

Water for Climate Adaptation: Assessing Policy Integration and Evaluating Implementation in Malaysia

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Abstract

Policy integration is fundamental for effective adaptation, and water is the primary medium through which climate change impacts are experienced. However, integration of adaptation into water governance remains limited and fragmented. Malaysia's move to integrate adaptation is further challenged by institutional fragmentation, costly dependence on infrastructure measures, and the absence of a mechanism to track finance. This highlights the paradigm divide between adaptation, typically framed as a flexible iterative process that is focused on resilience, and the hydraulic-utility logic in water governance, which is too focused on control and predictability and reliant on structural solutions.

This study explores the extent of adaptation integration into the climate and water policy frameworks in Malaysia and expands the scholarship by applying the interpretive lens of policy paradigms to assess how institutional logics and policy paradigms shape integration outcomes.

Preliminary analysis suggests policies are evolving, but integration is uneven across governance levels. This points to an emerging 'Adaptation Divide': policies have increasingly framed adaptation in iterative and risk-based logic but are not supported by robust mechanisms for standards, finance, and monitoring.

Keywords: Climate Adaptation, Water Governance, Policy Integration, Malaysia, Flood Management, Sea Level Rise, Multilevel Governance, Climate Policy Integration

1. Introduction

Recent development suggests that water is increasingly recognised as central to adaptation. The Sharm El Sheikh Implementation Plan acknowledges water as a thematic priority and emphasises addressing water-related vulnerabilities to increase climate resilience (UNFCCC, 2024). This follows the findings that water-related hazards account for the majority of adaptation interventions globally (IPCC, 2022; Shyamala et

al. (2025). For adaptation, addressing the root causes of water insecurity and ensuring sustainable resource management would increase immediate and long-term climate resilience (Rockström et al., 2023).

Water governance is central in climate change adaptation. Addressing challenges in water governance would also address broader social and environmental issues, particularly in drier regions where water scarcity disproportionately impacts vulnerable populations (Rodina, 2018). However, water also presents a dual paradox that governance has to manage. High endowment or abundance of water does not necessarily guarantee security when existing challenges such governance, safety and accessibility continue to persist, especially in developing countries like Malaysia (IPCC, 2022, p.562).

Malaysia, one the wettest country in the world, is an example of the paradox of water challenges where flood, water stress and pollution still exist despite abundance of water. These challenges suggest the water governance, rather than lack of resources, is the core of the adaptation issue, as argued by Pahl-Wostl (2009).

Water governance adopts an integrative lens through the Integrated Water Resource Management (IWRM) concept, which aligns water management with sustainable development and climate change adaptation (Giupponi & Gain, 2017; Meran et al., 2021). IWRM encourages cross-sectoral alignment with other policy frameworks such as environment, agriculture, energy, and public health (Capon et al., 2018). A paradigm shift was proposed by Rockström et al (2023) to position of water as a common good (Rockström et al., 2023).

Globally, climate discourse highlighted that policy integration is as key for effective adaptation across sectors and governance levels (Adelle & Russel, 2013; Biesbroek, 2021). In Malaysia, water is one of the key sectors of adaptation within its climate policy framework and its climate obligation, Nationally Determined Contributions (Alves & Filho, 2020, Pereira & Zain, 2022).

While these global frameworks have advanced the discourse of water's centrality in adaptation, both adaptation and water are based on two distinct paradigms. For adaptation, seminal work by Smit et al (2001) and Smit & Pilisofova (2001) framed adaptation as systems adjustment, which requires flexibility to respond to climate stimuli (Smit et al, 2001; Smit & Pilisofova, 2001). In contrast, water governance requires a system approach to ensure optimisation of resources in which little flexibility can be tolerated (Biswas, 2004; Pahl-Wostl, 2009).

This difference creates a paradigm divide: adaptation seeks to manage uncertainty, while water governance seeks to eliminate it (Walker et al., 2013; Pahl-Wostl, 2017; Jordan et al., 2022). Evidently, both adaptation and water governance have different institutional logics and policy paradigms that shape integration outcomes as argued by Gordon (2024) and Kennelly et al (2024).

Different policy paradigms could result in a policy tension where they may have similar aim but remains limited and fragmented as highlighted in recent studies in Asia by

Michalak & Szyja (2024) and comparative governance reviews by Benson & Rouillard (2024) (Michalak & Szyja, 2024; Putra, 2024; Benson & Rouillard, 2024).

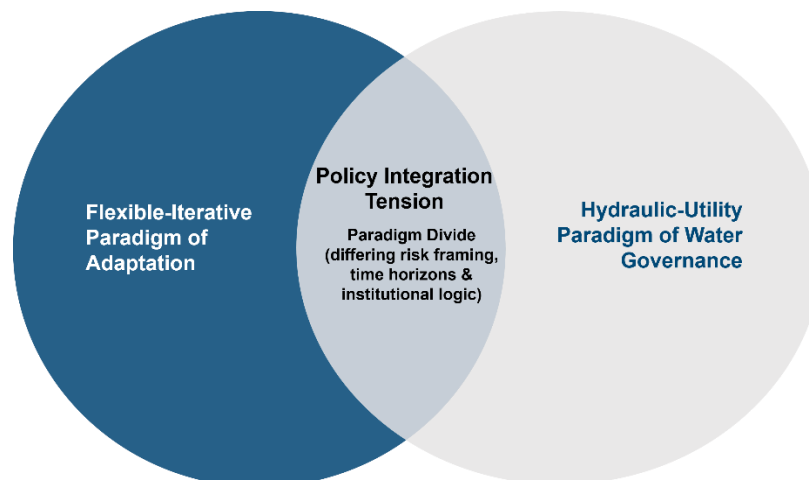
The Policy Challenges for Climate-Water Nexus

Although climate adaptation and water governance intersect in obvious ways, they are rooted in fundamentally different paradigms: adaptation seeks to manage uncertainty, while water governance seeks to eliminate it. The result is a policy tension that limits the depth of integration between climate and water policies or a *paradigm divide*: The deep paradigm divide adds another layer to the challenges of adaptation.

Adaptation measures may be reframed as conventional water projects (e.g., flood mitigation projects) rather than systemic climate responses. Conversely, water institutions may resist adaptation strategies that require operational flexibility, stakeholder participation, or redistribution of decision authority. The theoretical divergence of adaptation is illustrated in **Figure 1**. This mismatch creates a policy integration tension:

- i) Risk framing: Adaptation sees climate impacts as evolving systemic conditions; water governance tends to frame them as hazards that are discrete, predictable events;
- ii) Time horizons: Adaptation prioritises iterative long-term planning; water governance often works in fixed investment cycles tied to infrastructure lifespans; and
- iii) Institutional logic: Adaptation calls for cross-sectoral, multi-level coordination; water governance operates within entrenched jurisdictional and sectoral silos.

Figure 1 the policy integration tension contributed by the paradigm divide of adaptation and water governance



In water-scarce contexts, water security has often focused on allocation of scarce resource under changing climatic conditions. However, in water-abundant contexts, the governance challenges are centred around managing excess, variability, and quality. The dominant hydraulic-utility paradigm is reinforced by decades of utility provision,

flood management infrastructure engineering and coastal defence investment, thus creating strong institutional path dependencies. This makes it harder to introduce adaptation principles that view water abundance itself as a driver of vulnerability, a framing rarely embedded in climate discourse.

In Malaysia, the paradigm divide manifests in the dominance of structural flood and coastal defence measures, with adaptation planning frequently conflated with hazard mitigation. This results in “formal alignment”, where adaptation is referenced in water policy frameworks without “substantive integration” that translates into implementation mandates, decision criteria, or accountability systems.

Bridging this divide requires more than aligning terminologies and semantics. It demands a reframing of governance to incorporate the adaptation principles, such as flexibility in infrastructure design, introducing nature-based solutions, anticipatory planning to manage long term risks, and governance mechanisms that can operate under uncertainties and ambiguities. Similarly, it also requires adaptation strategies to recognise the water governance realities and acknowledge existing path dependencies. Without this paradigm shift, Malaysia risks maintaining policy integration that exists only on paper but remain disconnected in practice.

The adaptation paradigm emphasis on flexibility-iterative logic is difficult to harmonise with the water governance hydraulic-utility thinking to achieve stability and control. This divergence is not merely theoretical; it shapes how policies are framed, implemented, and integrated in practice shown in **Table 2**.

Table 1 shows the differences in the climate adaptation and water governance paradigms

Dimensions	Water Governance	Climate Adaptation
Primary Objective	Secure reliable water supply and control variability	Reduce vulnerability and enhance resilience to uncertain climate risks
Approach to Risk	Seeks to eliminate uncertainty through engineering	Accepts uncertainty, emphasises iterative learning
Planning Horizon	Long-term fixed investments with infrequent revision	Dynamic, multi-scalar, often revisited
Governance Mode	Predictive/Control	Responsive, flexible
Preferred Interventions	Hard infrastructure, physical control systems	Soft measures, nature-based solutions, governance reforms

Adaptation Integration in Malaysia

As one of the few countries in the world that have abundant rainfall, Malaysia's water cycle has been altered due to climate change. By the end of the century, the country will experience increase in temperature between 1.7°C to 2.1°C and precipitation increase between 14.8% to 25.4% (NRES, 2024, p.5 & 7). The feature of high rainfall and the physical vulnerability to climate change have shaped its adaptation measures,



especially in managing flood. It is reported that 144 out of 191 river basins in Malaysia are prone to flooding, significantly impacting its Peninsula (NRES, 2024, p.91-214). More areas are expected to experience flooding, with an increase of 18.2% in Peninsular Malaysia, Sabah for 5.2% and Sarawak for 3.5% respectively by the end of the century (NRES, 2024, p.91-214).

Responding to the scale of damages from flood and cascading socio-economic impacts is enormous and requires significant amount of infrastructure investment (Chan 1997, Chan, 2012). The December 2021 flood alone caused RM6.5 billion in damages, contributing to an estimated 46% GDP loss relative to the 2019 level (Yin, 2022; DOSM, 2022; IFRC, 2022, BNM & WB, 2024). Long-term projection also estimates climate-related damages could cost almost RM5.5 billion from 2010 to 2110 (Ahmed et al., 2019). The expenditure amount and the degree of loss suggest how reliant Malaysia is in infrastructure intervention and this has shaped the adaptation pathway as argued by Chan (1997) and Chan (2012).

Managing variability of water resources and mitigating these damages elevate the centrality of water in existing national frameworks. Compliance reducing threats to water security has prompted water governance to respond to the need of integrating adaptation in its policy framework. Yet, this integration often stops at policy alignment, without substantive adoption in planning frameworks, decision-making criteria, or implementation mandates. The climate policy driven by the focus on mitigation over the years has long sidelined the need for adaptation integration across sectors and governance levels (Pereira & Zain, 2022; KRI, 2022, KRI, 2024, UNEP, 2023). Adaptation is frequently framed with scaling up structural defences, reinforcing the hydraulic-utility paradigm and sidelining adaptation's flexibility-oriented orientation. This suggests that the *paradigm divide* may contribute to water's ability to fully adopt adaptation's more flexible and iterative process.

2. Objectives

This paper aims to:

- 2.1. Assess the extent of adaptation integration across the dimensions of normative, procedural, normative and outcome-based dimensions in Malaysia.
 - 2.2. Analyse how policy paradigms contribute to the lack integration within governance.
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3. Methodology

The qualitative study utilised the Climate Policy Integration (CPI) as analytical foundation and expands the concept of policy paradigms as an interpretive lens. This was carried out through:

- 3.1. Policy and document analysis (national and state-level climate and water policies)
 - 3.2. Case study in Selangor to explore to contrast governance dynamics in a multilevel governance.
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4. Findings

Policy Integration

Preliminary findings suggest that adaptation integration is highest in the normative and procedural dimensions and lowest in instrumental and outcome-oriented dimensions across climate and water policy framework.

Climate policies have progressively strengthened the normative and procedural dimensions in more recent National Policy on Climate Change 2.0 (2024). It has improved the policy framing for adaptation with clearer institutional arrangements and financing mobilisation. However, instrumental elements remain weak with absence of standards and failure to address vertical alignment across governance levels. This echoes findings from Gupta & Pahl-Wostl (2022), who stress that transformative water governance requires systemic institutional reforms, not just technical adjustments (Gupta & Pahl-Wostl, 2022). Similar governance gaps are also reported elsewhere (Arndt & Heiland, 2025; Shams, 2024).

The Selangor Climate Change Policy 2024 represents the agency of sub-national governance to formally mainstream climate change. A significant policy measure is through the establishment of the Selangor Climate Change Adaptation Centre (SCAC) in early 2025 (UPEN, 2024). DPINS 2024 has a clear cross-sectoral intent and coordination commitments, where presence of adaptation integration and risk-based planning increases its normative framing. However, the policy scores lower in procedural and outcome-based dimensions, lacking mandate standards and finance conditionality and vertical alignment with local level. This indicates that integration remains a formal integration in the subnational policy framework, with constraints due to limited authority and top-down implementation.

The water governance has made progress over the years in initiating adaptation integration within its policy framework, that are supported by sectoral technical guidance. Although normative integration is present in the Water Resources Policy (2012), but it has limited substantive procedural, instrumental, and outcome elements. This emphasises that collaborative water management does not necessarily translate into mandates, standards, finance conditionalities, or vertical conformity.

Sectoral technical documents are confined as guidance and reflects the deep hydraulic-utility paradigm that relies on technical fixes and infrastructure reliability. Adoption of towards resilience-iterative nature of adaptation is challenging without improvement in procedural, instrumental and outcome-based dimensions. It further hinders integration of adaptation within the already fragmented water governance.

The challenge of water governance is reflected in low vertical alignment. For Selangor, the absence of water resources policy shaped its reliance on strong state legal authority and regulation mechanisms under the Selangor Water Management Authority (LUAS). The state water enactments are not explicit with adaptation principles, risk-based planning, or integration with climate governance, hence scoring very low for normative, instrument and outcome-oriented elements. The enactments were designed for



resource regulation and enforcements for water security rather than adaptation integration.

Paradigm Divide

The paradigm divide analysis highlights the dominance of hydraulic-utility logic across the climate and water policy documents in Malaysia.

This analysis also shows that climate recent policies indicate a paradigm shift towards risk-based and iterative approaches compared to earlier policy documents. However, only the subnational policy has shown leaning towards the flexibility-iterative logic.

The finding also shows that water governance is dominated by hydraulic-utility paradigm, especially at state level. The Selangor water enactments demonstrate total absence for flexibility-iterative logic where its regulatory and enforcement nature is anchored fully for water security.

Case Reflections on Flood and Sea Level Rise

Flood management in Malaysia has been critiqued as reactive post-disaster response, significantly dominated by infrastructure interventions (Chan, 2012; Rosmadi et al, 2023; KRI, 2024). Over reliance on physical infrastructure reflect a continued preference for structural measures, despite the high costs (Chan, 1997, p.81; Chan, 2012, p.523; NRE, 2015; Rosmadi et al, 2023).

Engineering measures driven by hydraulic-utility thinking shapes policy responses so far: large scale projects like the SMART Tunnel, river straightening and diversions (Biswas, 2004; Rosmadi et al., 2023; Ishiwatari et al., 2023; Van Dyke et al., 2025). Similar critiques are found in Rosmadi et al (2023) on Malaysia's flood governance, while Van Dyke et al (2025) document how utilities globally are adopting adaptive, flexible infrastructure strategies (Rosmadi et al, 2023; Van Dyke et al, 2025). This is designed to avert hazards than adapting to systemic uncertainty. The flexibility-iterative approaches are continually dismissed as flood management is framed as hazard control.

Increasing impacts of rising sea levels are often overlooked as it is slow onset. However, the impacts are already felt through increasing extreme climate events, especially coastal erosion and flooding. Projections indicate a rise of 0.22 to 0.25 meters by 2050 and 0.69 to 0.73 meters by 2100 (NRES, 2024). By the end of the century, up to 9,295 km² of coastal areas could be inundated (NRES, 2024). This has direct impact to 60% of Malaysia's population currently living in coastal areas (Ehsan et al., 2019).

Similar to flood management, managing sea level rise requires costly investment as it is dependent on coastal infrastructure pathway, with estimates up to 12% of GDP by 2050 (ADB, 2017). This places Malaysia among the top 15 countries with high national adaptation costs. Another assessment estimated Malaysia would require USD 5.75 billion in additional economic costs for sea level rise by 2030 (Sarkar et al., 2014).

Sea level rise responses similarly remain locked in the dominant infrastructure focused coastal defences over systemic, long term adaptation strategies that incorporate nature-based solutions. CPI analysis highlights that this is due to weak outcome-based integration, with the absence of systemic monitoring or iterative learning mechanisms to guide long-term adaptation and adjusted pathways under deep uncertainties.

Both flood and coastal management face similar governance challenges (Mokhtar & Aziz, 2003). Fragmented governance is contributed by the division between national and subnational powers with similar challenges noted in other studies related to water governance (Mokhtar & Aziz, 2003; Chaiyapa et al, 2024; Abdillah et al., 2025; Krantzberg et al, 2025).

Earlier climate policy was unable to integrate adaptation and provide the instruments to guide implementation, hence the reactive, project driven flood management. The December 2021 flood was a testament that the breach in limits of adaptation requires vertical alignment with subnational and local level to address vulnerabilities.

Limited integration of adaptation within water policies also discouraged the adoption of non-structural measures. Without instrumental binding mandates, transforming flood and coastal management will be challenging. The dominance of hydraulic-utility paradigm in water governance may contribute to:

- i) continued reactive short-term interventions over long-term planning for resilience;
- ii) existing institutional logic and weak policy integration could not overcome the fragmentation in existing governance; and
- iii) lessons from past flood events could not be utilised to improve procedures and instruments as a result of the absence of outcome-oriented in policies.

These reflections highlight findings from the CPI analysis that weak procedural and instrumental adaptation integration discourages alignment across sectors and governance levels. It would leave adaptation to be conceptualised as managing hazards through infrastructure, instead of systemic conditions that require long-term cross sectoral planning.

The disconnect is clear: while climate policies reference flexibility and iteration, water governance remains locked in a regulatory mode that privileges infrastructure and resource stability. This duality reflects the broader paradigm divide identified in this study.

Discussion

Combining CPI and the paradigm analysis shown that policies are evolving but trapped on normative and procedural dimensions with limited instruments and outcome to encourage deeper integration across climate-water policies. This shows that policies have increasingly framed adaptation in iterative and risk-based logic but not supported by robust mechanisms for standards, finance and monitoring.

The assessment demonstrates that water governance in Malaysia is locked in hydraulic-utility thinking, a dynamic also highlighted by Rosso (2025) in Southeast Asia, and

consistent with global evidence on the need for socio-ecological integration in nature-based adaptation argued by Rosso (2025) and Locatelli et al (2025) (Locatelli et al, 2025; Rosso, 2025). It limits adaptation to be acknowledged in policy documents but guided by the command-and-control approach. Based on this, the dominant regulatory and infrastructure logic will continue to sideline the flexibility and iterative adaptive requirements. It can be concluded that integration is formal and not substantive as argued by Adelle & Russel (2013), Runhaar et al (2020) and Rosso (2025).

It also highlights that paradigm divide exists where the element of flexibility is marginalised in water governance. Policy documents embraced adaptation elements but the mechanisms for integration are non-existent in the context of Malaysia. The institutional resistance in water governance impedes transformational change required for further integration. This will further be discussed in flood management and responses to sea level rise.

To interpret the CPI results, the Malaysia's adaptation policy paradigm is contrasted against the water governance paradigm. Table 5 summarises the key dimensions of this divide and the implications for integration:

Dimension	Adaptation Paradigm Flexibility-Iterative	Water Governance Paradigm Hydraulic– Utility	Implications for Policy Integration in Malaysia
Core Objective	Build resilience and reduce systemic vulnerability	Ensure stability and service reliability	Climate policies (NPCC 2.0, DPINS) frame resilience; water statutes (e.g. LUAS) emphasise control and regulation without adaptation duties.
Planning Approach	Iterative, flexible, responsive to new risks	Fixed design life, based on past hydrology	Misaligned cycles: climate side pushes iterative planning; water planning is rigid and infrastructure bound.
Risk Framing	Risks as systemic, uncertain, cross-sectoral	Risks as discrete hazards, manageable by control	Climate policy language diluted into hazard-specific water projects; integration remains formal, not substantive.
Decision-making Norms	Inclusive, multi-stakeholder, adaptive learning	Technocratic, centralised, engineering-led	DPINS attempts inclusion; LUAS enactments remain top-down.
Intervention Approaches	Mixed approaches incl. NbS, social measures	Structural infrastructure and regulation	NbS referenced in climate frameworks, but no binding rules in water law; infra bias dominates.
Institutional Logic	Cross-sectoral integration, shared responsibility	Sectoral mandates, jurisdictional boundaries	NPCC 2.0 promotes coordination; water governance fragmented and regulatory split federal–state

Dimension	Adaptation Paradigm Flexibility-Iterative	Water Governance Paradigm Hydraulic– Utility	Implications for Policy Integration in Malaysia
Monitoring & Evaluation	Feedback loops, iterative review	Compliance-based service and infrastructure metrics	Climate lacks binding M&E; water focuses on service indicators → no adaptive learning.

Source: Author's analysis, based on CPI-paradigm coding of national and state policies.

5. Subnational action: Selangor's strategies to bridge the adaptation divide

Selangor provides an important case study for examining the governance challenges of adaptation in Malaysia. As the country's most industrialised state and a hub for logistics, trade, and manufacturing, Selangor contributes nearly a quarter of Malaysia's GDP and the most populous state in Malaysia (DOSM, 2022). Yet it faces increasing climate risks, including 79 identified flood hotspots and five coastal districts exposed to sea level rise.

Recent policy efforts, such as the Selangor Climate Change Policy (DPINS 2024), represent a significant step forward in mainstreaming adaptation at the state level (UPEN Selangor, 2024). These measures include:

- i) Policy development: Selangor is the first state to develop its own climate change policy, with provisions for iterative review and learning.
- ii) Climate governance restructuring: The Selangor Climate Action Council has been restructured under the leadership of the Chief Minister to strengthen cross-sectoral coordination.
- iii) Institutionalisation: The establishment of the Selangor Climate Adaptation Centre (SCAC) in 2025 provides a focal point for adaptation knowledge and action.
- iv) State–local alignment: Efforts are underway to integrate climate policy into local government planning processes, empowering municipalities to implement adaptation priorities.
- v) Framework development: Work on a Selangor Adaptation Framework aims to adopt cyclical planning approaches for long-term, risk-based adaptation.

Despite these measures, Selangor still faces governance barriers. The state water enactments, which regulate water resources, has not embed adaptation principles, risk-based planning and integration is still weak. The absence constrains alignment between state climate ambition and water sector implementation. In practice, adaptation efforts remain shaped by fragmented policy paradigms and an over-reliance on structural flood defences.



Selangor thus illustrates the Adaptation Divide: national and state climate policies increasingly articulate flexibility and resilience but deep rooted hydraulic-utility logics in water governance continue to prioritise stability, regulation, and infrastructure dependent. Bridging this divide will require not only stronger policy frameworks but also binding standards, financial mechanisms, and empowered local institutions to deliver substantive adaptation outcomes.

6. Conclusion

Malaysia's adaptation response remains inadequate in addressing systemic climate-water risks. Fragmented governance, short-term planning, and lack of stakeholder engagement undermine resilience efforts.

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