*Research Paper*

# Research on climate adaptive spatial planning strategy and governance mechanism: the case of Hokkaido, Japan

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## Abstract

*Continuous global climate change has triggered more frequent natural disasters, extreme weather events, and increased uncertainties in the safety of human habitats, posing significant obstacles to sustainable development. Global urban development now places a high priority on integrating climate change adaptation into spatial design to improve urban resilience. This paper systematically examines the spatial strategies and governance pathways adopted by Hokkaido, Japan in climate change adaptation, aiming to provide a reference for spatial governance in cities worldwide during the process of global climate change. Firstly, it comprehensively reviews the challenges that Hokkaido faces under climate change and the progress in spatial planning and urban governance. It explores the adaptive transformations in Hokkaido including the establishment of systematic planning thinking, formulation of sustainable development goals, development of proactive climate change adaptation planning paradigms, and utilization of scientifically assessed planning methods. Secondly, it investigates the strategic layout proposed by Hokkaido in spatial planning to address climate change, summarizing the "mitigation" and "adaptation" spatial planning strategies the region has proposed in ecological, productive, and living spaces to achieve regional sustainable development. Lastly, it discusses Hokkaido's transition from 'fragmented adaptation' to 'collaborative adaptation' in response to uncertain climates and constructs a dynamic adaptive mechanism framework for climate change adaptation, forming a scenario of multi-stakeholder co-governance. The conclusions of this study aim to provide spatial governance guidance for global cities in the dimensions of climate change and sustainable development.*

## Keywords

*climate change, synergistic effects, multi-party collaboration, sustainable development*

## 1. Introduction

Extreme weather events including storm surges, floods, and droughts have been brought on by global climate change, which is primarily characterized by climate warming, increasing the dangers that cities have to face. Climate change adaptation has become a significant challenge for future sustainable development in human habitats, drawing attention from international organizations and various sectors

of society, demanding comprehensive action measures. Since 1990, Intergovernmental Panel on Climate Change (IPCC) has been thoroughly investigating climate change. It is obvious that climate change brought on by human activity has either become inevitable or difficult to prevent when taking into account the shifting key views of the IPCC's periodic assessment reports. The environmental issues caused by climate change in urban areas are not limited to the urban environment alone, but also encompass complex problems involving the economy, society, and resources (IPCC, 2012). Moriondo, M also opines that climate change will have implications for urban spaces, such as urban construction land and ecosystems. In response to this issue, the IPCC has put forward a series of appeals, forming two major approaches 'mitigation' and 'adaptation' to address climate change (IPCC, 2012; Moriondo, M., et al., 2010). On the one hand, they tackle the root causes of climate change by reducing carbon emissions and waste emissions from activities contributing to climate change, such as reducing wastewater and gas emissions. On the other hand, they enhance urban resilience to climate change by adjusting land use patterns, strengthening construction management, climate risk forecasting, and promoting climate adaptation awareness and education.

According to relevant studies, in the process of adapting to climate change, cities not only need to address the impacts of extreme weather directly caused by climate change but also tackle the social, economic, and environmental problems resulting from climate change (Carter, J. G., et al., 2015; Lindley, S., et al., 2011). Some scholars have categorized the enhancement of urban climate adaptation capacity into two main aspects: physical space and socio-economic. In terms of physical space, urban climate adaptation capacity can be reflected through the quality and location of infrastructure and disaster prevention facilities, as well as the overall urban spatial form, compactness, and transportation layout. In the socio-economic aspect, it is mainly assessed through the climate adaptability of urban residents, including their awareness of climate change hazards and the degree of support displayed. Enhancing urban climate adaptation capacity has gradually become one of the crucial tasks for urban development. As a way to encourage urban adaptation to climate change, more and more scholars propose the formulation of relevant spatial planning (Storbjörk, S., et al., 2015; Greiving, S., et al., 2012; Wang, W., et al., 2023). First, it involves coordinating various land uses, spatial forms, and facilities to enhance urban spatial resilience (Grieving, S., et al., 2012). Secondly, it also emphasizes that urban climate adaptation capacity requires not only improvements in material space but also innovative governance models and response mechanisms (Song, Y., et al., 2011; Shen, P., et al., 2012; Kruse, S., et al., 2014; Kothari, A., 2014).

Countries around the world have taken response measures from multiple aspects and consider spatial planning as one of the policy domains in addressing climate change. In order to face or adapt to climate change, a variety of spatial planning strategies have been formulated, focusing on infrastructure such as buildings, transportation, communication, municipal facilities, healthcare, and residents' living, as well as green infrastructure like parks and wetlands. These planning efforts aim to enhance urban resilience from a physical space perspective and improve social coordination at the community level, enabling cities to effectively respond to risks posed by natural disasters (Wang, W., et al., 2023; Wang, K., et al., 2023; Kruse, S., et al., 2014; Healey, P., 2006). As one of Japan's agricultural bases, Hokkaido has a wealth of resources, including water, mountains, and snow. Hokkaido has witnessed a shift in spatial planning due to the evolving regional climate, transitioning from primarily prioritizing climate mitigation to incorporating a combination of climate adaptation and mitigation measures since the 1970s. This shift has been guided by international actions on climate change and national measures in Japan, such as the "National Climate Change Adaptation Plan" and "Climate Change Adaptation Law". Hokkaido has also formulated a range of policies and plans to adapt to climate change, some of which have helped the region develop sustainably (Yi, X., et al., 2014). Specifically, this process can be divided into three stages of development.

**(1) Before 2009: Spatial planning focusing on climate mitigation**

In the late 20th century, Japan experienced rapid economic and social development, which resulted in negative impacts on urban environments due to large-scale production and consumption patterns. At the same time, under the international call for climate change mitigation, Japan needed to transition its rapid development model. As a result, a number of laws were enacted to combat climate change, including the "Special Measures Law" for the Promotion of "Use of New Energy", "Act on Promotion of Measures to Cope with Global Warming", and "Law Concerning Special Measures Concerning Use of New Energy by Electricity Utilities".

Hokkaido, which frequently experiences natural disasters including earthquakes, volcanic eruptions, and torrential rain, was influenced by both local and international trends and prioritized climate change mitigation in its urban development initiatives. To guide these efforts, "the 6th Hokkaido Comprehensive Development Plan" was formulated. On the one hand, Hokkaido proposed reducing the urban environmental burden and constructing a socio-economic system based on resource recycling to minimize the impact on the air and water. This involved improving the efficiency of urban transportation, infrastructure, and public facilities. On the other hand, Hokkaido concentrated on improving public infrastructure's seismic resistance and disaster prevention capabilities in order to reduce the dangers associated with natural disasters. However, the effectiveness of climate mitigation strategies in improving the environment is relatively slow. It becomes difficult to respond quickly and to lessen the impact on communities when extreme weather occurrences occur. Therefore, Hokkaido needs to continuously innovate and expand its approaches to address climate change, seeking new directions beyond climate mitigation for a more comprehensive response.

**(2) 2009-2015: Coexistence of climate adaptation and mitigation in spatial planning**

As the threat of extreme weather to human habitats continues to increase, the international approach to addressing climate change has become more diverse. It has shifted from an early focus on climate change mitigation to a primary focus on climate change adaptation in planning strategies. In its Global Monitoring Report from 2008, the World Bank recommended the creation of climate adaptation plans for urban growth. In 2014, the Fifth Assessment Report of IPCC highlighted the impacts of climate change and advocated in favor of combining mitigation and adaptation activities. It emphasized the need not only to reduce greenhouse gas emissions but also to adapt to the impacts that have already occurred and those that are inevitable in the medium to long term, in order to effectively respond to climate change. In 2010, Japan explicitly set out strategic goals for adapting to climate change in the report "Technological Development Directions for Building a Climate-Adaptive New Society".

Guided by the concept of climate adaptation, Hokkaido has gradually made "adapting to climate change" an important issue in urban development. Drawing on the opportunity presented by the Toyako Summit in 2008, Hokkaido aims to mitigate increasingly severe environmental issues such as species depletion, depletion of natural resources, and global warming by adapting to climate change. The goal is to prevent extreme weather disasters such as earthquakes and torrential rain from impacting Hokkaido's healthy development. During this period, Hokkaido formulated plans such as "Hokkaido Plan for Coping with Global Warming" and the "New Hokkaido Comprehensive Development Plan Leading the Earth Environment Era". These plans not only proposed mitigation measures such as controlling greenhouse gas emissions but also advocated for enhancing climate change adaptation in various aspects, including urban disaster prevention, industry development, and environmental health. The mindset of climate adaptation planning was increasingly integrated into spatial planning. On the one hand, there is a focus on reducing environmental burdens and building a low-carbon and circular society. On the other hand, a climate adaptation governance mechanism has been proposed to promote symbiosis between humans and nature. This includes encouraging cooperation between many stakeholders, including the

government, public organizations, citizens, and corporations to actively participate in environmental preservation initiatives. It also includes creating public knowledge about adapting to climate change. During this period, the Hokkaido government changed its strategy and developed a climate adaptation-oriented spatial planning in response to the impacts of extreme weather. However, the implementation of climate adaptation activity lacks corresponding legal basis and safeguards, posing certain challenges.

**(3) After 2015: Climate adaptation-oriented spatial planning with legal safeguards**

To ensure the effective implementation of relevant climate change response strategies, Japan has begun to clearly acknowledge the significance of adjusting urban development to climate change at the legal level. In 2018, Japan passed and enacted its first law specifically addressing climate change adaptation, "Climate Change Adaptation Act". In the same year, the "Climate Change Adaptation Plan" was improved, describing the goals, duties of various stakeholders, and adaptable actions to be implemented in many domains. At the same time, Hokkaido began to comprehensively and methodically improve the region's adaptability from a variety of perspectives, including policy development and planning guidance, as research on climate change adaptation and related topics continued to grow and lessons were learned from incidents like the 2011 earthquake of the Pacific coast of Tohoku.

On the one hand, the area advocated for legislative support of climate change adaptation measures. Hokkaido developed "Hokkaido Climate Change Impact Adaptation Policy" and "Hokkaido Climate Change Adaptation Plan" as well as compiled handbooks on climate change adaptation. These initiatives facilitated and ensured the implementation of climate adaptation-oriented planning in the region. On the other hand, Hokkaido emphasized that climate adaptation-oriented spatial planning is an important component of urban planning. It accelerated the implementation of measures to adapt to climate change. To continuously improve the area's capacity to adapt to climate change, plans such as "New Hokkaido Comprehensive Development Plan", "Basic Principles of Compact Urban Construction" and "Hokkaido Plan for Coping with Global Warming" were launched. On the basis of the efforts, methods for climate change forecasting and assessment were developed, and climate adaptation measures were routinely promoted. Reducing the detrimental effects of catastrophic weather occurrences and actively encouraging the development of cooperative mechanisms among many stakeholders were the goals.

In the process of addressing climate change, Hokkaido has systematically formulated adaptation plans and measures from the aspects of land space, socio-economy, and ecosystem. These efforts have enhanced the region's climate resilience, met the diverse requirements of residents, and promoted sustainable development. This study examines the geographical strategies and governance frameworks the Hokkaido region of Japan has implemented for climate change adaptation using a literature review and empirical analysis. On the one hand, it thoroughly analyzes how regional spatial planning has changed in response to climate change, presenting adaptive spatial planning approaches from a broad perspective as well as in terms of ecological, productive, and living elements. On the other hand, it adopts a collaborative viewpoint among various stakeholders and uses a summarizing and generalizing approach to outline the dynamic adaptive mechanism framework and spatial strategy framework for climate change in Hokkaido, with the aim of examining inclusive, equitable, and adaptive community planning avenues. The conclusions of this study aim to provide spatial governance guidance for global cities in the domains of climate change and sustainable development.

## 2. Spatial Planning Strategies in Hokkaido Guided by Climate Adaptation

### 2.1 Paradigm Shift in Spatial Planning in Hokkaido Guided by Climate Adaptation

In terms of spatial planning strategies, Hokkaido has transitioned from a passive defence approach to proactive adaptation (Hokkaido, 2020). In the early stages, the focus of traditional adaptation actions in

Hokkaido was to mitigate the losses caused by extreme climate change. For example, measures to improve the ability of cities to control flooding and to create sponge cities were put into place. However, Hokkaido has suggested a new development strategy for climate adaptation in "Hokkaido Climate Change Adaptation Plan" in response to current and unavoidable mid-to-long-term impacts. It emphasizes the adjustment of natural environment, buildings, and society to avoid and reduce the impacts of climate change. Hokkaido has gradually developed a systematic and comprehensive spatial planning framework for climate adaptation through this process.

From the perspective of planning paradigm, there have been two notable transitions in spatial planning strategies in Hokkaido. Firstly, there has been a shift from short-term climate adaptation actions to long-term climate adaptation plans. In the early stages, Hokkaido struggled to address long-term threats and instead concentrated mostly on short-term climate adaptation measures. However, as technology such as climate forecasting and assessment has advanced and adaptive spatial planning has become more sophisticated, Hokkaido has begun to take into account both short-term climate risks and long-term climate variability, highlighting the long-term nature of planning and promoting the creation of safe, secure, and sustainable societies (Hokkaido Global Warming Countermeasures Subcommittee, 2020). Secondly, there has been a transition from fragmented adaptation to regional collaborative adaptation, putting an emphasis on complex and cross-regional climatic disturbances such floods, droughts, and high temperatures. Hokkaido has recognized that traditional, singular, fragmented adaptation approaches are insufficient for a comprehensive climate change response. As a result, Hokkaido has actively promoted regional collective adaptation, strengthening regional networking and fostering flexible cooperation among regions. Through these efforts, Hokkaido can ensure the security of both production and ecological systems from multiple perspectives.

## 2.2 Pathways for Spatial Planning in Hokkaido Guided by Climate Adaptation

### 2.2.1. Optimization of Regional Patterns under Climate Adaptation

Urban spatial planning and regulation can to some extent mitigate the impacts of environmental climate change and reduce the frequency and intensity of extreme weather events, thus adapting to climate change. Hokkaido has been facing increasing natural disasters such as torrential rain, landslides, earthquakes, and tsunamis, which have led to river flooding. Based on the characteristics of urban form and low population density distribution, Hokkaido proposes the establishment of an intensive and compact, networked spatial pattern in "Basic Guidelines for Compact Urban Development". In terms of spatial layout, Hokkaido aims to create the ‘compact + networked’ spatial pattern that is adaptable to climate change by implementing a rational concentration of regional space. On the one hand, Hokkaido improves the efficiency of land use and the mixing of functions in the region, curbing excessive urban expansion, protecting ecological green spaces such as farmland and forests surrounding cities, and promoting the formation of micro-climates in the region. Through extensive forests and wetlands, this strategy partially reduces the heat island effect while also lowering carbon emissions in the region. On the other hand, Hokkaido enhances the connectivity between local governments and communities through the establishment of a reliable regional transport network. This improves urban accessibility, reduces transportation energy use, and boosts the operational efficiency of cities while conserving resources.

In Sapporo City, Hokkaido, the combination of regional conditions and characteristics aims to concentrate the development of urban infrastructure and public facilities, aiming to optimize the use of urban construction land and enhance efficiency by addressing urban vacancy, outdated buildings, or space reuse. The goal is to create a compact city by integrating various resources from rural areas, establishing a spatial pattern that is mutually connected and relatively concentrated. This endeavor aims to foster the

formation of a "creative regional cycle and ecosystem" to adapt to climate change (Figure 1), reduce carbon dioxide emissions, and promote economic circulation (Teruhiro Satake, 2021).

2.2.2. Adjustment of Various Spaces under Climate Adaptation

In terms of living spaces, Hokkaido combines compact spatial forms to arrange urban business, medical care, welfare, education and other functions in spatial planning. This is done to guide the region to maintain an appropriate population density, which allows for efficient maintenance and operation of public services, infrastructure, and public transportation facilities. This improves the resilience of various facilities and enables them to continue operating normally even in extreme weather conditions.

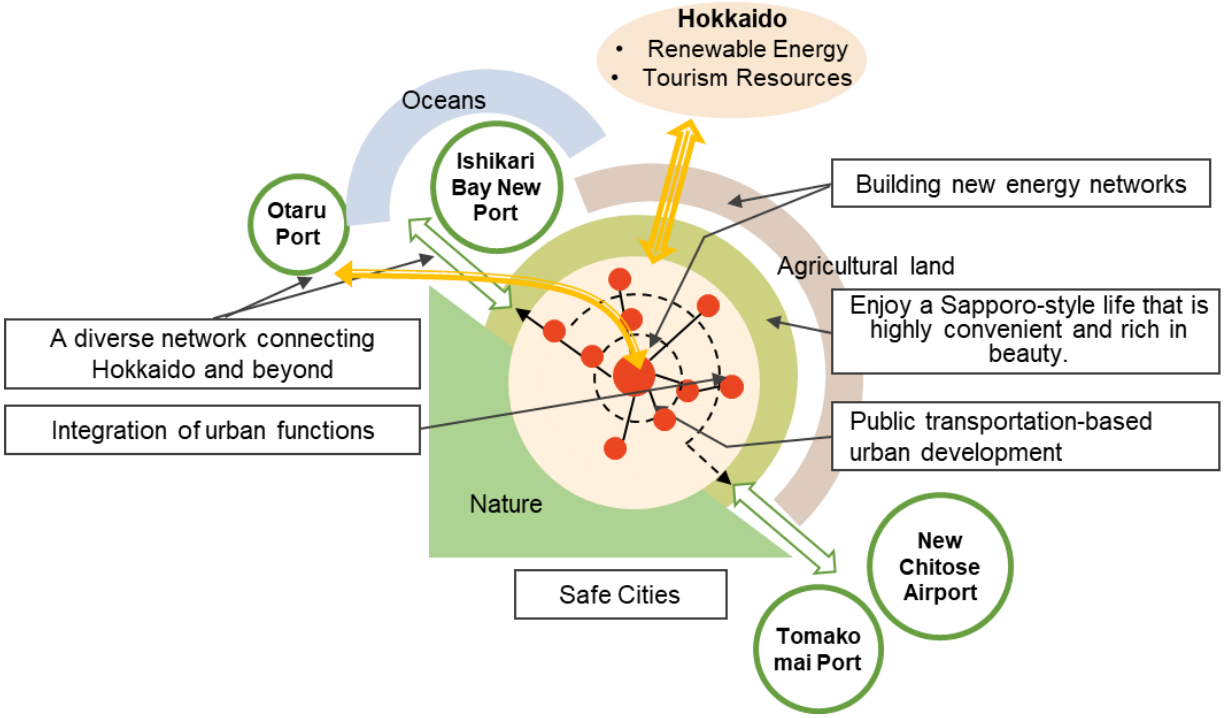


**Figure 1. Schematic diagram of urban space development in Sapporo. Source: Sapporo City Climate Change Action Plan.**

Furthermore, in order to ensure the safety of the living environment, Hokkaido implements region-specific spatial optimization strategies and designates residential construction guidance zones. For areas prone to climate disasters, existing disaster risk information and urban planning information are analyzed to develop regional "disaster prevention guides" and optimized location plans for new residential developments. This visualization of urban disaster risks helps to define the objectives of disaster prevention urban development. In areas with relatively high climate risks, if necessary, relocation plans for disaster prevention may be developed through the formulation of optimized location plans. In order to adapt to climate change, Sapporo City has incorporated various functions such as books, sports, and community services into elementary schools. It has proposed the construction of integrated public facilities to effectively improve the service level of various urban facilities. At the same time, it has enhanced the urban slow traffic system and created small-scale living communities that are not dependent on cars and can be walked. These efforts have reduced environmental burdens from multiple aspects of urban development and are in line with climate change adaptation (Sapporo, 2021).

In terms of industrial spaces, Hokkaido, being one of Japan's food production bases, possesses abundant resources such as snow, mountains, and rivers. The primary and tertiary industries are the key industries that the region focuses on cultivating. However, industrial development in the region also faces significant challenges due to climate change, such as higher temperatures and increased rainfall. Some

agricultural products are prone to diseases, resulting in reduced yields and compromised quality. In addition, the fishing industry is affected by rising sea temperatures, leading to a decrease in catch volume. Furthermore, changes in snowfall due to climate change have negatively impacted the development of the tourism industry. In order to seek and create new economic vitality, Hokkaido adopts an active approach to accept and adapt to climate change, proposing an industrial development concept of "transforming adaptation into opportunities". In terms of agricultural development, Hokkaido formulates agricultural management strategies based on meteorological forecasts and evaluations, continuously develops cultivation techniques to stabilize yields, and plans for the protection and improvement of agricultural fields and forests. This includes promoting actions to adapt fishing grounds to changes in marine species distribution, thereby facilitating regional agricultural development. Regarding tourism development, Hokkaido closely monitors climate change patterns and evaluates the hazards posed by extreme weather to the tourism industry. Based on the considerations of climate change, the region undertakes efforts to enhance and optimize its tourism spaces. For example, Hokkaido continues to improve tourism-related supporting facilities and strives to ensure that the facilities can operate normally under extreme weather conditions on the basis of taking into account the lives of residents.

In terms of ecological spaces, Hokkaido proposes the use of greenery to nourish urban development and enhance urban climate resilience through green ecological construction. First, by renovating existing green infrastructure, structures, or open spaces, ineffective and abandoned industrial, commercial, infrastructure, and residential areas are converted into green infrastructure, urban parks, and green spaces. This strengthens the city's resilience against disasters. Secondly, Hokkaido is committed to protecting forests, green spaces, and river basins. It focuses on the restoration, maintenance, and conservation of various ecological functions, such as forest water conservation. It establishes natural landscape conservation areas and national parks, considering municipalities as the "green foundation" of Hokkaido. In 2021, Hokkaido enacted the "Hokkaido Landscape Ordinance", calling for joint activities between the government, residents, and businesses to promote landscape protection and creation. By establishing a healthy ecosystem, the region's water storage and drainage capacity can be enhanced, reducing the burden on rivers and water channels and increasing regional resilience. Thirdly, Hokkaido emphasizes the ecological restoration and reclamation of abandoned mountains and key river areas. Particularly, it focuses on restoring mountainous areas prone to hazards, thereby enhancing the region's adaptability to climate change through improved natural environments.

## 3. Innovation in Climate-Adaptive Urban Governance Mechanisms

The impacts of climate change on urban development are extensive (Carter, J. G., et al., 2015). Action plans driven by a multi-stakeholder collaboration model can both mitigate the risk of administrative inefficiency, reduce the pressure on government responses, and effectively minimize negative impacts on residents (Rosenzweig, C., et al., 2011; Henstra, D., 2017; Flannery, W., et al., 2015; Woodruff, S. C., 2022). In Japan, "Climate Change Adaptation Law" emphasizes that tackling climate change is not solely the responsibility of the government and climate associations. Residents and businesses who are stakeholders also need to recognize their roles in climate adaptation actions. Building on domestic and international experiences, Hokkaido, in its "Hokkaido Climate Change Adaptation Plan", proposes collaborative efforts among various actors to promote climate-adaptive spatial planning. It has innovatively constructed a regional climate-adaptive governance mechanism (Figure 2).

### 3.1. Government Collaborative Governance

In the process of addressing climate change, the government needs to develop climate change adaptation initiatives based on local economic, social, and natural conditions. It is also essential for the government to actively integrate climate-adaptive planning into disaster prevention, resilience, and the

development of industries such as agriculture, forestry, and fisheries. To efficiently implement these measures, the government has organized and led diverse stakeholders in promoting climate-adaptive spatial planning. Firstly, the Hokkaido government has coordinated with various levels of government and relevant departments to establish a framework for collaborative action. Different levels and types of spatial planning are developed accordingly, and a mechanism for vertical coordination is formed during the implementation process. For example, whereas municipalities create climate-adaptive spatial plans based on the real conditions of their local regions, the Hokkaido government concentrates on coordinating regional spatial forms. Secondly, the government collaborates with multiple stakeholders to ensure the understanding and cooperation of residents, businesses, and social organizations regarding climate-adaptive spatial planning. The Hokkaido government disseminates knowledge about climate change to different stakeholders and guides them to take responsibility for addressing climate change. For instance, through workshops, training sessions, promotional activities, and science education events, the Hokkaido government enhances residents' understanding of climate change, making them aware of the negative impacts and the importance of climate-adaptive spatial planning for urban development. Additionally, the government shares examples and experiences related to "climate risk management" with businesses to facilitate the development of industry-specific measures for climate change adaptation in the spatial domain.

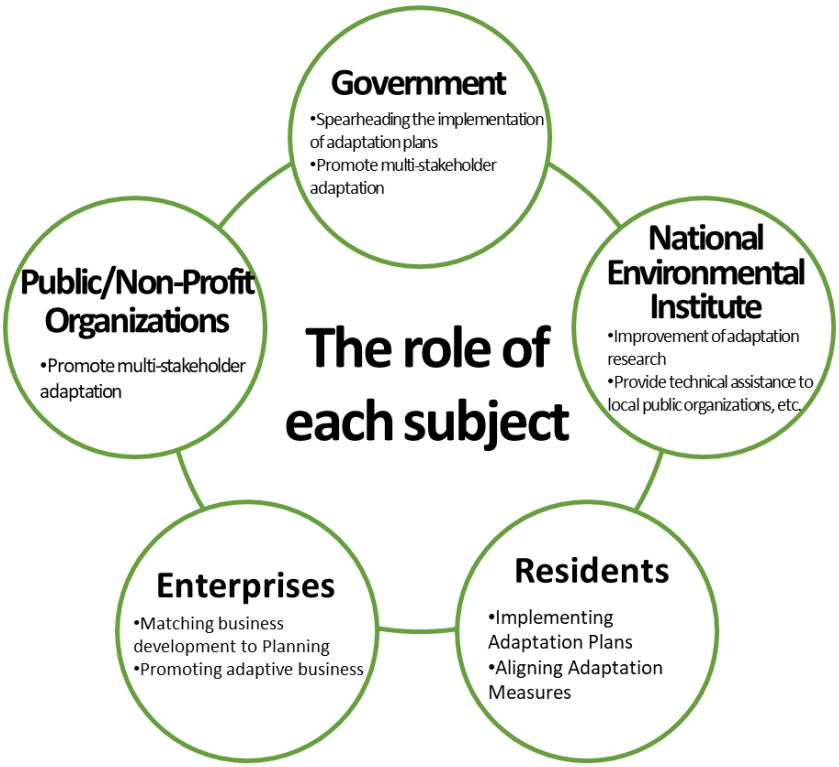


**Figure 2. The role of each subject in climate-resilient spatial planning. Source: Hokkaido Climate Change Adaptation Plan.**

## 3.2 Collaborative Governance Assisted by Relevant Organizations

In 2006, Environmental Protection Office Hokkaido (EPO Hokkaido) was established in Hokkaido. This office consists of diverse stakeholders, including the government, NGOs/NPOs, businesses, schools, and experts (Figure 3). It has formed a management system with non-governmental organizations and non-profit organizations as the core entities. In addition to tackling Hokkaido's climate challenges, EPO Hokkaido is committed to fostering the implementation of policies including climate-adaptive spatial

planning. On the one hand, EPO Hokkaido assists in the comprehensive and systematic promotion of climate change adaptation-related efforts in the region. This is achieved through organizing public opinion workshops, hosting biodiversity conservation dialogues in Hokkaido, and establishing a portal website (Environment Navi Hokkaido). These measures engage the participation of local residents, enable residents and organizations involved in environmental protection activities to access environmental information, provide a platform for residents to engage in discussions and exchanges with the government regarding climate change issues, and prompt Hokkaido residents and businesses to think collectively about climate change issues in the region. On the other hand, EPO Hokkaido works in conjunction with the Ministry of the Environment to deliver theme-based instruction on environmental conservation and climate adaptation in Hokkaido schools. It promotes projects to enhance regional environmental education facilities, improving nature centers, museums, resource centers, and other learning and enlightenment sites in Hokkaido. EPO Hokkaido helps schools establish cooperative relationships with multiple environmental protection centers, museums, parks, and strengthens practical training between schools and research institutions. For example, EPO Hokkaido developed "Education for Sustainable Development" and, between 2013 and 2015, raised awareness among students in multiple schools in Hokkaido about the issues related to climate change and the actions and plans adopted by different regions. This allows students and even residents to gain a deeper understanding of climate-adaptive spatial planning.

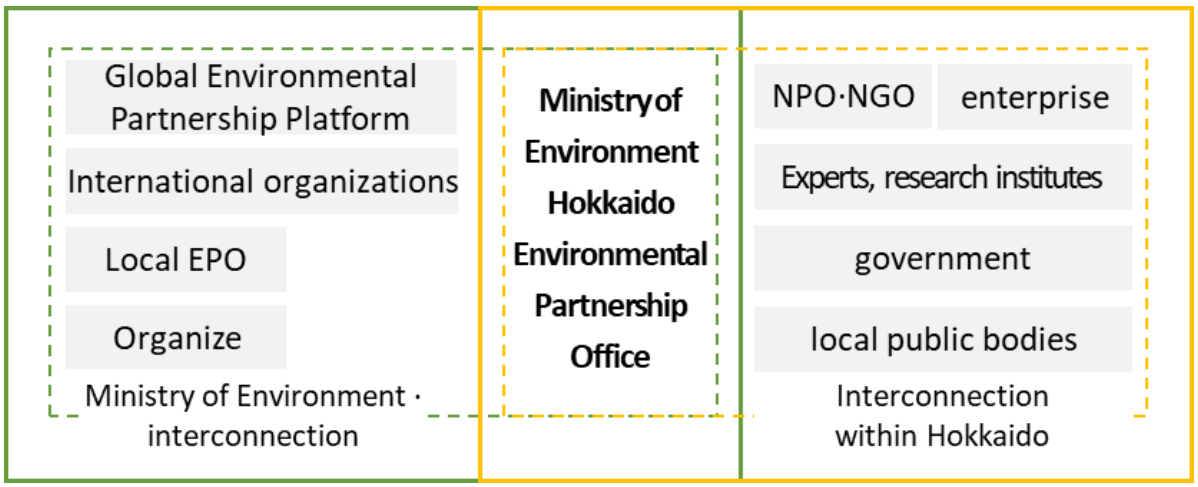


**Figure 3. Composition of Hokkaido Environmental Partnership Office.**

In addition, Hokkaido has established a Regional Climate Change Adaptation Center to assist in collecting, organizing, and analyzing relevant information and data on climate change in the region (Figure 4). Under the protection of "Climate Change Adaptation Law", the center also serves as a conduit for communication. It cooperates with the National Institute for Environmental Studies (NIES) to provide timely feedback to local governments at various levels on the effectiveness and challenges of local climate-adaptive planning. For projects deemed ‘particularly significant’ or ‘urgently important’ in the national climate change impact report, the Regional Climate Change Adaptation Center is responsible for collecting climate change data, forecasting climate change conditions, assessing climate change impacts, and even discussing the measures adopted for such projects to ensure their smooth progress. The Regional Climate Change Adaptation Center collaborates with regional governments, relevant departments, and residents to provide necessary information and technology to the region. It assists municipalities in developing adaptive spatial planning based on regional conditions, accelerating the implementation of climate change-related research findings and the conversion of relevant plans and decisions formulated by the government. Additionally, the center promptly disseminates relevant news on climate change to residents.

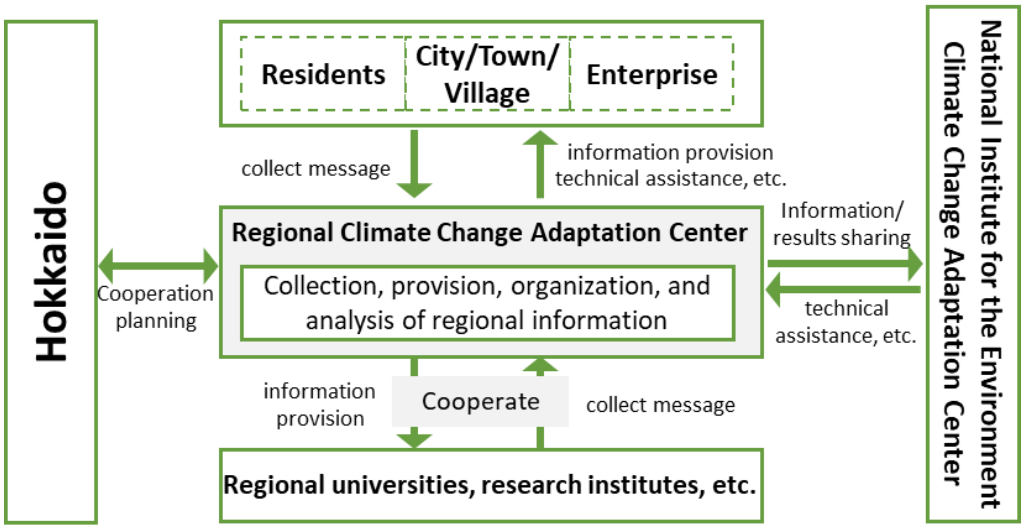


**Figure 4. Operational Mechanisms of Regional Climate Change Adaptation Centers. Source: Hokkaido Climate Change Adaptation Plan.**

### 3.3 Active Participation of Community Residents

In recent years, due to the frequent occurrence of extreme weather events in Hokkaido and the continuous efforts of the government and local social groups to raise awareness about climate change, residents in Hokkaido have become increasingly aware of the serious impact of climate change on their daily lives. More and more residents are taking up the responsibility to address climate change. On the one hand, locals collaborate with the government and social organizations and actively adopt climate-adaptive practices in their daily lives. For example, they participate in climate change awareness education activities initiated by local public bodies and help promote and publicize the significance and importance of climate-adaptive planning in Hokkaido. This has helped awaken a sense of responsibility among more residents (Yuan, Y., et al., 2020). On the other hand, residents provide feedback to the national and local governments through platforms and workshops, sharing climate-related issues they encounter in their daily lives, as well as suggestions and views on climate-adaptive actions. As a result of the public self-initiated and communal approach, Hokkaido has improved urban spatial resilience from a variety of perspectives. Overall, the active involvement of residents in climate change adaptation efforts in Hokkaido has contributed to raising awareness, promoting cooperation with the government, and generating valuable insights for improving urban resilience.

## 4. Conclusion

In the process of addressing climate change, Hokkaido has continuously explored and evolved its planning strategy from passive defense to proactive adaptation (Hokkaido, 2020). It has gradually developed sustainable, goal-oriented, systematic, and actionable climate-adaptive spatial planning and governance. There are three important conclusions that can be drawn from Hokkaido's approach to climate change adaptation:

Firstly, the uncertainties and complexities of climate change implications cannot be handled by using conventional planning paradigms. It is necessary to innovate and adopt an approach that combines adaptation and mitigation strategies. Scientific assessment and prediction systems should guide planning, and legal and policy measures should support the plan implementation.

Secondly, effective spatial planning can successfully mitigate the negative impacts of climate change. Urban resilience can be improved overall by developing compact and networked spaces and utilizing

ecological, productive, and living spaces in a rational manner. This approach reduces damage to the living environment during extreme climate events, safeguards the safety of urban living, ecological, and production spaces, and promotes sustainable development of the spatial environment.

Thirdly, the effectiveness of adaptive planning has increased because Hokkaido's planning process shifted from fragmented adaptation to collaborative adaptation. In addition to suggesting space optimization solutions, climate change adaptation spatial planning also creates governance structures and procedures. The government needs to transition from being a sole manager to becoming a facilitator and coordinator. It needs to provide more opportunities for participation by residents, businesses, and social organizations, effectively mobilizing the energy of all stakeholders. By enhancing climate change adaptation capabilities at the societal level, cities can be built to be sustainable, resilient, and inclusive, while adapting to climate change.

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