THREE

PRESERVING WATERSHED INTEGRITY FOR PEOPLE AND NATURE: ALIGNING GOVERNANCE WITH HYDROLOGICAL STRUCTURE AND TIME

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Transforming watershed governance

Watershed systems are widely recognized as fundamental units for managing water resources, ecosystems, and human well-being. Watershed governance has therefore long sought greater integration across sectors and scales, most prominently through integrated water resources management. More recent United Nations and United Nations Environment Programme (UNEP) discussions have placed renewed emphasis on the continuity of the full hydrological cycle and on the interconnections among terrestrial, surface-water, groundwater, coastal, and marine systems. These developments point toward a more explicitly full-cycle approach to water governance.[1]

However, persistent challenges remain. Integration across sectors and scales has often proven insufficient in addressing persistent challenges related to water quality, ecosystem degradation, and resource sustainability. A key limitation lies in the misalignment between governance responses and the structural and temporal characteristics of watershed systems. In many basins, governance responses continue to struggle to align interventions with how

1 Global Water Partnership (2000); United Nations Environment Assembly (2024); UNEP (2025).

water systems actually behave. Water quality degradation, sediment accumulation, groundwater depletion, and ecosystem decline often develop gradually over long periods, while governance responses tend to be shaped by shorter-term priorities and administrative boundaries.

A key reason for this gap lies in how watershed systems are understood. Watersheds exhibit a continuum of conditions ranging from retention-dominated to flow-dominated environments, with processes unfolding over varying spatial and temporal scales.[2] While connectivity is widely acknowledged, less attention has been given to differences in system behavior across space and time. As a result, interventions are often designed to address visible problems without fully engaging with the processes that generate them. Consequently, governance responses are frequently shaped by sectoral mandates and short-term considerations, leading to mismatches between intervention and system dynamics.

This chapter argues that improving watershed governance requires a shift in emphasis—from integration as a structural objective to alignment as a dynamic process. Effective governance emerges progressively through iterative, cyclic processes of planning, implementation, monitoring, and adjustment, rather than from predefined integrated designs and institutional arrangements. The perspective developed here draws on several decades of accumulated experience in lake basin management practice, including global case-based learning from diverse lake basins, human resource development, basin-level strategy formulation, and contributions to global water discussions.[3] These experiences demonstrate that improving governance depends on cyclic processes that progressively strengthen key governance functions.

Drawing on the accumulated experience in lake-centered basin management, this chapter introduces a hydro-structural lens for interpreting watershed behavior and aligning governance more effectively with the continuum of retention and flow that characterizes real-world watershed systems. This chapter further suggests that such alignment can be operationalized through a platform process of iterative governance strengthening over time, enabling progressive adaptation across diverse basin contexts.

Building on this perspective, the chapter also points to a practical pathway for implementation, based on iterative, experience-driven processes that enable governance systems to progressively align with basin dynamics. The chapter concludes that maintaining watershed integrity requires governance systems capable of continuous learning and alignment with system behavior, supported by practice-based processes that sustain ecosystem services across interconnected water systems.

Watershed systems as dynamic and heterogeneous

Watersheds exhibit a wide range of conditions, from retention-dominated environments—such as lakes, wetlands, reservoirs, and groundwater-connected systems—to flow-dominated riverine systems. In retention-dominated environments, water, sediment, and pollutants tend to accumulate, often producing delayed system responses. These systems may appear stable over long periods, even as underlying conditions gradually deteriorate. In contrast,

2 Jones et al. (2017).

3 ILEC (2005).

flow-dominated environments tend to transmit impacts more rapidly across space. However, they are often influenced by upstream retention processes that determine the timing and magnitude of downstream effects.

Most basins combine these conditions, forming interconnected systems in which accumulation and propagation processes interact. Observed conditions, therefore, reflect both present influences and accumulated past processes. Understanding this continuum is essential for designing governance responses that align with system behavior.

Temporal mismatch and governance challenges

A defining feature of watershed systems is that many underlying processes unfold gradually and remain only partially observable. By the time impacts become visible, they often reflect long-term cumulative processes.

Governance responses, however, are typically triggered by present conditions. This creates a persistent temporal mismatch: Interventions respond to what is visible now, while system dynamics reflect past influences and continue to evolve. This mismatch becomes particularly pronounced in systems where retention and flow processes interact across space and time.

The conditions observed in this system are not unique. Similar combinations of retention-dominated and flow-dominated components are found in basin systems across continents, ranging from small catchments to large transboundary basins, and across diverse climatic and socioeconomic contexts. In many such systems, governance challenges arise from the same underlying factors: delayed system responses, cumulative impacts, and fragmented sectoral arrangements. The patterns of gradual adjustment observed in the Lake Biwa-Yodo River-Osaka Bay system (see box 3.1) can therefore be understood as representative of a broader class of basin dynamics that remain insufficiently recognized in current water governance practice.

A hydro-structural lens for understanding basin behavior

To interpret these dynamics more systematically, this chapter introduces a hydro-structural lens—a practical way to understand how water behaves under different conditions and how governance can align with these dynamics (see box 3.2). Key dimensions include the degree of retention versus flow, position within the basin, connectivity across system components, level of regulation, and intensity of diversion.

These dimensions influence whether impacts accumulate or propagate, and how governance responses need to be calibrated accordingly.[4]

4 ILEC and RCSE (2014).

BOX 3.1

The Lake Biwa-Yodo River-Osaka Bay system

The Lake Biwa-Yodo River-Osaka Bay system provides a widely cited example of basin management. However, it is often misunderstood as a success achieved through coordinated planning and effective institutional design.

In reality, governance in this system evolved over several decades through a series of fragmented, sector-driven responses to emerging problems.

Early efforts focused on flood control and water resource development. As economic growth accelerated, new challenges emerged, including eutrophication, industrial pollution, and increasing urban water demand. These issues were addressed through separate policy initiatives, infrastructure investments, and regulatory measures, often with limited coordination.

Over time, it became evident that isolated interventions were insufficient. Water quality improvements lagged behind expectations, and downstream impacts persisted. This led to the introduction of additional measures, including lake water quality conservation planning, expanded monitoring systems, and adjustments to institutional arrangements.

Even then, progress was gradual. Improvements in environmental conditions took years to materialize, and in some cases decades. Governance continued to evolve through repeated cycles of planning, implementation, and revision, with different sectors adjusting their roles and interactions over time. This experience highlights that governance alignment is not achieved through a single integrated plan, but through sustained, incremental adjustment under conditions of uncertainty and delayed response.

A key institutional mechanism supporting this process is the Law Concerning Special Measures for Conservation of Lake Water Quality, under which designated lakes are subject to periodically revised conservation plans based on national policy. This long-term process of adjustment later found expression in broader policy developments, including the Basic Act on the Water Cycle, which promotes more coordinated and comprehensive management of water systems at the national level.

SOURCES: Nakamura et al. (2020); Government of Japan (1984); Ministry of the Environment, Japan (2020); Government of Japan (2014).

BOX 3.2

Early recognition of lake basin diversity and its governance implications

An important but often overlooked contribution by Ballatore and Muhandiki (2005), subsequently drawn upon and extended in ILEC and RCSE (2014, Annex 1), described the wide variation in the biophysical characteristics of lake basins and the practical management implications of these differences. Their work helps show why management approaches need to reflect how each basin functions in practice (see table 3.1).

TABLE 3.1.

Linking hydro-structural conditions to governance implications

Hydro-structural condition	Typical system behavior	Governance implications	Key risks if misaligned
Retention-dominated systems (lakes, wetlands, groundwater-connected zones)	Accumulation of nutrients, sediments, pollutants; delayed response; long memory	Long-term monitoring; precautionary policies; sustained investment; cross-sector coordination	Gradual, often unnoticed degradation; difficult and slow recovery
Flow-dominated systems (river channels, steep basins)	Rapid propagation of impacts; short response time	Real-time management; upstream-downstream coordination; early warning systems	Rapid spread of impacts; downstream transfer of problems
Mixed retention-flow systems (most basins)	Interaction of accumulation and propagation; spatial and temporal variability	Integrated but adaptive governance; iterative learning; flexible coordination mechanisms	Misinterpretation of system signals; fragmented responses
Highly regulated systems (dams, diversions)	Altered flow regimes; artificial stabilization or disruption	Strong institutional coordination; rule-based management; periodic reassessment	Overconfidence in control; unintended downstream impacts
Highly connected systems (surface-groundwater-coastal linkages)	Cross-domain interactions; hidden pathways	Cross-sector governance; integrated information systems; shared data platforms	Policy gaps between sectors; invisible system linkages ignored
Heavily utilized systems (urban, agricultural, industrial pressures)	Multiple competing demands; cumulative stress	Allocation mechanisms; stakeholder participation; financial sustainability	Overuse, conflict, and inequitable access

SOURCE: Author's compilation, drawing on Ballatore and Muhandiki (2005) and ILEC and RCSE (2014).

Governance as cyclic strengthening and progressive alignment

The patterns described in the preceding sections are not theoretical abstractions. They reflect accumulated experience from decades of basin management practice, in which governance systems have evolved amid uncertainty, delayed system responses, and sectoral fragmentation.

A central lesson emerging from these experiences is that governance effectiveness develops through iterative processes of planning, implementation, monitoring, and adjustment, as reflected in established lake basin management practice.[5] Through these processes, governance capacity is strengthened over time, allowing responses to become more closely aligned with how basin systems actually behave.

This process is inherently iterative. Interventions are introduced based on partial understanding, their effects are monitored over time, and subsequent adjustments are made as new information becomes available. Through repeated cycles of action and learning, governance systems gradually improve their ability to respond to both visible problems and underlying processes.

Importantly, this evolution is neither linear nor uniform. Different aspects of governance develop at different rates, influenced by institutional constraints, resource availability, and shifting societal priorities. As a result, governance systems often exhibit imbalances, where certain functions are relatively well developed while others remain weak. Addressing these imbalances requires sustained effort over extended periods.

At the same time, governance does not operate within a single unified structure. It is distributed across multiple sectoral systems—such as water supply, agriculture, flood management, and environmental protection—each with its own mandates, decisionmaking processes, and planning cycles. The challenge, therefore, is not only to strengthen governance within individual domains, but also to align these domains in ways that reflect the interconnected nature of basin systems.

ENTRY POINTS AND PROGRESSIVE EXPANSION OF SCOPE

In practice, governance processes rarely begin with a comprehensive understanding of the entire basin system. Instead, they are typically initiated in response to specific problems or sectoral priorities, such as deteriorating water quality, increased flooding risk, or growing demand for water resources.

These initial entry points are necessarily partial. They reflect immediate concerns and available capacities rather than a complete picture of system dynamics. However, they play a crucial role in initiating action.

As interventions are implemented, their limitations become evident. Measures that address one aspect of the system often reveal interactions with other components, such as upstream-downstream linkages, land-water interactions, or competing sectoral demands. These emerging insights prompt adjustments in both understanding and practice.

5 Ibid.

Over time, this leads to a gradual expansion of governance scope. What begins as a localized or sector-specific effort evolves into a broader engagement with the basin system as a whole. This expansion is not planned in advance but emerges through experience, as governance systems respond to the complexity of real-world conditions.

SECTORAL COEVOLUTION AND THE CHALLENGE OF ALIGNMENT

A defining feature of basin governance is its distribution across multiple sectoral systems, each of which evolves according to its own logic. These systems differ in their objectives, institutional structures, regulatory frameworks, and planning cycles.

As a result, governance challenges often arise not from the absence of action but from the misalignment of actions across sectors. For example, measures to increase water supply may conflict with efforts to improve water quality, while land-use changes may undermine flood management strategies.

Alignment among these sectoral systems cannot be imposed through a single coordinating mechanism. Instead, it emerges gradually as sectors adjust their practices in response to shared challenges and evolving understanding of system dynamics.

This process of coevolution is inherently complex. It involves negotiation, learning, and adaptation across institutional boundaries. It also requires mechanisms for communication, information sharing, and joint problem-solving.

Over time, repeated interactions among sectoral systems can lead to more coherent patterns of action. However, this coherence is always provisional, subject to further adjustment as conditions change.

CYCLIC PROCESSES AS THE CORE MECHANISM OF GOVERNANCE IMPROVEMENT

The gradual alignment of governance with basin dynamics is enabled by cyclic processes that link planning, implementation, monitoring, and revision.

These cycles provide a structured yet flexible framework for managing uncertainty. They allow governance systems to act based on available knowledge, assess the outcomes of interventions, and incorporate new information into subsequent decisions.

Crucially, cyclic processes enable governance systems to engage with delayed and cumulative system responses. Because the effects of interventions may take years or even decades to become fully apparent, a one-time approach to planning is insufficient. Continuous monitoring and periodic reassessment are essential for adjusting strategies in light of emerging evidence.

Over extended periods, these cycles strengthen governance capacity. Weaknesses in institutional arrangements, information systems, technical measures, or financial mechanisms can be identified and progressively addressed. This leads to a more balanced and resilient governance structure.

At the same time, cyclic processes provide a means of coordinating across sectoral systems that operate on different temporal rhythms. By creating opportunities for periodic reflection and adjustment, they help align actions across different domains, even when those domains are governed by distinct institutional cycles.

Moving forward: From fragmented efforts to structured learning processes

The implications of the above analysis are practical and immediate. The key issue facing many basin systems is not the absence of governance frameworks, but the difficulty of making them function effectively under real-world conditions characterized by uncertainty, limited information, and institutional fragmentation.

In this context, progress does not require the creation of entirely new structures. Instead, it can begin from existing governance arrangements, however partial or fragmented they may be.

Entry points may include ongoing sectoral programs, established monitoring systems, or specific water bodies where problems are most visible. These entry points provide opportunities to initiate cyclic processes of action and learning.

What is required is the deliberate strengthening of these processes so that they can:

- Link actions to system understanding.
- Incorporate monitoring and feedback.
- Support periodic reassessment and adjustment.

Over time, this approach enables governance systems to move beyond isolated interventions toward more coherent and adaptive patterns of action.

Importantly, this process also provides a means of bridging differences among sectoral systems. By creating shared reference points—such as monitoring results, observed system responses, and agreed-upon objectives—it becomes possible to align actions across domains without requiring full institutional integration.

In this way, governance evolves not through structural redesign, but through the accumulation of experience and the gradual alignment of practices.

Implications for global application and emerging challenges

The conditions described in this chapter are widely observed across basin systems, consistent with global assessments showing widespread pressures on lakes and their basins.[6]

In many of these systems, retention-dominated environments play a central role in sustaining ecosystem functions and human livelihoods. At the same time, they are particularly vulnerable to cumulative degradation, with impacts that may extend across entire basin systems.

6 UNEP-DHI Centre and UNEP (2016).

Despite their importance, these dynamics remain insufficiently reflected in current water governance approaches. Recent global discussions, including the U.N. 2023 Water Conference, have called for stronger integrated water resources management, cross-sectoral planning, and governance addressing the whole hydrological cycle.[7] The perspective developed here complements these discussions by bringing the structural and temporal characteristics that shape the behavior of particular basin systems more explicitly into view. Yet, lakes and reservoirs remain insufficiently recognized despite their central role in water security and climate resilience.[8]

Consequently, a significant gap persists between the realities experienced in basin systems and the frameworks intended to guide their management.

This gap is especially consequential in many low-income and water-dependent settings, where livelihoods rely heavily on water but effective governance frameworks and institutional capacity are often limited.[9] In such contexts, the challenge is not only to improve coordination but also to build the capacity for sustained, adaptive management.

Addressing this challenge requires mobilizing both local and global capacities. Locally grounded processes of learning and adaptation must be supported by broader efforts to share knowledge, develop human resources, and strengthen institutional frameworks.

The perspective presented in this chapter suggests that such efforts can be guided by a focus on cyclic processes of governance improvement and alignment with system behavior. By grounding action in observed realities and progressively expanding understanding, it becomes possible to bridge the gap between global aspirations—particularly the emphasis on integrated water resources management [Sustainable Development Goal (SDG) 6.5] and the protection and restoration of water-related ecosystems (SDG 6.6)—and local conditions.[10]

TOWARD A GLOBAL PLATFORM PROCESS FOR PROGRESSIVE BASIN GOVERNANCE

While the preceding discussion highlights structural and temporal challenges in basin governance, it also points toward a practical pathway for addressing them. The experience accumulated across diverse basin systems suggests that governance improvement does not emerge from the adoption of any single comprehensive framework, but from the gradual strengthening of governance functions through structured, iterative processes.

Over several decades, practice-based efforts in lake and basin management have demonstrated the value of what may be described as a platform process—a sustained, cyclic approach that brings together policy development, institutional coordination, stakeholder engagement, knowledge generation, technological application, and financial mechanisms within a shared process of learning and adjustment.[11]

7 United Nations (2023).
8 Global Water Partnership (2000); Hirji and Duda (2025).
9 UNESCO World Water Assessment Programme (2024); UNEP and UN-Water (2024).
10 United Nations (2015).
11 ILEC (2007); ILEC and RCSE (2014).

Such a process typically evolves through repeated cycles of:

- Diagnosing system conditions and governance gaps.
- Formulating and implementing response measures.
- Monitoring system behavior and intervention outcomes.
- Periodically revising strategies based on accumulated experience.

Importantly, this process does not require fully integrated institutional arrangements at the outset. It can begin within existing sectoral structures and progressively expand in scope and coherence as understanding deepens and coordination improves. In this sense, the platform process provides a practical mechanism for aligning governance with the structural and temporal characteristics of basin systems over time.

The relevance of this approach extends beyond individual basins. The challenges described in this chapter—delayed system responses, cumulative impacts, and fragmentation across sectors and scales—are widely observed across regions. They are particularly pronounced in systems where retention-dominated components such as lakes, wetlands, and reservoirs play a central role, yet remain insufficiently recognized in prevailing governance approaches.

Current United Nations discussions on accelerating progress toward SDG 6 and shaping the post-2030 agenda increasingly emphasize systemwide coordination and attention to the full hydrological cycle.[12] However, translating these directions into effective basin-level practice remains a major challenge.

The platform process described above offers a way to operationalize these aspirations. By grounding governance in iterative cycles of action and learning, and by linking sectoral efforts through shared processes rather than predefined structures, it provides a means of:

- Progressively strengthening governance capacity.
- Aligning interventions with system behavior.
- Bridging the gap between global policy aspirations and local realities.

At a global scale, this suggests the need to promote and support such platform processes across basin systems, with attention to the diversity of hydro-structural conditions and socio-institutional contexts. This does not imply replicating a single model but rather adapting a common process framework to different settings.

Key elements of such global promotion may include:

- Development of practice-oriented guidance based on accumulated experience.
- Strengthening of human and institutional capacity for iterative governance.
- Mechanisms for knowledge exchange and comparative learning across basins.
- Sustained support for long-term monitoring and evaluation.

Through such efforts, it becomes possible to move beyond episodic interventions toward continuous governance processes that sustain watershed integrity over time.

12 United Nations System Chief Executives Board for Coordination (2024); UNEP (2025).

From recognition to sustained governance practice

The analysis presented in this chapter points to a fundamental challenge in watershed governance: the persistent misalignment between basin system behavior and the design and implementation of governance responses.

Watershed systems are shaped by the interplay of retention and flow processes that operate across space and time. In many cases, particularly in retention-dominated environments, system changes occur gradually and remain only partially visible until they reach advanced stages. Once such conditions emerge, recovery is often difficult and prolonged, and impacts may extend beyond the immediate area to affect downstream and connected systems.

These characteristics imply that governance cannot rely on episodic interventions or one-time planning efforts. Instead, it must be understood as a sustained process of adjustment, capable of responding to delayed system behavior and evolving conditions.

Experience accumulated over several decades of basin management practice demonstrates that such adjustment is possible through cyclic processes that link planning, implementation, monitoring, and revision. Through these cycles, governance capacity is progressively strengthened, enabling more effective responses to both visible problems and underlying system dynamics.

A critical aspect of this process is the gradual strengthening and alignment of key governance functions—policy, institutions, participation, technology, information, and finance—across multiple sectoral domains. Because these functions evolve under different institutional conditions and temporal rhythms, alignment cannot be achieved through a single coordinating framework. It must emerge through sustained interaction, learning, and adaptation over time.

At the same time, it is important to recognize that retention-dominated components of basin systems are not only vulnerable but also central to sustaining ecosystem services that support human well-being and ecological stability. Governance that focuses solely on mitigating problems risks overlooking these broader values. By linking governance processes to ecosystem service outcomes, it becomes possible to move beyond reactive responses toward the sustained realization of system potential.

The experience reflected in the Lake Biwa-Yodo River-Osaka Bay system and insights from earlier efforts to understand basin diversity indicate that these patterns are not exceptional. They are widely observed across basin systems of different scales and contexts. This suggests that the challenges identified in this chapter are not isolated but rather represent a broader, insufficiently addressed dimension of global water governance.

Addressing these challenges requires not only refining existing frameworks, but also actively promoting sustained, platform-based processes of governance strengthening that enable continuous alignment with basin system behavior. It calls for strengthening governance as a practice—grounded in real system behavior, supported by cyclic learning processes, and capable of evolving over extended periods.

In many parts of the world, particularly where livelihoods and ecosystems depend directly on water systems, the need for such governance capacity is urgent. Bridging the gap between global aspirations and local realities will

depend on the ability to develop and sustain these processes across diverse contexts, with support from global efforts to promote shared learning and capacity development.

By focusing on alignment with hydrological structure and time, and by building on accumulated practice, watershed governance can move beyond recognition toward sustained and adaptive action—supporting both the protection and the long-term realization of the values embedded in interconnected water systems.

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