technical transactions

No. 2024/016

architecture and urban planning

sciendo

Orientation for sustainable architectural development in Vietnam – an evolution of strategies

Patrycja Haupt
phaupt@pk.edu.pl | https://orcid.org/0000-0001-5595-9612
Cracow University of Technology, Faculty of Architecture

LE Quan
lequan@hau.edu.vn | http://orcid.org/0009-0002-9787-2464

LE Chien-Thang
lethang.ird@gmail.com | http://orcid.org/0000-0001-8962-030X
Hanoi Architectural University

Nicolas Pham
nicolas.pham@versailles.archi.fr | https://orcid.org/0000-0001-9827-0524
Ecole Nationale, Supérieure d'Architecture, Versailles

Małgorzata Fedorczak-Cisak
mporanna@wp.pl | http://orcid.org/0000-0003-1125-4068
Cracow University of Technology, Faculty of Architecture, MCBE

Scientific Editor: Mateusz Gyurkovich, Cracow University of Technology
Technical Editor: Aleksandra Urzędowska, Cracow University of Technology Press
Typesetting: Anna Pawlik, Cracow University of Technology Press

Received: September 20, 2024
Accepted: November 18, 2024

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing interests: The authors have declared that no competing interests exist.

Citation: Haupt, P., Quan, L., Chien--Thang, L., Pham, N., Fiedorczak-Cisak, M. (2024). Orientation for sustainable architectural development in Vietnam – an evolution of strategies. *Technical Transactions, e2024016*. https://doi.org/10.37705/TechTrans/e2024016

Abstract

The evolution of sustainable architectural development in Vietnam demonstrates a strategic response to climate change and environmental challenges. The Vietnamese government has implemented key policies, including the establishment of the Department of Environment in 1990 and the Law on Environmental Protection in 1993. Regulations such as QCXDVN 09:2005 and QCVN 09:2017/BXD emphasize energy-efficient construction. At COP26, Vietnam pledged to achieve net zero emissions by 2050 and is actively participating in a fair energy transition partnership (JETP) with G7 countries. To support these goals, Vietnam has developed green building evaluation systems like LEED, EDGE, and LOTUS, promoting renewable energy use and resource-efficient materials. This paper presents the guidelines for the new-built objects to meet the sustainability requirements based on case studies. This proactive approach not only addresses environmental concerns but also fosters economic growth and sustainable urban development.

Keywords: architectural sustainable development, guidelines for green architecture, sustainability standards

1. Introduction

Vietnam is a country with a diverse terrain and climate. It is located in the hot and humid tropical monsoon climate zone and has seven different climate zones. The terrain is mostly mountainous, covering three-quarters of the country, while the coastline is over 3,000 km long. As a result, the climate ranges from temperate in the northern mountainous region to tropical, hot and humid in the central region, and hot and dry in the south. There are also seven cultural regions in Vietnam (from mountainous cultural regions in the North to the coastal cultural regions as well as the unique Central Highlands cultural regions), each with its own unique architectural culture (Hoang Thi Thu, 2022: 535–558).

The issue of climate change mitigation in Vietnam has become a prominent area of focus, largely due to the country's heightened vulnerability to the adverse effects of climate change. These effects include rising sea levels, increased storm intensity, and altered precipitation patterns. In response, numerous strategies have been implemented in Vietnam with the aim of reducing the country's greenhouse gas emissions and promoting sustainable development. These strategies encompass the adoption of renewable energy sources, energy efficiency measures, forest conservation, and the promotion of sustainable urban development.

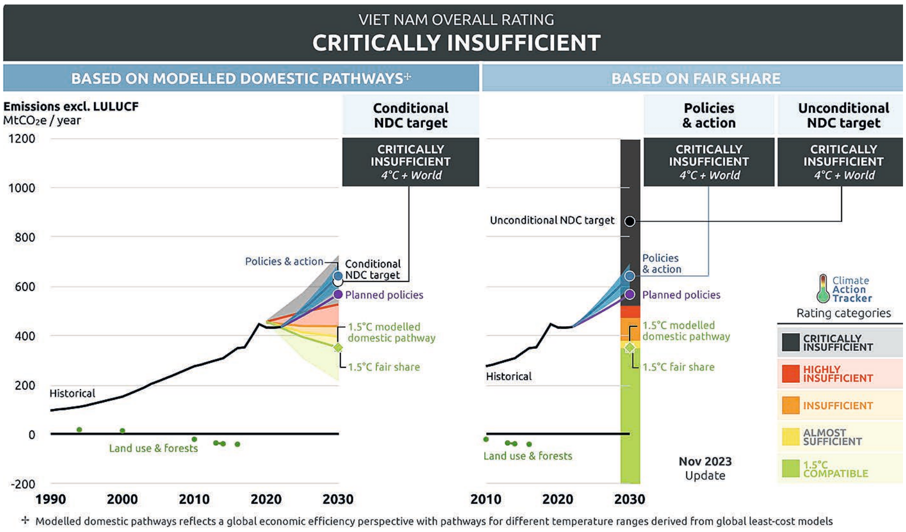


Fig. 1. CO_2 emission chart (source: Climate Action Tracker)

Despite Vietnam's CO_2 emissions being lower than those of the European Union, the two regions present contrasting pictures due to differing stages of economic development and policy approaches (Olivier, Peters, 2022) Vietnam, in the midst of rapid industrialization, faces a rise in emissions largely attributed to its heavy reliance on coal for energy production (Fig. 1). The country is grappling with the challenge of balancing economic growth with environmental sustainability (Nguyen, 2022). In contrast, the European Union has been successful in reducing its carbon footprint through comprehensive climate policies and technological advancements, such as the European Green Deal and the shift toward renewable energy sources (EC, 2021). These differences highlight the importance of understanding the unique circumstances and challenges faced by different regions. Crafting effective strategies to combat climate change globally requires recognizing these dynamics and tailoring solutions to fit each region's specific needs and capabilities.

https://doi.org/10.37705/TechTrans/e2024016

2. Building stock in Vietnam

The variety of architectural styles in Vietnam is a reflection of the country's diverse geography, economic development, and cultural influences. The building stock encompasses a range of structures, including residential, commercial, industrial, and institutional edifices. In urban areas such as Ho Chi Minh City and Hanoi (Logan, 2000), modern high-rise apartments, office buildings, and mixed-use developments constitute the predominant features of the urban landscape. Nevertheless, traditional Vietnamese architecture, typified by wooden houses and tiled roofs, persists in rural areas (Tran, 2017). The mean residential floor space per capita in Vietnam is approximately 24.4 square metres, which reflects the country's rapid urbanisation and housing development efforts. In terms of land use, buildings occupy approximately 2.1% of the country's total land area. The majority of this is located in urban regions, where population growth and increased demand for housing and commercial spaces have driven the construction of new buildings. In rural areas, the building density is significantly lower, with the majority of the land used for agriculture. Overall, Vietnam is rapidly urbanising, and the country's diverse building stock is shaped by a combination of traditional designs and modern constructions (Le, 2019).

Vietnamese architecture from the Oc Eo and Dong Son civilizations to the Nguyen Dynasty exhibits a rich diversity in building types, reflecting local material use and environmental adaptation. Residential buildings were typically one-story structures with large, sloping roofs and a column-beam frame made of bamboo and wood, featuring walls of wooden or bamboo panels with soil and straw plaster (Anh, Minh, 2020). Public buildings like palaces and communal houses were grander, using materials such as bluestone and laterite. Religious structures, including pagodas and temples, showcased intricate wooden carvings and tiered roofs, while fortifications utilized durable stone for protection. These architectural forms reveal a blend of functionality and aesthetic sophistication.

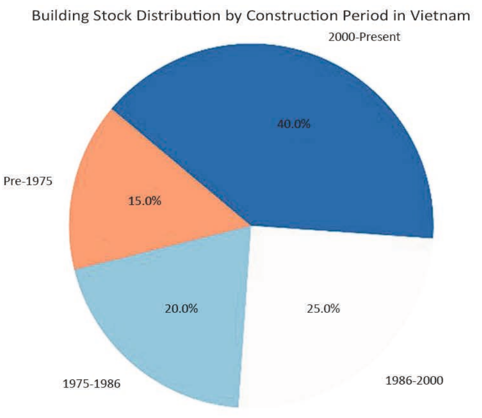
Fig. 2. The communal house of Mong Phu village (photo by Le Chien Thang)

During the French colonial period, which lasted from 1885 to 1945, Vietnamese architecture experienced a significant change as it adopted contemporary architectural styles from around the world, such as Neoclassical architecture, Art Nouveau, and Art Deco. The French brought not only modern planning but also modern architectural styles and materials that were previously unprecedented in Vietnam. The French brought reinforced concrete for load--bearing systems, pure steel floor beams, baked brick walls, and colorful tiles, among other materials, to create monumental works that showcased the country's strength Vo, 2014). These new aesthetics were unfamiliar and oppressive to the colonial people of Annam. However, they continue to influence contemporary Vietnamese architecture Nguyen, 2010).

Fig. 3. Indochina Governor General's Palace (now the Presidential Palace of VietNam in Hanoi) (photo by Le Chien Thang)

Fig. 4. Indochina Governor General's Palace (now the Presidential Palace of VietNam in Hanoi) (photo by Le Chien Thang)

In contrast, the period from 1945 to 1975, when the country was divided between North and South, was characterized by its relationship with countries in the socialist bloc in the North and Americans in the South. The socialist countries helped the young government of Northern Vietnam to build the country after its founding. They introduced typical planning and architecture, as well as new construction materials and technologies, such as prefabricated structures made of reinforced concrete, and assembly techniques (concrete large slabs, small slabs), to build collective quarters and other public works. Meanwhile, in South Vietnam, Americans also introduced new materials and techniques to build modern architecture, which transformed Saigon into the "Pearl of the Far East".



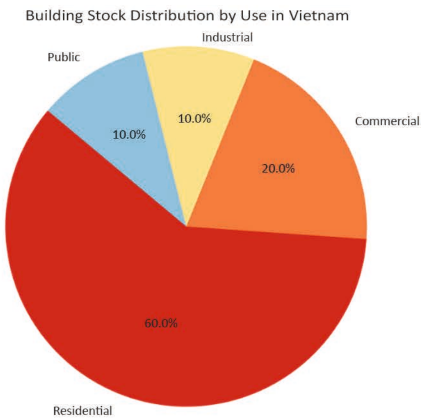


Fig. 5. Building stock distribution by construction period in Vietnam (by P. Haupt, source of data: Vietnam Ministry of Construction)

Fig. 6. Building stock distribution by the Use in Vietnam (by P. Haupt, source of data: Vietnam Ministry of Construction)

The charts illustrating the distribution of building stock in Vietnam reveal that residential buildings are the most prevalent, dominating the architectural landscape. Additionally, there has been significant growth in the number of buildings constructed since 2000, reflecting a surge in urban development and population expansion (Fig. 7–10). This trend highlights the critical need to prioritize sustainable construction incentives for residential new builds and renovations. Focusing on these areas is essential, as they represent the majority of the building stock and are undergoing rapid expansion. By implementing sustainability measures in residential projects, we can effectively address environmental concerns and improve living standards while accommodating the growing population.

https://doi.org/10.37705/TechTrans/e2024016

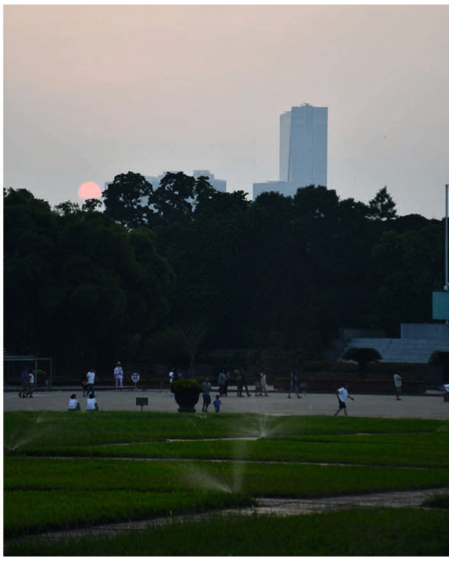


Fig. 7. Hanoi Doji Tower, NKB Archi Vietnam, 2019 (photo by P. Haupt)

Fig. 8. Hanoi silhouette with contemporary architecture (photo by P. Haupt)

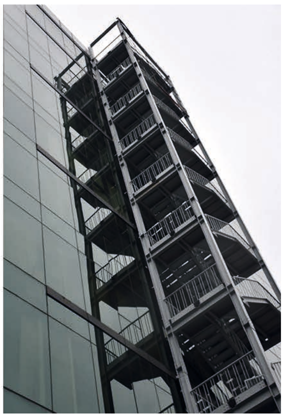


Fig. 9. Godmother. Restaurant, Hanoi, Au Trieu (photo by P. Haupt)

Fig. 10. Hanoi contemporary architecture detail (photo by P. Haupt)

3. Strategies for sustainable design

Traditional architecture in Vietnam is designed to withstand and adapt to the local climate. Buildings in the northern mountainous region are constructed to withstand the cold and snow in the winter, with thick walls made of bricks and earth, small doors and windows, and multi-layer roofs for good insulation. In hot and humid areas, buildings are designed to provide ventilation and protection from the elements, with "openings" on the floor, walls, and roofs, corridors surrounding the house to create effective heat-insulating buffer zones, and large roofs to shield direct heat radiation and prevent rain from falling during heavy storms (Pham, Tran, 2018), (Nguyen, Pham, 2019). The climatic differences between regions have led to variances in the building facade. Therefore, the facade design in Vietnam with a hot and humid climate (excluding the Northern mountainous region) is shown in the following design contemporary strategies.

3.1. Insulation for structures

Maintaining a comfortable temperature inside a building is crucial for productivity and well-being. To achieve this, it is imperative to increase the building's thermal resistance and reduce heat flow through the structure. The insulation properties of the building's covering structure, as well as its size and shape, play a significant role in controlling the amount of heat absorbed. Sunshades provide an energy-efficient solution for regulating the temperature of buildings, whether they are naturally cooled or artificially controlled. They

https://doi.org/10.37705/TechTrans/e2024016

also offer excellent waterproofing ability, especially in regions with high--intensity rain and wind, such as tropical areas. Sunshade structures can be designed to cover the entire building or specific areas like corridors, loggias, windows, and doors. They can also be used in conjunction with various architectural elements, such as balconies, porches, plant beds, and trellises, to create an aesthetically pleasing and functional design (Givoni, 1998). The building's floor plan and shape can be optimized to create light and dark patches on the facade, further enhancing the building's aesthetic appeal.

Fig. 11. Hanoi contemporary architecture – horizontal shading (photo by P. Haupt)

Fig. 12. Vietnam National Assembly Building,Meinhard Von Gerkan, Nikolaus Goetze, Dirk Heller and Joern Ortmann, 2014, Hanoi – vertical shading (photo by P. Haupt)

There are two types of sunshade components: horizontal and vertical (Moudon, 2021). Horizontal sunshades include chajja (window/door overhang), balconies, and fixed, and mobile-controlled sunshades (Fig. 11, 12). Vertical sunshades include vertical blinds, loggia walls, and fixed and mobile-controlled vertical blinds. Structural materials for sunshades are available in a wide range of options. Apart from traditional materials like concrete or wood, one can also opt for metals that have low heat capacity and can absorb heat while radiating it slowly. Additionally, composite plastic and glass, such as heat-absorbing glass and reflective glass can be used (Lee, Lee, 2015; Miller, 2016). Another option is to incorporate solar battery devices that can not only provide high thermal efficiency but also reduce the overall weight of the building.

3.2. Reducing the surface area of the cover that receives solar radiation energy and increase the heat exchange coefficient of the structural exterior

Using covering, shading, and reflecting techniques to minimize structural heating and heat transfer into interior spaces. This solution is related to the building facade, and the use of covering forms and techniques can affect both the thermal regime and aesthetics of the building. The designer should also consider the structure of the block shape and layout between buildings to create the effect of shielding each other from solar radiation. This helps to limit the intensity of solar radiation affecting the surfaces of the enclosure.

In Hanoi, the West and East directions receive higher solar radiation than the South and North. Among these, the West direction receives the highest solar radiation. In the North region, the north-facing wall receives the most during the hottest months of the year despite receiving less solar radiation than in other directions. Conversely, in the southern climate region, the North wall receives more solar radiation but does not coincide with the month with the maximum temperature.

In the Temperate zone, thick walls that increase insulation and slow heat dissipation are an excellent solution for keeping heat in the house during winter. Large windows and glass walls can bring natural light and sunshine into the building. However, multi-layer walls are becoming more widely applied with the development of materials and dividing partitions (Fig. 13).

https://doi.org/10.37705/TechTrans/e2024016

This solution is also popular in humid tropical countries, where multi-layer walls are more effective than single-layer solid walls, as they can reduce solar radiation and provide good insulation, ventilation, and waterproofing. Doors and walls should have flexible opening and closing shield solutions to serve the diverse purposes of users. Multi-layer walls are widely used to create environmentally friendly buildings, especially in urban construction projects.

Fig. 13. The overall proportion, structure, direction, shape, and layout help limit the impact of solar radiation on the envelope of the Cantavil apartment building (by P. Haupt)

Using materials and choosing the shape of the building block and the shape of the building envelope surfaces creates convenience for the movement of air on the surface of the envelope structure. Thereby increasing the heat convection ability of the hot air layer on the outer surface of the cover structure (Olsen, 2013).

Special microclimate phenomena often occur in the North. Surface dew will damage structures and reduce their effectiveness so it causes the necessity of preventing dew on indoor structural surfaces.

3.3. Enhance natural ventilation, evaporative cooling, cooling radiation

In a hot and humid climate like Vietnam, natural ventilation is mandatory to improve the microclimate and hygiene of the building. This strategy requires synchronization in solutions from overall building shape to architectural structure. In choosing a solution for the shell, in addition to covering and arranging reasonable gaps on the shell, it will also bring value to the interior space regarding ventilation and visibility.

To convert heat in a structure or solar radiation heat into latent steam heat, you can apply techniques such as standing water, surface permeation, or mist spraying on the surface of the shell structure (Nguyen, Pham, 2021). This method works particularly well when surfaces are heated by solar radiation (Li, Lam, 2007). However, it is essential to note that this solution can be expensive to implement and maintain. Additionally, careful selection of surface materials is necessary to ensure proper operation.

Utilizing heat radiation during the night time to cool both skin structures and court surfaces can prove to be quite effective, especially in countries with significant temperature fluctuations between day and night. This innovative technique can assist in conserving cooling energy for use during the following day (Tzempelikos, 2007). However, in regions with hot and humid climates, where heat radiation might not be as effective, it is crucial to explore alternative methods such as incorporating surface materials with higher radiation abilities or implementing detailed structural measures to optimize the speed and effectiveness of cooling heat radiation.

3.4. Active use of solar energy & Controlling the delay of cyclic heat flow during the hot season

Use technological devices to collect and convert solar energy (electrical or chemical methods) to generate electricity and provide heat for various living purposes (Sopian, Othman, 2021). The process of receiving incoming solar radiation, converting it, and bringing it to the service space includes three parts: heat collection equipment (by electricity, gas, or water), heat accumulation equipment, and service space. Energy battery devices and solar thermal power technology are also widely used in Vietnam and have certain advantages. In particular, their diverse shapes and materials facilitate easy and diverse installation into buildings (walls, roofs). These technologies not only use on-site renewable energy but also help increase the aesthetic efficiency of the project (Mousazadeh, Sharifi, 2016).

In order to ensure that the highest temperature inside a shell structure does not occur during times of human activity, it is important to consider the function of the space. Structural measures and appropriate materials should be used to achieve effective heat protection, depending on the project's requirements.

3.5. Using trees and water surface

Trees, especially those with considerable foliage, are essential in reducing glare and blocking direct sunlight below the canopy. They can also absorb heat radiation by using chlorophyll (30-80% depending on the density of the leaves), and the evaporation of water from the leaf surface helps reduce the ambient temperature (Akbari, Kolb, 2005). Because the soil beneath trees is often wetter than bare soil surfaces, water from the wet ground will evaporate and absorb heat when the sun shines, significantly lowering the temperature. Trees can also block or change wind direction, absorb dust (20-65%), and hold dust, which purifies the air and reduces noise (Nowak, 2000). Furthermore, trees contribute significantly to the aesthetics of housing and urban areas (Jim, Chen, 2009). Plants on walls and roofs have been widely used in traditional and contemporary Vietnamese architecture (fig.14,15) and their use on the roofs of contemporary buildings for cooling has gained international recognition (Wang, 2012).

Fig. 14. Hanoi contemporary architecture – roof gardens (photo by P. Haupt)

Fig. 15. Hanoi contemporary architecture – water reservoirs in the city spaces (photo by P. Haupt)

4. Orientation for sustainable architectural development in Vietnam

Vietnam is among the countries that have been seriously impacted by global climate change. The Vietnamese government has acknowledged this issue from an early stage and has taken measures to tackle it at both national and international levels. Since 1990, Vietnam has been working towards sustainable development, including setting up the Department of Environment, creating a national environmental protection strategy for 1991–2000, and enacting the Law on Environmental Protection in 1993. The country has also adopted other strategic policies such as the National 21st Century Agenda (2000), the National target program to respond to climate change (2008), the National Strategy on Green Growth (2012), the National target program on economical and efficient use of energy for the period 2012–2015, and the Vietnam urban development project to respond to climate change (2013). Notably, with the introduction of Regulation QCXDVN 09:2005 on construction projects using energy efficiently in the Construction sector, and later the National Technical Regulation QCVN 09:2017/BXD on Construction energy-efficient construction projects, Vietnam is gradually shifting towards designing and constructing energy-efficient buildings to meet its government commitments (Gordon, 2020).

At COP26 in Glasgow, Vietnam committed to achieving net zero emissions by 2050. They also joined the Global Declaration on converting coal power to clean energy, pledging to not build new coal power plants after 2030 and gradually reduce coal power from 2045. Additionally, Vietnam has set a goal to reduce methane emissions by 30% by 2030 compared to 2020 and plans to strengthen forest protection and land use management to reduce greenhouse gas emissions. Vietnam has also joined the global adaptation alliance.

At the COP27 Conference, Vietnam actively negotiated to build a Political Declaration establishing a fair energy transition partnership (JETP) with countries inside and outside the G7. One of the concrete actions taken towards this goal is the issuance of Decree No. 09/2021/ND-CP. This Regulation governs the development, management, production, and use of construction materials in construction projects to ensure safety, efficiency, sustainable development, environmental protection, and resource-saving. The State encourages organizations and individuals to conduct research, develop, apply science and technology, and invest in the production of construction materials that save mineral resources, energy, and are environmentally friendly. The environment is given preferential policies and investment support from the State according to relevant laws (Vietnam Association of Architects, 2021). The Prime Minister has also stipulated a roadmap to limit and eliminate construction material production facilities with outdated technology, high raw material consumption, high energy consumption, and environmental pollution.

Vietnam has developed its Green Building Evaluation Criteria Systems with the help of government and non-governmental organizations. The most popular criteria sets in Vietnam include LEED, Edge, and Lotus. Additionally, the Vietnam Association of Architects has issued a green architectural design system, while the Vietnam Built Environment Association has issued a green building evaluation system (Pham, Le, 2019).

LOTUS is a Green Building certification system developed by the Vietnam Green Building Council (VGBC). VGBC is an international non-profit organization member of the World Green Building Council (World GBC). The system has been in development since 2010. It includes rating systems that are applicable to most types of construction projects, covering residential, interior, non-residential, new construction, and renovation projects, for which the Material and resource criteria account for about 10–12% of the weight of the total criteria.	LEED (Leadership in Energy & Environmental Design) is the most popular set of green building evaluation standards worldwide and is also widely used in Vietnam. It is primarily used to evaluate foreign-invested projects	EDGE (Excellence in Design for Greater Efficiencies) is a system developed by the International Finance Corporation (IFC), a World Bank Group member. EDGE has three evaluation criteria for energy savings: water, energy, and materials.

5. Summary

The study reveals that residential buildings dominate Vietnam's architectural landscape and that there has been notable growth in new constructions since 2000. This trend underscores the urgent need to focus on sustainable construction incentives for residential new builds and renovations to address environmental concerns and support rapid urban development. Despite Vietnam's lower CO_2 emissions compared to the European Union, the country faces significant challenges due to its reliance on coal and the pressures of industrialization. The European Union's successful emission reduction strategies highlight the disparity in approaches to climate policy. Vietnam's current policies are deemed insufficient for tackling its rising emissions. Embracing sustainable architectural practices could improve both environmental outcomes and living standards. Tailoring solutions to Vietnam's specific needs while learning from global best practices is crucial for advancing towards more sustainable development and effectively managing the balance between economic growth and environmental stewardship.

References

Akbari, H., Kolb, C. (2005). The Effects of Trees and Vegetation on Urban Heat Islands. *Environmental Pollution 138*(1), 55–65.

Anh, L.V., Minh, P.T. (2020). The Role of Traditional Materials in Contemporary Vietnamese Architecture. *Sustainable Architecture and Building Materials Journal 6*(3), 78–89.

Climate Action Tracker. Retrieved from https://climateactiontracker.org/countries/vietnam (access: 01.07.2024).

European Commission (2021). *The European Green Deal*.

Givoni, B. (1998). *Climate Considerations in Building and Urban Design*. Van Nostrand Reinhold.

Gordon, C., Gordon A.L. (2020). Vietnam's Approach to Sustainable Development and Climate Change Mitigation. *Journal of Sustainable Development 13*(3), 67–89.

Government of Vietnam (1993). *Law on Environmental Protection*.

Hoang Thi Thu, H., Dang Kinh, B., Van Rompaey, A. (2022). Comprehensive assessment of coastal tourism potential in Vietnam. *Vietnam Journal of Earth Sciences 44*(4), 535–558. https://doi.org/10.15625/2615-9783/17374

Jim, C.Y., Chen, W.Y. (2009). Assessing the Benefits and Functions of Urban Trees in the Context of Environmental Management. *Urban Forestry & Urban Greening 8*(2), 155–167.

Le, T.P. (2019). *Vietnamese Architecture and Urbanism*. Hanoi Architectural Publishing House.

Lee, E.S., Lee S.H. (2015). Design and Performance Analysis of Sunshades for Improving Building Energy Efficiency. *Energy and Buildings 85*, 243–255.

Li, D.H. W., Lam, J.C. (2007). Cooling Potential of Radiant Surfaces in Buildings. *Building and Environment 42*(6), 2235–2245.

Logan, W.S. (2000). *Hanoi: Biography of a City*. University of Washington Press.

Miller, R. (2016). *Architectural Science Review: Sunshades and Their Effect on Building Thermal Performance*. Cambridge University Press.

Moudon, A.V. (2021). Vertical vs. Horizontal Sunshades: Comparative Study and Recommendations. *Journal of Architectural Science Review 64*(2), 95–108.

Mousazadeh, H., Sharifi, S. (2016). Optimizing Solar Thermal Systems for Building Applications. *Building and Environment 109*, 111–123.

Nguyen, H.C. (2010). The Impact of French Colonial Rule on Vietnamese Urban Planning and Architecture. *Urban Studies Journal 47*(7), 1497–1516.

Nguyen, K.Q. (2022). The Challenge of Energy Transition in Vietnam: Balancing Economic Growth and Environmental Sustainability. *Energy Policy 156*, 112433.

Nguyen, L.H., Pham, T.P. (2019). Climatic Adaptation in Traditional Vietnamese Architecture: A Study of Housing in Different Regions. *Journal of Asian Architecture and Building Engineering 18*(1), 67–74.

Nguyen, L.H., Pham, T.P. (2021). Thermal Management in Buildings: Techniques and Materials for Effective Cooling. *Journal of Building Performance 12*(3), 45–58.

Nowak, D.J., Nowak D.E. (2000). The Effects of Urban Trees on Air Quality. *Urban Ecosystems 4*(3), 257–272.

Olivier, J.G.J., Peters, J.A.H.W. (2022). *Trends in Global CO_2 and Greenhouse Gas Emissions: 2022 Report*. PBL Netherlands Environmental Assessment Agency.

Olsen, D. (2013). *Sustainable Building Design: Principles and Practice*. Routledge.

Pham, D.H., Tran, Q.A. (2018). Vernacular Architecture in Vietnam: Adaptation to Climate and Culture. *Sustainable Cities and Society 38*, 82–93.

Pham, T.H., Le, T.N. (2019). Green Building Practices in Vietnam: Implementation and Challenges. *Building and Environment 150*, 365–373.

Sopian, K., Othman, M. (2021). Integration of Solar Thermal and Photovoltaic Systems in Building Designs. *Journal of Building Performance 12*(4), 13–25.

Tran, Q. (2017). Traditional Vietnamese Architecture: From Houses to Palaces. *Journal of Vietnamese Studies 12*(1), 25–46.

Tzempelikos, A., M.J. (2007). Radiant Cooling and Heating Systems for Buildings. *Energy and Buildings 39*(6), 654–664.

Vietnam Association of Architects. (2021). *Green Architectural Design System*.

Vo, Q. (2014). French Colonial Architecture in Vietnam. *Journal of Southeast Asian Studies 45*(2), 326–348.

Wang, L., Wang W.B. (2012). Cooling Effects of Urban Trees and Green Roofs in Hot Climates. *Building and Environment 58*, 102–110.