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Lessons from ancient houses in Dong Hoa Hiep village – sustainable architecture in the face of climate change

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KEYWORDS

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ABSTRACT

Climate change is increasingly having a significant and evident impact on the Mekong Delta, in Vietnam, negatively affecting various aspects of daily life, culture, and society for the local communities. In particular, housing is a type of architectural structure that is directly influenced by extreme weather phenomena. These impacts include (i) heat causing thermal discomfort; (ii) heavy rains, flooding, and erosion leading to landslides and the collapse of riverside structures; and (iii) droughts causing saltwater intrusion, freshwater shortages affecting the house-garden ecosystem. In this context, the ancient houses in the Dong Hoa Hiep ancient village, located in Cai Be District, Tien Giang Province, which have been recognized for their cultural and artistic heritage values, have demonstrated their ability to adapt to climate change in the current era through architectural solutions developed by previous generations over hundreds of years. This study aims to synthesize and analyze the climate-adaptive design solutions found in the ancient houses of Dong Hoa Hiep village, thereby drawing lessons on climate-adaptive architecture for housing in the Mekong Delta region.

1. Introduction

Global climate change is no longer a future issue; its negative impacts are already occurring. Some changes, such as droughts, wildfires, and extreme heavy rainfall, are unfolding more rapidly than previously assessed by scientists. In fact, according to the Intergovernmental Panel on Climate Change (IPCC) - a United Nations body established to assess climate change science - modern humans have never witnessed the scale of changes currently observed in the global climate. Some of these changes will be irreversible for hundreds to thousands of years. The IPCC's Sixth Assessment Report, published in 2021, found that human greenhouse gas emissions have warmed the climate by nearly 1.1 °C above pre-industrial levels (starting from 1750). Global average temperatures are projected to reach or exceed 1.5 *°C in the coming decades [1]. According to the World Meteorological Organization, in 2023, global mean sea levels reached a record high in satellite records (dating back to 1993), reflecting the continued warming of the oceans as well as the melting of glaciers and ice sheets. The rate of global sea level rise over the past decade (2013–2022) was twice as fast as the rate recorded in the first decade of satellite observations (1993–2002) [2].

Due to urbanization and industrialization, the construction industry is considered one of the main contributors to global climate change through greenhouse gas emissions, energy consumption, and the depletion of natural resources. The relationship between this industry and climate change is particularly critical, as Vietnam faces mounting pressure from rapid population growth and the increasing demand for construction in the near future. In the context of encouraging a global response to the threat of climate change, architectural solutions and sustainable building practices are essential, especially in rural areas that are highly vulnerable to natural disasters and have limited adaptive capacity [3].

The Mekong Delta region is no exception in the global climate change scenario. As one of the world's largest deltas, it is home to 17 million people and contributes over half of Vietnam's rice production. However, the Mekong Delta faces multiple threats, some arising from ongoing climate change and others resulting from human activities within the delta or upstream. Global climate change is expected to increase temperatures and alter rainfall patterns in this region. The Mekong Delta, including Tien Giang province, is experiencing environmental consequences due to climate change impacts, not only in the form of sea level rise but also saltwater intrusion, land erosion, erratic rainfall, and storms [4]. In response to these challenges, Tien Giang province has been actively implementing various measures to prevent and mitigate natural disasters, protect agricultural production, and ensure the stability of people's livelihoods -especially in rural areas, where housing is most vulnerable to climate-related damage.

The housing architecture in the Mekong Delta is facing severe challenges due to climate change, particularly flooding, saltwater intrusion, and sea level rise. These issues not only damage building foundations but also accelerate the deterioration of structures and construction materials, while significantly impacting the garden-house

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ecosystem. Traditional housing models, such as stilt houses - historically designed to adapt to flooding conditions and proven effective for centuries - are becoming increasingly rare. Instead, spontaneously built row houses and townhouses with inadequate designs are more common. These structures often fail to withstand the harsh conditions brought about by climate change. Additionally, high construction costs and a lack of support programs further hinder the development of sustainable housing in the Mekong Delta [5].

Tien Giang is a typical province of the Mekong Delta, characterized by an extensive network of rivers and a long coastline. According to the 2021 climate change scenario, erosion along major canals and inland waterways is expected to become increasingly complex across most areas of Tien Giang, particularly in rural regions, including the historic Dong Hoa Hiep village (DHH). Located in Cai Be district, Tien Giang province, DHH village is home to century-old houses that are considered unique architectural masterpieces, despite enduring historical upheavals. Notable examples include the Kiet House, Ba Duc House, and Xoat House. In recognition of its artistic and architectural significance, the village was designated as a National Historic Site by the Ministry of Culture, Sports, and Tourism under Decision No. 2080/QD-BVHTTDL in 2017. Researchers regard the village as a valuable cultural heritage site with great potential for ecological tourism development [6].

Currently, in DHH ancient village, approximately 5 to 7 historic houses remain, serving as vivid examples of traditional architecture with exceptional value in climate change adaptation. In November 2023 and September 2024, two field surveys were conducted in the village to study, document, and measure the architectural features and microclimate conditions of these heritage homes. These surveys focused not only on analyzing innovative architectural solutions but also on collecting data on spatial arrangements, decorative details, and garden landscapes, thereby clarifying the relationship between architecture and the local climate. Additionally, secondary data was gathered from reputable sources, including academic research, scientific journals, doctoral dissertations, and master's theses. The collected data was then systematically compiled, compared, and evaluated to highlight and confirm the climate-adaptive architectural values of the DHH ancient houses. Through this process, valuable lessons for contemporary housing design in the Mekong Delta were drawn.

2. Climate change scenarios in the Mekong Delta and in Tien Giang

According to the updated 2020 climate change scenario published by the Ministry of Natural Resources and Environment, the Mekong Delta is among the most vulnerable regions and is expected to face severe impacts from climate change and sea level rise. Projections indicate that sea levels could rise by up to 100 cm by the end of the 21st century, putting vast areas of land in the region at risk of flooding. Provinces such as Tien Giang, Ben Tre, Tra Vinh, Soc Trang, Bac Lieu, Ca Mau, and Kien Giang are predicted to experience high inundation rates. If the sea level rises by 100 cm, an estimated 47.80 % of Tiền Giang's total area, 77.22 % of Tan Phuoc district, and 56.05 % of Go Cong Tay district could be submerged. Additionally, coastal provinces such as Ben Tre and Tra Vinh are also expected to suffer significant impacts from sea level rise [7].

The forecast also indicates that the average annual temperature in the Mekong Delta under the RCP8.5 scenario (a high greenhouse gas concentration scenario) will increase by 1.7 °C to 2.0 °C by the mid-21st century and could reach 3.2 °C to 3.5 °C by the end of the century, accompanied by a rise in extreme temperatures. Rainfall patterns are also changing, with an increase of 10-15 % by the mid-21st century and 10-25 % by the end of the century, but with uneven distribution, leading to alternating floods and droughts. The situation is further exacerbated by land subsidence in the region, primarily caused by excessive groundwater extraction. The total average subsidence from 2005 to 2017 for the entire region was 12.3 cm, with an average rate of 1.07 cm per year, increasing the risk of flooding [7,8].

These impacts not only affect agricultural production but also threaten people's livelihoods, infrastructure, natural ecosystems, and especially residential structures. The Vietnamese government has introduced several adaptation measures, including strengthening the dyke system, constructing flood prevention structures, and planting mangrove forests. However, closer cooperation between different levels of government, international organizations, and local communities is still necessary to mitigate the effects of climate change and ensure the long-term sustainability of the Mekong Delta region.

Climate change is posing serious challenges to housing architecture in the Mekong Delta, directly impacting the sustainability of structures and the quality of life for local communities. Rising temperatures and prolonged droughts lead to water scarcity, affecting daily life while also increasing thermal discomfort in living spaces, posing health risks. Additionally, heavy rainfall causes flooding, weakening foundations, damaging building materials, and increasing the risk of structural degradation and collapse. The growing severity of riverbank erosion and landslides directly threatens the safety of riverside homes, which are a key feature of the traditional settlement system in southern Vietnam. Furthermore, rising sea levels exacerbate saltwater intrusion, affecting building structures and traditional garden ecosystems. Salinization not only reduces the durability of construction materials but also has far-reaching impacts on plant ecosystems, leading to long-term consequences for housing models and local livelihoods. The impacts of climate change on housing architecture in the Mekong Delta are summarized in Table 1.

3. Current status of ancient house architecture in DHH ancient village

The ancient houses in DHH ancient village are a remarkable representation of traditional Southern Vietnamese architecture, harmoniously blending Eastern architectural elements with Western influences. These historic houses not only showcase sophisticated

design but also reflect the cultural lifestyle, customs, and spiritual beliefs of the local people. With a history spanning hundreds of years, the DHH ancient houses serve as a testament to the evolution of traditional architecture across generations and play a crucial role in preserving both the tangible and intangible cultural heritage of the Mekong Delta region [6,9].

The ancient houses of DHH follow the Southern Vietnamese garden house style, featuring a layout of either "three main halls with two wings" or "five main halls with two wings", a typical architectural form in the Mekong Delta, where people traditionally live in harmony with nature. These homes are set within spacious gardens filled with fruit trees, large rainwater storage jars, and airy verandas, all contributing to a seamless connection between the house and its surrounding landscape. The DHH ancient houses also adhere to the traditional principle of “first near the market, second near the river, third near the road” (“nhất cận thị, nhị cận giang, tam cận lộ" in Vietnamese) - meaning close to the market, near the river, and accessible by road. This strategic positioning not only facilitates daily life and agricultural production but also reflects the unique cultural identity of the riverine communities in Southern Vietnam.

In DHH ancient village, seven traditional houses remain, built in the classic Southern Vietnamese architectural style with a "three main halls and two wings" layout, in either the “Nhất” (一) or “Đinh” (丁) shape. There are two main architectural styles: purely Vietnamese houses (Rọi or Ruong houses (“nhà Rường” in Vietmese), constructed during the feudal period) and houses influenced by Western architecture (built or renovated during the French colonial era) [6]. The colonial-style houses feature architectural elements such as doors, windows, verandas, arches, classical columns, and intricately decorated balustrades - all adorned with refined Western-style motifs and reliefs. Nevertheless, their interiors remain true to traditional Vietnamese architecture, with a clearly defined spatial arrangement for worship, guest reception, and family living areas. The ancestral altar, placed in the most dignified position, is adorned with elaborate carvings, reflecting deep respect and reverence for ancestors—a core value in Vietnamese culture.

The houses of Mr. Xoat, Mr. Kiet, and Mr. Ba Duc (Figure 1) are considered outstanding examples of ancient architecture in DHH [9]. Among them, Mr. Kiet’s house follows the traditional "three main halls and two wings" structure, embodying classic Southern Vietnamese design, while Mr. Xoat’s and Mr. Ba Duc’s houses exhibit strong Western architectural influences. These houses are not only architecturally significant but also serve as repositories of cultural and historical narratives passed down through generations. Mr. Kiet’s house has been recognized by the Japan International Cooperation Agency (JICA) as one of the most beautiful ancient houses in Vietnam and has also been acknowledged by UNESCO Asia-Pacific as a cultural heritage site. Meanwhile, Mr. Xoat’s house was designated as a provincial-level architectural and artistic heritage site in 2014.

The ancient houses of DHH are not merely places of residence but also custodians of intangible cultural values, serving as cultural spaces where traditional community activities such as “Đờn ca tài tử” (southern folk music), traditional festivals, and ancestral worship rituals have been preserved and passed down for generations. These houses are not just a heritage of the local people but also priceless cultural assets that contribute to the preservation of national identity and the promotion of sustainable tourism in the region. However, after centuries of existence, the DHH ancient houses are facing severe deterioration. Restoration and renovation efforts are sometimes carried out improperly due to a lack of technical guidance or financial constraints. Many wooden structures have suffered from termite damage, weakening their load-bearing capacity and affecting the overall stability of the buildings. Moreover, original materials such as cement tiles, traditional clay tiles, and wood are gradually being replaced with modern materials, which may compromise the authenticity of the original architecture. To effectively preserve this heritage, close cooperation is required between local authorities, heritage management agencies, relevant organizations, and preservation experts. Developing appropriate conservation policies in alignment with sustainable development strategies will not only help protect the architectural and cultural values of DHH ancient houses but also ensure their long-term viability and relevance in the modern era.

4. Climate change adaptive architecture in ancient houses in the ancient Dong Hoa Hiep village

Beyond their cultural and historical value, the climate-adaptive architectural features of the DHH ancient houses stand out as a particularly distinctive and significant aspect. These houses incorporate adaptive design solutions to mitigate flooding and saltwater intrusion, such as integrating gardens, ponds, and canals to effectively store and drain water. Additionally, their architecture is well-suited to the local climate, featuring steeply sloped roofs to shield against intense sunlight and heavy rain, and an orientation toward the south or southeast to capture cool breezes while avoiding the harsh western sun. Natural materials are also utilized to minimize heat absorption, enhancing thermal comfort. The climate-adaptive design strategies of the DHH ancient houses are detailed in Table 2 (Figures 2–6).

The traditional DHH houses possess several advantages in adapting to climate change, demonstrated through: (i) the use of natural materials that help prevent overheating and maintain indoor thermal balance; (ii) a sturdy structure with sloping tiled roofs and durable wooden frames, which mitigate the impacts of storms and reduce leakage risks; (iii) an ecological garden system, including ponds, canals, and waterways, which regulate water flow and minimize flooding risks. Additionally, the sustainability and environmental friendliness of these traditional houses are further reflected in passive design solutions that optimize adaptability without increasing carbon emissions. However, in the face of increasingly complex climate change challenges, traditional ĐHH architecture also

encounters several issues, including: (i) rising sea levels and saltwater intrusion threatening garden ecosystems; (ii) erosion and landslides posing risks to houses near riverbanks; (iii) prolonged heat waves affecting thermal comfort and disrupting the microclimate balance; (iv) low house foundations increasing the risk of flooding during extreme storms. These factors necessitate appropriate improvement strategies to preserve the value of traditional architecture while enhancing resilience in an increasingly dynamic living environment.

To enhance the climate change adaptation capacity of traditional DHH architecture in particular and the Mekong Delta in general, a combination of effective conservation and renovation solutions can be applied. These include (i) Strengthening embankment systems and planting vegetation to prevent erosion, landslides, and saltwater intrusion; (ii) Raising house foundations and improving drainage systems to cope with storms and flooding; (iii) Mitigating heat and drought impacts by expanding green spaces, optimizing natural ventilation, utilizing renewable energy, and implementing rainwater harvesting; systems; (iv) Promoting sustainable conservation by reinforcing structures, upgrading materials, and renovating or expanding traditional houses while maintaining architectural harmony; and (v) Enhancing community awareness of heritage conservation and fostering interdisciplinary collaboration, alongside financial, human resource, and policy support for heritage preservation planning. Table 3 presents a comprehensive overview of the proposed conservation and renovation solutions for traditional DHH houses to improve their climate resilience.

Table 1. Impact of climate change on housing architecture (Source: authors).

Impact of climate change	Impact of climate change on housing architecture
Prolonged drought and rising temperatures	Fresh water resources are scarce, there is a lack of domestic water; High temperatures cause the covering materials to deteriorate easily, increasing the heat absorption into the house, making the living space hot and not ensuring thermal comfort.
Unusual heavy rains causing flooding	Flooding causes damage and deterioration of natural building materials such as wood and bamboo; House structures are at risk of collapse due to water gradually weakening the foundation; Drainage systems do not ensure timely drainage.
Riverbank erosion	Riverside houses are at risk of collapse due to erosion causing foundation landslides.
Rising sea levels causing saltwater inundation	House foundation structures are affected and damaged due to salinity; Water supply and drainage systems are affected by salinity, affecting daily life; The ecosystem of Southern garden houses is affected.

Figure 1. From left to right: Mr. Xoat, Mr. Kiet, and Mr. Ba Duc Houses.

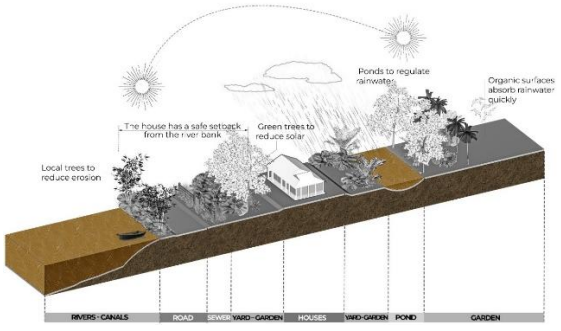

Figure 2. Climate change adaptation solutions for an ancient DHH house.

Figure 3. Shading and rain protection solutions with sloping roof and porch in the house of Mr. Xoat (left, middle) and Mr. Ba Duc (right).

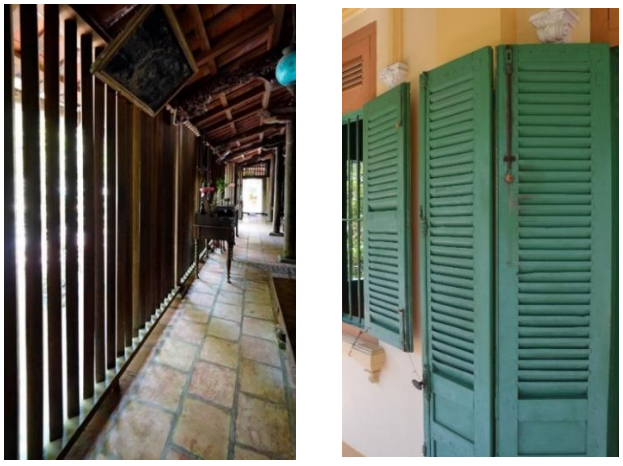

Figure 4. Natural ventilation solution with louvered doors, slatted walls, and tiled roofs in the house of Mr. Kiet (left) and Mr. Ba Duc (right).

Figure 5. Natural lighting solution with gable roof and slatted wall in Mr. Kiet's house.

Figure 6. Solution to limit heat penetration using tile, wood, and brick materials in Mr. Ba Duc's house.

Table 2. Climate change adaptation design solutions in ancient houses in the ancient DHH village.

Impact of climate change	Design strategy	Design Solution	
		Planning	Architecture
Rising sea levels cause saltwater intrusion	Prevent salt, prevent salt contamination	Flexible and suitable garden/planting arrangement	Natural materials (wood, stone) are resistant to salt contamination.
Unusually heavy rain causes flooding	Drainage system	Organize a pond/lake system to collect/store water.	Pitched roof, porch (row three), rain protection, gutters to collect and drain rainwater.
Prolonged drought and rising temperatures	Natural ventilation	Build houses facing South and Southeast, plant fruit trees to shade the West and East, and organize ponds/lakes at the windward end.	Organize cross-room ventilation (horizontal and vertical). Windows, skylights, courtyards, awnings, louver walls... for natural ventilation and cooling. Use natural materials, of organic origin, to limit heat absorption.
Riverbank erosion	Geology	Plant local trees that can resist and prevent landslides (nature palm, mangrove…).	The house has enough distance from the canal and river corridor to ensure safety.

Table 3. Solutions for preserving and renovating ancient houses to improve their adaptability to climate change (Source: authors).

Solution		Description
Enhanced resilience to storms, floods causing erosion, landslides and sea level rise causing saltwater intrusion	Reinforce soft river embankment system	Plant and supplement local trees that can prevent landslides, erosion, and are highly tolerant to salinity such as: Sonneratia, mangrove palm, Avicennia, Rhizophora, mulberry, etc.
	Raise the floor	Some houses have been raised to improve their flood resistance, such as Mr. Ba Duc's ancient house.
	Improve natural and artificial drainage systems	Enhancing the surfaces that absorb rainwater quickly, clearing canals, dredging ponds and lakes helps increase water storage area and flow circulation during heavy rains and floods.
Improve resistance to heat and prolonged drought	Optimize ventilation	Preserve and maintain natural ventilation structures such as louvered doors and wooden slats. Incorporate low-energy air-conditioning devices such as fans.
	Renewable energy and technology applications	Use solar panels to provide additional electricity for the house, reducing dependence on grid power.
	Green development	Arrange trees and lakes to create shade and natural cooling, helping to improve air quality.
	Rainwater harvesting system.	Install a rainwater collection and reuse system to provide water for daily use, especially during dry seasons.
Conservation and Modern, Sustainable Design	Structural reinforcement	Some load-bearing wooden frame structures, tiled roofs, etc. degrade over time and need to be properly reinforced.
	Renovate or Expand Function	For renovation or expansion projects, it is necessary to combine modern solutions while still harmonizing and preserving traditional architectural values.
Cooperation and community awareness	Community Training	Organize propaganda and training to help local people become aware of the values of ancient houses and understand methods of preserving and renovating ancient houses to adapt to climate change.
	Collaborate with experts	Organize workshops with interdisciplinary experts (planning, architecture, heritage, environment, etc.) to propose solutions for sustainable preservation of ancient villages and ancient houses.
Support policy	Financial and human resources policy	The State needs to have policies to support human and material resources so that people can invest in renovating and preserving ancient houses to adapt to climate change.
	Heritage conservation planning	There needs to be a long-term master plan to preserve the ancient village of DHH and develop infrastructure to help the community better adapt to climate change.

5. Conclusions

This study asserts that the traditional houses in DHH village are not only emblematic of Southern Vietnamese vernacular architecture but also demonstrate remarkable adaptability to climate change. Passive design solutions—such as ventilated wooden louvers, natural lighting, sloped roofs for sun shading and heat mitigation, and temperature regulation - combined with an integrated ecosystem of gardens, ponds, and lakes, not only create a harmonious landscape but also help regulate water flow, reduce flooding, and minimize the impacts of extreme weather events. Based on this foundation, the study proposes conservation and renovation strategies to enhance the adaptability of traditional DHH houses amid increasing climate challenges. The local traditional architecture offers valuable lessons for modern housing design and construction, especially in the context of complex climate change developments. Future solutions should inherit and build upon traditional values, particularly elements that have been proven effective in adapting to local climatic conditions.

The sustainable housing design process should follow three key steps, including (i) *Identifying Climate Change Challenges* – This includes rising sea levels, heavy rainfall causing flooding, prolonged droughts, and increasing temperatures; (2) *Analyzing the Impact of Climate Change on Housing Architecture* – For instance, extreme heat affects thermal comfort, flooding weakens foundations and building materials, and saltwater intrusion negatively impacts garden ecosystems; and (iii) *Proposing Adaptation Solutions* – These may include elevating house foundations, improving drainage systems, collecting and reusing rainwater, using insulating, moisture-resistant, and salt-resistant materials, and integrating renewable energy technologies to enhance energy efficiency and reduce environmental impact.

Harmonizing traditional architectural heritage with modern technology not only helps preserve cultural identity but also creates sustainable, resilient structures that effectively adapt to climate change. This approach represents a crucial pathway toward a sustainable future for the Mekong Delta region.

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References

[1]. IPCC, *Climate Change 2021: The Physical Science Basis, the Working Group I contribution to the Sixth Assessment Report*. Cambridge, UK: Cambridge University Press, 2021.

[2]. The World Meteorological Organization, *2023 shatters climate records, with major impacts*, WMO Press Release, 30/11/2023.

[3]. Le Thi Hong Na, Dang Hai Dang, Nguyen Dang Hoang Nhat Truong, "Architectural Solutions with Regards to Climate Change for the Rural Housing of Vinh Long Province in Vietnam," in *AUC 2019, Advances in 21st Century Human Settlements*, Springer, 2019, pp. 51-60. DOI:10.1007/978-981-15-5608-1_5

[4]. Le Thi Hong Na, Nguyen Tuan Hai Long, and Vo Dang Phuc, "Proposing Solutions for Rural Housing Architecture to Adapt to Climate Change of Tien Giang province in Vietnam," in *ICSCEA 2023, Lecture Notes in Civil Engineering*, Springer, 2023, vol. 442, pp. 129–136. DOI:10.1007/978-981-99-7434-4_14

[5]. Tran Huy Anh, Le Anh Tuan, "What realities need to be considered when building flood-prone housing in the Mekong Delta?", *Vietnam Architecture Magazine, Ministry of Construction* (2017), [online]. Link: https://kientrucvietnam.org.vn/xay-dung-nha-o-vung-lu-cho-dbscl-can-nhin-vao-nhung-thuc-te-gi/ [Accessed 12/15/2017].

[6]. Tran Cong Danh và Le Thi Hong Na, Identifying the architectural heritage value of Dong Hoa Hiep ancient house, *Vietnam Architecture Magazine, Ministry of Construction* (6/2024), pp.56-61.

[7]. Dang Hai Dang, *Rural housing architectural solutions following sustainable architectural trends in Vinh Long*, Master's thesis in architecture, Ho Chi Minh City University of Architecture, 2019.

[8]. Department of Climate Change, Ministry of Natural Resources and Environment, Climate change scenarios updated in 2020. Hanoi: Vietnam Environment Resources and Cartography Publishing House, 2021.

[9]. Le Thi Hong Na, Jin-Ho Park, Yangsook Jeon, and Sejung Jung, "Analysis of vernacular houses in southern Vietnam, and potential applications of the learned lessons to contemporary urban street houses," *Open House International*, vol. 47, pp. 533-548, 2022. DOI:10.1108/OHI-12-2021-0276