



The Watershed Planning Methods Affecting the Porous Structural Model for the Coastline'S Da Nang City in the New Context - Vision to 2045

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The watershed planning methods affecting the Porous structural model for the coastline's Da Nang City in the new context - vision to 2045

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Abstract— The tourist city of Da Nang will become even more livable when harsh weather conditions and natural disasters are minimized to as good as possible. For a city with high porosity to natural conditions, cultural tourism, socio-economic factors, infrastructure, and landscape architecture, such as Da Nang, adverse weather has had a significant impact on watershed planning solutions in urban design for tourism purposes in Da Nang. Watershed planning plays the most crucial role among the factors contributing to the formation of urban sprawl.

Keywords— Porous Structural Model, watershed planning, the Coastal City, harsh weather phenomenon, urban designing for tourism.

I. INTRODUCTION

Da Nang is a city located in Central Vietnam, with diverse natural resources including the sea, rivers, mountains, and a favorable geographical location for traveling. Da Nang has been designated to take tourism as a key economic sector in developing the Central region's economy [1], especially beach tourism.

However, there are the biggest challenges for Da Nang, it is harsh weather and natural disasters every year, leading to serious consequences for the local life lives as well as the quality of tourist services. In addition, the urbanization process has increased the environmental consequences [2]. Thus, the tourist city called Da Nang is not an exception, the terrifying floods, and climate changes created rainfall and an escalating flood risk. It is evidence that the historic flood in 2022 in Da Nang [3].

The "Porous City model" has gradually taken shape in some cities worldwide that are vulnerable to flooding and natural disasters, such as Berlin, Germany, New York, USA, etc. This model is described for watershed planning solutions for flood urban, with complex river systems and climate shocks. It means that there are parks, and greenery in designing urban green spaces or utilizing natural drainage systems, in order to improve city climate.

Therefore, "The watershed planning methods affecting the porous structure model for coastline's Da Nang City in the new context, vision to 2045" is considered to be necessary and urgent.

Tóm tắt — Thành phố du lịch Đà Nẵng trở nên tốt hơn nếu kiểm soát tốt các hiện tượng thời tiết cực đoan, thiên tai. Đối với đô thị có tính xốp cao về điều kiện tự nhiên, du lịch văn hoá, kinh tế- xã hội, cơ sở hạ tầng, kiến trúc cảnh quan như thành phố Đà Nẵng, thời tiết tiêu cực đã gây ảnh hưởng nghiêm trọng đến giải pháp quy hoạch lưu vực trong thiết kế đô thị phục vụ du lịch tại Đà Nẵng. Trong khi đó, quy hoạch lưu vực đóng vai trò là yếu tố quan trọng nhất trong các yếu tố mà tạo thành cấu trúc đô thị xốp.

Keywords—cấu trúc đô thị xốp, quy hoạch lưu vực, thành phố du lịch biển, hiện tượng thời tiết cực đoan, thiết kế đô thị phục vụ du lịch.

II. SCIENTIFIC BASIS

A. An Overview of Coastal Urban Areas in Da Nang City

1) Climate Conditions:

Da Nang City is located in a tropical monsoon climate region, characterized by high temperatures and minimal fluctuations. There are two distinct seasons each year: the dry season (from January to September) and the rainy season (from October to December).

The average temperature is around 25°C, with the highest temperatures occurring in June, July, and August, averaging between 28°C and 30°C. The lowest temperatures are in December, January, and February, averaging between 18°C and 23°C.

The average air is 83.4%, with the highest occurring in October and November, averaging between 85.67% and 87.67%. The lowest humidity is in June and July, averaging from 76.67% to 77.33% [2].

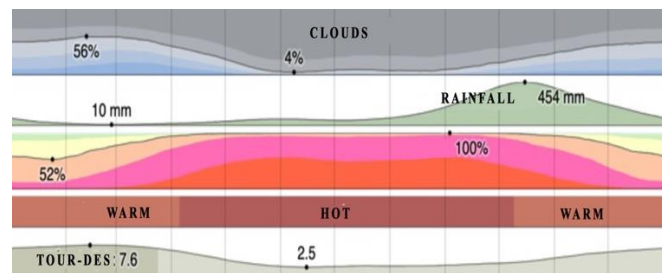


Figure 1. Climate chart in Danang City

2) *Geographical Location and Landscape:*

Da Nang City is located in the Central of Vietnam with unique and captivating natural landscapes. The combination of beaches, mountains, and architectural elements creates a distinctive coastal scenery, referred to as one of the most beautiful beaches on the planet, leading to attracting tourists every year.

- Beaches: Da Nang beaches are renowned for their stunning beaches with fine white sand, such as Bai Bac, Bai Nam, and Bai O beach. Among them, My Khe Beach is ranked among the world's most beautiful beaches and stands out as one of Da Nang's notable attractions

- Unique Mountain-Sea Range: The coastline's Da Nang features a unique combination of mountains and the sea. The famous mountain peaks (Marble Mountains and Son Cha Mountain), create a unique landscape with views from above of the sea and the city

- Thuan Phuoc Bridge and Dragon Bridge: are 2 famous bridges in Daang being enhance the coastal landscape. Dragon Bridge is an impressive design to expand and carry the image of a Vietnamese dragon, creating a spectacular scene at night.

- The Parcel Islands and the Spratly Islands: play a crucial role in creating the majestic coastline of Da Nang with symbols and memorials related to the protection of Vietnam's island sovereignty. [2, 4].



Figure 2. Coastal landscape in Da Nang City

3) *Infrastructure:*

The coastal infrastructure in Da Nang City has been significantly developed to ensure convenience, safety, and comfort for both residents and tourists.

- Transportation: is growing, encompassing roads and highways in connecting between the city and neighboring regions, it has also been improved for convenient coastal travel.

- Da Nang's International Airport is an important gateway for international and domestic visitors. That is upgraded and expanded to accommodate the increasing annual passenger traffic.

- Pedestrian Walkways along Beach: Da Nang offers a network of pedestrian walkways along coastal roads, allowing residents and tourists to enjoy the seaside view and natural landscapes. That has been equipped with resting huts,

benches, and other amenities to create a relaxing environment.

- Coastal Construction Projects: There are numerous works and tourism development projects along the coast that include apartments, villas, and luxury resorts. In addition, the coastline's Da Nang is equipped with public facilities such as schools, hospitals, healthcare facilities, shopping centers, stores, and golf courses. Maximizing the harmony between architectural structures and urban landscapes creates an attractive destination for coastal areas.

- Water and electricity supply system: developed to ensure a stable source of energy and necessary resources for residents and tourists.

4) *Economic potential:*

- The coastal urban in Da Nang City is an attractive investment destination, offering numerous business opportunities, real estate, services, and various other industries.

- Creating economic revenue: The tourism sector generates income for accommodation, entertainment, cuisine, and shopping services. Meanwhile, the tourism economy plays a significant role in creating employment opportunities and local economic development. Furthermore, the government can utilize this tax revenue to invest in infrastructure and other public services as coastal tourism develops, enhancing the tourist experience, and improving the quality of local life.

- Property Development: Increasing demand for real estate projects, including resorts, apartments, villas, and hotels, creating investment opportunities for investors and businesses in the real estate sector

- Promotion of culture and exchange: Coastal tourism creates opportunities for cultural exchange, enabling local residents to interact with tourists and fostering a diverse and enriching environment, resulting to attracting more visitors and investments. [2, 4].

B. *Concept of a porous urban area*

The concept of a "Porous City" is created by the elements having diverse functions in the expanded ability with multi-dimensional way, including socio-econo, population, architectural space, urban function, etc. That can be understood as the intricate, within an interactive urban environment, where each component undergoes dynamic changes while maintaining a tightly integrated connection, fundamentally embodying a strong cohesion within their interlinkages. These distinct characteristic elements can blend together in various ways in terms of form, structure, aspects, etc., while still creating soft spaces like urban voids, variations in urban watersheds, and even the adaptability of urban infrastructure. The integration of manufacturing, housing, and service facilities is increasingly dependent on the advancements in the information technology [5].

There are several features affecting the resilience of urban areas. In terms of the urban planning field, there are three main areas that influence the porosity of urban areas as follows:

1) *Urban Porosity:*

The high population phenomena results in high building density, the fragmentation of public spaces, and a decline in the quality of urban residents' lives as well as the tourist quality.

2) *Porosity in transportation:*

There is increasing pressure on the rigid, hierarchical transportation system that contrasts with the porous, non-hierarchical nature of the functional structure entities. The 'Porous urban model' requires a network-like transportation system, emphasizing multidirectional connections rather than being constrained by specific frames, circular routes, and predetermined radial patterns. This leads to the expansion of arterial routes becoming costly and time-pressured, due to traffic congestion, because of increasing traffic influx into the main axes.

3) *The porosity of watershed planning:*

Watershed planning responds to changes and adapts flexibly to environmental, social, and economic factors. In the porous urban structure, watershed planning holds the utmost significance among the factors. This ensures that the watershed planning system not only meets the fundamental drainage needs but also supports urban development in a sustainable manner [5].

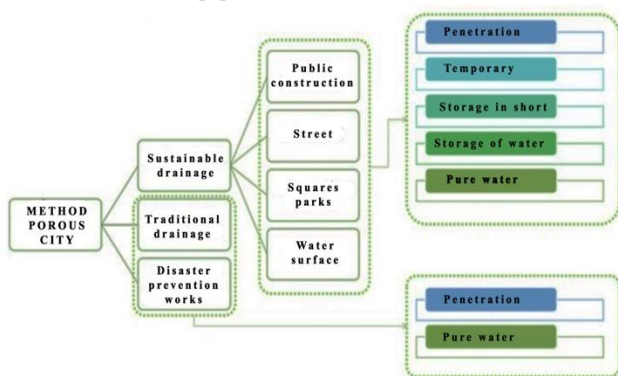


Figure 3. Urban drainage escape solutions group according to the Sponge City model (Peter Nicholson, 2020).

In another interpretation of a porous urban structure, it is considered a useful version that responds to coping with the increasingly heightened climate change, leading to the consequences of extreme weather events and natural disasters. It means that watershed planning is identified as playing a role that is even more crucial and distinct. [6]

C. *Experience in applying lightweight urban models worldwide.*

1) *Germany*

There are 2 consequences of climate change, Berlin is mitigating flooding and severe storms within the city. This is achieved by allowing a portion of rainfall to permeate into the ground, while the remaining portion (due to urbanization and a reduction in greenery) is directed through drainage systems into reservoirs for retention and cooling purposes during the summer. Furthermore, Berlin consistently incorporates additional greenery, covering rooftops with grass and moss, painting buildings with bright colors, applying thermal insulation layers along streets to prevent asphalt from melting during hot weather, and planning water storage, leading to avoiding being "locked" in a landscape dominated by

concrete and asphalt, transforming into permeable surfaces, parking lots and medians [7].

2) *Thailand*

Voraakhom Park in Bangkok has been transformed into a lush green oasis, offering expansive recreational spaces, and playgrounds. Since its opening in March 2017, the park has garnered the attention of numerous students and residents. In addition to its other important functions, the 4.5-hectare area serves a crucial role for this flood-prone city in its ability to collect and manage rainfall during storm seasons. Thereby mitigating the urban heat generated by high temperatures influenced by human activities in the summer. This park can hold up to nearly 1 million gallons of water (about 4 million liters) during severe flooding events through its design for controlled inundation. [8].

III. RESULTS

A. **The perspective of urban planning for sustainable development adapting to the harsh weather phenomenon in Da Nang City**

1) *Orientation for sustainable tourism development::*

- Sustainable tourism: Tight management of tourism infrastructure, investment in green infrastructure such as parks, eco-friendly green spaces, promotion of public transportation usage, cycling, and walking to reduce emissions. Furthermore, it is essential to manage excessive tourism growth to prevent situations of overloading that can adversely impact the environment and local community, leading to achieved by restricting both the quantity and types of tourists visiting attractions, with a focus on providing high-quality experiential opportunities.

- Promote sustainable tourism is closely integrated into environmental conservation efforts. Tourists should be encouraged to engage in nature-experience activities with environmental awareness in receiving the transmission of local cultural significance and values. This aids in the preservation and development of Da Nang's cultural heritage.

- Ensure a balanced benefit between the tourism industry and the local community. Tourism businesses should create employment opportunities for the residents and local products.

- Collaboration and Cross-disciplinary Management: Establishing a collaborative model among local authorities, tourism businesses, and communities in sustainable tourism trends with the stakeholders involved benefits.

2) *Watershed Planning*

- Enhancing Waterlogging and Flood Resistance Capability: The watershed planning is designed to have the capacity to efficiently collect and process rainfall, thereby minimizing the risk of waterlogging and urban flooding.

- Developing a natural drainage system: Incorporating porousness into the watershed plan involves safeguarding and generating green spaces, natural river systems, permeable land areas, parks, and green zones to enhance natural water drainage capacity.

- Functional diversification: The watershed planning should possess the capability to diversify the functions of

land usage, ranging zones to commercial, industrial, and recreational zones, to foster flexibility in land utilization and adaptation to the urban environment's changes.

- Designing a network to connect urban drainage systems: The watershed planning needs to be consistently integrated with other elements of the porous city, such as transportation, infrastructure, and urban residents.

- Sustainable Management: Resilience in watershed planning ensures sustainable management, encompassing activities from rainwater collection to wastewater treatment, as well as water source preservation.

B. Watershed planning affecting the porous urban

1) The Coastal Structural Characteristics

The coastal sandy shores lead to erosion of the coastal structures throughout the seasons during the rainy and stormy seasons at the coastline of Da Nang. It means that high tides and wave levels affect the coastline, roads, and coastal structures. Furthermore, the coastline of Da Nang plays a crucial role in generating sand movement and gravel within the area, leading to pushing sand or rock particles in various directions, leading to erosion phenomena in coastal regions, the lower-lying areas, and inundation in these areas. The consequences of these phenomena are detrimental to the coastal structures and the shoreline infrastructure.

Tropical storms are a crucial factor influencing the coastal structure of Da Nang City with rocky slopes such as Son Tra Peninsula, Hon Chao Island, Bai Sung Co Beach, and Black Rock Beach. It is explained by the strong influence of high winds, tall waves, and heavy rainfall during storms, lead to severe erosion alterations to the coastal structure. Furthermore, the coastal structure of Da Nang City is also influenced by the coastal facilities and transportation infrastructure such as roads, bridges, tourism services, etc.

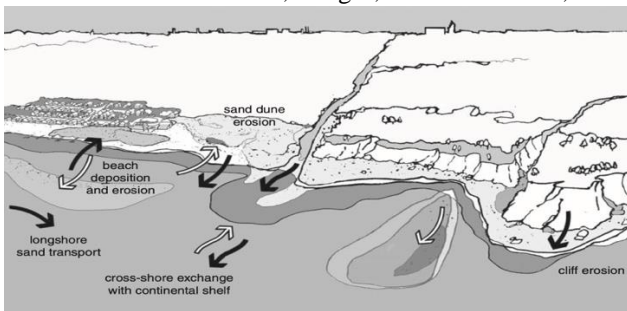


Figure 4. Coastal Structure in Danang City

2) Proposed Solution

Rainfall and tidal intensity contribute to the flooding occurrence and high tides. Firstly, heavy rainfall causing flooding and tidal intensity (the increase in seawater level) can affect coastal areas. Therefore, the water design flows the regulation of watershed management, and technical solutions to control water flow in heavy rain or high tides. This is achieved through the design of drainage systems, water reservoirs, rainwater drainage systems, and other relevant infrastructure to ensure efficient water circulation.

Furthermore, the extreme weather phenomena, including abnormal climate situations such as heavy rain, storms, high tides, and severe droughts, watershed planning

needs to be integrated with urban infrastructure to ensure safety and sustainability for residents. The coastline's Da Nang City has a unique geographical position closely tied to frequent occurrences of extreme weather events each year.

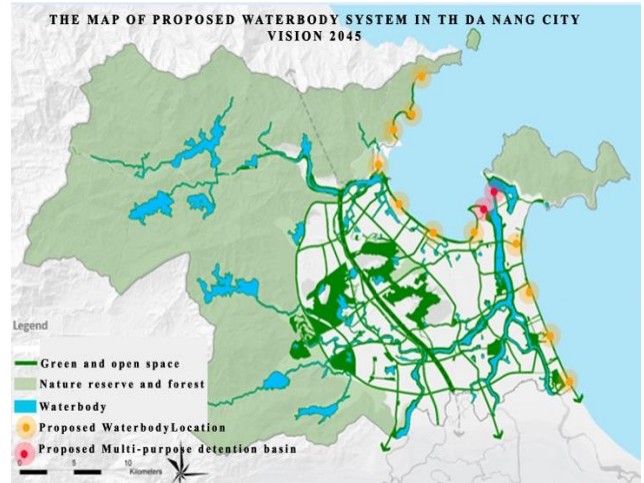
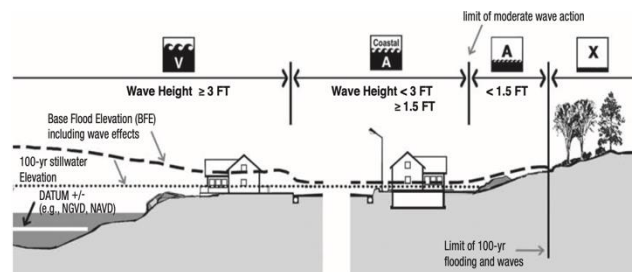


Figure 5. Proposed Map of Multi-functional Infiltration Position in Watershed Planning.

Based on the watershed planning map of Da Nang City, the authors determine that setting up water collection points and storage along the coastal road plays a crucial role. In this context, the authors have identified several potential danger points (a total of 11 points) where significant erosion events could occur. The identifying purpose establish a water collection and storage system, aiming to minimize the flooding risk in the coastline and inhabited regions that are exposed to these danger points [9].



Hình 7. House constructed before NFIP provision

"A special case that is mentioned involves a location situated on both sides of the Thuận Phước Bridge, which is the intersection of sea and river. Notably, this location is also considered a vital wind funnel of the Son Tra Peninsula. In this context, the author has proposed the construction of a versatile container structure, which holds particular significance and importance compared to other storage structures. This model may be related to regulating water flow, safeguarding coastal areas against flooding, and simultaneously capitalizing on the opportunity to create an efficient interaction between freshwater and saltwater systems [9]

In watershed planning, identifying potential hazardous points and implementing water storage are crucial components to ensure the safety and sustainability of the environmental system and population within the context of changing weather patterns in Da Nang City [9].

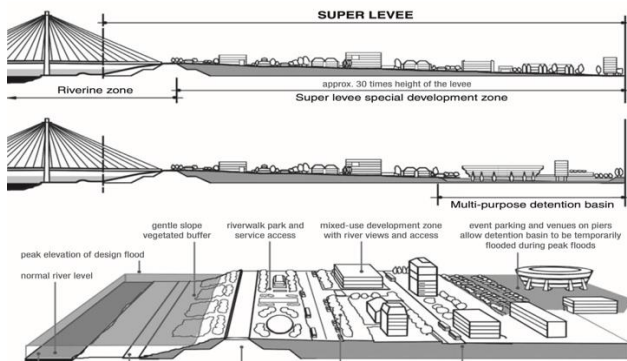


Figure 8. Super levees and multipurpose retarding basins (temporary flood detention areas) are part of flood control, river enhancement, and urban reinvestment zone initiatives.

IV. CONCLUSION

Coastline's Da Nang City has strong potential for robust development due to its unique geographical location,

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comprehensive infrastructure, attractive investment, business opportunities, and appealing living environment.

However, achieving development concurrently with environmental protection is of utmost importance, to leverage the strengths of coastal tourism in Da Nang City and maintain the value of coastal urban in the future. In this context, the article aims to address the sustainable development criteria of a highly vulnerable urban area like Da Nang. Within these criteria, watershed planning is considered the most crucial factor. Therefore, based on analyses of favorable geographical location, robust infrastructure appeal living environment, and the backdrop of extreme weather along the coastline's Da Nang City, the authors propose several solutions to contribute to the construction and development of a tourism-oriented urban landscape, similar to that of Da Nang City.

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