are used mainly for observation, with more limited institutional mechanisms to translate information into timely and coordinated responses. Moreover, the absence of a fully consolidated national drought coordination framework in each case constrains vertical and horizontal integration, resulting in uneven and still-incomplete coordination across governance levels and more localized responses to drought impacts, while also indicating potential for further institutional strengthening through improved cross-scale alignment.

These differences are further reflected in governance structures. Spain operates through basin-scale institutions that provide a relatively integrated framework for water allocation, despite some misalignment with administrative boundaries. In Ecuador, the absence of a permanent and binding national drought framework limits coordination across territorial levels and weakens continuity in policy implementation.

Overall, the comparison shows that the effectiveness of drought governance instruments depends less on the availability of monitoring tools and more on their institutional integration into decision-making and inter-level coordination. This distinction provides the basis for the following section.

4.4 Thematic Analysis of Drought Governance

Institutionalization and Planning Capacity. The analysis of these two study areas includes the socioeconomic and environmental impacts of droughts in both regions, vulnerability assessments for rural and urban areas, and a comparison of land use planning approaches in Alicante and northern Ecuador.

Descriptive Analysis. Further descriptive analysis was conducted to understand the current drought management practices in both regions. This section summarizes the findings from existing reports, government policies, and expert opinions, focusing on the primary strategies employed in each region to mitigate drought impacts and improve resilience.

Spain's governance system, particularly in Alicante, is deeply institutionalized. Drought management planning (DMP) is embedded within water resource policy at the basin level, with clearly defined indicators, emergency levels, and legal authority for enforcement (Hervás-Gámez and Delgado-Ramos, 2019; Urquijo-Reguera *et al.,* 2022). This level of institutional maturity enables anticipatory governance and rapid mobilization of emergency resources. On the other hand, Ecuador's northern region lacks a formal drought management plan, leaving much of the response dependent on local and often reactive coordination. Although INAMHI provides periodic bulletins, these are not embedded in a binding policy framework, and local governments frequently face challenges in translating meteorological information into concrete action plans. Similarly, in transboundary basins such as the Mira River, cross-border water cooperation remains weak and largely informal. While some recent initiatives signal progress, they tend to be temporary and project-based.

Taken together, these gaps, both internal and cross-border, highlight the pressing need for long-term binational planning and sustained cooperation, moving beyond isolated actions toward more coordinated and resilient water governance.

Data and Monitoring Systems. In both countries, SPI is the shared technical standard, but the degree of integration into operational decision-making diverges significantly. We observe that Spain's

CHJ and CHS authorities use real-time hydrological and climatological data, along with consumption patterns, to manage reservoir operations and activate legal drought declarations. Ecuador's data infrastructure is more limited in scope and institutional uptake; real-time water monitoring systems are generally lacking, especially in rural or border communities.

Territorial and Multilevel Governance Gaps. Southern of Alicante's water governance is nested within a vertically coordinated framework spanning municipal, basin, and with lower incidence, national levels. River basin authorities function as core nodes of planning and implementation, facilitating legal enforcement of drought protocols.

Conversely, northern Ecuador experiences significant fragmentation. Coordination between INAMHI, MAATE, the (N)SGR, and local GADs is ad hoc and often limited by institutional silos. Transboundary river basins such as the Mira and Carchi remain outside formal binational drought planning frameworks, which constrain resilience-building in climate-sensitive border zones.

The comparative analysis also highlights the concept of *"governance glitches"* systemic blind spots or mismatches that hinder effective drought response.

In Spain, glitches may occur within an otherwise robust system due to sectoral conflicts or bureaucratic delays, especially between agricultural users and environmental authorities. In Ecuador, glitches are more structural and persistent, resulting from the absence of formal drought protocols, limited data integration, and weak coordination across governance levels.

5. Discussion

5.1. Governance "Glitches" and Institutional; Dynamics

Building on the study's objectives, (1) assessing drought vulnerability drivers, (2) evaluating institutional capacity, and (3) identifying pathways to strengthen governance resilience, this section interprets the findings through the lens of drought governance "glitches."

Despite contrasting institutional and socio-political contexts, both cases reveal governance limitations that constrain drought resilience. The existence of formal frameworks—such as Spain's *Planes Especiales de Sequía* (MITECO, 2023) and Ecuador's *Plan Nacional de Acción frente a la Sequía* (MAATE, 2022), does not guarantee effective implementation. Instead, systemic glitches emerge in different forms: operational constraints in Spain and structural limitations in Ecuador. (OECD, 2012). We maintain that these reflect deeper issues in institutional capacity, particularly the ability to translate formal mandates into coordinated and timely action.

From a governmentality perspective (Mills-Novoa *et al*., 2020), drought governance is shaped not only by institutional design but also by power relations, political dynamics, and knowledge systems. In Ecuador, limited institutional presence and dispersed governance mandates contribute to reactive and locally driven responses, such as uncoordinated irrigation and rationing measures implemented by provincial authorities, while national institutions prioritize infrastructure and monitoring (Megens Santos *et al.,* 2022). This uneven distribution of authority reinforces a disconnect between planning and implementation, further shaped by socio-political dynamics. Indigenous mobilizations and territorial conflicts, for example, influence how water policies are negotiated and enforced, reflecting broader struggles over access, control, and recognition (Boelens *et al.,* 2018).

In contrast, Spain's governance system is institutionally consolidated and operates primarily at the river basin district scale, which serves as the core unit for drought planning and implementation. Local and municipal actions play a complementary role but remain dependent on basin-level decision-making. Within this framework, governance glitches arise from operational misalignments, sectoral competition, and political pressures. During the 2022–2024 drought cycle, critically low reservoir levels intensified pressure on authorities to secure water supply, leading to contested measures such as

desalination expansion and emergency transfers. These interventions did not fully resolve supply constraints and instead intensified conflicts between economic sectors (especially agriculture and tourism) and between political positions supporting or opposing supply-side solutions, as observed in other similar regions such as Barcelona and the Axarquía in Málaga.

Across both contexts, we identify three types of governance glitches can be identified:

- Failures, referring to technical or operational breakdowns;
- Deficiencies, linked to gaps in policy design or institutional arrangements;
- Inconsistencies, reflecting misalignments between plans and implementation.

These typologies manifest differently across cases. In Spain, these glitches occur within a relatively consolidated institutional framework and are mainly operational, often delaying responses despite the availability of planning instruments. In Ecuador, they are more structural, stemming from incomplete policy frameworks, limited inter-agency integration, and weak institutional continuity.

We observe this distinction most clearly in the Mira River Basin. Although the basin is transboundary, this analysis focuses on the Ecuadorian portion; therefore, governance asymmetries are interpreted from a partial institutional perspective. Within this scope, provincial governments in Carchi and Imbabura have historically implemented ad hoc rationing measures, often misaligned with national frameworks previously led by SENAGUA. Empirical evidence points to persistent supply deficits affecting local populations, reflecting not only infrastructural constraints but also limitations in governance integration. These challenges have continued despite institutional restructuring, including the transfer of water governance responsibilities to the Ministry of Environment, Water and Ecological Transition (MAATE), which has not yet resulted in clearly improved coordination or drought management outcomes at the basin level.

Beyond administrative factors, socio-political dynamics also shape governance outcomes. Social mobilizations and territorial conflicts, particularly in Indigenous regions, influence how water policies are negotiated and implemented. We suggest that these dynamics highlight that drought governance is not only a technical or institutional issue, but also a contested political process (Boelens *et al.,* 2018).

Overall, we find that governance effectiveness depends not only on institutional design but on how systems operate in practice. In Spain, drought governance is structured at the river basin district scale, enabling coordinated planning but still generating operational tensions under conditions of scarcity, particularly across competing sectoral demands. Although the *Planes Especiales de Sequía* (PES) represent one of the most advanced drought management systems in Europe, their effectiveness remains constrained by cross-level coordination challenges and political pressures (Hervás-Gámez and Delgado-Ramos, 2019).

In Ecuador, by contrast, governance challenges are more structural. In the Ecuadorian portion of the Mira River Basin, drought responses are shaped by incomplete policy frameworks, limited inter-agency integration, and weak institutional continuity. Despite institutional restructuring, including the transition from SENAGUA to MAATE, these changes have not yet translated into more effective or coordinated drought management at the basin level. In addition, socio-political dynamics, particularly Indigenous mobilizations and territorial conflicts, continue to shape how water policies are implemented in practice.

Taken together, we argue that Spain's challenges are primarily operational and Ecuador's are structural. In both cases, governance effectiveness depends on the alignment between institutional design and implementation. Bridging this gap remains central to strengthening drought resilience.

5.2. Implications for Governance Resilience

The findings indicate that drought resilience is conditioned less by the existence of formal plans than by their coherent, inclusive, and timely implementation. We argue that bridging the gap between institutional capacity (formal structures and resources) and institutional capability (their effective implementation) is therefore central to improving governance outcomes. Addressing governance glitches demands more integrated, participatory, and adaptive approaches that align technical knowledge, policy frameworks, and socio-political realities.

In Ecuador, recent reforms to the disaster risk management system, including the restructuring of civil protection in 2021 and the creation of a national platform for risk reduction, reflect efforts to strengthen institutional frameworks. However, our analysis suggests that these arrangements remain largely reactive, with limited capacity for anticipatory planning and prevention, highlighting a persistent gap between institutional design and implementation.

In Spain, governance systems show higher institutional consolidation; yet, we observe that operational coordination and flexibility remain constrained, particularly under prolonged drought conditions. This results in delays, sectoral tensions, and limited adaptability within existing planning frameworks.

Across both contexts, we find that improving drought resilience requires strengthening key governance dimensions: enhancing multi-level integration, increasing stakeholder inclusion, particularly of vulnerable groups, and improving the integration of technical and local knowledge in decision-making processes. In addition, more depoliticized and evidence-based planning is essential to align decisions with climatic conditions and long-term sustainability goals.

Table 5 synthesizes these differences, showing how distinct types of governance glitches produce similar constraints on adaptive capacity. These insights inform the recommendations presented in Section 6.

Table 5. Comparison of "Glitches" in Drought Management: Ecuador vs. Ecuador Spain.

Glitch Category	Spain (south of Alicante Region)		Ecuador (Cross-Border Zone)	
(F) Failure (Technical or systemic problem)	General: Lack of coordination mechanisms between state and regional administrations in water management and drought events Specific: Excessive dependence of municipalities on conventional water resources (Segura River and Tagus-Segura transfer)	- Occasional delays in activating emergency plans due to bureaucratic bottlenecks. - Tensions in applying environmental vs. agricultural priorities during crisis moments.	General: Lack of adequate water infrastructure and technology for monitoring and early warning. Specific: Local problems in the interoperability of water management systems, generating redundancies or inefficiencies.	-Lack of real-time water monitoring systems. -Delays or absence of response in rural/border areas. - Inadequate coordination between meteorological alerts and local implementation.

(D) Deficiency (Policy or governance failures)	National: Lack of coordination between water and territorial policies. Transnational: Fragmentation of water resource governance (watersheds) and territorial political administration (autonomous communities)	- Weak integration of local knowledge or community-based insights. - Limited participation of marginalized or small municipalities in drought planning.	National: Lack of coordination between regional and national policies, affecting sustainable water resource planning. Transnational: Fragmentation of cross-border governance, with weak articulation between Ecuador and Colombia	- Absence of formal drought management plans. - Fragmented governance among GADs, SGR, and INAMHI. - Weak cross-border coordination with Colombia. - No standardized protocols across actors.
(I) Inconsistency (Irregularity or unexpected problem)	Fragmentation: High economic losses in agriculture due to a lack of long-term planning. Innovation: Maintaining the traditional water planning paradigm based on a continuous supply of resources through structural engineering solutions.	- Discrepancies between national forecasts and basin-level triggers. - Competing priorities between water users (e.g., agriculture vs. conservation).	Fragmentation: Disproportionate impact of drought on rural and indigenous communities due to lack of long-term planning. Innovation: Reliance on advanced technological solutions without sufficient focus on social resilience and community engagement.	- Disconnect between technical assessments (SPI) and community-based alerts. - Local knowledge not integrated into institutional frameworks.

6. Conclusion and Recommendations

6.1. Strengthening Institutional Coherence and Adaptive Governance

Enhancing drought resilience requires moving beyond the expansion of formal frameworks toward improving how institutions function in practice. Our comparative analysis shows that governance failures are not primarily due to the absence of policies, but to misalignments between institutional capacity (formal structures) and institutional capability (their implementation). We argue that addressing these "governance glitches" requires context-specific but analytically transferable strategies.

Ecuador: Strengthening Institutional Capability and Multi-level Integration

- Consolidate drought governance frameworks: Move from temporary or reactive instruments toward permanent, operational drought policies with clear triggers and responsibilities.
- Reinforce multi-level integration: Improve alignment between national institutions (e.g., MAATE) and decentralized governments to reduce inconsistencies in implementation.
- Invest in local operational capacity: Strengthen early warning systems, data interpretation, and response mechanisms at provincial and municipal levels.
- Institutionalize knowledge co-production: Integrate scientific monitoring with local and Indigenous knowledge to improve responsiveness and legitimacy in drought management.

Spain (Alicante): Enhancing Operational Flexibility within Consolidated Systems

- Improve cross-scale articulation: Strengthen linkages between river basin authorities and regional/municipal planning systems to reduce implementation delays.
- Increase adaptive flexibility of PES instruments: Complement threshold-based systems with more dynamic, context-sensitive decision rules under prolonged drought conditions.
- Reduce political sensitivity in crisis response: Reinforce the role of technical and scientific advisory bodies to support timely and evidence-based decisions.
- Address sectoral trade-offs explicitly: Incorporate mechanisms to mediate conflicts between agricultural, urban-tourism, and environmental water uses during scarcity.

6.2. Transferable Insights and Comparative Contributions

Beyond case-specific findings, this study contributes to drought governance debates by identifying patterns that extend across different institutional contexts.

First, the distinction between structural and operational governance glitches provides a conceptual tool to diagnose why drought policies fail even in systems with formal planning instruments. While Ecuador illustrates how weak institutional consolidation limits implementation, Spain shows that even advanced governance systems face constraints related to coordination, flexibility, and political pressures.

Second, we show that institutional capacity alone is insufficient. Effective drought governance depends on the ability to translate formal arrangements into coordinated action, highlighting the importance of institutional capability as a complementary dimension.

Third, our findings suggest that drought resilience is shaped by governance processes rather than climatic conditions alone. Similar outcomes -delayed responses, allocation conflicts, and uneven impacts- emerge from very different institutional configurations, pointing to shared governance challenges across contexts.

As recommended, these insights provide a basis for comparative learning while emphasizing that policy transfer must remain sensitive to socio-political and institutional conditions.

6.3. Conclusion

This study demonstrates that drought governance is fundamentally an institutional and political challenge, not only a technical one. By applying the concept of governance "glitches," we show how misalignments between policy design and implementation constrain adaptive capacity in different ways: operationally in Spain and structurally in Ecuador.

We find that resilience does not depend solely on the presence of planning instruments, but on their capacity to function coherently across scales, actors, and decision-making processes. In this sense, bridging the gap between institutional capacity and institutional capability is central to improving drought governance outcomes.

Rather than offering universal solutions, we emphasize the need for context-sensitive yet analytically informed approaches that address the specific sources of governance failure. Future research could build on this framework by examining how governance systems adapt over time and whether institutional disruptions can serve as entry points for learning and transformation in water management.

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