Proceedings of ICEMGD 2024 Workshop: Policies to Enhance Sustainable Development through the Green Economy
DOI: 10.54254/2754-1169/123/2024MUR0117

Resilient Urban Design Concept in the Context of Climate Change

Yilun Li[1,a,*]

[1]*HNU-ASU Joint International Tourism College, Hainan University, China*
a. yilunli2@asu.edu
**corresponding author*

Abstract: Climate change has a significant adverse impact on cities, including extreme weather events, rising sea levels, intensified urban heat island effects, ecosystem changes, and ecological imbalances. In this paper, urban design must enhance resilience to climate change in order to meet the needs of the community. Using Singapore and Melbourne as case studies, this paper analyzed their responses to climate challenges and summarized the characteristics of resilient cities. It compared successful factors and proposes methods for emulation and design concepts. Singapore has demonstrated innovative planning in water resource management and mitigation of the urban heat island effect; while Melbourne focuses on experimental research governance and implementation of resilience policies. The significance of this study lied in its exploration of how urban design could improve urban resilience to address the increasingly severe negative impacts of climate change. By analyzing these two resilient cities' cases, the paper summarized their successful experiences and characteristics in responding to climate challenges. Through comparing these two response strategies, this paper not only provided valuable references for other cities but also offered targeted design ideas. These research findings were crucial both theoretically and practically for enhancing cities' ability to respond to climate change effectively while achieving sustainable development.

Keywords: Climate Change, Resilient City, Urban Planning.

1. Introduction

Climate change became a matter of great concern, both for domestic and global reasons, being described as the most substantial challenge faced by humanity worldwide due to its profound and enduring impact on all aspects of life, including ecosystems [1-3]. The current climate change was recognized as a pressing issue, with its effects likely to harm every natural and man-made system on the planet, including the environment, economy, and society, which would have a significant impact on the future of human society. As global climate change became increasingly severe, cities faced unprecedented and diverse challenges, including frequent extreme weather events, rising sea levels, and ecosystem collapse, which would have a significant impact on the future of human society. Therefore, urgent action was required to address this challenge, and the scale and scope of such action varied greatly depending on the circumstances, including the level of economic development, the level of scientific and technological development, and the level of political will. At that time, the main global response to the threat of climate change was mitigation measures, including the reduction

DOI: 10.54254/2754-1169/123/2024MUR0117

of greenhouse gas emissions to various degrees, which was a necessary and effective way to address the problem of climate change. Most scientific evidence showed that greenhouse gas emissions caused and exacerbated climate change, and reducing the amount of gas emitted would limit the impact of climate change, which was a necessary and effective way to address the problem of climate change. Frequent extreme weather events, rising sea levels, and ecosystem collapse not only threatened the sustainability of urban infrastructure but also posed significant challenges to residents' quality of life and economic development, which would have a significant impact on the future of human society.

The concept of resilience was used in ecology and interdisciplinary fields for nearly more than 50 years [4-5], with numerous confusing definitions and usages [6], which was a necessary and effective way to address the problem of climate change. Folke et al. simplified it by defining resilience as the ability of a system to maintain its functions, structure, and feedback mechanisms when subjected to disturbances [7], which was a necessary and effective way to address the problem of climate change. In the context of climate change, resilient cities referred to those that could maintain stable operations and rapidly recover in the face of various environmental pressures and challenges [8-9], which was a necessary and effective way to address the problem of climate change. Urbanization triggered changes in urban morphology and global climate, with urban open spaces playing a crucial role in evaluating the ecological factors of urban development performance [10], which was a necessary and effective way to address the problem of climate change. Picketts et al. pointed out that climate adaptation measures "were highly beneficial to local governments" as they provided citizens with the opportunity to participate in formulating adaptation strategies specifically targeting significant local impacts, which would bring actual benefits to local residents, which was a necessary and effective way to address the problem of climate change. The sustainable development of urbanization and the construction of resilient cities had many intersections, which was a necessary and effective way to address the problem of climate change. In the process of urbanization, the construction planning of resilient cities could be carried out around the United Nations Sustainable Development Goals (SDGs), with a focus on Goal 11 "Make cities and human settlements inclusive, safe, resilient, and sustainable" and Goal 13 "Take urgent action to combat climate change and its impacts," which was a necessary and effective way to address the problem of climate change. At that time, countries were making efforts in building resilient cities to address climate change, which was a necessary and effective way to address the problem of climate change. However, due to the complexity of cities as systems and the unique characteristics of each city, there was still a lack of general principles and commonalities in advancing resilient cities domestically, which was a necessary and effective way to address the problem of climate change.

In this paper, the concept of resilient cities emerged, aiming to enable cities to maintain stable operations and recover quickly in the face of stress and challenges, which was a necessary and effective way to address the problem of climate change. This paper aimed to fill the gap in the domestic research field on nature-based solutions, improving the guiding theoretical framework for climate-resilient city design, which was a necessary and effective way to address the problem of climate change. It also combined detailed research methods and analytical frameworks to explore the strategies and actions taken by Singapore and Melbourne in responding to the challenges of climate change, which was a necessary and effective way to address the problem of climate change.

2. Success Cases of Resilient Cities

2.1. Urban Planning in Singapore for Climate Change

The Singapore, with a land area of only 735.2 square kilometers, faces significant challenges in urban expansion and infrastructure development due to its extremely limited land resources. Enhancing

DOI: 10.54254/2754-1169/123/2024MUR0117

urban resilience necessitates efficient planning and multifunctional land use within these constraints, placing high demands on urban planning. As a low-lying coastal nation within a tropical marine climate, Singapore is persistently threatened by rising sea levels. Global warming, resulting in glacier melt and thermal expansion of seawater, continuously endangers Singapore's coastal areas and infrastructure. As a crucial global shipping and financial hub, its port activities are vital to the national economy. Maintaining coastal areas ensures the normal operation of ports and the stable development of the economy. Consequently, Singapore places great emphasis on coastal maintenance. The following are measures taken by the Singaporean government to protect its coastline:

(1) Singapore adopted a series of planning measures to optimize limited land use in national resource management. Through the "Sustainable Singapore Blueprint" and "Land Use Plan," Singapore achieves high-density, multifunctional land use[11]. Additionally, the government has proposed the concept of an "underground city," relocating certain infrastructure, such as water storage and power facilities, underground to free up surface space.

(2) The "Coastal Protection and Adaptation Strategies" involved constructing flood barriers and sea walls to strengthen shoreline protection against the threat of rising sea levels[12]. The government has also established the National Coastal Protection Office, dedicated to coordinating and implementing these measures.

(3) In the Punggol Northshore area, Singapore has implemented eco-smart concepts and experimented with green technologies during construction, determining the optimal location for facilities based on factors such as wind and sunlight. System simulations help planners better balance green functions. In public areas, sensors control lighting and fans to optimize energy use, while households manage energy consumption, use clean pneumatic waste systems, and track waste and recycling volumes for efficient collection.

Singapore highly values resilience and sustainability in urban planning. Through the construction of integrated infrastructure, such as underground complexes, sky gardens, and vertical greenery, Singapore not only optimizes land use but also enhances flood control and climate adaptability. For instance, Marina Barrage serves as a dam, recreational facility, and freshwater reservoir, addressing flooding in low-lying areas. Moreover, Singapore is committed to urban greening, incorporating vast green spaces, parks, and nature reserves into urban planning under the "Garden City" concept. Vertical greenery and rooftop gardens beautify the urban environment, regulate temperature, and improve air quality. Singapore also invests significant resources in coastal and wetland protection and restoration to bolster urban ecosystem resilience. In terms of public engagement, Singapore mobilizes residents to participate in environmental protection and climate action. Through the "Garden City" concept, extensive green spaces, parks, and nature reserves are integrated into urban planning. The widespread application of vertical greenery and rooftop gardens reduces the urban heat island effect, enhancing residents' comfort and quality of life.

2.2. Urban planning in Melbourne for climate change

Melbourne differs significantly from Singapore in terms of geographical location and climatic conditions. As Australia's largest city, Melbourne covers an area of 8,831 square kilometers. Situated on a plain with the Pacific Ocean to the south, Melbourne experiences a climate that intersects subtropical and temperate zones, with moderate temperature variations throughout the year. Similar to other coastal cities, Melbourne faces issues such as rising sea levels and an increase in extreme weather events. Additionally, droughts, high temperatures, and the resulting bushfires significantly impact air quality, posing persistent challenges to the urban environment. Unlike Singapore, Melbourne has undertaken policy reforms in addition to upgrading its infrastructure to address these primary issues.

DOI: 10.54254/2754-1169/123/2024MUR0117

(1) The Resilient Melbourne Strategy (RMS), initiated by the Rockefeller Foundation's "100 Resilient Cities" (100RC) initiative, is one of the most renowned urban networks advocating for urban resilience. This strategy identifies local resilience challenges in the Melbourne metropolitan area and takes actions to provide, organize, and coordinate urban services and infrastructure in new and more robust ways across various papers, including transportation, energy, housing, health, climate change, and social cohesion [13]. Under the framework of RMS-related indicators, Melbourne has undertaken a series of targeted urban governance experiments [14].

(2) In 2009, Melbourne launched the Climate Change Adaptation Strategy, identifying major climate risks such as flooding, sea-level rise, and extreme weather events [15]. Priority actions to mitigate these risks include enhancing flood resilience, addressing sea-level rise, and preparing for extreme weather events. Melbourne has developed flood maps and risk assessments, particularly for vulnerable areas such as Southbank, Docklands, and Fishermans Bend. The city implements principles to mitigate the impacts of extreme heat, increase green infrastructure, ensure water supply under drought conditions, and improve thermal comfort, making the urban environment more livable during heatwaves. In building a resilient city, Melbourne strictly adheres to the RMS and the United Nations Sustainable Development Goals, advocating for compact urban layouts to enhance accessibility and public transportation, thereby reducing reliance on private vehicles. Encouraging mixed-use development within compact layouts integrates residential, commercial, and recreational spaces, minimizing travel distances, supporting the local economy, and enhancing social interaction and community resilience. Additionally, Melbourne focuses on developing a resilient infrastructure network, including adaptive water management systems, sustainable energy solutions, and resilient telecommunications and transportation networks. Engaging the community in the planning and design process helps address diverse needs, preferences, and resilience priorities, thereby strengthening social cohesion and community resilience.

3. Analysis of Resilient Urban Planning under Sustainable Development Goals

According to the United Nations Sustainable Development Goal 11 (SDG11), "Sustainable Cities and Communities," the aim is to make cities and human settlements inclusive, safe, resilient, and sustainable. SDG13, "Climate Action," focuses on taking urgent action to combat climate change, specifically limiting the increase in global average temperature to well below 2 degrees Celsius, while striving to limit the increase to 1.5 degrees Celsius, enhancing climate resilience, and reducing greenhouse gas emissions. In their respective efforts to build resilient cities, Singapore and Melbourne showcase the ingenuity of urban planners in addressing various challenging climate scenarios. Both cities follow the overarching guidelines of the United Nations Sustainable Development Goals, tailoring their policies to the local paper and embarking on resilience-building initiatives aligned with SDG11 and SDG13.

Singapore, building on its green city foundation, has integrated flood prevention and storm resilience design elements. Through the "Smart Nation" initiative, the city enhances its adaptability to natural disasters. The "2030 Sustainable Development Blueprint" emphasizes compact and dense urban planning to mitigate the impacts of urban sprawl, thereby enhancing the city's compactness and accessibility.

Melbourne, on the other hand, has increased public participation and set specific emission reduction targets and adaptation strategies in the "Climate Change Adaptation Action Plan," promoting a low-carbon economy and the use of renewable energy. Community projects and educational programs enhance public engagement and support for climate action. The "Urban Resilience Strategy" further evaluates and improves the resilience of urban infrastructure, including flood control capabilities and measures to cope with extreme weather events, thereby reducing urban vulnerability and enhancing overall resilience.

DOI: 10.54254/2754-1169/123/2024MUR0117

The urban planning and climate actions of Singapore and Melbourne demonstrate how to construct sustainable and resilient urban environments in the face of global warming and climate change. Their innovative approaches not only enhance the adaptability of their cities but also provide valuable insights for other cities worldwide.

4. Suggestions for resilient city construction

The successful cases of Singapore and Melbourne resemble software and hardware, respectively, adaptive to their respective resilience system constructions. Both developed and developing countries can draw valuable lessons in resilience building from these two cities.

(1) Urban planners can employ advanced layouts and rational planning to protect the natural systems, built environment, and human living conditions within cities, minimizing the impacts of destructive climate change on urban areas and their inhabitants. For instance, integrating greening initiatives analogous to the "Garden City" concept into urban planning can effectively mitigate the urban heat island effect [16].

(2) Sound policy orientation and attention to climate change determine the feasibility of building resilient cities. The extent to which governments can mobilize public awareness and enthusiasm significantly influences the progress and success rate of resilience city construction. Issues such as residents' agreement to renovations and their acceptance of policies play a crucial role.

(3) Building or transforming into a resilient city requires a certain level of economic foundation. Both having a robust management system and utilizing smart city technologies necessitate financial support.

(4) Raising public environmental awareness through education and outreach activities encourages community participation and support for climate action projects. Public training and information sharing can enhance citizens' abilities in environmental protection and emergency preparedness.

(5) Conduct regular systematic risk assessments to identify major risks facing the city, such as climate change, natural disasters, and socio-economic challenges. Develop targeted strategies based on assessment results to enhance the city's overall risk resilience.

In essence, the approaches demonstrated by Singapore and Melbourne illustrate how urban planning and climate action can be synergistically applied to create sustainable and resilient urban environments, providing a model for cities worldwide to follow.

5. Conclusion

The increasing severity of climate change poses significant challenges to the sustainable development of cities. This paper presented successful experiences in addressing climate change through case studies of resilient city construction in Singapore and Melbourne. Both cities have rigorously followed the guidelines of the United Nations Sustainable Development Goals (SDG11 and SDG13) in their urban planning and climate actions, adapting their strategies to local conditions.

Singapore, through initiatives like the "Underground City" and the "2030 Sustainable Development Blueprint," has enhanced its compactness and accessibility while improving its adaptability to natural disasters. Melbourne, through the "Climate Change Adaptation Action Plan" and the "Urban Resilience Strategy," has proposed specific emission reduction targets and adaptation strategies, promoting a low-carbon economy and the use of renewable energy. In conclusion, the cases of Singapore and Melbourne serve as complementary models, akin to software and hardware, in their respective approaches to resilience system construction. These examples provide valuable insights for both developed and developing countries in building resilient cities. Urban planners can adopt advanced layouts and rational planning to safeguard natural systems, the built environment, and human living conditions, thereby minimizing the impacts of climate change. The integration of

DOI: 10.54254/2754-1169/123/2024MUR0117

greening initiatives, similar to Singapore's "Garden City" concept, offers a practical solution to urban heat islands. Furthermore, sound policy orientation and active public engagement are critical to the success of resilience-building efforts. Economic resources are essential to support the development of smart city technologies and robust management systems. Public environmental awareness, cultivated through education and outreach, fosters community participation in climate action projects. Regular risk assessments are vital for identifying major threats and devising targeted strategies to enhance urban resilience. Ultimately, the experiences of Singapore and Melbourne exemplify how urban planning and climate action can be effectively combined to create sustainable and resilient urban environments, serving as a blueprint for cities around the world. Based on the successful experiences of Singapore and Melbourne, this paper offered recommendations in five areas—urban layout, policy orientation, economic support, education and outreach, and risk assessment—that other cities can reference when building resilient cities.

In the context of global climate change, future resilient city construction should adopt nature-based solutions, utilize smart technologies and data-driven decision support systems, conduct regular risk assessments, and develop response strategies to enhance risk resilience. By learning from the successful experiences of exemplary cities and combining them with their own circumstances, cities around the world can actively advance resilient city construction. This will enable them to meet the challenges posed by climate change and achieve more sustainable and livable development goals. Through this study and analysis, we have observed the innovative practices of Singapore and Melbourne in successfully building resilient cities in the face of climate change. These practices not only enhanced the adaptability of these cities but also provided valuable insights for other cities worldwide.

References

[1] *Dargusch, P., and Griffiths, A. (2008). Introduction to special issue: a typology of environmental markets. Australasian Journal of Environmental Management, 15(2), 70-75..*

[2] *Jagarnath, M., Thambiran, T., and Gebreslasie, M. (2020). Heat Stress Risk and Vulnerability under Climate Change in Durban Metropolitan, South Africa—Identifying Urban Planning Priorities for Adaptation. Climatic Change, 163(2), 807–829.*

[3] *Potter, E. (2020). Contesting Imaginaries in the Australian City: Urban Planning, Public Storytelling and the Implications for Climate Change. Urban Studies, 57(7), 1536–1552.*

[4] *Holling, C. S. (1973). Resilience and Stability of Ecological Systems. Annual Review of Ecology and Systematics, 4(1), 1-23.*

[5] *Holling, C. S. (2001). Understanding the complexity of economic, ecological, and social systems. Ecosystems, 4(5), 390-405.*

[6] *Grimm, V., Schmidt, E., and Wissel, C. (1992). On the application of stability concepts in ecology. Ecological Modelling, 63(1-4), 143-161.*

[7] *Folke, C., Carpenter, S., and Walker, B. (2004). Regime Shifts, Resilience, and Biodiversity in Ecosystem Management. Annual Review of Ecology, Evolution, and Systematics, 35, 557-581.*

[8] *Bernhardt, J. R., and Leslie, H. M. (2013). Resilience to climate change in coastal marine ecosystems. Annual review of marine science, 5(1), 371-392.*

[9] *Bernhardt, J. R., and Leslie, H. M. (2013). Resilience to climate change in coastal marine ecosystems. Annual Review of Marine Science, 5, 371-392.*

[10] *Oke, T. R. (1973). City size and the urban heat island. Atmospheric Environment 1967, 7(8), 769-779.*

[11] *Kang, E., and Lam, N. B. (2023). The Impact of Environmental Disclosure on Initial Public Offering Underpricing: Sustainable Development in Singapore. Corporate Social-Responsibility and Environmental Management, 30(1), 119–133.*

[12] *Donner, S. D., and Webber, S. (2014). Obstacles to climate change adaptation decisions: a case study of sea-level rise and coastal protection measures in Kiribati. Sustainability Science, 9(3), 331-345.*

[13] *Fastenrath, S., Coenen, L., and Davidson, K. (2019). Urban resilience in action: The Resilient Melbourne Strategy as transformative urban innovation policy. Sustainability, 11(3), 693.*

[14] *Hodson, M., Geels, F., and McMeekin, A. (2017). Reconfiguring urban sustainability transitions, analysing multiplicity. Sustainability, 9(2), 220-229.*

DOI: 10.54254/2754-1169/123/2024MUR0117

[15] *Fastenrath, S., and Coenen, L. (2020). Future-proof cities through governance experiments? Insights from the Resilient Melbourne Strategy (RMS). Regional Studies, 55(1), 138-149.*
[16] *Cai, Z., Page, J., and Cvetkovic, V. (2021). Urban ecosystem vulnerability assessment of support climate-resilient city development. Urban Planning, 6(3), 227-239.*