



# URBAN DESIGN ADAPTING TO CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT OF QUY NHON CITY

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## Abstract

**Backgrounds:** Adaptation to climate change is one of the important criteria of sustainable urban development. Quy Nhon is a coastal city in Viet Nam that is affected a lot by climate change and sea level rise. If there is no timely solution, the impact of climate change will affect the sustainable development of the city. Therefore, adapting to climate change in Quy Nhon city is a problem that needs to be discussed.

**Purpose:** The article aims to discuss the concept of strategy in urban design to adapt to climate change, promoting the sustainable development of Quy Nhon city.

**Methodology/ approach:** The approaches to sustainable development are outlined: natural – based approach and water-sensitive urban design. The article focuses on urban design solutions, including urban planning and landscape design.

**Findings:** Green infrastructure is effective in most urban areas, making an important contribution to the sustainable development of Quy Nhon city.

**Values:** The article developed a new strategy for the urban design of Quy Nhon city that concerns in ability to adapt to climate change.

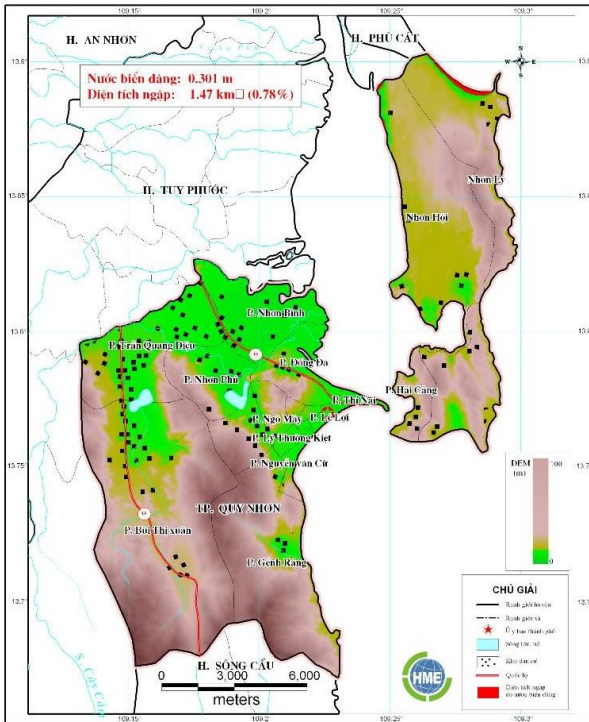
**Keywords:** *Sustainable development, Quy Nhon city, urban design, climate change*

## 1. Introduction

Quy Nhon is a seaport city in the Central Coast region, Vietnam and the administrative center of Binh Dinh province, Vietnam. Quy Nhon has many different terrains, diverse geographical landscapes such as mountains, hills, fields, lagoons (Thi Nai Lagoon), lakes (Phu Hoa Lake, Nhon Phu Ward), and rivers (Ha Thanh River), sea, peninsula (Phuong Mai Peninsula). Quy Nhon's coastline is 72 km long, with a large area of lagoons and brackish lakes, rich marine resources, and many types of precious specialties with high economic value. The city's main economic sectors include industry, trade, import and export, seaport services, seafood farming and exploitation, and tourism. Cultural conditions, geographical location, transportation system, natural conditions... are advantages for Quy Nhon city to rise to the level of a class I urban area and create new motivation for sustainable development.

Early 21st century, the global warming had been coming, Quy Nhon city is strongly affected by climate change. Under the impact of climate change, sea levels

will rise, natural disasters, especially storms and heavy rain, will likely increase in both intensity and frequency. In the future, it will be difficult for the City's current dyke infrastructure system to effectively respond to complex changes in climatic factors such as changes in rainfall regimes with more concentrated rainfall. During the rainy season, sea level rises, high tides and the frequency and intensity of natural disasters, storms and floods increase. The sea level may rise higher than 0.12 m, the drainage system will degrade over time, and heavy rains may increase in both frequency and intensity and be difficult to forecast. All will reduce or not meet drainage needs and may lead to re-flooding. [6]



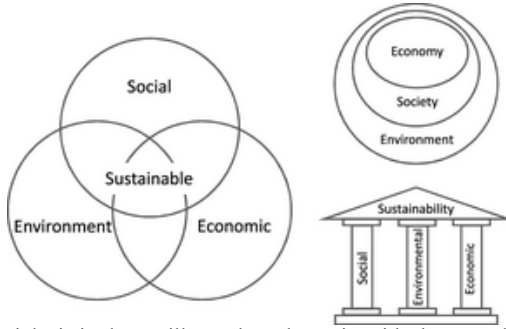
**Fig 1.** Flood map of Quy Nhon in the highest risk script [6] Tuy Phuoc district), reducing agricultural production area and affected farmers' livelihoods.

**2. Literature Review**

Sustainable development has its roots in ideas regarding sustainable forest management, which were developed in Europe during the 17th and 18th centuries. The direct linking of sustainability and development in a contemporary sense can be traced to the early 1970s. In 1975, an MIT research group prepared ten days of hearings on "Growth and Its Implication for the Future" for the US Congress, the first hearings ever held on

It can be seen from the flood map, the area affected by flooding is a low-lying area in Nhon Binh, Nhon Phu, Quang Trung communes and a part of Phuong Mai peninsula. The entire flooded area is influenced by the tidal regime of Quy Nhon Bay. On the other hand, prolonged drought combined with rising sea levels will cause salinity in irrigation areas, leading to a shortage of irrigation water (especially in the 4 eastern communes of

sustainable development. In 1992, the UN Conference on Environment and Development published the Earth Charter, which outlines the building of a just, sustainable, and peaceful global society in the 21st century. [2]



Several visual representations of sustainability and its three dimensions: the left image shows sustainability as three intersecting circles. In the top right it is a nested approach. In the bottom

right it is three pillars. The schematic with the nested ellipses emphasizes a hierarchy of the dimensions, putting environment as the foundation for the other two. [5]

**Fig 2. Dimensions of sustainability**[2]

The Paris Agreement exemplifies efforts of political will on a global level, a multinational agreement between 193 parties intended to strengthen the global response to climate change by reducing emissions and working together to adjust to the consequent effects of climate change.[2] Cities are both factors that directly impact global warming and are severely affected by climate change. The need to mitigate and adapt to climate change and build resilience is the top priority in urban development policy. Certain solution needed to be implemented to adapt to this change and mitigate the impact.

Cities are both factors that directly impact global warming and are severely affected by climate change. The need to mitigate and adapt to climate change and build resilience is the top priority in urban development policy. Certain solution needed to be implemented to adapt to this change and mitigate the impact. Because climate change and urban development are closely interlinked and often interact negatively, it will be shown that a big part of measures dealing with climate change can be taken from the toolbox of sustainable



**Fig 3. Nature – based solutions** [3]  
urban development.

### 3. Methodology

The International Union for Conservation of Nature (IUCN) defines *Nature-based solutions* NBS as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits".

*Nature-based solutions (NBS)* in urban planning involve integrating natural elements and processes into the design, development, and management of cities to address various environmental, social, and economic challenges. These solutions leverage the inherent benefits provided by ecosystems and biodiversity to create more sustainable, resilient, and livable urban environments. Here are some examples of nature-based solutions in urban planning:

**Green Infrastructure:** Incorporating green spaces such as parks, urban forests, green roofs, and green walls into urban areas helps to mitigate the urban heat island effect, improve air quality, manage stormwater, and enhance biodiversity.

**Urban Agriculture:** Introducing community gardens, rooftop gardens, and urban farms promotes local food production, reduces food miles, enhances food security, and provides opportunities for social interaction and education.

**Natural Water Management:** Implementing strategies like restoring wetlands, creating green buffers along water bodies, and constructing rain gardens helps to manage stormwater runoff, reduce flooding, improve water quality, and recharge groundwater.

**Biodiversity Conservation:** Protecting and enhancing natural habitats within urban areas, such as wetlands, forests, and urban wildlife corridors, supports native species diversity, improves ecosystem resilience, and provides recreational and educational opportunities.

**Natural Climate Solutions:** Utilizing natural features like urban forests and green spaces to sequester carbon dioxide, mitigate urban heat islands, and buffer against extreme weather events contributes to climate change adaptation and mitigation efforts. [3]. By integrating these nature-based solutions into urban planning practices, cities can become more sustainable, resilient, and equitable while fostering a closer relationship between residents and the natural environment.

***Water Sensitive Urban Design (WSUD)*** is an approach to urban planning and design that aims to integrate water management into the built environment sustainably and holistically. It recognizes the interconnectedness of water systems, the environment, and urban infrastructure, seeking to minimize negative impacts on water resources while enhancing urban liveability and resilience. [3]

According to the Viet Nam Institute of Green Urban Science and Technology, Nature-based Solutions have some advantages:

- More cost-effective in the long term,

- Designed as flexible and sustainable climate adaptation solutions,
- Highly adaptable and resilient
- Providing urban living environments and delivering benefits from biodiversity
- Providing shade and reducing the urban heat island effect
- Controlling air and noise pollution
- Providing social and spiritual benefits

*Grey Infrastructure and Broken Connections*

The landscapes that we inhabit are visibly interconnected: motorways connect urban and rural settlements; power lines transport energy and connect power stations to individual families; aqueducts transport drinking water from reservoirs to our kitchens; trucks on highways that carry fertilizer and herbicides connect factories with farms. Supposedly, we have created a connected world. However, the landscape matrix and its invisible processes are fragmented and disconnected. The movement and cycles of water, nutrients, food, energy, species, and people are broken. Their interconnected relationship is being interrupted, and in a harmful way, more than ever before.

Grey Infrastructure	Blue/Gray combined solution	Green Infrastructure
Traditional techniques, using concrete and steel, do not fully consider ecological sustainability	Combining ecosystem elements and gray engineering interventions to realize goals	Create, simulate or restore ecosystem elements to achieve development goals

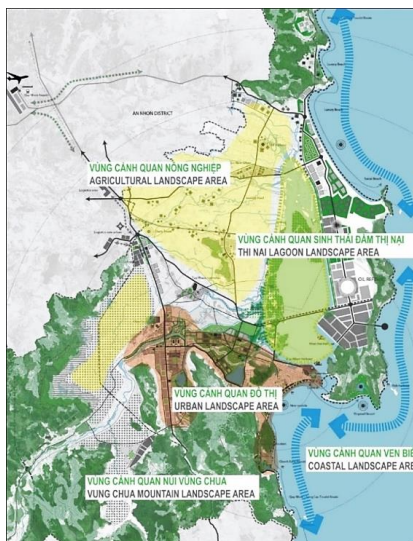
**4. Results and Discussions**

By assessing the impact of climate change on Quy Nhon urban development according to corresponding flood scenarios and maps, using nature-based planning tools, it is possible to evaluate the urban planning solutions. Here are some solutions that were performed:

*Urban planning solution*

Solutions to preserve and consolidate undeveloped natural lands

- Building an "Urban Agriculture" model in flooded rural areas of Tuy Phuoc district. This is a model



*Fig 4. landscape zoning of Quy Nhon city [4]*

applied in rural areas adjacent to urban areas and is mutually supportive, capable of promoting economic development for people while still maintaining the agricultural landscape. preserve agricultural land area. Rural development adapts to negative impacts and limits the risks of climate change.

- Control construction battles in riverine areas, flood corridors, and estuaries. For village clusters along the Thi Nai Lagoon area, limit expansion and new construction to avoid obstructing flood drainage. Encourage the relocation of residential areas along Thi Nai Lagoon to the center of the district to protect the landscape environment and limit urbanization activities that narrow the river mouth.

- Ecological area along Thi Nai: An area associated with agricultural economic development, acting as a buffer space to limit urban development. Here developing an "urban agriculture" model that applies technology to create high-quality agricultural products to supply to the market and identify offensive drainage behaviors to minimize extreme activities that contribute to climate change. It is necessary to restore mangrove forests with aquaculture. Preserve natural ecosystems of all estuaries; Illegal construction; Encourage conversion of crops for tourism. It is necessary to design tourist waterways to create attractions for tourists. The system of public boat wharves must also meet the requirements of harmonious and natural architecture. At this marina, it can be combined with other system information communities so that customers can access it conveniently.

*Green/grey infrastructure solutions:*

- Ha Thanh River area: This is a large river flowing through Quy Nhon city. Due to the high risk of flooding, the proposed orientation is to develop green flood drainage corridors on both sides of the river with a distance between 30 meters to 50 meters, which will not only have the effect of draining water in the rainy season but also contribute to creating landscapes on the riverside in the winter. dry season. In the non-flooding season, equivalent to 11 months, green spaces on both sides of the river can become public spaces and recreational spaces to serve urban and rural residents.

- Forming a green landscape space along the two river banks, with a minimum distance of 30m, creating public living, resting, and sports spaces for the City's people. Exploiting Ha Thanh River to become a green corridor to bring unique natural landscape values into the city's space and at the same time connect important spaces of the city. It is proposed to plant trees that have the effect of preventing landslides and preserving soil, and at the same time, the distance between trees must still ensure flood drainage and water drainage when there are floods and waterlogging.





**Fig 5. Illustration of Solution for Ha Thanh River [4]**

*Shore remediation solutions:*



**Fig 6. Dong Da lake [4]**

WSUD tools to help improve water quality, create vibrant community spaces. Steps, waterside grounds and boardwalks provide diverse experiences along the water's edge. Example: Design and renovation of Dong Da ecological lake:

Located in the overall complex of Quy ecological lake is directly connected to the inflow and outflow of sea water, contributing a very important role in promoting the beautification of the green and urban environment cleaner.

*Solutions of parks and greenways*

The walking axis along main avenue serves as both a landscape axis and a green space to help reduce the urban heat island. In addition, this space can serve the daily needs of urban residents as well as the visiting and walking needs of tourists. Paving materials and green plants are designed to create uniformity and uniqueness of the walking space.

Park strips and greenways have the following effects: Increase carbon absorption through green space; Green infrastructure helps regulate water vapor and balance water in urban areas. Building the ability to absorb small amounts of rain, increasing the ability to adapt to climate change in Quy Nhon urban area.



**Fig 7. Green Park in Quy Nhon center [4]**



**Fig 8.** *Green area in Quy Nhon city [4]*

Shortly, many important activities for Quy Nhon City's climate change adaptation planning are proposed as follows:

- + In-depth research for the eastern communes on vulnerability due to climate change and guidelines for planning urban development, construction, infrastructure, and agriculture.
- + Research, design, repair and upgrade of river and sea dike systems to strengthen them and ensure safety in extreme conditions in the future.

## 5. Conclusion

Urban planning to adapt to climate change is important for the sustainable development of Quy Nhon City. Solutions for infrastructure, and planning are outlined:

- Nature-based solutions, applied to the flooded areas of Tuy Phuoc district and along Thi Nai lagoon, have the following advantages: 1) adapt to climate change, ensuring sustainability; 2) provide urban habitat and biodiversity benefits; 3) Bring social and spiritual values to urban people.

- Solution combining green and gray infrastructure designed for Quy Nhon city: Construction of green corridor on both banks of Ha Thanh River, design of Dong Da ecological lake, Nguyen Tat Thanh green promenade, etc. Used to reduce load during the rainy season, reducing pollution.

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