



Deeper understanding of the barriers to national climate adaptation policy: the case of South Korea

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Abstract

As climate change adaptation has become essential for the sustainable development of nations, national adaptation policies have increasingly been adopted and implemented over the past decade. However, an adaptation gap is observable and getting wider. We investigate the barriers to national adaptation policy and their origins, influence as well as relationships between them in South Korea. We also analyse used and suggested solutions to overcome the barriers. Based on interviews with core stakeholders, we find 49 factors (16 barriers, 14 origins, 19 influences) related to barriers to national adaptation policy and draw a barrier map that shows all factors and relationships between them. We also explain how the barriers occur and how they affect national adaptation policy by mapping the relationships between barriers, origins, and influences. Key barriers to Korea's national adaptation policy are related to institutions, fragmentation, and resources. With an analysis of used/suggested solutions, we conclude by suggesting a procedure for diagnosing problems of national adaptation policy, understanding related barriers and origins, and devising practical solutions for national policymakers and stakeholders.

Keywords Climate change · Adaptation · Barrier · National adaptation policy · South Korea

1 Introduction

Climate change adaptation has become essential for the sustainable development of nations. Adaptation refers to the process of adjustment to actual or expected climate change and its effects, seeking to moderate or avoid harmful effects or exploit beneficial opportunities (IPCC 2014). Given inevitable impacts of climate change on ecosystems and economies,

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the importance of adaptation is widely acknowledged (Adger et al. 2009a, b; IPCC 2012, 2014; CCC 2017). Nations are under international and domestic requirements to adapt to climate change, and the national government's roles for adaptation are stressed (Mullan et al. 2013; Biesbroek et al. 2013; Berrang-Ford et al. 2014; Eisenack et al. 2014; IPCC 2014; Henstra 2017). Since the Intergovernmental Panel on Climate Change (IPCC)'s fourth assessment report in 2007 (AR4), many countries have adopted and implemented official national adaptation policies that include national adaptation strategies and sectoral adaptation actions (IPCC 2014). Examples include the National Adaptation Programme of the UK (2013, 2018), Germany's national adaptation strategy (2008), Danish Strategy for Adaptation to a Climate Change of Denmark (2008), National Climate Resilience and Adaptation Strategy of Australia (2015, 2021), Wise Adaptation to Climate Change of Japan (2008), and China's National Strategy for Climate Change Adaptation (2016).

However, despite these efforts, an 'adaptation gap' persists and is getting wider: adaptation needs are not met by adaptation actions and policies (Burton 2009; UNEP 2021; IPCC 2022). The adaptation gap has been reported across sectors/scales and in both developed and developing countries (Burton and May 2004; Burton 2009; Dupuis and Knoepfel 2013; Ashwill and Heltbrg 2013; Markus and Savini 2016; Lonsdale et al. 2017; Clissold et al. 2020; Marcus and Hanna 2020; IPCC 2022).

Barriers to adaptation are considered a major reason for the adaptation gap (Simoes et al. 2017; Clissold et al. 2020; Lee et al. 2022), and identifying and overcoming them is urgently required to reduce the adaptation gap and enhance adaptive capacity (Eisenack et al. 2014; Simoes et al. 2017; Bednar et al. 2019; Clissold et al. 2020; Liu et al. 2020). Barriers are factors that impede adaptation processes, and they can be overcome with concerted effort, creative approaches, and different use of resources (Moser and Ekstrom 2010; Biesbroek et al. 2011; Eisenack et al. 2014; Lee et al. 2022). Earlier studies have identified barriers to adaptation and classified them into various categories (Agrawala and van Aalst 2005; IPCC 2007, 2014; Adger et al. 2009a, b; Berrang-Ford et al. 2011; Biesbroek et al. 2011; Wise et al. 2014; McNamara et al. 2017; Hurrilimann et al. 2018), which offer a broad conceptual and empirical base of the barriers (Eisenack et al. 2014).

However, the critical limitations of previous studies have been repeatedly emphasised. First, the existing approach focused on identifying and describing barriers to adaptation has been insufficient to systematically address the barriers in the adaptation process (Prabhakar et al. 2014; Waters et al. 2014; Ghasemzadeh and Sharifi 2020). The concept of barriers to adaptation has been used to list existing impediments to adaptation policy (Dupuis and Knoepfel 2013), and long lists of context-specific barriers have been suggested (Waters et al. 2014). However, this approach hinders explaining and understanding barriers, and as a result, the results of the research have rarely been used in actual policy processes (Wise et al. 2014; Waters et al. 2014; Biesbroek et al. 2015). Much of the existing literature has been conducted under functionalist assumptions that suppose identifying barriers will automatically lead to overcoming them (Wellstead et al. 2018). Also, the broader body of literature on national adaptation policy and planning has been predominantly based on document analysis, and empirical insights are largely missing. Secondly, from the early 2010s, questions related to the underlying causes of barriers, their short- and long-term consequences, and internal dynamics have been raised, but they remain unanswered (Moser and Ekstrom 2010; Biesbroek et al. 2013; Eisenack et al. 2014; Waters et al. 2014; Fayazi et al. 2020; Ghasemzadeh and Sharifi 2020). As earlier research has mostly omitted the barriers' origins or causal mechanisms, it has failed to explain barriers to adaptation beyond describing them (Dupuis and Knoepfel 2013; Wise et al. 2014; Wellstead et al. 2018; Liu et al. 2020). A lack of understanding of how barriers are linked to the decision-making

process and how barriers affect adaptation policies and actions means that the barriers have been dealt with as isolated entities (Biesbroek 2014). Also, the current fragmented understanding of the relationships between barriers or the internal dynamics is one of the important reasons for lack of specific and systematic solutions for the barriers (Biesbroek et al. 2015; Spires and Shackleton 2018; Fatorić and Biesbroek 2020; Valente and Veloso-Gomes 2020). Lastly, only a few studies have provided useful insights into how barriers can be addressed, and this is related to the limited state of the art in explaining the barriers (Eisenack et al. 2014). Although some studies have suggested solutions or guidelines to overcome the barriers, they are barely used in the actual adaptation processes because they are too general or normative to apply (Clar et al. 2013; Lee et al. 2022). Yet, there is a great demand for practical solutions (Biesbroek 2014; Wise et al. 2014; Braunschweiger and Pütz 2021). Thus, a research shift that can provide a better understanding of barriers has been required (Burch 2010; Eisenack et al. 2014; Waters et al. 2014; Clissold et al. 2020). The better understanding should involve the explanations of barriers' origins, influences, and dynamics, which can produce practical insights into overcoming the barriers in actual adaptation processes.

This research seeks to advance research by providing a deeper understanding of barriers to adaptation through analysing barriers to national adaptation policy, including their origins, influences, and relationships between them. It suggests a potential approach for policymakers and policy practitioners to address the barriers. The questions guiding this research are (1) what are the barriers to national adaptation policy and their origins and influences? (2) how do the barriers, origins, and influences interact? and (3) what can policymakers and stakeholders do to address the barriers?

This research examines the national adaptation policy in the Republic of Korea (Korea). Most research to date on national adaptation policy has focused on western developed countries, particularly in the EU. Therefore, an examination of the Korea case can contribute to a better understanding of barriers to national adaptation policy as well as to providing new insights into adaptation policy in Asia.

2 Case context

Climate change projections suggest that the mean temperature in the Korean peninsula will increase 1.3 times more than the projected global and East Asian mean annual temperatures by the end twenty-first century (KMA 2017). To respond to the projections, the Korean government has implemented the National Climate Change Adaptation Plan (NCCAP) since 2011 (the first 2011–2015 and the second 2016–2020), under the Framework Act on Low Carbon, Green Growth (2010). The Ministry of Environment (MoE) leads the policy process, and NCCAP involves a range of government departments and sectors; a total of 14 departments in the first plan and 20 departments in the second one (Korea Government 2010, 2015). NCCAP involves only central government departments and their actions. Policy evaluation also focuses on government department tasks and projects. In 2017, the Korean government carried out an intermediate evaluation of the second NCCAP focused on the relevant departments' 285 tasks and 100 key projects and their implementation results: the results suggested that 96% of the tasks are implemented as planned, and 4% of tasks are delayed or not implemented in terms of the criteria of implementation and goal achievement efforts (Sin et al. 2017).

The Korean government conducted climate change risk assessments in 2014 and 2019. The 2019 risk assessment identified 93 risks in eight sectors that the NACCAP needs to address. These include, for example, the increased drying up of streams due to droughts (water sector), decrease in the productivity in manufacturing due to heat waves, cold snaps, and heavy rainfall events (industry and energy sector), increase in flooding in coastal areas due to heavy rain, tidal surges, and sea level rise (ocean, fishery, and coastal sectors) and increase in mental health problems due to heat waves (health sector) (Song et al. 2019).

Korea Adaptation Centre for Climate Change (KACCC), an affiliated institute of MoE, provides services to the central government by formulating and implementing NCCAPs, evaluating the impacts of climate change and vulnerability, and developing and disseminating adaptation programmes and information.

Although Korea has gained substantial experience from 10 years of policy implementation of NCCAPs, problems have been identified, and questions about the effectiveness of adaptation policies have been raised (Chae et al. 2014; Jang et al. 2019).

3 Methodology

3.1 Key terms

To overcome the above-mentioned limitations of earlier research, and make this research more explanatory, a new research approach focusing on the factors of origins, barriers, influences, and relationships between the factors is suggested. As a term, ‘barrier to adaptation’ refers to factors that hinder national adaptation policy processes, which interviewees experienced in their activities, referring the definition of barriers to adaptation in Biesbroek et al. (2013). To highlight how barriers to adaptation occur, factors that give rise to the barriers are defined as ‘origins’. To analyse how barriers affect adaptation processes, factors affected by the barriers are defined as ‘influences’: they are national adaptation policy problems caused by the barriers. ‘Relationships’ refer to connections between factors, indicating that a factor contributes to the occurrence of another: they include relationships between barriers, origins, and influences.

3.2 Data collection

A case study investigates a contemporary phenomenon in depth and within its real-world context, focusing on answering how and why questions (Yin 2003, 2018; Baxter and Jack 2008). Barriers to adaptation can be identified based on the experiences of actors who participate in the adaptation process, and most barriers are related to the actors themselves (Eisenack et al. 2014). Semi-structured interviews with core stakeholders of NCCAPs and qualitative content analysis of the interview results was thus considered the best method for the research.

Interviewees were selected based on the list of participants of NCCAP workshops and they were from four key stakeholder groups: (A) civil servants of the managing department (MoE); (B) civil servants of other governmental departments; (C) experts of an official supporting institute (KACCC); and (D) experts of each sector or department. Also, (E) experts of local adaptation policy were interviewed for additional information. Interviews were conducted from 10th April to 19th July 2019, and a total of 23 interviewees participated in the interviews (A = 5, B = 2, C = 3, D = 10, E = 3).

The main interview questions were (1) based on your experience, what were the barriers to national adaptation policy? (2) what problems were caused by the barriers? and (3) what do you think the reason for the barriers? Also, questions about used/suggested solutions for the barriers were asked to understand the limitations of existing solutions and to analyse what stakeholders can do to address the barriers. The detailed Interview protocol is in Appendix Table 2.

3.3 Analysis

The analysis method, codifying barriers based on factors that interviewees mentioned as barriers, has been used in earlier studies based on interviews with key informants or stakeholders (Barnett et al. 2013; Ekstrom and Moser 2014). Ishtiaque et al. (2021) also attempted to codify reasons for why the barriers occur alongside identifying barriers based on transcribed interview results.

We identify barriers to Korea's national adaptation policy using evidence provided by the interviews. Every factor that the interviewees mentioned as barrier to national adaptation policy is considered a barrier. The barriers are classified¹ following Lee et al. (2022), who suggested 8 categories of barriers covering the characteristics of national-level policies as well as related problems based on systematic review of existing research. We assume that the categories are applicable for examining barriers to national adaptation policy in Korea. Next, we analyse the barriers' origins and influences based on the interviewees' responses to questions 2 and 3. For example, the response 'this problem is caused because we do not have explicit indicators that show the effectiveness of adaptation policy, ... It also means that we do not have clear directions of national climate adaptation policy' is linked to an absence of effective monitoring and evaluation system. Thus, an absence of explicit indicators for the effectiveness of adaptation policy is deemed an origin of the barrier, and its influence is the unclear direction of national climate adaptation policy.

Some recent studies have sought to highlight the interdependences between barriers to adaptation with arrows (Fatoric and Biesbroek 2020; Fayazi et al. 2020; Mercado et al. 2020), but they still do not consider causal mechanisms around barriers, including origins and influencing factors. We map the relationships between barriers, origins, and influences as well as between barriers with arrows. Based on interview response analysis, if one factor affects the occurrence of another factor, the two factors are connected by an arrow, and the direction of the arrow presents the relationship between the two factors. We can arrive at a 'barrier map' of NCCAPs that presents all of the relationships in their totality. With the mapped relationships, we explain what factors are related to the occurrence of a barrier, how the barriers influence adaptation policy, and how the barriers interact. We also identify key barriers by analysing the number of sources, influences, and interactions the barriers have. The key barriers have more than the average number of arrows coming in and out; they thus play a more significant role than the other barriers. To come up with potential ways to address the barriers, we analyse used and suggested solutions on the basis of the interviews.

¹ 1) conflicting timescales and priorities, 2) uncertainty, 3) institutional crowding and voids, 4) fragmentation, 5) lack of awareness and communication, 6) resources, 7) power of the main department, and 8) other.

4 Results

4.1 Barriers to national adaptation policy

4.1.1 Conflicting timescale and priority

The low priority of adaptation, especially in government departments, is identified as a barrier to national adaptation policy. Politicians and high-ranking decision-makers have to demonstrate achievements within their 4- or 5-year term. They consider adaptation issues cannot generate tangible results within this timeframe. This leads to governmental indifference towards adaptation and a low priority of adaptation among other national issues. D1 pointed out that governmental departments, even MoE, cannot give adaptation a high priority, because they cannot expect quick tangible results from adaptation policies. C2 opined that 'civil servants think adaptation issues are future issues, not the current issues which are pressing'. This low priority of adaptation undermines longer-term policies and securing resources for implementing adaptation policies. Interviewees considered that the origin of this barrier lies in the absence of explicit long-term directions of NCCAP and unclear achievements of adaptation policy.

4.1.2 Uncertainty

Two types of barrier relate to uncertainty. First, the uncertainty of outcomes of adaptation policy was identified as a barrier. Interviews indicate that this uncertainty leads to cautious responses by government departments. Because outcomes are uncertain, civil servants will not initiate transformative policies with limited resources. D2 highlighted that it is hard for the departments to invest for 10 or 20 years for uncertain results of adaptation. Yet, the uncertainty of climate impacts is not considered a barrier. The interviewees recognised that climate change projections cannot be perfect and that they need to make decisions on adaptation policies under uncertainty.

4.1.3 Institutional crowding and voids

Two key institutional barriers were identified: (1) the absence of effective monitoring and evaluation (M&E) system, and (2) the lack of detail in the current Act. Half of the interviewees indicated that NCCAP does not have a formal M&E system. They viewed that the current informal M&E system cannot establish the effectiveness of national adaptation policies. The M&E, focusing on individual projects, evaluates whether the projects are executed and if their budgets are used well, rather than establishing their contribution to adaptation. The evaluation is also conducted by government departments themselves. Interviewees highlighted that the current M&E system cannot establish the outcomes related to adaptation (C2, C3, E2), that it is impossible to conduct a comprehensive evaluation of the national adaptation policy (D2), that characteristics of regions or projects are not considered (D5), and that feedback from the M&E system is pointless for next processes (D5, D9). C2 also pointed out that 'this problem is caused because we do not have explicit indicators that show the effectiveness of adaptation policy, ... It also means that we do not have clear directions of national adaptation policy'. D7 warned this problem would continue if the same M&E solution is retained.

A lack of detail about adaptation in the current Act is also considered a barrier. The Framework Act on low carbon, green growth has 64 articles and focuses on the mitigation of greenhouse gas emissions. Only article 48 of the act and article 38 of the enforcement decree provide a legal basis for the national adaptation policy. Interviewees viewed that the Articles are insufficient to support adaptation policy because they do not provide for formal procedures, e.g., there is no provision for risk assessments or M&E systems (D4). The hierarchical nature of the policy also causes conflicts with and overlaps with other policies, e.g., mitigation policies. The Act does not specify the policy's form, range, and linkages with other adaptation policy levels which leads to inconsistencies between them. A4, A5, D8, D10 all suggested that the current Act does not provide for sufficient authority and resources for the MoE to operate a national-level policy, limiting its power.

4.1.4 Fragmentation

Both horizontal (between government departments) and vertical (between the central government and sub-national stakeholders) fragmentation was identified as a barrier. Interviewees from MoE and KACCC, in particular, had experienced unwillingness of other departments to cooperate. From the early stages of the policy process, other departments participated inactively, and some declined to participate, suggesting that they do not need adaptation policy. Although there is a cross-departmental consultative group consisting of high-ranking civil servants of participating departments, it has not functioned in the past decade. Interviewees described this as 'indifference of other governmental departments' which originated from a lack of understanding of adaptation. E1 mentioned that many departments consider that adaptation is not directly related to their agenda. D1 gave an example of policies for heatwaves in Korea: 'various departments make their policy to respond to heatwaves, but they don't think the policy is a kind of adaptation policy and don't want to implement it with other departments concerning losing their authority. ... In a national view, heatwave policies do not have consistent directions, and it causes overlaps of similar policies and waste of resources'.

Vertical fragmentation barriers are about cooperation between the national adaptation policy and local adaptation policies. In Korea, every local government and lower-level local government has to establish their adaptation policy, but the national-level and local-level policies are seldom linked, and they are implemented separately. Interviewees said that the national adaptation policy did not consider local governments' roles and authorities, and there was no discussion on how to link different levels of policy from the outset. There is no linkage between climate change risk assessments at different levels either. Interviewees criticised that the current national policy and risk assessment do not capture the reality on the ground nor suggest common goals that all stakeholders would pursue, because of the vertical fragmentation (B1, C3, D8, E2). Furthermore, NCCAP does not involve private sector and civil society organisations.

The interviews indicate that the vertical fragmentation barrier is caused by a perception gap between central government civil servants and sub-national stakeholders. In the interviews, central government civil servants recognise that the national adaptation policy is only about central government departments' goals and actions. In contrast, other stakeholders (experts, local government civil servants, private sectors) perceive that the national-level policy should address adaptation comprehensively at all levels. Because NCCAP is made up of a small number of central government civil servants and experts, their perceptions inform the national adaptation policy.

4.1.5 Lack of awareness and communication

Barriers related to lack of awareness and communication were most often mentioned by interviewees, and they have three subtypes: (1) the lack of understanding; (2) the lack of awareness; and (3) the absence of a comprehensive and continuous communication system. Interviewees suggested that a lack of understanding of adaptation by stakeholders, especially government departments, is a significant barrier, which relates to horizontal fragmentation barriers. They said that although NCCAP has been implemented for a decade, the participating departments still question what they can do for adaptation and whether adaptation needs specific, dedicated policies. Government departments find it difficult to link adaptation and their core agenda (B1). Even MoE civil servants talked about the difficulty of understanding the concept of adaptation. For example, A5 said that ‘the range of climate change impacts is too broad, and many departments are involved ... the concept of adaptation is difficult and complex compared to the concept of mitigation’. It is still hard to distinguish adaptation policy from, for example, disaster risk reduction policy, and to explain to other departments how adaptation is deeply related to their work (A2, A4). C1 thought that ‘civil servants have an awareness of adaptation, and they know we need adaptation policies. However, they hardly understand what adaptation is and what we can do now’. Moreover, interviewees suggested that unclear definition and different interpretation of key adaptation terms makes them hard to understand. This lack of understanding leads to the result that the current national adaptation policy mainly consists of policies which are government departments want to do, rather than considering effectiveness for adaptation.

A lack of awareness of adaptation by the public also hinders national adaptation policy. The public does not link the concept of adaptation to the climate change issues that they are experiencing. D2 said ‘the public feels inconvenience caused by climate events such as heatwaves, and they think something should be changed. However, this thought is not linked with adaptation policy’. D7 considered that people usually think about mitigation when they face climate change issues. Interviewees identified two key origins of this barrier: (1) over-emphasis by the government in its response to climate change on mitigation, (2) adaptation issues are only dealt with by a small number of experts. A lack of awareness by the public leads to political apathy among politicians and high-ranking decision-makers.

Interviewees also identified an absence of a comprehensive and continuous communication system as a barrier. The NCCAP does not have a formal communication platform engaging stakeholders in a continuous manner. Interviewees highlighted that there are communication problems between scientists who generate scientific data and policymakers, who use it. D5 said the functions of climate research and adaptation policy are separated, and it is hard to link them because of different views of time-scales. Also, there is a lack of communication between the central government and sub-national stakeholders. In Korea’s current national adaptation scheme, there is no way for local governments or private sectors to participate in or local realities to be incorporated into the national-level policy. This barrier influences policy acceptance and its effectiveness at the ground.

4.1.6 Human and financial resources

Interviewees frequently mentioned three barriers related to human resources: frequent rotation of civil servants, human resources shortage of the NCCAP, and lack

of adaptation experts. Frequent rotation of civil servants from one position to another impedes national policy implementation. Civil servants in charge of the NCCAP change at least three times in any 5-year period because civil servants are rotated every 2 years. Interviewees said that civil servants have varied understandings of adaptation, some in need of further training, and NCCAP is significantly influenced by their different understandings. Experts from outside of the government departments viewed that the rotation system negatively affects expertise, continuity, and policy experience for national adaptation policy. However, civil servants consider that it is inevitable because the rotation system is part of the civil service regulations. Interviewees mentioned that it needs to accept the situation and find solutions, like other policies do (A2, A4, A5).

Although NCCAP involves many departments and projects, it is led by a small group of only four civil servants who have high workloads. In contrast, mitigation policies are implemented by several teams or a full department. Interviewees considered that it is almost impossible to lead policy implementation effectively with this small group of civil servants. Interviewees also felt they do not have enough experts of adaptation who could give consistent and clear policy advice. Adaptation is a secondary area of expertise for most of the experts who currently advise the NCCAP: they have different understandings of adaptation and interpret key terms and concepts in light of their primary areas of expertise which often leads to confusion (A4, A5).

Almost every interviewee identified the lack of financial resources as a barrier. No department has a budget for adaptation policy specifically, and MoE does not have finances to support other departments' adaptation policy. Therefore, departments want to implement existing policies with sufficient budgets as their adaptation policy and are reluctant to seek additional finances to implement new and progressive adaptation policy (D2). Interviewees also highlighted that the current legal basis of adaptation policy leads to insufficient funds. D10 mentioned that NCCAP does not have enough power to lead departments unless the policy has a sufficient budget to do so.

4.1.7 Power of the main department

The limited power of MoE is a barrier: the interviewees considered that MoE does not have sufficient budget and procedures to oversee and coordinate adaptation actions across the departments. Although limited power is a smaller problem in the policy adoption stage, it is a big one in policy implementation. MoE cannot force other departments to make more effort or to dedicate resources or to change their course of action. D2 also asked: 'although MoE manages NCCAP, essential projects are implemented by other departments. ... For adaptation, what is MoE doing on the ground?'. With a limited authority, MoE cannot require other departments to participate actively, which undermines the functioning of the cross-departmental consultative group (A4, A5). The limited power of MoE entails limited authority of the KACCC as well. Interviewees traced the origin of the barrier to the current Act, which does not provide for authority and budget to MoE.

4.1.8 Others

The interviewees identified two further barriers. First, the climate change risk assessment does not play a sufficient role in NCCAP. Stakeholders did not see a link between its

findings and their activities. They pursue the activities they want regardless of the identified risks, which are addressed only superficially by the policy. As a result, NCCAP does not have well-established priorities for adaptation policies (A2, A4, A5, D1, D2, E2, D7, D8, D10). Secondly, NCCAP is not sufficiently supported by research. Research on the effectiveness of adaptation policy was considered insufficient in particular. Civil servants said that existing research does not provide support for the design of adaptation policies and or establish their outcomes and performance. D1 highlighted the lack of studies justifying adaptation policy which typically involve substantial uncertainty regarding outcomes. In particular, the dearth of research on the economic feasibility of adaptation policies affects their acceptance. Interviewees stressed that more research is needed on the cost of climate change impacts and the benefits of adaptation policy to provide a strong rationale for why adaptation is needed now.

4.2 Relationships between factors and key barriers

The relationships between barriers, origins, and influences are presented with arrows in Fig. 1. The barriers occur and intertwine with many factors in a complex way: barriers are related to several origins, influences, and other barriers across categories. Although the relationships are complex, Fig. 1 highlights why barriers and national adaptation policy problems occur, and which factors are related to each other. In what follows, we analyse the key barriers that are more influential than others for Korean national adaptation policy.

Barriers have on average three arrows coming in and out. We defined a key barrier as one which has at least four arrows (more than the average) and identified seven key barriers. Barriers related to institutions are most notable among them. Although they are themselves barriers, they are also direct or indirect origins of other factors. For example, 'Lack of detail in the current Act (insufficient legal basis)' directly relates to three other barriers and two influences: it gives rise to one origin, two more barriers, and five influences. Although the barrier has multiple effects, only one factor is pointed out as its origin: 'national climate change response focus on mitigation'. 'Absence of effective M&E system' is also a key barrier, which has three direct origins. It affects 'Unclear achievement of adaptation policy' and causes four further barriers and three influences. Resource barriers, particularly 'Frequent rotation of civil servants', are also key barriers. It is an administrative factor not directly related to climate change, but it has four problematic influences for adaptation policies. It originates from 'Civil servant regulation' that is also an administrative factor. 'Lack of financial resources' leads to two influences related to conservative policies which result in less progressive adaptation actions. The barrier has complex origins in institutions, indifference, and understanding. 'Difficulty of securing resource for adaptation policy' arises from the origins and barriers related to low understanding and attention issues. Horizontal and vertical fragmentation barriers are all key barriers with different origins. Horizontal fragmentation is caused by government departments' lack of understanding of and indifference toward adaptation. Vertical fragmentation is caused by weak institutions and a perception gap about the range of national adaptation policy between central and local government civil servants. 'Low priority of adaptation' is also a key barrier which arises from a combination of origins to do with timeframe gaps, unclear achievement and lack of explicit directions of adaptation policy, indifference, and understanding of adaptation.

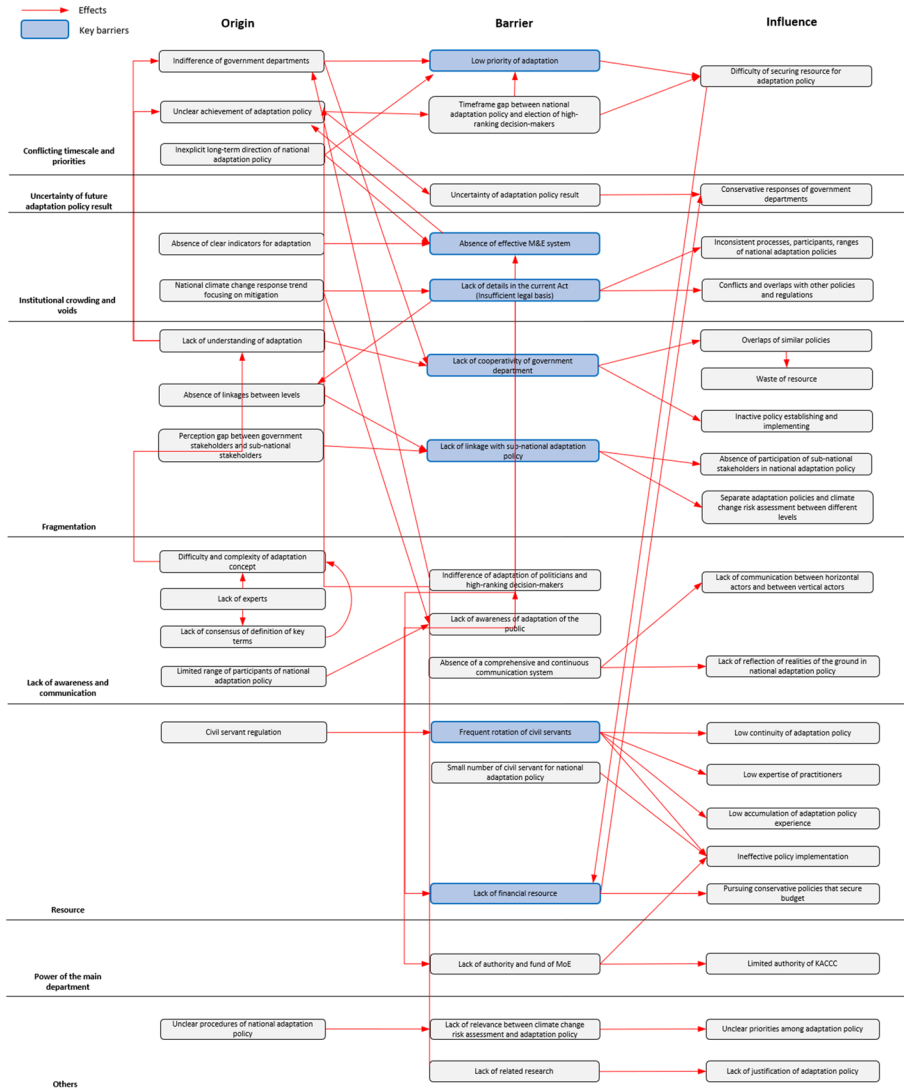


Fig. 1 Relationships between barriers, origins, and influences in Korea's national adaptation policy (barrier map)

4.3 Solutions for the barriers

4.3.1 Used solutions

Interviewees from groups A and C mentioned three types of solutions that had been used. First, there were solutions to increase communication. From the early stage of establishing the policy, the managing department had held several general and sectoral workshops to gather the views of the experts and key stakeholders and to explain the concept of climate change adaptation to them. Through the workshops, participants from government

departments could obtain feedback for their department's adaptation policy, and to help make the policies more practical (A2, A3). By holding a public hearing, the managing department tried to gather views from the public and to communicate with them (A3, C2). Secondly, successful examples were disseminated. In the implementation stage, the managing department and the official supporting institute searched for successful examples among policies in NCCAPs. They provided incentives to other departments by evaluating successful adaptation policy examples in each department and tried to increase the interest in adaptation policies more generally (A1, A4, A5, C1). The interviewees had also tried to improve the current legislative system for adaptation. The MoE and KACCC conducted research to help legislate a Climate Change Adaptation Act and submitted a draught to the National Assembly. They also tried to legislate regular M&E of NCCAPs (A4, A5, C2, D6). However, attempts at changing the legislation have not yet passed the National Assembly. While the interviewees identified the above three solutions, none of them could tell whether they had been effective in overcoming the barriers or not.

Interviewees outside of groups A and C said that no solutions were attempted to overcome barriers. They saw no specific action to help reduce or overcome the barriers, although they said they had given a lot of thought on such solutions. D5 said, 'unfortunately, as far as I am concerned, no solution has not yet been applied. ... It is the reality that we have covered up and ignored the barriers, although we have experienced them'. There was no concept or awareness of barriers in the process of the policy, so that, the used solutions were not barrier-specific (D1, D2, D9).

4.3.2 Suggested solutions

Interviewees suggested a variety of solutions which we group into nine categories (see Table 1). Interviewees emphasised that improving civil servants' understanding of and expertise on adaptation is important to overcome barriers. Because national adaptation policy involves multiple sectors, education for understanding of and expertise on adaptation is needed for civil servants in relevant departments, not only in the environment department. Education for high-ranked civil servants and leaders was seen particularly important. To address the problems caused by the civil servants' rotating system, interviewees suggested introducing an expert committee for continuous policy support. Supporting research on climate change impacts and policy research was also suggested to reduce policy uncertainty and to increase public awareness. Interviewees also suggested better prioritisation of adaptation policies. They highlighted that the current national adaptation policy focuses on very detailed projects, without priorities. They suggested selecting and focusing on core policies based on risk assessment results, and establishing a clear long-term vision for the national-level policy. The current risk assessment practise was also seen to need improvements, by focusing also on other than key risks. The interviewees considered that the national climate change risk assessment should be linked with local-level risk assessments to have comprehensive spatial coverage. Better linking of adaptation research results, risk assessment results, and departmental activities was also emphasised as a solution. It was also seen necessary to legislate the M&E scheme and to establish clear and measurable indicators. Communicating the M&E between implementing civil servants was also considered important. Finally, it was considered important to expand the range of participants in the policy process, as the current policy is implemented by a small number of experts and civil servants.

Table 1 Suggested solutions given by interviewees by category

Category	Solutions	Interviewee
Improving civil servants' understanding and expertise of adaptation	<ul style="list-style-type: none"> • Including climate change content in the education curriculum for civil servants above a certain level and high-ranked leaders • Conducting regular education for civil servants of government departments • Introducing an expert committee with special civil servants or experts, which can supplement the rotating system of civil servants 	A2, A3, C1, C2, C3, D1, D5, D8, E1,
Reducing uncertainty	<ul style="list-style-type: none"> • Continuous investment in climate change impact research • Expansion of government support for research on the difference between adaptation policy and other policies 	B1, D1
Finding concrete results of adaptation policy / good examples	<ul style="list-style-type: none"> • Presentation and publication of specific results of adaptation policy to the public • Finding and sharing good examples of adaptation policy 	C1, D1, D2, D5
Prioritising among adaptation policies	<ul style="list-style-type: none"> • Selecting and focusing core policies, projects, or issues • Establishing clear goals based on the risk assessments • Focusing on establishing a clear and long-term vision, not focusing on detailed short-term projects 	A2, C2, D2, D3, D4, D9, E2, E3,
Improving the current risk assessment	<ul style="list-style-type: none"> • Prioritising less but core risks through a systematic process of risk assessments • Including a spatial concept in risk assessment by linking with local-level risk assessments 	B1, D2
Improving communication between stakeholders	<ul style="list-style-type: none"> • Establishment and practical operation of an official adaptation consultative group • Clarifying participants of national adaptation governance and their roles • Holding regular meetings for civil servants who participate in the policy 	D3, D5, D10
Creating linkage between adaptation and practical tasks	<ul style="list-style-type: none"> • Linking evidence between climate adaptation research results and the current tasks of government departments • Making linkages between risk assessment results and departments' current tasks 	B1, C2, E1

Table 1 (continued)

Category	Solutions	Interviewee
Improving the M&E system	<ul style="list-style-type: none"> ● Making a clear and regular M&E system with a legal basis ● Research supporting for practical indicators ● Clear presentation of policy achievements and failures ● Conducting hands-on regular meetings for M&E with civil servants 	A3, D5, D7, E2
Expanding the range of participants of the policy including subnational stakeholders	<ul style="list-style-type: none"> ● Establishing the policy with a bottom-up way from local and private level adaptation ● Including roles of local authorities for adaptation in the policy ● Expanding the current participant range from risk assessment stage 	D5, D6, D7, E3

5 Discussion and conclusion

We have examined the barriers to the Korean national adaptation policy and their origins, influences, and relationships to provide a deeper understanding of barriers to national adaptation policy. Although caution is needed in drawing general conclusions from a single case study, this research draws conceptual, methodological, and empirical contributions beyond the existing literature in this research field.

First, the idea of analysing barriers, origins, influences, and relationships between them was introduced by Lee et al. (2022). By developing the idea into a research methodology and applying it to an empirical case, we provide a theoretical contribution to answering questions that remained long unanswered because of the limitations of previous studies; namely, why barriers occur and how they affect adaptation processes (Biesbroek et al. 2013; Eisenack et al. 2014; Waters et al. 2014; Clissode et al., 2020). We identified 16 barriers, 14 origins, and 19 influences. Among 16 barriers, some are similar to the barriers identified in previous studies (Biesbroek et al. 2011; Wise et al. 2014; McNamara et al. 2017), but we identified national-level barriers that are new or more concrete, such as ‘absence of a comprehensive and continuous communication system’, ‘frequent rotation of civil servants’, ‘small number of civil servants for national adaptation policy’, and ‘lack of relevance between climate change risk assessment and adaptation policy’. The existing literature has given limited attention to the influence of the barriers, for example, impeding progress from one stage to another or resulting in unintended consequences in adaptation policy processes (Moser and Ekstrom 2010). The analysis identified 19 concrete influences of barriers in national adaptation policy, problems that practitioners and policy-makers experience in real-world policy processes. Our results also help understand why the problems have occurred and what barriers are related to them. Interviewees discussed some barriers in detail, including their origins and influences, but other barriers only very briefly, as elaborated in the result section. This reflects how often and deeply the interviewees were confronted with the barriers in adopting and implementing the policy.

Secondly, we make a methodological contribution to understanding an underlying ‘dynamic web of barriers’, which has been conceptually suggested in the literature (Agrawala and van Aalst 2005; Eisenack et al. 2014), by mapping the relationships between sources, barriers, and influences. We have demonstrated how barriers interact and mapped these interactions visually. Lack of understanding of why barriers occur and what are the interdependencies and dynamics between the barriers have been considered key knowledge gaps in the existing literature (Biesbroek et al. 2013; Eisenack et al. 2014; Clissold et al. 2020). Based on the interview results, we presented all identified factors and connections between them in Fig. 1 and explained how the complex interactions cause challenges for national adaptation policy in Korea. The results highlight the overlaps and interactions between barrier categories (Shackleton et al. 2015) and that barriers need to be addressed simultaneously, not individually (Spires and Shackleton 2018). We also demonstrate how administrative factors that are not directly related to climate change can cause serious problems to the policy (Storbjörk and Hedrén 2011), for example, ‘frequent rotation of civil servants’.

Third, we identified key barriers. The literature on barriers to adaptation has usually dealt with barriers on the same footing. But we analysed what barriers are more influential than others: this can contribute to providing preliminary insights into where solutions need to start to overcome the barriers (Eisenack et al. 2014; Clissold et al. 2020; Esteve et al. 2018). In Korea, barriers related to institutions, resources, and fragmentation are clearly central.

Fourth, we addressed the used and suggested solutions for the barriers. We found that only interviewees who directly manage the policy from MoE and KACCC brought up

solutions that had actually been tried. Although there were three types of used solutions, their outcomes remain unclear. For example, an attempt to improve the current legislation has not yet been successful. We also found that the solutions in the process of national adaptation policy do not give any explicit attention to barriers. As Biesbroek (2014) writes, the concept of barriers to adaptation remains isolated from the real adaptation processes. We argue that the absence of consideration of barriers in the policy process leads to an absence of practical solutions to overcome them, at least in our Korean case study. The nine categories of suggested solutions are clearer and more specific about what needs to be done than the solutions discussed in the existing literature (Jones 2010; Storbjörk and Hedrén 2011; Clar et al. 2013; Waters et al. 2014; Spires and Shackleton 2018).

Compared with previous studies on barriers to adaptation, we provide a more practical and deeper understanding of barriers to adaptation processes. Also, the used research approach with its conceptual and methodological innovations can be applied in other cases across adaptation contexts and levels to provide a deeper yet more concrete understanding barriers to adaptation. It is expected that reducing barriers would lead to substantial progress of adaptation to climate change.

Based on the results, we conclude this study by providing practical insights into national adaptation policy. We suggest a methodology that can diagnose national adaptation policy problems, understand related barriers and origins, and devise concrete solutions, which can be used in adaptation policy processes beyond the Korea case. The procedure of the method is (1) identifying factors of barriers, origins, influences, and relationships between them, (2) checking current adaptation policy problems, among identified influence factors, (3) identifying related barriers and origins by tracing relationships backwards, and (4) adopting an entry point or obtaining insights to address the barriers with an analysis of relationships between factors and used/suggested solutions. For example, in Korea, there are problems with the NCCAPs, such as ‘overlaps of similar policies’, ‘waste of resource’, and ‘inactive policy establishing and implementing’. Policymakers and stakeholders can consider that ‘lack of cooperativity of government departments’ barrier and ‘indifference of government departments’, ‘lack of understanding of adaptation’ origins are related to the problems through tracing relationships in Fig. 1. Based on the relationships and suggested solutions, potential solutions can be devised. For example, the Korean government could include climate change content in the education curriculum for civil servants and provide regular training for participants of the policy to improve the understanding of adaptation among civil servants in different departments. MoE and KACCC can highlight connections between adaptation and departments’ other priorities by analysing evidence between adaptation research results and the departments’ current tasks, making linkages between risk assessment results and department’s priority tasks, and by finding and sharing good examples of adaptation actions. The Korean government can also clarify the national adaptation governance arrangements, establish a formal adaptation consultative group, and organise regular meetings among high-ranked civil servants of participating departments and political leaders for continuous cooperation.

We acknowledge that this research does not necessarily identify every factor, aspect, or relationship related to barriers to the Korean national adaptation policy. The results are based on a relatively small number of interviews (unequal number of interviewees for each group), and the interviewees’ experiences and opinions, although they are important stakeholders who participate in the process of the adaptation policy. Thus, if policymakers and stakeholders would develop Fig. 1 based on their own experiences and updated evidence, it would gain granularity and could better guide policy development. Also, as we focused on a single in-depth case study, the question remains as to whether the findings are generalisable more widely. Thus, comparative research with multiple country cases based on the methodology used in this research is needed for generalisability.

Appendix

Table 2 Interview protocol

Content

Pre-interview checks

- Before we start, there are a few things that I'd like to confirm with you
- Purpose of research and interview
 - The aim of this study is to answer two questions 1) what national adaptation policies and their barriers are, and 2) how can the national adaptation policy processes be improved?
 - This interview is conducted to collect primary data related to the barriers to national adaptation policy process based on major stakeholders' experiences, opinions, and views
- Definitions of key terms
 - To prevent a confused understanding or use of key terms that are used in this interview, we define key terms as below
 - 'National adaptation policy' refers to
 - 'Barriers to national adaptation policy' refers to
 - If you have any question about definitions or concepts of any terms that are used in the interview, feel free to ask it anytime during the interview
- General information of the interview
 - This interview will take approximately 30 min to 1 h. If it is needed to shorten, there is no problem, it can be tailor to suit
 - This interview will be recorded, are you happy to be recorded?
 - If you don't want to answer specific questions, you can freely reject to answer. In addition, you have the right to withdraw your participating within 2 months after this interview without giving any reason. Details about your right are in this consent form
 - Before we start, please take a few minutes to read and sign it. You can also keep a copy of this consent form. If you have any concerns about this, do not hesitate to ask any question to me
 - Ok, are you happy to start interview or do you have any question before we start?

Introduction and Warm-up

- Tell me a little bit about your background
- Questions
 - What is your current job?
 - What was your role in the process of national adaptation policy?
 - Have you participated from the first national adaptation policy?

Barriers to national adaptation policy

- Questions (Barriers)
 - Based on your experience, what were the barriers to national adaptation policy?
 - Can you tell me specific examples? (with stages of policy process)
 - These are seven clusters of barriers that have been identified in previous research. With these seven cluster, was there any other barrier that you can remember?
 - What was the biggest barriers among the barriers and why?
- Questions (Influence and Origin of the Barriers)
 - You said A, B, C.... were the barriers to national adaptation policy. Then, what problems were caused or what problem did you experience because of the barriers?
 - Can you tell me specific examples?
 - You said A, B, C.... were the barriers to national adaptation policy. Then, why do you think each barrier occurred? In other words, what do you think the reason of the barrier?
 - Is there any reason you think so?
 - Do you think that the barriers occur because this is the national adaptation policy or other national policies have similar barriers too?

Solutions for the Barriers

- Questions (Solution that were used)
 - To overcome or reduce the barriers that you encountered in the process of national adaptation policy, what did you do?
 - Were the solutions different depending on each barrier?
 - Why did you use the solution? (What made you use the solution?)
-

Table 2 (continued)

Content

- Questions (Results and Evaluations of the Solution)
 - By using the solutions, did you overcome or reduce the barriers?
 - The barriers were completely solved?
 - In your opinion, was the solutions good and why?
 - If not, is there more effective and efficient solution that you think?

Ending

- Thank you very much for your time and answer for this interview. Your opinions are really helpful for my research. I have included my contact information on the consent form, so if you have any concerns or questions about this interview, or if you want to further clarify some of your comments, please do not hesitate to contact anytime. Also, please forgive me if I have any followed-up questions to ask and bother you again in the future. Thank you again for your help in this interview

Author contribution Seunghan Lee (70%): research design, data collection, and analysis, article writing. Jouni Paavola (15%): research supervising, article reviewing. Suraje Dessai (15%): research supervising, article reviewing.

Data availability Interview data, the primary data of this research, was collected through face-to-face, telephone, and paper interviews in South Korea with 23 interviewees, and documentary data was collected through official websites below. www.law.go.kr, www.me.go.kr, www.kei.re.kr, kacc.kei.re.kr.

Code availability Not applicable.

Declarations

Ethics approval This research obtained ethical approval from ESSL, Environment, and LUBS (AREA) Faculty Research Ethics Committee, University of Leeds. (AREA 18–071).

Consent to participate/publication Before conducting interviews, interviewees wrote a consent form and submitted to the author.

Conflict of interest The authors declare no competing interests.

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