Review and Enlightenment of Sponging Renovation Design of Old Communities Based on Smoke-free City Reconstruction and Ecological Restoration

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Objectives: The COVID-19 epidemic crisis has attracted the attention of people who are experiencing climate change and resources shortage to the human environment and ecology. In the meantime, COVID-19 and cigarette overlay have become one of the greatest global public menace, which aggravates people's concern of well-being and urgency about the risk of spreading smoke and poses new challenge to public sanitation, urban management in every nation. City is the key of the revival from COVID-19 crisis and worldwide economy. Community is the basic unit in city. Material circumstance is the vital carrier of healthy ecology in community. Faced with issues concerning healthy ecological chain circle in communities involving frequent abnormal climate, constant urban waterlogging, scarcity of infrastructure in old communities and so on, it is imperative to incorporate relevant mechanism and ways of sponge reconstruction design on old communities based on smoke-free city reconstruction and ecological reparation from visual exploration in all domains. For the sake of that, the study probe for the accordance of smoke-free city reconstruction and ecological restoration via originating from researches and practices concerning smoke-free city, domestic and foreign reconstruction of old communities, rain and flood management/sponge city, green infrastructure and so on, so as to prompt big strategy of health and ecology and construct resilient community and city with resistant ability.

Key words: smoke-free city; old communities; sponging renovation; design research
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INTRODUCTION

The COVID-19 makes urban living environment very poor due to climate anomaly and resource shortage, and brings urban waterlogging, water pollution, heat island effect and other frequent occurrences. Thus, construction facilities, road network and management in early years need to be improved urgently. However, even at the end of the 20th century, urban construction has entered an era of changing from quantity-oriented to quality-oriented and incremental planning to stock renewal, [1] the urbanization process is still accelerating. According to UN-Habitat's 2020

World Cities Report, in the next 10 years the proportion of the world's urban population will increase from the current 56.2% to 60.4% in 2030, with China, India and Nigeria accounting for 35% of the global urban population growth. [2]

Meanwhile, COVID-19 and cigarette overlay have become one of the greatest global public menace, which aggravates people's concern about well-being and urgency and the risk of spreading smoke, which also poses new challenge to public sanitation, urban management in every nation. Community is the cell of city. Material circumstance is the vital carrier of ecology in community. So far, national governments attach vital importance to legislation on controlling smoke and impelling the construction of city without smoke, and at the same time dedicated to renovation of living environment with increasingly dense population. But both of them perform on parallel pathway, and related implementation effect differs due to community power. Material circumstance is crucial to human health, so improvement of healthy ecology in old communities is urgent. Global Cigarette Prevalence Presentation enacted by World Health Organization in 2020, 2021 assured decline of tradition cigarette and control of smoke made new progress, and meanwhile governments of every country are required to be alert to the rise of new type of cigarette manufactures and ban from starting using these products for non-smokers, so as to prevent normalization of smoking in communities again.[3] Therefore, for the sake of tackling gradually dense population and improving urban ability resistant to risk, it is requisite to probe into more effective design and planning, as well as management and governance, which accelerates promotion on the sustainable and harmonious development of material circumstance and healthy ecology. On the basis of it, the research arrange and incorporate studies regarding sponge reconstruction design of old communities on smoke-free city reconstruction and ecological reparation, striving to propel urban sustainable development, so as to offer reference to the renovation of both of them in harmony under healthy and ecological strategy.

T here are abundant research data resources in foreign countries, which are collected from the perspective of old communities (with old community, neighborhood, settlements as key words), sponge cities (with sponge city, stormwater management, green infrastructure. By combing foreign literatures from 1950 to 2020, it is found that there are as many as 146,349 research data of old communities, but the research on sponging renovation of old communities accounts for less than 1% and is based on case design, as shown in Fig. 1. By September 19th in 2021, regarding smoke control, smoke-free city as key words to search literatures, the data of which is 83824 and 298 respectively. These figures involving community are respectively 5375 and 42, which are all surveys, present feature and measures taken of people group, health, activities etc, without investigations relevant to integration into old community renovation.

Fig. 1 Distribution of foreign literature on sponging renovation of old communities

Although domestic research is later than foreign research, it has increased in recent years. As of December 2020, CNKI had inquired 2,938 journal articles related to "old communities", including 837 articles on "renovation of old communities", mainly focusing on the policies and organizations for the comprehensive treatment and renovation of old communities, with few sponge renovation designs. [4] However, there were as many as 8,597 pure sponge city studies, and only few involving stormwater management/sponging renovation in old communities (see Fig. 2 for the distribution of relevant data). Up to September 19th in 2021, searched literature figures with smoke control, smoke-free city as the key words has been severally 14519 and 129, among which the outcomes refer to community are 1329 and 19 severally. The majority of them are explorations on smoke control of specific people group, illness condition, as well as policy and legal regulations, none researches concerning community renovation. As the sponging renovation of old communities involves multi-links of technical management and cross-disciplinary fields, the series of researches on "reconstruction of none waste city", "renovation of old communities", "stormwater management/ sponge cities", green infrastructure, and urban renovation and ecological restoration under sponging renovation at home and abroad are tracked from the perspective of conservation, environmental protection and ecological sustainability, so as to provide reference for the renovation of old communities currently under way in China and other developing countries and regions.

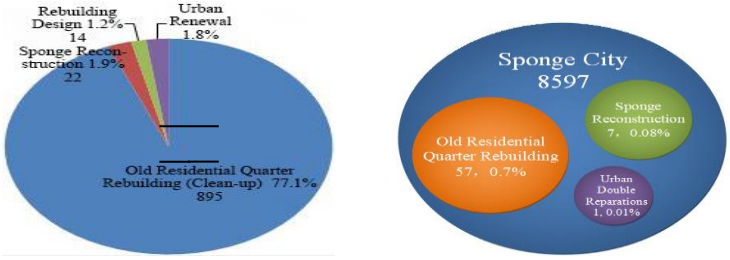

Fig. 2 Data distribution of research in old community sponging renovation of CNKI

METHODS

Smoke-Free City Construction

With entirely discovered studies connected with smoke-free city, they mostly focus on illness affect, policy acknowledgement, controlling measure of specific people group in hospitals and other spots. It is of vital importance to reach common sense that smoking is harmful to health with active and stable controlling smoke policy, which promotes healthy crowd to benefit more than that with high income, yet tricky implementation is an indisputable truth as well. Smoke-free city as essential segment of urban governance also demands extension and innovation apart from requisite legislations. G.P. Morris (2006) et al. supposed long-lasting infective and poisonous challenges caused by material circumstance were tangible, the impact of which on health was marked. Human health were influenced by material circumstance to a great extent, it was necessary to formulate environmental healthy tactics and carry out innovative interference tactics out of legislation, for example, there were various circumstances for participants to devote themselves in, as well as green land and community planning with and adequate quality and biodiversity etc. [5] Candace Nykiforuk (2006) et al. regarding Canada as illustration, discovered regulatory institutions about urban spaces without smoke were exceedingly vital to solution to remarkable health risk with regard to second hand smoking whereas with different implementation strengths of communities. According to Framework Convention on Tobacco Control, the effect community character had on local smoke-free regulation had a definite impact

on worldwide cigarette control fields. As policies exposed to polluted environments constantly emerged within global scope, ecological circumstance would become useful base of ensuring adoption feature during different stages of political period and successful extent of relevant policy formulation, which would facilitate the creation of international practical community in policy development aspect. [6] Fallin Amanda (2011), Sanders-Jackson (2020) et al. via investigating rural communities, uncovered touching passive smoking could result in cardiovascular disease, lung cancer, as well as lung illness, and smoke-free policy was the effective method of preventing contact of second hand smoking, and rural smoke-free policy required long-term supervision.[7,8] Tal Simons (2014) et al. found social cohesion of crucial communities was confronted with resistance of institutional stress by surveying active resistance to smoking in small pub of Netherlandish community. [9] Cheng Huang (2017) et al. deemed Chinese primary students' smoking experiment was still a severe issue, with interference aiming at youth, family and community, so as to make sure the implementation of no smoking policy. [10] Berg, CJ (2019) et al. discovered ENDS had appeared in America in the past decade with strong social media, with Twitter activities (Twitter article number) regarding ENDS positively linked to purchase behavior of consumers per month, negatively related to advertisement expenditure measures, and future social media (such as Twitter) was likely to supervise and/or interfere use offer platform of ENDS. [11] Leung Raymond (2010) et al. taking Philadelphia as an illustration, raised areas via elaborate planning and implementation were able to carry out outdoor smoke-free policy successfully, for the sake of reducing exposure of passive smoking and prompting no smoking criterions. [12] Seen from concern focuses of studies, carrying out smoke-free city needed to pay significant attention to undeveloped countries and developing countries, as well as urban and rural integration department. With urban public areas expanding to such as community rooms, considering teenagers as vital people group, ENDS as reducing stress way had been increasing so far, which was required to strengthen various management measures from family and community.

Renovation of Old Communities

Evolution: from large-scale demolition and construction to stock renewal and flexible utilization

Throughout China and abroad, the renovation of old communities has experienced the development process from demolition and reconstruction to regeneration, during which the policies, [13] regulations and technical practices of each region have their own characteristics, as shown in Fig. 3.

Fig. 3 Overview of renovation and evolution of old communities in China and abroad

Development: sustainable renewal of community units

(1) Community. Communities are the urban cells in which people live and work that American sociology has extended from Tonnies's sense of intimacy and unquestionable ties. In the 1970s, the United States proposed a social building model in Ward VII District of Washington, D.C., which mainly encouraged community residents to participate in the renewal and management of their living environment and changed the way of resource reuse through technical means such as community design, community technical assistance, neighborhood protection, community planning and development. Britain implemented the construction model of community building at No.1 Black Road, which was established in

1976 within the Royal Institute of Architects and built on the basis of self-construction with residents as the main body and multi-party cooperation, emphasizing rich methods and small-scale gradual progress. In the 1980s, Japan implemented a "district planning system" in daikanyama, which combines "street-building activities" with districts, with an average area size of 20-30 hectares, similar to residential quarters in China.[14,15] Since then, all kinds of research and practice have mostly concentrated on communities, while foreign research has mainly focused on land use, relevant policies, social infrastructure and models, hoping to continuously improve the economic, material, social and environmental conditions of the old city by formulating comprehensive and integral measures, [16] and technically inclined to adopt means such as intensive reconstruction, stock utilization and use conversion to upgrade the housing itself, environment and supporting facilities. Domestic research mostly focuses on the involvement and management of government, community, property and residents, and the importance of residents' participation and introduction of social capital, and technically inclined to structural reinforcement, elevator installation, old-age pension, energy-saving renovation and sponge city, among which the first four aspects account for more than 90%, involving the development of above-ground and underground spaces, the construction of intelligent living facilities, the division and distribution of new space functions and other technologies.[17,18] However, the research on sponging renovation to prevent waterlogging and improve water pollution accounts for only 2% and is limited to the pilot of one plan for one project. In the 21st century, community neighborhood scale is considered to be the most suitable for urban renewal and regeneration planning, just like the "les moulins" community in Switzerland. [19]

(2) Organic renewal-sustainability. In 1989, Wu Liangyong put forward the theory of "organic renewal" after the "residential renovation of Ju'er Hutong", arguing that from city to building, whole to part, they are organically related and fit each other; urban construction should follow and cater to the inherent order, laws and texture of the city, adopt appropriate scale, deal with the relationship in an appropriate way according to the content and requirements of renovation, seek the renewal and development of the city based on the concept of sustainable development, continuously improve the quality of urban planning and construction, and make the environment of the urban transformation area coordinate with the overall environment of the city. Since then, the theory has been further developed and applied. After Zhu Wenyi's Space• Symbol City: A Theory of Urban Design (1993), Fang Fang's Renewal of the Old City of Contemporary Beijing (2000) and Wan Yong's Harmonious Renewal of the Old City (2006) respectively discussed the characteristics and evolution law of urban space in China and the West, the theoretical research and policy framework of the organic renewal of the old city of Beijing, the experience reference and interaction mechanism and coordination mechanism of the old city renewal, the research on the renovation environment, supporting, guarantee and management of the old residential quarters based on the organic renewal increased sharply, mainly focusing on the physical renewal of buildings. However, due to the high complexity and far-reaching impact of urban renewal projects, the community environment and facilities, economic and cultural policies of various countries are different, and comprehensive redevelopment of material, socio-economic and environmental aspects in urban poor areas is involved. [20] In view of the importance of environmental resource conservation to the sustainable development of cities under the pressure of population growth, physical improvement of urban renewal needs to focus on relieving the local social pressure demand, taking into account the cultural elements of physical buildings, resource protection and environmental factors such as pollution prevention and control. [21] Design elements under resource saving and environmental factors have a significant contribution to the sustainability of urban reconstruction projects. [22] By carefully

designing and constructing good building environments, such as open and green spaces, designs and facilities for vulnerable groups, and measuring and improving community design with node-location-green model, 75% of energy use and greenhouse gas emissions can be reduced, which is crucial to improving the overall ecological efficiency of local communities and promoting sustainable development. [23] At the same time, due to the frequent urban waterlogging in many communities in China, which has seriously affected the safety of production, living and property of residents, the sponging renewal of old communities is being formed as a new way and is setting off a boom, which is highly satisfactory to the young people and requires attention to the relevant policies. [24]

Stormwater Management/Sponge City

Due to frequent waterlogging in cities, the emphasis of renovation of old communities is on the ground and underground stormwater pipe network. Foreign stormwater management entered the period of sustainable integrated management in the 1990s after experiencing the period of water quantity control and water quality control. At present, it has changed from a large-scale unified centralized management system to a small-scale system such as decentralized, networked and regionalized urban streets and communities,[25] upholding the concept of low-impact development, advocating the treatment of stormwater at its source and maintaining the hydrological characteristics unchanged before and after development through green infrastructur.[26] Related practice and research are earlier.[27] The sponge city advocated by China is also called "water-elastic city", which is collectively referred to as "low-impact development stormwater system construction",[27] referring to the city that can absorb, infiltrate, retain, store, purify, utilize and discharge 70% of stormwater like a sponge, and has good "elasticity" in adapting to environmental changes and coping with natural disasters. The ecological utilization and treatment of stormwater with modern significance in China began in 1980s and developed in 1990s. Especially after the concept of "sponge city" was first proposed in 2012, the research, planning, design and construction related to sponge city continued to advance, [28,29,30] and sponge city became the mode of stormwater management in China. Related research and practice are in the initial learning stage.

Top-level design

Policy orientation is the primary guarantee to promote stormwater management to sustainable ecological utilization system, which is manifested in the formation of systematic policies and regulations in developed countries, and the implementation of corresponding policies in sectoral pilot advocacy in China, as shown in Fig. 4.

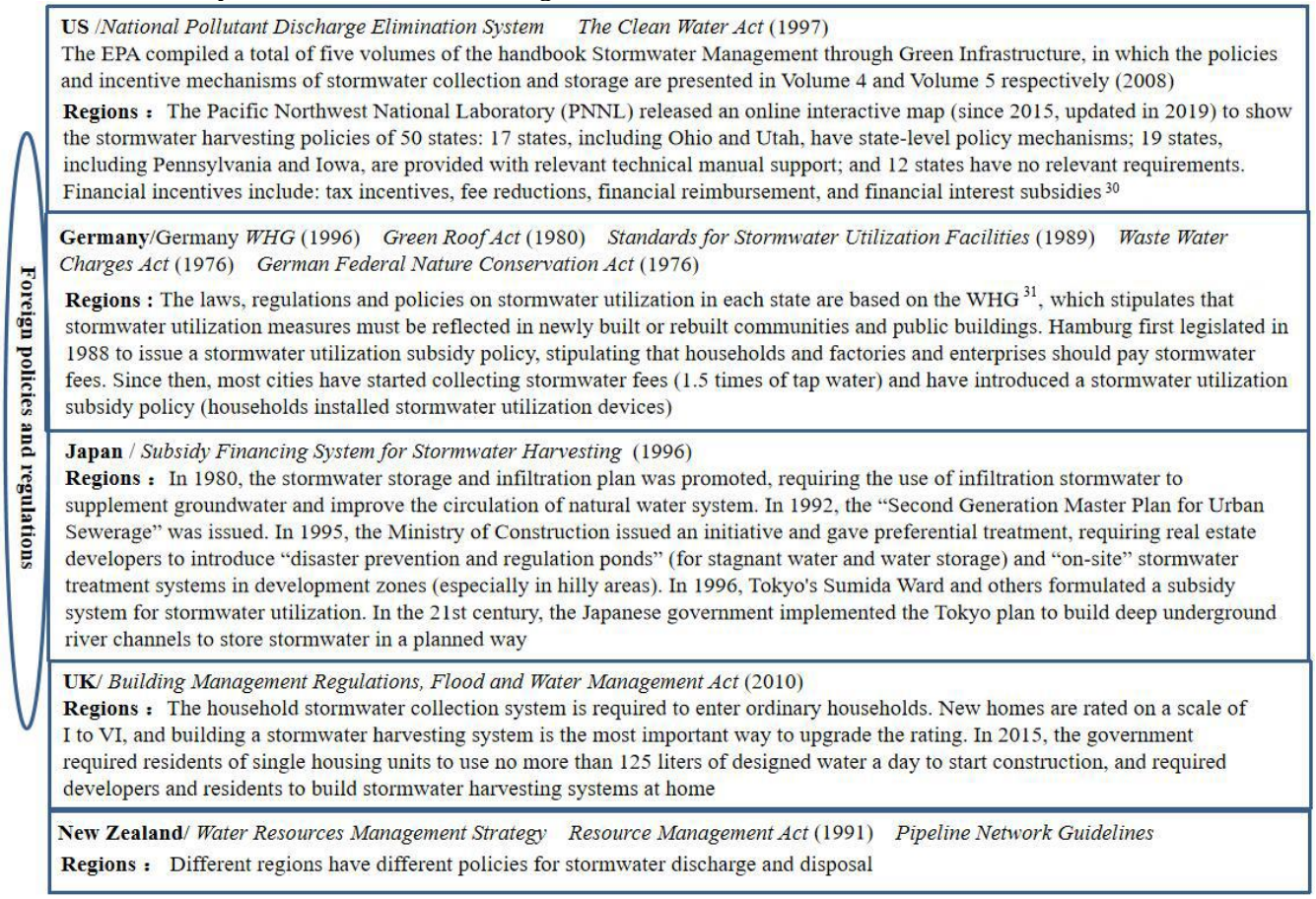

Fig. 4 Comparison of top-level design of stormwater management/sponge city in China and abroad

Technical support-low impact development system

Technical system is the support of project implementation. Most of the studies on stormwater management technologies based on the concept of low-impact development have been conducted since the 1950s, [31,32,33] with the United States, Britain, and Australia as the most representative ones. Japan and Germany also formed their own complete systems. See Fig. 5.

US/ LID: It was put forward in 2007, based on the U.S. best management practices (BMPs：Best Management Practices) strategy in 1972, which encountered bottlenecks such as too high implementation cost, too large scale and area, and focused on reducing pollution and reducing impact through small-scale runoff control, with low cost [33]. The design focuses on site design, hydrological analysis, technology utilization and pollution erosion research. Each state has its own design standards and specifications. **Representative cases:** Hoyt Community in Portland [34, 35]. High Point Community. Silver Lake Residential Reconstruction Project
UK/SUDS: It is a stormwater management system based on BMPs and LID of the United States, which is suitable for domestic development, focusing on water quantity, water quality, beautification of city appearance and biodiversity to maximize the benefits of surface runoff management. Design includes target determination, site analysis, planning and design, selection of appropriate design management measures, and supplement of scheme design details. The design standards are uniformly enforced throughout the country, and can be slightly modified with the approval of the government only in very special areas. **Representative cases:** Greendale Grange Avenue, Wisconsin. Ranhaneng Community, Malmö West, Sweden. Bethnal Green Alley, Derbyshire Street. Springhill Residential Development Project
AUS/WSUD: It integrates urban design planning with urban water cycle based on US LID and BMPs according to national conditions, and pays attention to the integration of water supply,sewage and stormwater management,and vegetation protection.Design includes target determination,site analysis and planning, design, selection of appropriate design management measures, schemes and value evaluation. **Representative cases:** Edinburgh Royal Water Garden. Victoria Park. Fig plot. Moonee Valley City Rain Garden. Aberfeldie Wetland Protection Park
JPN/RWPP: In 1980, the Rain Water Penetration Plan was implemented, which advocated the installation of landscape facilities for stormwater infiltration in newly built and rebuilt large public buildings, and promoted the recycling of stormwater. The design runs through stormwater collection, regulation, storage, purification and utilization. **Representative cases:** City of Sky. Sumida Ward City Hall, Tokyo
GER/ MRs: In the early 1990s, the "on-site treatment at source" of stormwater runoff was advocated, and an ecological stormwater management model of depression-infiltration canal system (MRs: Mulden Rigolen System) was formed. The design focuses on integrating urban landscape construction and deployment with stormwater landscape equipment and optimizing environmental improvement. **Representative cases:** Potsdam Commercial Square. Manheim Wallstadt Residential Quarter. Arkadien Winnenden Ecological Village
Main technical measures: storm water retention, water reservoir, sidewalk, biological depression, flat slope, green/blue roof, rain bucket, storm water garden, vegetation filter belt

Fig. 5 Overview of low-impact development technology system in developed countries

Research and practice trends

Since the concept of low-impact development technology was released in developed countries, relevant research in various countries focused on the value exploration and application model of this system. Through the optimization of various models such as computer simulation and genetic algorithm, the multi-stage low-impact technology development and construction in cities of the United States, New England, South Korea, Singapore, Poland, Iran and China's pilot sponge cities of Suzhou and Qingdao[34,35,36,37,38] shows that LID and other technologies integrate urban planning and design and adopt the "method of combining design with nature" to achieve the minimum urban development.[39] Thus, in order to solve the problems of rapid development of urbanization and environmental resources brought by population density, the application of low-impact stormwater planning must be increased.[40] However, the most difficult problem in practice is location selection and technology combination design to achieve optimal efficiency, so that the city is safe, sustainable and can adapt to climate change. Besides, due to the lack of design standards that can be accepted all over the world and the fact that most of the research practices are carried out in newly developed cities in the United States, Britain and Germany in cold climates, there are still challenges in Asian regions with very different climatic conditions and geographical locations. At the same time, all kinds of infrastructure have been laid on the ground or underground in Asia, especially in China's old communities with underdeveloped economy and technology, which makes the related practice more

complicated. In addition, local residents and stakeholders face challenges in terms of their understanding, trust and support of technology application, pre-practice research and forecast, site selection design and technical standards during implementation, post-implementation management and maintenance, especially the standard operation and maintenance plan manual for the implementation of relevant technologies in old communities, planning and design criteria, modeling and optimization, monitoring and performance methods at various stages in various regions,[41] how to apply and how to evaluate the potential of technology application through modeling, etc. Most of them are individual cases explored by scholars from various countries (see Fig. 6), and relevant in-depth research needs to be comprehensively promoted.

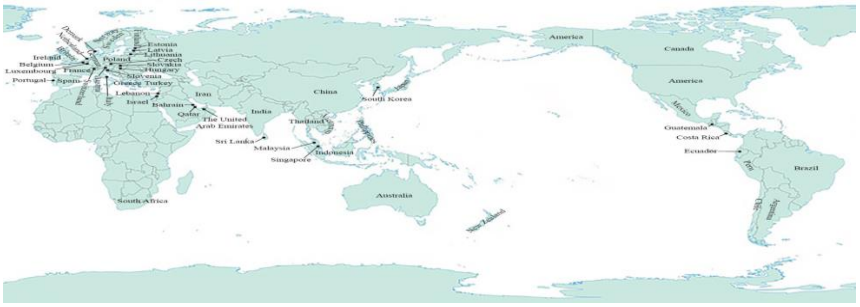

Fig. 6 Some countries in the world that practice research on sustainable water cycle landscaping

The research on rain and flood management model in China has been carried out since 2000 by the teams of Che Wu and Li Junqi, aiming at the problems of scouring and pollution caused by the initial rain, the reform and innovation of the urban rain and flood management system, the low-impact development and construction method, the effect of landscape[42] and equipment on rain and pollution reduction, the target area division of total runoff control, and others aspects in terms of stormwater disposal and management.[43] Subsequently, scholars such as Yu Kongjian and Li Dihua proposed the conceptual planning, design and construction of the sponge city on a case-by-case basis on the pattern and measures of rain and flood management in the construction of the sponge city,[44,45] and the Cao Lei team (2012) and the Xu Tao team (2014), so that the systematic layout of the source facilities can achieve the best effect of rain and flood control.[46] In recent years, there have been more and more case studies on sponge cities and stormwater management models in Chinese academic circles (see Fig. 7), but they are mainly focused on parks, river courses and newly-built areas.

Fig. 7 Distribution of research and practice on sponge city residential area construction in China

(Source: sorted out according to relevant research literature and open website. Among them, communities in China include newly built areas and old communities)

Research on Green Infrastructure Concept

Concept development

In the mid-1990s, the concept of Green Infrastructure (GI: Green Infrastructure) was formally put forward in the United States due to the re-understanding of land use and sustainable development. It clearly highlights the "life support" system of the natural environment and integrates community development into the organically linked green space network formed by nature,[47,48] artificial elements and various open spaces to reduce habitat fragmentation. Concept development is mainly based on the United States and Canada, which can be used for reference by other countries. See Table 1.

Table 1
Development of Green Infrastructure Concept

Time	Summary
1999.5 1999	The President's Council on Sustainable Development of the United States pointed out in Towards a Sustainable America —— Advancing Prosperity, Opportunity, and a Healthy Environment for the21st Century that GI, as one of the important strategies for sustainable development of the community, actively seeks to understand and balance the ecosystem and protect the ecosystem.[49]
2001	According to Mark A. Benedict and Edward T. McMahon of the United States, GI is a network of natural processes composed of many different elements and interacting with each other
2004	Mark A. Benedict, Will Allen, Ed T. McMahon proposed in Advancing Strategic Conservation in the Commonwealth of Virginia that GI, as one of the environmental protection strategies, is a green space network formed through the interaction of different elements and spaces in order to explore and manage the value of its natural resources or the joint interests of mankind. It also represents the strategic protection process of different regions for the land protection system.
2004	Sebastian Moffatt of Canada pointed out in A Guide to Green Infrastructure for Canadian Cities that green infrastructure is mainly developed and constructed in an ecological way, [50] to solve the problems encountered in the construction and development process. At the same time, the design process should be regarded as a system, models for the use of energy and material flows should be added, and appropriate dimensions and spaces for the site should be planned and designed.
2005	In Green Infrastructure for Sustainable Communities, Jane Heaton Associates of Britain pointed out that GI, as a multifunctional green space network, has made great contributions to sustainable and high-quality environment, casting a balance between land protection and development, thus providing a land protection and use structure for reference by the public, private and non-profit groups.
2006	The North West Green Infrastructure Think-Tank put forward that GI is a system composed of natural environment and green space, which has five characteristics: typology, functionality, context, scale and connectivity.

Research and practice trends

After the GI concept was put forward, the academic vision shifted from the initial discussion of the concept, planning principles and methods of GI to the research and development of quantitative model application in various special fields, and finally based on the research on the benefit evaluation and comprehensive management of urban risk resilience to a multidisciplinary and multifunctional ecosystem service model (see Fig. 8), [51] recognizing that GI is the lower foundation on which the community relies for sustainable development and is crucial to the sustainable development of the community. GI should follow the principles of integration, connectivity, comprehensiveness, strategy and functionality in design and application. The quantitative study on Singapore, Berlin, Philadelphia, Melbourne, Sino-Singapore Tianjin Eco-cities using the evaluation model has confirmed that GI has a very significant

regulatory function in special areas such as urban stormwater, heat island, and biodiversity.[52] GI projects of all sizes for urban communities should work in many ways.[53] Since landscape fragmentation is not conducive to social and economic integration of man and nature,[54] treating landscape as an integrated ecosystem contributes to the creation of GI. It is necessary for designers to determine the degree of random interference that a specific landscape or city may face, and fully consider redundancy, modularity, (biological and social) diversity, multi-scale network and adaptive planning and design,[55] in order to enhance the resilience of the city and promote sustainable development. However, GI intersects with sociology, economics and other disciplines, and its practical application involves multi-level and multi-interest groups. How to control the maximum cost effect to meet the multi-functional needs requires GI to change from general consensus to design policy and from general assumption to local evaluation,[56] so as to establish a sound and reliable research model. The more GI is promoted in densely populated urban areas, the more it is necessary to evaluate the ecological, economic and social environmental systems in collaboration with relevant departments, establish multi-functional standards, carry out multi-functional design and management, and control different spatial scale designs.[57] Consciously incorporating local biodiversity, planning and designing green (and blue) spaces in the landscape can help build resilient and sustainable communities.[58] Germany's application in GI stormwater management has proved that landscape planning enables the government to formulate a comprehensive coverage strategy to achieve multiple benefits at the local and regional levels. The transition to a mixture of grey and green infrastructure requires a quantifiable long-term goal and a set of incentives and support policies.[59] By motivating citizens to participate in stormwater management, it can play an important role in contributing to a more comprehensive sustainable system.[60] Germany's German Federal Nature Conservation Act and "rainwaterbis/rw", the EPA provides owners with free inspection services for stormwater management facilities, and Emschergenossenschaft conducts public outreach activities in the form of brochures and distributed rainstorm water management handbooks[58] state that family residents should be arranged to adopt the GI method along the urban-rural gradient, across the biophysical and landscape, and in accordance with different norms and systems. [61]

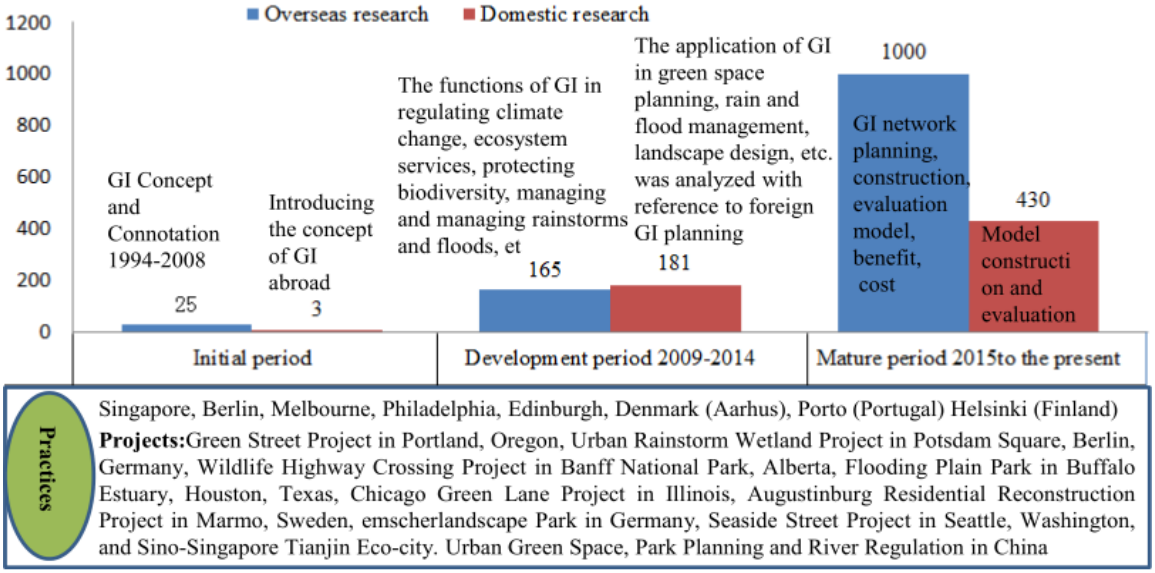

Fig. 8 Overview of GI research and practice at home and abroad

(Source: collated according to references)

Research trends

How to use GI to integrate environmental and social, economic, cultural and aesthetic functions in the limited space of compact cities to serve all the functions of cities and provide multi-dimensional ecosystem services is a high demand because of the enhanced functions that cities are required to carry due to their dense population and abnormally intensified climate. The quantitative evaluation of the standards, functions and benefits of various dimensions, such as GI supply, regulation and support services, integrates the urban context, community history and poverty assistance, and needs to be further studied. The control of design scale details is easily overlooked by many planners, such as spatial assessment, strategic planning, site design, and residents' acceptance. The urban landscape facing growth in the future needs to seize opportunities and technologies, and consider balancing resource consumption and minimizing environmental impact when designingi. The application involves the functional management of GI (water management, ecosystem services, biodiversity), stakeholder management (government, designers, developers, residents), and political, economic, social, cultural, geographical and other factors related to communities in various countries and regions, so it is necessary to scientifically evaluate and study the strategies of each department. For example, in 2020, Kuo-Wei Hsu and Jen-Chih Chao, based on the urban renewal of Taichung City in Taiwan Province, proposed to integrate the concept of green infrastructure in an economic way.[62] The application of GI by mainland Chinese scholars focuses on river regulation and landscape design, including GI planning, application and plant selection under the vision of sponge city.

Research on Sponging Renovation of Old Communities Based on Urban Renovation and Ecological Restoration

Urban renovation and ecological restoration[63] refers to repairing damaged and old parts of the city to renovate them, and restoring the damaged ecological system in the city by artificial means to refresh the damaged ecological parts, thus creating an excellent urban living environment. At present, there are only a few research articles on the design of sponging renovation of old communities in China based on the urban double repair, which are limited to the case analysis of the cause of the problem and the technical measures[64,65], as shown in Fig. 9.

Issues concerning sponging renovation of old communities	**Difficulties:** the complex site, mixed rain and sewage, chaotic pipelines, large population and building density, insufficient renovation space and lack of supporting facilities[64]; complex subjects, especially land use with mixed functions and less available space; many restrictive factors in renovation and great difficulty in construction; limited renovation time and capital[65] **Design issues:** Emphasis on the upper level indicators but lack the background conditions (the conventional sponging renovation of old buildings is designed based on the newly-built sponge indicators, and the sponge facilities are not effectively integrated with the old renovation); emphasis on the solution of water-related problems and lack of coordination of various problems (lack of integration of water, landscape and human settlement activities beyond water-related technologies); emphasis on single function and lack of integration and refinement; emphasis on early stage display effect and lack of convenience for later operation and maintenance **Construction technique:** Poor organization participation, lack of successful cases and mature technologies
Technologies for design of sponging renovation of old communities	**Renovation ideas:** people-oriented, sponge element+ engineering technology+ landscape element **Renovation mechanism:** "Sponge+", "Design-", experience-based practice, and training-based construction, balancing[66] **Design principles:** overall layout, local adaptation, classified policies, applicable technology, convenience for the people, innovation and optimization, minimum impact, safety first, economy and efficiency, and ecological priority **Design strategy:** based on the classification of the old residential quarters, such as residents' wishes for renovation, amount of renovation funds, greening rate of underlying surface, environmental sanitation conditions, status of outdoor drainage system and development intensity of underground space, the design is divided into basic type, upgrading type and comprehensive type, changing from a simple "menu type" plan to an accurate plan of "basic menu+ characteristic menu"[67] **Technical measures:** model analysis, waterlogging characteristics and drainage evaluation, optimal layout test and network system, "grey +green+ blue" combination, transition from single technology to "sinking green space+ permeable pavement +stormwater storage"[68, 69, 70, 71]
Cases: Dormitory of Shandong Economic and Technological Development. Center and No.11 Courtyard of Qianfoshan South Road. Huangshui Garden in Xining. Gudong Community in Hangzhou. Old communities in Zhenjiang	

Fig. 9 Research trends of sponging renovation of old communities in China

MEASURES

Technology

The accuracy of technology such as selection and configureuration, model analysis and so on is positively correlated with implementation efficiency. The sponge renovation technology of the old communities is very crucial due to the geographic, climate, population and economic factors of China. At present, although China's spongy city technology system has been initially established and pilot cities are provided with guidance manuals, they are relatively extensive and lack precise treatment. Especially, the spongy renovation of old communities is carried out in individual pilot projects, the accuracy needs to be improves in combination with the actual situation with reference to the practice in Germany and other countries. First is the comparative study of each model technology[66]. The United States, Britain, Germany and Japan have all formed their own system models and instruction manuals based on LID. The data standard, simulation demonstration, technical requirements, implementation validity, etc. of each model technology need long-term and stable exercises and comparisons by various cross-field project teams to form sustainable technical standards at all levels in combination with the climate, soil, hydrology, economy and community environment of various places[67,68]. Second are special technical monitoring and tracking. Because Germany's series of technologies and equipment for stormwater collection, sewage interception, storage, filtration and recycling control have reached the world's leading level, and a complete product industry chain has been formed, China needs to learn from them, and carry out fixed-point and long-term accurate monitoring on the product chain of various special technologies such as building materials and facility performance, track the effect, and promptly investigate any abnormality. Thirdly is establishing a site comparison model. The site models of each catchment area and sub-catchment area need to be compared with the computer test, and the hydrology, meteorology, and soil should be calculated in real time and compared with the

adjustment prediction model, so as to reduce the risk of unsatisfactory effect of indigestion facilities and achieve the best simulation state. Fourth is refinement of technical standards. In view of the large difference in slope and climate in different parts of China, it is necessary to classify and work out detailed technical standards on how to integrate stormwater reuse and recycling system with landscaping technology, including point selection technology, model analysis and facility indexes, in combination with experimental results, simulation reports and demonstration results. Fifth is optimization of technology implementation[69,70,71]. With reference to the intensity, economy, resources and environment of the old residential area, the peak value of stormwater runoff, pollution control and related treatment effects are predicted and checked, and the appropriate points-regional division-technical combination-facility installation-maintenance management and other details in each link need to be implemented accurately so as to ensure that the optimal technical means are matched with the optimal implementation benefit.[72,73,74,75] See Fig.10.

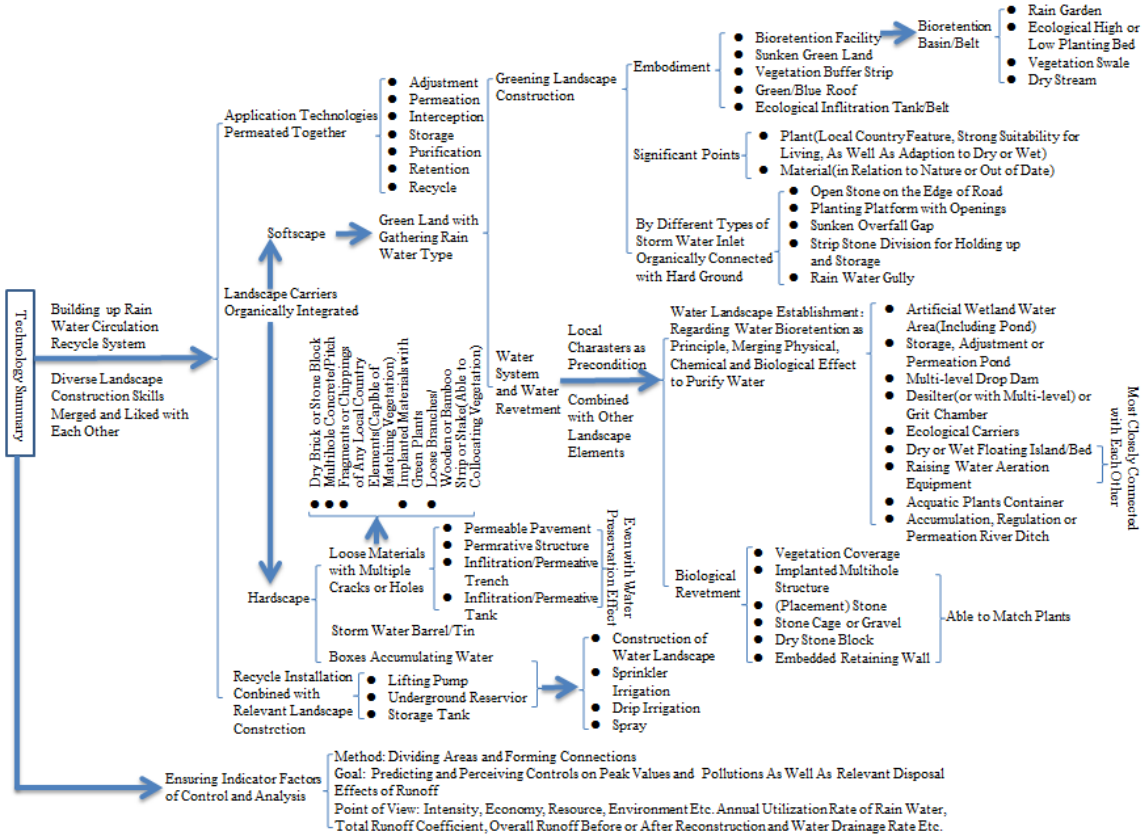

Fig. 10 Overview of sponging renovation design technology for old communities

Design

As the sponging renovation of old communities is a cross-system project involving multiple disciplines, levels and departments, its design is more like a dance with chains, and the safety, convenience, comfort, diversity and sharing must be fully considered in light of the actual situation of the old communities. Through the sponge technology landscaping design, the broken ecological system can be repaired to prevent rain and flood pollution to the maximum extent. It should be suitable for industry and centered with the characteristics of business, culture, tourism and education. The distribution form, composition style, terrain metaphor and plot environment composition of the sponge landscaping incorporate different landscaping elements with different

styles to meet the multiple needs of residents, investors, government, etc. See Fig. 10. It is possible to set up a joint office for sponging renovation, including the combination of government, industry, research and application, and relevant departments, with research group, design group, coordination group, security group, etc., and establish a liaison system for community planning designers. At the early stage of the design, the relevant management departments, the old community management Committee, the re-constructor and the community representatives shall be included in the development and design. At the same time of promoting the technical publicity of the sponging renovation, relevant opinions on the original pipe network and the division of water catchment areas of the old community shall be listened to, so as to lay a solid foundation for the design of the source, process and terminal control system of stormwater. In the design, people from various disciplines including municipal engineering, environmental engineering, architecture, planning, landscape and other disciplines shall be included in the team, aiming to achieve the best coordination between site selection design and model analysis, including green and grey infrastructure, the coupling of above-ground and underground, landscape and function, the connection of mountain forest water system, soft and hard landscape, different blocks, and the division of functional areas, artistic conception space, nodes and traffic. The coordination team shall include personnel with working background of policies and engineering construction, and strive to closely cooperate with the design intent and technology implementation, and make seamless connection more scientific. The security team is undertaken by the property management of the subdistrict, and is responsible for the management and maintenance after the completion of the project, so as to find out the relevant problems after the implementation and ensure the fastest way to solve them. Community planners shall participate in the whole process from investigation to final implementation and maintenance.[76,77,78] See Fig.11.

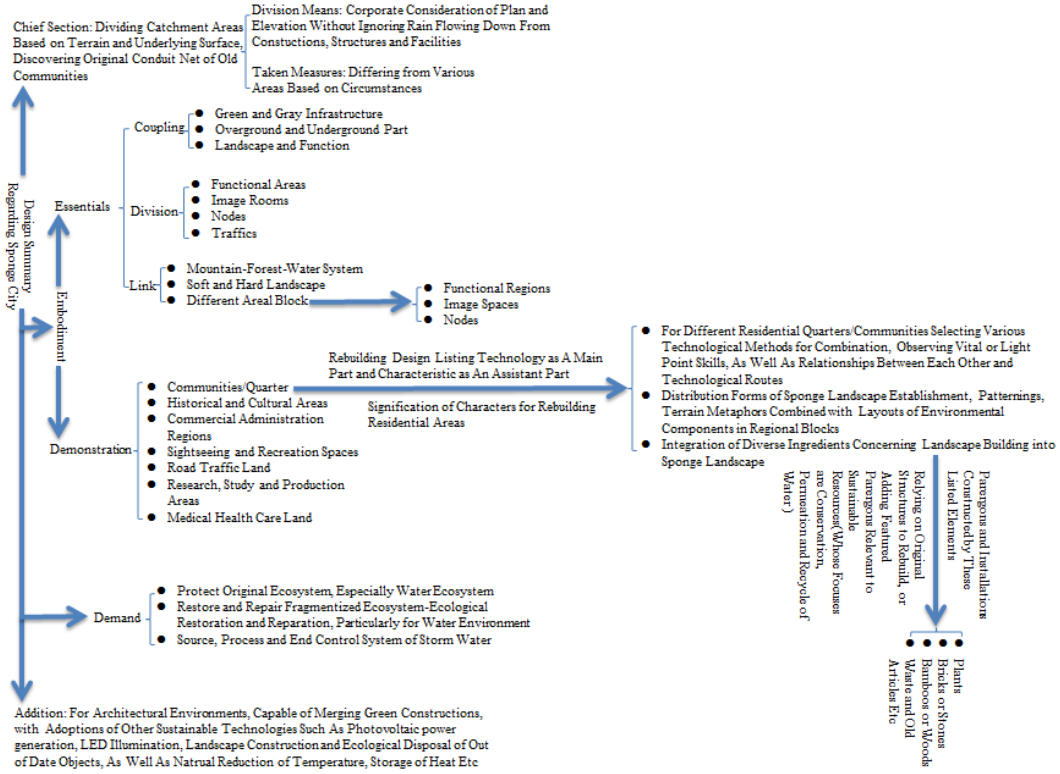

Fig. 11 Overview of sponging renovation design for old communities

Laws and Regulations

Laws and regulations are the strong support for the sponging renovation and determine the spread of advanced ideas. In developed countries such as Germany, the United States and Britain, various systems and interlinked laws and regulations have been formed to maximize the promotion of sustainable utilization and protection of urban resources. In China's existing sponge city construction, guidance documents such as opinions and measures are issued, with low legal level, so it is necessary to establish and improve relevant laws and regulations for supporting sponge city construction from national to local. At the national level, efforts should be made to integrate various laws and regulations, incorporate relevant indicators such as smart cities and rainwater collection and utilization into relevant laws and regulations, put forward a set of stormwater utilization and disposal plans for new and old communities in different regions and under different conditions, and formulate relevant rules and regulations and incentive mechanisms for the implementation of sponge city construction, so as to provide suggestions and reference for sponging renovation design in various regions. At the local level, relevant local departments should refine the sponging indicators of old communities, establish a suitable hydrological control index system and perfect flood risk assessment system, and formulate different risk assessment reports and flood risk maps for different river basins, so as to guide the construction of sponge cities. Besides, appropriate emission standards and charging systems should also be formulated according to the ecological environment, social and economic conditions, and the current situation of water resources. In addition, drawing lessons from Germany, the management standard of stormwater utilization fees for classified drainage and sewage discharge in residential areas, commerce, industry and schools should be established, and departments, units and families that use rainwater recovery and have good implementation results should be rewarded. Moreover, according to the needs, a series of industry technical standards and specifications, such as various system specifications for sponging renovation design, urban blue-green line management measures, sponge city design maps and plant lists, should be introduced to guide the application and implementation of grassroots communities.

Wisdom

Modern information technologies such as big data and logistics network have brought bright spots of wisdom to the renovation of the residential quarters. However, the real great wisdom design is to transform the original living environment and reconstruct and optimize the functions in combination with the sustainable utilization of the future society, so as to incite the development of urban economy. In Germany, rainwater utilization, landscape design, solar energy and wind energy are combined according to the size and characteristics of the community to maximize the harmony between society, habitat and nature. [31] Therefore, the technical concept of design must have forward-looking wisdom. Sponge landscaping technology+ other sustainable technologies, such as building environment+green buildings, and sustainable energy-saving technologies such as photovoltaic power generation, LED lighting, waste landscaping and ecological treatment and natural cooling are adopted to achieve the unity of technology and artistry. At the same time, the design specifications and standards must be organically integrated in combination with the latest technical specifications from all walks of life. For example, in combination with the Intelligent Technical Requirements for Energy-saving Renovation of Existing Buildings and Technical Regulations for Intelligent Renovation of Residential Areas, various new technologies and materials such as sponge renovation and green technical facilities should be incorporated into the design, construction, acceptance and operation and maintenance of intelligent renovation projects of residential buildings to improve the intelligent implementation. Third, the wisdom function should be considered in combination with the community residents' needs for public services such as

economy, employment, parking for the elderly and epidemic prevention, and rooftop gardens, water features, and infiltration should be conducive to anomaly observation and sustainable management and maintenance. In a word, the renovation of the old communities is the restoration, improvement and upgrading on the basis of the old facilities and environment, with the goal of promoting the improvement of the habitat through the sponge concept and technology. The intelligent concept and intelligent technology must be utilized to the maximum extent with low impact. Therefore, the renovation design should be based on the community, with an eye to the sustainable development of the environment, economy, society and culture, leaving redundancy for the future wisdom upgrade, and constructing a large ecological and sponge with vertical and horizontal communication, such as legal system chain, planning chain, design chain, technology chain, application chain, management chain and service chain. People should make use of nature while respecting nature, i.e. change the concept of rainwater discharge and sewage treatment to improve water quantity, water quality and habitat, form an organic cycle of resources, and upgrade the renovation design of old communities to integrate with the development of new community infrastructure and the new consumption concept of residents[78,79].

Data

The data source is the joint of the sponging renovation technology model. Due to the incomplete information of old communities, scattered data and lack of standard system, the breadth of collection seriously affects the model analysis and disaster preparedness plan under abnormal climate. Therefore, it is urgent to establish and improve the sponge city monitoring platform by referring to the German hydrological information management system, collect and sort out all kinds of data resources in a standardized and detailed way, and establish data standard codes and data trees based on the platform. First is basic database and sharing. Special sorting out should be carried out for various types of old housing before the year 2000, relevant land climate and hydrological data should be mined, basic data atlas for old communities should be formed, meteorological, hydraulic and environmental monitoring databases from national to provincial, municipal to district, county to township should be improved, and standards for classified storage, classification, sharing and coordination should be established. Second is the risk management chart. The special tracking simulation data of scientific research institutes in colleges and universities should be summarized in time, and the abnormal climate, hydrology and soil risk warning chart should be established. Third is design picture. All kinds of planning drawings and design drawings should be collected, sorted out and archived electronically and in a standardized way. Reference and comparison should be made in a timely manner to establish a design effect tracking map. Fourth is construction picture. The construction technology, product standards and procedures should be standardized. Fifth is supervision plan. Technical specifications and indicators of sponge renovation in residential areas are required to be supervised in conjunction with expert committees, review of design drawings and construction drawings, inspection of construction materials, and acceptance of municipal completion. Sixth is talent pool. Talent pool of various disciplines and echelons should be established to link projects, people and jobs, and record credit ability through big data. Only when the inter-disciplinary talents who are familiar with the regional characteristics of sponging renovation design and the integration of extensive data resource models and design the solutions and flexible management system for extreme weather emergencies beyond planning can the urban disasters be effectively dealt with, the community cells be activated optimally and the urban maximum development be promoted.

Integration of No Smoking

For political level, stand at great healthy and ecological tactic, impel completion of legislation and policy relevant to smoke-free city construction, enhance motivational power of

smoke-free communities, smoke-free parks. For technical level, take examples of national research domains on smog control such as Britain, France, Germany, Japan, America, Australia etc, list sustainable smog system design and preventing fire safety, preventing flood installation in proposing design and reconstruction in renovation of communities, complete preventing fire alarm system supervision mechanism with smog of family and community interaction, perform evaluation standard for existing constructions of green sustainable building completion system about daylight, water consumption, waste management, smog management and so on. For design level, equip smoke-free supervision points, smoking rooms and other elements with urban scene, internet bar, café, cinema and other regions with dense population, prompt to monitor electronic cigarette. For publicizing level, add publicity regarding smoke harm and epidemic precaution to community rest spots, as well as no smoking monitor team for elder people in communities, strengthen supervision on teenagers smoking, perform alternative controlling smoke persuasion. For overall planning level, list none waste city, smoke-free city and other constructive principles in related planning, complete overground and underground, controlling smoke and preventing flood and other correlation of sustainable healthy and ecological permanent system in communities.[80,81]

CONCLUSION

Sponge city is an ecological, low-cost, high-efficiency "elastic" renovation management concept, which can not only realize the effective management of stormwater, solve the problems of waterlogging and stormwater runoff pollution, but also enrich the landscape diversity inside the community, at the same time, it is more conducive to improving the living environment of the old communities and exerting multiple functions such as leisure and entertainment, education and popular science. However, China is still in the stage of basic development in various aspects, and it is necessary to speed up the overall promotion in combination with the actual situation after reference, in order to achieve sustainable development.

Conflicts of Interest Disclosure Statement

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