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Climate Change as a Stress Test for Public Governance

Kamu Yönetişimi İçin Bir Stres Testi Olarak İklim Değişikliği

Özden Şentürk[a]
[a]Dr., Visiting Researcher, University of Malta, Department of Risk Management and Insurance. mail: ozden.senturk@ogr.iu.edu.tr, ORCID: 0000-0002-6801-6530

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ABSTRACT

This study conceptualizes climate change as a stress test for public governance systems. Moving beyond technological and informational explanations, it examines how institutional design, coordination mechanisms, digital governance tools, and participatory processes shape climate policy implementation. The article uses a structured narrative literature review with systematic search, screening, and thematic synthesis steps, drawing on peer-reviewed studies, academic books/book chapters, working papers, and leading institutional reports. Findings show that persistent implementation gaps stem primarily from weak governance capacity, even where formal strategies and commitments exist. Core barriers include limited vertical and horizontal coordination, institutional fragmentation, low policy coherence, weak governance of digital tools, and under-institutionalized participation. The "stress test" metaphor is used analytically to show how climate change reveals structural vulnerabilities in governance systems. The study concludes that durable climate action requires long-term investment in governance reforms: strengthened coordination, closer integration of policy and budgeting frameworks, accountable governance of digital infrastructures, and institutionalized participation.

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ÖZ

Bu çalışma, iklim değişikliğini kamu yönetişim sistemleri için bir "stres testi" olarak kavramsallaştırır. Teknolojik ya da bilgi eksikliği açıklamalarının ötesine geçerek kurumsal düzenlemelerin, koordinasyon mekanizmalarının, dijital yönetişim araçlarının ve katılımcı süreçlerin iklim politikalarının uygulanmasını nasıl şekillendirdiğini inceler. Çalışmada, sistematik arama, eleme ve tematik sentez adımlarını içeren yapılandırılmış anlatı temelli bir literatür taraması kullanılmış; hakemli çalışmalar, akademik kitap/kitap bölümleri, çalışma raporları ve yüksek politika etkisine sahip kurumsal raporlar incelenmiştir. Bulgular, resmî strateji ve taahhütler bulunsa bile uygulama boşluklarının esasen yönetişim kapasitesindeki zayıflıklardan kaynaklandığını göstermektedir. Temel engeller; dikey ve yatay koordinasyon eksikliği, kurumsal parçalanmışlık, sınırlı politika uyumu, dijital araçların hesap verebilir biçimde yönetilememesi ve katılım mekanizmalarının yeterince kurumsallaşmamasıdır. "Stres testi" metaforu, iklim değişikliğinin yönetişim sistemlerindeki yapısal kırılganlıkları görünür kıldığını göstermek üzere analitik olarak kullanılır. Sonuç olarak etkili iklim eylemi; koordinasyonu güçlendiren, politika-bütçe entegrasyonunu sağlayan, dijital altyapıları hesap verebilir biçimde yöneten ve katılımı kurumsallaştıran uzun vadeli yönetişim reformları gerektirir.

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Introduction

Climate change is increasingly recognized not merely as an environmental or technical problem but as a governance challenge that confronts public institutions at every level. Earlier policy debates often treated it primarily as a scientific and technological issue, assuming that uncertainty could be reduced through further research and that emissions would be addressed through technical pathways. Contemporary climate scholarship, however, places governance at the centre of the problem because climate action depends on administrative capacity, institutional coordination, fiscal alignment, and political legitimacy (Jordan et al., 2018; OECD, 2025).

From a public administration perspective, climate change constitutes a paradigmatic example of a "wicked problem" characterized by high levels of uncertainty, cross-sectoral interdependencies, long time horizons, and contested values (Rittel & Webber, 1973; Head, 2008). Such problems cannot be addressed through linear policy instruments or siloed bureaucratic structures. Instead, they require governance arrangements capable of integrating multiple policy domains, coordinating across administrative levels, and engaging diverse stakeholders (Ansell & Gash, 2008).

Public governance therefore provides the core analytical lens for explaining why climate policies frequently fail to deliver outcomes proportionate to their stated ambitions. Despite the proliferation of national climate strategies, international agreements, and digitally networked monitoring instruments, implementation gaps persist. These gaps are visible between national targets and local action, but they also appear within the public sector through fragmented ministerial mandates, weak interagency coordination, and participation mechanisms that remain largely disconnected from binding decision-making (Bulkeley & Newell, 2010; Peters, 2018).

Recent policy analyses reinforce this diagnosis. The OECD (2025) underlines that climate governance failures often stem from weak horizontal coordination within governments and insufficient vertical alignment between national, regional, and local authorities. Similarly, UN DESA (2024) argues that the structural deficiencies revealed by climate change demand a transformation in how governments coordinate policies and allocate resources, alongside meaningful citizen engagement. At the same time, digital tools have reshaped the governance landscape of climate policy. Governments increasingly rely on data-driven platforms and algorithmic systems to monitor emissions, model climate risks, and assess policy performance against intended objectives. Proponents highlight gains in efficiency and evidence-based decision-making; however, a digitally enhanced toolset does not automatically translate into higher-quality governance without strong accountability mechanisms and transparency standards. Without safeguards for public participation, technocratic tendencies can re-emerge and narrow deliberation (Meijer & Rodríguez Bolívar, 2016; Janssen et al., 2020).

Against this backdrop, this article argues that climate change should be conceptualized as a stress test for public governance systems. Rather than treating governance as an auxiliary condition for climate policy success, the study positions governance capacity as a central explanatory factor shaping the legitimacy, effectiveness, and sustainability of climate action. The article makes three interrelated contributions. First, it reframes climate change as an institutional stress test rather than a sector-specific environmental policy problem. Second, it integrates four strands that are often discussed separately: multi-level coordination, institutional coherence, digital governance, and participation/justice. Third, it translates this integrated perspective into five governance-capacity dimensions—coordinative, policy coherence, fiscal, digital, and participatory capacity—that can guide future empirical diagnosis. The term "stress test" is used analytically as a metaphor, not as a quantitative simulation exercise. It denotes the way climate change exposes weaknesses in public institutions, coordination mechanisms, fiscal alignment, digital infrastructures, and participatory legitimacy. The argument advanced here is that effective climate action depends not only on technological innovation and ambitious targets, but also on governance arrangements capable of managing complexity, sustaining coordination, and preserving democratic legitimacy over time.

1. Review Method and Conceptual Framework

1.1. Review Design, Search Strategy, and Screening

This study uses a structured narrative literature review informed by guidance for transparent evidence synthesis in management and public policy research (Tranfield et al., 2003). Given the interdisciplinary nature of climate governance—spanning public administration, climate policy, digital government, and political science—the review combines systematic search and screening steps with narrative thematic synthesis. It is not presented as a PRISMA-style systematic review; instead, its purpose is to identify, compare, and integrate the main governance-capacity dimensions that explain climate policy implementation gaps.

Table 1: Governance Capacity Dimensions and Operational Indicators

Governance Capacity Dimension	Analytical Focus	Operational Indicators (Illustrative)
Coordinative Capacity	Vertical and horizontal coordination across governance levels	Existence of binding intergovernmental coordination bodies; formal national–local climate planning alignment; regular feedback mechanisms
Policy Coherence Capacity	Alignment of climate objectives across policy sectors	Consistency between climate goals and energy, transport, and fiscal policies; absence of contradictory subsidies; integrated climate strategies
Fiscal Capacity	Availability and alignment of financial resources	Climate budget tagging; share of climate-related expenditure; long-term climate financing instruments
Digital Capacity	Governance of data-driven and digital tools	Transparent MRV systems; open climate data platforms; algorithmic impact assessments; data stewardship frameworks
Participatory Capacity	Democratic inclusion and procedural justice	Institutionalized public consultations; citizens' assemblies; stakeholder participation linked to decision authority

Source: Author's compilation based on governance and policy capacity and coherence frameworks (Wu et al., 2015; Nilsson et al., 2012), collaborative governance design (Ansell & Gash, 2008; Emerson et al., 2012), and digital/data governance principles for the public sector (Meijer & Rodríguez Bolívar, 2016; OECD, 2022). Climate budgeting and tracking indicators are informed by public finance guidance (OECD, 2021; World Bank, 2021; UNDP, 2021).

To enhance analytical precision, this study further operationalizes the concept of governance capacity. While governance capacity is often treated as a broad and abstract construct, its analytical usefulness depends on the identification of observable and comparable indicators. Governance capacity is therefore defined here as a multidimensional construct comprising coordinative, policy coherence, fiscal, digital, and participatory dimensions. The source corpus was developed through multidatabase searches in Scopus and Web of Science Core Collection, supplemented by targeted searches in ScienceDirect for climate-governance and digital-governance articles and in Google Scholar for working papers, books, and highly cited conceptual sources. In addition, authoritative institutional and policy sources were retrieved from OECD iLibrary, UN DESA publications, UNDP knowledge repositories, and the World Bank Documents & Reports portal to capture governance-relevant grey literature with high policy influence (OECD, 2021; UN DESA, 2024; UNDP, 2021; World Bank, 2021).

The search used combinations of the following keyword clusters:

1. climate governance terms: "climate governance", "climate policy", "adaptation governance", "mitigation governance", "climate mainstreaming";
2. public governance terms: "public governance", "governance capacity", "policy coherence", "institutional fragmentation", "multi-level governance";
3. digital governance terms: "digital government", "data-driven governance", "open data", "algorithmic governance", "data governance", "climate data platform", "MRV systems";
4. participation/justice terms: "participation", "deliberative governance", "climate justice", "procedural justice", "just transition".

A representative Boolean string was: ("climate governance" OR "climate policy") AND ("multi-level governance" OR "policy coherence" OR "governance capacity") AND ("digital government" OR "data-driven" OR "data governance" OR "algorithmic governance" OR "open data").

The screening proceeded in three stages. First, titles and abstracts were reviewed for relevance to climate governance, public governance, and public policy processes. Second, full texts were assessed against three inclusion criteria: (i) the source addressed climate change in relation to governance structures or processes rather than only environmental outcomes; (ii) it focused on public-sector institutions, public policy processes, or governance-relevant interactions with subnational and non-state actors; and (iii) it contributed conceptually, empirically, or methodologically to at least one analytical dimension of this review (multi-level governance, fragmentation/coherence, digital governance, or participation/justice). Third, selected sources were coded against the governance-capacity dimensions shown in Table 1. Studies were excluded if climate change appeared only as background context, if the focus was purely technical without public-governance implications, or if the source did not contribute to the analytical categories. The final synthesis retained 42 sources cited in the reference list. Because the review was developed through iterative structured searches rather than a single database export, exact initial hit and exclusion counts were not used as an inclusion metric; the synthesis therefore reports conceptual patterns, implementation risks, and research gaps rather than statistical effect sizes.

1.2. Conceptual Framework

The concept of governance is crucial for analysing how state structures respond to integrated and systemic challenges such as climate change. In this study, governance is understood beyond the narrow sense of hierarchical command-and-control implementation inside public administration (Kooiman, 2003; Rhodes, 2007). A network-oriented conception is adopted because climate risks cross administrative boundaries and require coordination among public, private, and societal actors.

Governance, in this wider sense, refers to the systems and mechanisms through which collective goals are set, pursued, and enforced under conditions of diffused authority and high interdependence (Pierre & Peters, 2000). Climate governance therefore extends beyond formal government action to include non-state actors, multi-level institutions, and hybrid decision-making arrangements that influence climate-related choices. Climate policy outcomes are shaped not only by regulatory instruments but also by the capacity of governance systems to coordinate actors, mobilize resources, align incentives, and build legitimacy under uncertainty (Jordan et al., 2018).

In public governance scholarship, climate change is increasingly framed as a challenge that exposes the limits of sectorally fragmented and institutionally weak systems. Traditional governance arrangements are generally designed for relatively stable and bounded policy problems. Climate risks, by contrast, connect energy, urban planning, fiscal policy, social protection, welfare, and technological innovation. A governance-capacity perspective is therefore useful because it links climate governance to broader debates on policy integration, institutional adaptability, and the state's ability to manage complex, cross-cutting risks.

Another key dimension is policy coherence, which refers to the alignment of policy objectives and instruments across sectors and levels of government (Nilsson et al., 2012). Climate change governance requires strong policy coherence, as climate objectives must be integrated into energy systems, transportation planning, fiscal policy, and social protection mechanisms. However, empirical studies consistently demonstrate that climate goals are often subordinated to short-term economic priorities or fragmented across competing policy domains (Jordan & Lenschow, 2010). From a governance perspective, this lack of coherence reflects deeper institutional and political constraints rather than purely technical failures.

The conceptual framework adopted in this study also draws on theories of collaborative and network governance, which emphasize the role of horizontal coordination and stakeholder engagement in addressing complex policy problems (Ansell & Gash, 2008). Climate governance increasingly relies on partnerships among governments, private-sector actors, civil society organizations, and scientific institutions. These arrangements can enhance problem-solving capacity and legitimacy, but they also raise questions about accountability, power asymmetries, and democratic control (Emerson et al., 2012). Understanding climate governance, therefore, requires attention to both the potential and the risks of collaborative governance mechanisms.

Multi-level governance theory was initially developed to explain decision-making within the European Union by analyzing how authority is distributed across supranational, national, regional, and local levels; it has since been applied to policy domains where responsibilities and resources are similarly dispersed (Hooghe & Marks, 2003, 2004). Climate change governance fits this pattern because international agreements, national strategies, and local implementation are tightly interlinked. However, a multi-level architecture does not automatically produce coordination: weak interaction across levels can create implementation gaps and accountability deficits (Bulkeley et al., 2014). Digitalization adds an additional layer to this conceptual framework. Digital governance can be understood as the use of data-driven technologies, digital platforms, and algorithmic tools in public decision-making (Meijer & Rodríguez Bolívar, 2016). In climate policy, such tools are increasingly used for emissions monitoring, climate-risk modeling, and policy evaluation. While they may support transparency and evidence-based governance, scholars caution against narrow technocratic interpretations: without safeguards, digital systems can centralize expertise, obscure decision logic, and weaken democratic oversight. Normatively, legitimacy and justice are therefore preconditions for assessing climate governance; governance must address procedural fairness, inclusiveness, and transparency (Scharpf, 1999). If climate policies harm vulnerable groups or exclude citizens from decision-making, they can erode public trust and political commitment.

Taken together, these conceptual strands suggest that climate change governance cannot be reduced to a single model or instrument. Instead, it involves a dynamic interplay between institutional structures, coordination mechanisms, technological tools, and democratic processes. This study adopts an integrative framework that brings together governance capacity, policy coherence, multi-level coordination, digital governance, and participation as interdependent dimensions of climate governance in the public sector. By situating climate change within this broader governance framework, the article moves beyond sector-specific analyses and highlights the structural conditions under which climate policies are formulated and implemented. This

conceptualization lays the foundation for the subsequent sections, which examine in detail how multi-level governance arrangements, institutional fragmentation, digital tools, and participatory mechanisms shape climate governance outcomes.

1.3. Literature Review

Table 2 synthesizes key strands of contemporary climate governance literature by integrating academic research and institutional reports across four interrelated thematic dimensions: multi-level and polycentric governance, policy coherence, digital transformation in governance, and participatory justice. Rather than providing an exhaustive review, the table maps influential and representative contributions that collectively demonstrate how governance capacity, institutional coordination, and accountability mechanisms influence climate policy implementation. By juxtaposing peer-reviewed studies with major international policy reports, the table highlights both analytical insights and practical governance challenges across various decision-making levels.

Table 2: Literature Review

Reference	Publication Type	Thematic Category	Key Findings / Contributions
Contipelli, E. (2018). Multi-level Climate Governance: Polycentricity and Local Innovation.	Peer-reviewed journal article	Multi-level & polycentric governance	Polycentric governance enhances local innovation capacity and facilitates cooperation across governance levels by enabling experimentation and adaptive learning.
Cole, D. H. (2011). From Global to Polycentric Climate Governance.	Institutional working paper	Multi-level & polycentric governance	Argues that climate governance requires multiple, semi-autonomous but interconnected decision centers to foster policy learning, experimentation, and resilience.
Dubash, N. K., et al. (2022). National and sub-national policies and institutions.	International organization report (IPCC)	Multi-level & polycentric governance	Over 10,500 cities and ~250 regions have made voluntary mitigation pledges, yet local actors face persistent deficits in national support, finance, and institutional capacity.
Dzebo, A., Shawoo, Z., & Browne, K. (2025). Does Policy Coherence Make National Implementation of Global Sustainability Agendas More Successful?	Peer-reviewed journal article	Policy coherence	Although policy coherence is widely endorsed, political barriers and value conflicts often undermine implementation, disproportionately burdening vulnerable groups while privileging dominant interests.
OECD (2025). Government at a Glance 2025: Policy coherence and coordination for sustainable development.	Institutional report	Policy coherence	Effective climate governance requires cross-sectoral coordination and long-term strategic vision; most governments have established inter-ministerial coordination mechanisms, with mixed effectiveness.
European Parliamentary Research Service (2019). A Governance Framework for Algorithmic Accountability and Transparency.	Institutional policy report (STOA)	Digital transformation & governance	Recommends mandatory algorithmic impact assessments for public authorities and stresses the need for coordinated transparency and accountability standards for algorithmic systems.
Lamb, W. F., et al. (2020). What are the social outcomes of climate policies?	Peer-reviewed journal article	Participatory justice & inclusiveness	Most climate policies fail to generate positive social outcomes; equitable climate action requires distributive and procedural justice mechanisms to ensure fair cost-benefit sharing.
IPCC (2023). Climate Change 2023: Synthesis Report.	International organization report	Participatory justice & inclusiveness	Prioritizing equity, climate justice, inclusiveness, and just transition processes is essential for durable mitigation and adaptation outcomes.
OECD (2025). Government at a Glance 2025: Governing for the Green Transition.	Institutional report	Participatory justice & inclusiveness	Inclusive justice systems and strengthened legal protections—particularly for Indigenous land rights—are critical to building societal consensus for climate action.
Van Loo, R. (2022). Stress Testing Governance.	Peer-reviewed law review article	Stress-testing approach	Governance stress tests can enhance crisis preparedness, but their effectiveness is often limited by weak transparency, voluntary participation, and insufficient oversight.

Source: (Cole, 2011; Contipelli, 2018; Dubash et al., 2022; Dzebo et al., 2025; European Parliamentary Research Service, 2019; IPCC, 2023; Lamb et al., 2020; OECD, 2025; Van Loo, 2022)

Collectively, the studies summarized in Table 2 reveal several converging patterns. First, climate governance outcomes are significantly influenced by the degree of vertical and horizontal coordination across governance levels; polycentric arrangements facilitate innovation but also introduce coordination challenges. Second, policy coherence is identified as a necessary but insufficient condition for effective implementation, as political

economy constraints and institutional fragmentation often impede practical alignment. Third, although digital and algorithmic governance tools enhance monitoring, foresight, and resource allocation, they also introduce risks related to opacity, bias, and accountability. Finally, the literature consistently emphasizes that governance arrangements lacking distributive and procedural justice mechanisms may exacerbate social inequalities and erode public legitimacy. Recent work on subnational climate action, climate paradiplomacy, and sustainable digitalization extends this pattern: cities, regions, and digital infrastructures can accelerate implementation, but their effectiveness depends on coordination, reliable data governance, and inclusive access (Balogun et al., 2020; de Macedo et al., 2023; Hsu et al., 2020; Mietule et al., 2025). These insights establish a conceptual basis for reframing climate change as a stress test for public governance systems, rather than viewing it solely as a technical policy issue.

2. Multi-Level Governance in Climate Policy

2.1. Theoretical Foundations of Multi-Level Climate Governance

Multi-level governance (MLG) has become a foundational concept in the analysis of climate policy, reflecting the dispersion of authority across supranational, national, regional, and local levels of government. Originally developed to explain decision-making structures within the European Union, the MLG framework challenges state-centric models by emphasizing overlapping competencies, shared authority, and interdependent policy processes (Hooghe & Marks, 2003). Climate change governance exemplifies this complexity, as climate-related decisions are shaped simultaneously by international agreements, national policy frameworks, and local implementation dynamics.

From a theoretical standpoint, climate change represents a policy domain in which no single level of government possesses sufficient authority or capacity to act independently. International climate regimes define broad objectives and norms, national governments translate these commitments into legal and policy frameworks, and subnational actors operationalize climate action through planning, infrastructure, and service delivery (Bulkeley & Newell, 2010). Multi-level governance thus provides an analytical lens to understand how climate policies emerge from interactions across levels rather than from hierarchical command-and-control structures.

However, the literature also emphasizes that MLG should not be interpreted as an inherently effective governance model. While it enables flexibility and experimentation, it also introduces coordination challenges, blurred accountability, and uneven capacity across levels (Jordan et al., 2018). In the context of climate change, these tensions are particularly pronounced due to long-term policy horizons, scientific uncertainty, and competing economic and social priorities.

2.2. Vertical Coordination and Implementation Gaps

A recurring theme in the climate governance literature is the persistent gap between national climate commitments and local-level implementation. National governments often adopt ambitious mitigation and adaptation targets, yet these goals frequently fail to translate into concrete action at the subnational level (Peters, 2018). This phenomenon is widely attributed to weak vertical coordination mechanisms and misaligned policy instruments across governance levels.

Vertical coordination challenges manifest in several ways. First, local governments are often tasked with implementing climate policies without adequate financial resources, technical expertise, or legal authority (OECD, 2025). Second, national climate strategies may lack sufficient flexibility to accommodate local conditions, leading to policies poorly adapted to regional socio-economic and environmental contexts. Third, overlapping responsibilities between national and subnational institutions can create ambiguity about accountability, thereby reducing incentives for effective implementation.

Empirical studies demonstrate that successful climate governance requires not only a clear division of responsibilities but also institutionalized coordination mechanisms that facilitate information sharing, joint planning, and policy learning (Bulkeley et al., 2014). In the absence of such mechanisms, climate policies risk becoming symbolic commitments rather than operational strategies. UN DESA (2024) emphasizes that strengthening vertical coordination is essential to bridge the gap between high-level climate objectives and place-based action. Notably, the literature suggests that vertical coordination should not be understood as a one-way transmission of policy from the center to the periphery. Instead, effective multi-level governance depends on feedback loops through which local experiences inform national policy revision. This interactive model of governance enhances adaptability and resilience, particularly in the context of climate risks that vary significantly across regions.

2.3. The Role of Cities and Subnational Actors

Cities and subnational governments have emerged as central actors in climate governance, often operating as policy innovators and first movers. Urban areas concentrate population, infrastructure, and economic activity, making them both highly vulnerable to climate risks and strategically positioned to implement mitigation and adaptation measures (Betsill & Bulkeley, 2006). Recent research also shows that subnational and non-state initiatives may make a substantial contribution to mitigation, although their actual contribution depends on implementation, tracking, and coordination with national commitments (Hsu et al., 2020). As a result, climate governance research increasingly focuses on cities and regions as critical sites of multi-level interaction.

The literature highlights that cities frequently adopt climate initiatives that exceed national requirements, particularly in areas such as energy efficiency, public transportation, and urban resilience. These initiatives are often facilitated through transnational municipal networks, which enable knowledge exchange, norm diffusion, and climate paradiplomacy beyond national frameworks (Bulkeley & Newell, 2010; de Macedo et al., 2023). Such dynamics illustrate how multi-level governance extends horizontally across jurisdictions, not solely vertically between levels. Nevertheless, the growing prominence of cities in climate governance also raises governance concerns. Uneven administrative capacity among municipalities can exacerbate territorial inequalities, while reliance on voluntary networks may undermine democratic accountability (Schlosberg, 2013). Moreover, strong local leadership does not compensate for weak national coordination; without supportive national frameworks, local climate action risks fragmentation and limited scalability.

Recent governance analyses argue that cities should be integrated into national climate strategies through formalized coordination mechanisms rather than treated as autonomous actors (OECD, 2025). This integration requires aligning regulatory frameworks, fiscal incentives, and data infrastructures across levels of government. From a governance perspective, the challenge is not merely to empower cities, but to embed local innovation within coherent multi-level policy systems.

2.4. Multi-Level Governance as a Source of Both Opportunity and Risk

Taken together, the literature portrays multi-level governance as both an opportunity and a risk for climate policy. On the one hand, it enables experimentation, local adaptation, and policy learning. On the other hand, it introduces coordination failures, accountability gaps, and capacity asymmetries that can undermine climate action. Whether multi-level governance enhances or constrains the effectiveness of climate policy depends mainly on the institutional design of coordination mechanisms and the distribution of resources and authority across levels.

This ambivalence underscores the importance of viewing multi-level governance not as a normative ideal but as a governance arrangement that must be actively managed. Climate change governance requires deliberate institutional choices to align policy objectives, clarify responsibilities, and sustain cooperation across levels. Without such efforts, multi-level governance risks reinforcing fragmentation rather than fostering integration

3. Digital Governance and Data-Driven Climate Policy

3.1. Digitalization as a Transformative Force in Climate Governance

Digitalization has emerged as a central driver of transformation in public governance, reshaping how governments collect information, design policies, and monitor outcomes. In climate policy, digital tools are increasingly prominent in emissions tracking, climate-risk modeling, early warning systems, and policy evaluation. These developments have fueled expectations that data-driven governance can enhance the effectiveness, transparency, and responsiveness of climate action (Meijer & Rodríguez Bolívar, 2016). Research on urban adaptation and sustainable digitalization further shows that digital tools can strengthen early warning, resource management, citizen engagement, and the twin digital-green transition when they are embedded in sustainability-oriented and inclusive governance frameworks (Balogun et al., 2020; Mietule et al., 2025).

From a governance perspective, however, digitalization should not be understood merely as a technological upgrade. Instead, it constitutes a profound reconfiguration of decision-making processes, power relations, and accountability mechanisms within the public sector (Janssen et al., 2020). Climate governance offers a particularly salient context for examining these dynamics, as digital tools mediate interactions between scientific knowledge, administrative authority, and political judgment. The literature increasingly cautions against techno-deterministic narratives that portray digital technologies as neutral solutions to governance failures. While data-driven systems can improve analytical capacity, they also risk reinforcing technocratic decision-making and marginalizing non-expert forms of knowledge if not embedded within robust governance frameworks (Kitchin, 2014). In climate policy, this tension is evident in the growing reliance on complex models and indicators that may obscure normative choices and distributional consequences.

3.2. Data-Driven Climate Governance: Opportunities and Risks

Data-driven climate governance refers to the systematic use of digital data, analytics, and modeling tools to inform climate-related decisions. Governments increasingly employ satellite data, sensor networks, and algorithmic models to monitor greenhouse gas emissions, assess climate risks, and evaluate policy performance (Hughes et al., 2020). These tools promise enhanced precision, real-time monitoring, and evidence-based policymaking.

Table 3: Opportunities and Governance Risks of Digital Tools in Climate Policy

Digital Governance Function	Potential Benefits	Governance Risks
Emissions Monitoring (MRV systems)	Improved transparency and real-time tracking	Indicator fixation; data manipulation risks
Climate Risk Modelling	Enhanced anticipatory capacity and scenario analysis	Technocratic decision-making; opaque assumptions
Data Dashboards and Platforms	Public access to climate information	Unequal access; digital exclusion
Algorithmic Decision Support	Efficiency and consistency	Accountability dilution; algorithmic bias

Source: (Balogun et al., 2020; Hughes et al., 2020; Janssen et al., 2020; Kitchin, 2014; Meijer & Rodríguez Bolívar, 2016; Mietule et al., 2025; OECD, 2025; OECD, 2021)

Table 3 highlights that digital tools in climate policy simultaneously enhance monitoring, transparency, and anticipatory capacity, while also introducing governance risks related to accountability, bias, and technocratic opacity. The effectiveness of digital climate governance, therefore, depends not on technological sophistication alone but on robust institutional safeguards that ensure transparency, oversight, and democratic control. The literature identifies several governance benefits associated with data-driven approaches. First, digital tools can improve transparency by making climate data publicly accessible, enabling external scrutiny and accountability. Second, they can support coordination across institutions by providing shared information platforms that align policy actors around standard metrics and targets. Third, digital analytics can enhance anticipatory governance by enabling scenario analysis and early warning systems for climate-related risks (Balogun et al., 2020; OECD, 2021).

At the same time, empirical studies highlight significant limitations. Hughes et al. (2020) argue that data-driven climate governance may incentivize governments to prioritize narrowly measurable indicators at the expense of broader sustainability goals. Similarly, Kitchin (2014) warns that algorithmic systems can embed hidden assumptions and biases, shaping policy outcomes in ways that are difficult to contest. From a governance standpoint, these risks underscore the importance of scrutinizing not only data availability but also the institutional contexts in which data are produced, interpreted, and used.

4. Discussion

4.1. Synthesis: Climate Change as a Stress Test for Public Governance

The preceding sections examined climate change governance through multi-level coordination, institutional fragmentation, digitalization, and participation. The main pattern is clear: climate change does not merely challenge specific policy sectors; it exposes structural weaknesses within public governance systems. This section therefore synthesizes the review by treating climate change as a stress test for governance capacity and by showing how institutional arrangements condition the effectiveness, legitimacy, and durability of climate action.

A central insight is that governance failures in climate policy are rarely attributable to the absence of technical solutions or scientific knowledge. They more often reflect limitations in coordination, policy coherence, fiscal alignment, and democratic engagement (Jordan et al., 2018; OECD, 2025). Climate change thus works as a diagnostic pressure: it makes governance deficits visible because climate action requires sustained coordination across institutions, sectors, territorial levels, and time horizons.

Multi-level governance illustrates this dynamic directly. The dispersion of authority across governance levels enables flexibility and local adaptation, but it also creates coordination pressures. Without institutionalized vertical coordination, shared data systems, and feedback loops, multi-level governance can widen implementation gaps and blur accountability (Bulkeley et al., 2014). Climate change intensifies these pressures because it requires policy decisions that remain coherent across changing scientific, fiscal, and political conditions.

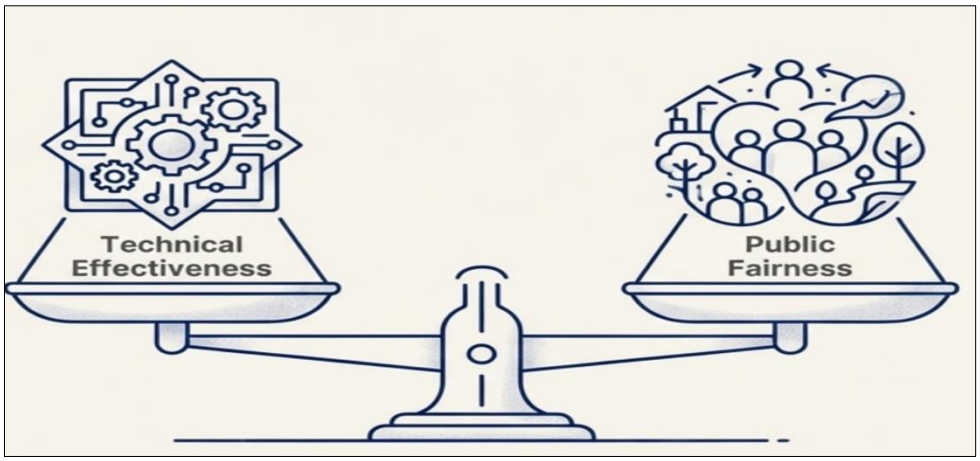
Institutional fragmentation compounds these challenges. Fragmented governance structures weaken policy coherence by dispersing responsibilities across ministries and agencies with divergent mandates. Climate

objectives, which require long-term commitment and cross-sectoral integration, are particularly vulnerable to such fragmentation (Peters, 2018). From a governance-capacity perspective, fragmentation is not merely an organizational inconvenience; it is a systemic risk that constrains the state's ability to act strategically.

Digitalization creates a second layer of stress. Data-driven tools can improve monitoring, forecasting, and policy evaluation; however, they can also reinforce technocratic decision-making and obscure accountability when transparency, data stewardship, and oversight mechanisms are weak (Janssen et al., 2020). Climate governance therefore reveals a central paradox of digitalization: more sophisticated tools do not automatically produce more legitimate or effective governance.

Participation and climate justice further underscore the governance-intensive nature of climate change. Climate policies entail distributional consequences that cannot be resolved through technical analysis alone. Legitimacy and social acceptance depend on inclusive decision-making processes that recognize diverse perspectives and address equity concerns (Schlosberg, 2013). Where participation remains weak or symbolic, climate governance risks political backlash and declining public trust. Digitalization and algorithmic decision-support systems sharpen this issue because their design choices may affect representation, resource allocation, and risk distribution. As Figure 1 illustrates, digital climate governance must therefore balance technical effectiveness with public fairness; otherwise, data-driven optimization may reproduce or intensify social inequalities rather than support just climate action.

Figure 1: Balancing Technical Effectiveness and Public Fairness in Digital Climate Governance



Source: Created by the author

This synthesis supports the argument that climate change should be conceptualized as a governance challenge rather than merely an environmental problem. Climate policy outcomes depend not only on policy design but also on the institutional and political contexts in which policies are embedded. Governance capacity becomes a critical explanatory variable because it shapes how climate objectives are translated into action, how trade-offs are negotiated, and how legitimacy is sustained over time.

The implication is that incremental adjustments to existing governance arrangements are unlikely to be sufficient. Climate change calls for governance reform that privileges coordination over administrative silos, learning over rigid control, and participation over technocracy. This does not imply abandoning expertise or efficiency; it requires embedding them within transparent, accountable, and inclusive governance frameworks.

In this sense, climate governance is both a challenge and an opportunity. It exposes structural weaknesses in public governance systems, but it also creates momentum for institutional innovation. Governments that adapt their coordination mechanisms, fiscal frameworks, digital infrastructures, and participation systems in response to climate change may improve not only climate performance but also broader governance capacity.

4.2. Implications for Future Research

The review identifies five priority directions for future research. First, more comparative empirical work is needed to evaluate how different institutional designs, such as binding versus advisory coordination bodies, shape multi-level climate implementation and accountability outcomes. Second, research should better integrate digital governance and climate justice by examining how data infrastructures and model choices distribute risks and resources across communities, particularly where digital divides persist. Third, scholarship should advance measurement approaches for climate governance capacity, linking governance dimensions (coordinative, policy

coherence, fiscal, digital, and participatory) to observable policy outputs and legitimacy indicators. Fourth, more attention is needed on budgeting and public finance instruments—such as green budget tagging and climate expenditure tracking—as mechanisms of policy coherence rather than technical accounting exercises (OECD, 2021; World Bank, 2021; UNDP, 2021). Finally, future studies should examine governance risks of data-driven climate tools, including accountability dilution and vendor dependence, and develop auditable documentation standards and oversight models for public-sector climate analytics (OECD, 2022; Hughes et al., 2020).

For policymakers and public managers, the literature implies that closing the climate implementation gap requires institutional reforms rather than isolated projects. First, governments should formalize vertical coordination mechanisms and feedback loops that align national targets with local planning and delivery, consistent with UN DESA's guidance on strengthening multilevel governance for climate mitigation and adaptation (UN DESA, 2024). Second, addressing fragmentation requires embedding climate objectives into core budgeting and accountability systems via green budgeting tools and expenditure tracking, ensuring that tagging practices inform resource allocation and performance management rather than remaining descriptive exercises (OECD, 2021; World Bank, 2021; UNDP, 2021). Third, digital climate tools should be governed as accountability infrastructures: governments should define data stewardship roles, interoperability standards, public documentation requirements, and independent verification arrangements, consistent with OECD data governance policy guidance (OECD, 2022). Finally, participation should be institutionalized with inclusion safeguards and explicit links to decision authority, ensuring that climate governance is not only effective but also legitimate and socially sustainable.

Conclusion

This review contributes to climate governance and public administration scholarship by integrating four strands that are often treated separately: multi-level coordination, institutional coherence, digital governance, and participation/justice. It also operationalizes the stress-test metaphor through five governance-capacity dimensions: coordinative, policy coherence, fiscal, digital, and participatory capacity. In this respect, the study offers both a conceptual synthesis and a diagnostic framework for public institutions seeking technologically sustainable and democratically legitimate climate governance.

The synthesis shows that persistent climate-policy failures cannot be explained adequately by informational or technological deficits alone. They stem from weak vertical and horizontal coordination, fragmented policy mandates, insufficient fiscal alignment, under-governed digital infrastructures, and weakly institutionalized participation. Climate change amplifies these weaknesses because it places sustained pressure on governance arrangements originally designed for more bounded and short-term policy problems (Jordan et al., 2018; OECD, 2025).

The practical implication is direct: durable climate action requires governance reform. Public institutions need formal coordination mechanisms, climate-responsive budgeting and expenditure tracking, transparent and auditable digital tools, and participatory mechanisms connected to decision authority. Without these reforms, climate policies risk remaining fragmented, technocratic, or socially contested.

The study is conceptual and review-based; it does not claim to measure causal effects across countries or policy sectors. Its value lies in offering a structured analytical lens for future comparative and empirical research. Viewed as a stress test, climate change reveals where public governance systems require integration, accountability, adaptive capacity, and democratic legitimacy to deliver effective and resilient climate action.

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