Traditional Ecological Wisdom Inheritance and Resilient Urban Planning Taking Cold City as an Example

Jingxin QI, School of Architecture and Design, Harbin Institute of Technology; Key Laboratory of National Territory Spatial Planning and Ecological Restoration in Cold Regions, Ministry of Natural Resources, CHINA

Hong LENG, School of Architecture and Design, Harbin Institute of Technology; Key Laboratory of National Territory Spatial Planning and Ecological Restoration in Cold Regions, Ministry of Natural Resources, CHINA

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Abstract

Integrating indigenous ecological wisdom with modernization crucial for revitalizing the resilience of cold cities while honoring human knowledge. Through the lens of traditional ecological wisdom inheritance, this study reexamines the core connotation of resilience in cold cities, and delineates the evolution trajectory of ecological wisdom. Ultimately, proposing planning inspirations for the application of traditional ecological wisdom within modern cold cities.

Keywords

Traditional Ecological Wisdom, Resilient City, Climatic adaptation, Cold City

1 Introduction

The IPCC Sixth Assessment Report shows that climate change in all regions will intensify in the coming decades (IPCC, 2019). As a special urban group, cold cities face more unique and diverse climate problems, such as prolonged snowfall and freezing. The intensification of global climate change, significant regional climate background effects, rising temperatures, and increased frequency and intensity of extreme weather events will not only exacerbate the winter climate impact in cold cities, but also bring heat waves, cold waves, droughts, floods, and storms, threatening the health of urban residents and posing increasingly severe emerging risks and challenges to the social ecosystem in cold cities.

Under the dual influence of regional severe cold climate and climate change, it is particularly important to enhance the resilience of cold cities (Zeng et al., 2023). Enhancing the resilience of cold cities can not only alleviate the limitations of the original climate and resist the impact of extreme weather events, but also restore and rebuild the functions of their social ecosystems through flexible response strategies, reducing the impact of new disaster risks caused by climate change. This is of crucial significance for achieving sustainable development of cold cities (Xu et al., 2024). In this process, scientific assessment of the impacts and risks of climate change, based on the economic and social development status and resource and environmental carrying capacity, enhances the comprehensive adaptation capacity of cold region cities to climate change, and requires the establishment of a new climate adaptation strategy system through multi perspective

observation. Traditional ecological wisdom, as a cultural heritage that has been tested over time, provides valuable local practical experience and adaptation strategies. This wisdom stems from long-term observation of nature and interaction with the environment, emphasizing the harmonious coexistence between humans and nature. By exploring and inheriting traditional ecological wisdom, cold region cities can find innovative local solutions in urban planning practices that adapt to climate change, promoting the resilient development of social ecosystems.

This study aims to systematically sort out the basic attributes and core characteristics of cold cities, understand the connotation of indigenous traditional ecological wisdom, and attempt to deduce its evolutionary laws, in order to deeply explore the impact of traditional ecological wisdom on the resilience of cold cities. On this basis, we further propose a modern cold city resilience enhancement strategy based on traditional ecological wisdom. In order to provide support for future cold city initiatives to enhance urban climate adaptation capabilities and resilience planning decisions.

2 The connotation and application of traditional ecological wisdom

2.1 The concept and evolution process of traditional ecological wisdom

2.1.1 Definition of Traditional Ecological Wisdom

Traditional Ecological Wisdom (TEW) refers to the knowledge system developed by indigenous peoples and local communities via long-term natural observations, environmental interactions, and practical experiences. It incorporates wisdom in many areas, including culture, society, and the economics, in addition to understanding of the natural world. TEW emphasizes the harmonious relationship between humans and nature, which is a thinking mode and practical guideline for the survival and development of humans in specific regions in the natural environment. Its function is not only to guide planning actions through social ecological practices, but also to inspire and empower people with tailored approaches in urban systems(Liao and Chan, 2016).

2.1.2 The core characteristics of TEW

TEW has several core characteristics. Environmental adaptation emphasizes human flexibility in response to environmental changes, which is the most important feature of TEW and can help people cope with climate change and natural disasters. By observing temperature and natural phenomena, people in cold cities can use TEW to design buildings and agricultural technologies that adapt to climate change. This requires selecting an appropriate culture, establishing a sound structure, and developing effective resource management plans.

Sustainability places a strong emphasis on social justice and the circular use of natural resources, which are especially important in cold city land use and community involvement. For instance, to deal with the issues of resource volatility and workforce shortages, locals establish a shared tribal government system.

Furthermore, TEW is a distinctive ecological knowledge system that has been established by diverse groups with a range of knowledge based on their particular ecological environment and sociocultural background. Both the substance and the variety of inheritance techniques exhibit this diversity. Many TEW have been passed down through oral transmission, rituals, and practical activities. In the process, many indigenous communities have explored new ecological management methods while maintaining traditional knowledge, combining modern technology and management concepts, and providing new ideas and practical references for modern society.

2.1.3 The evolution process of TEW

TEW have continuously developed and enriched over the course of history. The earliest can be traced back to the primitive worship of the natural environment by humans, when many natural phenomena were intuitively perceived and became the foundation for harmonious coexistence between humans and nature. With the continuous development of productivity, people have accumulated judgments on plant growth, animal behavior, and natural phenomena of climate change through extensive observation and practice(Participants, 2015 and updated in 2017). TEW gradually shifted from pure worship to rational thinking, and people began to analyze natural laws and summarize corresponding survival experiences.

Through repeated practice and intergenerational inheritance, survival experiences such as production technology, climate prediction, and resource management have been continuously refined and refined, gradually forming a systematic ecological knowledge system. TEW is now widely accepted as a natural law and community model (Zhang, 2017).

After entering modern society, cultural ideas, technological means, and coping systems continue to develop, and cold settlements develop into cities. Traditional ecological knowledge is tested in urban construction practice, and traditional knowledge and practical experience with practical feasibility are further developed and utilized in the local geographical environment and social culture(Alexander and E., 1989), Evolved into environmental cognition, resource utilization, production activities, and social organization strategies with rich regional characteristics (Table 1), to adapt to the greater challenges and risks brought by climate change and achieve resilient development of urban planning. This process is consistent with the social learning cycle evolution process proposed by Professor Xiang Weining (Xiang, 2014).

Table 1. Differences in Key Contents of TEW between Indigenous Societies and Modern Cold City (Source: Compiled information based on references)

	Indigenous Society	Modern City
Environmental cognition	Nature Worship	Ecological Civilization
Resource utilization	Moderate use of resources	Fully utilize resources and control development intensity
Production activities	Shared agriculture, gathering, fishing, and animal husbandry among tribes	Neighborhood interactive farming and public activities, shared public service facilities, etc
Social organization	Common decision-making based on the existence of spirits in all things	Age friendly public participation

In the 1990s, the Inuit Circumpolar Council proposed the concept of integrating Inuit traditional knowledge with Arctic governance values, address the limitations of the region's native cold climate and the risks brought by constantly changing climate conditions. In the 21st century, with the world's environmental problems and climate change becoming more serious.. More and more research shows that TEW can provide valuable solutions for modern society to address climate change, ecological protection, and sustainable development. Especially in urban resilience planning under special climate conditions, the value of TEW is becoming increasingly prominent, promoting its transformation towards proactive development and sustainable management. This stage emphasizes the combination of modern technology and TEW to form modern ecological wisdom and achieve harmonious coexistence of "human city natural environment" (Figure 1).

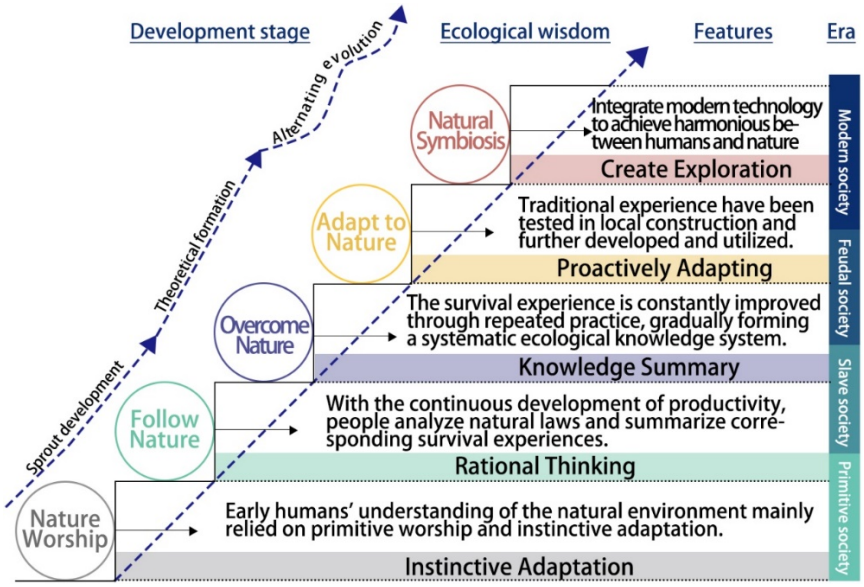

Fig.1 Evolution process of traditional knowledge(Source: Own Draw)

2.2 The impact of TEW on the resilience of cold cities

2.2.1 Cultivation of ecological awareness

The traditional ecological wisdom in cold regions is based on a large amount of understanding of the environment and ecosystem, emphasizing the ecological awareness of identifying, understanding, and responding to environmental changes in extremely cold climate conditions (Folke, 2004). This ecological awareness plays a positive role in maintaining ecological security, and sustainable development of resources in cold cities.

(1) Ecological integrity protection

In cold climate conditions, the overall management and protection of the environment are particularly crucial. Indigenous people in cold regions, represented by shamanism, show respect and care for all elements such as climate phenomena, natural environment, and biology, and have established a natural worship belief characterized by equality and mutual benefit between humans and nature. This kind of nature worship has a distinct purpose, which is to identify and respond to climate and environmental change, and to integrate human activities with the natural environment (Jackson and Holden, 2013). Derived from a series of taboo behaviors, guiding a comprehensive assessment of the local ecosystem, combined with climate change prediction, to achieve ecological integrity and biodiversity conservation.

TEW emphasizes the importance of ecosystem services in addressing climate change risks. Indigenous peoples in cold regions adopt traditional land management models, fully utilizing ecosystem services such as climate regulation and biodiversity maintenance to increase crop yields while enhancing ecosystem resilience, achieving flexible spatial utilization and maximizing public interests.

(2) Sustainable development of resources

In terms of land use, TEW advocates planning in accordance with natural ecological laws, avoiding excessive development and improper use. In Northeast China, Manchu rulers implemented willow edge bans on the black soil, controlling the development of land and forest resources(Chen, 2016). The Sami people follow the efficient resource development principle of "living after prey" to ensure harmonious coexistence between humans and land. TEW also provides effective renewable resource management methods for cold cities. In the barren and limited

resource conditions, the ancestors of Changbai Mountain in Jilin Province effectively used natural construction materials, adopted sustainable timber harvesting and transportation methods like "ice release ditches," and used dense forests to create the iconic Jinjiang Wooden House. The Oroqen people support public resolutions and the cooperative use and management of resources (Wang and Sun, 2018). To a certain extent, it has resolved the issue of resource dispersion and fluctuation in cold cities, achieving rational utilization of resources. In addition, the use of cooking waste heat for heating and snow melting to supply energy consumption reflects the profound understanding of traditional ecological wisdom in cold regions in the virtuous cycle of materials (Liu, 2002).

2.2.2 Optimization of survival strategy

(1) Space adaptability construction

In order to adapt to local climate boundaries, early residents developed adaptive building design techniques, rational designed outdoor physical environments, and provided effective climate protection measures(Leng and Yuan, 2004), maintaining the comfort of their living environment.

The dome shaped structure reduces the direct impact of wind and evenly disperses the weight of snow, increasing the stability of the building. In order to minimize indoor heat loss to the greatest extent possible, the ice house is designed with a low and narrow entrance that can successfully prevent cold air from directly entering the space. The layered design of indoor space concentrates heat in higher central areas and provides additional activity areas (Figure 2). Modern cold cities have retained some features such as building orientation and roof shape on the basis of traditional building methods, and have also innovated insulation materials.

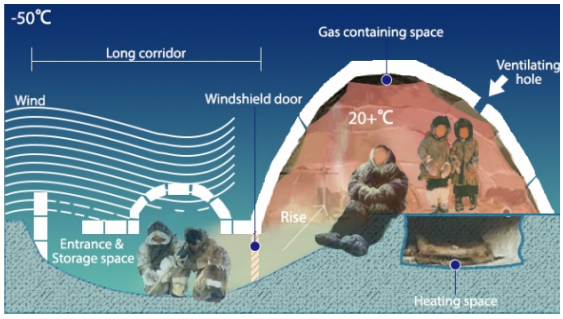

Fig.2 The climate adaptation wisdom of Inuit igloos (Source: Own Draw)

Flexible responses to extreme cold weather and its related climate change challenges are also made possible by TEW's distinct expertise in open space and green space development. Compact layouts in sunny and leeward places are typically chosen for winter camping sites by ethnic groups in colder climates in order to avoid wind and snow while aiming for more sunshine(Liu, 2020). Typically found in the heart of communities, public areas like squares and meeting spots serve as hubs for social interactions. In order to shield locals from severe weather, makeshift shelters like fences are erected concurrently. Native plants that can withstand cold temperatures are frequently used to green landscapes.

(2) Multi party interactive maintenance

Residents in cold climates developed a close-knit cooperative relationship known as "spontaneous co governance" as a result of their early survival instincts. To deal with the challenges of extremely cold weather, the Inuit have created a "winter extended family" by accumulating wisdom and experience. This cooperative concept has developed into systemic governance and community sharing in the present day. assembling native specialists in chilly urban areas and using their traditional wisdom to preserve biodiversity. Through shared public facilities and community services, the local administration has also actively coordinated group efforts to address extreme

weather conditions, enhancing the community's capacity to manage the hazards associated with climate change.

3 Enhancing the Resilience of Modern Cold Region Cities Based on TEW

3.1 Constructing a climate security spatial pattern based on the TEW behavior path

The modernization of traditional wisdom in cold cities is being implemented through the practice of spatial planning for climate risk prevention and adaptation(Xiang, 2016). Technical assistance for improving spatial resilience governance for climate adaptation is provided by TEW's ecological awareness of comprehensive protection and flexible land use. TEW should be included into the national spatial planning system in a number of ways, including technical standards, implementation oversight, regulatory policies, preparation and approval, and the coordinated execution of general, detailed, and special planning. In particular, the resilience special plan should employ TEW to drive the practice of building resource security spaces, strengthening disaster prevention and warning facility networks through nature-based solutions, and adapting to the cold climate in cold cities. In addition to provide a material carrier for enhancing urban resilience, this will produce a healthy and inclusive spatial pattern for climate security (Figure 3).

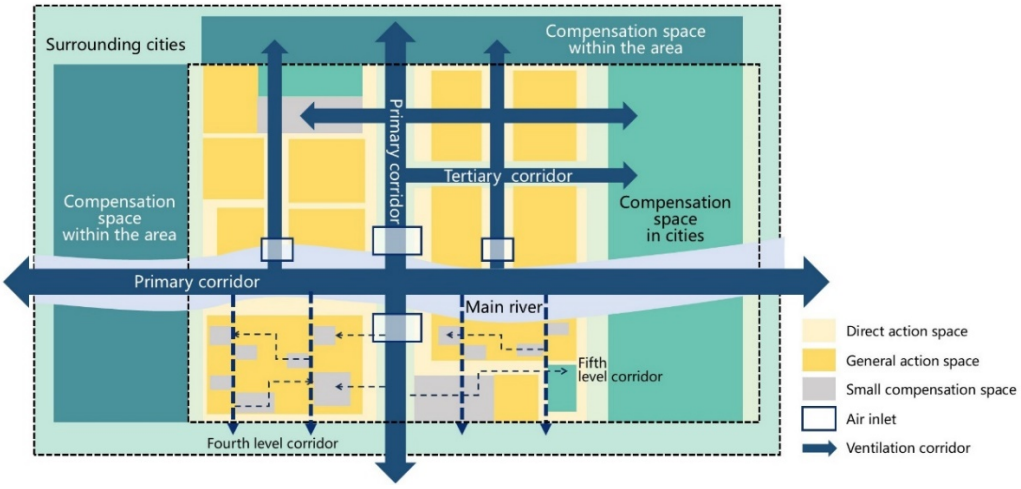

Fig.3 Climate security spatial pattern based on natural solutions (Source: Own Draw)

Referring to the TEW "identification prediction avoidance" behavior path, key basic dimension assessments, climate change scenario simulations, land use safety pattern inspections, etc. are conducted to implement resilience space management and control work, such as urban resilience target positioning design, climate risk mapping, disaster prevention structure and avoidance space division, emergency space reservation, etc., in order to deal with the environmental pressure of cold cities brought on by climate change. This is done while taking into account the original impact of a severe cold climate and the emerging risks of climate change. Therefore, preserving the natural ecological areas surrounding the city, controlling the climate, lowering the chance of floods brought on by the melting of ice and snow, and creating an ecological security pattern should be prioritized. At the same time, creating vertical vegetation and green roofs at the block level can improve the ecological connectivity and microclimate of the city (Figure 4).

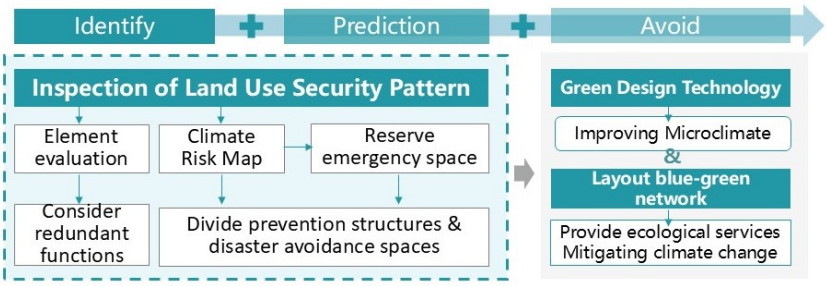

Fig 4 Climate safety spatial planning based on TEW behavior path (Source: Own Draw)

Based on the TEW's sustainable resource management system, cold area cities should build distributed energy systems, actively develop and employ renewable energy, and apply extreme thinking as a guidance. The emphasis is on boosting infrastructure's resilience to cold temperatures, as well as its redundancy and risk management capacities in the face of climate change risks.

3.2 TEW guidance enhances climate adaptation planning technology

In order to improve climate adaptation planning techniques, better identify vulnerable areas, infrastructure, industries, and populations under various types of extreme weather events, and assist cold cities in developing spatial engineering methods that are more suited to severe cold climates, TEW advises cold cities to concentrate on localized needs and scenario analysis in conjunction with modern multi-source data, modern climate models, and multi-departmental support. Prioritize the design of habitable spaces, build shelters for public gathering places, and modify the local microclimate by arranging green plants.

Promote the creation of adaptable, seasonal spaces for winter activities, enhance the way that outdoor public space functions are used collectively, and create urban living spaces that are good for the physical and emotional well-being of people who live in cold climates. Enhance the conventional dome structure throughout the architectural design phase to guarantee the building's security and comfort during inclement weather.

3.3 Innovative Inheritance TEW Resilience Governance Policy

Under the survival principle of multi-party interaction and maintenance, resilience governance based on TEW requires multi-level and cross departmental cooperation and linkage among government departments, civil society, and private sectors. Formulating and issuing relevant policy documents is the primary guarantee for promoting the smooth implementation of resilience planning. It is necessary to appropriately establish resilience planning management departments, strengthen cooperation between governments at all levels, society, institutions, enterprises, and residents, and horizontally coordinate and collaborate with researchers and government departments at the same level and with different functions. Additionally, the percentage of climate adaptation planning in urban development projects should be suitably raised for cities located in cold climates. To draw the attention of different department levels to this effort, it is advised that the outcomes of climate adaptation planning be incorporated into the assessment system of different department levels.

Drawing on the experience of TEW's efficiency and fairness in responding to extreme weather events, cold region cities should open up cooperation with enterprises and society, establish a multi-party collaborative intelligent emergency command system and grassroots emergency rescue mechanism, integrate urban governance information systems such as the "City Brain", develop a human-machine interactive emergency response decision support system, and provide

substantial and effective contingency plan support for emergency response. Focus on improving the climate risk prevention capabilities of vulnerable groups, coordinate social organizations and volunteer resources(Magne Skjelvik et al., 2011), and efficiently and widely mobilize diverse social forces to participate in emergency response to extreme weather events, in order to enhance the city's ability to balance efficiency and fairness in disaster response (Figure 5).

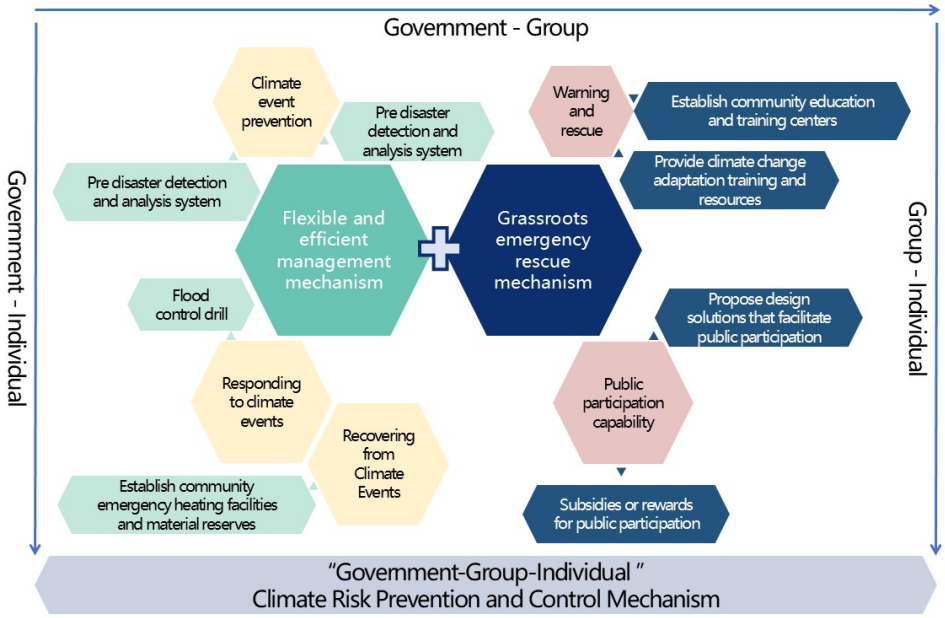

Fig.5 Multi subject collaborative resilience governance mechanism based on TEW (Source: Own Draw)

Cold cities must start with interdisciplinary and participatory research, comprehensively studying and determining local TEW. Secondly, it is necessary to explore the entire value chain and management of TEW in extreme weather events, including intelligent data information, to support the spiral development of urban systems under extreme weather conditions. By forming a virtuous cycle of self-organization and self-learning, we can expand the connotation of traditional ecological wisdom, protect and inherit it.

4 Discussion

We can protect and promote these priceless cultural heritages in the process of modernization through social participation and effective policy guidance, which will also provide substantial support for addressing climate change and resource management. However, despite TEW's profound cultural and environmental roots, the urbanization process often masks this knowledge, especially in extreme weather conditions where its adaptability is overlooked. Traditional wisdom may ultimately be replaced by the rapid development of modern technology.

To address these issues, governments in cold cities should establish rules that ensure recognition of the value of their traditional ecological knowledge and protect and preserve their heritage. Academic institutions and non-governmental organizations should work together to investigate the use of TEW in the development of modern cold cities for resilience and to promote multi-party participation. Moreover, when traditional ecological knowledge is collected and preserved through digital platforms, more people can learn and apply it. Together they will contribute to the spread of traditional ecological knowledge in cold climates.

5 Conclusion

The inheritance process of TEW includes preparation, perception, adaptation, and learning. It not only maintains ecological awareness, but also continuously optimizes various efficiency-oriented management tools and technologies, guiding the coordinated development of "human technology environment" in cold cities. The purpose of this study is to construct a traditional ecological intelligence network for cold cities and investigate its value in improving the resilience of cold cities. Furthermore, contribute local theories and practical experience to the sustainable development of modern cold cities. In the future, cross-cultural comparative research can be combined to supplement the spatiotemporal background, typical connotations, and modern concepts applied to the evolution of TEW regions.

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