

Research on the Development Experience of Resilient Cities in Guangdong Hong Kong Macao Greater Bay Area Take Zhuhai as an Example

Junzhang Chen^{1*}, Yile Chen², Liang Zheng³

¹City University of Macau

^{2,3}Macau University of Science and Technology

ABSTRACT: With the continuous construction of urbanization, climate change, crowd concentration, disasters and risks and other factors have led to the continuous exposure of urban vulnerability, so the issue of urban safety and urban resilience has become an unavoidable issue in urban planning and construction in today's society. Zhuhai, located in the southwest of the Pearl River Delta, is an important node city in the Guangdong-Hong Kong-Macao Greater Bay Area, and in recent years, the flood disasters caused by extreme climate have adversely affected Zhuhai's economic development and social level. Based on the concept and meaning of resilient city, this study summarizes the relevant experience of resilient cities in China, analyzes the difference between disaster prevention planning and traditional planning from the perspective of resilient city planning, technical means and ideas, and studies on the governance of the current planning status of resilient cities in China, and discusses the resilience assessment of urban disasters in Zhuhai under the support of the resilient city theory based on the Zhuhai sponge city drainage special planning project, and from the urban disaster prevention and mitigation policies and disaster relief. The three aspects of climate adaptation planning technology and the construction of Zhuhai Community Disaster Prevention Park put forward corresponding countermeasures conducive to zhuhai's economic development and people's living standards improvement, enhance urban resilience, and at the same time adopt regional innovation methods, learn from the relevant treatment methods and methods of disaster prevention and mitigation and relief planning under the concept of Shenzhen Resilient City, and provide reference value for Zhuhai's resilient urban planning research and even for the resilience development of typical coastal cities.

Keywords: Resilient city, Guangdong-Hong Kong-Macao Greater Bay Area, Local conditions, Zhuhai City, Urban safety

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*Corresponding Author: u19091105192@cityu.mo

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INTRODUCTION

Resilient city is an important direction of urban development in the future. The concept of resilient city was first put forward at the 2012 low-carbon city and regional development science and Technology Forum: it refers to that a city is like a piece of water absorption toughness. In rainy weather, it can absorb water and store it, so as to reduce the disasters brought by rainstorms to the city; When necessary, the stored water can be released, so as to realize the goal of free shuttle of rainwater in the city, and then achieve the purpose of purifying the city and protecting the ecosystem function of the city. The construction and development of resilient cities complement and are inseparable from the landscape design of the whole city. It is necessary to give full play to the slow storage and release of rainwater by the ecosystem of buildings, roads, green spaces and water systems in the city, and integrate them into the construction of urban resilience, so as to better serve the city and improve the quality of the city.

In subsequent meetings and official documents, such as the central urbanization work conference in 2013, the central urban work conference in 2015, the national comprehensive disaster prevention plan (2016-2020) in 2016, and the 13th five year plan for scientific and technological innovation and special planning for public safety in 2017, the development requirements for optimizing urban drainage, water storage, disaster relief and mitigation, and urban safety have been mentioned. With the rapid development of cities, China's economic level is also growing. At the same time, it is also facing the problems of lack of urban water resources, waterlogging and environmental pollution. Zhuhai, a typical coastal city located in the Great Bay area of Guangdong, Hong Kong and Macao, has also suffered from many typhoons in recent years, and serious floods have occurred in the city. According to the statistical data of Zhuhai three prevention department, there are 54 water immersion points in Zhuhai City. The deepest water immersion point is in the existing historical ancient villages to be renovated in Zhuhai, and the deepest water immersion area has reached the peak of 1.7m. In view of the current situation, Zhuhai clearly pointed out in the special plan for a resilient city in Zhuhai (2015-2020) released in October 2016 that as a core city located on the West Bank of the Pearl River Estuary, Zhuhai has obvious regional advantages, developed water systems, rich regional precipitation, high groundwater level, large soil moisture content, high bearing capacity, and rapid evaporation. In terms of green space area, the per capita green space area is in the forefront of the country. There are many islands, which have rich tourism resources, providing a good hydrological foundation for the construction of resilient cities. Therefore, the construction of resilient cities should start with landscape design. Not only the landscape design is developing in the direction of greening, but also the design of the building itself should be green. In the comprehensive evaluation system of resilient cities in Zhuhai, the transformation and upgrading of the industrial development of residential areas to achieve resilience and greening is the main direction of the construction of resilient cities at this stage.

THEORETICAL REVIEW

Review of dynamic literature on the construction of domestic resilient cities

The term "toughness" first appeared in the 1970s. Its original meaning is to restore to the original state after damage. Professor Hollin of ecology proposed the concept of toughness in his 1973 book "resilience and stability of ecological systems". Therefore, the ability to resist, absorb and recover is the main feature of wayward system. In the existing research, resilient cities have the cognition of three directions. When disasters come, the urban system has the ability to absorb disasters but will not be damaged by disasters, and has the ability to recover itself. At the same time, it has the ability to resist, gradually produce resistance, and resist more serious disasters in the future.

The creation of resilient cities has attracted the attention of scholars. For example, the representative Micheletti and David R. goldschalke proposed that the primary goal of urban disaster reduction is to create resilient cities, which have the ability of self-regulation, slow recovery and gradually adapt to the impact of disasters on cities without the need for external human assistance. [13] However, scholars such as Moore, goldschalke, milletti, bitley and burby believe that cities, as a complex complex, need to have the thinking of sustainable development in the face of huge risks of disasters, and it is very necessary to establish a sustainable disaster reduction and prevention system, especially to build resilient model communities, through urban planning and construction supervision departments, Emergency Management Bureau, community hospitals Schools and community institutions for disaster reduction and prevention to deal with natural disasters.

On the other hand, domestic scholars respectively stated that the concept of synergy should be adopted in the governance of resilient cities, that is, the participation of the government should be guided by the relevant policies issued by the government to guide the flood disaster, how the city discharges pollutants, and how to deal with and manage the risks of the city by setting up evaluation indicators. The evaluation methods include economic, community and Organizational Resilience. At the same time, we should also determine the location of the city in the outer space of urban toughness, scientifically analyze and calculate the areas that are not suitable for development, skillfully avoid, renovate and repair the river system in the surrounding areas of the city, and enhance the safety and disaster prevention functions of water storage and flood control of the city.

To sum up, the above scholars have the following common points about the discussion direction of resilient cities: ① the overall system of resilient cities has good self-healing ability and organizational ability, and can adapt to sudden disasters; ② The resilient urban system has diversity, which can well adapt to different types of disasters, and the social ecosystem is diversified; ③ Resilient cities have a good reserve capacity, which is mainly reflected in the pressure resistance of urban infrastructure construction in disasters, providing a good guarantee for social people and cities to resist disasters.

The research on domestic resilient cities is in its infancy. Chengdu, Shenzhen, Deyang and Huangshi carry out the construction of resilient cities under the relevant policy background, mainly focusing on the governance from the perspective of synergy, that is, the decentralization and checks and balances of the government, enterprise institutions and the people, formulate policies and regulations according to local conditions, and ensure the stability and flexibility of resilient cities through supervision and control.

Table 1. Comparison of theoretical background of Chengdu, Shenzhen, Deyang and Huangshi resilient cities

City	Theoretical background	Practical experience
Chengdu, Sichuan	In August, 2011, the Second World Forum on urban scientific development and the first mayors' summit on disaster prevention and mitigation were held. The Chengdu action Declaration on "ten major indicator systems" to make cities more resilient and the action plan for sustainable urban development were adopted. Chengdu action declaration.	Organize public awareness publicity and education activities, strengthen disaster and emergency management at the urban level, and coordinate stakeholders and citizen groups.
Shenzhen, Guangdong	The overall urban planning of Shenzhen Special Economic Zone (1986-2000), (1996-2010), (2010-2020).	Formed a good relationship of coordination and checks and balances, and realized toughness planning, interval control and dynamic organization.
Deyang, Sichuan	The main challenges are the threat of floods and seismicity, economic transformation, floods and landslides, and environmental pollution.	Promote the construction of ecological civilization and establish a solid Implement the penalty system for excessive water quality in key river basins and establish a cooperative mechanism for the protection of drinking water sources in cross regional cities.
Huangshi, Hubei	In the urban and rural master plan of "two towns and one district", the design concept of low impact is used to reduce the overexploitation of the natural environment; Declare the national "sponge city".	Take the construction of ecological resilience as a breakthrough in building resilient cities, and communicate with cities that have done a good job in building resilient cities around the world.

Source: the author collated according to literature [12].

METHODOLOGY

The overall development level of Zhuhai's resilience construction is at the forefront of the country. At present, Jinwan District, Doumen District, Hengqin new area, high tech Zone and western special economic zone have issued relevant policy documents for the development of resilient cities in various districts, providing good policy support and legal guarantee for the construction and development of Zhuhai's ecological environment.

RESULTS and DISCUSSION

Case study on the construction of a resilient city in Zhuhai

1. Airport East Road

In the engineering construction of the greening and beautification improvement and reconstruction project of Zhuhai Airport East Road, the pavement form with permeable function is first set (Figure 1-2), and the road is divided into red and green roads according to the color, which are waterfront non motorized lanes and greenways respectively. The gel material is transformed by using the nano material treated by special process, so that it has high absorption, water permeability, high strength and the functions of impermeability, antifreeze, friction resistance and chemical corrosion resistance. The rainwater can be preliminarily evolved, and nano materials can be added at the same time, which can not only improve the wear resistance function of the road, but also reduce automobile exhaust and improve air quality. Then set a sunken green landscape with a depth of 100-200mm to make the landscape three-dimensional. Overflow openings are set in the internal area of the green space to reasonably ensure the runoff and overflow accumulation efficiency of rainwater in ordinary rainy weather. In case of severe rainstorm caused by typhoon weather, it can be drained to the reservoir through the internal overflow pipeline or directly discharged to the municipal pipeline, effectively reducing the intensity of drainage and reducing the risk of ponding to the airport. At the same time, grass ditches are set on the lawn, which can adjust, collect, transport and discharge rainwater when heavy rain comes, purify the rainwater, and use the treatment method of height difference to form a sunken landscape. It can not only create a harmonious atmosphere and meet the viewing needs of residents in Jinwan area, but also in the sunken landscape, from the structural point of view, it is divided into water storage, coverage and gravel layer from top to bottom, which can collect and absorb rainwater and avoid the harm caused by rain and flood. When the weather is hot, the stored water can be released to soak the plants. Finally, the artificial rainwater wetland is set up to purify the rainwater by using the means of artificial physics, the adsorption of aquatic plants and the respiration of microorganisms, which can adsorb, absorb, transform and filter the polluted substances. At the same time, it can beautify the environment and make Jinwan citizens who come for a walk feel comfortable. In summer, the lake can adjust the temperature of the surrounding area to better adapt to the weather in Zhuhai.



Figure 1. green space next to permeable pavement of Zhuhai Airport East Road

Source: official account of "resilient city"



Figure 2. Zhuhai Airport East Road Roadside greening improvement project

Source: Zhujiang Evening News

2. Xiangyang Village

In the design of residential area planning, Xiangyang Village (Figure 3), which is the pilot area of Hengqin New Area as a resilient city in 2018, has a wet pond in the middle. At this stage, the main Village Road on the north side of the wet pond has been paved with asphalt, and a rainwater garden, parking lot, grass planting ditch and green buffer belt have been set on one side of the road. Every few meters of the road, openings of several centimeters in length are set for rainwater drainage in rainy days. After being discharged, the rainwater can flow downstream to the area of greening facilities and be discharged into the ecological wet pond through the buffer zone. Under the guidance of relevant theories of resilient cities and green ecology, comprehensive regulation is carried out to realize the diversion of rain and sewage, improve residents' satisfaction, provide a force for the development of resilient cities, and then improve the overall quality of Xiangyang village. Another garden project in Jinwan District, "AVIC Garden Phase II" (Figure 4), the internal site is mostly agricultural cultivated land, which has been filled up at this stage. The project focuses on the source control of rainwater in rainy days, and adopts the form of permeable concrete and permeable brick pavement inside the site, so as to effectively extend the runoff time of the road to rainwater, reduce the substances polluted by rainwater runoff, and then reduce the pressure on municipal pipeline drainage.



Figure 3. Xiangyang Village, Hengqin, Zhuhai

Image source: Zhuhai Special Zone News



Figure 4. Real scene of Zhonghang Garden Phase II rainwater garden
Image source: <http://www.cuwa.org.cn/guoneizixun/1348.html>

3. Central River embankment works

As a coastal city, water is the soul of Zhuhai City, which can improve the urban river environment and ensure the safety of water, so as to build a livable environment for Zhuhai (Figure 5). In terms of water system design, Jinwan District, as a popular science base of a resilient City, the Central River embankment project and the Central Lake replenishment wetland set the activity space as a vegetation buffer zone, and transformed the fish pond into a wet pond. In the design, the lake is set as a regulation and storage space to store the rainwater of the plot whose drainage direction is the Central River in the aviation new town, so as to solve the problems of rainwater collection, purification and drainage in the aviation new town area. At the same time, through the construction of the water replenishment project of the central lake, an ecological water circulation system is formed. Therefore, the lake within the green space has the function of toughness, regulating the temperature, storing rainwater and making use of it, which is of reference significance.

4. Central urban area in the West

In the pilot area of resilient city construction, the green belt in the central urban area of Western Zhuhai will be widened and used as a biological detention belt, and the carriageway will be transformed from white to black. The project controls the rainwater on the pavement of non motorway and sidewalk through permeable concrete and permeable brick pavement. A sedimentation tank is set at the side stone opening to dissipate energy and purify rainwater. Through the transformation, the rainwater in the aquifer of the biological detention zone can basically be discharged two hours after the rain. While increasing the infiltration capacity of the infiltration area, the rainwater can also use porous fiber cotton to store part of the rainwater, and slowly release water to the surrounding soil in the dry season.



Figure 5. Central River embankment project
Image source:<http://www.chinajsb.cn/html/201912/23/6981.html>



Figure 6. Aerial view of Baitengshan Wetland Park
Image source:<http://www.cuwa.org.cn/guoneizixun/1348.html>

In terms of sustainable development, the sustainable development of landscape is of great significance to the social level and natural environment. The landscape ecosystem can provide food and resources for urban people to survive (Figure 6-8). Zhuhai Baitengshan Wetland Park mangrove wetland park plays a very important role in the treatment, storage and physical purification of rainwater, and the surrounding infrastructure is complete,

Provide a better recreational space for the surrounding residents, and provide a better reference for the construction and development of resilient cities.



Figure 7-8 Zhuhai mangzhou Wetland Park
Image source: taken by the author

Problems existing in the construction of Zhuhai's resilient City

1. Construction of Zhuhai's resilient city is difficult to fund and lacks a stable income return

According to relevant data, as of June 2019, there were 227 resilient city pilot construction projects in Zhuhai resilient city pilot area, of which 217 were under construction, 123 in non pilot areas and 78 under construction. The progress of projects in some pilot areas is slow, and the gap between the actually completed project requirements and the requirements of the target completion project is too large. As the resilient city construction project in Zhuhai is a non-profit project, there is a large demand for funds. In the three years from 2015 to 2017, the average planned investment in Zhuhai is about 8 billion yuan, and the construction of resilient cities in China is expected to need 3 trillion yuan in the future. At present, China's economy is facing downward pressure. At present, the construction of Zhuhai resilient city is parallel to the reduction of financial revenue and expenditure of functional units, and the resilient city does not have a mechanism to charge end users, so it is impossible to calculate public services. For the green ecosystem, the micro and unstable components are large, and it is impossible to calculate accurate figures through formulas or related software, which leads to the failure of the resilient city pilot PPP project to obtain corresponding returns, which is easy to generate implicit debt, and has certain difficulties in promoting the construction of resilient cities in Zhuhai.

2. Construction of resilient cities has encountered unprecedented difficulties in the transformation of new and old cities

The implementation of resilient cities has also encountered unprecedented difficulties in the transformation of new and old cities. There are many uncertain factors involved, such as problems in project construction, human factors in land disputes, and natural factors that hurricane weather has affected the old village. In the reconstruction design of taiheyuan community and Baiteng 2nd and 4th roads in xiangyangjiu village of Hengqin new area and Baiteng Subdistrict Office of Doumen District (Figure 9-10), not only the temporary resident population has grown from 1million to 3million, the building density inside the village is large, there are few greening facilities in the village, the residents lack public activity space, the terrain is high outside and low inside, the community is just inside the village, and the flooding problem caused by a large amount of rain on a Rainstorm Day, Facing the problem that the reconstruction construction of built green space and the reconstruction construction of municipal space conflict with each other. In the past, villagers often had conflicts with relevant municipal personnel and designers because of land problems and compensation, which prolonged the time of village reconstruction. The available green space of the new community is larger than that of the old community. Therefore, the new community has higher requirements for the design and quality of drainage pipelines, difficult construction, long time, and frequent operations produce more noise, which makes the residents of the community unable to get a good rest. They gradually have a sense of resistance, and the construction is slow, which affects the follow-up practice of resilient cities.



Figure 9. Taiheyuan community,
Baiteng Street office, Doumen District



Figure 10. Baiteng 2nd and 4th roads

Picture 9-10 source: Southern Metropolis Daily

Zhuhai Qianshan Cuiwei village is in a low-lying state, high on all sides and low in the middle. The maximum height difference between the village and Zhuhai cuiqian road can reach two meters. In rainstorm weather, the village is like a funnel, and the water on all sides pours back into the village, causing floods. After the rain, Cuiwei village, located in the low-lying area, was unable to distribute water, resulting in serious ponding in many places in the village

(Fig. 11-12). The sewers built in 1970-1980 were no longer available, and the domestic sewage produced by the villagers could not flow into the municipal pipelines. Although the village has set up a special drainage pump in the early stage, it can not fundamentally solve the problem that the ponding in the lane and lane cannot be eliminated. In summer, the whole village spreads in the odor of accumulated sewage, so Cuiwei village has long become one of the black spots of Zhuhai flooding. As the old houses and some historical buildings have been soaked in water for a long time, the walls have become black, the foundation has gradually loosened, the structure is unstable, and the wall ash has fallen off, facing the danger of collapse. If the garbage placed by the villagers downstairs is not cleaned up, the odor generated will cause serious damage to the physical and mental health of the villagers.

The low-lying ponding in old residential areas and urban villages is not caused by the autonomy of the residential area, but the deterioration of the ecological environment under the joint influence of human factors and environmental factors. The impact of natural disasters is not only a problem that the whole Zhuhai City, but also the whole Pearl River Delta region needs to face together. Due to the natural impact of seawater, the Pearl River Delta has formed a low-altitude area, which is vulnerable to the erosion of rainstorms and tides in climate change, making it subject to the erosion and backflow of rainwater, as well as the invasion of floods. Over the past 10 years, drought in winter, typhoon erosion and heat waves in summer have brought water pollution and land salinization to the Pearl River Delta, which has caused serious damage to the infrastructure in the city.



Figure 11-12. Rainstorm flooding point in Cuiwei Village
Image source: taken by the author

Zhuhai's strategy for building a resilient City

1. Innovate the investment pipeline for the construction of resilient cities in Zhuhai

In the construction of a resilient city in Zhuhai, there are many opportunities and challenges, among which huge investment is one. In the relevant methods of Zhuhai urban pipe network special fund management, the construction of urban pipe network is regarded as the future investment direction of the city. For the traditional rainwater drainage system, there are more transverse pipes, which need to have a certain slope. If there are more risers, it will affect the aesthetics of Urban Pipelines and need to use more accessories. Therefore, the construction personnel excavate the ground in a wide range, which will increase the construction volume on site and produce higher maintenance costs in the later stage. In the future construction of Zhuhai, the rainwater collection pool is used to store rainwater, which is convenient for construction. The rainwater collection pool is set on the top floor of the building and does not occupy the road green space. The green space rate of the road will increase, thereby increasing the area of the ground parking lot. And formulate the policy mechanism system of functional units and pilot PPP projects, establish relevant enterprise groups and joint mechanisms with comprehensive businesses, so as to build a multi-channel investment model, and encourage relevant financial institutions to increase investment credit and support for Zhuhai's resilient city.

2. Transformation of resilient cities is organically combined with old buildings to form a system

Set up stagnant grass ditches, rainwater gardens and other facilities in the green space to absorb the rainwater from nearby vehicle roads (Fig. 11-14). The main function of rainwater garden is to purify rainwater and regulate rainwater. The site plane needs to be paved with various plants and stones, and the overall design is mainly vertical layout. The stagnant grass planting ditches are arranged in basketball courts, squares and other areas, so as to build a resilient facility system of the plot. Rainwater from sidewalks, basketball courts and squares in rainstorm weather is discharged into rainwater gardens through topographic grass ditches, so as to purify and store the rainwater on the site and prevent flooding disasters caused by rainstorms in urban areas. The rainwater that has exceeded the standard is discharged through the rainwater channel set in the project, so as to realize the diversion of rainwater and sewage. Add relevant ductile infrastructure, transform and update the original water body, increase the volume of purified rainwater in the area, and combine the design of public spaces such as parking lots and the planning of green space system to build the water body in front of the village into a multifunctional wet pond and build a village landscape pattern close to mountains and rivers.

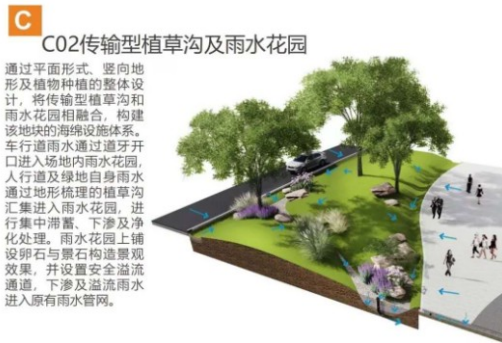


Figure 11. Rainwater garden form of Shanghai Maritime University toughness construction project

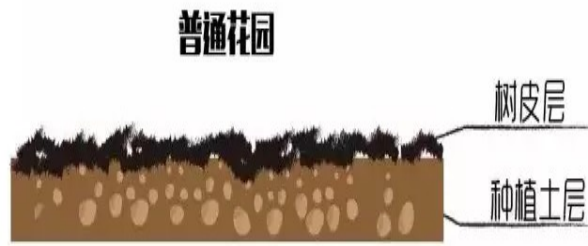


Figure 12. Soil layer structure of ordinary garden

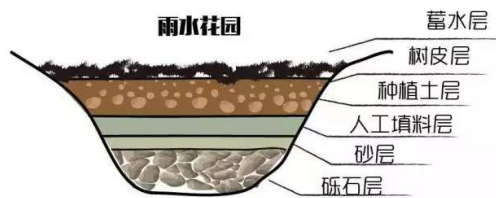


Figure 13. Soil layer structure of rainwater garden

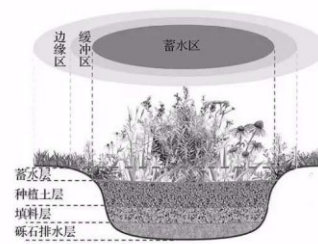


Figure 14. Schematic diagram of rainwater garden water storage area zoning

Figure 11-14 source: "resilient city" wechat official account

Communicate with residents in urban residential areas to understand their basic needs, and invite professionals to participate in the construction of resilient cities, so that the people can truly understand and realize the great benefits that resilient cities bring to society. For example, at this stage, the relevant departments of Cuiwei village have cooperated with Aoyuan group and Zhuhai Architectural Design Institute to transform and update this Cuiwei village. In terms of the vertical design of the village, we can refer to the reconstruction design of Guantang village in Zhuhai, and adopt retaining walls to avoid flooding. In terms of drainage, the drainage system of Cuiwei old village is the combined system of rain and sewage, the rainwater pipe and channel system has not yet formed a system, and the form of rainwater drainage mainly depends on the ground for scattered drainage. In terms of planning and design, in the near future, it can be determined that this area is a drainage mechanism system of intercepting and confluence system. The new pipelines in the village should be connected with the peripheral municipal roads. In the long term, the internal and external environment of the village can be renovated in combination with the reconstruction design of the old village, so as to realize the drainage system of rainwater and sewage diversion.

The relationship between resilient cities in Zhuhai urban construction

1. Identity and compatibility

The interaction of urban ecological construction, service ethics and energy storage has identity, and plays a guiding role in the construction of a resilient city in Zhuhai. Resilient cities not only emphasize the idea of adjusting measures to local conditions, but also reflect the regionality in the face of different climate, geographical environment and soil indicators in different cities, which is a systematic project. According to local conditions, analyze the geographical environment, natural environment and site construction conditions of the project itself. In the weather with heavy rainfall caused by typhoon, it can reasonably ensure that rainwater flows into the pipelines of infrastructure through surface runoff to achieve the role of water storage and seepage. We should also carry out collaborative design. Urban management units should cooperate with water supply and drainage majors and landscape majors to jointly discuss reasonable solutions. Landscape majors should pay attention to the harmony and beauty of the whole design, such as the configuration of plants, the shape of roof greening, the seasonal style of landscape, etc., so as to create a pluralistic and aesthetic environment.

2. Benchmarking analysis of evaluation of resilient urban design results

The benchmarking analysis of the evaluation of resilient urban design results includes:

① design description or calculation sheet. The professional units are landscape departments or resilient urban consulting institutions, mainly including underlying surface analysis, catchment area division, zoning design goal verification, etc. the focus of resilience evaluation is to determine the rationality of rainwater catchment area division, and the design concept, that is, whether the direction and goal meet the expected requirements.

② In the general drawing of rainwater drainage, the professional unit is the water supply and drainage design unit. The focus of toughness evaluation is whether the storage tank can play a direct role in the terminal of the drainage project when considering the regulation and storage volume. Secondly, in the same area of the subarea catchment, the overflow outlet is set around the site, and whether the drainage pipeline needs to be set repeatedly in the site.

③ In the landscape drainage diagram, the professional unit is the landscape construction unit, and the research content is the drainage pipe at the bottom of the infrastructure and the rainwater treatment system outside the building. The focus of the toughness evaluation is whether the connection between the perforated drainage pipe and the outdoor rainwater pipe is reflected when the perforated drainage pipe is set at the lower part of the toughness facility.

④ In the general landscape plan, the professional unit is the landscape construction unit. The research content is the horizontal and vertical design of the landscape site, and the size of the resilient complex. The focus of the resilience evaluation is whether the resilient urban infrastructure is set in any low-lying catchment area when it regulates the flood brought by rainstorm. The

second is whether to mark the percentage of slope when the sea infrastructure is conducting. Then consider the rationality of infrastructure layout. Finally, whether the size of infrastructure and building spacing meet the drainage specifications, and how to take relevant protective measures when they do not meet the specifications.

⑤ Detailed structure diagram of main facilities. The professional units are the combination of landscape functional units and water supply and drainage functional units. The research content is the basic situation of infrastructure construction and plant configuration. The toughness evaluation first needs to pay attention to the depth range of flood regulation caused by rainstorm. There is also the permeability coefficient of the infiltration infrastructure and the tolerance characteristics of the configured plants.

The construction of Zhuhai's resilient city is based on the concept of adjusting measures to local conditions and sustainable development, and advocates the practice of resource conservation and environmental protection. At this stage, the planning is not perfect. Therefore, in the design, we should pay attention to the principles of ecology, function and safety to create a green ecological activity space with Zhuhai characteristics. In the process of construction management, paying attention to the utilization ability and practicality of modern information technology requires not only exploring the planning methods of Zhuhai's resilient City, but also constantly expanding the database necessary for building a resilient city to provide strong support for subsequent in-depth research. With the rise of big data technology, researchers can take engineering technology as the main means to effectively combine resilient cities with digital cities, and can also combine with the urban pipe network constructed by Bim and the water conservancy model constructed by GIS to build a 3D drainage system model of the urban water supply pipe network system, set up rainstorm weather scenes, and simulate drainage. At the same time, cut off and branch the urban domestic sewage, guide it to be discharged into the sewage pipeline for treatment and purification, and finally strengthen the supply of domestic water for urban residents, so that the construction efficiency of Zhuhai's resilient city can be effectively improved and effectively recycled.

Planning and construction of disaster prevention, mitigation and relief under the theory of resilient cities

1. Zhuhai's disaster prevention policies for coping with extreme weather

The disaster prevention of traditional cities follows the idea of traditional engineering, focuses on the prevention of disasters in the project, and formulates different defense standards according to different disasters. With the development of cities, global warming, extreme climate changes are more and more frequent and difficult to guess, and the Disaster Prevention criteria of traditional cities are gradually not applicable to the changeable climate and environmental premise. Zhuhai is located at the mouth of the Pearl River and belongs to the subtropical marine monsoon climate. It is adjacent to Hong Kong and Macao. The precipitation is relatively rich, the river network density is

large, there are many islands, and the geomorphic types are diversified. Affected by tropical cyclones, it causes wind disasters and floods, with less rainfall in autumn, cold and dry in winter, and less rainfall. Typhoons "Dove" and "mangosteen" have had a serious impact on the people of Zhuhai.

Table 2 Comparison between traditional cities and resilient cities in Zhuhai

Comparison items	Zhuhai traditional city	Zhuhai resilient City
Planning concept	Focus on emergency response and emergency rescue, showing the project that will return to the original state in the shortest time after disaster damage.	It is emphasized to adapt to the safety of the new normal ecosystem and reduce disaster risks through the material aspects of planning technology, construction standards and social governance.
Technical means	Engineering mechanics and mathematical analysis methods calculate standard formulas for disaster prediction and engineering defense.	Big data means to conduct urban safety assessment and risk assessment, and formulate reasonable countermeasures.
Thinking method	The means of disaster prevention are single, earthquake, fire, flood disaster, war, all kinds of systems work independently, and the coordination is not complete.	It covers a wide range of fields, including nature, economy, society and so on. Emphasize the speed and ability of post disaster recovery.
Tolerance		

Data source: the author can get it through literature review and analysis

Facing all kinds of disasters caused by human and social factors, the scope of research has been extended to the public safety problems of the whole Zhuhai City. Therefore, urban risk assessment based on the concept of resilient city is an important theoretical basis and practical means of disaster prevention and mitigation planning in Zhuhai. In order to improve the ability of Zhuhai City to prevent typhoons, the regulations of Zhuhai Special Economic Zone on typhoon prevention was implemented in February 2020. Among the basic elements of the city, such as the natural conditions, geographical location, population density and safety problems of the city, the relevant terrain height difference analysis, sunshine analysis, climate and hydrology analysis are carried out through ArcGIS, and the problems faced by the city in the future are

predicted through safety assessment, and the countermeasures are formulated in advance.

2. Technical means of climate adaptation planning Zhuhai disaster reduction policy

Through the investigation, it is found that the security situation in Zhuhai is relatively severe, with many old villages, such as Qianshan Cuiwei village, tangjiahuitong village and other large villages. The building density in the area is large, the wires in the village are entangled, the sunshine spacing is insufficient, the fire passage does not meet the standard specifications of residential buildings in Zhuhai, and it is prone to flooding in rainstorm weather. In addition to the old residential areas, Zhuhai, as a window of reform and opening up, the rapid development of new industries and new models has brought many hidden dangers. In particular, the awareness of public safety is weak. In the face of crisis, the response ability is low. In addition to natural disasters, major emergencies also include fire caused by gas leakage, burst of ground water pipes, major infectious diseases and other risks, which should also be considered as key objects (Figure 15).

Zhuhai should consider all kinds of safety risk factors in urban planning and construction management, and take effective measures to adapt to the impact of social and human factors on the city. First of all, improve the early warning of disaster types in Zhuhai, improve the early warning level of disaster monitoring in the city, delimit the emergency map of each region, evaluate by analyzing the location, climatic conditions and Humanities of the region, and carry out management and governance respectively, so as to promote the construction of Zhuhai sponge City, preserve the technical capacity of rivers, lakes and Zhuhai wetlands, and improve the city's flood control and drainage capacity. Finally, improve the civil air defense function of the city, and constantly develop underground space, including Zhuhai station square of urban rail transit, underground shopping mall of Gongbei port, underground shopping mall of Yangming square, etc., to ensure the requirements of disaster prevention and mitigation of the city. In the quantitative analysis, based on the 100rc toughness framework, the 100rc quantitative analysis tool (Figure 16) is used to clarify the main factors and sub factors, and the satisfaction is divided into good, good to be strengthened, to be improved, and operation improvement. By collecting people's opinions and suggestions to clarify the evaluation requirements of Zhuhai's urban resilience, the results of the participatory discussion are displayed in a concise and clear way, which is convenient for planners and city participants to sort out the advantages and disadvantages of the city's resilience, and then focus on key issues to ensure the interests of functional units, enterprises and people.

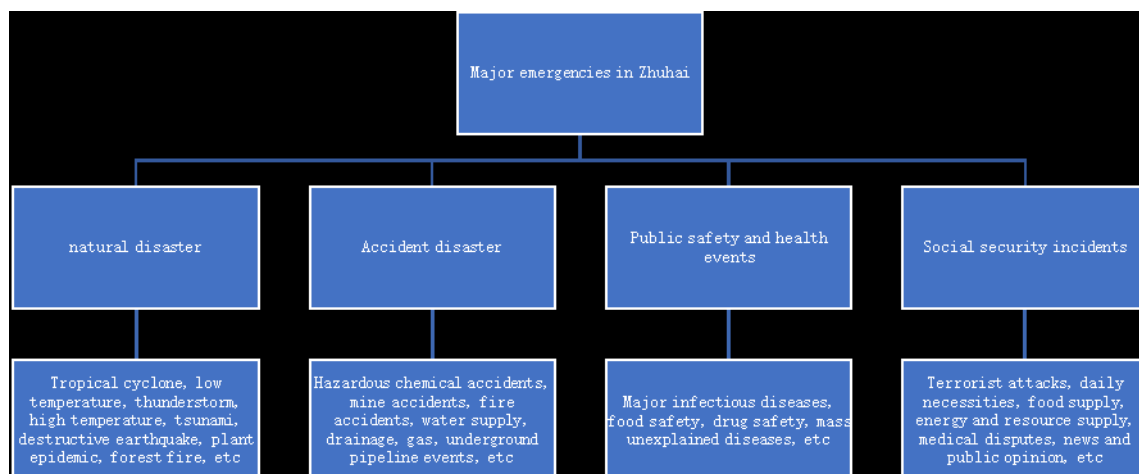


Figure 15. Major emergencies in Zhuhai

Source: the author sorted out according to the overall emergency plan for emergencies in Zhuhai

CONCLUSIONS AND RECOMMENDATIONS

In recent years, the flood disaster brought by the torrential rain to Zhuhai is testing the city's ability to adapt to recovery. How to improve the influence of uncertain human and social factors on Zhuhai, the adaptation level and recovery ability, is a problem that Zhuhai must face in its development. The construction of a resilient city is a new way to deal with urban waterlogging at this stage. There is no fixed routine to follow, and its development direction is ever-changing, The results cannot be presented immediately and need to be developed step by step. Planners need to design according to local conditions according to the current land use situation of Zhuhai, and cooperate with the joint efforts of the government, scholars and residents, so as to truly contribute to the construction and development of a resilient city.

FURTHER STUDY

This research is very interesting to follow up by paying attention to each section of the previous discussion.

REFERENCES

- Shi Xuan, Zou Han, Sun Hua, Gao Yuexia Thoughts on the intersection design of green buildings and resilient cities [j] Proceedings of 2019 International Conference on green building and building energy efficiency, 2019:625 ~ 629.
- Cao Yu Zhuhai City, in line with local conditions, explores a replicable and resilient city construction model [j] Urban and rural construction, 2019 (22): 36 ~ 40.
- What is the current situation of the construction of resilient cities? Relevant units in Zhuhai feel the harmony between human and water on the spot [n] Zhuhai Special Zone News, 2018 ~ November ~ 24.
- Shenzhen tenacity Rainwater Utilization Technology Co., Ltd What is the difficulty of building a resilient city in Zhuhai? Relevant units in Zhuhai feel the harmony between human and water on the spot [n] Zhuhai Special Zone News, 2019 ~ 07 ~ 30.
- Can Zhuhai Hengqin become a template for a "resilient city"? [N]. Southern Metropolis Daily, 2018 ~ September ~ December
- Shutdown for nearly a year! The transformation of resilient cities in this area of Zhuhai is referred to as "unfinished" [n] Southern Metropolis Daily, 2019 ~ 08 ~ 08.
- Song Fangxiao, Zhang Hairong Analysis on the problems and Strategies of construction and management of resilient cities in China [j] Urban development research, 2016 (10): 99 ~ 104.
- Comprehensive application practice of resilient city construction technology - Zhuhai Airport East Road Greening and beautification improvement project [n] Tough City, 2019 ~ 01 ~ 07.
- Dai Wei, sun Yimin, Han Meier, Tani Baqing Research on urban resilience planning in the Delta under climate change [j] Urban planning, 2017 (12):26-34.
- Wang Xiangrong, Xie Yujing, Xu Yiyang, Lu Yi, Li Kun Research on climate change and Development Countermeasures of resilient cities [j] Shanghai urban planning, 2016 (01): 26-31.
- David R. goldschalke, Xu Chan Urban disaster reduction: creating resilient cities [j] International urban planning, 2015 (2): 22-29.
- Dai Shenzhi Safety and disaster prevention strategies to enhance urban resilience [j] Beijing Planning and construction, 2015 (2): 14-17.
- Wang Hui, Ren Yilu, Lu Siqi, Du Qin Urban resilience guided by ecological wisdom to cope with the threat and occurrence of flood disasters [j] Journal of ecology, 2016 (16): 4958-4960.
- Zhou Yangyue, long Tingting Strategic response to the construction of resilient cities in China under the new normal [j] Sharing and quality - Proceedings of 2018 China urban planning annual conference (01 urban safety and disaster prevention planning), 2018 (01): 383-391.

- Chen Yumei, Li Kangchen Research progress and practice of resilient cities from the perspective of foreign public management [j] China Administration, 2017 (1): 137-143.
- Shao Yiwen, Xu Jiang Concept analysis of urban Resilience Based on international literature review [j] International urban planning, 2015 (2): 48-54.
- Bing Qiliang, Li Xin, Luo Yan Discussion on urban disaster prevention and reduction planning under the guidance of resilient city theory [j] Planner, 2017 (08): 12-17.
- Xu Jiang, Shao Yiwen New ideas for resilient cities to cope with urban crises [j] International urban planning, 2015 (02): 1-3.
- Qiu Aijun, Guan Jing, Bai Wei Exploration and innovation of the compilation method of the Global 100 resilient cities strategy -- a case study of Deyang City, Sichuan Province [j] Urban development research, 2019 (02): 38-44+73.