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Living With Risk: Building the Future of Resilient Cities

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ABSTRACT

The disasters frequently happened these years made the term "resilience" gained increasing attention. Since the end of the 20th century, the way of responding to disaster risks has evolved from disaster prevention to reduction, and now to resilience governance, shifting from the pursuit of "zero risk" to living with risk. In this interview, Professor Guofang Zhai from Nanjing University summarizes the development process of resilient city construction in China, highlighting that the primary task is to enhance infrastructure resilience. Facing the issue of spatial imbalance of urban resilience, it is essential to give full play to the role of territorial spatial planning, with whole-process, multi-factor, multi-system research on urban resilience as an important reference for planning and design, and take disaster scenario simulation as a crucial technical approach. It is necessary to implement both engineering and non-engineering measures, to increase public awareness of risks and to encourage individual participation into the building of resilient cities. Planners and designers should also have a deeper understanding of the possible disasters and be prepared for emergency responses to disasters that exceed standard defense levels.

KEYWORDS

Resilient City; Risk; Climate Change; Territorial Spatial Planning; Sponge City; Disaster Scenario Simulation

HIGHLIGHTS

- The years of 2005, 2015, and 2020 are three significant milestones of China's resilient city construction
- The whole-process, multi-factor, multi-system research on urban resilience is an important reference for planning and design, which takes disaster scenario simulation as a crucial technical approach
- Resilient city construction necessitates both engineering and non-engineering measures

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Introduction of Guofang Zhai

Professor Guofang Zhai currently serves as the Director of the Center for Urban Safety and Development at Nanjing University. He also holds several positions, including being a member of the Chinese National Committee for Future Earth (CNC-FE) and the secretary-general of the Society for Risk Analysis Asia (SRA Asia). His main research interests and practice include territorial spatial planning, urban public safety planning, and particularly focuses on the development and evaluation of resilient city construction both in China and abroad. As an expert consultant, he has contributed to the planning in cities such as Shanghai, Shenzhen, and Nanjing, and the preparation of the *National Territorial Spatial Planning Outline (2021–2035)*.

The disasters frequently happened these years made the term "resilience" gained increasing attention. Could you first share your understanding of the concepts of "risk" and "resilience"?

Guofang ZHAI ("ZHAI" hereafter): Risk is generally understood as a possibility of an event causing potential negative impacts on individuals, cities, and societies—the event can be an earthquake, a flood, a debris flow, a landslide, and other disasters. Since the end of the 20th century, the strategies for risk response have evolved from disaster prevention to reduction, and now to resilience governance, shifting from the pursuit of "zero risk" to living with risk. Humans have realized there is no objective "zero risk" and acknowledged their limited control over the occurrence of disasters. Due to the fact that the manpower, economic, and technological resources invested in reducing risk are finite, humans must live with risk—as explicitly stated in the Hyogo Declaration adopted by the UN at the 2nd World Conference on Disaster Reduction held in Hyogo, Japan in 2005, that "human societies have to live with the risk of hazards posed by nature."[1] The ability of humans to live with risk is termed "Resilience," referring to the capacity to withstand, absorb, adapt to and learn from external shocks, while also can rapidly recover from damage. If such shocks are caused by natural disasters, it encompasses disaster prevention, emergency rescue, post-disaster recovery and reconstruction, and learning and adaptation.

How is the development process of resilient city construction in China?

ZHAI: The resilient city construction in China has three significant milestones. First in 2005, following the 2nd World Conference on Disaster Reduction, the concept of "resilience" was introduced to China with various translations. The confusion in translation has hindered the development of related planning disciplines.

The year of 2015, the second milestone, marked the real beginning for resilient city construction in China after a ten-year preparatory period, when Nanjing University applied to hold a "Risk Society and Resilient City" sub-forum on the Annual National Planning Conference of China, a prestigious conference organized by the Urban Planning Society of China (UPSC). However, "tanxing" (弹性, meaning "flexibility") was adopted as the Chinese translation of "resilience" at that time according to the recommendation of the UPSC. In light of the prevalent translation of "resilience" as "renxing" (韧性, official translation at present) in literature and to distinguish it from the established concept of "flexible planning" in the realm of planning, the *Urban Planning International* journal published a special issue on "Resilient Cities: A New Shift to Urban Crisis Management" which adopted the translation "renxing" later in the same year. Also in 2015, Nanjing University undertook China's first planning practice project on the basis of resilient city theory—the study on resilience enhancement planning for municipal facilities in Hefei. Since then, the term "resilience" has been more widely translated as "renxing" and increasingly diverse related practices have emerged.

By 2020, the third milestone, the construction of resilient cities was highly valued in *the Proposal of the Communist Party of China Central Committee on Formulating the 14th Five-year Plan for Economic and Social Development and the Long-range Objectives through the Year 2035*. *The Report of the 20th National Congress of the Communist Party of China* published in 2022 further explicitly proposed to build "livable, resilient, and smart cities," elevating resilient city construction to a national strategic level. Subsequently, Beijing and Shenzhen have carried out policies on promoting resilient city construction, and cities including Beijing, Zhengzhou, and Xining have published their resilient city planning documents. It is informed that the Ministry of Natural Resources of the People's Republic of China plans to start the urban resilience assessment to help enhance urban safety at national level.

Referring to the international advanced experiences, which aspect of resilience improvement is most pressing in China?

ZHAI: Although the construction of resilient cities in China has seen significant progress, there is still a gap compared with developed countries. An analysis of the death toll from earthquakes of magnitude 6.5 or higher occurring in Japan and in China after 1900 shows that the number of death in China was tenfold of that in Japan; and the economic loss caused by floods each year in China was about 2.5 times of that in Japan[2].

Our research team has developed an resilience evaluation indicator system of urban disasters from six aspects: economic, social, environmental, community, infrastructural, and institutional resilience, and assessed the disaster resilience and its spatial differences in 288 prefecture-level cities across China[3]. Firstly, all aspects of resilience are equally important and interconnected with each other. For reducing the losses caused by natural disasters, the primary task is to enhance infrastructure resilience, as the city's first line of defense. For example, although Nature-based Solutions can be a positive supplement to address flood disasters, the infrastructure (levees, reservoirs, drainage

networks, etc.) always plays the greater role, especially when facing heavy or extreme rainfall. Establishing infrastructure resilience is relatively lagging behind in China, for instance, some infrastructure cannot meet the protection standards, which urgently needs to be improved.

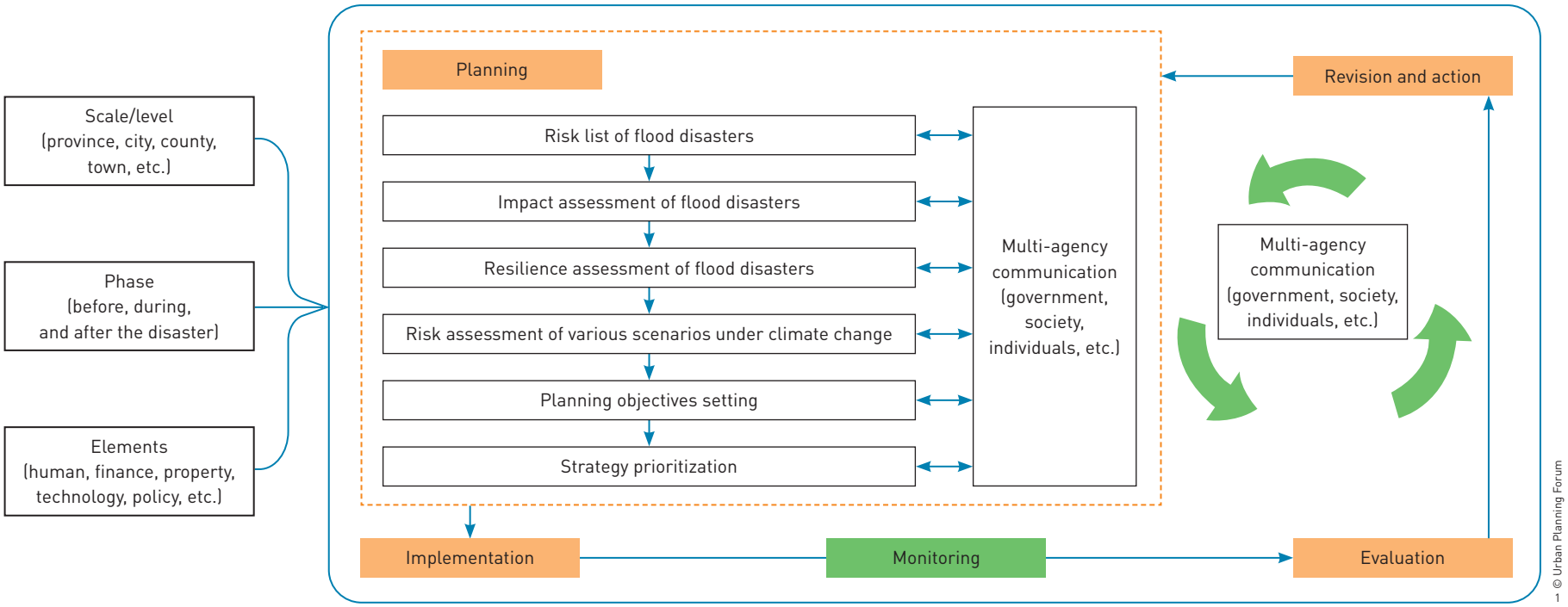
Regarding environmental resilience, disaster risk is closely related to the hazard inducing environment. For instance, a low green coverage can increase the risk of secondary disasters such as debris flows after an earthquake. Community resilience and social resilience are closely related, as community is the basic unit of society. Complete disaster prevention, reduction, and rescue facilities, and increased public awareness of disaster prevention within a community can effectively strengthen the ability of the society at large to cope with risks. Harmony and inclusiveness among different social strata and groups also contribute to jointly resisting risks. Institutional resilience reflects the guidance or governance capability over economy, environment, and society. All forementioned aspects are established on the foundation of economic resilience, in other words, economic development is the most pressing task at present. In the study, the research team also found that the top ten cities in resilience ranking are mostly located in the coastal areas of eastern China, while the bottom ten are medium- and small-sized cities in central and western regions, with a difference as high as nearly ten times between the top and bottom ones[3]. Generally, the resilience of rural areas is lower than urban areas because of the lagging economic level, less developed infrastructure, lack of protection standards of building construction, weaker disaster prevention awareness, and a larger number of left-behind elderly and children. On the one hand, the development of economy can support the enhancement of other aspects of resilience; on the other hand, economic growth is inseparable from disaster prevention and mitigation. When a city's capability to cope with disasters is enhanced, losses would be reduced and social wealth accumulation is facilitated accordingly. Studies have shown that every dollar invested in disaster prevention and mitigation can yield a return of six dollars[4]. However, the current difficulty lies in raising people's awareness of resilience construction. Since the return period of enhancing resilience is relatively long, it is hard to see immediate results or achievements during the tenure of managers and thus such construction is often overlooked by administrators.

Recent research on urban resilience increasingly advocates for comprehensive governance throughout the whole process, incorporating multiple factors and systems (including society, economy, spatial environment, culture, management, and infrastructure)[5]. How can such research offer effective support for planning and design practice? Is there any disconnect?

ZHAI: Current research has proposed many theoretical frameworks—for instance, I have proposed a comprehensive governance framework of resilient cities that encompasses five dimensions: scales/levels, types of disasters, phases, elements, and participating entities. It helps make various planning, construction, and management departments aware of that the governance focuses should vary when facing different entities, at different scales, in response to different types of disasters, and at different phases of a disaster (Fig. 1). These theoretical studies have already provided effective guidance for planning and design practice with extreme disaster scenario simulation. For example, the *Resilient City Spatial Planning of Beijing (2022–2035)* involves all types of disasters of Beijing and conducted a whole-process scenario simulation for two major threats—flood and earthquake. The severe disaster situations, the "7·20" extreme rainfall in Zhengzhou and the magnitude 8.0 Sanhe–Pinggu earthquake, were referenced for disaster scenario simulation. Based on the simulation results, the ways to prevent, recover, and rebuild from the disasters, and the responsibilities of various entities were clarified. Similarly, the *Emergency Evacuation and Rescue Spatial Planning of Shenzhen (2021–2035)* deploys a "5+1" spatial system of emergency evacuation and rescue, which consists of shelters, rescue facilities, medical and health care facilities, supplies storage and distribution facilities, escape and refuge space for emergency, and transportation facilities. The planning team also simulated the maximum population size needed to be evacuated during extreme disasters that have occurred over the past forty years.

The rainfall and flood disasters need a special focus in resilient city construction in China. In your view, apart from common engineering measures such as infrastructure and sponge city construction, what non-engineering measures are worth noting?

ZHAI: There are four common non-engineering measures to enhance resilience to rainfall and flood disasters. The first measure involves formulating disaster prevention planning that defines restrictions on building or structure types within zones of different flood risk levels. Notably, construction of residential buildings is prohibited in zones identified with a 50-year flood frequency. The



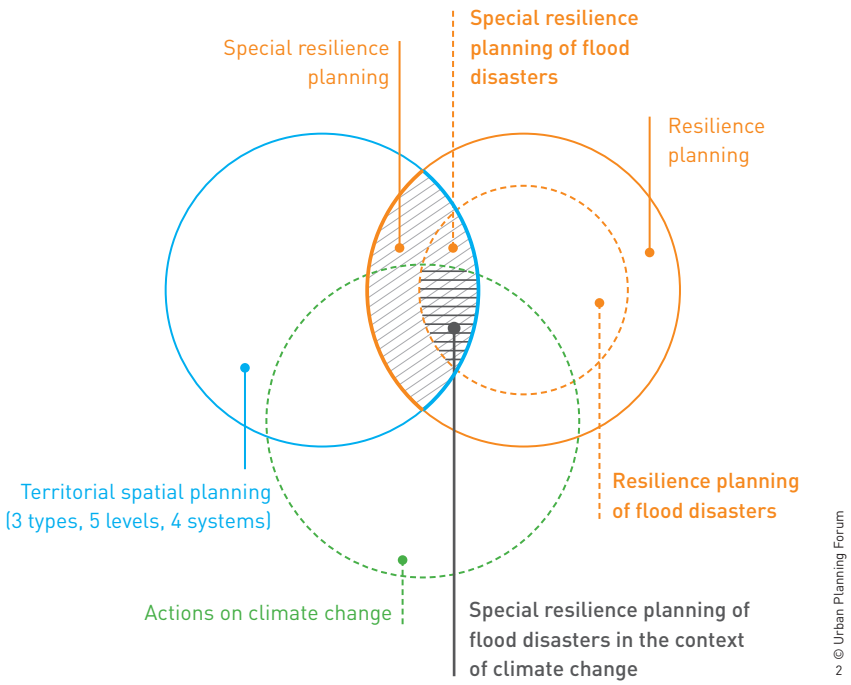
1. Action model for multiple agencies in general planning framework for resilient management of flood disasters in the context of climate change (adapted from Ref. [2]).

second measure refers to the generation of flood risk maps that are open-access to the public, detailing predicted flooding depths to enhance preparedness for significant rainfall events. Currently, China is promoting the development of such maps, though their adoption has not been made mandatory. The third one emphasizes the application of advanced technology in forecasting and early warnings. For instance, in Japan, a tsunami warning was issued within three minutes of the earthquake on March 11, 2011, offering relatively more evacuation time compared with the 17-minute warnings in the 1950s[6]. While China has developed mature early warning technology for earthquakes and floods, their widespread implementation remains sparse. The fourth one is raising public awareness of risks and enhancing individual disaster preparedness skills, as well as establishing community-based aid systems. The last measure is the exploration of catastrophe insurance to mitigate economic losses, but such insurance schemes have not been fully implemented in China.

By the way, I firmly support the continuation of sponge city construction, despite current challenges. Many misunderstand that sponge city construction can permanently prevent flooding. Instead, its major function is the retention of water resources, mainly addressing issues of uneven temporal and spatial distribution of water. Furthermore, sponge city projects are normally large in scale with prolonged timelines, involving complex stakeholders. In some regions, the construction has strayed from scientific guidelines, with decisions on locations made based on ease rather than necessity, or even diverting dedicated funds for other uses, leading to diminished public acceptance. Nevertheless, numerous excellent domestic and international cases of coping with rainfall and flood disasters have proven that spongy city construction can effectively reduce the risk.

How should we enhance public awareness of risks and thereby promote individual participation in resilient city construction? And what role should planners, designers, and researchers play?

ZHAI: Firstly, ensure economic development, as only after solving the basic needs for survival can the public's awareness of risks be further enhanced. Secondly, within permissible limits, the information disclosure should be strengthened, regarding disaster prevention, mitigation, and rescue. Thirdly, emphasizing the emergency preview. Fourthly, promoting both the domestic and international paradigms of excellent resilient city construction to public, as well as self-help and rescue measures facing extreme events. Every individual should recognize his/her primary



2. Relationship between territorial spatial planning and resilience planning in the context of climate change (e.g., flood disaster) (adapted from Ref. [2]).

responsibility for disaster prevention under the management of the government.

For planners and designers, it is essential to have a deeper understanding of the possible disasters and their trends. For instance, when preparing the resilience planning responding to flood disasters, it is necessary to integrate with the relevant territorial spatial planning, as well as assess the changing trend and impacts of flood events in the context of climate change (Fig. 2). It is stated in the *Climate Change 2023: Synthesis Report* released by the Intergovernmental Panel on Climate Change (IPCC) that "some future changes are unavoidable and/or irreversible"[7]. This suggests that for East Asia, the risk of rainfall and flood disasters and droughts will increase. Therefore, facing the issue of spatial imbalance of urban resilience, it is necessary to give full play to the role of territorial spatial planning based on whole-process, multi-factor, multi-system research on urban resilience for planning and design practice. Planners and designers need to consider the impacts of climate change on cities, such as rising sea levels and increased variability in rainfall; raise protection standards to ensure that existing drainage networks, levees, and other infrastructure can effectively withstand disasters; promote emergency evacuation and rescue spatial planning; conduct vertical planning and design to reasonably determine the functions, forms, and accessible building or structure types of predicted flood inundation areas; and adopt Nature-based Solutions to drive the work by nature. Moreover, with increased extreme climate disasters, it necessitates the emergency responses to disasters that exceed the established protection standards.

For researchers, there are several aspects that are worth attention. First, the study of the interlocked effects and disaster-forming mechanisms when multiple disasters such as earthquakes, floods, and fires occur simultaneously or successively. Second, the transmission mechanisms of the impacts by disasters, for example, how the impact on electricity and transportation can transfer to other urban systems such as mobility and public health, and how this impact spreads tempo-spatially. Third, the formation mechanisms and assessment methods for regional network resilience which considers cities as a series of nodes. Finally, theoretical and technical frameworks for responding to rarely occurred disasters (or "low-probability, high-consequence events") and unknown disasters (e.g., black swan events).

Competing interests | The author declares that he has no competing interests.

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与风险共存：构建韧性城市未来

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摘要

近年来，各类灾害风险频发，“韧性”一词愈发受到关注。自20世纪末至今，灾害风险的应对方式也不断转型——由防灾到减灾，再到韧性治理；从追求零风险转变为与风险共存。在本次访谈中，南京大学的翟国方教授总结了中国韧性城市建设的发展历程，并指出韧性城市建设的首要任务是提升基础设施韧性。面对城市韧性空间失衡的问题，需要以国土空间规划为抓手，以全过程、多因素、多系统的城市韧性研究为规划设计的重要基础，以灾害情景模拟为重要技术手段。韧性城市建设过程中需要坚持工程性措施及非工程性措施并举，提升民众对风险的认识，促进个人这一主体的参与。规划师和设计师也应当对当前形势具备理性认知，做好超越设防标准灾害发生时的应急响应工作。

关键词

韧性城市；风险；气候变化；国土空间规划；海绵城市；灾害情景模拟

文章亮点

- 2005年、2015年和2020年是中国的韧性城市建设的三个重要时间节点
- 全过程、多因素、多系统的城市韧性研究是规划设计的重要基础，灾害情景模拟为其重要技术手段
- 韧性城市建设要坚持工程性措施与非工程性措施并举

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翟国方简介

翟国方教授现任南京大学城市安全发展研究中心主任，兼任联合国“未来地球”计划中国国家委员会（CNC-FE）委员、亚洲风险分析学会（SRA-Asia）秘书长等多个职务。他主要从事国土空间规划、城市公共安全规划等领域的研究与实践，尤其关注国内外韧性城市建设的发展与评估，以专家顾问的身份参与了《全国国土空间规划纲要（2021—2035年）》编制，以及上海、深圳、南京等城市的规划工作。

近年来，各类灾害风险频发，“韧性”一词愈发受到关注。首先请您谈谈对于“风险”和“韧性”概念的理解。

翟国方（以下简称翟）：“风险”指人们不希望发生的事件发生的可能性与后果，多指致灾因子（如地震、洪涝、泥石流、塌方）对人、城市和社会所造成的负面影响。自20世纪末至今，灾害风险的应对方式也不断转型——由防灾到减灾，再到韧性治理；从追求零风险转变为与风险共存。这是因为人们不断认识到，绝对的“零风险”是不存在的。人们无法控制灾害的发生，且降低风险需要各类资源的投入（如人力、经济、技术），随着风险水平的降低，降低风险所需投入的资源愈发增加，而资源是有限的，这就决定了我们人类必须与风险共存——正如2005年联合国在日本兵库举行的第二届世界减灾大会通过的《兵库宣言》就明确指出，“人类社会必然要与自然界的危害风险并存”[1]。人类与风险共存的能力被称为“韧性”，指对于外来冲击具有抵御、吸收、适应和学习的能力，同时还具有受到损伤后快速恢复的能力。如果这种冲击是由自然灾害引起的，通常涉及灾害防御、应急救援、灾后恢复重建和学习适应等方面。

中国的韧性城市建设经历了怎样的发展过程?

翟：中国的韧性城市建设有三个重要时间节点。首先，自2005年第二届世界减灾大会，“resilience”的概念被引进中国，并出现了“弹性”“韧性”“抗逆力”“综合防灾减灾能力”“恢复力”等多种翻译，而这种混乱的译词使用制约了相关规划学科的发展。

2015年，南京大学向中国城市规划年会申请举办“风险社会与韧性城市”分论坛，中国韧性城市建设也迎来了第二阶段。在这次论坛中，最终依从学会建议，将“resilience”译作了“弹性”。考虑到相关文献中译作“韧性”的比重越来越高，而且规划学科中已有“弹性规划”这一概念，易造成混淆，《国际城市规划》在同年出版的“韧性城市：应对城市危机的新思路”专辑中应用了“韧性”的译法。南京大学则于当年承接了中国首个基于韧性城市理论的规划实践项目——“合肥市市政设施韧性提升规划研究”。可以说，2015年是中国韧性城市建设“元年”，不仅“韧性”一词的译法更为普及，各类相关实践也陆续涌现。

2020年，建设“韧性城市”出现在《中共中央关于制定国民经济和社会发展第十四个五年规划和二〇三五年远景目标的建议》中，并受到高度重视；2022年，党的“二十大”报告中更加明确地提出来要建设“宜居、韧性、智慧城市”，并将其提升至国家战略高度，这标志着中国韧性城市建设迈入了第三个阶段。其后，北京、深圳等城市出台了关于推进韧性城市建设的意见；北京、郑州、西宁等城市还编制完成了韧性城市的规划。据悉，自然资源部将择机启动城市韧性的评估工作，助力我国城市安全水平的进一步提升。

与国际先进韧性城市建设经验相比，中国在韧性城市发展的过程中，哪方面韧性的提升最为迫切?

翟：从国际上看，虽然中国韧性城市建设已经得到非常大的发展，但相较于发达国家仍然存在差距。通过对1900年以后发生在日本和我国6.5级以上地震造成的死亡人数分析，发现同样等级的地震造成的死亡人数比例或可达1:10；每年因雨洪灾害造成的经济损失占GDP的比重，中国约是日本的2.5倍[2]。

我曾带领团队从经济韧性、社会韧性、环境韧性、社区韧性、基础设施韧性及组织韧性6个方面构建中国的城市灾害韧性评价指标体系，并对全国288个地级市的灾害韧性及其空间差异进行评估[3]。首先，上述各方面韧性都同等重要且相互关联。减少自然灾害带来的损失，首要任务是夯实城市的第一道防线——提升基础设施韧性。以应对雨洪灾害为例，虽然基于自然的解决方案对于提升雨洪韧性有积极作用，但在面对大暴雨或特大暴雨时，其效果相对有限，而防洪堤、水库、排水管网等基础设施的建设可有效应对雨洪冲击。对中国的城市而言，基础设施韧性建设为薄弱环节，“欠账”较多，如基础设施在设防标准方面不达标，迫切需要提升。

就环境韧性而言，灾害风险和孕灾环境息息相关。以地震为例，如若绿地率很低，引发泥石流等各类灾害的风险就会相应增加。社区韧性和社会韧性密切相关，社区是构成社会的基本细胞。当社区内部防灾、减灾、救灾设施齐全、居民防灾意识较高时，将有效提升社会应对风险的能力；社会不同阶层、群体之间的和谐包容，也有助于共同抵抗风险。组织韧性则反映了对经济、环境、社会的引导或治理水平。而这一切的基础则是经济韧性；换言之，经济发展是目前最为迫切的任务。在上述对288个地级市的研究中，研究团队也发现，韧性排名前十位多处于中国东部沿海地区，后十位均为中西部地区的中小城市，且首尾相差高达近十倍[3]。就城乡而言，城市的韧性总体来说要高于乡村，因为乡村经济水平较低，基础设施建设落后，缺乏建筑设防标准，防灾意识薄弱，且居民多为老、幼等弱势群体。一方面，经济水平的提高可以支撑其余各类韧性的提升；另一方面，经济的发展离不开防灾减灾，当城市应对灾害的能力提升，减少相应损失，社会财富便能得以积累。有研究表明，在防灾减灾上投入1美元，就能得到6美元的回报[4]。但是，当前的难点则在于提升人们对韧性建设的认知。由于韧性建设回报周期相对较长，难以在管理者任职期间立竿见影、创造业绩，也经常被城市管理者所忽视。

近年来的城市韧性研究更加提倡全过程、多因素、多系统（包含社会、经济、空间环境、文化、管理、基础设施建设等）的综合治理[5]，这类研究对于实际的规划设计的参考价值如何？研究和实践之间是否存在脱节的情况?

翟：这类研究是提出了许多理论框架——例如，我也曾提出层次/尺度、灾种、阶段、要素、参与主体等五个维度的治理框架——目的在于从多维度切入韧性城市的综合治理，同时使各规划建设管理部门认识到，面对不同的主体、在不同的尺度下、应对不同灾害种类，以及在灾害发生的不同阶段，治理的侧重点都有所不同（图1）。这些理论研究已经对规划设计实践形成了有效指导，并通常结合极端灾害情景分析这一重要技术手段得出应对措施。例如，《北京市韧性城市空间专项规划（2022年—2035年）》针对北京市展开了全域、全灾种的空间规划，并针对北京的主要灾害种类（雨洪灾害和地震），开展“全过程”情景分析，通过设想最严重的灾害情况，考虑如何预防、恢复和重建，以及各类主体应承担怎样的责任等问题。在规划过程中，雨洪灾害的情景分析以郑州“7·20”特大暴雨的降雨量为参考，地震则参考历史上北京曾发生过震级最高的地震（8.0级的三河–平谷地震）进行情景分析。再如，《深圳市应急疏散救援空间规划（2021—2035年）》对深圳市的应急

避难场所、应急救援设施、应急医疗卫生设施、应急物资储备与配送设施、战略预留应急用地，以及应急交通设施的“5+1”应急疏散救援空间体系进行了规划部署。在规划过程中，也对极端灾害（如近四十年来台风等极端自然灾害）再次发生时需要进行应急疏散的最大人口规模进行了模拟分析。

雨洪灾害是中国韧性城市需要重点关注的灾害类型之一，在您看来，除了“基础设施的建设”“海绵城市建设”等常见的工程性举措，还有哪些促进应对雨洪韧性提升的非工程性举措值得关注？

翟：常见的提高应对雨洪韧性的非工程性措施主要有以下几类：一是编制防灾规划，确定每一区域内的建筑物／构筑物类别，不允许进行相应类别之外的建设，例如，在50年一遇泄洪区内不可建设住宅。二是绘制灾害地图并向公众发放，说明各个地区的可能淹没深度，让市民能够在强降雨来临前及时做好防范工作。目前，国家正在推动灾害地图编制工作，但尚未纳入强制性要求。三是加强预报、预警等方面的新技术应用。例如，2011年的3・11日本地震的海啸预警时间，从20世纪50年代的地震后17分钟降低到3分钟，提供了相对充裕的避难时间[6]。我国的地震、雨洪等灾害的预警技术也已相对成熟，可以加强推广。四是提升民众对风险的认识，加强个人防灾技能培训和建立公众互助体系。五是探索利用巨灾保险补足经济损失的途径，但目前在市场上此类保险工作尚未完全铺开。

此外，我还想特别说明，我认为应当坚定不移地继续开展海绵城市建设。目前，公众对海绵城市存在一定的误解，认为建设了海绵城市就可以一劳永逸地杜绝洪涝的发生。但海绵城市的主要功能并不是防灾，而是储蓄水资源，主要解决的是时空分布不均的问题。其次，海绵城市建设项目投资规模大、周期长、涉及到的利益相关方较为繁杂，部分地区还出现了未按照科学规律展开建设的情况（例如，在项目选址时只考虑什么地方“容易建”而非“需要建”，甚至把专项资金挪为他用），导致社会公众对海绵城市建设认可度较低。国内外众多应对雨洪灾害的优秀案例也充分表明，海绵城市建设能够有效降低雨洪灾害风险。

请问应如何提升民众对风险的认识，进而促进个人这一主体参与韧性城市建设？规划设计师和研究者又应该如何发挥作用？

翟：一是要保障经济发展，在解决温饱问题之后才可以进一步提升民众的风险意识。二是要在允许的范围内加强防灾减灾救灾信息披露。三是要加强防灾减灾救灾演练。四是加强媒体宣传，科普国内外优秀韧性城市建设范例，以及遇到极端事件时的自救及救人方式。在这个过程中，政府主导防灾减灾救灾工作，而每个人都是防范灾害的第一责任人。

对于规划设计师而言，首先对当前灾害形势要有理性的认知。例如，雨洪灾害韧性应对规划，既要考虑在国土空间规划体系中相关规划的衔接，也要评估气候变化背景下雨洪事件的变化趋势及其影响（图2）。联合国政府间气候变化专门委员会（IPCC）第六次评估报告综合报告《气候变化2023》已经发布，提出“未来一些气候变化是不可避免和／或不可逆转的”[7]。对东亚地区而言，未来雨洪灾害风险和干旱风险均会增加。所以，面对城市韧性空间失衡的问题，需要以国土空间规划为抓手，以全过程、多因素、多系统的城市韧性研究为规划设计的重要基础。规划设计师要考虑到气候变化背景下海平面上升、降雨量波动增大对城市的影响；提高设防标准，确保现有排水管网、防洪堤等基础设施能够有效应对灾害，加强应急疏散救援空间规划；做好竖向规划及设计，在不同高程布设不同类型的建设项目，合理确定潜在洪水淹没区的功能和形式；在基于自然的解决方案中，同样要通过塑造地形，让自然做功，以此提高场地韧性。此外，未来极端气候灾害会更加频发，也要做好超越设防标准灾害发生时的应急响应。

对于研究者而言，有以下几方面值得关注：一是当地震、雨洪、火灾等多种灾害同时或先后发生时，所产生的复合灾害联动效应及其成灾机制研究；二是灾害效应的传递机制研究，例如，灾害对电力、交通等城市系统的冲击将如何传递到物流、卫生等其他系统，以及其影响在时空上是如何扩散的；三是以城市作为节点时，区域网络韧性的形成机理及其评估方法的研发；最后是对罕遇灾害（又称“小概率大后果事件”）和未知灾害（例如黑天鹅事件）的应对理论与技术框架研究。

图 1. 气候变化背景下规划视角的城市雨洪灾害韧性应对通用框架中的多主体行动模式（改绘自参考文献 [2]）

图 2. 气候变化背景下国土空间规划与城市韧性规划关系图（以雨洪灾害为例）（改绘自参考文献 [2]）