

Beyond hazards and sectors: governing systemic climate risks

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Summary

This report explores how, and to what degree, adaptation policies and governance arrangements are beginning to acknowledge and respond to the systemic nature of climate change – where risks are interconnected across hazards, sectors, scales and borders, and where deep uncertainty, tail risks, tipping points, and distributional outcomes can shape resilience. The report uses an exploratory comparative analysis of adaptation governance across selected countries and US states to examine both the recognition of systemic risks (i.e. how these are framed in strategies and assessments), and how systemic thinking is put into action (i.e. the extent to which it is embedded in mandates and funding streams, and in appraisal, monitoring, and accountability). Evidence is drawn from a desk-based review of regional, national and subnational strategies and closely related resilience frameworks; a short expert survey covering multiple regions; and semi-structured interviews with adaptation coordinators and policy specialists across levels of governance.

The findings suggest a recurring implementation gap: while the language of systemic risk is increasingly visible in plans and assessments, the routines that shape day-to-day decisions remain largely organized around specific hazards and sectors. The analysis also highlights a policy-coherence challenge: adaptation is frequently pursued alongside competing objectives, yet mechanisms to identify trade-offs, capture co-benefits, and resolve conflicts across portfolios are often weak – creating risks of maladaptation and missed resilience gains.

Across the reviewed cases, progress is most evident where a) cross-sector coordination is institutionally resourced and politically supported, b) data and analytical capacity are aligned with decision needs, and c) incentives reward prevention and long-term resilience rather than short-term recovery. The report concludes by proposing an initial conceptual framework structured around three pillars: systemic risk framing, policy interlinkages, and managing deep uncertainty. These pillars are supported by principles and criteria that can be used to selectively stress-test plans, investments or reforms for systemic effects, including interdependencies, trade-offs, maladaptation risks and distributional consequences.

Key messages

- Adaptation policies increasingly *talk* about interconnected and systemic climate risks, but far fewer *act* on them through mandates, budgets, appraisal rules, delivery systems, and accountability.
- In the reviewed cases, the main implementation gap is not a lack of recognition of climate risk, but weak operational routines that still default to hazard- and sector-based approaches.
- Systemic climate risks emerge through interactions between sectors, infrastructure networks, ecosystems, and social vulnerabilities – meaning progress in one area can unintentionally create risks elsewhere.
- Managing deep uncertainty may call for moving beyond “predict-then-act” planning towards iterative approaches that remain robust across a range of futures, including tail risks and non-linear change – a lesson suggested by the cases examined in this report.
- Policy coherence remains a bottleneck: competing objectives across portfolios are often left unresolved, and co-benefits are frequently neglected because coordination and incentives are not designed to capture them.
- Climate risks may be shaped more by “non-climate” policies that amplify exposure and vulnerability – such as land use, infrastructure standards, fiscal rules and public procurement – than by adaptation strategies and policies that seek to reduce them.
- In cases where systemic approaches are advancing, they tend to be supported by cross-sector coordination that is adequately resourced, decision-relevant risk information, and incentives that reward prevention and long-term resilience rather than short-term recovery.
- The cases examined in this report reinforce well-established insights that without explicit attention to distributional outcomes, adaptation can shift risks onto marginalized groups, reinforce existing inequalities, or generate maladaptation.
- The evidence base and literature informing systemic adaptation is geographically uneven. The findings should therefore be treated as illustrative, and the proposed framework used as adaptable scaffolding to inform future research rather than a universally transferable model.
- The proposed framework can support selective stress-testing of plans, investments, or reforms by helping to identify interdependencies, trade-offs, co-benefits, and potential risk shifting before decisions are locked in.

Intended audience

This report is written for policymakers and practitioners responsible for designing, coordinating, financing, and implementing adaptation across levels of governance. It is particularly relevant for central/national coordinating bodies and finance functions, sector ministries and regulators (e.g. infrastructure, health, energy, water, agriculture, land use), and subnational and local authorities managing planning and service delivery. It will also be useful to civil protection and disaster risk management agencies, climate advisory bodies, and analysts supporting risk assessments and investment appraisal. Researchers and development partners may use it as a structured synthesis of emerging practice and gaps in systemic adaptation governance, helping to organize future inquiry and research priorities. The case examples are illustrative and should be read as vignettes, not as representative evidence.

1. Background

Climate change poses systemic risks to societies, economies, and ecosystems because impacts rarely remain confined to single hazards, sectors, or jurisdictions. As warming intensifies, risks increasingly arise through interacting hazards and interdependent systems, producing consequences that cannot be adequately understood through traditional assessments focused on isolated, spatially bounded impacts (EEA, 2024; IPCC, 2023b, 2023a; USGCRP, 2023).

This complexity is compounded by deep uncertainty around low-probability but high-impact “tail risks” and the possibility of crossing climatic and ecological tipping points, where gradual pressures can trigger abrupt or irreversible shifts (Kemp et al., 2022; Wunderling et al., 2024). In this report, we use the term “systemic climate risks” to describe risks that arise within, and propagate through, interconnected socio-ecological and socio-economic systems.

These risks can compound across hazards and risk pathways, cascade across sectors and systems, and cross borders through trade, supply chains, migration and shared ecosystems (Benzie & Harris, 2021; EEA, 2024; IPCC, 2023b; Seto et al., 2016; USGCRP, 2023). They often interact with non-climatic drivers and socio-economic vulnerabilities, meaning that climate shocks can generate ripple effects that travel across time and space, turning local disruptions into wider consequences for food security, public health, economic stability and social cohesion (Benzie et al., 2018; Benzie & Harris, 2021; EEA, 2024).

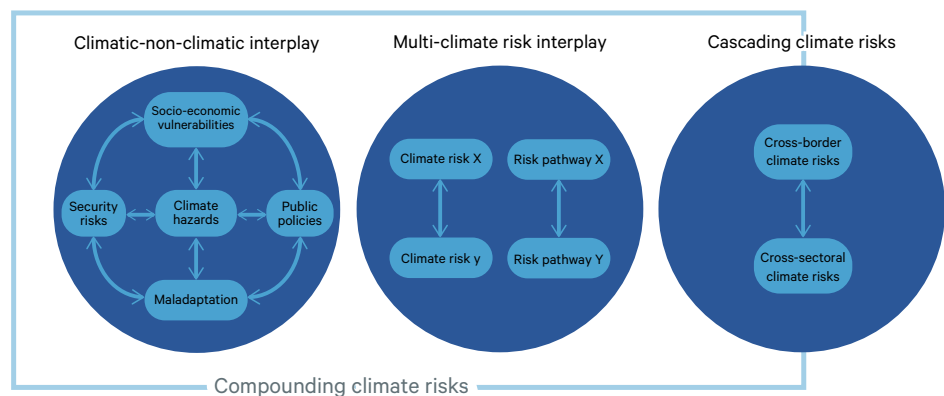
Systemic climate risks also have distributional outcomes. Climate impacts layer onto and magnify pre-existing inequalities in income, housing, health, and access to services, meaning that marginalized groups and places often bear disproportionate harm even where aggregate losses appear contained (Carr & Thompson, 2014; EEA, 2024; IPCC, 2023a; Mikaelsson & Lager, 2024; Mumtaz & Theophilopoulou, 2024; Thompson-Hall et al., 2016). In this sense, climate risk is not only determined by physical hazards, but also by historically produced vulnerabilities and uneven development trajectories.

Despite growing recognition of these dynamics, adaptation policies and governance arrangements often remain organized around individual hazards or sectors, with limited capacity to manage cross-sector and cross-scale interdependencies (Benzie et al., 2025; EEA, 2024; IPCC, 2023a). Hazard- and sector-based framings can encourage narrowly targeted interventions that overlook how risk is produced and shifted through policy choices and social vulnerability, and in some cases can contribute to maladaptation when protection concentrates on high-value assets while residual or relocated risks fall on less powerful communities (IPCC, 2023a; Mikaelsson & Lager, 2024; Schipper, 2020; Swanson, 2021). This creates a practical implementation gap: although systemic language is increasingly visible in strategies and assessments, the operational routines that determine action, including mandates, appraisal, funding, monitoring and accountability, often remain aligned with hazard- and sector-based approaches. The result is that risks recognized as interconnected in analysis may still be managed through fragmented instruments in practice.

These challenges point to the need for a shift toward systemic adaptation: that is, approaches that explicitly engage with compounding and cascading risks, manage deep uncertainty, and align adaptation with the wider policy landscape shaping vulnerability and resilience (EEA, 2024; Global Commission on Adaptation, 2019; IPCC, 2023a). Systemic adaptation requires more than mainstreaming climate risks into sectoral planning. It calls for governance and decision-making that can address feedback dynamics across systems and avoid lock-in and path dependencies that amplify future vulnerability (Benzie & Harris, 2021; EEA, 2024; IPCC, 2023b; Seto et al., 2016). It also requires policy coherence across domains – including the ability to identify trade-offs, capture co-benefits, and reduce maladaptive incentives that reinforce fragmented policy delivery (Findlater et al., 2022; Garbarino et al., 2024; Hutton et al., 2019). Figure 1 summarizes the mechanisms through which climate impacts become systemic and serves as a reference point for the analysis that follow.

Figure 1. Climate impacts become systemic when a) climate hazards interact with non-climatic stressors and socio-economic vulnerabilities (including policy choices and maladaptation), b) multiple distinct but interacting climate hazards and risk pathways compound, through synchronous or sequential events, to produce combined effects, and c) disruptions cascade via interdependencies across sectors and across borders; cascading impacts may also generate compounding effects, but can occur without them.

Systemic climate risks



1.1 Aims and objectives

This report aims to help define how the challenge of systemic adaptation manifests in practice, and offer a starting point for the critical inquiry needed for a more integrated approach to climate adaptation policy and planning. It focuses on three limitations in current adaptation practice: limited engagement with compounding and cascading risks (including with non-climatic drivers and socio-economic vulnerabilities); weak operational treatment of tail risks and tipping dynamics under deep uncertainty; and insufficient governance of policy links across domains.

Recent major assessments and the policy literature highlight three challenges that motivate this report. First, climate risks increasingly arise through compound events and cascading impacts across interconnected systems, which conventional hazard- and sector-based framings can miss (EEA, 2024; IPCC, 2023a; Townend et al., 2023; United Nations Office for Disaster Risk Reduction, 2022). For example, heatwaves can

drive spikes in electricity demand that stress grids and disrupt cooling and health services, while floods can interrupt transport and logistics with knock-on effects for supply chains and emergency response.

Second, adaptation policy and planning is de facto operating under deep uncertainty, including tail risks, non-linear change and potential tipping dynamics, yet these considerations are difficult to translate into routine planning and appraisal approaches, which often assume incremental change and stable baselines (Armstrong McKay et al., 2022; Haasnoot et al., 2013; IPCC, 2023a; Lenton et al., 2019; Stanton & Roelich, 2021).

Third, resilience depends not only on a narrow definition of adaptation policy, but on policy coherence across portfolios – that is, how adaptation aligns with (or is undermined by) wider objectives, incentives and financing, and the practical identification of trade-offs and co-benefits in real decisions (Benzie et al., 2025; Kappe et al., 2025; OECD, 2024; University of Technology and Economics Budapest & United Nations Environment Programme, 2024).

Against this backdrop, the report assesses how, and to what degree, adaptation strategies and governance arrangements are beginning to acknowledge and address systemic risk. It also identifies where current approaches remain limited in their ability to operationalize interdependencies, manage deep uncertainty and strengthen coherence across policy portfolios.

Guided by the three challenges discussed above, the report pursues three main objectives:

1. To develop initial empirical evidence – through an illustrative set of regional, national and subnational cases – on how adaptation policies in Europe, Southeast Asia and the US engage with systemic climate risk, and to identify gaps in governance and implementation that limit deeper engagement, recognizing that evidence and policy literature are uneven across regions and governance levels.
2. To map the key considerations for addressing compounding, cascading and cross-sectoral risks, and for managing links between adaptation and other policy domains that emerge from the cases – including how funding streams and incentive structures often favour reactive, incremental and project-based measures (frequently centred on engineered or “grey” fixes), thus shaping what adaptation “looks like” in practice and what remains harder to finance.
3. To sketch the foundations of a conceptual framework for systemic adaptation that can inform future research into barriers and enablers of systemic adaptation, and, as the framework is further developed, help decision-makers design and prioritize interventions that strengthen resilience across interconnected systems, and take into account tail risks, tipping points and distributional effects.

In doing so, the report contributes to debates on systemic resilience and strategic climate risk management while remaining grounded in the practical realities of adaptation governance (e.g. fragmented mandates, capacity constraints, short political cycles, and competing policy priorities). It does not provide a comprehensive evaluation of adaptation in any region; instead, it identifies emerging patterns and tensions that are likely to shape how systemic adaptation evolves in the coming decade.

1.2 Scope, design and methods

The report undertakes an exploratory cross-case analysis of systemic adaptation, rather than a comprehensive global mapping. The aim is to trace broad contours and illustrative dynamics, not to provide exhaustive coverage or definitive rankings. The empirical material draws on three complementary sources – desk research, semi-structured interviews and a short survey.

The desk research reviewed regional, national and subnational adaptation strategies, plans and closely related policy documents across the EU, Southeast Asia and the US (Table 1). Semi-structured interviews with adaptation coordinators and policy specialists at regional, national and subnational levels provided qualitative insight into how systemic risks are understood and how day-to-day mandates, capacity constraints, incentives and political dynamics shape implementation. Interviews were guided by an open-ended questionnaire covering systemic risk framing, compounding and cascading impacts, transboundary risks, deep uncertainty (including tail risks and tipping points), distributional outcomes, and the handling of co-benefits, trade-offs and cross-sector dependencies. Selected roles were anonymized where required.

The desk review and interviews were organized around selected cases to balance governance context, risk profile, policy relevance, evidence availability, and feasibility of expert engagement. Interviews were conducted with 21 participants across levels of governance: five in the US, seven in Southeast Asia, and nine in the EU and European member states (three and six, respectively). The set of cases is intended to surface recurring dynamics and implementation bottlenecks across diverse contexts, not to represent regions exhaustively.

A short survey of national adaptation policy experts from eight countries in Europe, North America and Asia (one respondent per country; n=8) examined how far national strategies and plans recognize and operationalize systemic climate risks, including compounding/cascading impacts, policy interlinkages, monitoring arrangements and resource allocation (Box 1). The survey used an opportunistic sampling approach, depending on the availability and willingness of respondents, with additional outreach supported by the International Climate Councils Network through its adaptation working group. The survey was designed to triangulate themes from the document review and interviews and to capture practitioner judgements, rather than to generate statistically generalizable estimates.

Because adaptation policy instruments differ between governance systems and levels, the reviewed planning documents are not treated as directly equivalent. The purpose of reading these materials side by side is to explore commonalities and differences in how systemic risks are recognized and acted upon, rather than to compare jurisdictions on a like-for-like basis. The analysis therefore focuses on governance functions and operationalization: how systemic risk framings and interdependencies translate into mandates, appraisal routines, funding streams, delivery mechanisms, monitoring and accountability. US state examples are used as illustrative subnational vignettes within a (currently dysfunctional) federal system, not as national-level analogues.

Taken together, these sources enable triangulation to identify points of convergence and divergence in systemic adaptation challenges as they emerge across a set of diverse contexts, while recognizing that a fuller mapping would require broader geographical coverage and more systematic data collection. The analysis is organized around three analytical pillars: a) compounding and cascading risks (including interactions with non-climatic drivers and socio-economic vulnerabilities), b) deep uncertainty management (including tail risks and tipping points), and c) policy interlinkages across domains. To support consistent comparison, the document review, survey and interviews were structured around the same analytical dimensions, enabling triangulation across sources.

Table 1. This table lists the regional, national and subnational adaptation strategies, plans and closely related resilience/hazard frameworks reviewed for the selected cases in Europe (EU level; Sweden, Ireland, Spain, Greece), Southeast Asia (ASEAN level; Philippines, Cambodia) and the US (federal level; Georgia, South Carolina). The table reflects the study's desk-based evidence base and the specific document versions reviewed; it is not intended as an exhaustive inventory of all adaptation-relevant policies in each jurisdiction.

Region	Governance	Documents
Europe	EU level	Forging a Climate Resilient Europe – the new EU strategy on adaptation to climate change Joint communication on the European Preparedness Union Strategy European Climate Risk Assessment European Commission Communication on Managing Climate Risk
Europe	Ireland	National Adaptation Framework National Adaptation Guidelines
Europe	Greece	National climate change adaptation strategy
Europe	Spain	Spain's National Climate Change Adaptation Plan (PNACC)
Europe	Sweden	Sweden's 2023 National Adaptation Strategy and Action Plan Ordinance on public authorities' climate adaptation work
Southeast Asia	ASEAN level	ASEAN state of climate change report: Current status and outlook of the ASEAN region toward the ASEAN climate vision 2050
Southeast Asia	Cambodia	Cambodia Climate Change Strategic Plan 2014–2023
Southeast Asia	Philippines	National adaptation plan of the Philippines 2023–2050
US	Federal level	US National Adaptation and Resilience Planning Strategy 2025 Fifth National Climate Assessment," U.S. Global Change Research Program (USGCRP)
US	Georgia	Georgia Hazard Mitigation Strategy 2024
US	South Carolina	Strategic Statewide Resilience and Risk Reduction Plan South Carolina State Hazard Mitigation Plan

1.3 Depth of analysis and regional governance context

The depth of analysis intentionally varies across the three regional settings, reflecting differences both in the maturity and transparency of adaptation governance and the scope of this study. Evidence for Europe is most granular, Southeast Asia sits in an intermediate position, and the US is treated as an exploratory case. The European material therefore forms the largest share of the empirical discussion, with Southeast Asia and the US providing more selective, illustrative insights rather than fully symmetrical case studies.

The evidence landscape that informs this report is also uneven. Published policy evaluation and “systemic risk” scholarship is more extensive for some regions and governance levels than others, reflecting differences in publication ecosystems, language access, data availability, and the visibility of locally grounded practice in formal literature (Byskov & Hyams, 2022; Eriksen et al., 2015; IPCC, 2023a). The report therefore treats the reviewed cases and supporting literature as illustrative rather than representative and avoids interpreting differences in coverage as differences in importance. Where the evidence base is thinner, conclusions are framed as “not evidenced in the reviewed material” rather than absence in practice. In applying the framework, users should complement these findings with locally grounded evidence and inclusive deliberation, including Indigenous and local knowledge, where relevant (WRI, n.d.).

In Europe, the analysis combines EU-level frameworks with four member-state case studies (i.e. Sweden, Ireland, Spain and Greece), reflecting the region’s relatively dense adaptation architecture and the availability of detailed strategies, guidance and evaluations. This enables a more granular examination of how systemic risks are recognized and partially operationalized, and how constraints such as capacity, data and funding shape implementation.

In Southeast Asia, the report analyses ASEAN’s emerging regional framework alongside national planning in the Philippines and Cambodia. The focus is on how systemic language is beginning to appear (including references to cross-sector assessments, transboundary risks and social vulnerability), while the tools, institutions and analytical capacities needed to operationalize this understanding remain limited (ASEAN, 2021).

In the US, the analysis draws on a smaller set of federal documents and selected state and municipal examples, with particular attention to South Carolina and Georgia. Given the constraints of scope and data, this material is explicitly exploratory: it is used to surface how systemic challenges arise in a highly decentralized and politically contested federal system, rather than to provide a comprehensive picture of adaptation policy across all levels of government.

A cross-cutting issue in the report is how regional and constitutional arrangements shape policy coordination in different contexts. For example:

- **in the EU**, strong regional instruments can enable cross-border and cross-sector initiatives, but subsidiarity and competence boundaries can constrain the ability to mandate coordination in practice.
- **in ASEAN countries**, consensus-based, non-binding regionalism relies on soft instruments (visions, peer learning, voluntary commitments), limiting formal steering power while enabling experimentation.
- **in the US**, formal federal capacity coexists with political polarization, uneven continuity across electoral cycles, and fragmented implementation through siloed agencies alongside high state and municipal autonomy.

Throughout this report, regional labels are used as shorthand for the selected cases reviewed, and findings are presented as illustrative patterns rather than region-wide or global generalizations.

2. Systemic climate risks in adaptation practice

This section examines how far adaptation strategies and governance arrangements are beginning to recognize and operationalize the systemic nature of climate risk across the selected cases in Europe, Southeast Asia and the US. The analysis distinguishes between recognition (i.e. how systemic risk is framed in strategies, assessments and guidance) and operationalization (i.e. whether that framing is translated into mandates, appraisal routines, funding streams, delivery mechanisms, monitoring and accountability). This distinction is used throughout to identify a recurring implementation gap: systemic language is increasingly visible, while operational routines often remain hazard- and sector-based.

Two summary outputs below provide an at-a-glance guide to the evidence. Box 1 synthesizes headline insights from the expert survey on how far national strategies and plans recognize and operationalize systemic risks (including compounding/cascading impacts, policy interlinkages, monitoring and resourcing).

Figure 2 provides an indicative, qualitative overview of patterns across the reviewed cases, with “recognition” and “operationalization” shown separately. It should be treated as a navigational aid for the report’s analysis rather than as a ranking or comprehensive assessment.

This section is organized around three dimensions of systemic adaptation:

- cascading and compounding risks (including interactions with non-climatic drivers and socio-economic vulnerabilities),
- managing deep uncertainty (including tail risks and tipping points), and iii)
- governing policy interlinkages, including trade-offs and co-benefits.

Findings are presented as illustrative patterns rather than region-wide generalizations. Where evidence is thinner, we use the formulation “not evidenced in the reviewed material”, rather than absence in practice, and draws on triangulation across documents, interviews and survey inputs to identify convergence and divergence.

BOX 1: SURVEY INSIGHTS ON NATIONAL ADAPTATION POLICY AND SYSTEMIC CLIMATE RISKS

This box draws on a short online survey of national adaptation policy experts from eight countries, carried out in collaboration with the International Climate Councils Network. The survey asked respondents how their national adaptation strategies and plans recognize and operationalize systemic climate risks, including compounding and cascading impacts, policy interlinkages, monitoring arrangements and resource allocation. It was designed as a parallel data-gathering exercise to the stakeholder consultations used elsewhere in this report, with partial overlap in respondents and country coverage. Further details on the survey design and its relationship to the consultations are provided in Section 1.2 on methods.

Overall, the findings suggest that while recognition of systemic climate risks is increasing globally, operational integration into adaptation planning and governance remains limited.

Area of assessment	Key findings (aggregated across respondents)
Structure of national adaptation plans	Around 60% of respondents reported that their country's adaptation plans remain sector-based, while a smaller share (about 25%) apply a systems-based or hybrid structure that links multiple domains such as water, energy, and agriculture. The remaining respondents are in transition toward more integrated approaches.
Acknowledgement of systemic climate risks	Nearly 90% of surveyed experts indicated that their national plans explicitly acknowledge systemic climate risks such as cascading or compounding impacts. However, only a minority noted that this recognition translates into dedicated actions or institutional mechanisms.
Type of risk addressed	Roughly two-thirds of countries consider cross-sectoral or cascading risks, and about half incorporate compounding hazards (e.g. heatwaves coinciding with drought or disease outbreaks). Transboundary risks are addressed in fewer than 30% of cases, and tail risks or tipping points remain largely absent from national frameworks.
Tools and analytical capacity	Around 60% of respondents reported the use of modelling tools or datasets to assess systemic risks. These range from hydrological and ecosystem models to integrated climate–socioeconomic scenarios. In many cases, however, these tools are developed by research institutions and are not systematically embedded in government decision-making.
Policy integration and co-benefits	A majority (about 65%) indicated that their national frameworks acknowledge policy interlinkages, such as co-benefits between adaptation and mitigation or health and economic objectives. Yet only a few countries have formal mechanisms to manage trade-offs or evaluate synergies across sectors.
Monitoring and evaluation	Roughly half of respondents reported the existence or development of national monitoring systems for adaptation. Yet most indicated that indicators for systemic or cross-sectoral risks are lacking, and progress tracking is often fragmented across ministries.
Funding and resources	Around half of the respondents identified dedicated or earmarked funding for systemic or cross-sectoral adaptation measures. However, resource allocation is typically fragmented, with limited long-term investment in systemic risk management or anticipatory adaptation.

Figure 2. The heatmap shows the average qualitative scores (1–3) assigned to each dimension across the countries and jurisdictions covered in the underlying study, displayed separately for Recognition (how clearly strategies and assessments acknowledge the dimension) and Operationalization (the extent to which it is embedded in mandates, appraisal and funding routines, tools, and monitoring/evaluation). Colours represent relative performance (yellow = more developed; orange = moderate; red = limited; numeric values shown in cells are mean scores). Scores are derived from triangulation of documentary analysis, expert survey inputs, and consultations reported in the underpinning report, and are indicative of patterns within the study sample rather than a comprehensive ranking.

Qualitative synthesis across study sample

	Recognition	Operationalisation
Compounding & cascading risks (incl. transboundary)	3	2
Tail risks & tipping points (deep uncertainty)	2	1
Policy interlinkages (co-benefits, trade-offs, maladaptation)	3	2
Equity & justice (distributional outcomes, MEL)	2	1

○ More developed / stronger integration (3) ● Moderate / partial integration (2) ● Limited / weak integration (1)

2.1 Cascading and compounding climate risks

Climate change increasingly generates compound and cascading risks that cut across hazards, sectors, and jurisdictions. Cascading impacts occur when an initiating hazard (e.g. heat, flood, drought) triggers knock-on disruptions through interdependent systems (such as electricity, water, transport, healthcare, communications, and supply chains), sometimes amplifying losses far beyond the initial impact area. Compound risks arise when multiple hazards occur simultaneously or sequentially (e.g. drought and heat; wildfire followed by heavy rainfall and flooding), or when climate hazards interact with non-climatic stressors (such as conflict, pandemics, economic shocks, or governance failures) to intensify exposure and constrain response capacity.

Compounding and cascading dynamics often reinforce one another: compound events can increase the likelihood and severity of cascading failures, while cascades can propagate across borders via trade, migration, and shared resources. These dynamics are increasingly recognized in assessments and strategies, but remain difficult to translate into routine mandates, appraisal practices, funding rules, delivery mechanisms, monitoring and accountability.

Across the cases reviewed, the discourse of systemic and cross-sector risk is increasingly visible in strategies and assessments. The recurring gap is operational: compounding and cascading dynamics are less consistently translated into the day-to-day “grammar” of policy – mandates, appraisal routines, funding rules, delivery mechanisms and monitoring.

Europe

EU policy officials describe notable progress in recognizing compounding, cascading, cross-sectoral and transboundary climate risks within adaptation and preparedness work. Preparedness initiatives increasingly acknowledge cascading pathways (e.g. links between heatwaves, air quality and health), and EU-level strategies frame climate impacts as multi-sectoral and cross-border challenges (EEA, 2024; Joint Communication on the European Preparedness Union Strategy (JOIN2025) 130 Final), 2022).

However, officials also emphasize persistent barriers: policy and delivery systems remain shaped by sectoral silos, coordination authority is uneven across portfolios, and transboundary risks (trade, migration, international supply chains) are not yet consistently embedded in operational routines. In addition, cascading impacts in sectors such as health, food security and infrastructure – while increasingly acknowledged – are still not systematically reflected in planning, response and investment templates.

“Systemic risks are recognized on paper, but in practice they are rarely addressed with urgency.”

–EU policy official 2 (extracted from the anonymized interviews)

At EU level, recent policy and assessment work increasingly frames climate impacts as interdependent and cross-border, emphasizing compounding events, cascading failures across critical systems, and the ways in which trade, supply chains and shared ecosystems can transmit shocks beyond the initiating hazard area (European Commission, 2021, 2025; EEA, 2024). The European Climate Risk Assessment (EUCRA) reinforces this framing by highlighting how risks propagate across sectors (e.g. energy–health–water, transport–logistics–emergency response) and across borders, and by linking physical hazards to socio-economic vulnerabilities and broader system dynamics (EEA, 2024). In parallel, preparedness and resilience initiatives increasingly recognize that climate-related disruptions often intersect with wider shocks (e.g. economic and geopolitical pressures), which can amplify cascading impacts and constrain response capacity (Joint Communication on the European Preparedness Union Strategy (JOIN 2025) 130 Final), 2022)

At the same time, interviews and document review suggest that this systemic framing remains unevenly translated into operations. While risk assessments and strategies more frequently acknowledge interdependencies, the mechanisms that shape day-to-day delivery, mandates, appraisal routines, program rules, and monitoring indicators, often still align more closely with sectoral remits and hazard-specific responsibilities. This creates a familiar pattern: recognition advances faster than operationalization, particularly for cross-sector and transboundary cascading risks that do not “belong” to any single ministry or program.

In the EU-level material reviewed, three operational levers are increasingly seen, but are not yet consistently made routine:

- **Coordination:** cross-sector and cross-border coordination is recognized as necessary, but responsibilities and authority to manage interdependent risks remain dispersed across portfolios and levels.
- **Decision routines:** consideration of systemic risk appears more frequently in strategic framing and assessment outputs than in the templates that govern investment appraisal, funding eligibility, and regulatory standards.

- **Data and tools:** progress is evident in system-level risk assessment and awareness, but integrated modelling and decision-support for cascading impacts is still fragmented and unevenly connected to the routines that govern sector delivery (European Commission. Joint Research Centre, 2023; EEA, 2024).

In Ireland, Sweden, Spain and Greece, systemic recognition of compounding and cascading risks is increasingly evident, but implementation is constrained by two recurring issues: i) institutional fragmentation across ministries and levels of government; and ii) an uneven interface between analytical tools and real decision routines, where assessments and modelling are stronger than the institutional mechanisms that would embed cascading-risk considerations into appraisal, budgeting, programming and monitoring.

These conclusions are derived from the review of national strategies and closely related guidance, complemented by interview evidence. Table 2 summarizes the distinctive patterns and bottlenecks in each case. In brief, Ireland is notable for having a relatively structured assessment ecosystem; Sweden for attention to transboundary and institutional dimensions alongside variable local capacity; Spain for more advanced analytical work on interdependencies but early-stage policy uptake; and Greece for persistent siloed governance, despite recognition of compounding sequences (Alda et al., 2025; Department of the Environment, Climate and Communications, n.d.; Government Offices of Sweden, Klimat- och näringslivsdepartementet, 2024; Ministry for the Ecological Transition and the Demographic Challenge, 2020; Ministry of Environment and Energy, 2016).

Europe takeaway: The key challenge is less the absence of systemic language than the absence of operational hooks, such as clear ownership for interdependent risks, incentives and funding rules that reward cross-sector prevention, and monitoring/ accountability routines that track cascading vulnerabilities rather than sector outputs. Where these hooks are stronger, systemic framing is more likely to influence real decisions; where they are weaker, implementation reverts to hazard-by-hazard responses and sectoral optimization.

Table 2. Member state insights on cascading and compounding risks (recognition → operationalization).

Case	What is recognized	What is emerging in practice	What still blocks operationalization (and why it matters)	Illustrative detail (high-density)
Ireland	Systemic risk explicitly acknowledged via National Adaptation Framework and national risk assessment work. Growing awareness that risks cascade into and out of sector domains.	Coherent national framework and structured assessment. Coordination and guidance improving over time.	Delivery still runs mainly through sector plans and routines. Cross-sector coordination is uneven in appraisal, budgeting and implementation. Non-climatic shocks are weakly integrated; local capacity constraints persist.	Experts described a systemic perspective as early-stage: stronger in assessments than in investment and delivery rules. Local authorities face resource constraints for long-term cross-sector action.
Sweden	Increasingly holistic framing (including One Health lens) and attention to transboundary risks (e.g. supply chains). Interdependencies across critical societal functions acknowledged.	Cross-authority coordination procedures exist (e.g. under adaptation ordinance). Place-based delivery supported through the proximity principle.	Proximity principle can fragment responsibilities across municipalities with uneven capacity. Separation between adaptation and civil preparedness governance weakens alignment. Cross-sector implementation remains stronger on paper than in delivery routines.	Interviewees emphasized that holistic ideas outpace practical routines. Uneven municipal capacity makes cross-boundary cascading risks hard to manage consistently.
Spain	National Adaptation Plan treats risks as cross-sectoral across many ministries. Explicit recognition of interlinkages (water–agriculture–energy–health).	Analytical methods emerging to map cascading risks and prioritize key risks. Early efforts to assess interdependencies and sequences.	Uptake into operational appraisal, budgeting and delivery remains early. Non-climatic drivers and cross-portfolio incentives remain underdeveloped. Coordination goals still compete with sector delivery logics.	Graph analysis used to explore relationships among 51 identified climate risks. Heatwave analysis traced cross-sector effects (wildfires, air quality, health, transport), but routine policy uptake remains limited.
Greece	Strategy acknowledges nexus dynamics (water–land use–energy–agriculture) and compounding sequences (e.g. wildfire → flood) Interlinked risks recognized at strategy level.	Research community has advanced modelling; EU funding has supported coordination ambitions in principle.	Governance siloed and reactive; coordination structures underperform. Capacity constraints slow uptake of modelling into routine decisions. Policy incoherence can shift risk (e.g. land allocation trade-offs; water governance challenges).	Experts described adaptation as systemic on paper, sectoral in practice. Reported underuse of some coordination resources; competing objectives persist in land and water decisions.

Note: “Recognized” summarizes how strategies/assessments frame cascading/compound risks; “emerging in practice” captures early operational steps; “blocks” identifies constraints preventing routinization in mandates, appraisal, funding, delivery and monitoring.

Southeast Asia

In Southeast Asia, explicit “systemic risk” terminology is less common than in some European and US documents, but regional and national strategies increasingly acknowledge that climate risks are interlinked across hazards, sectors and borders. This is reflected in ASEAN’s reporting and strategic framing, which highlight multi-hazard exposure, cross-sector vulnerability, and the importance of multi- and cross-sector risk and vulnerability assessment – alongside the reality that operational capacity, data and resourcing remain uneven across member states and governance levels (ASEAN, 2021; ASEAN Secretariat, 2021; Climate Change Commission, & Department of Environment and Natural Resources, 2023; Royal Government of Cambodia, National Climate Change Committee, 2013).

At the regional level, ASEAN’s approach provides useful signals of systemic awareness, particularly around transboundary dimensions such as food and water security, shared ecosystems, mobility, and interconnected infrastructure systems (ASEAN, 2021). However, implementation is shaped by the governance characteristics of ASEAN cooperation: many instruments are consensus-based and non-binding, which can enable agenda-setting and peer learning but limits formal steering power. As a result, systemic framing often appears more strongly in visions and assessments than in enforceable routines that would standardize how cascading and compound risks are screened in investment, land-use planning, sector regulation, or monitoring.

Across the two national cases reviewed, the pattern is broadly similar: recognition is advancing, while operationalization remains constrained by fragmented mandates, limited analytical tools, and uneven subnational delivery capacity.

Philippines: The National Adaptation Plan contains comparatively explicit recognition of interdependencies and cascading pathways across sectors and governance levels, linking climate hazards to underlying drivers of vulnerability and to impacts that propagate through systems and services (Climate Change Commission, & Department of Environment and Natural Resources, 2023). This framing supports a more systemic reading of risk– for example, how extreme rainfall and flooding can disrupt transport and logistics, which then affects access to health services, delivery of relief, and supply chains for essential goods; or how drought and heat can jointly affect agriculture and water resources with knock-on effects for food security and livelihoods. It also opens space to consider how climate shocks interact with non-climatic stressors, such as volatile commodity prices or public health pressures, to intensify vulnerability and constrain response.

The persistent challenge is translating this systemic framing into routine decision rules, especially in budgeting, appraisal, and program implementation across sectors and levels. Interview and document evidence suggests that fragmented responsibilities, uneven subnational capacity, and data gaps constrain consistent stress-testing of plans and investments for cascading impacts. As a result, systemic recognition can be strongest in strategy language and project narratives, while day-to-day delivery continues to be shaped by sector mandates and hazard-focused planning cycles.

Cambodia: National climate planning recognizes cross-sector vulnerabilities and the need for integrated approaches, linking climate risks to wider development

pressures and socio-economic vulnerability (Royal Government of Cambodia, National Climate Change Committee, 2013). This provides a basis for identifying compound and cascading dynamics: for example, how drought and heat can interact with water governance constraints to affect agriculture and rural livelihoods, prompting knock-on pressures on household income, nutrition, and access to services; or how flooding can damage roads and local infrastructure, disrupting access to markets, schools, and healthcare while also affecting water quality and disease risks.

In practice, operationalization remains challenging where administrative bandwidth and analytical capacity are limited and where implementation relies heavily on project-based interventions. This reinforces a common gap between multi-sector strategy language and hazard-centred delivery routines, particularly at local levels where exposure is high and the capacity to anticipate and manage cascading risks is often weakest. The reviewed material suggests that the systemic dimensions of risk are frequently visible in vulnerability narratives, but less consistently embedded in the routines that govern investment screening, program prioritization, and monitoring.

Southeast Asia takeaway: The reviewed evidence suggests emerging systemic awareness – especially around multi-hazard dynamics and cross-sector vulnerability – but also a persistent implementation gap. The binding constraints are less about “recognising cascades” and more about (i) institutional authority and coordination across portfolios, (ii) decision-support tools and data that connect systemic analysis to appraisal and budgeting, and (iii) resourcing and capacity at subnational levels where cascading impacts are experienced and managed in practice (ASEAN, 2021; ASEAN Secretariat, 2021; Climate Change Commission, & Department of Environment and Natural Resources, 2023; Royal Government of Cambodia, National Climate Change Committee, 2013).

United States

In the US, federal strategies and assessments increasingly frame climate change as a source of cascading impacts and compound events, while many adaptation efforts remain organized through hazard-focused and sectoral planning. The National Adaptation and Resilience Planning Strategy and the Fifth National Climate Assessment (NCA5) emphasize that climate shocks can propagate through interconnected social, economic and ecological systems, generating knock-on effects across critical services and supply chains (United States of America, 2025; USGCRP, 2023). NCA5 also notes that disruptions to food and industrial supply chains can transmit local shocks into wider economic and security consequences (USGCRP, 2023).

Despite this conceptual recognition, operationalization is a challenge. NCA5 highlights that adaptation planning and investment are fragmented across different communities of practice and priorities (e.g. disaster resilience, liability/risk management, and equity/justice), and often focus on individual hazards such as flooding, sea-level rise, wildfire or heat. This fragmentation can obscure compounding stresses and, in some cases, unintentionally deepen vulnerability for frontline communities facing intersecting risks (USGCRP, 2023).

State examples illustrate uneven uptake within a shared federal context:

South Carolina: South Carolina’s resilience planning explicitly recognizes compound and cascading dynamics, including compound coastal risks where sea-level rise interacts with storm surge, tides, heavy rainfall, and changing baseline coastal conditions (South Carolina Office of Resilience, 2023). The State Hazard Mitigation Plan also provides concrete illustrations of cascading impacts across “community lifelines” (e.g. flooding leading to prolonged power outages, with knock-on effects for food systems and medical equipment) and treats extreme heat as a multi-system stressor rather than a standalone hazard (South Carolina Emergency Management Division, 2023). Together, these documents suggest an increasing ability to describe systemic pathways and cross-sector dependencies. However, the reviewed material also points to familiar operational constraints: it remains difficult to translate systemic recognition into routine appraisal, funding priorities and cross-agency accountability where mandates and program rules are centred on sectors or hazards.

Georgia: Georgia does not have a dedicated statewide adaptation or resilience plan and relies primarily on hazard mitigation planning (GEMA/HS, 2024). The reviewed materials provide detailed hazard assessment and prioritization but largely treat hazards as discrete, with more limited explicit treatment of cross-hazard propagation or cross-sector cascading dynamics. Where “compounding” is noted, it tends to be framed within individual hazard categories rather than as multi-system pathways that would require cross-sector coordination and stress-testing of investment and delivery routines. This illustrates a key point of variation within the same federal system: the salience of systemic framing and the degree to which it is translated into operational routines can differ markedly across states.

US takeaway: Federal assessments increasingly articulate cascading and compound risks, but state-level operationalization remains uneven. The main bottlenecks are: i) fragmentation of mandates and funding streams across hazard/sector silos, ii) limited routinization of cascading-risk considerations in appraisal and programme rules, and iii) variable local capacity to act on interdependencies identified in plans (USGCRP, 2023).

Cross-regional synthesis: compounding and cascading risks

Across Europe, Southeast Asia and the US, recognition of compounding and cascading climate risks is increasing, but operationalization is still limited. In Europe, systemic and transboundary linkages are increasingly visible in strategies and assessments, yet delivery is still shaped by sectoral mandates and fragmented governance. Promising analytical work (e.g. Spain’s interdependency analysis) is not consistently reflected in routine appraisal, monitoring or implementation. In Southeast Asia, ASEAN and national plans in the Philippines and Cambodia emphasize cross-sectoral and transboundary risk dynamics, but because of data and capacity constraints practice remains largely hazard- and sector-based, especially at subnational level – often “systemic on paper; hazard-centred in practice”. In the US, federal assessments (notably NCA5) articulate cascading and compound events and some states (e.g. South Carolina) recognize cross-sector impacts, but sector-specific funding streams and limited local capacity mean systemic thinking is still often event-driven rather than embedded in everyday planning.

Overall, the three regions show a shared implementation gap: systemic risk language is advancing faster than the tools, mandates, incentives and resources needed to manage cascading and compounding risks routinely.

2.2 Justice and equity in climate adaptation

Systemic climate risks are not only about how hazards propagate through infrastructures and economies; they are also about how those risks are distributed across societies. Climate impacts intersect with existing patterns of inequality, discrimination, and marginalization, meaning that the same hazard can have very different consequences for different groups and places. These distributional patterns are themselves shaped by public policy, market dynamics, and historical development choices (IPCC, 2023b; Mikaelsson & Lager, 2024; Swanson, 2021; Walker et al., 2024). As a result, questions of who is exposed, who can adapt, and who bears the costs of both impacts and responses are central to understanding systemic climate risk (IPCC, 2023b; Mikaelsson & Lager, 2024).

Adaptation measures can therefore either reduce structural vulnerabilities or reinforce them. Interventions that focus narrowly on protecting high-value assets, that relocate risks rather than reducing them, or that neglect the needs and knowledge of affected communities can inadvertently shift or amplify risk elsewhere in the system (Higuera Roa et al., 2025; IPCC, 2023b; Swanson, 2021). Conversely, approaches that address underlying drivers of vulnerability, such as insecure housing, lack of basic services, or exclusion from decision-making, can generate resilience benefits that cascade across sectors and scales (Swanson, 2021; Walker et al., 2024). In this sense, justice and equity are not an “add-on” to adaptation, but a core dimension of how systemic climate risks are produced, managed, and transformed. The following subsections examine how justice and equity considerations are framed and operationalized in adaptation policies and practices in Europe, Southeast Asia, and the US, and how far they align with the systemic risk dynamics outlined in Section 2.1.

Europe

Across the EU, policy officials describe justice and equity as increasingly central to adaptation framing. The term “just resilience” appears in core EU texts (including the 2021 Adaptation Strategy and the Communication on Managing Climate Risk), and equity is referenced in the Better Regulation Toolbox (European Commission, 2021, 2023, 2025). However, the European Commission still focuses largely on frameworks and guidance, with delivery left to member states. At the same time, officials emphasize that operationalization is still uneven: they did not identify a shared set of indicators to track distributional outcomes, and equity is more often present in guidance than treated as a binding criterion in day-to-day investment decisions.

Coordination remains partial across the strands of work touching on social vulnerability (notably DG CLIMA and DG ECHO). The emerging “preparedness-by-design” principle under the Union Civil Protection Mechanism signals intent to strengthen resilience through EU finance (potentially for vulnerable groups), but the supporting machinery

(funding lines, metrics, assessment templates) is still under development. Overall, the EU level is in transition: equity is increasingly signalled, but the routine tools to deliver it systematically are still being built.

In the EU-level material reviewed, three operational levers are visible, but not yet consistently made routine:

- Decision routines: equity appears in appraisal guidance more than in binding eligibility/appraisal templates.
- Coordination: responsibility for social vulnerability is distributed across portfolios, with uneven joining-up in day-to-day operations.
- Monitoring/metrics: limited shared indicators make it hard to track distributional outcomes and accountability.

Progress and challenges at the member state-level

Among the four member-state cases reviewed (Sweden, Ireland, Spain and Greece), justice and equity are increasingly recognized in national adaptation framing, but translation into binding decision routines remains uneven. Equity is more often expressed as a guiding principle than embedded in the appraisal criteria, program rules, monitoring indicators and accountability systems that shape what gets funded and delivered. Capacity constraints – especially at local level – further widen implementation gaps, and the cases vary in emphasis: Sweden and Ireland show relatively strong recognition with uneven uptake in routine decisions, Spain pairs explicit social/territorial vulnerability framing with uneven delivery across regions, and Greece shows a sharper gap where equity is frequently overshadowed by reactive measures and fragmented governance.

Sweden: Sweden’s national adaptation strategy positions equity as a guiding principle and increasingly recognizes uneven impacts across age, income and regions, including links to broader social vulnerability (Government Offices of Sweden, Klimat- och näringslivsdepartementet, 2024). A national support tool helps integrate justice considerations into stages of planning and prioritization (SMHI, n.d.), but uptake is voluntary and therefore uneven across sectors and municipalities. Interview evidence suggests that where distributional analysis is weak, adaptation can become regressive in practice – for example, through prioritization of high-value areas or forms of “green renewal” that contribute to gentrification and displacement. Overall, Sweden illustrates a pattern where equity is clearly signalled in strategy and guidance, but is not consistently made routine through binding appraisal criteria, earmarked resources, or national indicators that track whether adaptation reduces inequality.

Ireland: Ireland’s adaptation framework explicitly requires sectors to consider vulnerable groups and regions, and the evidence base has strengthened through national risk assessment work and supporting guidance (Department of the Environment, Climate and Communications, n.d.; Environmental Protection Agency, 2025). In practice, equity considerations are often acknowledged in planning but compete with appraisal norms that prioritize technical efficiency and near-term deliverability. A salient justice–adaptation nexus concerns housing: pressure to accelerate housing supply can conflict with risk-informed siting and long-term

resilience, particularly where land-use decisions intersect with flood exposure and infrastructure constraints. Capacity constraints also matter: local authorities play a pivotal role but often face short-term staffing and competitive funding, which limits the ability to sustain equity-oriented engagement, monitoring, and follow-through. Overall, Ireland shows relatively strong recognition but incomplete integration into binding investment and delivery routines.

Spain: Spain's national plan provides one of the clearer framings of social and territorial vulnerability as cross-cutting dimensions of climate risk, supporting a more systemic diagnosis of how exposure and disadvantage overlap and how equity considerations should inform adaptation priorities (Government of Spain. Ministry for the Ecological Transition and the Demographic Challenge (MITERD), 2021). It also articulates potential co-benefit pathways – for example, measures that improve housing quality and energy performance can reduce energy poverty, while improving thermal comfort, and urban greening can deliver cooling and health benefits. The main implementation challenge is routinization across governance levels: delivery is shaped by regional variation across Autonomous Communities and by differences in capacity and priorities, and the reviewed material provides limited evidence of binding criteria or dedicated monitoring indicators that would consistently prioritize distributional outcomes in investment decisions. Spain therefore demonstrates strong framing and co-benefit logic, with uneven translation into routine decision machinery.

Greece: Greece's strategy references social cohesion and territorial balance and recognizes the social dimensions of climate vulnerability (Ministry of Environment and Energy, 2016). However, interview evidence suggests that equity remains largely rhetorical and is frequently overshadowed by reactive measures and fragmented governance. Typical responses (e.g. cooling centres, one-off compensation) were described as intermittent rather than embedded in a sustained social-resilience approach, and there is limited evidence of routine mechanisms to appraise distributional impacts or track equity outcomes. Capacity and absorption constraints can further exacerbate inequity over time, as better-resourced regions and actors are more able to secure and implement projects, while areas with higher vulnerability may fall behind. Greece thus illustrates a pronounced gap between recognition and operationalization, with equity weakly embedded in delivery routines and accountability systems.

Member-state takeaway: Across the cases, equity is increasingly named but weakly embedded in the operational routines that shape funding, appraisal and delivery. Where equity tools exist, they are often advisory; where capacity is limited, short-term and reactive measures dominate, risking regressive outcomes.

Southeast Asia

Across Southeast Asia, justice and equity are increasingly visible in adaptation framing, but remain unevenly embedded in the operational rules that shape planning, appraisal, and implementation. At regional level, ASEAN frameworks emphasize inclusive, “whole-of-society” approaches and recognize that climate impacts disproportionately affect vulnerable groups, but they tend to frame equity in broad terms rather than as a set of explicit distributional or procedural criteria (ASEAN, 2021; ASEAN Secretariat,

2021). ASEAN reporting notes that member states are increasingly attentive to gender and vulnerable groups, yet also highlights constraints that slow operational follow-through – especially limited budgets, human resources, and uneven technical capacity (ASEAN, 2021). As a result, equity frequently appears as a principle in strategies and communications, while common metrics, safeguards, and accountability mechanisms to track distributional outcomes across programs are less evident. In the reviewed national cases, the pattern is similar: equity and vulnerability are named and described, but the mechanisms that would translate these commitments into consistent delivery – binding appraisal criteria, accessible finance for vulnerable communities, enforceable compensation or grievance arrangements, and monitoring indicators – remain limited or unevenly applied.

Philippines: The National Adaptation Plan foregrounds social inclusion and distributional vulnerability, including the ways climate hazards interact with poverty, services, and institutional capacity (Climate Change Commission, & Department of Environment and Natural Resources, 2023). It provides a basis for addressing equity in adaptation priorities and for recognizing that risk is shaped by social and territorial inequality, not only physical exposure. In terms of tools, Comprehensive Disaster Risk Assessments (CDRAs) are intended to help local governments identify vulnerable groups and integrate these insights into land-use and development planning (Housing and Land Use Regulatory Board, 2014). However, interview and document evidence suggests that operationalization remains uneven: local capacity and data limitations constrain the ability to translate vulnerability analysis into enforceable planning controls, investment screening, and sustained delivery. Equity risks can also arise through implementation choices, for example, where infrastructure projects reduce risk in one area but worsen flooding elsewhere, or where compensation and accountability for displaced risk are weak in practice.

Cambodia: Cambodia's strategic planning offers a clear equity framing, highlighting the vulnerability of poor rural populations and territorial disparities, and calling for measures that reduce vulnerability across sectors, regions and groups (Royal Government of Cambodia, National Climate Change Committee, 2013). Decentralization reforms and commune-level vulnerability assessments create openings for locally grounded needs to inform planning, and community-based adaptation and adaptive social protection are recognized as relevant pathways. Yet the reviewed material and interview evidence point to persistent constraints: decision-making remains largely centralized; commune-level capacity and stable funding are limited; and initiatives often take the form of pilots with weak mechanisms for scaling, continuity, and monitoring. This can mean that while equity commitments are present in strategy language, the practical levers that would sustain equitable delivery – programme rules, finance access, and accountability – remain underdeveloped.

Southeast Asia takeaway: Equity is increasingly recognized as integral to adaptation, but practice is constrained by limited administrative bandwidth, uneven subnational capacity, and weak routinization of equity into decision templates and monitoring. Strengthening systemic adaptation in this context therefore depends not only on naming vulnerable groups, but on embedding distributional criteria into investment and programme rules, supporting local implementation capacity, and developing practical indicators and accountability mechanisms that track who benefits from adaptation, and who is left exposed.

United States

In the US, justice and equity have become more prominent in adaptation framing, reflecting the way climate impacts intersect with structural inequalities, social vulnerability and uneven access to resources and decision-making. These distributional dynamics shape both who experiences climate harms and how adaptation priorities are set across federal, state and local levels.

At federal level, the National Adaptation and Resilience Planning Strategy (2025) and the Fifth National Climate Assessment (NCA5) emphasize that climate change interacts with existing inequalities and structural discrimination, and that impacts are projected to fall disproportionately on communities that are already socially and economically stressed (United States of America, 2025; USGCRP, 2023). NCA5 underscores that these impacts can cascade through interconnected social and ecological systems – raising household costs for healthcare, food, insurance and housing – and can compound with other stressors in ways that exacerbate segregation, income inequality and reliance on social safety nets (USGCRP, 2023). At the same time, NCA5 notes that equity is not consistently centred in adaptation practice, highlighting barriers such as limited or inaccessible forums for participation, and power asymmetries that constrain the ability of overburdened groups to shape decisions – particularly Indigenous communities in remote and climate-exposed locations. This points to a familiar implementation gap: distributional risk is increasingly recognized in national framing but is less consistently translated into binding routines for appraisal, budgeting, monitoring and accountability.

State and local experience illustrates how equity concerns often surface through “non-climate” drivers of vulnerability – precarious housing, limited access to services and environmental injustice – that intersect with climate hazards and shape recovery. In South Carolina, interviewees noted that cost-benefit approaches focused mainly on monetized property values would tend to concentrate investments in wealthier coastal cities such as Charleston, even though less-resourced rural counties and communities may face high residual risks and have less capacity to cope with floods, heat and other hazards. Local governments and counties also identify specific groups whose vulnerabilities are easily missed by standard metrics, such as Native American communities, Gullah and Geechee peoples, immigrant communities with limited English proficiency, residents of mobile-home parks, and low-income households in inundation zones or heat-exposed neighbourhoods.

Where equity is pursued more deliberately, it is often through projects designed to deliver clear everyday co-benefits alongside crisis protection, for example, storm shelters that function as community or daycare facilities outside emergency situations. However, the ability to mainstream equity into adaptation practice is mediated by capacity and funding constraints. Many jurisdictions struggle to maintain baseline services, have limited staff time to sustain engagement or undertake distributional analysis, and face fragmented, hazard- and program-specific funding streams that are poorly designed for cross-portfolio coordination or for tracking who benefits. As a result, justice and equity considerations remain unevenly reflected in practice: they are visible in some local resilience initiatives, but remain marginal in others, and there are

few systematic mechanisms to ensure that adaptation investments consistently reduce, rather than reproduce, social and territorial inequalities.

Cross-regional synthesis: systemic risks, justice and equity

Across the reviewed cases, justice and equity are increasingly visible in adaptation framing but are only partially institutionalized. Differences between Europe, Southeast Asia and the US hinge largely on institutional context and capacity: European cases show a relatively dense adaptation architecture and growing analytical resources, alongside persistent fragmentation and implementation gaps; the Southeast Asian cases articulate ambitious systemic framings, but severe data and capacity constraints are frequently reported at the “last mile”, where vulnerability is highest; and the US examples illustrate how political contestation, decentralized governance and fragmented funding create pockets of equity-aware practice alongside areas where adaptation remains narrowly focused and under-resourced. Across all three contexts, strategies more often name vulnerable groups than embed equity as binding decision machinery: tools such as CDRA in the Philippines or equity-oriented support tools in Europe offer pathways, but distributional metrics, safeguards and accountability mechanisms remain rare. Without these, adaptation can unintentionally shift or intensify burdens for groups already experiencing disadvantage, even where hazards are reduced for others.

Overall, the cross-regional pattern is an implementation gap: equity language is advancing faster than appraisal criteria, monitoring systems and accountability routines that would consistently show who benefits, who is protected and who bears residual risks.

3. Deep uncertainty in systemic climate risk: tail risks and tipping points

While Section 2 focused on how systemic climate risks are being recognized and managed in practice, a second layer of complexity arises from deep uncertainty about how climate systems may evolve. Standard risk assessments and adaptation plans tend to emphasize central or “most likely” futures and incremental change, but systemic risk is also shaped by low-probability, high-impact tail events and the possibility of crossing climatic and ecological tipping points, which can trigger abrupt, irreversible shifts and cascading failures across sectors and scales (Kemp et al., 2022; Wunderling et al., 2024).

Tail risks refer to low-probability, high-impact outcomes with potentially catastrophic consequences that are poorly captured by planning based on averages or historical baselines, meaning strategies grounded in “central scenario” models may be underprepared for worst-case disruption (Global Association of Risk Professionals, 2023, 2025; Quiggin, 2018).

Tipping points are critical thresholds in Earth systems where small changes can generate disproportionately large and potentially irreversible transformations, such as large-scale ice-sheet loss, disruption of the Atlantic Meridional Overturning Circulation (AMOC), or widespread ecosystem collapse. They are characterized by non-linear dynamics, uncertain triggers and hard-to-quantify impacts that make them difficult to integrate into conventional deterministic modelling and policy appraisal (Bonnet et al., 2021; Flores et al., 2024; Nath et al., 2024; Rosser et al., 2024; Shin et al., 2025)

Taken together, the limited treatment of tail risks and tipping points can leave adaptation policy overly focused on short-term, incremental change and ill-equipped for rapid systemic shifts, including maladaptive outcomes where infrastructure and institutions are optimised for “moderate” futures (EU Joint Research Centre, 2025; Global Association of Risk Professionals, 2023, 2025).

This section therefore examines how tail risks and tipping points are conceptualized and addressed in adaptation policy in Europe, Southeast Asia and the US, and the extent to which these forms of deep uncertainty are (or are not yet) being translated into decision-making.

3.1 Europe

At both EU and member state levels, there is growing recognition that adaptation must address not only intensifying “everyday” extremes but also deep uncertainty, including tail risks and potential tipping points. Across the reviewed material, these risks are increasingly visible in strategies and assessments but remain harder to translate into routine governance and investment practice.

At EU level, the EU Adaptation Strategy and the European Climate Risk Assessment (EUCRA) explicitly flag the need to anticipate low-probability, high-impact scenarios

and the possibility of abrupt system change, reinforced by subsequent EU communications on managing climate risks (European Commission, 2021; EEA, 2024). However, operationalization remains limited, with three recurring barriers carrying similar weight in practice.

First, methodological constraints: deep uncertainty makes it difficult to model, time, and quantify tail risks and tipping dynamics, complicating prioritization and weakening the case for long-horizon investment compared with better-characterized hazards such as heatwaves or flooding.

Second, governance and coordination constraints: sectoral mandates and siloed planning structures make it difficult to act on risks that cut across domains and timescales, and there are few established EU-wide routines that embed deep-uncertainty thinking into appraisal templates, standards, or programme rules.

Third, political and financial constraints: because potential tipping dynamics and tail events have uncertain timing and benefits of anticipatory action are less visible, they often struggle to compete for attention and resources against near-term, deliverable measures – leaving long-horizon resilience thinking present in narrative terms but thinly reflected in incentives and delivery systems.

“On tipping points, the truth is stark: we don’t know how to deal with them, so we don’t.”

–EU policy official 1 (extracted from the anonymized interviews)

Member state cases reflect similar themes while illustrating different entry points for tail-risk and tipping-point considerations. In Spain, national climate risk assessment work has started to consider extreme and potentially irreversible risks using both quantitative and qualitative approaches, including efforts to model interlinked hazards and identify cascading pathways such as drought-heat-wildfire interactions (Alda et al., 2025). This strengthens the evidence base for stress-testing by treating extremes as potentially systemic events rather than isolated episodes. At the same time, the reviewed material suggests that practical planning and delivery still focus largely on short- to medium-term risks, while tipping points – though referenced – remain difficult to operationalize given uncertainty over thresholds, timing and magnitude, and are not yet consistently embedded in decision routines such as investment criteria, standards, or cross-sector triggers.

In Greece, the treatment of tail risks and tipping points follows a broader pattern seen across Europe – that they are acknowledged without being operationalized – but the implications are especially acute. Policy experts described institutions that “do not understand these risks unless they happen,” even where strategies recognize compounding hazards such as wildfires, floods and drought. These hazards are frequently handled through emergency response and recovery pathways, rather than through systematic exploration of how shocks may interact with ecological degradation, water stress and socio-economic vulnerability to generate non-linear crises or cascading failures. Research initiatives and scientific networks are emerging, but scientific insights remain weakly connected to routine policy cycles and implementation, limiting their influence on anticipatory planning and budgeting.

Ireland and Sweden also illustrate how tail risks and tipping points are more developed in assessment and research than in day-to-day adaptation delivery. While Ireland’s national risk assessment provides a structured overview of hazards, it gives limited

emphasis to high-impact, low-probability scenarios. Experts noted that consideration of tail-risks and tipping-points often remains in the research space rather than being translated into sector adaptation plans, which tend to prioritize nearer-term hazards such as flooding and heat stress. Sweden's One Health framing provides an entry point for thinking about systemic and compounding risks, but dedicated approaches for tipping-point dynamics (e.g. ecosystem collapse or interconnected infrastructure failures) are undeveloped. Interviewees also pointed to gaps in indicator and evaluation systems, which if addressed would help monitor risks over time and trigger reassessment as conditions change.

Overall, Europe combines strong analytical capacity and high-level recognition with persistent methodological, coordination and political-economy barriers that limit action on deep uncertainty. Across the reviewed cases, the recurring need is to make tail risks and tipping points more decision-relevant through long-term foresight, systematic stress-testing of critical investments and standards, clearer triggers for revisiting decisions as evidence evolves, and sustained resourcing for anticipatory resilience, so that policy does not rely primarily on learning only after shocks occur.

3.2 Southeast Asia

Across Southeast Asia, regional and national adaptation frameworks acknowledge intensifying extremes and climate-related disasters, but they rarely engage explicitly with tail risks or tipping points as distinct governance challenges. The ASEAN State of Climate Change Report (ASCCR) notes that the region is already experiencing “significant climate change impacts”, including more frequent and severe extreme events, with major social and economic consequences (ASEAN, 2021). However, the dominant framing remains incremental: adaptation is described as “site-specific, adaptive and process-oriented”, and is strongly oriented towards aligning adaptation and mitigation goals (including net-zero pathways), rather than towards explicit preparation for low-probability, high-impact systemic shocks.

The regional agenda on loss and damage reflects similar limitations. While the ASCCR reports that most ASEAN countries maintain disaster-loss databases, these tend to prioritize economic and infrastructure losses and only weakly capture non-economic impacts. It also notes that loss-and-damage projections for different future climate scenarios “have not yet been formulated”, limiting forward-looking analysis of deep uncertainty and non-linear outcomes (ASEAN, 2021). As a result, regional instruments provide only limited basis for anticipating abrupt, irreversible crises beyond general calls to strengthen data and modelling capacity.

At national level, the Philippines and Cambodia approximate tail-risk/tipping-point thinking but do not institutionalize it. The Philippines' National Adaptation Plan (NAP) uses a dual-scenario structure – a “middle-of-the-road” 2030 scenario alongside a “worst-case” 2050 scenario – to inform priorities and allow some stress-testing against more severe futures (Climate Change Commission, & Department of Environment and Natural Resources, 2023). Yet tail risks and tipping points are not defined or modelled explicitly, and there is little evidence of structured decision approaches (e.g. robust decision-making or adaptive pathways) designed for low-probability, high-impact

disruption. Cambodia's Climate Change Strategic Plan similarly references "extreme events and critical changes", indicating awareness of potential non-linear dynamics, but does not employ the analytical vocabulary or tools associated with tail risks and tipping points; interview material highlights that research capacity and data gaps constrain efforts to identify thresholds or map when systems might be pushed beyond recovery (Royal Government of Cambodia, National Climate Change Committee, 2013).

Overall, Southeast Asian adaptation planning remains centred on observable extremes and incremental change. While worst-case scenarios and growing attention to loss and damage signal rising awareness of volatility, policies still lack strong stress-testing mechanisms, multi-sectoral foresight tools and contingency arrangements geared to abrupt or irreversible crises. Deep uncertainty tends to be acknowledged in principle rather than translated into routine decision rules and preparedness strategies.

3.3 United States

In the US, attention to tail risks and tipping points is emerging but remains weakly institutionalized in the reviewed federal and state-level materials. The 2025 National Adaptation and Resilience Planning Strategy does not explicitly reference tipping points, and tail risks are not named as a distinct planning challenge, although the broader federal narrative strongly emphasizes intensifying extremes (United States of America, 2025). The National Climate Resilience Framework similarly stresses that climate change is increasing the frequency and severity of extreme weather and that large numbers of Americans have recently been affected, signalling a shifting risk profile but stopping short of translating this into formal tail-risk concepts, decision rules, or precautionary governance implications (The White House, 2023).

NCA5 reinforces this pattern. It provides rich description of hurricanes, floods, heatwaves and associated impacts, and frames escalating extremes as strengthening the case for rapid mitigation, warning that risks will continue to rise without deep emissions reductions (USGCRP, 2023). However, NCA5 gives less sustained attention to how adaptation policy should manage low-probability, high-impact scenarios that may occur even under ambitious mitigation, or how governance should respond to the possibility that underlying distributions and thresholds are changing in non-linear ways.

At state level, tail-risk and tipping-point thinking is even more implicit and typically channelled through existing hazard and infrastructure planning. South Carolina's Strategic Statewide Resilience and Risk Reduction Plan uses a coastal vulnerability index that includes an "extreme conditions" scenario (≥ 90 th percentile), indicating some statistical acknowledgement of tail behaviour (South Carolina Office of Resilience, 2023). The State Hazard Mitigation Plan defines extremes for hazards such as heat, floods and storms and compiles detailed occurrence data, but does not generally explore thresholds where qualitatively new systemic risks might emerge or how climate change could reshape hazard distributions in non-linear ways (South Carolina Emergency Management Division, 2023).

Interview evidence suggests that practical awareness of tail risks is often driven by lived experience of "unthinkable" events, such as the 2015 "thousand-year" flooding

in Columbia, South Carolina, or hurricanes that sever access routes and expose single points of failure in transport, power and water systems. These events have sometimes prompted pragmatic adaptations – e.g. strengthening critical infrastructure or requiring multiple egress routes, but responses remain largely event-specific rather than embedded in systematic stress-testing, adaptive pathways, or tipping-point governance frameworks. Overall, the reviewed material suggests that US adaptation increasingly recognizes more frequent extremes, but has yet to develop robust, formal approaches for governing tail risks and potential tipping dynamics as distinct forms of deep uncertainty.

3.4 Cross-regional synthesis: deep uncertainty, tail risks and tipping points

Tail risks, deep uncertainty and tipping points are increasingly acknowledged in assessments and policy narratives in the regions studied but remain weakly embedded in the practical machinery of adaptation (standards, appraisal, implementation and funding).

In Europe, EU strategies and risk assessments explicitly reference low-probability, high-impact events and potential tipping dynamics, yet these concerns are still more visible in analysis than in routine stress-testing or investment decision rules.

In Southeast Asia, documents emphasize intensifying extremes and loss and damage, but tail risks and tipping points are rarely treated as a distinct planning challenge. Limited data, capacity and resources also constrain efforts to examine non-linear dynamics and prepare for abrupt or irreversible change. In the US, federal and state materials describe extreme events and impacts in detail, but seldom treat them as evidence that risk thresholds and distributions may be shifting in ways that require different governance approaches.

A shared pattern is incremental, scenario-based planning oriented around “most likely” futures. As a result, critical systems (water, energy, food, health and infrastructure) may remain exposed to abrupt, compounding and cascading failures. Differences reflect institutional context – Europe’s coordination and political-economy constraints, Southeast Asia’s high vulnerability and resource limits, and US fragmentation and contestation – yet the implication is similar: governance has not yet matched the demands of robust, learning-oriented adaptation under deep uncertainty.

4. Beyond mainstreaming: shifting from systematic to systemic adaptation

Current approaches to climate adaptation are often presented as systemic, but in practice they are more accurately described as systematic adaptation: that is, climate risk considerations and adaptation are mainstreamed and integrated into each sector's planning and policy processes (Baack et al., 2024; European Commission, 2021; Hoff, 2013). While this is important progress, it is fundamentally limited because it addresses risks *within* sectors rather than *across* the interconnected systems through which climate impacts unfold. As a result, systematic approaches do not adequately account for cross-sector dependencies or for the fact that impacts in one sector frequently require coordinated action in others. For example, managing health risks during heatwaves depends not only on emergency response within the health sector, but also on action in housing, energy and urban planning – ensuring homes are adequately cooled, electricity is reliable, and urban heat islands are mitigated (Nicholls et al., 2017; Schuch et al., 2014; Tomlinson et al., 2011).

Because current frameworks are not designed to manage interdependencies, climate risk assessments and adaptation plans can miss how decisions in one area reshape risks elsewhere. Agricultural adaptation that prioritizes irrigation to address drought, for example, may neglect implications for energy generation and public water supply – highlighting the need for integrated planning across the agriculture–energy–water nexus (Dzebo et al., 2025; FAO, 2014; U.S. Department of Energy, 2014). Likewise, inaction in one domain can generate new climate risks in another: climate-proofing electricity transmission may not be prioritized in energy planning, yet aging or exposed power lines are increasingly vulnerable to high winds and extreme heat, raising risks of wildfire ignition and shifting hazards into land management, public safety and health (Wang & Bocchini, 2023).

The empirical and conceptual insights from Sections 2 and 3 reinforce this conclusion: despite increased awareness of compounding and cascading risks, tail events, tipping points and equity concerns, governance arrangements, funding streams and accountability structures still incentivize hazard- and sector-specific responses. In practice, adaptation remains largely systematic rather than systemic. Moving toward systemic adaptation requires governance and decision-making that can coordinate across sectors, manage trade-offs and competing interests, and avoid lock-in and path dependencies that amplify vulnerability. This implies not only identifying synergies and co-benefits with objectives such as mitigation, economic development and social justice, but also embedding interlinkages in how risks are assessed, priorities set, and decisions governed across scales and portfolios.

4.1 Europe

As the systemic nature of climate risk becomes increasingly evident, the interconnections between adaptation and other policy domains – economic growth, land use, social protection and the energy transition – are emerging as defining determinants of resilience in Europe. Climate impacts do not unfold neatly within sectoral boundaries; they cascade through infrastructure, production and governance systems, where decisions in one domain can either strengthen resilience or amplify vulnerability. Yet across the EU and its member states, institutional capacity to manage these policy interlinkages remains limited.

EU adaptation and preparedness strategies increasingly acknowledge these interdependencies. Officials describe a growing understanding that adaptation cannot be pursued in isolation from objectives ranging from biodiversity to competitiveness and fiscal policy. However, implementation still largely operates through mainstreaming, ensuring climate risks are considered within sectoral mandates, rather than through systemic approaches that align cross-sector priorities. As one EU official observed, “everyone understands the linkages, but no one has the mandate to manage them.” Similar dynamics are visible nationally: Sweden, Ireland, Spain and Greece have strengthened adaptation frameworks (Department of the Environment, Climate and Communications, n.d.; Government of Spain. Ministry for the Ecological Transition and the Demographic Challenge (MITERD), 2021; Government Offices of Sweden, Klimat- och näringslivsdepartementet, 2024; Ministry of Environment and Energy, 2016)), yet coordination across ministries remains weak and responsibility for intersectoral risks diffuse. Co-benefits are left untapped, trade-offs remain unresolved, and some public policies continue to exacerbate the very risks adaptation seeks to reduce.

Adaptation co-benefits: neglected and leveraged

At the European level, adaptation co-benefits are widely recognized in principle but remain weakly institutionalized. Policy experts emphasized that nature-based solutions (e.g. wetland or soil restoration) can deliver multiple dividends for flood and drought management, biodiversity, and carbon sequestration. Yet, as one senior official observed, “we talk about co-benefits constantly, but we do not know how to count them.” This captures a recurring constraint: while co-benefits are acknowledged rhetorically, the mechanisms to measure, value and prioritize them are still limited, reducing their influence on appraisal, budgeting and program design.

The Commission’s promotion of nature-based solutions remains the most visible vehicle for multi-benefit adaptation. However, interview evidence suggests implementation is often narrowly conceived as climate risk reduction rather than framed and funded as integrated environmental or socio-economic investment. The preparedness-by-design principle – requiring EU-funded projects to strengthen resilience – represents incremental progress but is still widely seen as procedural rather than transformative, particularly where the supporting machinery (e.g. metrics, assessment templates and associated routines) is not yet sufficiently developed to shift investment choices at scale. Experts also pointed to the largely untapped potential of the insurance sector to incentivize risk reduction and discourage maladaptive development, but its role in EU adaptation remains peripheral.

Overall, the EU-level picture is one of conceptual maturity but operational inertia: a persistent gap between recognizing that co-benefits matter and embedding them in routine economic and policy appraisal systems.

Among member states, similar patterns persist. In Sweden, experts noted that adaptation and civil protection share overlapping mandates and objectives but are still managed through parallel governance systems, which means efficiency gains are unrealized. Nature-based measures are recognized but often deployed ad hoc rather than through systematic programmes.

In Ireland, the co-benefits of urban greening are well understood, but remain insufficiently prioritized in practice and have yet to consistently influence investment choices or performance metrics. Spain shows visible advances in urban nature restoration and rural diversification initiatives, but their wider social and economic returns are not consistently valued or reported, limiting their competitiveness against conventional infrastructure outputs.

In Greece, ecosystem-based approaches, especially soil and watershed restoration, remain underused despite their multi-benefit potential. Modelling capacity exists in the research community, but ministries have yet to embed these insights into routine policy and programs. Taken together, these cases highlight a structural weakness: co-benefits are firmly established in principle, but the institutional and financial tools to valorize them remain nascent.

“Post-disaster recovery too often restores the status quo instead of building back better.”

–EU policy official 1 (extracted from the anonymized interviews)

Competing policy demands and risk-generating policies

The EU’s adaptation agenda operates within a dense policy landscape in which objectives frequently pull in different directions. Adaptation now features across major EU strategies, yet it continues to collide with other drivers – especially competitiveness, economic growth, and short-term fiscal efficiency. These competing demands not only dilute adaptation, they can also generate new vulnerabilities when non-climate policies proceed without systematically accounting for future climate risk.

At EU level, experts highlighted persistent tensions between adaptation goals and sectoral priorities in agriculture, energy and finance. In agriculture, long-standing emphasis on productivity and global food supply can undermine resilience when intensive practices degrade soils and water systems – the foundations of adaptive capacity. In energy, hydropower expansion in support of decarbonization can, in some contexts, increase exposure to drought and flood volatility. In finance, efforts to simplify or deregulate frameworks, such as the Sustainable Finance Taxonomy, may sideline resilience criteria and weaken incentives for long-term adaptation investment.

Experts also described a “political economy of short-termism.” Because many adaptation benefits accrue over decades rather than electoral cycles, they struggle to compete with immediately visible projects tied to employment, infrastructure, or industrial growth. This creates an institutional bias toward immediacy and a structural undervaluation of resilience in policy appraisal and prioritization. The resulting paradox is that adaptation is increasingly framed as essential to economic stability,

"We have the maps, we have the knowledge – yet people can still buy flood-prone apartments for the same price as safe ones, with no insurance required."

–EU policy official 3 (extracted from the anonymized interviews)

"It's not enough anymore to simply 'do no harm' – preparedness must be built in by design."

–EU policy official 3 (extracted from the anonymized interviews)

yet implementation can be constrained by the very growth agendas it is meant to safeguard.

This misalignment extends into post-disaster recovery, where incentives and political imperatives often favour rapid reconstruction over transformative rebuilding. Despite formal commitments to "build back better", recovery funding frequently restores pre-disaster conditions – effectively "rebuilding the same vulnerabilities" and locking in existing risk patterns rather than addressing their underlying drivers.

A further, recurring pressure comes from efforts to streamline regulation in the name of efficiency and competitiveness. While simplification can have legitimate aims, experts warned it can also remove safeguards that help prevent maladaptive development. Fragmentation within the European Commission compounds the challenge: coordination mechanisms exist, but their effectiveness can depend on the initiative of individual departments rather than institutional design, allowing contradictory measures to persist across policy silos.

National cases illustrate how these dynamics play out in practice. In Sweden, streamlined permitting and deregulation can weaken climate oversight and enable development in hazard-prone areas. In Ireland, housing supply pressures can override risk-informed spatial planning, while growth in energy-intensive data centres increases strain on water and electricity systems, creating interlocking vulnerabilities. In Spain, forestry and tourism priorities can unintentionally heighten exposure: monoculture afforestation aimed at carbon sequestration can increase susceptibility to drought, pests and wildfire, and permissive coastal planning can sustain settlement patterns in flood- and erosion-prone zones even where strategies acknowledge these risks. Greece provides a particularly acute illustration of maladaptation through policy disconnect: rapid expansion of renewables with limited spatial integration, fragmented ministerial responsibilities for wildfire, erosion and flood risk, and development choices (including large tourism projects) that intensify water scarcity and heat risk. Weak water governance has also enabled over-abstraction and aquifer depletion, aggravating salinization and livelihood pressures.

Taken together, these patterns underscore that Europe's constraint is less a lack of awareness than a misalignment between adaptation objectives and the incentives and mandates embedded in wider policy systems, which can systematically undermine resilience even as it gains prominence.

4.2 Southeast Asia

There is growing recognition in Southeast Asia that climate adaptation must be linked with broader development and governance agendas, but translating this into practice remains at an early stage. Regionally, the ASEAN State of Climate Change Report (ASCCR) and ASEAN Climate Vision 2050 frame synergies between adaptation and mitigation as central, calling for an "adaptation transition" aligned with the net-zero mitigation transition, and emphasizing cost-effective solutions that maximize well-being (ASEAN, 2021; ASEAN Secretariat, 2021). The Climate Vision's AIIM framework (Acquaint–Integrate–Involve–Motivate) reinforces this by promoting mainstreaming

into sectoral and development planning, multi-scale adaptation planning, stronger institutions, and adaptation-mitigation co-benefits.

The Philippines and Cambodia have embedded climate change within development, disaster risk reduction (DRR) and social protection strategies. The Philippines' National Adaptation Plan (NAP) links sectoral priorities (food, water, health, ecosystems and critical infrastructure) with cross-cutting enablers (technology, finance and social inclusion), and is designed to support vertical coordination through local climate change action plans alongside horizontal collaboration with academia, civil society and the private sector (Climate Change Commission, & Department of Environment and Natural Resources, 2023). Cambodia's Climate Change Strategic Plan (CCCSP) similarly provides an overarching framework bridging adaptation and mitigation, explicitly linking climate impacts to development goals and supporting mainstreaming across national and subnational plans, including connections to the National Strategic Development Plan and National Social Protection Strategy (Royal Government of Cambodia, National Climate Change Committee, 2013).

Adaptation co-benefits: Neglected and leveraged

On paper, both countries recognize that adaptation can deliver co-benefits across development, mitigation and social objectives. In the Philippines, the NAP's multi-layered structure signals an intention to align adaptation with sectoral development priorities and cross-cutting goals (including social inclusion, research and climate finance) (Climate Change Commission, & Department of Environment and Natural Resources, 2023). Experts described deliberate efforts to identify synergies – for example, ecosystem-based measures that can support food security, biodiversity and livelihoods. However, co-benefits are not yet systematically quantified or tracked: monitoring, evaluation and learning (MEL) systems remain under development, limiting the ability to manage trade-offs or prioritize measures that deliver the greatest systemic gains.

Cambodia's CCCSP similarly calls for “interdisciplinary, cross-sectoral and multi-scale approaches”. It frames adaptation within wider development and social protection agendas and explicitly engages with the water–energy–food nexus (Royal Government of Cambodia, National Climate Change Committee, 2013). It also encourages line ministries to prepare sectoral climate change strategic plans aligned with the national framework. Decentralization and DRR mechanisms – including commune-level vulnerability assessments – create opportunities to steer investments toward options that reduce climate vulnerability while supporting development, for instance by guiding choices toward multi-purpose infrastructure or social protection schemes that enhance resilience and reduce poverty.

In practice, these opportunities are only partly realized. Co-benefits are seldom measured or highlighted in reporting, and pilots often proceed without systematic evaluation of their multiple impacts. As in Europe, weak indicators and valuation approaches can leave multi-functional measures at a disadvantage in funding decisions relative to single-purpose infrastructure or sectoral projects.

Competing policy demands and risk-generating policies

Despite formal integration of climate change into development strategies, experts describe a persistent misalignment between national climate policies and local implementation realities. In Cambodia, adaptation remains highly centralized and fragmented, even as the CCCSP calls for mainstreaming across sectors and scales. Commune-level administrations receive annual funds and are responsible for local investment planning, but interviewees note that they often “just do as normal”, prioritizing conventional infrastructure projects that may not be climate-resilient. Roads, drainage and public buildings are sometimes sited or designed without accounting for future flood or heat risks, which can lock in exposure and embody new climate risks in buildings. This reveals a structural tension between national integration mandates and decentralization reforms intended to empower local actors.

Similar dynamics are visible in the Philippines, where local governments are expected to “localize” the NAP through their own plans. Limited capacity and resources, however, mean that adaptation priorities must compete with pressing development needs. Infrastructure and land-use projects can undermine adaptation goals when they protect some areas while exacerbating flooding or other hazards elsewhere. Legal frameworks may provide for compensation and safeguards, but evidence from interviews suggests that these are often weakly enforced.

4.3 United States

In the US, responsibilities for adaptation are distributed across federal agencies, states and local governments, and climate-relevant decisions are embedded across policy domains such as land use, infrastructure, public health and emergency management. The National Adaptation and Resilience Planning Strategy and NCA5 both describe climate risk as a “whole-of-system” challenge and emphasize that adaptation plans should be connected to other planning documents, performance goals and budgets (United States of America, 2025; (USGCRP, 2023). However, federal practice remains largely sectoral and hazard specific. The National Climate Resilience Framework translates high-level objectives into actions mainly through departmental strategies, without requiring cross-agency planning or joint implementation (The White House, 2023). NCA5 notes that existing policies on disasters, infrastructure and environment are often ill-suited to the long-term, transformative changes needed for effective adaptation (USGCRP, 2023).

At state and local level, repeated experience of climate-related impacts – particularly flooding and hurricanes – has raised awareness of policy interlinkages and, in some cases, driven change in planning and practice. Experts from South Carolina, for example, describe how damaging floods contributed to new coordination across state agencies and the development of a statewide resilience plan. Yet much of the policy that could improve adaptation outcomes remains anchored in specific agencies and their mandates, limiting opportunities for sustained work on cross-sectoral interlinkages.

Adaptation co-benefits: Neglected and leveraged

State and local actors often rely on adaptation co-benefits to make climate-related investments politically acceptable, especially in contexts where climate change remains contentious. Experts highlight projects that provide clear day-to-day benefits while also enhancing resilience. One example is the idea to construct a strengthened building that can function as an emergency command centre during disasters, but in normal times serve as a community centre or daycare facility. Another example is the upgrading of Columbia's water system following the 2015 floods. While the improvements enhance the city's adaptive capacity, they are framed primarily as measures to secure basic services rather than as climate adaptation per se.

This pattern reflects a broader political context in which the justification and legitimacy of adaptation investments often derive from their immediate benefits, such as safer infrastructure, better services or economic development, rather than from long-term climate arguments. As a result, adaptation co-benefits can become a crucial lever for advancing systemic resilience, even if the climate rationale remains implicit. However, the lack of systematic tracking of co-benefits means that their role in delivering broader resilience outcomes remains under-acknowledged and under-quantified, which can limit learning and replication.

Competing policy demands and risk-generating policies

Experts consistently highlight limited time, capacity and resources as major barriers to working on policy interlinkages across jurisdictions. Many municipalities and counties, particularly in rural areas, "have a hard time with just day-to-day operations", leaving little room for cross-sectoral coordination or long-term resilience planning. When adaptation is discussed, it quickly implicates multiple policy domains (e.g. zoning, transport, childcare, education, public health) raising questions about how whole communities function during and after disruptions. Yet individual departments and agencies often operate under narrow mandates and budget constraints, constraining efforts to address these interconnections.

Fragmented funding further complicates systemic approaches. Adaptation-relevant resources flow through a patchwork of federal programmes, often tied to specific hazards, sectors or eligible activities. Within a given municipality, it may not be clear who has applied for which funds or for what projects, creating risks of duplication and missed opportunities for coordination. Additional communication is required simply to ensure that funding applications do not overlap or work at cross purposes.

Where policy interlinkages are addressed, it is often the result of concrete experience of climate impacts and close, sometimes informal, collaboration between agencies and municipalities seeking to avoid a repeat of past disasters. In some cases, resilience considerations are embedded across multiple policy documents so that, regardless of which sectoral strategy is being used (e.g. transportation, land use, social services), resilience issues are visible. However, the lack of overarching coordination mechanisms and the dominance of hazard- and sector-specific funding means that development and infrastructure policies can still generate or exacerbate climate risks, for example

by enabling construction in vulnerable areas or failing to consider future climate conditions in design standards.

Overall, US practice illustrates the tension between systemic rhetoric and the realities of fragmented governance. Adaptation co-benefits can help unlock action, but without aligned mandates, funding and accountability, policy interlinkages are addressed unevenly, and risk-generating policies may persist across sectors.

4.4 Cross-regional synthesis: policy interlinkages and systemic adaptation

Across Europe, Southeast Asia and the US, adaptation is shaped by how climate action intersects with development, infrastructure, social protection and mitigation. All three regions increasingly emphasize policy interlinkages and co-benefits, yet governance, mandates and funding still favour sectoral and hazard-specific interventions, leaving synergies unrealized and allowing some policies to generate risk.

In Europe, adaptation often competes with competitiveness and short-term fiscal priorities; co-benefits (notably from nature-based solutions) are widely recognized but weakly embedded in appraisal and funding, limiting scale. In Southeast Asia, ASEAN frameworks promote synergies between adaptation and mitigation, and national strategies link climate, disaster risk reduction and development. However, delivery is constrained by centralized decision-making, limited subnational capacity and project-based financing. In the US, systemic rhetoric contrasts with fragmented practice: jurisdictional boundaries, uneven capacity and funding tied to specific hazards complicate coordination, and development or infrastructure choices can lock in exposure.

Common challenges include weak methods to value and track co-benefits; misalignment between adaptation goals and incentives in non-climate policies; and limited accountability for cross-sector risks. Differences reflect context: the EU must coordinate within a dense policy landscape, Southeast Asia integrates climate and development under high vulnerability and constrained resources, and the US faces decentralized authority and contested politics. Overall, advancing systemic adaptation requires aligning incentives, mandates and funding rules so routine decisions across sectors contribute to long-term resilience.

BOX 2: THE POLITICAL AND INSTITUTIONAL CONTEXT FOR ADAPTATION IN THE US

The political environment in the US has introduced significant uncertainty into adaptation planning and governance at the national level. The Trump administration has dismantled or weakened offices and even entire agencies with responsibility for climate and adaptation issues, while federal leadership on adaptation has become fragmented. Although some of these changes have been reversed, questions remain about the continuity and authority of national adaptation efforts.

Despite this, recent federal strategies still provide a window into how systemic climate risk is framed at the national level. The 2025 National Adaptation and Resilience Planning Strategy and the Fifth National Climate Assessment (NCA5) both describe climate risk as a “whole-of-system” challenge, emphasize compounding and cascading impacts, and call for transformative adaptation that addresses the physical and social drivers of vulnerability and integrates equity into decision-making.

At the same time, federal practice remains largely focused on specific sectors and hazards. The National Climate Resilience Framework translates high-level objectives into actions mainly through departmental strategies, without requiring cross-agency planning or joint implementation. NCA5 notes that existing policies on disasters, infrastructure and environment are often ill-suited to the long-term, widespread, and transformative changes needed for effective adaptation. As a result, there is a gap between systemic rhetoric at the federal level and fragmented implementation in practice.

In this context, state and municipal actors have become central to adaptation. Many start from other policy priorities – such as landscape restoration, hazard mitigation, or economic development – and only indirectly frame their work as climate adaptation. The preliminary US evidence presented in this report therefore focuses on these subnational experiences, using them to illustrate how systemic adaptation is constrained and enabled in a highly decentralized and politically contested governance system.

5. Discussion

This report has examined how selected governments in Europe, Southeast Asia and the US are beginning to grapple with the systemic nature of climate risk, and what this means for adaptation policy and practice. Given the exploratory approach and purposive case selection, the conclusions in this section should be read as indicative, not as representative of all countries or of entire regions. Nonetheless, they highlight both cross-cutting dynamics and important divergences. Across the reviewed cases in Europe, Southeast Asia and the US, the analysis suggests a striking convergence: climate change is increasingly framed in terms of interdependencies, cascading impacts and cross-border spillovers, yet adaptation on the ground remains largely organized around individual hazards, sectors and programs. Systemic risks are acknowledged, but are filtered through existing governance architectures, funding streams and capacity constraints, which tend to reproduce fragmented responses and uneven protection for different groups and places.

At the same time, the regional cases reveal important divergences in how these dynamics play out, shaped by differences in institutional legacies, levels of development, exposure and political context. Europe illustrates the challenges of maintaining coherence and ambition within a relatively dense and mature regional adaptation architecture; Southeast Asia highlights the tension between emerging systemic framings and severe capacity and data gaps, particularly at the local level; and the US foregrounds the effects of political contestation and complex multi-level governance on continuity and coordination. The remainder of this section synthesizes common patterns and points of divergence across the three regions, discusses their implications for governance and emerging debates on strategic resilience, and explains how these findings have informed the development of a conceptual framework intended to guide, rather than prescribe, more systemic approaches to climate adaptation policy.

5.1 Cross-regional patterns in systemic adaptation

While the evidence base in this report is intentionally uneven, it is complementary: Europe provides the most granular view (EU-level architecture plus four member states), Southeast Asia offers intermediate insight (ASEAN plus two national cases), and the US material is explicitly exploratory and used to surface dynamics in a decentralized and politically contested system. These recurring themes are best understood as working hypotheses to guide further inquiry and testing, rather than as a comprehensive mapping of adaptation practice.

A persistent gap separates systemic rhetoric from operational practice.

Strategies and assessments increasingly describe climate risk as cross-sectoral and interconnected, and in some instances recognize compounding, cascading and cross-border effects. Yet implementation routines, mandates, program design, appraisal, budgeting, and delivery still default to hazard-by-hazard and sector-by-sector logics. This “recognition–operationalization” gap is reinforced by how adaptation responsibilities are distributed across portfolios and by the fact that many

consequential resilience decisions are made through standard sectoral policy rather than through adaptation plans themselves.

Capacity and data constraints shape how far systemic ambitions can travel into practice. In Europe, constraints often relate to fragmented mandates, staffing limits, and the difficulty of integrating long-horizon uncertainty into routine policymaking even where analytical resources are comparatively strong. In the US, capacity gaps are particularly visible among smaller municipalities, rural counties and frontline communities, where immediate service pressures crowd out deeper systemic planning. In Southeast Asia, these constraints are sharpest at the “last mile”: limited granular data and weak institutional capacity in highly exposed areas make it difficult to trace secondary and tertiary effects, even when national strategies call for more systemic assessments.

Incentives and funding rules frequently steer adaptation toward narrower, reactive measures. Much implementation is mediated through existing programs focused on disaster risk reduction, infrastructure, development and social policy. Their metrics, grant conditions and appraisal conventions often privilege short-term outputs or easily monetized benefits, which can bias portfolios toward discrete projects and visible assets rather than toward interventions that manage interdependencies, reduce underlying vulnerability, or deliver co-benefits across sectors. Where incentives reward recovery more than prevention, systemic resilience goals struggle to compete.

Monitoring, evaluation and learning (MEL) lag behind systemic ambitions. Where monitoring frameworks exist, they tend to track sectoral outputs rather than systemic risk reduction. Indicators for compounding, transboundary or cascading risks remain rare. Feedback mechanisms that would allow institutions to detect maladaptation, learn from different shocks and adjust course are often thin, limiting both accountability and strategic learning across portfolios.

Equity and justice concerns are widely acknowledged but weakly institutionalized. Across regions, documents often name vulnerable groups and recognize uneven distributions of impacts and benefits. However, binding safeguards, distributional metrics, and accountability mechanisms to prevent risk shifting remain limited. Where MEL systems do not capture who benefits and who bears residual risks – including gendered and intersectional dimensions – distributional harms can persist largely unseen within national decision cycles, even when hazard impacts are reduced for some groups.

Taken together, these patterns support a central conclusion for the cases reviewed: systemic adaptation is widely recognized as necessary, but only partially realized in practice – constrained by enduring sectoral framings, limited capacity, misaligned incentives, unresolved justice questions, and under-developed governance for tail risks, tipping points, transboundary climate risk and systemic learning.

5.2 Regional divergences and their implications

Alongside shared patterns, the three regional cases also reveal distinct trajectories and constraints that shape what systemic adaptation can realistically achieve in different governance contexts. While regional labels are used as shorthand for the three cases, variation within each region is substantial, and the discussion should not be read as characterizing whole regions.

In Europe, adaptation and wider climate risk governance are comparatively advanced, supported by a strong regional regulatory architecture and extensive analytical efforts such as the European Climate Risk Assessment. EU and national documents increasingly frame climate change as a systemic, multi-hazard challenge spanning infrastructure, health, ecosystems, finance and other domains, and call for integrated approaches bridging adaptation, mitigation and disaster risk reduction. Yet the member state cases underline that fragmentation and capacity constraints are persistent: responsibilities for systemic risks are dispersed among ministries and agencies, coordination is often ad hoc, and local authorities face tight budgets and competing mandates. These conditions make it difficult to translate systemic diagnoses into implementation that consistently reflects interdependencies, cross-border dynamics and deep uncertainty.

In Southeast Asia, strategies are less mature and developed under high baseline vulnerability, limited fiscal space and strong development pressures, but several documents show conceptual innovation. The Philippines' NAP frames climate change as systemic – disruption in one sector can trigger “vicious cycles of vulnerability” – and calls for assessments tracing secondary and tertiary effects; it maps interdependencies across agriculture, water, ecosystems, health and mobility. Cambodia likewise highlights “complex and interconnected” risks and proposes organizing adaptation around food, water and energy security. Yet delivery is constrained by thin data, limited analytical capacity and structural vulnerability: implementation is sector- and hazard-based, cross-border dynamics are acknowledged but underdeveloped, and exposed localities focus on immediate hazards, with vulnerable communes least able to manage compounding and cascading risks. The result can be described as “systemic on paper, hazard-centred in practice”.

The US case is deliberately exploratory, drawing on a smaller set of federal and subnational examples, and surfaces challenges shaped by political volatility and fragmented multi-level governance. Federal strategies and assessments increasingly reference interdependencies and compounding risks (and occasionally cross-border dimensions), but implementation is influenced by contested federal leadership, divergent state-level priorities and uneven capacities among municipalities and rural counties. Some state and local actors pursue innovative systemic approaches, while others are constrained by short-term economic pressures or scepticism toward climate policy, producing a patchwork in which systemic thinking can emerge in specific places or sectors but remains vulnerable to reversals and gaps in sustained federal support.

These divergences underline that systemic adaptation is not a single model to be transferred wholesale, but a context-dependent process. They also suggest that governance systems shape which dimensions of systemic risk are recognized

and acted upon: strong regional regulation in Europe supports sophisticated risk assessment but can increase implementation burdens; non-binding regionalism in Southeast Asia allows experimentation but limits enforcement; and federal-state dynamics in the US can foster innovation in some places while leaving others exposed. Finally, progress is likely to be uneven within and between regions: pockets of good practice coexist with areas where adaptation remains focused on single hazards or sectors, or where capacity constraints and political resistance stall even incremental advances. Recognizing this unevenness is essential for realistic expectations about what systemic adaptation can deliver and for targeting support to where constraints are most severe.

5.3 Governance implications: towards strategic, systemic resilience

Across the reviewed contexts, the findings point to a need for governance innovation that goes beyond incremental mainstreaming of climate considerations into existing policy portfolios. Three strands of recent work align with this conclusion.

First, analysis of strategic resilience argues that cross-sector arrangements closer to the centre of government may be needed to treat climate change as a source of systemic risk alongside other strategic threats (Benzie et al., 2025). Relocating adaptation and resilience from environment ministries to central coordinating bodies can increase political salience, strengthen coordination across key portfolios, and enable more coherent responses to cross-border and cascading risks. However, institutional redesign is not a cure-all: without clear mandates, sustained resourcing and credible accountability, new structures risk becoming symbolic rather than transformative.

Second, recent analysis of European Green Deal implementation highlights how capacity constraints, administrative overload, competing policy demands and poorly managed interlinkages can derail transformative agendas when disruptive, economy-wide change is pursued through business-as-usual governance and limited institutional resources (Kappe et al., 2025). National authorities may struggle to transpose and coordinate large volumes of regulation, while tensions between policy objectives undermine delivery – an experience that is also relevant to systemic adaptation agendas that depend on sustained cross-portfolio coordination

Third, an essay on climate risks to mental health illustrates how hazards interact with food systems, trade, health and social determinants to produce multi-layered cascades that cut across sectors and generations, yet remain poorly captured by risk models and standard policy appraisal (Mikaelsson et al., 2025). It argues that prevailing governance structures struggle to recognize, value and manage such cascading impacts and calls for whole-of-government and whole-of-society responses that can generate cross-sector co-benefits while preventing maladaptation – echoing this report's finding that systemic risks are widely acknowledged but only partially reflected in the design and appraisal of adaptation measures.

A precautionary orientation becomes increasingly important as risks enter domains of deep uncertainty and systemic interdependence. Because many tail risks and tipping points cannot be reliably quantified in advance – and because shocks can propagate rapidly across borders through trade, finance, migration and shared ecosystems – governance systems need ways to act prudently on credible high-impact threats even when evidence is incomplete. This does not imply permanent “worst-case” planning, but ensuring that key decisions, investments and institutions are robust in the face of potentially irreversible or catastrophic outcomes, including transboundary crises that may unfold faster than expected.

Taken together with the report’s findings, these strands of work inform five initial governance recommendations, grounded in the patterns observed across the cases examined:

- **Elevate adaptation within government under a broader resilience agenda.** Move beyond environmental silos toward more central structures that can oversee systemic risk and coherence across portfolios, while avoiding a drift toward narrowly securitized framings. This helps ensure cross-border and cascading risks are treated as strategic issues rather than a peripheral environmental concern.
- **Design governance for shared risk ownership and continuity.** Clarify who owns which systemic risks, who coordinates across sectors and scales, and how accountability is maintained. Build arrangements that can endure political turnover and shifting priorities, avoiding periodic downgrading of adaptation leadership.
- **Embed systemic perspectives in everyday policy instruments.** Many consequential resilience decisions are made through “ordinary” policies (e.g. on energy, transport, housing, agriculture, trade, social protection). Systemic adaptation therefore requires routine “do-no-harm” screening to identify how policies may create, amplify or relocate risks – including transboundary risks – across sectors, groups and time, and mechanisms to redesign policies where they undermine resilience.
- **Invest in enabling conditions, especially locally and for frontline services.** Systemic adaptation depends on human, analytical and institutional capacity at local levels: decision-relevant data that captures “last-mile” realities; support for cross-sector coordination and learning; and channels for locally grounded knowledge of compounding risks, tail events and transboundary impacts to shape higher-level decisions.
- **Strengthen monitoring, evaluation and learning for systemic, equitable outcomes.** Invest in MEL that tracks cross-sector and transboundary effects, distributional outcomes (including gendered and intersectional dimensions), and lessons from extreme climate events, and feeds these insights back into everyday planning, budgeting and regulatory cycles.

5.4 Toward an initial conceptual framework for systemic adaptation: lessons from the cases

The conceptual framework presented alongside this report (www.sei.org/publications/systemic-climate-adaptation-framework) draws on insights from adaptation policy experts consulted for this project and the comparative analysis underpinning the regional and country cases. It sketches an initial picture of what systemic climate adaptation policy could look like in real governance contexts, rather than as an abstract ideal. It offers an initial way, informed by practice, to organize insights from a diverse – but necessarily partial – set of cases and expert inputs, and to translate them into decision-relevant questions and criteria that can be tailored to different governance contexts. It is intended less as a definitive model than as a means to organize what the cases suggest, surface recurring gaps, and structure further inquiry. At its core are three foundational requirements:

- **Systemic risk framing** recognizes that climate risks are interconnected, compounding and cascading across sectors, systems and borders, and that vulnerability is shaped by underlying social, economic and political conditions.
- **Policy interlinkages** highlight that adaptation outcomes depend on how climate considerations interact with wider regimes – such as trade, energy, health, social protection and development – and on the incentives and metrics that structure decisions in those domains.
- **Deep uncertainty management** emphasizes designing for futures where historical experience is a poor guide and where tail risks and tipping points cannot be ruled out.

Building on this foundation, the framework articulates normative principles – being interconnected by design, promoting shared risk ownership, prioritizing co-benefits, avoiding maladaptation, and ensuring equity and just resilience – and translates them into decision criteria for appraising measures and portfolios. These principles reflect the report’s empirical insights: persistent gaps between systemic rhetoric and hazard- or sector-based practice; the way responsibilities and risks are distributed across sectors, scales and actors; and the importance of enabling conditions such as local analytical capacity, data systems and institutional stability. The framework is therefore not presented as a definitive blueprint, but as a structured way of asking better questions about how adaptation choices reshape vulnerability and interdependencies over time.

The framework is also designed to support more robust research and evaluation by translating the report’s observations into testable questions and comparable dimensions. Future work can use it to i) extend the comparative sample (additional countries, sectors, and levels of governance), ii) apply a consistent coding scheme for “recognition” and “operationalization” across strategies, mandates, budgets, and MEL systems, iii) triangulate document analysis with interviews, process tracing, and budget/investment appraisal evidence, and iv) pilot “stress-tests” of real plans or investments to assess whether applying a subset of criteria changes prioritization, coordination, and distributional outcomes. Treated this way, the framework becomes a practical bridge between initial case-based signals and a stronger evidence base on what enables systemic adaptation governance in practice.

To make its purpose concrete: used selectively, the framework is intended to support experimentation and learning by helping decision-makers move from recognizing interconnected risks to more consistent operational choices by supporting better prioritization (co-benefits and avoiding risk shifting), better coordination (making interdependencies and shared risk ownership explicit), and more robust decisions under deep uncertainty (options that perform across a wider range of plausible futures). It is designed for use by central coordinating bodies, sector ministries and regulators, and subnational/local authorities shaping adaptation through planning, budgeting, investment appraisal, delivery and cross-sector coordination.

The framework is not a ready-made toolkit to be adopted wholesale. Given the constraints of everyday policymaking – tight budgets, limited analytical resources, competing priorities, political contestation and administrative overload – full integration would often be unrealistic (and sometimes undesirable). Instead, it is intended for selective use at key decision points to better account for systemic effects, in particular to:

- screen major investments or policy packages for systemic effects, including risk shifting and maladaptation
- prioritize measures that generate multiple co-benefits across sectors and social objectives, especially where resources are scarce
- identify governance gaps (e.g. unclear risk ownership, misaligned incentives, weak capacity at critical levels) that undermine systemic resilience
- strengthen learning and flexibility through monitoring, evaluation and iterative adjustment under deep uncertainty.

In practice, this may mean applying a small subset of principles to stress-test flagship projects or national adaptation plans or using the framework to inform cross-government structures and revisions to sector strategies. Its value lies less in exhaustive application than in shifting the questions asked – from “Does this reduce exposure to hazard X?” to “How does this change who and what is at risk, with what knock-on effects across systems, places and time?” The framework should be treated as iterative scaffolding: co-developed and revisited with those responsible for delivery, and refined through periodic stress tests of major investments or regular reviews of adaptation strategies as evidence, risks and political conditions evolve.

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