2021
CLIMATE
CHANGE
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# 2021
# Enhancing Climate Risk Governance in China

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## Executive summary

The past decade has been the hottest in human history.[1] From extreme rainstorms and floods in Europe and Asia to record-breaking heat waves and forest fires in North America, extreme weather events have swept the world, and the global climate change factors behind them cannot be ignored. Evidence is overwhelming that the systemic risks posed by climate change are the greatest threat facing humanity today.[2,3] China is one of the countries most vulnerable to the adverse effects of climate change. Since the middle of the 20th century, warming in China has been significantly higher than that of the rest of the world. Climate change poses a serious challenge to China's food production security, water resources, ecology, energy and economic development, and the level of climate risk tends to increase.[4] China urgently needs to take steps to improve its climate risk management capacity, especially its ability to cope with extreme weather and climate events.

This report aims to examine China's climate risk governance system at the national and local levels. Climate risk arises from the interaction of climate-related hazard with exposure and vulnerability of human and natural systems, where climate-related hazards include both extreme weather events such as typhoons, rainstorms, and heat waves, and slow-onset incremental environmental changes such as sea level rise and droughts.[5] Climate risk governance refers to the social function of enhancing climate resilience and reducing climate risk by guiding and incentivizing the behavior of human communities, and climate risk governance systems are the institutional arrangements that are created to achieve this governance function. This report focuses on the formal institutional arrangements established and implemented by governments at all levels, including institutional settings, governance mechanisms, and legal and policy systems.

China's climate risk governance system consists of two parts: a meteorological

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[1] IPCC. (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

[2] Li, H., Wang, X., Zhao, X., & Qi, Y. (2021). Understanding systemic risk induced by climate change. *Advances in Climate Change Research*, 12(3), 384-394.

[3] Stern, N. (2015). *Why are we waiting?: The logic, urgency, and promise of tackling climate change*. Cambridge, MA: MIT Press.

[4] Center for Climate Change, China Meteorological Administration. (2019). *China's Blue Book on Climate Change (2019).* Beijing: Science Press.

[5] IPCC. (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 582 pp.

disaster risk governance system and a climate change adaptation governance system. On the whole, China's climate risk governance is still focused on traditional disaster prevention and mitigation efforts, while adaptation actions are still nascent, and the two efforts have not yet formed a synergy. Based on its millennia of experience in disaster risk management, China has formed a disaster risk management system under the centralized supervision of the Ministry of Emergency Management (MEM), with the division of responsibilities among relevant departments and localities and the broad participation of the whole society. With a strong central government and an efficient hierarchical organization, China's disaster prevention and mitigation system has been effective in dealing with conventional meteorological hazards, but is still inadequate in considering risks related to climate change. The heavy rainstorm that happened on July 20, 2021 in Zhengzhou reveals critical loopholes in urban meteorological disaster management, such as incomplete disaster contingency plans that fail to consider disaster scenarios such as subway flooding, poor risk communication with the public, disconnect between sending meteorological warnings and activating emergency response, inadequate collaboration between organizations, and weak public awareness of disaster risk prevention. A strengthened meteorological disaster prevention and management system requires more timely risk communication, more agile response of government bureaus, and closer cross-departmental, multi-stakeholder collaborations. In addition, Chinese cities must enhance policy learning and experience sharing with each other in the area of disaster risk management.

Although few policies in China are specifically dedicated to climate change adaptation, policies formulated by industries and departments closely related to climate change are increasingly taking into account the needs of climate change adaptation, i.e., the mainstreaming of climate adaptation. Currently, Chinese cities are mainly working on climate change adaptation through "policy bundling", i.e. nesting climate adaptation in policies in related areas such as low-carbon city pilots and sponge city pilots.[6] Some pioneering cities such Qingdao are exploring how to formulate climate change adaptation plans through participation in international projects, such as Adapting to Climate Change in China (ACCC). As future climate risks escalate, it is insufficient to carry out adaptation actions in a “policy bundling” mode only. A more systematic and targeted approach to climate change adaptation is needed.

The risks arising from climate change are systemic and affect all aspects of the socio-economic system, thus requiring an integrated approach to risk management. It is

[6] He, X., Zhang, X. (2021). *Climate change adaptation research: international negotiation issues and domestic action strategies*. Beijing: Science Press.

imperative to adhere to and improve the existing meteorological disaster prevention and mitigation system, continuously strengthen capacity building for climate change adaptation, and establish a climate risk governance system in which meteorological disaster risk management and climate change adaptation are closely integrated. In the future, it is necessary to incorporate climate risk governance into national development strategies; build a pluralistic disaster reduction system that engages the government, market, and community; and promote the construction of climate-resilient smart cities through smart meteorological technology, climate-resilient urban design and green smart buildings.

## I. China's climate risk governance system

Since the founding of the People's Republic of China in 1949, China's disaster risk management system has been continuously improving. As a unitary government system, China has an efficient bureaucratic organization, which guarantees centralized leadership of the central government and quick mobilization of societal resources, so that disaster prevention and mitigation can be carried out in an orderly and effective manner. The central government coordinates with relevant state departments to distribute large quantities of supplies for disaster prevention and relief.

However, meanwhile, the Chinese government's risk management work is severely fragmented, with decentralized departmental functions and insufficient interdepartmental cooperation. Moreover, public participation in risk management has been limited due to the lack of public awareness of meteorological disasters and risk prevention. In 2017, the General Office of the State Council issued the National Comprehensive Disaster Prevention and Mitigation Plan (2016-2020), in which it promoted the transition of disaster risk management from focusing on post-disaster relief to pre-disaster prevention, from responding to single disasters to comprehensive disaster reduction, and from reducing disaster losses to disaster risks. In March 2018, the Ministry of Emergency Management (MEM) was established to integrate the functions of emergency rescue, disaster prevention, and mitigation and relief originally scattered in many ministries, such as the Ministry of Public Security (MPS), the Ministry of Civil Affairs (MCA), the Ministry of Land and Resources (MLR), the Ministry of Water Resources (MWR), the Ministry of Agriculture and Rural Affairs (MARA), the State Forestry Administration (SFA), and the China Earthquake Administration (CEA). This government reorganization aims to eliminate the institutional and sectoral barriers and mitigate the so-called phenomenon of “nine dragons ruling water,” meaning that many government bureaus share a common function yet cannot effectively coordinate and collaborate with each other due to conflicting interests.

Despite the significant efforts and progress made, climate risk governance remains a new concept for China. The system for governing sudden risks associated with weather extremes, i.e., the meteorological disaster risk governance system, and the system for governing incremental risks, i.e., the climate adaptation governance system, are not yet effectively integrated. This section reviews the two governance systems in order.

## 1. Meteorological disaster risk governance system

### (1) Disaster risk governance systems

Based on millennia of experience in fighting natural disasters, China has formed a system of meteorological disaster risk management under the authority of the MEM, with a division of responsibilities among the relevant departments and local governments and broad participation by the society. The core coordinating agencies for dealing with the extreme weather and climate events and disaster risk management include the National Committee for Disaster Reduction (NCDR), the National Headquarters for Flood and Drought Control (NHFDC), and the National Headquarters for Forest and Grassland Fire Prevention (NHFGFP). Although the duties of three coordinating agencies have a high degree of overlap, the focus of their work is different (Table 1-1). The offices of all three coordinating agencies are all located in the MEM.

### (2) Disaster risk governance mechanisms

In order to strengthen communication and coordination among departments, China has developed comprehensive working mechanisms for dealing with extreme weather and climate events and disaster risk management, as shown in Figure 1-1.

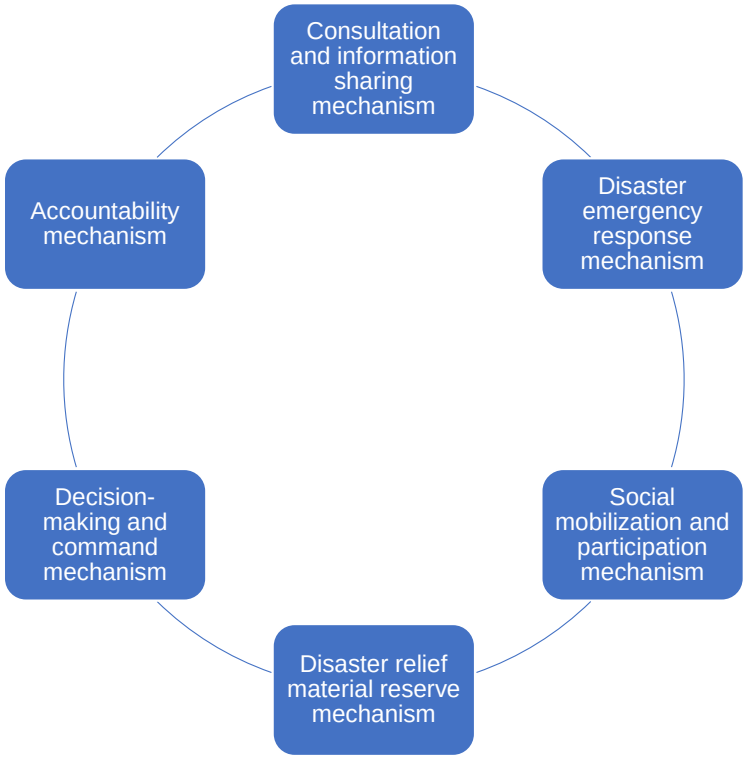


**Figure 1-1** Key mechanisms for disaster risk governance

**Table 1-1** Key institutions for disaster risk governance

| Institution | Responsibilities | Agency | Key info |
|---|---|---|---|
| **NCDR** | • Formulate national guidelines, policies and plans for disaster reduction;<br>• Coordinate major disaster reduction activities;<br>• Guide local governments to carry out disaster reduction work;<br>• Promote international exchanges and cooperation in disaster reduction. | • The relevant leader of the State Council serves as the director;<br>• Minister of MEM, the leader of the Joint Staff Department of the Central Military Commission (JSDCMC), and the deputy secretary-general of the State Council serve as deputy directors;<br>• Members include the leaders of the Publicity Department of the Communist Party of China (CPC), the Ministry of Foreign Affairs (MFA), the National Development and Reform Commission (NDRC), and the MCA. | • The highest national leading agency for disaster prevention and mitigation. |
| **NHFDC** | • Formulate national policies and regulations for flood control and drought relief;<br>• Prepare flood control plans for large rivers and water transfer plans across jurisdictions;<br>• Keep abreast of national floods, droughts and disasters and organize the implementation of flood and drought relief measures;<br>• Unify the control and dispatch of water from water conservancy and hydropower facilities, manage floods, organize post-disaster disposal. | • The deputy heads of the State Council are the commanders-in-chief;<br>• The ministers of the MEM and MWR, the leader of the JSDCMC, and the Deputy Secretary-General of the State Council are the deputy commanders-in-chief;<br>• Members include the relevant leaders of the Publicity Department of the CPC, the NDRC, the Ministry of Industry and Information Technology (MIIT) and other ministries. | • The highest authority in flood and drought control. |

| | | | |
|---|---|---|---|
| **NHFGFP** | • Guide the work of forest fire prevention and the fight against serious forest fires nationwide;<br>• Coordinate with relevant departments to solve problems in forest fire prevention;<br>• Inspect the implementation of policies, laws, and regulations on forest fire prevention by all regions and departments;<br>• Supervise the investigation and handling of forest fire cases and accountability and make decisions on forest fire prevention. | • The leader in charge of the State Council is the general commander;<br>• The minister of the MEM, the deputy secretary-general in charge of the State Council, the deputy minister in charge of the MPS, the director of the National Forestry and Grass Bureau (NFGB), and the leader in charge of JSDCMC are the deputy general commanders;<br>• Members include officials of MFA, NDRC, MIIT, MCA, MPS and other ministries. | • The highest authority in forest fire prevention. |
| **MEM** | • Organize the national overall emergency plans and actions;<br>• Guide all regions and departments in responding to emergencies, promote the construction of emergency response plan systems; organize drills;<br>• Clarify the division of responsibilities with relevant departments and localities, and establish a coordination and cooperation mechanism. | • It has 22 divisions and bureaus, including the Emergency Command Center, the Division of Risk Monitoring and Integrated Disaster Reduction, the Rescue Coordination and Preparedness Administration, the Division of Fire Prevention and Control Management, the Division of Flood and Drought Control, the Division of Safety Production Integration and Coordination, and the Division of Disaster Relief and Material Security. | • The national authority for disaster prevention and mitigation.<br>• Integrates emergency rescue, disaster prevention, mitigation, and relief functions originally scattered in other ministries in China. |

- **Consultation and information sharing mechanism for disaster warning**. The meteorological bureau releases the monitoring and forecasting information of meteorological disasters in a timely manner. The bureau also establishes the corresponding meteorological and secondary and derivative disaster monitoring and forecasting linkage mechanisms with relevant departments for real-time sharing of relevant disaster information. Regarding the consultation on extreme weather and climate events and disasters, the NCDR has established a disaster information consultation mechanism with the participation of the ministries such as MCA, MWC, CMA, CEA, the Ministry of Natural Resources (MNR), the State Oceanic Administration (SOA), and the National Bureau of Statistics (NBS). These ministries regularly organize consultation meetings to analyze and judge disaster trends and provide a basis for decision making on disaster emergency management. In terms of information release, all disaster-related departments have established a comprehensive information release mechanism, which mainly includes authorized release, distribution of press releases, organization of reports, interviews by reporters, and press conferences. The information released mainly includes monitoring and early warning of meteorological disasters and their secondary and derivative disasters, casualties, economic losses, and rescue situation.
- **Disaster emergency response mechanism**. In accordance with the Emergency Response Law and the National Emergency Plan for Natural Disaster Relief, the State has set four levels of emergency response for natural disaster relief in accordance with the degree of danger of the natural disaster. Level I response is organized and led by the Director of the NCDR; Level II response by the Deputy Director of the NCDR; Level III response by the Secretary-General of the NCDR, and Level IV response by the Office of the NCDR. The National Emergency Plan for Meteorological Disasters sets the warning standards as well as the activation conditions for Level I-IV responses for typhoons, heavy rain, snowstorms, droughts, freezing temperatures, cold waves, high temperatures, and other meteorological disasters.
- **Social mobilization and participation mechanism**. The local governments or emergency command agencies at all levels may mobilize social resources in the handling of meteorological disasters according to the nature, degree, and scope of the meteorological disasters. During an emergency, resources such as vehicles, materials, and personnel can be requisitioned and transferred in accordance with the law. The local governments or the corresponding emergency command agencies organize all parties to rescue people and to organize grass-roots units and personnel to carry out self-help and mutual rescue. The governments of

neighboring provinces and cities organize and mobilize social resources to provide relief to the disaster areas. The government encourages individuals and organizations to make donations in accordance with the Law on Public Welfare Donations and other relevant laws. The Departments for Audit and Supervision audits and supervises the use of donated funds and supplies. After the Sichuan earthquake of 2008, a large number of non-governmental organizations actively participated in the practice of disaster relief, and social organizations have attracted unprecedented attention due to their swift response.

- **Disaster relief material reserve mechanism**. Under the coordination of the MCA, China has planned and built 17 central disaster relief reserves for tents, cotton clothing and quilts, and other disaster relief materials. The departments for civil affairs of the local government have built reserves bases for disaster relief supplies at the provincial, municipal, county, and township (street) levels. Other local bureaus such as the development and reform commissions, flood control and drought relief agencies, public health bureaus, and forestry bureaus have also established corresponding material reserve mechanisms. On October 9, 2010, the Disaster Preparedness and Relief Center of the General Administration of the Red Cross Society of China was established as the first national disaster preparedness and relief center, with the main function of establishing a disaster preparedness and relief material reserve system and an information management system for the Red Cross Society system nationwide.
- **Decision-making and command mechanism.** The NCDR is the comprehensive coordinating body for the national natural disaster relief and emergency response. It is responsible for organizing and leading national natural disaster relief work and coordinating the implementation of relief activities for major natural disasters. It has established an expert committee to provide policy advice and recommendations on disaster assessment, emergency relief, and post-disaster reconstruction for major natural disasters. In the event of a large-scale meteorological disaster across administrative regions and causing major harm, the State Council activates the corresponding national emergency command mechanism to unify the leadership and command of emergency response work. The NHFDC is responsible for leading and organizing the national flood and drought control during typhoons, torrential rains, flash floods, flooding, storm surges, and droughts. When extreme weather conditions such as heavy rain, freezing weather, low temperature, and cold wave seriously affect the transportation, electricity, and energy systems, the NDRC starts the inter-ministerial coordination mechanism for the use of coal, electricity, oil, and gas. When communications, production of important industrial products, agricultural and animal husbandry production, and other important aspects of city

operations are seriously affected, the relevant functional departments are responsible for coordinating the disposal work. Disaster relief for victims of meteorological disasters is organized and implemented by the NCDR. Disasters such as high temperatures, sand storm, thunder and lightning, gale, frost, fog, and haze shall be dealt with by the local governments to initiate or establish the corresponding emergency command mechanism, with guidance from relevant departments of the State Council.

- **Accountability mechanism**. For those who neglect their duties in natural disaster relief and cause losses, and those who seriously misreport or conceal disaster information, the parties concerned will be held responsible in accordance with the relevant national laws and regulations. Those whose misbehaviors constitute crimes shall be held criminally responsible in accordance with the law. A mechanism has been established to monitor and supervise special funds for disaster relief with the participation of such departments as supervision, auditing, finance, civil affairs, and finance. Departments in charge of civil affairs and finance at all levels of government conduct special inspections of the management and use of disaster relief funds, especially checking the effectiveness of fund distribution by local governments.

**(3) Disaster risk management laws and policies**

China's legal system for coping with extreme weather, climate events and disaster risk management is continuously improving. Since the 11th Five-Year Plan (2005-2010), a series of laws such as the Emergency Response Law, Renewable Energy Law, Circular Economy Promotion Law, Energy Conservation Law, Cleaner Production Promotion Law, Soil and Water Conservation Law, Islands Protection Law, Flood Control Law, and Environmental Protection Law have been enacted or revised, and the legal framework is taking shape. Among the laws above, the Emergency Response Law, which came into effect on 1 November 2007, is the first basic law on responding to emergencies in China, and its scope covers natural disasters, accidents, public health emergencies, and social security incidents.

The administrative rules and regulations published and implemented by the State Council include but are not limited to the Natural Disaster Relief Regulations, Flood Control Regulations, Hydrological Regulations, Regulations on the Management of Artificial Weather Modification, Regulations on Prevention and Control of Geological Disasters, Forest Fire Protection Ordinance, Regulations on Prevention and Control of Forest Diseases and Insect Pests, Prairie Fire Protection Regulations, Regulations on the Administration of Marine Monitoring and Prediction, Regulations on Military

Participation in Emergency Rescue and Disaster Relief, and Regulations on Post-Sichuan Earthquake Recovery and Reconstruction. In particular, the Natural Disaster Relief Regulations came into force on September 1, 2010, filling the legal gap in and providing a legal basis for natural disaster relief.

The main regulative documents issued and implemented by the State Council include 1) the Opinions of the General Office of the State Council on Strengthening Meteorological Disaster Monitoring and Warning and Information Dissemination and 2) the Notice of the General Office of the State Council on Forwarding Several Opinions of the Ministry of Water Resources and Other Departments on Strengthening the Construction and Management of Flood Storage and Detention Areas. The regulative documents issued and implemented by the relevant departments of the State Council mainly include the Measures on the Issuance and Dissemination of Meteorological Disaster Warning Signals, Measures on the Administration of Lightning Disaster Prevention and Mitigation, Guidance of the Ministry of Civil Affairs on Strengthening the Assessment of Natural Disaster Relief, Notice of the General Office of the Ministry of Civil Affairs on Further Strengthening the Capacity Building of Disaster Information Staff, Regulations of the Ministry of Civil Affairs on Disaster Relief and Emergency, Rules on Life Relief for Disaster-Affected Persons in Winter and Spring, and the Guidance of the Ministry of Civil Affairs on Strengthening the Construction of Disaster Relief and Emergency Response Systems.

## 2 Climate change adaptation governance system

### (1) Climate change adaptation systems

In China, the institutional system for synergistic management of climate change adaptation and mitigation consists of a national leading group at the highest level, key departments, participating authorities, and decision support institutions (Figure 1-2).

- **National Leading Group.** In 2007, the State Council established the National Leading Group on Climate Change, Energy Conservation and Emission Reduction as a deliberative and coordinating body for addressing climate change and energy conservation and emission reduction in China. The Premier of the State Council serves as the head of the group; the Vice-Premier and State Councilors are the deputy heads of the group. Other members of the group consist of ministers and leaders of various ministries that are most relevant to climate change. The Office of the National Leading Group for Addressing Climate Change is located at the NDRC and undertakes the daily work of the Leading Group. With the institutional reform of the State Council in 2018, the function of addressing climate change was

moved from the NDRC to the newly formed Ministry of Ecology and the Environment (MEE), and the work of the Leading Group is now shared by the two ministries, i.e., MEE and NDRC. The National Leading Group is the highest leading body for climate adaptation work in China.

- **The key department.** The key department in charge of climate change in China is the Department of Climate Change within the MEE (formally in the NDRC).
- **Participating authorities.** The authorities involved in addressing climate change include the member ministries of the Leading Group, including MFA, NDRC, the Ministry of Education(MOE), Ministry of Science and Technology (MOST), MIIT, MCA, Ministry of Justice (MOJ), Ministry of Finance (MOF), MNR, Ministry of Housing and Urban-Rural Development (MOHURD), MWR, MARA, the Ministry of Commerce (MOC), the Ministry of Culture and Tourism (MCT), National Health Commission (NHC), the People's Bank, the State-owned Assets Supervision and Administration Commission (SASAC), State Taxation Administration (STA), State Administration for Market Regulation (SAMR), NBS, China International Development Cooperation Agency (CIDCA), China Meteorological Administration (CMA), and the National Forestry and Grassland Administration (NFGA).
- **Local institutions.** All 31 provinces, autonomous regions, and municipalities directly under the Central Government have set up leading bodies to deal with climate change, headed by the chief executive of the government. Corresponding bodies have been set up within the local development and reform commissions (later transferred to the bureaus of ecology and environment) to coordinate the work of various departments in dealing with climate change.

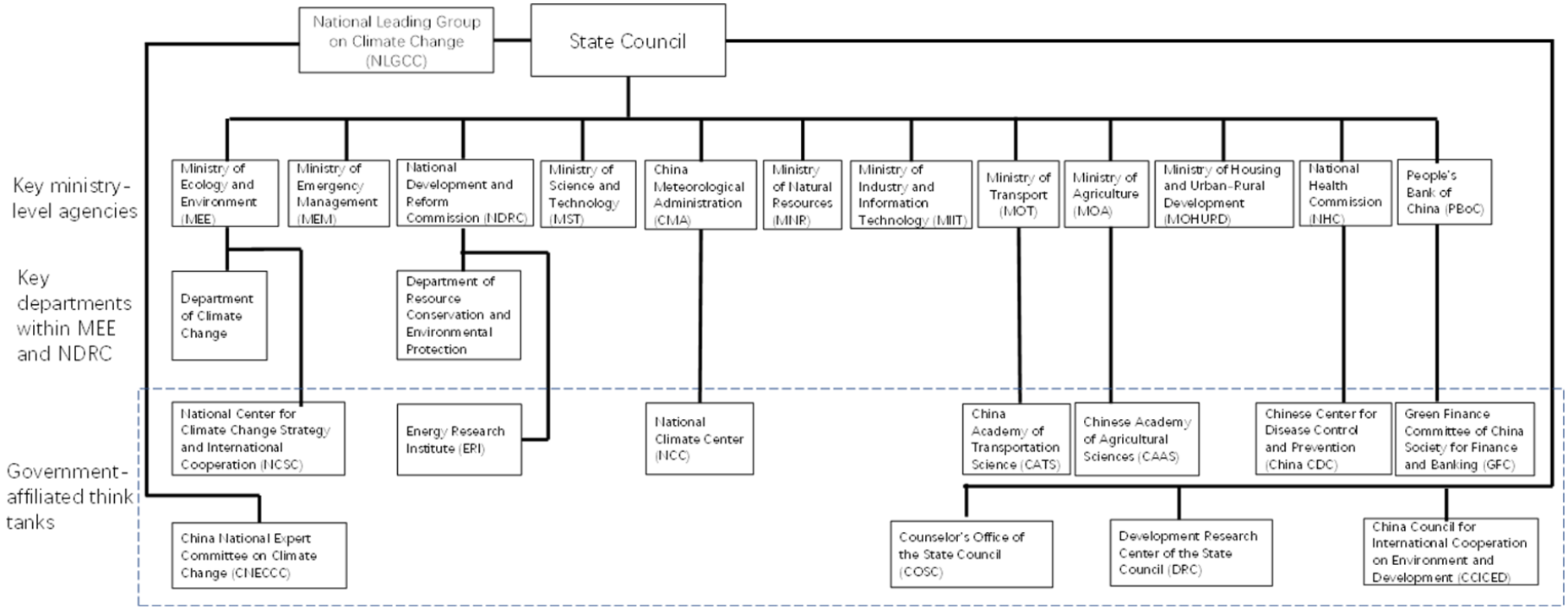


**Figure 1-2** Institutions involved in climate change adaptation

### (2) Climate change adaptation policies

So far, China lacks a specific law on adaptation to climate change or a comprehensive law on climate change in general. Nevertheless, a series of policies have been developed in response to climate change in general or to climate adaptation per se.

- **Comprehensive policies.** In 2013, the 18th Party Congress clearly put forward the task of building "ecological civilization", and specified that actively responding to climate change was an important part of building ecological civilization. In 2015, the central committee of the CPC and the State Council promulgated the Opinions on Accelerating the Construction of Ecological Civilization, which emphasized the importance of improving adaptation to climate change, especially the ability to cope with extreme weather and climate events, to strengthen the monitoring, early warning, and prevention of weather extremes, and to improve the level of adaptation to climate change in key fields such as the agriculture, forestry, and water resources, and in ecologically fragile regions. In 2018, for the first time in history, the report of the 19th Party Congress defined climate change as a non-traditional threat to national security, regarding it as a common challenge facing humanity and proposing that China "guide international cooperation in addressing climate change and become an important participant, contributor, and leader in the construction of a global ecological civilization."
- **Climate change policies.** The National Program to Address Climate Change formulated and implemented by the State Council in 2007 systematically elaborated on the challenges of climate change adaptation in the areas of forestry, agriculture, and water resources development and protection, put forward the principle of equal emphasis on mitigation and adaptation to address climate change, and proposed specific objectives and task requirements for enhancing the capacity to adapt to climate change in the areas of agriculture, forestry, water resources, and oceans. In 2009, the Resolution of the Standing Committee of the National People's Congress on Actively Addressing Climate Change again emphasized the equal importance of mitigation and adaptation. The NDRC issued the National Plan for Addressing Climate Change (2014-2020) in 2014, which set "significantly enhancing the capacity to adapt to climate change" as one of the main objectives. The capacity to adapt to climate change in key areas and ecologically fragile regions has been significantly enhanced since then. China's actions and achievements in climate change adaptation was detailed in the Intended Nationally Determined Contributions (INDCs) document entitled "Intensifying Actions to Address Climate Change - China's Nationally Determined Contribution"), which was submitted to the United Nations in 2015. In 2021, China submitted "China's Implementation of Nationally Determined Contributions and New Goals and New Measures" to the Secretariat of the UNFCCC, in which it summarized new actions and performance in climate change mitigation and adaptation since 2015.

- **Climate change adaptation policies.** The National Adaptation Strategy for Climate Change issued by the NDRC in 2013 clarifies the guidelines, principles, targets, and key tasks for climate change adaptation within the strategic target period (2013-2020). In 2015, the NDRC issued the Urban Adaptation Climate Change Action Plan, which suggests that cities build their capacity to adapt to climate change by strengthening urban planning, infrastructure, buildings, water systems, greening, and disaster risk management. In 2016 and 2017, the NDRC issued the Pilot Program for Climate Adaptive Cities and the Notice on Pilot Work for Climate Adaptive Cities, respectively, organizing pilot work for building climate resilient cities. The goal is that by 2020, the pilot areas will have strengthened climate change adaptation infrastructure, significantly improved adaptation capacity, and significantly increased public awareness of climate adaptation. Currently, the MEE is organizing the preparation of the National Adaptation Strategy for Climate Change 2035, which specifies the objectives and tasks of climate change adaptation by 2035 and integrates climate change adaptation with scientific development, infrastructure construction, and poverty eradication to build a new model for climate change adaptation.

In summary, since issuing the first top-level climate change design document (i.e., China's National Climate Change Program) in 2007, China has made "equal emphasis on mitigation and adaptation" one of the key principles for addressing climate change, and this principle has been reiterated in subsequent national climate change plans and Nationally Determined Contribution documents. Although there are still few policies that specifically target climate change adaptation, more and more comprehensive as well as sectoral policies are considering the need for climate change adaptation. According to the annual reports China's Policies and Actions to Address Climate Change released in the period of 2008-2018, the Chinese government has issued more than 300 policies and regulations related to climate change adaptation, which constitute the basic framework of climate change adaptation policies. Among them, only 14 policies specifically target adaptation to climate change. Most of the 300 policies are "mainstreamed" adaptation policies that integrate climate change adaptation into the policies of mainstream business of sectors and industries. In terms of the policy content, China's climate change adaptation focuses on the synergy between climate change adaptation and ecology, disaster prevention and mitigation, urbanization development strategies, and health security, as well as the synergy between harnessing the benefits from the positive impacts of climate change and avoiding the harms of the negative impacts.

## II. Urban climate risk governance

This chapter focuses on climate risk management actions in Chinese cities. Just like the climate risk governance system at the national level, city-level climate risk governance also consists of two parts: traditional meteorological disaster prevention and mitigation efforts and climate adaptation actions. So far urban climate risk governance has focused on traditional meteorological disaster prevention and mitigation, while adaptation actions are still at an early stage.[7] Take flood prevention and control as an example. All major cities in China have established flood control and drought relief headquarters, which are responsible for coordinating water affairs, hydrology, natural resources and planning, oceans, and other relevant departments to perform their flood control duties. Flood control emergency plans are prepared as the main basis for flood control decision-making and implementation and are regularly revised based on experience. The meteorological bureaus issue timely meteorological disaster monitoring and forecasting information and provide timely early warning information to the public via various platforms such as SMS, WeChat, and Weibo.[8] The flood control and drought relief headquarters activate the appropriate level of emergency response based on the severity and impact of the flood. Although the current disaster prevention and mitigation system is working well in the face of conventional natural disasters, it is still inadequate in considering the unconventional, systemic risks associated with climate change. In the future, Chinese cities need to further improve their emergency response plans, strengthen the coordination and cooperation among various departments and actors, and enhance policy learning and experience sharing among different cities in meteorological disaster management.

Urban adaptation to climate change is mainly the responsibility of the municipal bureaus of ecology and environment (BEE). The specific division in charge of climate change within the BEE varies from city to city, e.g., the Atmosphere Division, the Science and Technology and International Cooperation Division, or the Total Pollutant Control Division. However, even in climate-resilient pilot cities, the relevant government staff in charge of climate change still have limited awareness of climate change adaptation.[9] The case study of climate change adaptation in Qingdao in this

[7] Gandara, P., Zheng, Y. (2021). *Adaptation to climate change in Central European cities: policy and practice*. Beijing: Social Science Literature Press.

[8] WeChat, which means “micro-messaging” in Chinese, is a Chinese multi-purpose instant messaging, social media and mobile payment app developed by Tencent. First released in 2011, it became the world's largest standalone mobile app in 2018 with over 1 billion monthly active users. Weibo, which means “microblog” in Chinese, is a Chinese Twitter-like online networking tool. Hundreds of millions of netizens across China use Weibo as a platform to exchange information and voice opinions on social issues.

[9] This observation is based on the authors' field research in Qingdao, Zhuhai, and Shenzhen and interviews with experts from the National Center for Strategic Research and International Cooperation

chapter shows that climate adaptation work at the municipal level is mainly "nested" in the existing programs of relevant bureaus such as the housing and urban-rural development bureau and the water affairs administration. In other words, adaptation to climate change is primarily achieved through "policy bundling," while very limited work (mainly adaptation planning) has been carried out for the purpose of climate change adaptation. One reason behind the limited awareness of climate adaptation and the phenomenon of policy bundling at the city level is that the transfer of the climate change function from the development and reform commissions to the bureaus of ecology and environment after the government reorganization in 2018 has not been smooth and that capacity building takes time. In addition, for the relevant divisions in charge of climate change within the BEE, their primary responsibility is often pollution prevention and control, followed by climate change mitigation, with climate change adaptation at an even lower priority. As future climate risks escalate, it is insufficient to carry out adaptation actions in a "policy bundling" mode only. A more systematic and targeted approach to climate change adaptation is needed.

### 1. Responses to extreme weather and climate events: 2012.7.21 flood in Beijing and the 2021.7.20 flood in Zhengzhou

#### (1) 2012.7.21 flood in Beijing

**The incident**

The 2012.7.21 rainstorm in Beijing occurred from July 21 to July 22, 2012. During that period, most of China was hit by heavy rainfall. Beijing and its surrounding areas were hit by the heaviest rainfall and flooding since meteorological observations were recorded in 1951. The rainstorm killed 79 people, collapsed 10,660 houses, affected 1,602,000 people, and caused economic losses of 11.64 billion yuan.

Due to the intense rainfall, the flooding had serious impacts on the city's transport system.[10] About 63 roads in the city were waterlogged, and 30 sections were found to have more than 30cm of precipitation. Heavy precipitation led to severe waterlogging under a railway bridge, where several vehicles were flooded and the remains of three victims were found. Civil aviation, railways, and other modes of transportation were also affected to varying degrees. At the Beijing Capital International Airport, heavy rains caused over 500 flights to be cancelled and stranded more than 80,000 passengers. The Capital Airport Express of the Beijing Subway was shut down on the day of the

on Climate Change, the Shanghai Meteorological Bureau, and the Institute of Ecological Civilization of the Chinese Academy of Social Sciences.

[10] Xinhua News Agency. (2012). The biggest rainstorm in 61 years, the masses watch out for each other - Beijing's extraordinarily heavy rainstorm fact sheet. http://www.gov.cn/jrzg/2012-07/22/content_2189301.htm

storm, and part of the Jintai Road Station on Beijing Subway Line 6, which was under construction, collapsed.

**Figure 2-1** 2012.7.21 Flood in Beijing
(Source: Caixin[11])

The Beijing Municipal Meteorological Bureau issued early forecasts and warnings for the rainstorm on July 20, pointing out that there would be heavy rainfall from the evening to the night of July 21, and some areas may experience heavy rainstorms. China Central Meteorological Station began issuing blue warnings for heavy rain since the afternoon of July 20, upgraded to yellow at noon on July 21, and had frequent consultations with provinces and municipalities to alert the issuance of warnings. On July 21, Beijing Meteorological Station issued five warnings in a row in one day, and the level of the rainstorm warning rose to orange at 18:30pm, which is the first orange warning for heavy rain issued by Beijing Meteorological Station since the establishment of the weather warning system in 2005.[12] The Flood Control Headquarter increased the level of flood control emergency response from Level IV to Level II. The meteorological station issued five important weather reports to the municipal government, the municipal flood control office and the traffic management bureau and other relevant departments, released the rain gauges of some

[11] Caixin. (2021). Ninth anniversary of the 2012.7.21 flood in Beijing. http://special.caixin.com/event_0721/index.html
[12] NetEase News. (2012). Beijing hit by torrential rain. http://news.163.com/special/7yuebeijingbaoyu/#p=87EV807C00AN0001

meteorological observatories in the city and the city's rainfall distribution map 18 times, and jointly issued a Level III warning for geological disasters with the Municipal Geological Research Institute. For Fangshan District, which was hit hardest by the storm in Beijing, the district meteorological bureau reported the flooding situation to the district government by telephone once every hour and updated every 3 hours.

**Reflection and improvement**

After the 2012.7.21 rainstorm, Beijing has improved its preparedness for rainstorms in many ways, especially in terms of meteorological warning and emergency response capabilities, thus avoiding casualties and various types of damage in subsequent rainstorms. For example, the rainfall duration and total precipitation during the 2016.7.20 rainstorm exceeded those of the 2012.7.21 rainstorm, but there were no casualties in the former (see Table 2-1).

In 2014, the Beijing Municipal Government revised the Beijing Flood Control Emergency Plan, stating that when the city's meteorological department issues a red rainfall signal, primary and secondary schools and kindergartens must be closed, and enterprises and institutions can adjust their working hours accordingly. Early warning messages will be sent directly to citizens' mobile phones through channels such as Weibo, WeChat, and SMS. In addition, Beijing has set up a comprehensive warning information dissemination center, namely the Beijing Early Warning Information Distribution Center, which is in charge of issuing 14 types of warning information on behalf of 10 government bureaus in the city, with 10 kinds of and 22 types of warning information dissemination channels such as Beijing Radio, Beijing TV (BTV), Beijing Gehua Cable, buses, subways, China Broadcasting Corporation (CBC), outdoor displays, mobile phone SMS, and Internet applications. The relevant organizations and media can disseminate the orange and red warning messages to the public within 10 minutes, and the blue and yellow warning messages within 15 minutes. For example, during the 2016 flood season, the Beijing Early Warning Information Distribution Center issued 78 meteorological, geological hazard, flood warning and flood prevention warning messages through various means. In particular, the Center published the warning messages through mobile phone text messages on the entire telephone network and broadcast uninterrupted subtitles on all channels of Beijing Gehua Cable for five times. The Early Warning Information Distribution Centers of all districts issued 4,619,400 SMS messages in total.[13]

[13] Song, Q., Duan, W., Chen, L. (2019). Cases and experiences in enhancing urban resilience: a case study of Beijing meteorological department's response to heavy rainfall disasters. Xie Fuzhan, Liu Yaming (eds.). *Responding to climate change report (2019): safeguarding against climate risks* (pp. 343-351). Beijing: Social Science Literature Press.

In terms of traffic defense measures, the Beijing Flood Control Emergency Plan puts forward corresponding requirements for traffic flood control measures, including first and foremost the establishment of a special sub-headquarter of road traffic flood control, led by the Municipal Transportation Commission. The commander of the sub-headquarter is a top-profile official of the Municipal Transportation Commission, and the office is set up in the Municipal Transportation Commission. The responsibilities of the road traffic flood control sub-headquarter include ensuring road safety by organizing, coordinating, and directing the city's traffic safety operation of urban roads, highways, mountain roads, and rail transit during rainy days; carrying out prevention measures against heavy rainfall, flooding, and geological disasters; and organizing rescue and repair work such as road closure due to waterlogging, traffic diversion, emergency drainage, and road collapse. The plan provides that when the yellow warning response is issued, the traffic at the stagnant water points should be cleared; measures should be taken to block roads and to arrange detours when necessary; the flood season warning information should be issued in time through the road electronic display screens and the bus and subway station display screens.

**Table 2-1** Comparison of the 2012.7.21 flood and the 2016.7.20 flood in Beijing

| | **2012.7.21 flood** | **2016.7.20 flood** |
|---|---|---|
| Overview | Short total duration, but long duration and high intensity of heavy rain; the average precipitation was 190.3 mm, and the largest precipitation was recorded in Fangshan District at 541 mm. | The total precipitation was more than the 2012.7.21 rainfall, with longer total duration and wider coverage. |
| Casualties | 79 people died | No casualties. |
| Early warning communication | Mainly communicated through traditional media, and SMS dissemination was slow. | Warning messages conveyed through Weibo, WeChat, SMS, TV channels, radio channels, etc. |
| | Failed to inform the citizens to stay in safe places, and did not suspend schools. | About 430 million warning messages were sent, and schools were suspended timely. |

**Summary**

After the 2012.7.21 flood, Beijing quickly drew lessons from its experiences and

effectively improved its weather warning and emergency response capabilities, which enhanced the city's resilience and prevented losses and casualties in subsequent rainstorms. This demonstrates that local governments in China have a strong capacity for policy learning. However, this policy learning is often limited to lesson drawing based on their own experiences or mandatory policy diffusion under the orders from higher levels of government, whereas horizontal policy learning, i.e., spontaneous experience sharing among cities without higher orders from the above, remains very limited. The case of the 2021.7.20 flood in Zhengzhou in Central China's Henan Province in the next section illustrates that Beijing's lesson-drawing in flood control following the 2012.7.20 flood (e.g., improving weather warning mechanisms, synching weather warning with emergency response) failed to attract sufficient attention from other cities, including Zhengzhou.

### (2) 2021.7.20 flood in Zhengzhou, Henan Province

#### The incident

The 2021.7.20 extreme torrential rain[14] in Zhengzhou started on July 17, 2021 and gradually escalated from a light rain to a severe torrential rain and finally to a regional extreme torrential rain during the day of July 20, 2021. The 24-hour precipitation on July 20 reached 627.4mm, which was equivalent to the average annual rainfall in Zhengzhou (640.8mm). The maximum rainfall occurred from 16:00pm to 17:00pm on July 20, with hourly precipitation of more than 201.9mm, higher than the average monthly rainfall in July in previous years, and exceeded the record of the August 1975 heavy rainfall in Henan Province ("75.8 rainfall"). According to official statistics, the rainstorm disaster in Zhengzhou caused 302 deaths and direct economic losses of more than 65 billion yuan.[15]

The earliest weather forecasts for the 2021.7.20 rainfall appeared in the afternoon of July 17. The Zhengzhou Meteorological Station issued seven red rainstorm signals[16] in total, first at 21:59pm on July 19, and then at 6:02am, 9:08am, 11:50am, 16:01pm,

[14] The intensity grade of a relevant rainfall event is specified according to the Chinese National Standard GB/T 28,592–2012 Grade of Precipitation (China Meteorological Administration, 2012) based on the weather records of local stations or weather information in the failure incident reports. According to the standard, there are six rainfall intensity grades: extreme torrential rain (≥250 mm/day), severe torrential rain (100.0–249.9 mm/day), torrential rain (50.0–99.9 mm/day), heavy rain (25.0–49.9 mm/day), moderate rain (10.0–24.9 mm/day), and light rain (0.1–9.9 mm/day).

[15] Feng, S. (2021). A look back at Zhengzhou as the flood waters recede: How did this "natural disaster" happen? Yicai. July 29, 2021. https://www.yicai.com/news/101125402.html

[16] According to the Measures for Issuing and Disseminating Meteorological Disaster Warning Signals issued by the China Meteorological Administration, there are four levels of rainstorm warning signals, with red being the highest level of warning. Red signal is issued when the 3-hour precipitation exceeds 100mm, and orange signal when then 3-hour precipitation exceeds 50 mm, yellow signal when 6-hour precipitation exceeds 50 mm, and blue signal when 12-hour precipitation exceeds 50mm.

21:32pm on July 20, and finally at 00:25am on July 21. An emergency dispatch meeting was held in the morning on July 20, after which the Zhengzhou Flood Control and Drought Relief Headquarter upgraded the flood control emergency response from Level IV to Level II at 11:00am and to Level I at 16:30pm. Henan Provincial Flood and Drought Control Headquarter raised the flood emergency response from Level IV to Level II at 18:00pm on July 20 and to Level I at 3:00am on July 21.

The biggest casualties during the rainstorm occurred during the flooding on a Zhengzhou Subway Line 5 train (Figure 2-2) and the inundation of the Jingguang Road Tunnel (Figure 2-3). In the former, a Subway Line 5 train was forced to stop between the Haitansi Station and the Shakou Road Station at 18:00pm. Flooding of the train trapped more than 500 passengers and killed 14. In the Jingguang Road Tunnel, approximately 300,000 cubic meters of water filled the tunnel (1,835 meters long and 6 meters high), flooding 247 vehicles and drowning six victims.

**Figure 2-2** Flooding Disaster on a Subway Line 5 train during the 2021.7.20 flooding in Zhengzhou
(Photo: Sina Weibo[17])

In addition to these two catastrophic events which caused major casualties, the storm also triggered a series of chain reactions. As of July 24, the number of communities with waterlogging disasters in Zhengzhou reached 971, and there were 1,194 communities with power outage due to the disaster. The storm caused widespread disruptions to rail, air, and road transport in Zhengzhou, which is a major transportation

[17] Photo from Weibo user merakiZz-. Https: https://weibo.com/u/2014644147?is_hot=1

hub in China. Over 200 flights were cancelled and delayed at the Zhengzhou Xinzheng International Airport. At about 21:00pm on July 20, the subway and intercity trains entering and leaving Xinzheng Airport were suspended, and access to the airport highway was restricted, which prevented passengers from entering and leaving the airport. Xinzheng Airport decided to suspend incoming flights from 20:00pm on July 20 to 12:00pm on July 21. More than 5,000 passengers were stranded at the terminal. On the railway side, the Zhengzhou-West High-speed Railway and Longhai Railway between Zhengzhou and Luoyang were flooded with water, the roadbed collapsed and the equipment flooded, and the Longhai Railway collapsed in the Jiejigou section, making the trains impassable. Starting on July 20, nearly 100 regular and high-speed trains in China were suspended (some for more than 24 hours), and many trains were delayed, and passengers stranded.[18]


**Figure 2-3** Flooding of the Jinngguang Tunnel during the 2021.7.20 extreme torrential rainstorm in Zhengzhou
(Photo: Simon Song[19])

The heavy rain caused water to enter the power supply equipment of some hospitals in Zhengzhou, and the critically ill patients were once in danger. The First Affiliated

[18] Beijing Daily News. (2021). Water floods line, roadbed collapses on parts of Zhengxi high-speed railway, Longhai railway. July 21. https://news.sina.com.cn/o/2021-07-21/doc-ikqcfnca8068923.shtml
[19] South China Morning Post (2021). China floods: people still searching for missing relatives after official says four died in road tunnel. July 24. https://www.scmp.com/news/china/politics/article/3142360/china-floods-more-75-million-people-henan-now-affected

Hospital of Zhengzhou University had a power outage in the early morning of July 21, and there was an urgent shortage of power supply equipment. Several other hospitals, including the Henan Provincial Maternal and Child Health Hospital, and some residential areas also lost power. By 7:00am on July 21, although the flood on the first floor of the hospital had receded, the ground floor was still submerged and more than 1,000 patients and their families were stranded in the hospital due to transportation problems.

**Reflection: loopholes in the risk governance system**

**(a) Inadequate risk communication**

***Incomplete communication***

Article 2 of the China Meteorological Administration's Measures for Issuance and Dissemination of Meteorological Disaster Early Warning Signals (2007) stipulates that early warning signals be composed of names, icons, standards, and defense guidelines. According to the Guidelines for Early Warning Signals and Defenses for Emergency Meteorological Disasters, the relevant defense guidelines for red rainfall warning signals are as follows: (1) The government and relevant departments are required to carry out emergency and rescue work against rainstorms; (2) stop gatherings, suspend classes, and close business (except for special industries); (3) conduct prevention and rescue work during disasters such as mountain torrents, landslides, and mudslides. However, the seven red warning signals of heavy rain published on the official Weibo of the Zhengzhou Meteorological Bureau, i.e., "Zhengzhou Meteorology", did not publish any defense guidelines, but only reminded the public to "pay attention to travel safety" or "take precautionary actions."[20] Early warning signals did not even include icons, which significantly reduced their warning effect. Due to the incomplete risk communication, relevant government bureaus as well as the general public were not aware of the defensive advice of "suspending school and business" under the red rainfall warning signal and therefore went to work and school as usual, leading to casualties that could have been avoided.

***Limited channels of communication with poor timeliness***

The weather warning information of the 2021.7.20 rainstorm in Zhengzhou was mainly sent through traditional media such as TV, radio, and newspapers, and only a fraction of the population received the SMS of the red rainfall warning signal, which did not

[20] A red letterhead document issued by Li Kexing, director of the Zhengzhou Meteorological Bureau, at 11:50 a.m. on July 20 for a red rainstorm signal has been widely circulated on the Internet. Although this document contains defense guidelines, it is an internal document of the Meteorological Bureau and not supposed to be published to the public. The document was accidentally exposed by some media on the Internet.

include the key information "suspension of gatherings, classes, and business" and other defense guidelines. Although the official Weibo accounts of the Zhengzhou Meteorological Bureau, the Henan Provincial Meteorological Bureau, and the Propaganda Department of the Zhengzhou Municipal Party Committee all published weather warnings, such messages were rarely read. For example, the number of retweets for the three red warnings published by the "Zhengzhou Weather" Weibo account between 6:00am and 12:00pm on July 20 was 11, 4, and 9 respectively. This shows that the official Weibo of the Meteorological Bureau is not an effective channel for information dissemination. At the same time, the official WeChat accounts of the Zhengzhou Meteorological Bureau and the Henan Provincial Meteorological Department, i.e., Zhengzhou Weather and Henan Weather, did not publish any warning of the extreme rainfall. A search of the Internet news shows that there was almost no news about the rainfall until the afternoon and evening of July 20, which suggests poor timeliness of risk communication.

**(b) Late emergency response**

The 2021.7.20 rainstorm in Zhengzhou exposed the disconnect between weather warnings and emergency response in the emergency response system (Figure 2-4). In Beijing's flood control emergency plan, rainstorm warnings are synchronized with warning response. In other words, before issuing a red rainstorm signal, the municipal meteorological bureau must consult the municipal flood control office, which then requests approval from the commander-in-chief of the municipal flood control headquarters. Once the commander-in-chief approves the red rainstorm signal, the municipal warning center will formally release the warning messages. This means that the commander-in-chief is fully aware of the rainstorm situation, and the decision to activate a certain level of warning response is made at the same time as issuing the rainstorm warning. After the warning response is activated, if no flood control emergency event has occurred, the relevant flood control departments and divisions will stand by and get ready for any potential emergency. If any emergency events and secondary disasters have occurred such as collapse of houses, waterlogged roads, flooding of underground facilities, the flood control headquarter will activate emergency response. In addition, if necessary, the municipal flood control office may suggest that the whole city or parts of the city enter an “emergency flood season”, which means that the municipal flood control headquarter and the other sub-headquarters authorized by the municipal headquarter have the discretion to mobilize the necessary resources and take other emergency measures such as implementing traffic control. If the chief governor of the city government approves the request, then the flood control headquarter will announce that the city enter the emergency flood season. The

headquarter will announce the lifting of the emergency flood season when the situation is under control.

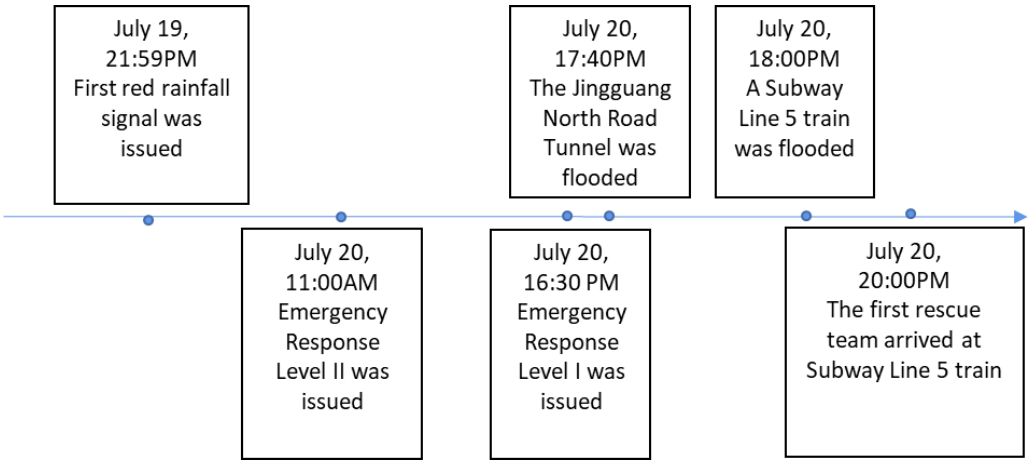


**Figure 2-4**. Timeline of emergency response during 2021.7.20 flood in Zhengzhou

In contrast, Zhengzhou's flood control plan does not provide for an early warning response, but only an emergency response. This means that the relevant flood control departments and organizations in Zhengzhou cannot stand by and get ready for emergencies when the rainfall warning signal is already issued. Although the municipal flood control and drought control headquarters had organized a meeting on the morning of July 20 (when the Zhengzhou Meteorological Bureau had issued three consecutive red rainfall warning signals), they still underestimated the impact of heavy rainfall and did not upgrade the emergency response level in time. The flood control response level was still at Level II at 11:00am that day and was not raised to Level I until at 16:30pm. The city or parts of the city were never declared to be in an "emergency flood season."

Most notably, the transportation department's response to this incident was slow. After the Zhengzhou Flood Control Headquarter announced the activation of the Emergency Response Level I at 16:30pm on July 20, the subway did not shut down until at 18:42pm, and the Jingguang Road tunnel was never closed. What was the reason for such a slow response? We may get some clue from the Zhengzhou Flood Control Plan, which vaguely describes the responsibilities of the transportation department as "providing support for the transportation of flood control materials." In addition, the plan failed to consider the variety of potential disaster scenarios. Specifically, the plan did not mention the flooding of the subway as a possible disaster scenario. The Zhengzhou Rail Transit Regulations specify that "when natural disasters, severe weather conditions or major safety accidents seriously affect the safety of rail transit and cannot guarantee safe operation, the rail transit business may suspend operations. Report to

the municipal transportation administrative department in a timely manner and make an announcement to the public." However, the regulations do not clearly define under what circumstances "safe operation cannot be guaranteed" and how to suspend operations. It is not surprising that the subway company dare not rush to suspend operations without clear instructions.

**Summary**

The case of the Zhengzhou rainstorm reflects the shortcomings of Chinese cities in the area of meteorological disaster risk management, such as incomplete disaster plans, poor risk communication, disconnect between climate warnings and emergency response, inadequate collaboration between organizations (e.g., between subway companies, transportation authorities, and the flood and drought control headquarters), and weak public awareness of and participation in disaster risk prevention. Chinese cities will face a combination of intensifying climate change impacts and rapid urban development in the coming decades, and the frequency of low-probability extreme weather events such as the 2021.7.20 rainstorm in Zhengzhou is likely to increase. This calls for a strengthened disaster prevention and management system that features more timely risk communication, more agile response of government bureaus, and closer cross-departmental, multi-stakeholder collaborations.

## 2. Climate change adaptation: Qingdao's "policy bundling" model

Bundling or nesting different pilot initiatives and policies together to achieve a coherent goal is a typical governance approach of local governments in China, and this is no exception in the case of climate change. For example, there are a number of urban pilot programs related to addressing climate change in China, including but not limited to the low-carbon city pilot, the sponge city pilot, and the climate-resilient city pilot. The low-carbon city pilot program focuses on greenhouse gas reduction and emphasizes energy system change; the sponge city pilot program addresses the risks associated with storm water and water resources, emphasizing urban storm water management and recycling and reuse of water resources; and the climate-resilient city pilot program focuses on multi-hazard risks, emphasizing the integration of risk concepts into urban governance.[21] Since the three pilots share some common objectives in addressing climate change, in practice local governments can often "bundle" these similar pilots or policies and carry out a series of actions to achieve multiple policy objectives at the same time. Qingdao, a city located in Eastern China's Shandong Province, provides a

[21] Wang, Y. (2021). Managing climate risk and improving urban climate resilience: Practical experience and insights from Qingdao City. *Environmental Protection*, 8, 35-38.

case in point.

In the past decade, Qingdao has nested climate change adaptation into its low-carbon city pilot program and sponge city pilot program (Table 2-2). Qingdao became the first national low-carbon pilot city in Shandong Province in 2012. In 2016, it was selected as the second batch of national sponge city construction pilot cities. In 2019, Qingdao's Climate Change Adaptation Plan was officially promulgated, making it the first city in China to prepare a climate change adaptation plan based on risk assessment and scientific research on climate change. The sponge city pilot in Qingdao takes the renovation of old communities and urban renewal as the starting point, but achieves synergistic effects in climate change adaptation through water management and infrastructure renovation. The process of building a low-carbon city pilot is also increasingly focused on the synergistic effects of greenhouse gas emission mitigation and climate change adaptation to build a low-carbon resilient city.[22]

**(1) Building a sponge city**

The MOF, MOHURD, and MWR launched the sponge city pilot program with financial support from the central government in December 2014, and announced the list of the first batch (16) and second batch (14) of pilot cities in March 2015 and April 2016, respectively. Qingdao was successfully shortlisted for the second batch of sponge city pilot cities and received 1.2 billion yuan of central financial subsidies to carry out pilot construction. At the end of 2019, Qingdao City successfully passed the national pilot assessment and ranked 2nd among the 14 pilot cities in the second batch, receiving another 120-million-yuan financial fund.

Unlike most cities that chose to build sponge city pilots in newly-built districts, Qingdao constructed the sponge city mainly through the renovation of old communities in Licang District (total area 25.24 km2). Qingdao used the sponge city concept to guide the improvement of urban quality in the old communities, particularly through the treatment of black and odorous water and improvement of the quality and efficiency of sewage treatment. While solving water-related urban diseases, Qingdao also improved the urban environment in these old communities. In this process, the needs and preferences of the public were fully considered, and a working mechanism oriented by "water-related problems + residents' needs" was established to make the sponge project also a welfare improvement project (Box 1). At the same time, Qingdao has adopted the PPP model for project construction in the pilot districts and is actively exploring innovations in the financing and operation mode of sponge city construction.

[22] Zheng, Y., Wang, W., Pan, J. (2013). Low carbon resilient cities: Concepts, approaches and policy options. *Urban Development Research*, 3, 10-14.

**Table 2-2** Measures to adapt to climate change in the pilot construction of Qingdao's low-carbon city and sponge city

| Pilot project | Area | Specific measures |
|---|---|---|
| Low carbon city pilot[23] | Industrial structure | Cultivate new green and low-carbon industries; Strengthen the upgrading and transformation of traditional industries. |
| | Energy mix | Improve the dual control system of total energy consumption and intensity; Reduce coal consumption and promote clean energy. |
| | Transport structure | Vigorously develop public transport and rail transport; Promote the popularization of new energy vehicles; Adjust the transport structure and reduce the proportion of cargo transportation by road. |
| | Green building | Implement energy-saving renovation of existing buildings; Promote ultra-low energy buildings and green roofs and walls; Improve building efficiency. |
| | Carbon sink | Promote afforestation campaigns to increase forestry carbon sinks; |
| Sponge City Pilot[24] | Water ecology projects | Build runoff control projects; Reconstruct ecological bank protection channels. |
| | Water environment projects | Control point source pollution to achieve rain and sewage diversion; Combine source reduction and end-of-pipe treatment to control non-point source pollution and to ensure the safety of the water environment. |
| | Water safety projects | Improve river banks and dredging works; Upgrade drainage pipes; Improve inland flood control. |
| | Water resources projects | Improve rainwater collection and resource utilization for residential communities, public buildings, and roads. |

[23] Summarized based on the Implementation Plan for Low Carbon City Pilot Work in Qingdao, Qingdao Low Carbon Development Plan (2014-2020), Qingdao Work Plan for Collaborative Treatment of Air Pollution Prevention and Carbon Emission Reduction (2021-2025).

[24] Based on the Qingdao City Sponge City Specific Plan (2016-2030).

**Box 1**

**Cuihu Model for the renovation of old communities through sponge city construction**

Cuihu Community is the largest relocation community in Qingdao*. It covers an area of 27.3 hectares, with 107 multi-story buildings and 5,031 households. In view of the large population in the community and the difficulty of coordination, the pilot district organized the street, community committees, and "old villagers" representatives to jointly set up the "Cuihu Community Reconstruction Action Special Coordination Group." The group is mainly responsible for publicizing the concept of sponge cities within the community, collecting opinions and plans from the public, mediating conflicts and disputes, and persuading the demolition of illegal constructions. The efforts of the this coordination group have greatly accelerated the construction of the renovation project and improved the satisfaction of the community, thus known as the "Cuihu Model" for the renovation of old communities.

After the renovation of the Cuihu Community, more than 43,000 square meters of permeable pavement were added; about 8,000 square meters of newly paved asphalt pavement and about 86,000 square meters of greening area were renovated; more than 1,000 meters of drainage pipes were renovated; and sunken green spaces and rainwater gardens of approximately 25,000 square meters were built, with nearly 500 new parking spaces. Through these renovations, Cuihu Community has alleviated the problems of waterlogging, overflowing pipelines, mixed rain and sewage, and difficult parking in the community. Moreover, Cuihu Community used the concept of sponge city to store rainwater. At the same time, the community's infrastructure and landscape have been greatly improved.

**Cuihu Community after sponge city renovations**

**Note**: * A relocation community is built by real estate developers as compensation to the relocating households when the developers requisitioned their land.

**(2) Drafting the climate change adaptation plan**

While actively promoting the construction of sponge cities, Qingdao issued the Qingdao City Climate Change Adaptation Plan in 2019, becoming a leader in the construction of climate-resilient cities nationwide. The NDRC recommended Qingdao to join the " Adapting to Climate Change in China Phase II Project (ACCC Phase II)" in 2014, and Qingdao was the only municipal pilot selected (the rest were provincial pilots). The results of the pilot study were used to support the preparation of the Qingdao Climate Change Adaptation Plan.

The preparation of the Qingdao Climate Change Adaptation Plan began in August 2018. The main team responsible for drafting the plan are a group of professional marine scientists from a local university in Qingdao – the Ocean University of China, which is one of the best universities in the field of ocean sciences in China. This academic team also worked alongside domestic and international experts as arranged by the ACCCII project. During the preparation of the plan, the Ocean University of China team visited the key relevant government departments several times to conduct interviews and seek opinions. The feedback from the government staff effectively enhanced the practicality and operability of the plan. After two rounds of project review, the plan was officially promulgated in August 2019 (Figure 2-5).

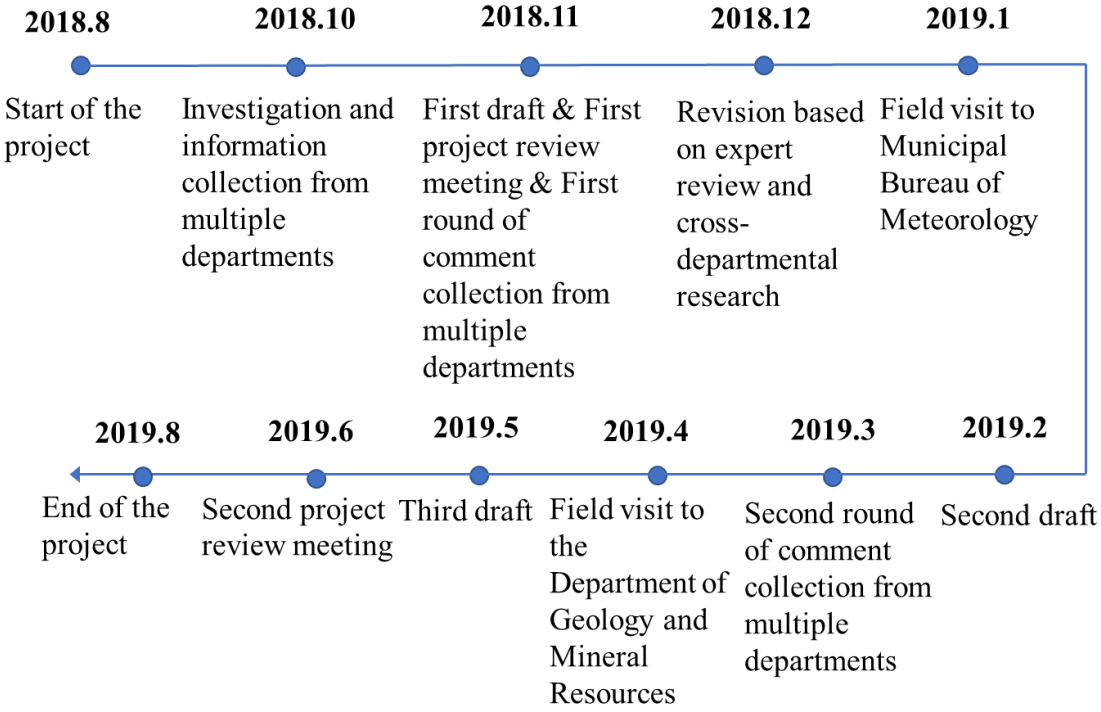


**Figure 2-5.** The planning process of the Qingdao Climate Change Adaptation Plan (2020-2025)

## III. Characteristics of China's climate risk governance system

### 1. A preliminary climate risk governance system has been established, and climate governance capacity is improving

#### (1) An emergency management system for meteorological disasters characterized by "unified leadership, comprehensive coordination, classified management, hierarchical responsibility, and territorial management"[25]

The establishment of the MEM integrated the functions of disaster management that were previously scattered among various departments within the government. The NCDR and other deliberative and coordinating agencies, as well as the MEM, have played established a comprehensive and interdepartmental communication mechanism for "risk identification and evaluation, information sharing, co-processing, and recovery and reconstruction." Since the establishment of the MEM, the number of people who died or were missing, the number of collapsed houses and direct economic losses due to the natural disasters nationwide have dropped by 41.5 per cent, 65.0 per cent and 10.6 per cent, respectively, compared to the three years before the establishment of the Ministry.[26]

After 2020, the MEM launched the first comprehensive national census of the natural disaster comprehensive risks since 1949. The major natural disasters covered are earthquakes, geological disasters, meteorological disasters, floods and droughts, marine disasters, and forest and grassland fires. This census mapped out the natural disaster risk potential, identified the natural disaster risks nationwide and in specific regions, and built a technical support system for natural disaster risk prevention and control. 200,000 public security firefighters and armed forest police officers merged into the MEM, which expanded the emergency rescue team. A national comprehensive fire rescue team was formed, along with specialized rescue teams for specific waters, mountains, caves, and other areas. The MEM also established an emergency command information network at the levels of ministries, provinces, cities, and counties, and built southern and northern air rescue bases.

Governments at all levels are paying more attention to improving meteorological disaster risk management services. With the help of a comprehensive three-

[25] Standing Committee of the Tenth National People's Congress (2007). Law of the People's Republic of China on Emergency Response.
[26] Ministry of Emergency Management (2021). Emergency rescue force system with Chinese characteristics has been initially constructed.

dimensional meteorological observation network, meteorological disaster risk business platforms have been established that integrate meteorological disaster monitoring and identification, impact assessment, risk estimation, and warning. Moreover, some governments have established long time-sequence databases of meteorological disasters.

**(2) A preliminary policy system for climate change adaptation**[27]

The Department of Climate Change of the MEE (originally within the NDRC) is mainly responsible for climate change mitigation and adaptation in China. After President Xi Jinping announced China's commitment to "achieve carbon emissions peak before 2030 and carbon neutrality before 2060", the Department of Climate Change of the MEE and the Department of Resource Conservation and Environmental Protection of the NDRC have worked together towards the dual carbon targets. In 2013, the National Adaptation Strategy for Climate Change was formulated, specifying the main objectives of climate change adaptation for the period of 2014-2020 and proposing adaptation measures for infrastructure, agriculture, water resources, coastal zones and related seas, forests and other ecosystems, human health, tourism, and other ecosystems. In 2020, the MEE began to organize and coordinate the drafting of National Adaptation Strategy for 2035. In addition to the MEE, functions related to climate risk management are also scattered in different administrative departments. For example, climate adaptation often relies on the construction of green space, which is led by the MNR; the responsibility of agricultural climate risk prevention and control and food security belongs to the MARA; water resources changes caused by climate change, such as flooding, are the duty of the MWR; the construction of sponge cities is promoted by MOHURD; the NHC is in charge of public health accidents due to climate change.

The main climate adaptation measures currently being taken in China include preparing action plans for climate change adaptation, constructing sponge city pilot and climate-resilient city pilot, strengthening urban green infrastructure, and improving the resilience of transport networks to extreme weather. Specifically, in coastal areas, the focus is on monitoring, investigating, and assessing sea level changes, protecting the coastal ecosystems (e.g., wetlands and mangroves), and preventing the impacts of extreme weather events on coastal cities. For ecologically fragile areas such as the Qinghai-Tibet Plateau, the northwestern agricultural and pastoral zone, and the Yangtze and Yellow River basins, more emphasis is placed on climate adaptation and ecological restoration.

[27] Jiang, X., Zhou, Z., Lin, Z., et al. (2021). International Cooperation on Adaptation in Post-Paris Times: Thoughts and Prospects. Advances in *Climate Change Research*, 17(4), 484-495

Adaptation actions focus on several key fields, including but not limited to water resources management, public health, and agriculture. The main efforts in the area of water resources management include improving the flood prevention and mitigation system, strengthening the construction of the water infrastructure, and optimizing allocation of water resources. In the area of public health, China has carried out health risk assessments for climate change, launched the Healthy Environment Promotion Initiative, conducted scientific surveys on weather-sensitive diseases, and focused on health emergency response to climate change. In the agricultural sector, the government has conducted risk assessment of agricultural meteorological disasters and promoted new technologies for disaster prevention and mitigation, climate resource utilization and other meteorological disaster prevention and adaptation. China has launched five major initiatives for green agricultural development, including straw processing in the Northeast China and improving agricultural carbon reduction and carbon sequestration capacity. From the perspective of natural resources management, China has also implemented national land greening projects and nine key projects for natural disaster prevention and control.

## 2. Existing governance systems are inadequate to meet the needs of climate risk management.

### (1) The concept of climate risk management has not been fully integrated into the national governance system.

At present, the awareness of climate risk among governments at all levels and other stakeholders is still low, which affects mainstreaming of climate riskd. Most climate risk management measures taken by the government are sectoral measures, and there is a lack of a comprehensive, systematic, and integrated thinking to guide climate risk management. It is imperative that the Chinese government take a holistic approach to climate security, and adjust and optimize the functions of related departments from the overall perspective of climate risk management. According to the different stages of risk management, climate risk governance is made up of four components, namely mitigation, prevention, response, and resilience.[28] The current climate policy system primarily focuses on response and resilience, while falls short of mitigation and prevention.

In formulating climate change policies, governments at all level have mainly focused on climate mitigation, while paying much less attention to adaptation.[29] Although the

[28] Heath, R. (2001). *Crisis Management*. Translated by Wang Cheng, Song Binghui and Jin Ying, Beijing: Citic Press, pp. 31-52.
[29] Cao, M. (2018). Reflection on Improving China's Adaptive Legislation on Climate Change. *Academic Journal of Zhongzhou*, 8, 53-57.

National Adaptation Strategy for Climate Change promulgated in 2013 points out the need to integrate climate change adaptation requirements into economic and social development strategies, adaptation to climate change remains inadequate in terms of objectives, capacity, resources, and decision-making and implementation, especially when compared to mitigation. The most common adaptation measures taken so far are government-led major infrastructure projects,[30] but there are insufficient policies, actions, and other institutional arrangements to address climate risks. In addition to the lack of specific plans and policies for climate adaptation or climate risk management, unlike developed countries such as the UK and Germany, climate risk has not been incorporated into most national and local economic and social plans and urban development plans in China.[31,32,33] For example, climate risk assessments are rarely conducted when making urban planning or undertaking urban construction. Climate change, industrial development, and urbanization processes have not been coordinated from a systematic and ecological perspective. [34,35]

**(2) Integration between disaster risk management and climate adaptation policy needs to be improved.**

In terms of disaster prevention and mitigation, a disaster relief emergency system composed of emergency command, emergency rescue, disaster relief, and restoration and reconstruction has been initially established, and the ability to respond to major natural disasters has been greatly improved. However, the current disaster risk management system is characterized by passive, post-disaster emergency response, which does not reflect the idea of risk management and control.[36] Some regions have not yet set up contingency plans for major meteorological emergencies or rarely rehearsed/implemented their contingency plans. Mechanisms to support risk management, such as the public dissemination of disaster information, climate risk assessment, the coordination for interregional or compound risk management, and

[30] Chen, S. (2019). On the Adaptation to Climate Change Requirements into the Environmental Impact Assessment System of Construction Project. *Journal of Chongqing University of Technology (Social Science)*,33(4), 27-37.
[31] Feng, X., Li, H., Yang, X. (2016). International Experience of Climate Change Adaption Actions at City Level and Its Implications. *Ecological Economy*, 32(11), 120-124 +135.
[32] Dong, X., Zhang, Z. (2021). Urban Renewal Under the Concept of Climate Adaptation: Experience and Implications from Germany. *Urban and Environmental Studies*, 2, 99-112.
[33] Yang, Y. Y.，Zheng, S. W.，Lu, F.，Ouyang, Z. Y. (2018). Comparative Case Study of Domestic and International Eco-Cities and Its Enlightenment to China. *Acta Ecologica Sinica*, 38(22), 8247-8255.
[34] Lin, N., Chen, S. W., Liu, Y. T. (2018). Research on the Impact of Climate Change on Urban Planning and Construction, 35th Annual Meeting of the Chinese Meteorological Society Scientists' Forum: Urban Climate Change Characteristics, Causes and Impacts.
[35] Zheng, Y. (2012). Resilient City: Mainstreaming Climate Risk Management and Adaptation to Climate Change into Urban Planning. *Urban Development Studies*, 19(01), 47-51.
[36] Zhang, H., Tong, X. (2015). Structural Change in China's Emergency Management: theoretical Generalizations. *Social Sciences in China*, 3, 58-84+206

inter-city policy learning in climate risk management, need to be improved.[37,38]

In terms of adaptation to climate change, there is a mismatch between the objectives of adaptation policies and the corresponding capacity and resources. Compared to mitigation policies, adaptation policies often lack a clear responsible agency or a specific working mechanism or supporting resources. The grassroots local governments particularly lack awareness of climate adaptation and ability to respond to climate risks.[39] At present, the main policies that specifically target climate adaptation are climate resilient city pilot and sponge city pilot, both crippled with implementation problems.

**(3) The engineering and technical capabilities of climate adaptation and disaster management have not adapted to the complexity of climate risks.**

With increased frequency and intensity of climatic disasters in recent years, there is an urgent need to improve response to these risks, highlighted by the need to improve urban infrastructure. In the case of the flood prevention and control, most cities either lack drainage capacity or suffer from outdated drainage systems, and many cities have problematic planning of drainage ditches, pipe networks, and pumping stations. Moreover, urban drainage system standards have not fully taken into account the impacts of extreme weather events, and drainage construction of underground facilities such as underground garages, shopping malls and subways is seriously lagging behind.[40] With the rise in sea level in recent years, the safety of seawalls has become a prominent issue. Seawalls around the country generally need to be improved, and the engineering systems and construction standards should be updated. For example, there are still 4,000 km of coastline that lacks seawall protection; of the 14,500 km of seawalls built, only 42.5 per cent met the tidal protection standards.

The technical level for climate risk adaptation and disaster prevention and mitigation needs to be strengthened.[41] First, climate risk-related technologies (such as early warning technologies, specialized technology development, assessment technologies,

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[37] Qin, D., Zhang, J., Shen, C., Song, L. (2015). *National Assessment Report on Risk Management and Adaptation to Extreme Weather and Climate Events and Disasters in China*. Beijing: Science Press.
[38] Liu, B., Xue, L. (2012). Implications for China of the Special Report on Managing the Risk of Extreme Climate Events and Disasters. *Chinese Public Administration*, 3, 92-95.
[39] Peng, S., He, X., Zhang, J., Ma, X., Sun, F., Liu, S. (2015). Current Status, Problems and Recommendations on Climate Change Adaptation Policies in China. *China Population, Resources and Environment*, 9, 1-7.
[40] Wang, Z. (2010). Urban Hazards Control and Release Construction Should Combine with Emergency Management. *China Water Resources*, 17, 23-24.
[41] Huang, C., Tan, X., Guo, J., Wang, Y., Niu, M., Zhang, Q. (2021). An International Comparative Research of the Climate Adaptation Governance and Its Strategic Implications. *Science Research Management*, 42(2), 20-29.

and disaster monitoring and prevention and control technologies[42,43]) are not yet mature. The key technologies for comprehensive disaster reduction have yet to be broken through, and decision support systems for integrated adaptation to climate change are lacking. The predictive capabilities of early warning signals for extreme weather events need to be improved.[44] Adaptation technologies in the fields of infrastructure, agriculture, forestry, water resources, coastal zones, ecological protection, and health have not developed in a balanced manner.[45] In addition, there is an urgent need to update databases related to disaster prevention and mitigation and to improve cross-sectoral and cross-regional data sharing.

**(4) Many key stakeholders have not yet participated in climate risk governance due to low awareness of climate disaster prevention and control.**

Complex climate risks require the participation of multiple stakeholders (e.g., the public, media, enterprises, financial institutions, and social organizations), yet currently there are limited channels and insufficient capacity for these stakeholders to participate.[46] Research shows that only 4% of urban residents are prepared for basic natural disasters in their daily lives, and only 10% of rural residents have any knowledge of these disasters.[47] The public is not sufficiently concerned about climate risks, lacks alertness to climate crises, has weak response capacity, and needs to improve its ability for self-rescue. This low awareness of meteorological disaster prevention and control is directly related to inadequate publicity and education provided by the governments. In addition, insufficient attention has been paid to the role of community in climate risk governance, and volunteer service needs to be more professional, standardized, and diversified.

Moreover, the involvement of businesses in climate risk governance is far from adequate. In 2015, the MCA published the Guidance on Supporting and Guiding the Social Forces to Participate in Disaster Relief, which affirms the positive role of enterprises in participating in disaster relief work. However, enterprises have not actively participated in addressing climate risks, partially due to the difficulty to obtain information about basic ways to participate in climate change adaptation from official

[42] Fu, D., Yan, F. (2016). Review of Research on Barriers to Climate Change Adaptation. *Ecological Economy*, 32(03), 137-143.
[43] Kong, F. (2019). Status, Challenges and Development Opportunities of Integrated Meteorological Disaster Prevention and Mitigation in China in the Context of the Establishment of the Ministry of Emergency Management. *Disaster Reduction in China*, 3, 34-37.
[44] He, X.J., Xu Y.L., Zheng D.W. (2017). The Pathway of Science and Technology Development in Climate Change Adaptation of China. *Journal of Arid Land Resources and Environment*, 31(08), 7-12.
[45] Xue, L. et al. (2014). *Risk Governance on Climate Change*. Beijing: Science Press.
[46] Qin, D., Zhang, J., Shen, C.C., Song, L. (2015). *National Assessment Report on Risk Management and Adaptation to Extreme Weather and Climate Events and Disasters in China*. Beijing: Science Press.
[47] Kou, J. (2016). China's Natural Disasters are Frequent; Public Awareness, Skills for Disaster Prevention and Mitigation Need to be Enhanced. People's Daily.

channels (e.g., the official website of the MEE).[48] As a result, enterprises lack basic knowledge about ways to avoid climate risks and have not made strong efforts in capacity building related to climate risk mitigation.

In addition, the participation of banks and other financial institutions is limited. So far only six state-owned banks have attempted to issue independent Social Responsibility Reports,[49] and the supporting policy measures need to be improved.[50] The participation of insurance companies is also crucial. While the climate insurance mechanisms in developed countries are well established, climate disaster losses in China are still mostly borne by the government and the public, and a market-based mechanism for sharing climate risks has not yet been fully established.[51] Taking agricultural insurance as an example. The State Council amended the Regulation on Agricultural Insurance in 2016. However, the coverage of the insurance remains quite small, and the level of protection is limited. Moreover, the meteorological departments are barely involved in the design and implementation of the insurance. As a result, the agricultural risks are not effectively shared among different parties in the society.[52]

**(5) Government funding for climate adaptation is limited, and a diversified funding mechanism has not yet been established.**

The central government's financial allocations for local governments' natural disasters prevention mainly focus on disaster relief, while insufficient funds are invested in pre-disaster disaster prevention and mitigation. Increasingly frequent natural disasters have led to growing disaster losses, which have exceeded the scope of the government's regular budget.[53,54] In 2020, as of August, the direct economic losses from floods reached 178.96 billion yuan, while the financial subsidies allocated by the central government for post-disaster recovery and reconstruction in that year were only 11.8 billion yuan.[55] The central government's Budgetary Investment Special Management Measures for Post-Disaster Recovery and Reconstruction and Comprehensive Disaster Prevention and Mitigation Capacity Building promulgated in

[48] Tian, D., Xu, T. (2020). Research on Information Disclosure System in Addressing Climate Change. *Journal of China University of Political Science and Law*, 5, 70-82+206.
[49] Li, X. (2021). State-Owned Banks' ESG Disclosure Out, Climate Risk Incorporated into Risk Management System Becomes Trend. 21st Century Business Herald.
[50] Zhang, M. (2020). Exploring the Development of Commercial Banks' Climate Finance. *China Banking*, 10, 105-107.
[51] Zheng, Y., Lin, C. (2021). A Review and Critique of Economic Measures for Climate Change Adaptation in China. *City*, 4, 66-72.
[52] Zhan, F.X., Luo, C.X., Wang, X.C., et al. (2017). Study on Law and Policy of Meteorological Service for Agricultural Insurance. *Meteorology and Disaster Reduction Research*, 40(01),1-6.
[53] Chu, C., Gao, M. (2013). Study on the Financial Mechanism for Climate Change Adaptation in China. *Gansu Social Science*, 4, 197-200.
[54] Fu L., Zhou Z., Yang, X. (2020). Experience and Enlightenment on Policy Mechanisms for the International Adaptation to Climate Change. *Advances in Climate Change Research*, 16(5), 641-651.
[55] Ministry of Finance. (2020). Notice on Issuing Financial Aid Funds for Post-Disaster Recovery and Reconstruction in 2020.

2021 does not mention climate disasters in the budget items.[56] Under the current fiscal system, local governments lack incentives to invest in pre-disaster prevention, which limits the capacity building for climate change adaptation.

The emergency management funds for dealing with emergencies in China consist of three main components, namely, the public funds, the social donation funds, and the commercial and policy insurance compensation funds. According to the Budget Law of China, the general public budgets at all levels shall set up reserve funds equal to 1% to 3% of the general public budget expenditures at the same level, which shall be used to deal with the increased expenditures of natural disasters and other emergencies during the execution of the budget and other unforeseen expenditure. In general, this part of expenditure focuses on emergency response rather than prevention and recovery. The financing model for disaster relief also has many shortcomings, such as the lack of risk-sharing mechanisms and the uncertainty and lag in social donations. In general, insurance and donation funds account for a small percentage of disaster relief financing.[57] Compared with developed countries, insurance tools are insufficiently developed in China. While catastrophe insurance payouts generally account for 30-40 per cent of disaster losses in other countries, the proportion is less than 1 per cent in China. [58]

[56] National Development and Reform Commission. (2021). Notice of the National Development and Reform Commission on the Issuance of the Special Measures for the Management of Central Budgetary Investment in Post-Disaster Recovery and Reconstruction and Comprehensive Disaster Prevention and Mitigation Capacity Building.
[57] China National People's Congress (2014). Budget Law of the People's Republic of China.
[58] Su, M., Wang, M. (2015). A Study on Fiscal Expenditure Policy for Emergency Management in China. *China Emergency Management*, 2,10-17.

## IV. Outlook for climate risk governance in China

The impacts of climate change on the economy and society are increasingly complex, uncertain, and dynamic, especially as manifested in more frequent, intense weather extremes in recent years. There is an urgent need for the whole society to pay full attention to climate security and strengthen its capacity to cope with climate risks.

### 1 Integrating climate risk governance into national development strategies

At the international level, China should actively participate in and contribute to international mechanisms and platforms for climate change adaptation and disaster reduction actions such as the United Nations Framework Convention on Climate Change (UNFCCC) and the International Strategy for Disaster Reduction (ISDR). At the domestic level, climate risk management has just started in China, and it is necessary to build a complete climate risk governance system by bridging the disaster management system and the climate adaptation system, and integrate the concepts and strategies to deal with climate risk into existing laws, plans, and policies.

There is an urgent need for targeted efforts to adapt to climate change. The Urban Adaptation to Climate Change Action Program introduced in 2016 and the 28 climate-resilient city pilot program launched in 2017 show that climate adaptation in China has just moved beyond the stage of planning to the stage of experimentation and implementation. The current round of urban renewal as well as rural revitalization in China should fully consider the impact of climate risks. Drawing on international experience, basic and applied research in natural and social sciences should provide a scientific and technical basis for disaster risk management and adaptation. It is necessary to first carry out systematic, refined, and long-term climate risk identification and assessment at the city level, and then formulate climate adaptation-related goals, plans, and strategies based on the risk assessment.

### 2 Building a polycentric climate risk governance system

#### (1) Government: establish an institutional mechanism for cross-sectoral cooperation and cross-regional coordination

China urgently needs to establish a multi-sectoral cooperation system led by emergency management departments and ecological and environment departments, with the participation of ministries closely related to climate change, such as the agriculture, water resources, energy, transportation, and construction bureaus. All these government agencies need to synergize actions on climate adaptation and disaster prevention and mitigation with other sustainable development goals such as

ecological protection and poverty alleviation. At the regional level, strengthen the decision-making and coordination mechanisms among cities and city clusters in climate disaster management, for example by hosting joint meetings attended by mayors, governors, and other officials; establishing regional technical support institutions or expert committees; and creating disaster risk statistics and monitoring information platforms. Cities may also work together to formulate emergency joint action plans for safeguarding water supply, electric power supply, and transportation in urban city clusters under various extreme weather and climate events such as heat waves, low-temperature rains and snows, heavy rains, waterlogging, and continuous droughts.

**(2) Non-state actors: engaging all key stakeholders in climate risk governance**

Reinforce the role of the private sector in climate risk governance. The private sector should fully recognize the impact of climate change and promote the sustainable development of enterprises and maximize shareholder value through changes in business strategies, such as supply chain management, business continuity planning, and the development of new business areas. Promote the partnership between the private sector and the public sector, and advocate public-private partnerships (PPP) as alternative funding mechanisms. Make full use of the investment of the commercial sector, and seek financial support for disaster risk mitigation by establishing public-private cooperation and partnerships in various fields such as risk assessment, risk analysis, risk management, and risk transfer.

Citizen participation is of great significance in the practice of risk management. The first and foremost task is to raise citizens' awareness of adapting to climate change and reducing disaster risks. Provide more diverse participation channels and methods for different groups to enhance the awareness and adaptability of vulnerable groups to respond to climate risks. Emphasize the monitoring and early warning and forecasting of climate risks. Improve the mechanisms for risk information communication and public release of disaster information. Guide the public to carry out self-rescue action in disaster situations. Reinforce the role of professionals and build a mechanism for experts to participate in government decision-making. Strengthen volunteer participation mechanism, optimize the makeup of the volunteers, and improve the training, policy support, and incentives for volunteers.

### 3. Building climate-resilient smart cities

**(1) Smart meteorology to improve climate risk prediction and early warning**

One of the foundations for climate-resilient, smart cities is the use of big data, cloud computing, the Internet of Things, artificial intelligence, and intelligent grids to collect

and analyze data and information and to promote technological change in urban risk prediction and integrated disaster mitigation. The climate forecasting system provides the basis for climate early warning, and it includes five subsystems, including climate monitoring and analysis, climate forecasting, meteorological disaster risk assessment, ecological climate assessment, and climate feasibility demonstration. Using big dat, data mining, and artificial intelligence technology to carry out intelligent risk analysis and prediction and early warning research is the development trend of international disaster prevention and mitigation.

Although smart meteorology has been developed in China, the integration between resilient cities and smart cities remains insufficient in terms of the accuracy of prediction and the coverage of early warning. Therefore, it is necessary to renovate and improve the existing meteorological observation system, especially the level of technical equipment in underdeveloped and remote areas, and to improve the accuracy of observation data. Second, it is necessary to break the barriers of climate data information and to establish a transparent, open platform for information sharing. In addition, In terms of early warning information release, it is possible to explore the decentralization of early warning information by stimulating the disaster prevention and mitigation capabilities of the grassroots-level organizations and clarifying the early warning information classification scheme. Strengthen and improve public awareness of climate risk prevention through emergency response capacity training and form an integrated model of climate risk governance that engages the government, enterprises, and the public.

**(2) Climate-resilient urban design to enhance resistance to meteorological disasters and to improve post-disaster recovery**

Urban planning and construction should consider the impact of meteorological disasters and strengthen urban resilience and intelligence. The planning and design of Green Infrastructure (GI) provides a case in point. GI refers to a green, open space where natural elements and man-made elements are interwoven. GI contributes to both climate adaptation and disaster prevention and mitigation as well as facilitating the green economic recovery in the post-pandemic era. With "nature-based solutions" as a guiding principle, China should define planning regulations, management methods, and contingency plans for GI construction and protection, and pay attention to the synergy between GI and other policies and programs such as the sponge cities pilot and the ecological restoration and urban repair pilot.[59]

[59] Wang, Y., Qi, Y. (2021). Promoting green infrastructure development to improve disaster prevention and mitigation capacity--a win-win solution to cope with climate risks and promote economic development. *China Environment*, 2-3, 40-43.

Adaptive urban design not only takes climate adaptation into account in urban construction at the early stages of urban planning, but also provides guidance for new or modified urban spatial planning and urban architecture in post-disaster reconstruction. More and more Chinese cities regard post-disaster reconstruction as a new opportunity for sustainable urban development. For example, the city of Ya'an in Sichuan Province, which experienced the 2008 Sichuan earthquake, planned post-disaster reconstruction by adapting to local condition, and organically integrated new urbanization construction with new rural construction as well as urban-rural housing reconstruction to improve the welfare of the residents.

**(3) Green, low-carbon, smart buildings to achieve the goals of carbon peaking and carbon neutrality**

With the development of national smart cities and resilient cities, Chinese cities should update design concept, standards, and specifications of buildings, and improve construction of integrated platform, cloud computing service platform, and embedded controller systems in buildings. It is necessary to build green, lower carbon, smart buildings to meet the needs of constructing climate-resilient, smart cities. Intelligent buildings mainly use buildings as platforms to integrate various intelligent information applications and architecture systems. Different from conventional buildings, smart buildings have strong perceptive and communication capabilities. Through scientific operation and safe applications, they can provide people with a sustainable, efficient, and convenient living environment.

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