

Mainstreaming climate adaptation and institutionalization: focusing on the water management of the third national climate adaptation plan of South Korea

Changdeok Gim ^{a,*} and Jiyoung Shin^b

^a Water UCI, Department of Urban Planning and Public Policy, University of California, Irvine, CA, USA

^b Korea Adaptation Center for Climate Change, Korea Environment Institute, Sejong, Korea

*Corresponding author. E-mail: cgim@uci.edu

 CG, 0000-0001-7848-1404

ABSTRACT

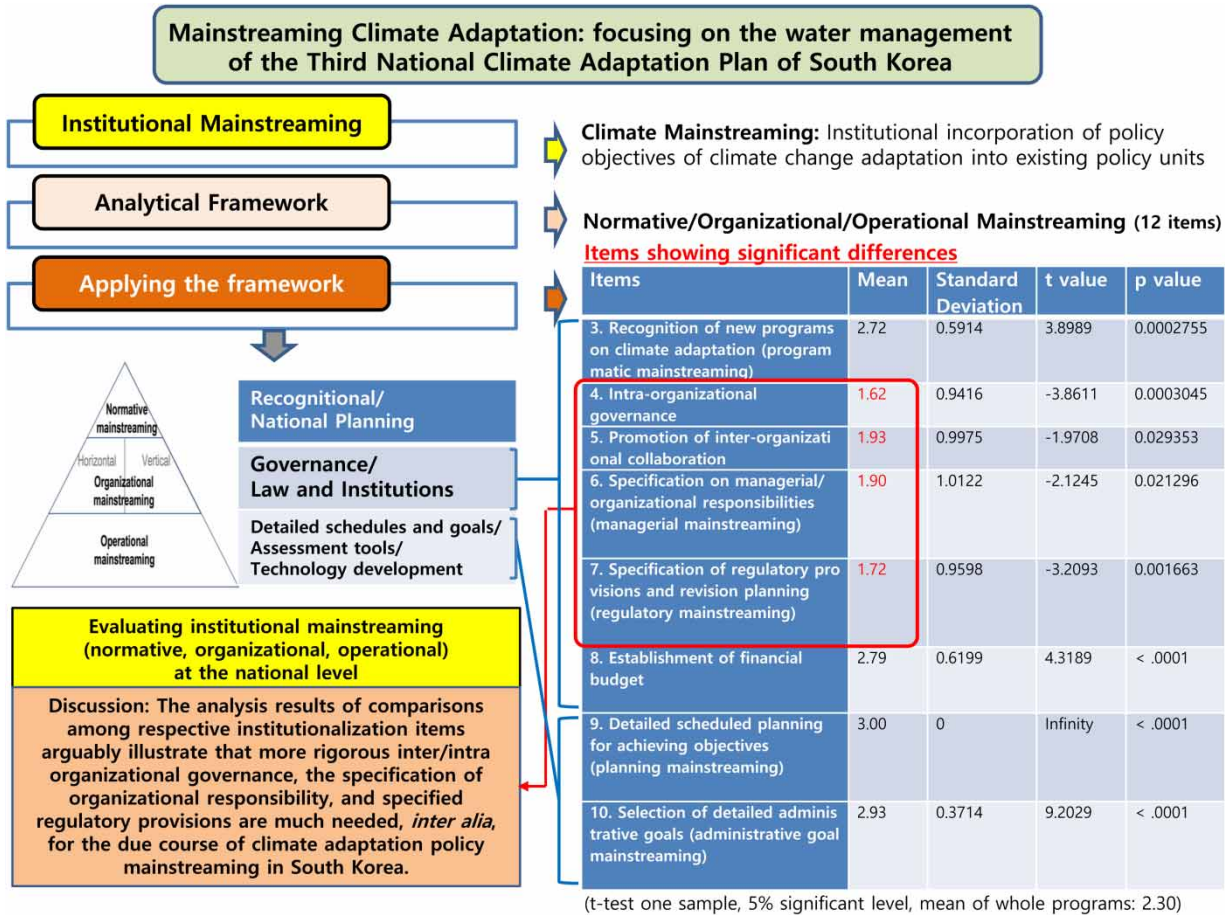
The Government of South Korea has devoted efforts to mainstream climate adaptation in the national framework for a decade, and the recent National Climate Adaptation Plan (2021–2025) is a part of the continued institutionalizing endeavor to enhance adaptive capacity. To cope with climate threats, such as financial loss and death toll, confirmed at the 55th Session of the Intergovernmental Panel on Climate Change (IPCC) in 2022, addressing a fundamental question of how to mainstream climate adaptations at the governmental policy level came to the fore. This study builds an analysis framework comprising three different domains of institutionalized mainstreaming – normative, organizational, and operational approaches – to understand how far climate adaptation has been institutionalized. Further, the framework is applied to analyze the extent to which an administrative project ‘I. Water Management’ specified in the Detailed Implementation Programs has been mainstreamed. The analysis results indicate more rigorous inter/intra organizational governance and responsibility supported by regulatory provisions are much needed, *inter alia*, for the due course of institutionalizing climate adaptation. It can be quite challenging to achieve national climate adaptation in a timely manner when there is a lack of comprehensive integration of resilience institutions into national recognition, regulatory organization, and operational tools.

Key words: analysis framework, climate adaptation, institutionalization, mainstreaming, national adaptation plan, water management

HIGHLIGHTS

- Few studies have focused on the institutional mainstreaming of climate resilience.
- Institutional approaches are essential to achieving national climate adaptation.
- This study provides an analytical framework for institutional mainstreaming.
- South Korea’s water management was analyzed with the proposed framework.
- The analysis results indicate the institutional deficiency in organizational mainstreaming.

GRAPHICAL ABSTRACT



1. INTRODUCTION

1.1. Background

Climate-related disasters have, on occasion, devastated vulnerable communities and areas and have caused economic losses of \$202 million worldwide in the past 50 years (World Meteorological Organization (WMO) 2021). Globally, total economic losses of 3.64 trillion US dollars stemmed from weather-related disasters from 1970 to 2019 (World Meteorological Organization (WMO) 2021). In the last decade (from 2010 to 2019), the average daily economic losses of 383 million US dollars are mostly attributed to storms, which is a dominant climatic event causing economic losses, which continue to increase (World Meteorological Organization (WMO) 2021).

From an economic perspective, the concept of the mainstreaming of climate adaptation (hereafter referred to as *mainstreaming* or *climate mainstreaming*) can be understood as an effort to consider climate change adaptation as a determinant of cost-effective adaptation policy, which can prepare governments for the loss of gross domestic product due to the impact of climate change, as well as the delay and revocation of development plans (Underdal 1980; Dicker et al. 2021; Bellon & Massetti 2022). ‘[...] The lack of investment in adaptation and resilience mirrors the lack of investment in disaster risk reduction (DRR)’ (Dicker et al. 2021, p. 6).

In addition to preventing climate disasters, mainstreaming can have synergetic economic benefits, such as greening urban spaces, which reduces the risk of pluvial flooding and contributes to spatial quality and biodiversity (Hallegatte et al. 2010). ‘The greatest benefit of climate adaptation is a more productive and stable economy in the long term, and a more equitable and sustainable development. In some cases, investments in adaptation may also have environmental and employment cobenefits’ (Bellon & Massetti 2022, p. 7).

Given disaster prevention and synergetic policy efficacies, mainstreaming might provide an innovative way of finding more resource-efficient paths of budget management (e.g., new roads considering future climate disasters) (Halsnæs & Trærup 2009; Runhaar *et al.* 2018, 2020). Indeed, '[t]he goal of mainstreaming is to enable more holistic responses and joined-up interventions to a given policy priority that is being resisted or challenged in other policy sectors (...)' (Scott *et al.* 2021, p. 203).

1.2. Theoretical review

Theoretically, the precedent studies on environmental integration shed light on the efforts made to incorporate environmental principles and values (Kraemer 2001; Lafferty & Hovden 2003; Persson 2004, 2008; Lafferty *et al.* 2005; Lenschow 2012). A wide array of strategies, such as the identification of vulnerabilities, the evaluation of policy decision-making processes, the assessment of policy impacts, and the implementation of policies including cultural and cognitive transition, have been developed for policy incorporation (UNAIDS/UNDP/World Bank 2005). How to structure and organize cultural recognition and national planning, governance, laws and institutions, and the specific process of implementation and assessment across departments has been identified as a critical point of policy mainstreaming.

Likewise, mainstreaming has long been discussed as a means of adaptive strategies at the national policy level in response to the increasing climate risks and extreme weather events (Widmer 2018). The climate adaptation processes at the national level include (i) identifying the vulnerability, which leads to the institutionalization of climate change adaptation, (ii) creating adaptive plans and performing the assessments of policy decision-making situations, (iii) establishing strategies for climate adaptation and making changes in plan, and (iv) monitoring and evaluating the implementation of adaptation (monitoring, reporting, and evaluation) (European Environment Agency 2015, 2020).

1.3. Problem statement

With respect to enabling and compromising variables for mainstreaming, numerous studies have discerned critical factors for the implementation of climate policies (Halsnæs & Trærup 2009; Persson & Klein 2009; Wamsler & Pauleit 2016; De Roeck *et al.* 2018; Runhaar *et al.* 2018; Widmer 2018; Braunschweiger & Pütz 2021). For instance, Runhaar *et al.* (2018) classified mainstreaming factors into (i) political, (ii) organizational, and (iii) cognitive factors, (iv) resources and characteristics of the adaptation problem at issue, and (v) timing. Additionally, Widmer (2018) highlighted the importance of integrating mainstreaming strategies into four imperative categories, depending on the levels of integration: legal aspects, organizational structures, policy tools, and governance systems.

However, there is a noticeable gap in the existing literature in the provision of a comprehensive framework for organizing and structuring climate resilience at the national level. While several studies have established analytical approaches to understand climate mainstreaming, only a few have specifically mentioned the institutional aspect of mainstreaming at the national level (Van Asselt *et al.* 2015) and lacked institutional analysis of mainstreaming. Few studies have focused on institutional coordination associated with mainstreaming, and some are concentrated on the analysis of policy conflict components or drivers, but there is still a lack of structurization of climate resilience at the national level (e.g., Runhaar *et al.* 2018).

Although policy mainstreaming has seen theoretical advancements, achieving climate mainstreaming poses significant challenges due to certain limitations, including (i) there is still no consensus on the definition of successful mainstreaming of climate adaptation, and because of which (ii) it is difficult to reach a consensus on effective mainstreaming methods and on how to assess the effectiveness of methods (Braunschweiger & Pütz 2021). Even though budget inputs and the establishment of guidelines are typically implemented, the materialization and implementation of climate adaptation policies are still delayed, and there is still a considerable gap among frameworks in achieving the practical implementation of strong on-ground measures (Dupuis & Knoepfel 2013; Braunschweiger & Pütz 2021).

1.4. An alternative approach: institutionalization of climate resilience

Under the recognition of the unfilled gap mentioned above, alternatively, we argue that the mainstreaming of adaptive capacity needs to be reconsidered as a complex process of constructing *institutionalization* of climate resilience, rather than a linear amalgamation of policy goals and implementation tools. In this paper, climate mainstreaming is defined as the *institutionalization of climate resilience at different policy levels*. The prolific definitions and applications of mainstreaming have not fully articulated resilience venues to fulfill the urgent need to incorporate climate resilience at the policy level. In this paper, instead, a theoretical question to *institutionalization* should be focused on *constitutional* and *cultural* agreements on climate threats, *regulatory* schemes for organizational and behavioral constraints, and *operational* tools to identify, reduce,

adapt to, and learn from such risks, events, and resulting financial loss and casualties (Gim *et al.* 2019; Gim & Miller 2022; IPCC 2022) (for the specific explanation of categories and terms, please see Gim *et al.* 2019).

In other words, structuralizing climate adaptation at the governmental policy level is based on constructing knowledge frames to inquire what plans are appropriate for adaptations, in what ways we can make decisions as well as design or reform adaptive strategies in detail, how vulnerabilities are identified and measured, and how adaptation is monitored and evaluated (Feagan *et al.* 2019; Muñoz-Erickson *et al.* 2021). To do this, first, we aim to review theoretical analysis and in-depth review on research gap in the integration and institutionalization of adaptive capacity, i.e., mainstreaming in Section 2. Further, we also propose a framework for the analysis of the mainstreaming of climate adaptation based on this review and apply this framework to a case study of water management programs in South Korea in Section 2. In Section 3, based on coding, the level and integration of institutional foundations of mainstreaming are analyzed and discussed.

2. MATERIALS AND METHODS

2.1. A theoretical review and research gap

Persson *et al.* (2018) recently defined environmental policy integration (EPI) as ‘building the consideration of environmental objectives into those policy sectors where environmental degradation is caused by avoiding inconsistencies and incoherence between the policies of different sectors’ (Persson *et al.* 2018, p. 113). Environmental mainstreaming, a type of sustainable policy transformation, centers on the institutional dimension of social, ecological, and technological transition (Van Den Bergh *et al.* 2011; Krueger *et al.* 2022). In other words, *mainstreaming* is ‘the informed inclusion of environmental concerns into the decisions of institutions that drive national, local and sectoral development policy, rules, plans, investment and action’ (Dalal-Clayton & Bass 2009), which means incorporating policy objectives of climate change adaptation into the existing policy units. As such, as a specific form of EPI (Braunschweiler & Pütz 2021), the mainstreaming of climate adaptation can be recognized as a part of research on EPI (Runhaar *et al.* 2014; Persson *et al.* 2018) to identify the root causes of failed approaches to sustainable development and appropriate addressing of climate risks (Lafferty & Hovden 2003; Wamsler & Pauleit 2016).

What has been underappreciated in climate mainstreaming efforts, theorized by Widmer (2018) and other studies, is the conceptualization of resilience work of institutions for climate mainstreaming (Gim *et al.* 2019). Institutions are referred to as a social and behavioral grammar of ‘observed regularities in the patterns of human behavior’ (Sue & Ostrom 1995), or ‘the humanly devised constraints that structure political, economic and social interaction’ (North 1990). Institutions are, thus, binding rules for human behaviors or a resultant equilibrium point of constraints from behavioral interactions (North 1990; Scott 1995; Ostrom 2005).

Less attention has been paid to the fact that institutions, which are a set of rules that govern human behavior, can be diversified into political consensus, legal regulations, and technical practices in forcing or enabling administrative actions to be favorable for climate change adaptation. Given that human behavior is interpreted as a type of social phenomenon, institutions can be recognized as a type of collective reference or even a cultural recognition (Coleman 1988; Scott 1995).

2.2. Historical backgrounds for environmental mainstreaming: institutional integration

Almost half a century ago, there was a strong focus on incorporating environmental initiatives into policy in order to promote the polluter-pays and precautionary principles for environmental protection in Europe. This was, in part, achieved through the establishment of the 1973 Environmental Policy Action Plan of the European Community (EC) (Lafferty & Hovden 2003, p. 4). Subsequently, the concurrent promotion of economic development and environmental paradigm across laws, policies, and governmental practices at the global level culminated in the Brundtland report, also known as ‘Our Common Future,’ in 1987, which integrated the economic development and environmental paradigm into policy (United Nations 1992).

‘Towards Common Actions: Proposals for Institutional and Legal Change’ of the Brundtland Report ‘Our Common Future’ states, ‘The ability to choose policy paths that are sustainable requires that the ecological dimensions of policy be considered at the same time as the economic, trade, energy, agricultural, industrial, and other dimensions – on the same agendas and in the same national and international institutions (WCED 1987, Ch. 12, p. 313).’

Furthermore, a binding ‘Cardiff process’ (1998) was an articulation of efforts to empower the environmental program at the EU level pursuant to Article 6 of the EC Treaty, which accentuated the integration of ‘environmental protection requirements’ into the sectoral policies (Kraemer 2001). In line with the ‘Cardiff process,’ the EU Sustainable Development Strategy (2001) authored by the Office of the President of the EU Commission is a declaration of environmental principles for the co-evolution of economic development and environmental protection (Commission of the European Communities (CEC) 2001, p. 14; Lafferty *et al.* 2005).

2.3. The structure of environmental mainstreaming

2.3.1. Rational perspective vs. normative perspective

Broadly, there can be two different structures tailored for mainstreaming. Underdal (1980, p. 163) proposed the concept of integrated ocean management to incorporate sustainability into marine policy and reduce negative externalities while aiming for more integrated marine policies. From this rational perspective, comprehensiveness, aggregation, and consistency were selected as the three criteria for the successful implementation of integrated marine policies. That is, from the economic perspective based on the rational point of view, the main implication of integrated marine policies was the reduction of inefficiency by curtailing overproduced institutional externalities across sectors, which reduces resource inefficiency as well as the potential for unnecessary conflicts (Underdal 1980). On the other hand, in the normative perspective, a successful EPI is understood as the prioritization of environmental issues across all sectors of governmental policies. Normative priority (including the implication of normative judgment) is assigned as ‘*environmental value*’ compared to other sectoral objectives, which can be regarded as a principled priority (Lafferty & Hovden 2003). In contrast, EPI from a rational perspective refers to a case in which policy integration is implemented only to a level of weak conceptualization, where a type of environmental perspective is only considered, not prioritized, in the policy decision-making process of other sectors (Persson 2004; Adelle & Russel 2013, p. 4; Braunschweiger & Pütz 2021). Then, another challenge in mainstreaming climate adaptation would be the incorporation of the two distinctively different perspectives on a case-by-case basis.

2.3.2. Horizontal and vertical integration

Lafferty & Hovden (2003) provided a structural analysis of environmental integration by focusing on two categories: horizontal and vertical dimensions. Horizontal integration refers to the central government’s development and implementation of comprehensive inter-ministerial environmental strategies, and vertical integration indicates each specific governmental ministry’s adoption and promotion of environmental objectives in pursuit of long-term general policy goals (Lafferty & Hovden 2003, pp. 12–14). The allocation of authority in the vertical dimension and the division of roles and responsibilities in the horizontal dimension are important for efficiency and mutual cooperation and checks in public administration (Kim 2006; Gim & Miller 2022).

To alleviate fragmentation in decision-making, consistent policies should be established in both vertical and horizontal perspectives (Underdal 1980). Van Oosten *et al.* (2018) expanded on the discussion of Lafferty & Hovden (2003) by systematically investigating the horizontal and vertical structures of policy integration in Rwandan administration (beyond more formalized mainstreaming). The discussion was further expanded to include informal and multilevel mainstreaming at the landscape level, which was generally split into productive bricolage, institutional bricolage, and institutional entrepreneurship, wherein various patterns of conflicts in policy integration occur (Van Oosten *et al.* 2018).

2.3.3. The content of environmental mainstreaming

Persson (2004) categorized content into normative, organizational, and procedural mainstreaming and discussed the ‘target’ of mainstreaming. According to his study, *normative mainstreaming* includes strategies for integration, high-level political commitment, and regulatory reforms. Mainstreaming in the normative domain promotes institutional changes; the maturation of mainstreaming as social norms through path-breaking changes in policy paradigm and tradition, as well as by acquiring societal endorsement, constitutes the criteria for normative integration. Next, *organizational mainstreaming* aims for structural changes in governmental or administrative organizations, which involves organizational preparatory mainstreaming processes or arrangements. According to Persson (2004), the content of organizational mainstreaming includes establishing institutions related to formal accountability, restructuring budgetary processes, or improving communication practices with members outside organizations and appropriate governance. Finally, *procedural mainstreaming* refers to institutional changes to current decision-making processes or information exchange procedures and includes the implementation

of EPI systems or the revision of administrative rules to implement the EPI process. Therefore, the impact assessment of climate change adaptation policies may serve as a key milestone for procedural mainstreaming.

2.3.4. The tools of environmental mainstreaming

In terms of the structural development of mainstreaming climate adaptation, a phase-in is required with different ‘entry points’ in the approach (OECD 2009). Mainstreaming climate adaptation serves as a way of formulating new adaptation policies and activities for the relevant ministry/sector (Massey & Huitema 2013) and includes structure development.

For this purpose, generally, the units of mainstreaming implementation can be diversified into nations/states, specific sectors, differing stages in the promotion and implementation of a program/project, distinctive regions, individual organizations, and decision-making units. As such, a number of studies centered on reducing conflicts and drawbacks that arise from different temporalities in entry points and scales of mainstreaming have been conducted (IPCC 2014; OECD 2016; Runhaar *et al.* 2018). To alleviate conflicting goals and frames, OECD (2016) presented a checklist of implementing policy coherence for sustainable development and factors in the analytical framework: actors, policy inter-linkages, enabling and disabling conditions (contextual factors), financial sources, and transboundary and intergenerational impacts. Policy coherence is linked to the understanding of the policy conditions that should be harmonized or prioritized to facilitate the policy integration of various factors stated.

2.3.5. The intensity and level of climate mainstreaming

The intensity and level of integration of climate mainstreaming in consideration of various perspectives can be summarized into three levels (Persson *et al.* 2018; Widmer 2018; Braunschweiger & Pütz 2021) based on the level of integration as shown in Table 1: coordination, harmonization, and prioritization. When the goal of mainstreaming is to avoid policy disputes between sectors, it implies coordination, whereas when it reaches an intermediate level of integration between sectors, it includes harmonization, in which environmental objectives are placed on equal terms with sectoral goals. When mainstreaming favors environmental objectives over others in sectoral policies, it includes prioritization, which promotes the redesign or reorganization of policies or decision-making processes from the perspective of climate change adaptation (Persson *et al.* 2018; Widmer 2018; Braunschweiger & Pütz 2021).

For example, adaptation strategies mentioned in the Swiss National Adaptation Strategy have different impacts on the corresponding sectoral policies. Management in areas such as natural disaster and forest management has a close relationship with climate adaptation and overlaps with the existing policy objectives; however, similar levels of success have not been attained in other areas (Widmer 2018; Braunschweiger & Pütz 2021). Successful cases of mainstreaming climate adaptation result from further development and expansion of existing policies (rather than new) (Braunschweiger & Pütz 2021). Arguably, institutional integration and appropriate governance for climate adaptation have been deemed as a very strong indication of mainstreaming when it comes to coordinating, harmonizing, and prioritizing environmental values and principles across policies (Lafferty & Hovden 2003; Jacob & Volkery 2004; Jacob *et al.* 2008; IPCC 2022).

Wamsler (2015) integrated the classification of mainstreaming strategies proposed by Lafferty & Hovden (2003) and Persson (2004) with reference to ecosystem-based adaptation mainstreaming to present the seven levels of mainstreaming integration in a hierarchical structure by linking the integration level to mainstreaming strategies, building on Persson’s (2004) discussion. Wamsler & Pauleit (2016) stated that the mainstreaming of climate adaptation can be defined as ‘the inclusion of climate consideration in sector policy and practice.’ Recently, Braunschweiger & Pütz (2021, p. 3) argued

Table 1 | Classification of integration level in mainstreaming

Concepts	Level of integration	Key features
Coordination	Weak	Aims to avoid contradictory sectoral policies; cross-ministerial coordination to avoid adverse consequences or conflicts to create synergistic effects
Harmonization	Intermediate	Attempts to bring environmental objectives on equal terms with sectoral objectives
Prioritization	Strong	Favoring environmental objectives over others in sectoral policies. It also refers to redesign or reorganization of policies or decision-making processes from the perspective of climate change adaptation

Source: Persson *et al.* (2018); Widmer (2018); Braunschweiger & (Pütz 2021).

that the main focus of the policy integration of mainstreaming lies in whether the objectives of mainstreaming are incorporated into individual non-environmental ministries and divisions (at the regional level as well as the national level). Although a number of countries have shown progress in establishing adaptation policies, gaps persist in direct implementation (Braunschweiler & Pütz 2021).

2.4. Scope

This paper aims to examine and assess the mainstreaming of a national climate adaptation plan by proposing and applying an analysis framework to answer the question of how climate adaptation policies are mainstreamed, or, in other words, *institutionalized*. Thus, this research is attentive to identifying legal and institutional basis (as an integration form) rather than the entire policy cycle of climate adaptive strategies (planning for adaptation, policy implementation, outcome evaluation, and feedback for future plans). Therefore, this study emphasizes the institutional dynamics of policy mainstreaming (Lenschow & Zito 1998) by fabricating institutional components of climate resilience policies varying in structure, content, and intensity. For the specified purpose, this research employs a mixed-method approach to illustrate the varying extent of institutional mainstreaming among factors by using a qualitative method (intercoder reliability) on the one hand, and, on the other hand, the quantitative comparison of mainstreaming among factors.

2.5. Data

Regarding data, among sectoral adaptive plans in the Detailed Implementation Plan (12 sections) under The Third National Climate Adaptation Plan [2021–2025] of South Korea, the section of ‘I. Water management considering future climate risk’ (hereafter, ‘I. Water Management’) was selected. The establishment of water adaptation programs in response to climate change is required in Article 52 of the ‘Framework Act on Carbon Neutrality and Green Growth to Cope with Climate Crisis.’

Conformant to the statutory article (i.e., Article 52 of the ‘Framework Act on Carbon Neutrality and Green Growth to Cope with Climate Crisis’), the South Korean government has established and organized 232 countermeasures (12 sections such as *water management*, ecosystem, land/coastal areas, agriculture/fisheries, health, industry/energy, monitoring, forecasting, evaluation capabilities, adaptation promotion, climate resilience, and adaptation cooperation system; the total number of programs of the National Climate Adaptation Plan is 286) (emphasis added) to tackle 84 climate risks induced from aligned analyses and recommendations of expert forums, working councils, and public hearings; this information has been used to develop these countermeasures into a national climate adaptation plan for 5 years (2021–2025) (Lee *et al.* 2022).

Specifically, the 29 adaptive programs of ‘I. Water Management’ considering future climate risks (with a focus on programs sponsored by the Ministry of Environment (MOE)) were examined by assigning differential distinctive meanings and scores to determine each level of institutional mainstreaming. The adaptive programs for water management in response to climate change are centered on the three areas of ‘water quantity (diversifying water resource) management (from programs 11 to 18),’ ‘flood management (from programs 1 to 10),’ and ‘water quality and aquatic ecosystem management (water environment) (from program 19 to 29).’

2.6. Framework

To analyze and evaluate the institutional mainstreaming of the 29 programs of the ‘I. Water Management’ section, we identified what and how specific institutional factors (e.g., whether national or ministerial plans exist; laws, regulations, and executive orders for adaptation goals and intra/inter-ministerial governance are implemented; and subsidiary administrative enforcement decrees for climate impact assessment tools are in effect) were implemented in the 29 adaptation programs in support of normative, organizational, and operational mainstreaming (Table 2). The full score that can be assigned was 36 points (12 items × 3 points).

In light of the aforementioned EPI and the ongoing conversation on mainstreaming, this research seeks to investigate the fundamental underpinnings that shape the structure of mainstreaming factors of intricacy: *institutions*. The discussion on EPI for decision-making and the implementation of climate adaptation are intrinsically tied to institutional approaches to policy-making. Precedent studies proposed mainstreaming components to understand and analyze climate adaptation policies (Runhaar *et al.* 2018; Widmer 2018). To better understand the structure of mainstreaming, institutional arrangements can be addressed with three different hierarchical levels: normative (constitutional), organizational (regulatory), and operational institutions (*please see* Cole (2017) for the levels of institutional interactions).

Figure 1 illustrates the institutionalization of climate adaptations by dividing it into hierarchies. In this respect, the framework (Table 2) was based on the notion that climate mainstreaming needs to be understood as the institutionalization of

Table 2 | Analytical framework of institutional mainstreaming

Mainstreaming foundations		Items
Normative recognition/national planning mainstreaming (Constitutional institutions)		Recognition of the uncertainty and severity of climate change Presence of administrative plans for ministerial implementation
Organizational mainstreaming of governance and laws/institutions (Regulatory institutions)	Governance (inter-ministerial, public/private, horizontal) mainstreaming Legal and Institutional (intra-ministerial, regulatory, vertical) mainstreaming	Implementation of new programs on climate adaptation (programmatic mainstreaming) Participation of stakeholders intra-organizational governance Promotion of inter-organizational collaboration Specification of managerial/organizational responsibilities (the clarification of responsible departments) (managerial mainstreaming) Specification of regulatory provisions and revision planning (regulatory mainstreaming) Establishment of financial budget
Operational mainstreaming of implementation and assessment (Operational institutions)		Detailed scheduled planning for achieving objectives (Planning mainstreaming) Selection of detailed administrative index goals (Administrative goal mainstreaming) Assessment of climate change impact and vulnerability Securing relevant technology on climate adaptation

Source: authors.

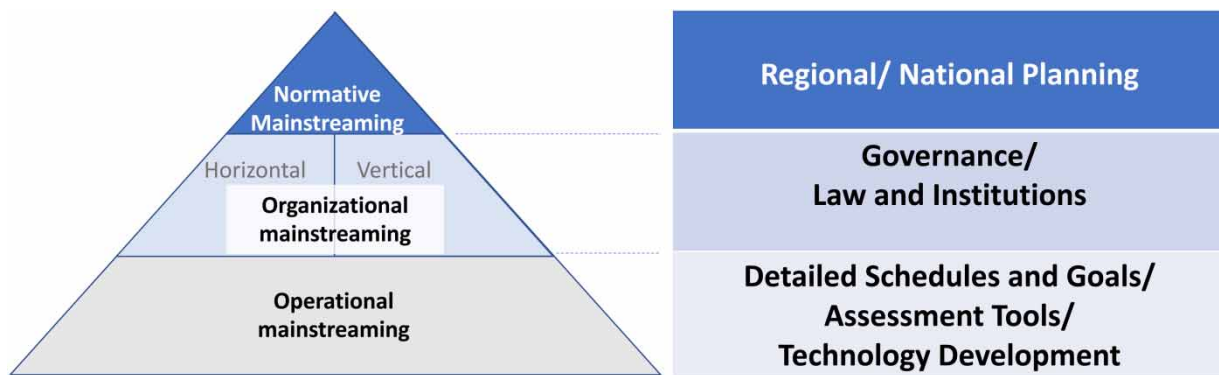


Figure 1 | Hierarchy of institutional mainstreaming (Source: authors).

climate resilience (i.e., norms, organizations, and operational practices) (Figure 1), and the coding guideline is formulated following the levels of the integration intensity (Table 1).

2.7. Evaluation and coding

The framework of climate adaptation mainstreaming, as presented in Section 2.6, was applied to analyze the institutional mainstreaming of the Detailed Implementation Plan (29 water adaptation programs) of ‘I. Water Management,’ for which the MOE was mainly responsible (29 programs). The created evaluation rubric for the ‘Evaluation score guidelines for individual adaptive plans (≤3 points)’ is provided in Table 3. In general, when evaluating a particular program (out of 29) for institutionalization, a score of 3 was assigned to items that demonstrated significant levels of institutionalization, while a score of 2 was given to programs that exhibited good levels of institutionalization. In cases where there was a need for improvement in the institutionalization of the program, a score of 1 was assigned. For instance, when technological developments related to climate change adaptation were underway, progress in technological mainstreaming was indicated, and points (from 1 to 3 points, 3 points maximum) conforming to the guideline were assigned. An example of evaluation on climate mainstreaming of a national water adaptation program is provided in Appendix 2.

Table 3 | Evaluation score guidelines for individual adaptive plans

Mainstreaming foundations		Items	Evaluation rubric (≤3 points)
Normative recognition/national planning mainstreaming (Constitutional institutions)		Recognition of the uncertainty and severity of climate change	Explicit statement on the impact of climate change (3)/Statement on the impact of climate-related disasters (2)/Lack of climate change recognition (1)
		Presence of administrative plans for ministerial implementation	Complete incorporation (3)/Intermediate incorporation (lack of detailed plans) (2)/Lack of incorporation (1)
Organizational mainstreaming of governance and laws/institutions (Regulatory institutions)	Governance (inter-ministerial, public/private, horizontal) mainstreaming	Implementation of new programs on climate adaptation (programmatic mainstreaming)	Implementation of new climate adaptation programs (prioritization) (3)/Expansion of existing programs (harmonization) (2)/Promotion of existing programs (coordination) (1)
		Participation of stakeholders Intra-organizational governance	Detailed governance in place (3)/Mention of governance (2)/No mention of governance (1)
		Promotion of inter-organizational collaboration	Detailed inter-organizational collaboration (3)/Mention of inter-organizational collaboration (2)/No mention of inter-organizational collaboration (1)
	Legal and Institutional (intra-ministerial, regulatory, vertical) mainstreaming	Specification of managerial/organizational responsibilities (the clarification of responsible departments) (managerial mainstreaming)	Specification of responsible managerial divisions (3)/Partial specification of responsible managerial divisions (2)/No specification of responsible managerial divisions (1)
		Specification of regulatory provisions and revision planning (regulatory mainstreaming)	Specification of relevant provisions and revision plans (3)/Partial specification of relevant provisions and revision plans (2)/No specification (1)
		Establishment of financial budget	Budget secured (3)/Partial budget secured (2)/Budget not secured (1)
Operational mainstreaming of implementation and assessment (Operational institutions)	Detailed scheduled planning for achieving objectives (Planning mainstreaming)	Presentation of detailed scheduled planning (3)/Mention of scheduled planning (2)/No scheduled planning (1)	
	Selection of detailed administrative index goals (Administrative goal mainstreaming)	Setting administrative index goals (3)/Partial specification of administrative index goals (2)/No specification (1)	
	Assessment of climate change impact and vulnerability	Specification of climate change impact/vulnerability assessment (3)/Partial specification of climate change impact/vulnerability assessment (2)/No specification (1)	
	Securing relevant technology on climate adaptation	Specification of technology R&D (3)/Partial specification of technology R&D (2)/No specification (1)	

Source: authors.

2.8. Reliability of coding: intercoder reliability

'Intercoder reliability' is defined as 'a numerical measure of the agreement between different coders regarding how the same data should be coded' (O'Connor & Joffe 2020, p. 2). Each author assigned points ranging from 1 to 3 to the qualitative data gleaned from institutional factors regarding the intensity of institutionalization (Persson *et al.* 2018; Widmer 2018;

Braunschweiger & Pütz 2021). Then, based on the independent rating of evaluation items by authors for reliability (MacQueen *et al.* 1998), the findings (coding) were compared. Thereafter, the justification for the ratings was provided, and the scores for the suitable adaptation policy were determined (O'Connor & Joffe 2020). In addition, after the evaluation of each adaptive plan, the scores were reclassified for each item, and by applying the same process, the scores per item were summed and reclassified.

3. RESULTS AND DISCUSSION

This research attempts to understand to what extent the mainstreaming of each water program is comparatively well-developed or not in South Korea.

3.1. Results

Overall, the result manifests there are well-structured institutions for the completion of institutionalization of assessment tools and vulnerability for climate recognition and codification at the national planning level. However, the governance and legal organizations for mainstreaming are manifested as weak compared to other areas of institutional mainstreaming. Specifically, the characteristics of mainstreaming and the level of institutionalization are outlined for each item in Figure 2. Based on the analysis on the data in Figure 2, with the *t*-test analysis (*t*-test one sample), eight institutional items, which are significantly different compared to the mean (i.e., 2.30; 5% significant level) (mean numbers are rounded to two decimal places, hereafter) level of institutionalization of the whole program (Table 4), were identified (items 3, 4, 5, 6, 7, 8, 9, and 10).

3.1.1. Normative mainstreaming

As illustrated in Table 4, first, we found that regarding 'Normative' mainstreaming, in each program, the 'recognition of climate threats' is explicated, and subsequently, related national plans are incorporated for respective programs at the *intermediate* level (point: 2; 'statement on the impact of climate-related disasters') in comparison to other items (mean 2.10, *p*-value > 0.05). Based on the evaluation result, specifically with a mean of 2.10 and a *p*-value greater than 0.05, it was observed that the aspect of '1. Recognition of the uncertainty and severity of climate change' is addressed in the 'statement on the impact of climate-related disasters' within each program. However, it should be noted that this recognition is not explicitly stated in Table 4. '2. Presence of administrative plans for ministerial implementation' (mean 2.31) is cataloged in many detailed national plans at the intermediate level as sectoral approaches, which is not significantly different from the whole program's mainstreaming level.

3.1.2. Organizational mainstreaming

Given the statistical test result in Table 4, regarding 'Organizational' mainstreaming, the mean evaluation scores for 'Governance' mainstreaming, such as '3. Implementation of new climate adaptation programs' (mean 2.72), '4. Intra-organizational governance' (mean 1.62), and '5. Promotion of inter-organizational collaboration' (mean 1.93), are significantly different compared to the mean of the whole program (mean: 2.30). The 'Legal and Institutional' mainstreaming, such as '6. Specification on managerial/organizational responsibilities,' '7. Specification of regulatory provisions and revision plans,' and '8. Establishment of financial budget,' provides the legal and institutional foundation of mainstreaming to the accountable governmental implementation. The means of legal and institutional instruments are, respectively, 1.90, 1.72, and 2.79, which are statistically different from the mean (i.e., 2.30) of the whole program (Table 4). The implementation of new adaptation programs (item 3) and the establishment of financial budget (item 8) are strongly prioritized compared to other factors. On the contrary, intra- and inter-organizational governance (items 4 and 5) as well as regulatory responsibilities/provisions (items 6 and 7) show weakly institutionalized mainstreaming compared to other factors (Table 4).

3.1.3. Operational mainstreaming

For the 'Operational' mainstreaming of climate adaptation policies as observed in Table 4, '9. Detailed scheduled planning for achieving objectives' (mean: 3) and '10. Selection of detailed administrative goals' (mean 2.93) are explicitly inscribed in adaptive programs, which is statistically different from other institutionalization items overall. The stronger mainstreaming of these two operational items can be attributed to the quantifiable nature (e.g., schedules and quantified objectives) of the operational items. However, despite the importance of the assessment tools and relevant technologies for climate change impacts and vulnerabilities in mainstreaming (i.e., item 11. assessment tools and item 12. adaptive technologies), the means (i.e., respectively, 2 and 2.5) of these items show no significant difference compared to the whole program.

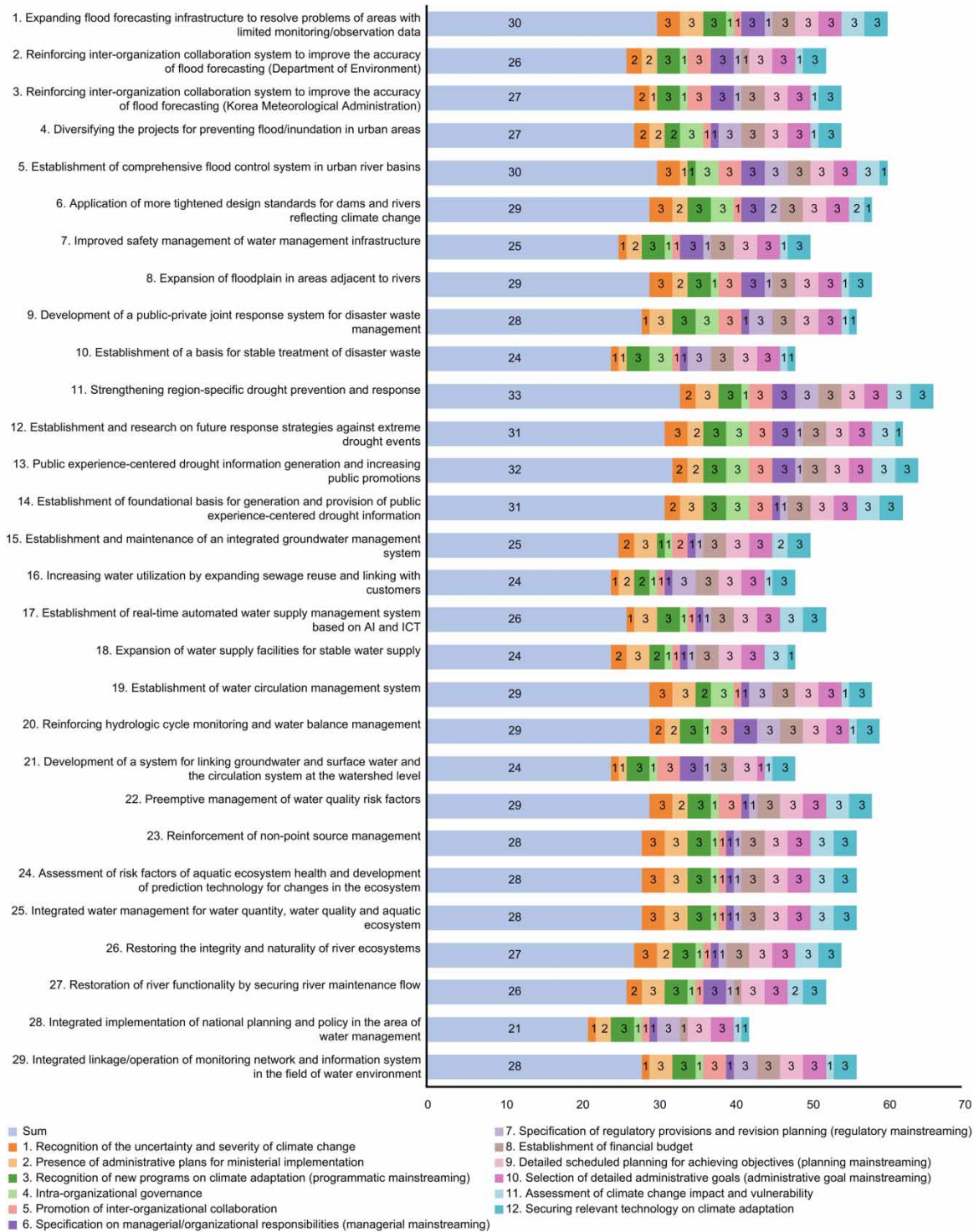


Figure. 2 | The application of the analysis framework to 29 programs of I. Water Management (please refer to Appendix 1. for the full title of each program). * Interestingly, regarding internal and external governance, some of 'drought management' programs such as '12. Public experience-centered drought information generation and increasing public promotions,' '13. Public experience-centered drought information generation and increasing public promotions,' and '14. Establishment of foundational basis for generation and provision of public experience-centered drought information' are deemed horizontally well-organized compared to other programs: they were all given 3 points in the evaluation on organizational mainstreaming (governance mainstreaming) such as recognition of new adaptation programs (item 3), collaboration or participation of relevant stakeholders (intra-organizational governance) (item 4), and inter-ministerial collaboration (inter-organizational collaboration) (item 5).

Table 4 | The evaluation results of institutional mainstreaming

Framework	Items	Mean	Standard deviation	p-Value
Normative	1. Recognition of the uncertainty and severity of climate change	2.10	0.817	0.107339
	2. Presence of administrative plans for ministerial implementation	2.31	0.7123	0.4573435
Organizational: Governance	3. Implementation of new programs on climate adaptation (programmatic mainstreaming)	2.72	0.5914	0.0002755
	4. Intra-organizational governance	1.62	0.9416	0.0003045
	5. Promotion of inter-organizational collaboration	1.93	0.9975	0.029353
Organizational: Legal and Institutional	6. Specification on managerial/organizational responsibilities (managerial mainstreaming)	1.90	1.0122	0.021296
	7. Specification of regulatory provisions and revision planning (regulatory mainstreaming)	1.72	0.9598	0.001663
	8. Establishment of financial budget	2.79	0.6199	<0.0001
Operational	9. Detailed scheduled planning for achieving objectives (planning mainstreaming)	3.00	0	<0.0001
	10. Selection of detailed administrative goals (administrative goal mainstreaming)	2.93	0.3714	<0.0001
	11. Assessment of climate change impact and vulnerability	2	0.9636	0.05
	12. Securing relevant technology on climate adaptation	2.51	0.871	0.09

Source: authors.

Notes: mean: 2.30; significant level: 5%. Please refer to Appendix 3 for data under analysis and coding. Please refer to Appendix 4 for a comprehensive list of the analyzed laws and regulations.

3.2. Discussion

3.2.1. Climate mainstreaming as normative and operational institutionalization

According to De Roeck *et al.* (2018), one of the essential foundations of mainstreaming includes *normative* drivers, such as political commitments for mainstreaming and the redistribution of resources to improve climate adaptation. Considering the normative institutional factors (Scott 1995), the ‘politics of climate change’ and ‘recognition (culture) of climate threats or the recognition and mitigation of uncertainties around climate change’ for each ministry are regarded as important components for overarching, cultural and recognitional factors at the highest level of policies (Villanueva 2011). To specify, according to Persson (2004, 2008), the following questions can be indicators for normative mainstreaming: Is the mainstreaming policy accurately aligned with the objectives of the high-level political system? Has the societal backing been secured? Does mainstreaming require fundamental changes in the policy paradigm? Has the policy framework for development goals been established? The results of this research state that, at the normative level, ‘1. Recognition of the uncertainty and severity of climate change’ (mean: 2.1) and ‘2. Presence of administrative plans for ministerial implementation’ (mean: 2.31) are comparatively well stated, and thus ‘societal backing’ and ‘political commitment’ for climate resilience can be regarded as being coordinated with national goals and frames at the intermediate level.

With respect to institutionalization at the operational level, *operational* mainstreaming emphasizes the implementation and evaluation tools of mainstreaming policies and their outcome, which entail mainstreaming the development of evaluation and monitoring tools of vulnerabilities and adaptation promotion strategies (Widmer 2018). The institutionalization of implementation tools to gather information and sustain ‘temporal momentum for climate adaptation’ is a critical factor for the engineered responses to climate risks (Runhaar *et al.* 2018; Gim *et al.* 2019). Operation with particularized tools and consistent schedule management are the enablers for the accomplishment of specified climate adaptation goals. Regarding climate vulnerability assessments, it is determined that adaptation measures are effective in two cases (Weiland *et al.* 2014). These include the cases when the level of exposure to adverse effects of climate change is reduced for a system or when the response capacity of a system is improved in the event of exposure. For instance, the mainstreaming of water hazard prevention necessitates the preemptive measures of lowering the level of vulnerability or strengthening response capacity to adverse effects of climate change through the assessment of climate change impacts and vulnerabilities. Thus, *operational* institutionalization includes (i) a detailed scheduled plan in place to enable consecutive checks and feedback for adaptation in progress, (ii) specified administrative adaptation goals, and (iii) the development of evaluation tools manifested in programs for the assessment of climate

impacts and vulnerability, and (iv) the development and innovation of relevant adaptation technologies. Based on the results, the detailed schedule plans (item 9) and specified resilience goals (item 10) align with Widmer's (2018) findings and exhibit a notably strengthened level of institutionalization. However, the development of tools (item 11) and technologies (item 12) (Weiland *et al.* 2014) leaves ample room for improvement in terms of institutionalization.

3.2.2. Organizational institutionalization

Organizational mainstreaming refers to structural changes in the legal and governance systems within or across governmental ministries (e.g., new integrated ministries and new collaborative networks) to overcome conflicts between ministries over priorities of climate change adaptation policies. Changes in legal and governance arise in both vertical and horizontal directions (Jacob & Volkery 2004; Persson 2004; Wamsler 2015; Widmer 2018). Based on the results mentioned above, the following sections relate analysis results to specific items (items 4, 5, 6, and 7), which are identified as in need of improvements for the resilience mainstreaming of water management in South Korea at the organizational level. The organizational institutionalization, such as the 'implementation of new programs on climate adaptation (programmatic mainstreaming) (item 3)' and the 'establishment of financial budget (item 8)' is, however, significantly well-structured (mean: 2.79).

In the following subsections, we provide a detailed explanation of the rationale behind the mainstreaming deficit of items 4, 5, 6, and 7 (organizational mainstreaming).

3.2.2.1. Enhancing governance approaches. Given the uncertainties coupled with climate change (Refsgaard *et al.* 2013), it is evident that coherent governance, including market, network, and government (Thompson *et al.* 1991; Pierre & Peters 2000), should be emphasized to propel climate adaptation (Hatfield-Dodds *et al.* 2007; Hahn 2011; Chaffin *et al.* 2014). Major tasks for climate adaptation are essentially responses to 'wicked' challenges (Incropera 2015), and adaptive approaches that draw on multiple perspectives are particularly integral to effective measures to tackle complex issues and weigh in on a governance to back a consensus on a common goal (The BASE Evaluation Criteria for Climate Adaptation) (Czempiel & Rosenau 1992; Rhodes 1997; Brown *et al.* 2011; Bours *et al.* 2013; Weiland *et al.* 2014). Arguably, Runhaar *et al.* (2020) shed light on the crucial role played by departmental coordination and cooperation in shaping the course of adaptation mainstreaming. Runhaar *et al.* (2020) emphasize the significance of these factors as fundamental drivers or inhibitors throughout the process.

Collaborations between ministries (inter-organizational collaboration) (Jacob & Volkery 2004; Wamsler 2015) and the participation of stakeholders (intra-organizational governance) such as public-private consultation groups are indicative of a horizontal structure to mainstream climate adaptations (please see Procedural II in Widmer 2018). For instance, the formation of a governance committee embracing the private sector, such as academia or civic organizations, is considered as a critical indicator for the successful implementation of climate adaptation strategies and planning to evade a collision course between pre-existing climate policies and sustainable development, for instance (Jacob & Volkery 2004; Eriksen *et al.* 2011; Gardiner 2010; Adelle & Russel 2013; Wamsler 2015). When a new adaptation program is launched, it can be assumed that the corresponding governmental ministry prioritizes adaptation policies with a focus on a relatively strong level of policy integration.

Unlike recent research of adaptive policies focused on governance structure to ensure administrative accountability, transparency, responsiveness, rule of law, stability, equity and inclusiveness, empowerment, and broad-based participation (Johnston 2006; IPCC 2022), the analysis findings indicate that the governance of inter- and intra-*organizational* mainstreaming lacks a well-defined structure (items 4 and 5). The mean of item 4 (4. Intra-organizational governance), which is 1.62, and the mean of item 5 (5. Promotion of inter-organizational collaboration), which is 1.93, show an institutional gap in terms of mainstreaming compared to the program's overall average level of the institutionalization of resilience (mean: 2.30). Thus, examination on the horizontal dimension of organizational mainstreaming manifests that there is a pressing need to establish comprehensive internal and external governance mechanisms in South Korea. Enhancing governance is a prerequisite for future direction for the orchestrated climate mainstreaming in South Korea.

3.2.2.2. Lacking regulatory institutions. Traditionally, one of the imperative factors in mainstreaming natural resources is organized regulations such as 'prohibitions, licensing schemes, and planning tools' and 'a combination of managerial, intra- and inter-organizational, and regulatory mainstreaming' (McDonald 2011; Runhaar *et al.* 2018; Park 2021, p. 1206). The codification of resilience (i.e., establishing legal institutions) needs to arise in land use and adaptation regulation by

coordinating conflicts between developmental goals and resilience (Woodruff 2018). To underpin normative resilience, which encompasses the recognition of climate risks and adaptation planning at the national level, the ruling environment of regulatory institutionalization of climate resilience is a must.

Regarding the vertical mainstreaming of organizations, the reimplementation or expanded implementation of existing adaptive programs/projects, rather than the establishment of new projects/programs, implies that environmental perspectives remain at the level of partial consideration of environmental factors in policy decision-making when balanced with other sectors in policy decision-making processes. In other words, there is no mainstreaming with horizontally equivalent or prioritized considerations (Adelle & Russel 2013, p. 4; Braunschweiger & Pütz 2021). In addition, detailed vertical mainstreaming factors also include the specifications of responsible departments in the organizational structure (managerial), relevant regulatory provisions as well as the presence of revision plans (regulatory), and specified budgetary planning (directed mainstreaming) (Wamsler 2015).

However, given the evaluation result, in South Korea, more attention should be paid to better specification of regulatory responsibilities and provisions (i.e., items 6 and 7) to improve weak institutionalization (Table 4) as found in 10 programs out of 29 programs (please refer to Appendix 3). Considering the relatively weaker institutionalization in the 'Legal and Institutional' mainstreaming, as observed in both 'Specification on managerial/organizational responsibilities' (mean: 1.90) and 'Specification of regulatory provisions and revision plans' (mean: 1.72), compared to the overall program (mean: 2.30), it is revealed that strengthened governmental intervention is also necessary to effectively promote better climate resilience at the national level. In fact, the several aspects of aquatic natural resource management including 'sustaining sound water environment' rely heavily on environmental regulations setting priorities (Craig 2010; Keessen & Van Rijswick 2013). Much consideration of governmental accountability is a future challenge to implement climate norms and ameliorate societal conflicts for better aligned climate mainstreaming.

3.2.3. Diagnosis on the deficit

Adaptive governance as 'an emergent form of environmental governance that is increasingly called upon by scholars and practitioners to coordinate resource management regimes in the face of the complexity and uncertainty associated with rapid environmental change' plays an important role in making institutions congruent with 'a specific scale of ecosystem dynamics' for ecological management (Chaffin *et al.* 2014). In South Korea, the complex nature and institutional fragmentations of management actors, however, concerning national rivers and regional streams, exacerbate the issue surrounding water management fragmentation. The responsibilities are distributed among various entities such as the Ministry of Land, Infrastructure and Transport (MOLIT) and the mayors/governors of cities/provinces, as outlined in Article 8 of the River Act. To illustrate, specific aspects of water management, such as sewage facilities, are managed by the MOE, while river facilities fall under the purview of MOLIT, and drainage pump stations are overseen by the Ministry of the Interior and Safety (based on interview data obtained through documented inquiries with a water expert on 24 March 2022). The fragmented accountabilities and regulations inherently compromise cohesive cooperation between different laws and institutions pertaining to climate uncertainties, resulting in various challenges while undermining the effective implementation of regulatory standards. Governmental accountability and related provisions are manifested as a locus where efforts to resolve conflicts and confrontations can ultimately be made for adaptation mainstreaming in South Korea.

3.2.4. Future directions

This research focuses on the extent of institutional mainstreaming, but the feedback process for better outcomes was not included as this research aims at the evaluation of the first year's institutional mainstreaming. To incorporate the implementation of the previous year's adaptation policies, there should be a factor that evaluates such practices of outcome incorporation. However, in the initial evaluation of the first year in this research, there is no specific criterion for evaluating feedback on this factor (Table 2). For the future consistency of adaptation mainstreaming, conducting yearly reporting on institutional mainstreaming and comparing the outcomes of institutionalization on an annual basis will be necessary to evaluate progress and take stock of national climate resilience. To ensure the successful mainstreaming of climate resilience, an effective matrix to assess annual outcomes can serve as a diagnostic tool to identify necessary institutions or regulations for improving national resilience. Subsequent yearly evaluations, starting from the second year, should integrate consideration of how normative, organizational, and operational feedback has been incorporated into the next year's policy.

4. CONCLUSION

The institutionalization of climate resilience was analyzed on the basis of normative, organizational, and operational implementation dimensions. This framework was applied to 29 climate adaptation programs of 'I. Water Management' sector among various climate adaptation policies of South Korea. As a result of the application, it is found that the normative dimension of national administrative plans in water management is relatively well established, which is not significantly different from the mainstreaming level of the whole program. Unlike normative institutionalization, the overall organizational mainstreaming (items 4 and 5) in relation to the horizontal dimension of internal and external governance is not well structured compared to the whole program mainstreaming. Further, the distinctive differences in the mean scores found in '6. Specification on managerial/organizational responsibilities' and '7. Specification of regulatory provisions and revision plans' highlight a significant national interest to address establishing the legal and institutional structure for mainstreaming. To the contrary, with respect to operational mainstreaming, the incorporation of specific timelines and clearly defined goals is institutionally structured, setting it apart from other aspects of mainstreaming.

The importance of our study lies in the finding that strengthening institutions for resilience policy integration is a key to unlocking the potential of mainstreaming (Kraemer 2001, p. 33). We emphasized the significance of embedding resilience in normative, organizational, and operational institutions when rendering water systems more resilient. The research results pointed out that there is a lack of adequate organizational governance and responsibility. Also, a significant deficiency is found in regulatory provisions for the successful integration of climate adaptation. By identifying specific measures for the structural development of mainstreaming, our study contributes to the ongoing efforts to build more resilient national adaptation systems.

The integration evaluation of climate resilience through institutionalization can help to elucidate institutional measures for enhancing climate mainstreaming. Through applying a proposed framework and conducting an institutional diagnosis, assessing the current status of mainstreaming can be facilitated in terms of specific items or adaptation programs with a focus on climate resilience. More importantly, institutional approaches for mainstreaming can empower national adaptation policies by crafting institutional instruments that legally establish regulatory provisions within each program. It can be quite challenging to achieve national adaptation in a timely manner to address climate risks when there is a lack of appropriate institutional mainstreaming. This entails the need for comprehensive integration of resilience measures into existing systems, including national recognition, regulatory organization, and operational tools. Without effective mechanisms in place to ensure such institutional integration, the ability to respond effectively to climate risks at a national level may be compromised. Our findings provide valuable insights for policymakers and practitioners seeking to effectively integrate resilience considerations into institutional frameworks.

ACKNOWLEDGEMENT

The study was supported by the Ministry of Environment in South Korea as part of national climate adaptation projects. The authors would like to express their sincere appreciation for the invaluable comments and in-depth guidance provided by the editorial and anonymous reviewers.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

REFERENCES

- Adelle, C. & Russel, D. 2013 *Climate policy integration: A case of Déjà Vu? Environmental Policy and Governance* **23** (1), 1–12.
- Bellon, M. & Massetti, E. 2022 *Economic Principles for Integrating Adaptation to Climate Change into Fiscal Policy*. IMF Staff Climate Note 2022/001, International Monetary Fund, Washington, DC.
- Bours, D., McGinn, C. & Pringle, P. 2013 *Monitoring and Evaluation for Climate Change Adaptation: A Synthesis of Tools, Frameworks and Approaches*. Change Community of Practice, UK Climate Impacts Programme (UKCIP), Phnom Penh, Cambodia.
- Braunschweiger, D. & Pütz, M. 2021 *Climate adaptation in practice: How mainstreaming strategies matter for policy integration. Environmental Policy and Governance* **31** (4), 361–373.

- Brown, A., Gawith, M., Lonsdale, K. & Pringle, P. 2011 *Managing Adaptation: Linking Theory and Practice*. UK Climate Impacts Programme, Oxford, UK.
- Chaffin, B. C., Gosnell, H. & Cosens, B. A. 2014 A decade of adaptive governance scholarship synthesis and future directions. *Ecology and Society* **19** (3), 56.
- Cole, D. H. 2017 Laws, norms, and the institutional analysis and development framework. *Journal of Institutional Economics* **13** (4), 829–847.
- Coleman, J. S. 1988 Social capital in the creation of human capital. *American Journal of Sociology* **94**, S95–S120.
- Commission of the European Communities (CEC). 2001 *A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development Commission's Proposal to the Gothenburg European Council*. Com. CEC, Brussels.
- Craig, R. 2010 Climate change comes to the clean water act: Now what? *Washington & Lee Journal of Energy, Climate & Environment* **9**, 128641988.
- Czempiel, E. & Rosenau, J. 1992 *Governance Without Government*. Cambridge University Press, Cambridge.
- Dalal-Clayton, B. & Bass, S. 2009 *The Challenges of Environmental Mainstreaming: Experience of Integrating Environment into Development Institutions and Decisions*. *Environmental Governance No. 3*. International Institute for Environment and Development (IIED), London.
- De Roeck, F., Orbie, J. & Delpitte, S. 2018 Mainstreaming climate change adaptation into the European Union's development assistance. *Environmental Science & Policy* **81**, 36–45.
- Dicker, S., Unsworth, S., Byrnes, R. & Ward, B. 2021 *Saving Lives and Livelihoods: The Benefits of Investments in Climate Change Adaptation and Resilience*. Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy, London School of Economics and Political Science, London.
- Dupuis, J. & Knoepfel, P. 2013 The adaptation policy paradox the implementation deficit of policies framed as climate change adaptation. *Ecology and Society* **18** (4), 31.
- Eriksen, S., Aldunce, P., Martins, R., Sygna, L., Ulsrud, K., O'Brien, K., Nhemachena, C., Molefe, J., Olorunfemi, F., Park, J. & Bahinipati, S. 2011 When not every response to climate change is a good one: Identifying principles for sustainable adaptation. *Climate and Development* **3** (1), 7–20. doi:10.3763/cdev.2010.0060.
- European Environment Agency. 2015 *National Monitoring, Reporting and Evaluation of Climate Change Adaptation in Europe*. European Environment Agency, Luxembourg.
- European Environment Agency. 2020 *Monitoring and Evaluation of National Adaptation Policies throughout the Policy Cycle*. Publications Office of the European Union, Luxembourg.
- Feagan, M., Matsler, M., Meerow, S., Muñoz-Erickson, T. A., Hobbins, R., Gim, C. & Miller, C. A. 2019 Redesigning knowledge systems for urban resilience. *Environmental Science & Policy* **101**, 358–363.
- Gardiner, S. 2010 Ethics and climate change: An introduction. *Wiley Interdisciplinary Reviews: Climate Change* **1** (1), 54–56.
- Gim, C. & Miller, C. A. 2022 Institutional interdependence and infrastructure resilience. *Current Opinion in Environmental Sustainability* **57**, 101203.
- Gim, C., Miller, C. A. & Hirt, P. W. 2019 The resilience work of institutions. *Environmental Science & Policy* **97**, 36–43.
- Hahn, T. 2011 Self-organized governance networks for ecosystem management who is accountable? *Ecology and Society* **16** (2), 18.
- Hallegatte, S., Ranger, N., Bhattacharya, S., Bachu, M., Priya, S., Dhore, K., Rafique, F., Mathur, P., Naville, N. & Henriot, F. 2010 *Flood Risks, Climate Change Impacts and Adaptation Benefits in Mumbai: An Initial Assessment of Socio-Economic Consequences of Present and Climate Change Induced Flood Risks and of Possible Adaptation Options*. *OECD Environment Working Papers, No. 27*. OECD Publishing, Paris.
- Halsnæs, K. & Trærup, S. 2009 Development and climate change: A mainstreaming approach for assessing economic, social, and environmental impacts of adaptation measures. *Environmental Management* **43** (5), 765–778.
- Hatfield-Dodds, S., Nelson, R. & Cook, D. C. 2007 Adaptive governance: An introduction and implications for public policy. In: *51st Annual Conference of the Agricultural and Resource Economics Society*, February 13–16, 2007, Queenstown, New Zealand. Australian Agricultural and Resource Economics Society, Canberra, pp. 1–13.
- Incropera, F. 2015 *Climate Change: A Wicked Problem*. Cambridge University Press, Cambridge.
- IPCC. 2014 Climate change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. In: *Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. (Field, C. B., Barros, V. R., Dokken, D. J., Mach, K. J., Mastrandrea, M. D., Bilir, T. E., Chatterjee, M., Ebi, K. L., Estrada, Y. O., Genova, R. C., Girma, B., Kissel, E. S., Levy, A. N., MacCracken, S., Mastrandrea, P. R. & Whit, L. L., eds.) Cambridge University Press, Cambridge.
- IPCC. 2022 Summary for policymakers. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Pörtner, H. O., Roberts, D. C., Tignor, M., Poloczanska, E. S., Mintenbeck, K., Alegría, A., Craig, M., Langsdorf, S., Lösschke, S., Möller, V., Okem, A. & Rama, B., eds.) Cambridge University Press, Cambridge, pp. 3–33.
- Jacob, K. & Volkery, A. 2004 Institutions and instruments for government self-regulation: Environmental policy integration in a cross-country perspective. *Journal of Comparative Policy Analysis: Research and Practice* **6** (3), 291–309.
- Jacob, K., Volkery, A., Lenschow, A., 2008 Instruments for environmental policy integration in 30 OECD countries. In: *Innovation in Environmental Policy? Integrating the Environment for Sustainability* (Jordan, A. J. & Lenschow, A., eds.) Edward Elgar Publishing, Cheltenham, UK, pp. 24–47.

- Johnston, M. 2006 *Good Governance: Rule of Law, Transparency, and Accountability*. United Nations Public Administration Network, New York.
- Keessen, A. & Van Rijswijk, H. F. M. W. 2013 *Adaptation to climate change in European water law and policy*. *Utrecht Law Review* 8 (3), 38–50.
- Kim, J. 2006 *Networks, network governance, and networked networks*. *International Review of Public Administration* 11 (1), 19–34.
- Kraemer, R. A. 2001 *Results of the ‘Cardiff Processes’: Assessing the State of Development and Charting the Way Ahead. (Report to the German Federal Environmental Agency and the German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, GZ: Z 1.6 -90 260-19/1)*. Institute for International and European Environmental Policy, Berlin.
- Krueger, E. H., Constantino, S. M., Centeno, M. A., Elmqvist, T., Weber, E. U. & Levin, S. A. 2022 *Governing sustainable transformations of urban social-ecological-technological systems*. *NPJ Urban Sustainability* 2 (1), 10.
- Lafferty, W. & Hovden, E. 2003 *Environmental policy integration: Towards an analytical framework*. *Environmental Politics* 12 (3), 1–22.
- Lafferty, W. M., Ruud, A. & Larsen, O. M. 2005 *Environmental policy integration: How will we recognize it when we see it? The case of green innovation policy in Norway*. In: *Governance of Innovation Systems: Volume 3 Case Studies in Cross-Sectoral Policy*. (OECD, ed.), OECD, Paris, pp. 221–244.
- Lee, D., Shin, J., Song, Y., Chang, H., Cho, H., Park, J. & Hong, J. 2022 *The development process and significance of the 3rd national climate change adaptation plan (2021–2025) of the Republic of Korea*. *Science of the Total Environment* 818, 151728.
- Lenschow, A. & Zito, A. R. 1998 *Blurring or shifting of policy frames? Institutionalization of the economic-environmental policy linkage in the European community*. *Governance* 11 (4), 415–441.
- Lenschow, A., 2012 *Greening the European Union: An introduction*. In: *Environmental Policy Integration* (Lenschow, A., ed.). Routledge, London, pp. 3–21.
- MacQueen, K. M., McLellan, E., Kay, K. & Milstein, B. 1998 *Codebook development for team-based qualitative analysis*. *CAM Journal* 10 (2), 31–36.
- Massey, E. & Huitema, D. 2013 *The emergence of climate change adaptation as a policy field: The case of England*. *Regional Environmental Change* 13 (2), 341–352.
- McDonald, J. 2011 *The role of law in adapting to climate change*. *WIREs Climate Change* 2 (2), 283–295.
- Muñoz-Erickson, T. A., Meerow, S., Hobbins, R., Cook, E., Iwaniec, D. M., Berbés-Blázquez, M., Grimm, N. B., Barnett, A., Cordero, J., Gim, C., Miller, T. R., Tandazo-Bustamante, F. & Robles-Morua, A. 2021 *Beyond bouncing back? Comparing and contesting urban resilience frames in US and Latin American contexts*. *Landscape and Urban Planning* 214, 104173.
- North, D. C. 1990 *Institutions, Institutional Change and Economic Performance*. Cambridge University Press, New York.
- O’Connor, C. & Joffe, H. 2020 *Intercoder reliability in qualitative research: Debates and practical guidelines*. *International Journal of Qualitative Methods* 19, 1609406919899220.
- OECD. 2009 *Integrating Climate Change Adaptation into Development Co-Operation*. OECD, Paris.
- OECD. 2016 *Better Policies for Sustainable Development 2016: A New Framework for Policy Coherence*. OECD, Paris.
- Ostrom, E. 2005 *Understanding Institutional Diversity*. Princeton University Press, Princeton, NJ.
- Park, S. K. 2021 *Legal strategy disrupted: Managing climate change and regulatory transformation*. *American Business Law Journal* 58 (4), 711–749.
- Persson, Å. 2004 *Environmental Policy Integration: An Introduction*. Stockholm Environmental Institute, Stockholm.
- Persson, Å. 2008 *Mainstreaming climate change adaptation into official development assistance: A case of international policy integration*. EPIGOV Papers 36. Ecologic – Institute for International and European Environmental Policy, Berlin.
- Persson, Å. & Klein, R., 2009 *Mainstreaming adaptation to climate change into official development assistance: Challenges to foreign policy integration*. In: *Climate Change and Foreign Policy* (Harris, P., ed.). Routledge, Abingdon, pp. 162–177.
- Persson, Å., Runhaar, H., Karlsson-Vinkhuyzen, S., Mullally, G., Russel, D. & Widmer, A. 2018 *Editorial: Environmental policy integration: Taking stock of policy practice in different contexts*. *Environmental Science & Policy* 85, 113–115.
- Pierre, J. & Peters, G. 2000 *Governance, Politics and the State*. Macmillan, Basingstoke.
- Refsgaard, J. C., Arnbjerg-Nielsen, K., Drews, M., Halsnæs, K., Jeppesen, E., Madsen, H., Markandya, A., Olesen, J. E., Porter, J. R. & Christensen, J. H. 2013 *The role of uncertainty in climate change adaptation strategies – A Danish water management example*. *Mitigation and Adaptation Strategies for Global Change* 18 (3), 337–359.
- Rhodes, R. A. W. 1997 *Understanding Governance: Policy Networks, Governance, Reflexivity and Accountability*. Open University, Philadelphia, PA, USA.
- Runhaar, H., Driessen, P. & Uittenbroek, C. 2014 *Towards a systematic framework for the analysis of environmental policy integration*. *Environmental Policy and Governance* 24 (4), 233–246.
- Runhaar, H., Wilk, B., Driessen, P., Dunphy, N., Persson, Å., Meadowcroft, J., Mullally, G., 2020 *Policy integration*. In: *Architectures of Earth System Governance. Institutional Complexity and Structural Transformation* (Biermann, F. & Kim, R. E., eds). Cambridge University Press, Cambridge, UK, pp. 183–206.
- Runhaar, H., Wilk, B., Persson, Å., Uittenbroek, C. & Wamsler, C. 2018 *Mainstreaming climate adaptation: Taking stock about ‘what works’ from empirical research worldwide*. *Regional Environmental Change* 18 (4), 1201–1210.
- Scott, R. 1995 *Institutions and Organizations*. Solid Action on Globalization and Environment Publisher, Los Angeles, CA, USA.
- Scott, A., Holtby, R., East, H. & Lannin, A. 2021 *Mainstreaming the environment: Exploring pathways and narratives to improve policy and decision-making*. *People and Nature* 4, 201–217.

- Sue, E. S. C. & Ostrom, E. 1995 [A grammar of institutions](#). *The American Political Science Review* **89** (3), 582–600.
- Thompson, G., Frances, J., Levacic, R. & Mitchell, J. 1991 *Markets, Hierarchies and Networks: The Coordination of Social Life*. Sage Publications, London.
- UNAIDS/UNDP/World Bank. 2005 *Mainstreaming AIDS in Development Instruments and Processes at the National Level: A Review of Experiences*. UNAIDS/UNDP/World Bank, Geneva.
- Underdal, A. 1980 [Integrated marine policy: What? Why? How?](#) *Marine Policy* **4** (3), 159–169.
- Van Asselt, H., Rayner, T., Persson, A., 2015 Climate policy integration: Common sense or political project? In: *Research Handbook of Climate Governance* (Backstrand, K. & Lovbrand, E., eds). Edward Elgar Publishing, Cheltenham, pp. 388–399.
- Van Den Bergh, J. C. J. M., Truffer, B. & Kallis, G. 2011 [Environmental innovation and societal transitions: Introduction and overview](#). *Environmental Innovation and Societal Transitions* **1** (1), 1–23.
- Van Oosten, C., Uzamukunda, A. & Runhaar, H. 2018 [Strategies for achieving environmental policy integration at the landscape level. A framework illustrated with an analysis of landscape governance in Rwanda](#). *Environmental Science & Policy* **83**, 63–70.
- Villanueva, P. S. 2011 *Learning to ADAPT: Monitoring and Evaluation Approaches in Climate Change Adaptation and Disaster Risk Reduction – Challenges, Gaps and Ways Forward*, (SCR Discussion Paper No. 9), *Strengthening Climate Resilience (SCR)*. Institute of Development Studies, Brighton, UK.
- Wamsler, C. 2015 [Mainstreaming ecosystem-based adaptation: Transformation toward sustainability in urban governance and planning](#). *Ecology and Society* **20** (2), 30.
- Wamsler, C. & Pauleit, S. 2016 [Making headway in climate policy mainstreaming and ecosystem-based adaptation: Two pioneering countries, different pathways, one goal](#). *Climatic Change* **137** (1), 71–87.
- WCED. 1987 *Our Common Future*. Oxford University Press, Oxford.
- Weiland, S., Tröltzsch, J., Capriolo, A., Den Uyl, R. M., Jensen, A., Giordano, F., Hildén, M., Karali, E., Mäkinen, K., Nielsen, H., Penha-Lopes, G. & Russel, D. 2014 *BASE Evaluation Criteria for Climate Adaptation (BECCA)*.
- Widmer, A. 2018 [Mainstreaming climate adaptation in Switzerland: How the national adaptation strategy is implemented differently across sectors](#). *Environmental Science & Policy* **82**, 71–78.
- Woodruff, S. C. 2018 [Coordinating plans for climate adaptation](#). *Journal of Planning Education and Research* **42** (2), 218–230.
- World Meteorological Organization (WMO). 2021 *WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019)* (WMO-No. 1267). World Meteorological Organization, Geneva.

First received 17 October 2022; accepted in revised form 11 October 2023. Available online 30 October 2023