A dissertation presented to the School of Architecture, Oxford Brookes University, in part fulfilment of the regulations for BA (Hons) in Architecture.

Statement of Originality

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Signed

Vernacular Climate Adaptation

Can vernacular architectural principles be applied globally, improving resilience against the effects of climate change across extreme environments such as deserts, polar zones and rainforests?




Fig. 1 Arctic, Studinger and NASA, 2011.
Fig. 2 Desert, GT, 2021.
Fig. 3 Rainforest, Liptak, 2025.
Fig. 4 Ocean, Apasciuto, 2017.

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Contents

1.1

Key Definitions

Climate Change - "A measurable systematic change in the state of the climate driven by natural events or anthropogenic activities that alter the composition of the atmosphere" (Idowu et al, 2023, p. 565). This can result in shifts in temperature and frequency of extreme weather events.

Anthropogenic Activity - "Describes all human-originating effects and processes on Earth's systems" (Sustainability Directory, 2025).

Sustainability - "Involves meeting the needs of the present without compromising the ability of future generations to meet their own needs, while considering economic, social and environmental factors" (Kazmi, 2023, p. 3222).

Extreme Environments - "Those where environmental factors - such as temperature, pressure, salinity, acidity or radiation - exceed the range typically tolerated by most organisms" (Guido di Prisco et al., 2020, p.Introduction).

Extreme Architecture - "Buildings designed for challenging environments, offering insights into the extremes of architectural thinking" (Slavid, 2009, p.7). This includes deserts, rainforests and polar zones.

Vernacular Architecture - "Refers to indigenous, primitive, folk or popular building traditions that are rooted in place, culture and history and that have come about without the involvement of professional architects" (Vellinga, 2023, p.313).

Fig. 5 Vernacular Mud House in Desert National Park, Rath, 2012.

1.2

Introduction

Effects of climate change are becoming increasingly more apparent; areas of the planet that were once habitable are being transformed into hostile places (Roaf, Crichton and Nicol, 2005). As environmental conditions intensify, the need for adaptation strategies becomes more significant. Ogla Bannova highlights that extreme environments "pose special limitations and/or hardships for people to survive and maintain relative physical and psychological comfort" (Bannova, 2014, p. 12). These challenges shed light on the importance of resilient architectural responses. Architecture has the potential to "reduce carbon emissions by 60%" (Zong et al., 2025, p. 1). The built environment should live in harmony with flora and fauna creating a space where we can learn and develop together, as one, (Ichioka and Pawlyn, 2021) we must be more than sustainable, we must be regenerative. Vernacular architecture achieves this, responding to changing microclimates using traditional construction techniques and knowledge to create low-emission housing. (Zong et al., 2025).

Vernacular architecture provides critical knowledge for the future of the built environment, designing to save energy, reduce environmental impacts and carbon emissions (Gabr and El-Assal , 2022). Vellinga defines vernacular architecture as "indigenous, primitive, folk or popular building traditions that are rooted in place, culture and history", (Vellinga, 2023, p.313) these traditions form over centuries resulting in climate responsive, material efficient and adaptive architecture. Nabokov argues that communities have "worked within the constraints of their localized cultural traditions… to confront virtually every climatic condition on the globe" (Nabokov, 1999, p.69). However, Gabr and El-Assal argue that indigenous cultures suffer from decay, deterring residents to abandon or demolish traditional homes in place of more sturdy materials. This results in the disappearance of indigenous knowledge and the need for highlighting this vital architecture (Gabr and El-Assal , 2022). This dissertation builds on this, examining how vernacular architectural principles in extreme environments can provide knowledge for climate adaptation as climate change intensifies.

Fig. 6 Drought Map, Seneviratne et al, 2021.

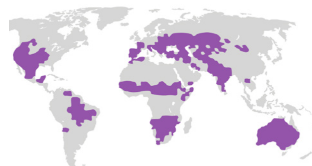


Fig. 7 Fire Weather Risk Map, Seneviratne et al, 2021.

Fig. 8 River Flooding Map, Seneviratne et al, 2021.

Fig. 9 Extreme Heat Stress Risk Map, Seneviratne et al, 2021.

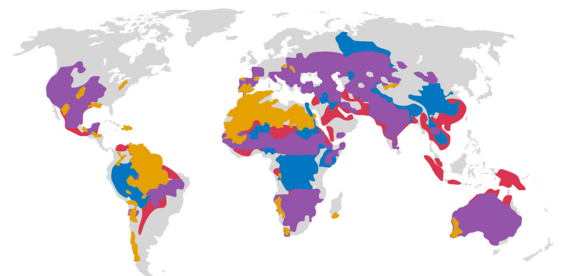


Fig. 10 Combined Environmental Impact Map, Venables , 2025.

In this dissertation, I will examine vernacular architecture in extreme environments. Specifically, deserts, rainforests and polar zones, through four key analytical lenses: material life cycles, traditional construction techniques, solar design strategies and responses to local environments. I will also use the vernacular typology matrix developed by myself, see Fig. 16 which will serve as a comparative tool to examine form and material logic across extreme environments. Using the data collated from case studies and my matrix, I will apply these insights to the macro issue of climate change, proposing how vernacular strategies in extreme environments can inform resilient architectural solutions globally as environmental conditions become more extreme.

Studying extreme environments will allow me to understand climate adaptation of the harshest ecosystems, using this knowledge we can apply these principles to contemporary architecture adapting to climate change. Deserts, polar zones, and rainforests represent three different extreme environments with climates of high humidity, extreme temperature, scarce resources, limited daylight and intense rainfall. Each case study will present valuable information for adapting to local climates.

Historical and current literature discuss vernacular architecture extensively; most studies focus on vernacular principles within specific regions, such as the analysis of roof shape, construction and materials in the UK (Brunskill, 1978). Jose Padro suggests that characteristics of vernacular architecture include: use of local material, design adapted to climate conditions and use of construction techniques passed down over time (Pardo, 2023). This dissertation pushes these discussions further by analysing adaptive techniques developed in deserts, polar zones and rainforests in order to apply vernacular principles in extreme environments to contemporary architecture in response to climate change.

My methodological approach for this dissertation is qualitative, combining literature review, multi-regional case study analysis, theoretical vernacular principles, adopted vernacular frameworks and Mahoney's climatic tables. Together, these methods provide a holistic analysis of vernacular architecture in extreme environments.

Finally, this dissertation pushes vernacular architecture as a framework for regenerative and climate responsive design. By analysing case studies and producing architectural principles across extreme environments, this research contributes to a broader debate on sustainable architecture offering knowledge for designers, and communities seeking solutions for the future of the built environment in the face of climate change.

1.3

Literature Review

Climate Change

Climate change presents an escalating global challenge with implications for the built environment. It is increasingly affecting wildlife and ecosystems with "regional increases in temperature, aridity and drought" (IPCC, 2023, p.44) acting as a domino effect impacting water and food security, infrastructure, health, economy and culture (IPCC, 2023). Traditional architecture once relied on passive climate responses, but modern buildings must now adapt to unpredictable environmental changes due to climate change (Aysha and Monto, 2024).

Extreme weather events, such as heatwaves and floods, are becoming more frequent, impacting infrastructure. Buildings will suffer from overheating, too much moisture and solar risks, directly impacting occupant health (Hayles, 2022). We must adapt architecture to climate change allowing cities to be more resilient to these weather hazards, making it safer to live in affected areas (UKGBC, n.d).

Architecture must adapt not only to increasing climate threats but also to policy delays. Despite the UK government's net zero target for 2050 (UK Government, 2021), according to the "Climate Change Committee" it criticizes slow, disjointed progress. Promises have yet to materialize and urgent action is needed with a coordinated national strategy across the government (Climate Change Committee, 2025). Without coordinated action, the built environment must independently adapt to the issues caused by climate change.

Fig. 11 Climate Change Protest. Anlim, L. (2019).

Extreme environments

According to Wikipedia the definition of "an extreme environment is a habitat that is considered very hard to survive in due to its considerably extreme conditions such as temperature, accessibility to different energy sources or under high pressure." (wikipedia contributors, 2024) This definition of extreme environments does not consider that life forms like humans, animals, plants and bacteria, do live in extreme environments and have for many years. For example, Elanor Bell explores in her book "Life at Extremes" that organisms have evolved to survive in extreme conditions across the globe (Bell, 2012). We can use this resilience found in specific conditions to combat architectural issues, related to climate adaptation, such as overheating and material degradation.

Architectural responses to extreme environments are introduced in "Extreme Architecture" by Ruth Slavid, she references case studies in deserts, polar zones and aquatic spaces, emphasizing techniques used to create sustainable design driven by climate change. David Garcia's "Extreme environments - Architectural possibilities for a challenged world" further contextualised the urgency of adaptation. Suggesting a use of local knowledge and contemporary technological advancements to create resilient alternatives (Garcia, 2025). Bjarke Ingels implies in the book "Hot to Cold, an odyssey of architectural adaptation" that the more extreme an environment gets, the greater its impact on architectural form and strategy. "By studying the design foundations of vernacular local architecture" (S. Gabr and M.S. El-Assal , 2022) in these extreme environments "it is possible to learn about sustainable practices to inform contemporary designs" (S. Gabr and M.S. El-Assal , 2022) which then can be applied globally.

Fig. 12 Sub-Zero Polar Ice. Science Photo Library (2016).

Vernacular Strategies

Amos Rapoport suggests that architecture is predominantly recognised through monumental buildings and movements such as Egyptian temples of Gothic cathedrals and rarely known for homes where people live. This implies that peasant or folk homes are seen as unimportant yet there are many lessons to be learnt from vernacular architecture (Rapoport, 1969). Vernacular buildings emphasise the use of local materials, traditional construction methods and design that is local to the environment. R.W. Brunskill examines case studies of natives responding to local climates, including mud shelters, pile houses and turf roofing (Brunskill, 1971). Whereas, Henry Glassie suggests that vernacular architecture is more than using local materials, it is a reflection of community values and beliefs over many years. Glassie uses case studies to show how vernacular architecture has changed over time, due to material availability, cultural expression and environmental adaptation (Glassie, 2000).

Traditional vernacular architecture uses "design aspects compatible with the environment, such as saving energy, reducing negative effects on the natural environment, reducing carbon emissions and environmental pollution, using natural materials available in the surroundings for construction" (S. Gabr and M.S. El-Assal, 2022). This knowledge from locals is important for traditional construction techniques to be passed down in generations. "Many traditional societies suffer from deterioration, which deter residents to move away from them, abandon them, or demolish them and opt to replace them with sturdier concrete houses ignoring the significance of those traditional heritage and their inherent values." (S. Gabr and M.S. El-Assal, 2022) The loss of these vernacular architectural buildings signify the disappearance of significant cultural spaces as well as the disappearance of valuable local knowledge of traditional construction techniques.

Fig. 13 Vernacular Roundhouse Architecture. Freeman, D. (2013).

1.4

Research Methodology

This dissertation is a body of research exploring key themes within the research question. These being, the relationship between climate change, extreme environments and vernacular architecture. To make a holistic argument and analysis of these areas, this study adopts a qualitative approach based on secondary data collection methods, such as literature review, case studies and comparative evaluation. A qualitative approach is appropriate because the research focuses on material strategies, spatial form and environmental adaptation rather than measurable data. Secondary data is used from case studies in place of fieldwork due to geographical constraints. The aim is to interpret how vernacular architecture has adapted in extreme climates to create principles to guide future design.

To understand more about the relationship of climate change, extreme environments and vernacular principles, I will conduct a qualitative literature review to effectively collect secondary data from a variety of research sources. A literature review gives a holistic approach to these topics looking at multiple different opinions to gain a better comprehension of knowledge.

Case studies are a way of understanding real life situations in depth creating a cohesive analysis of a topic that reflects on historical events, relying on multiple sources of information (Yin, 2014). For the collection of secondary data I will look at case studies in three different areas of extreme environments. These being: deserts, polar zones and rainforests. More specifically:

- Deserts, Dakhla and Kharga Oases, Egypt (Gabr and El-Assal , 2022, pp. 1-32) (Esmail and Tawfik, 2015).

- Polar zones, Canadian and Scandinavian Arctic (Mackin, 2017) (Savolainen, 2024).

- Rainforests, Northwestern Amazon (Gutierrez, 2019, pp. 1-24).

This analysis of data will allow me to illustrate if vernacular architecture in extreme environments is a sustainable route forward and a practice that should be thought about in the future to adapt to climate change. Using multiple case studies will allow me to compare data creating a holistic picture of vernacular architecture in extreme environments.

To document and compare each case study, this dissertation adopts a modified framework based on Professor Cordingley's extensive recording method from the University of Manchester see Figs. 14 & 15. The original framework has been adapted to accommodate the aims of this dissertation, with a focus on vernacular design principles in extreme environments see Fig. 16. This approach acts as a visual and comparative tool, creating a deeper understanding of materials and spatial form, used to build adaptive structures in extreme environments. The data gathered from each case study will be systematically compared using the adapted framework, this will allow me to generate a cohesive report on vernacular architecture and its relevance to climate driven design.

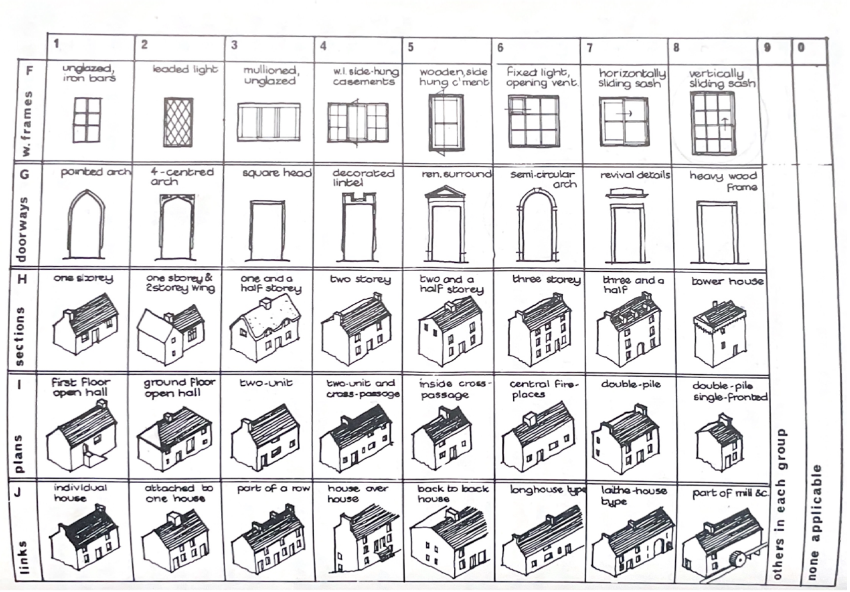


Fig. 14 Extensive Recording Framework, Brunskill, R.W. (1978).

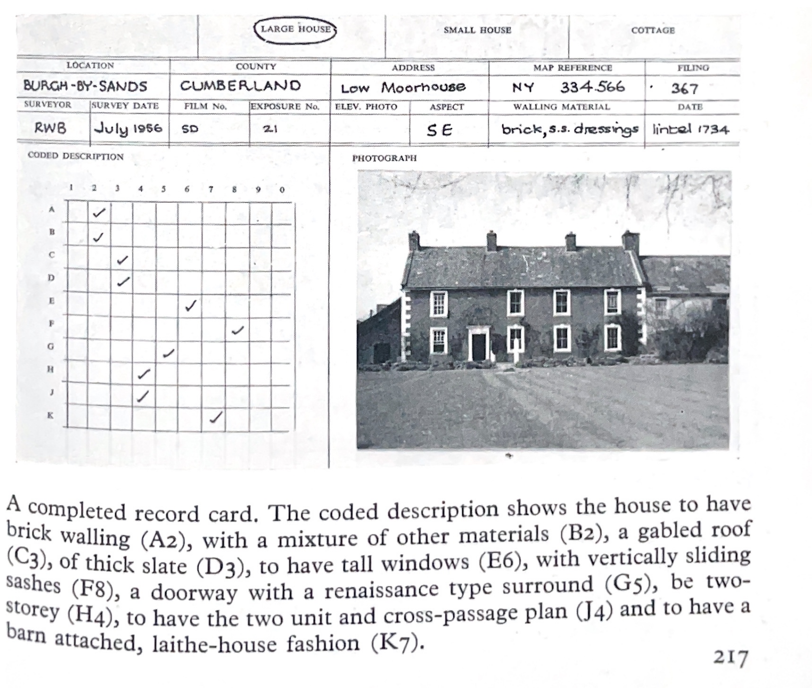


Fig. 15 Extensive Recording Record Card, Brunskill, R.W. (1978).

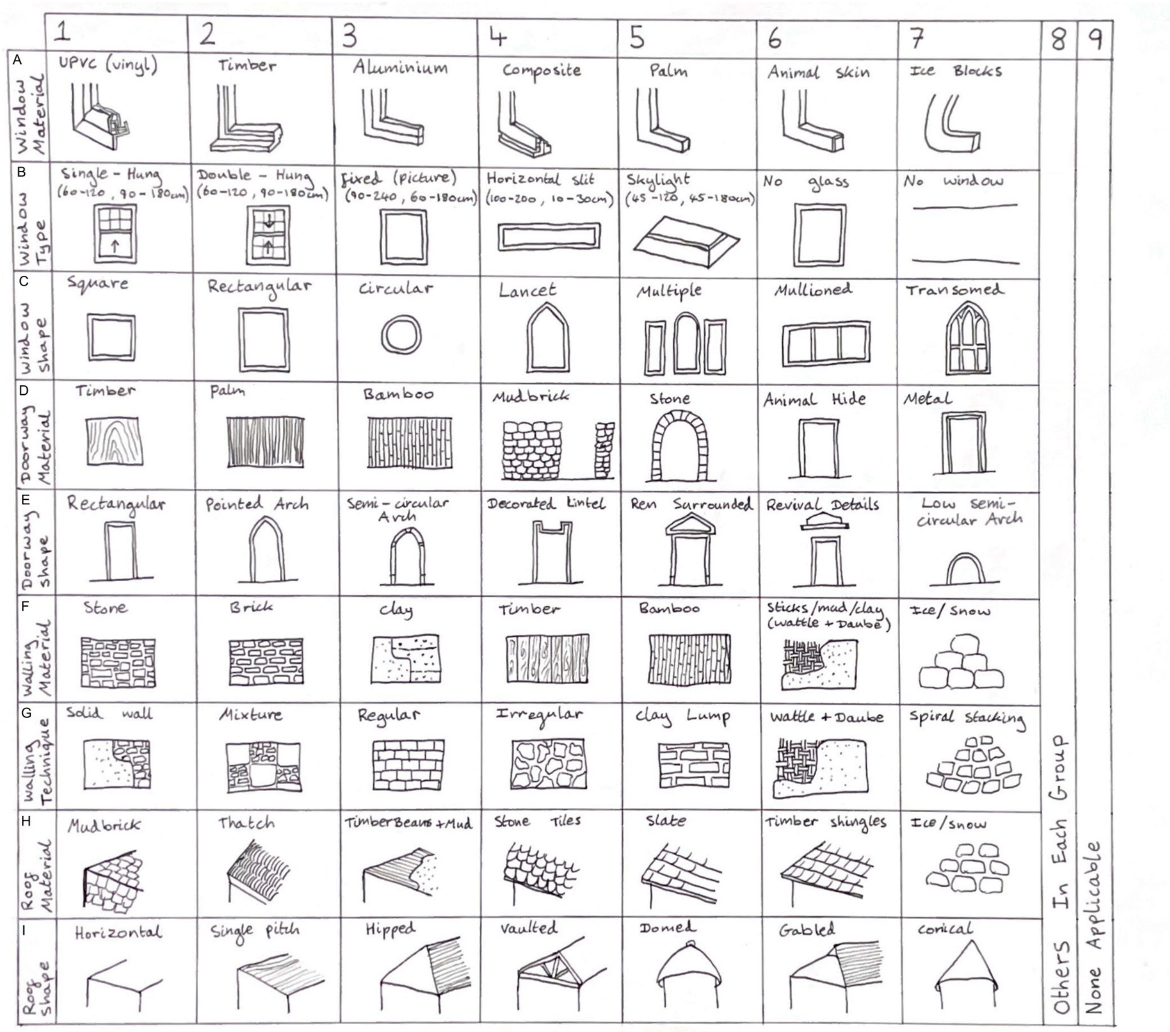


Fig. 16 Vernacular Typology Matrix, Author, 2025.

Building on the visual recordings based on Cordingley's framework, this dissertation applies a principles based analytical framework to gather directed information. This framework is derived from four analytical areas from vernacular architectural theory discussed in chapter 2.1:

- Material choices and life cycles.
- Traditional construction techniques.
- Solar design strategies.
- Response to the environment.

This analytical framework is applied to each case study allowing analysis to become deeper than visual descriptions of vernacular architecture and a more in depth interpretation of how they work in response to each climate.

To assess climatic conditions of each case study and analyse climate responsive design principles, this dissertation employs Mahoney's Tables, developed by Mahoney, Evans and Koenigsberger see Fig. 17. Monthly air temperature, humidity, wind and rainfall are analysed to indicate thermal stress and produce design recommendations based on a location (Rajini Chandra Waker, 2025). The Mahoney Tables are relevant to hot climates such as deserts and rainforests, where they can be used to compare vernacular solutions recommended by the tables. However, the Tables are not designed for extremely cold climates like the Arctic, so will function as a secondary comparative tool to highlight the bias towards warm climates. A trial adaptation to cold climates of Mahoney's Table was explored, see Appendix but this was not adopted as the primary analytical framework because it risks producing misleading results.

By combining a qualitative literature review, multi-regional case studies, Cordingley's visual framework, vernacular principles and Mahoney's Table climate analysis this methodology establishes a comprehensive approach to understanding vernacular architecture in extreme environments. This method supports the dissertation's aim of identifying possibilities and limits of vernacular principles in order to offer information for climate responsive architecture in the face of the climate crisis.

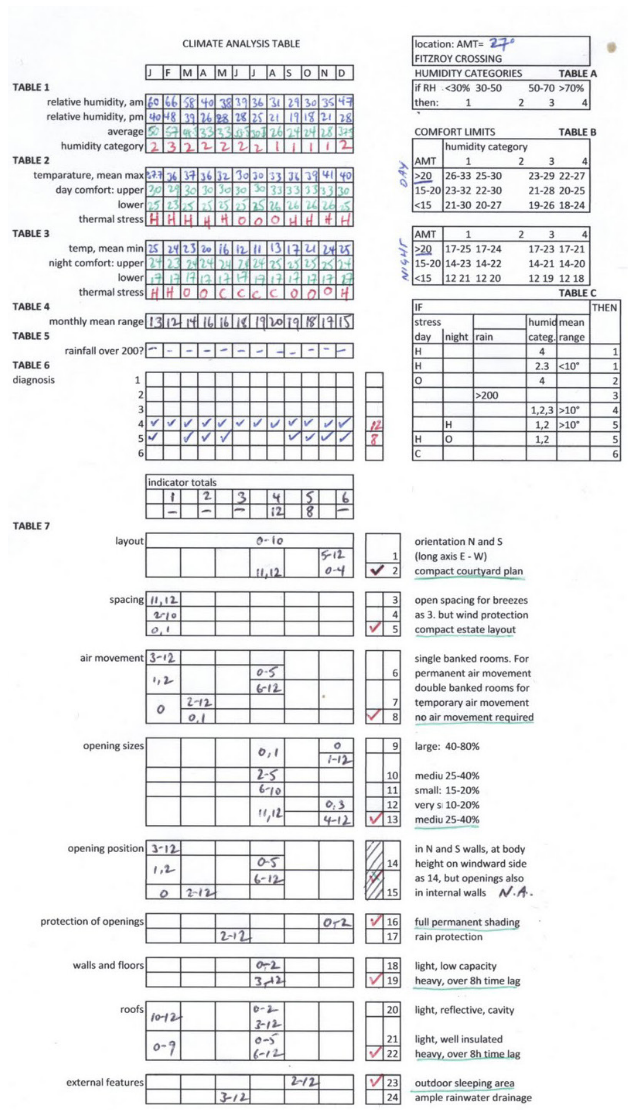


Fig. 17 Mahoney Table Example. Thomas-Sullivan (2025).

2.1

Vernacular Architecture Design Principles

This chapter will define vernacular architecture and examine its application to climate change. The discussion will outline four key vernacular principles; Materials, Traditional construction techniques, solar design and responses to the environment. These principles will serve as a framework to analyse each case study in Section 2. By researching how indigenous communities use vernacular architecture to adapt to extreme environments, I will highlight the need for ingenious knowledge to be passed down to future generations ensuring adaptive intelligence is not lost.

Sub Questions

- How are materials used effectively in vernacular buildings and what are their material life cycles?
- How do communities ensure traditional construction methods and knowledge are preserved?
- What architectural techniques are used within vernacular design to regulate solar gain?
- How do vernacular designs respond to environmental conditions, taking into account flora and fauna?

Vernacular architecture "refers to indigenous, primitive, folk or popular building traditions that are rooted in place, culture and history and that have come about without the involvement of professional architects" (Vellinga, 2023, p. 313). It uses building methods that directly respond to local environments such as; solar shading, local materials and traditional construction techniques. These approaches ensure buildings are made by the community for the community with environmental awareness at its core. This local expertise allows for adaptation to extreme environments. "Such people have worked within the constraints of their localized, cultural traditions, employing mostly available, organic building materials to confront virtually every climatic condition on the globe" (Nabokov, 1999, pp. 69). My research builds on this knowledge arguing that the adaptation of vernacular architecture in extreme environments can be applied globally to regions increasingly at risk to climate change and extreme weather.

How are materials used effectively in vernacular buildings and what are their material life cycles?

Vernacular buildings demonstrate the effective use of materials based on local availability, thermal performance and reparability. The "dense examples of material culture known as 'vernacular architecture' come in every conceivable shape; they are made from every possible kind of material" (Nabokov, 1999, pp. 69). Materials like timber, earth, stone and bamboo are used for their availability and performance. For example wattle and daub walls provide heat regulation qualities and structural stability (Pritchett, 2001). The material life cycle in vernacular systems strives for sustainability. According to Ann Francis buildings constructed using vernacular techniques lowers embodied carbon by over 30% compared to contemporary techniques (Francis, Padmanabhan and Thomas, 2024). This is due to materials being harvested, processed and transported locally. Manufacturing relies on the traditional craft of locals rather than industrial processing, reflecting cultural heritage and community. Ming Hu implies how local cultural knowledge enables materials to be used to their fullest potential, due to a deep understanding of the climate in which communities live (Hu, 2023). At the end of life, materials are repaired, reused, composted, or allowed to decay naturally, returning to the environment without waste. Durability isn't maintained through resilience but through repair which is achieved due to this availability of locally sourced materials. In my case studies I will examine material sourcing and lifecycles in extreme environments understanding how vernacular design principles are adapted. This will inform strategies for climate responsive design.

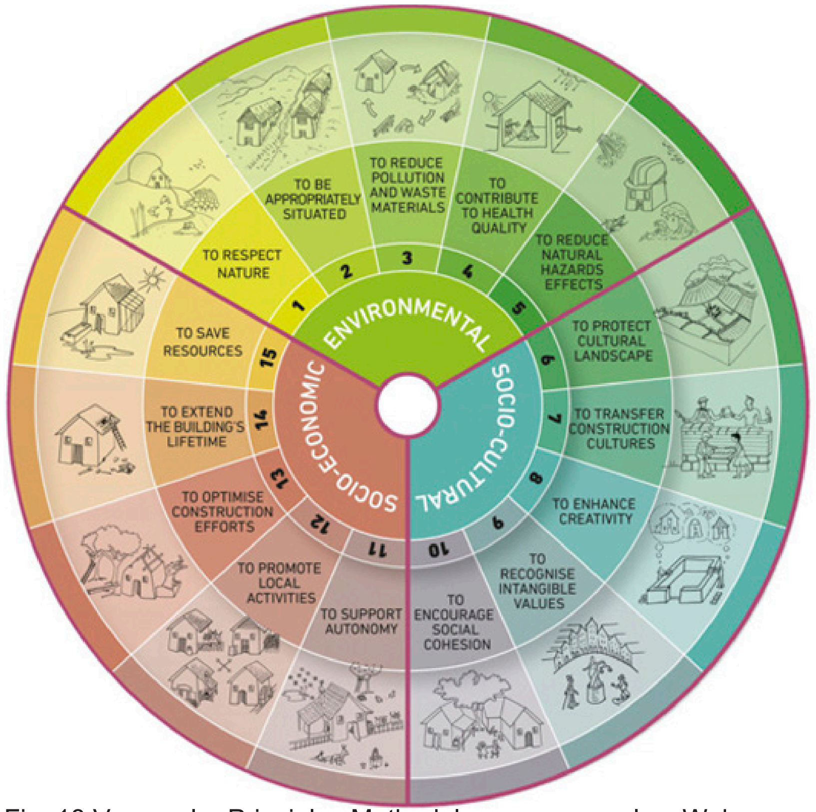


Fig. 18 Vernacular Principles Methodology – versus plus. Webs.upv.es. (2025).

How do communities ensure traditional construction methods and knowledge are Preserved?

Traditional construction methods are preserved through a combination of technical practice and cultural transmission. Techniques such as joinery, earthen masonry and thatched or woven roofing show centuries of adaptation to local environments, see Fig. 19 (Brunskill, 1978). Crafts are passed down through apprenticeships, masters teaching their students. However industrial made materials can be easily accessed all over the world with a click of a button, this option is quicker, easier and cheaper meaning traditional building techniques and materials are being lost to the high demand of industrial production. Patricia E. Green argues that one reason for the “sad decline” of vernacular technologies is "the stigma of it being old-fashioned, or primitive” (Nabokov, 1999, pp.74). By researching and publishing work about vernacular architecture we can make these techniques more known. According to Nan Yang et al vernacular architecture can be applied to contemporary design, this can be seen in Chinese rural construction, see Fig. 20 (Yang, Chen and Xi, 2024). Use of fundamental vernacular techniques and modern technology could be a positive way forward. In my case studies I will examine and analyse traditional vernacular techniques in order to document these crafts for future generations.

Fig. 19 Weaving through the Ages. Crowley, E. (2013).

Fig. 20 Aerial view of Tolou House Complex. Rachmat Rhamdhani, F. and Yuzhuang , L. (2015).

What architectural techniques are used within vernacular design to regulate solar gain?

Vernacular architecture integrates solar and passive design strategies to reduce energy and enhance comfort. Orientation and form are carefully chosen to maximize passive solar control, capturing winter sun while minimizing summer exposure (Sood, 2023). Shading devices such as overhangs, verandas, deep eaves, porches, and perforated screens provide layered protection, creating shaded zones that extend comfort outdoors, see Fig. 21 (Rethinking The Future, 2024). Material choice is also important, Hui Huang et al uses the Mahoney table (reference tables for climate appropriate design) demonstrating how thick earth walls and stone plinths have a high thermal mass that absorb heat during the day and release it at night, moderating temperature swings (Huang et al, 2024). However Monire Vatankhah et al argues that without technological adaptation, vernacular typologies are outdated and don’t meet the necessary LEED (Leadership in Energy and Environmental Design) requirements, due to receiving too much sunlight, see Fig. 22 (Monire Vatankhah et al., 2023).

In my case studies I will analyse specific case studies located in extreme environments such as deserts, polar zones and rainforests to evaluate solar resilience in vernacular architecture.

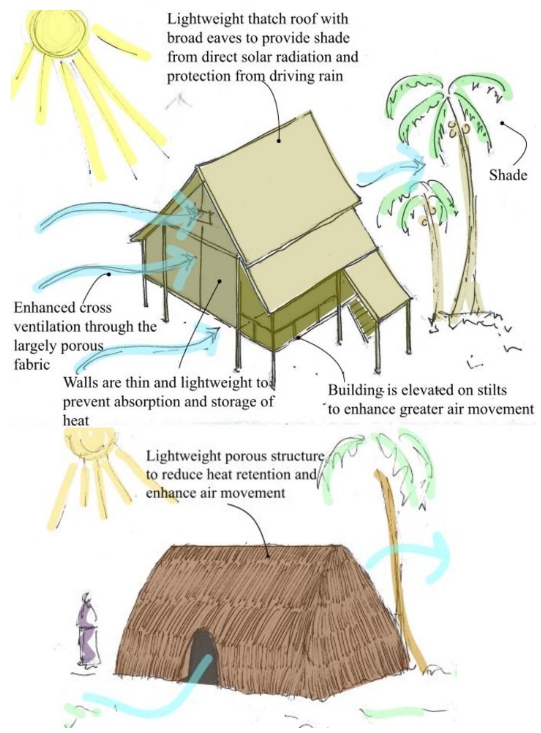


Fig. 21 Climate-Responsive Vernacular Swahili Housing. Kiamba, L., Rodrigues, L. and Lau, B. (2014).

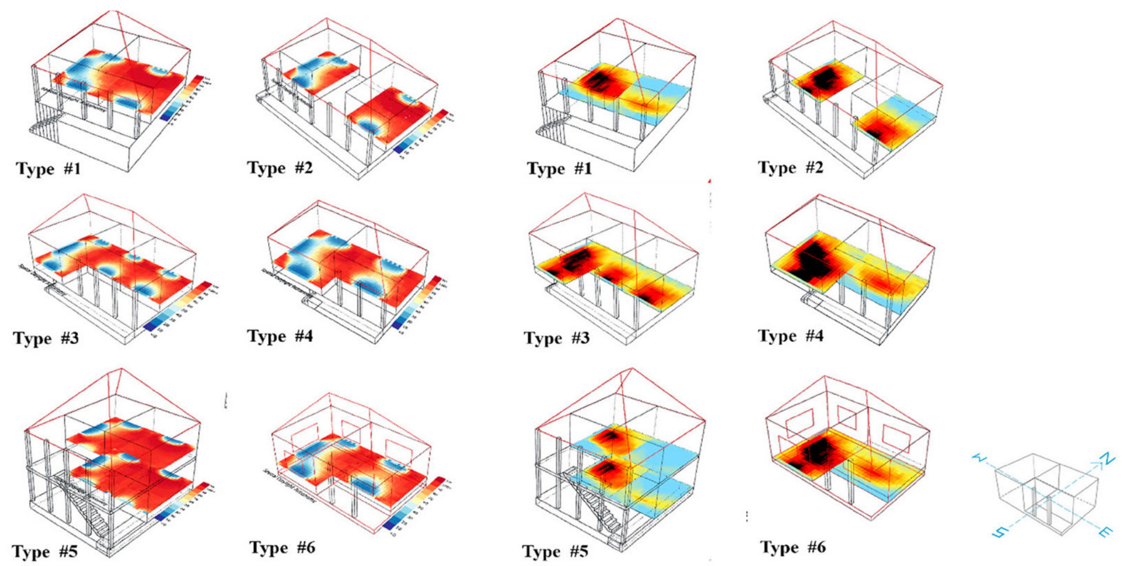


Fig. 22 Spatial Daylight Autonomy (left) and Annual Sunlight Exposure (right) in Models of Vernacular Dwellings. Monire Vatankhah, Roza Vakilinezhad, Hossein, M. and Fattahi, K. (2023).

How do vernacular designs respond to environmental conditions, taking into account flora and fauna?

Vernacular design responds to environmental conditions by shaping architectural design to local ecological knowledge, such as material choice and form. Oliver argues that vernacular architecture respects existing ecological systems, with communities working in harmony with the environment (Oliver, 2006). The built environment isn't a blank canvas, landscapes have existed for centuries. Fathy argues, "violence to the environment by building without reference to it, is committing a crime against architecture and civilisation" He further implies that the integration of flora and fauna is fundamental to vernacular architecture, where vegetation provides shading, wind buffering and attracts wildlife. Additionally, deep analysis of site planning is vital, to avoid disrupting tree roots and habitats (Fathy, 1986). Understanding environmental conditions extensively allows for more holistic and efficient design, allowing vernacular architecture to thrive as an ecologically adaptive practice. I will apply these principles to case studies in future chapters for more context on how indigenous communities respond to the environment.

Conclusion

In conclusion, this chapter has established vernacular architecture as a climate responsive system of cultural knowledge, with principles of local materials, traditional construction techniques, climate responsive design and environmental adaptation. By examining how communities use these principles this chapter demonstrates the relevance for vernacular architecture in the face of climate change. These principles will form the analytical framework for the case studies in chapters 2.2, 2.3 and 2.4, creating a fundamental base of knowledge to compare vernacular architecture in different extreme environments. This will preserve information for future generations with adaptive design recommendations in response to climate change.

2.2

Case study 1: Deserts
The Dakhla and Kharga Oases, Egypt

"Deserts are amongst the most inhospitable environments on Earth, characterised by extreme temperatures, minimal rainfall and sparse vegetation… covering approximately one-fifth of the planet's land" (Chapman, 2024a). Flora and fauna adapt to these harsh environments effectively, indigenous communities have mimicked this in order to survive.

This chapter will examine the vernacular architecture of the Dakhla and Kharga Oases located in Egypt's Western Desert, analysing through the four vernacular principles discussed in chapter 2.1. Based on my methodology in chapter 1.4, I will use my adapted vernacular typology matrix to plot building techniques and materials to identify features relevant to my other case studies. To deepen analysis I will also apply Mahoney's table to evaluate how climate conditions shape design responses. Together, these tools will create a systematic evaluation of how vernacular architecture adapts to extreme environmental conditions and what lessons it offers for climate design in the future.

Challenges of extreme temperature fluctuations, water scarcity and strong winds contribute to difficulty building in extreme desert climates (Kağan Keçeci, 2024). Esmail and Tawfik states the Kharga Depression is located approximately "150-200 kilometres West of the river Nile" (Esmail and Tawfik, 2015, p. 63), while the Dakhla Depression is situated around 190 kilometres further West. Each depression is around 185 kilometres in length, making them the longest in Egypt. The Oases experience an extreme climate where temperatures can reach 45°C between April and December, dropping to 20°C from October to March, with almost no rainfall throughout the year. Adding to this high wind speeds can result in sandstorms (Esmail and Tawfik, 2015).

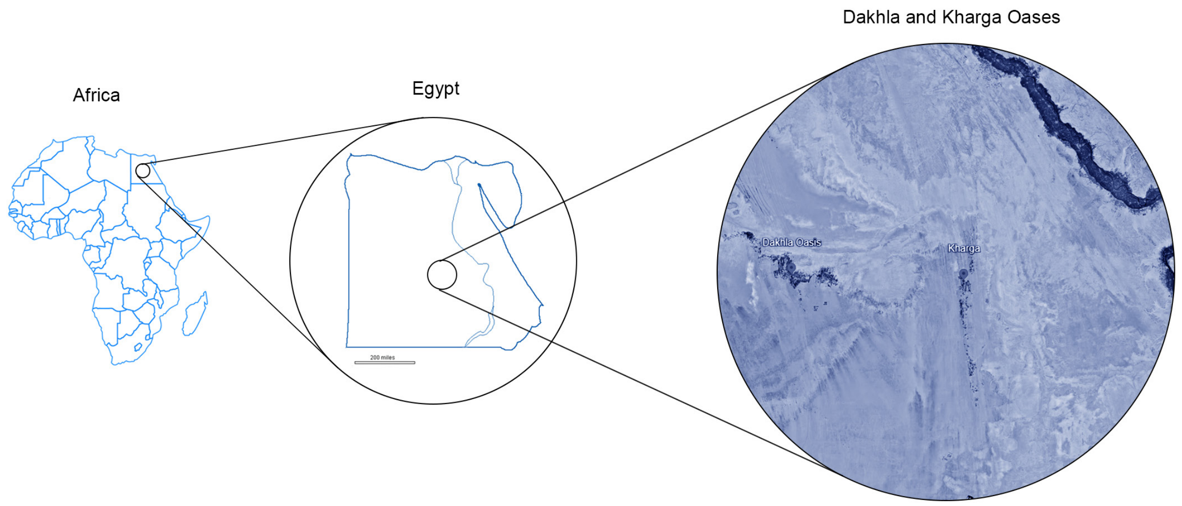


Fig. 23 Location Map of the Dakhla and Kharga Oases. Author (2026).

Soil studies by Abd El-Ghani et al suggest that public gardens within the oases support a larger variety of flora species compared to the surrounding desert, where fewer species are adapted to the harsh environment. This highlights the importance of integrating flora within the shelter of the city (Abd El-Ghani et al., 2025). Due to the oases being a shallow lake around 10,000 years ago, subterranean water created fertile soil for growing crops (Inside-egypt.com, 2021). The indigenous people were engaged in agriculture and local crafts such as basket weaving and pottery (Bagnall and Gaelle Tallet, 2019).

Vernacular architecture in the Dakhla and Kharga Oases have adapted to these environmental challenges using various vernacular techniques such as material choice, spatial organisation and solar shading. Their architecture reflects centuries of adaptation using features such as small window openings, thick earth walls and street roofing, see Fig. 24 (Gabr and El-Assal, 2022). Research on these case studies will offer insight into climate adaptive, sustainable design relevant to global climate resilience.

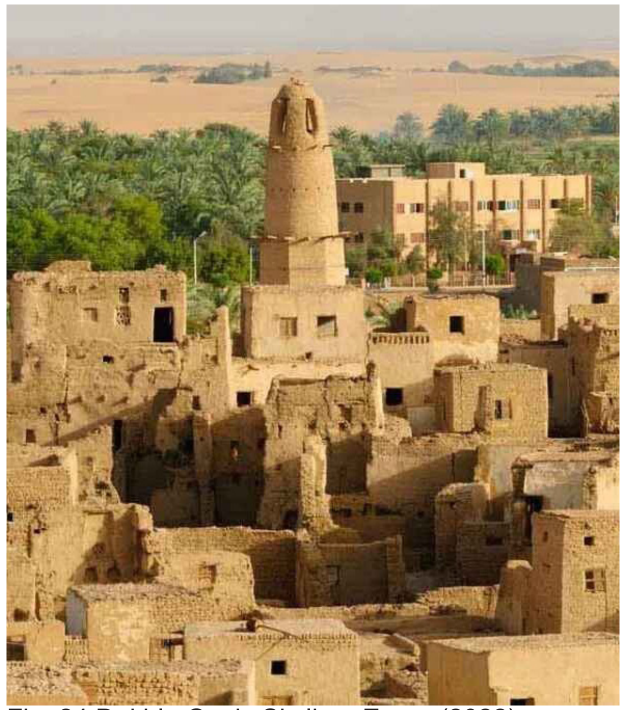


Fig. 24 Dakhla Oasis Skyline. Esraa (2022).

Being situated in the desert with lack of flora and fauna, the Dakhla and Kharga Oases respond to the existing environments to some extent. The use of traditional mudbrick and timber construction reflect the relationship of architecture and the local environment whilst adapting to climate conditions. Due to a lack of water in desert climates, layouts and settlements consider water management and agricultural practices, incorporating native plants into architecture, creating shade (De Filippi , 2005). On the other hand the Oases lack incorporation of flora, by introducing green roofs or community gardens utilizing native plants biodiversity will improve. Water in the oases is in depression, with the main source of water being from the Nile and surrounding lakes, see Fig. 25 (Centre, n.d.) Using water conservation and irrigation techniques, communities could introduce greenery back into the environment. These strategies aim to achieve ecological harmony, allowing architecture and living systems to live together.

Fig. 25 Nile rvier map. Dr. Laura Guertin (2019).

Buildings in the Dakhla and Kharga Oases are made using local materials which allows for a low-carbon lifecycle. Walls are made using adobe bricks which is a mixture of “clay, salt based soil and wheat chaff ” (Esmail and Tawfik, 2015, p.66) all blended with water, the final mixture is put into a timber cast and left out in the sun to dry, see Fig. 26 (Subika Manandhar, 2024). Walls are painted with lime and light colours to protect them from sunrays, see Fig. 27 (Gabr and El-Assal, 2022). Due to the mud bricks being made on site, transport time is reduced meaning “one person can produce approximately 600 bricks in 7 working hours” (Gabr and El-Assal , 2022, p.10). Although mud and clay erodes when exposed to too much moisture, being in the hot environment of the desert this has little effect. For the roof palm tree branches or olive tree trunks are used as a structural base with a layer of clay over the top, see Fig. 28 (Esmail and Tawfik, 2015). This method is similar to the vernacular technique of wattle and daub, dating back to the Neolithic period, which involves the weaving of sticks and layers of mud and clay. (Chronicles, n.d.) At the end of life, materials biodegrade due to them being natural and locally sourced. “The worldwide scarcity of construction materials” (Esmail and Tawfik, 2015, p.64) means looking at natural alternatives is necessary.


Fig. 26 Adobe and Mud Dakhla Architecture, Adams, 2014.


Fig. 27 Painted Wall Finish. Hosie, M. (2023).


Fig. 28 Palm Leaf, Timber and Mud Roof. Charoensinphon, N. (2024).

Natives choose certain building materials as they provide solar shading and ventilation benefits. According to research by Esmail and Tawfik, walls are around 100cm thick, leading to a delay in heating interiors during the day but filling up with warmth during the night. Roof edges research around 1.5m to create shade over streets and courtyards (Esmail and Tawfik, 2015), these courtyards are positioned centrally between buildings creating a sheltered area for air filtration and dusk control (Gabr and El-Assal, 2022). As well as courtyards providing shading and ventilation, wind towers are a distinctive feature, catching prevailing winds and creating exits for hot air see Fig. 31,32 (Esmail and Tawfik, 2015). To further increase ventilation and reduce solar heating, window holes are deep and small, reducing sunlight entry. Solar shading doesn't just occur in houses but on streets, roofing methods using timber and clay create cooler spaces walking around the whole city, see Fig. 30 (Gabr and El-Assal , 2022).

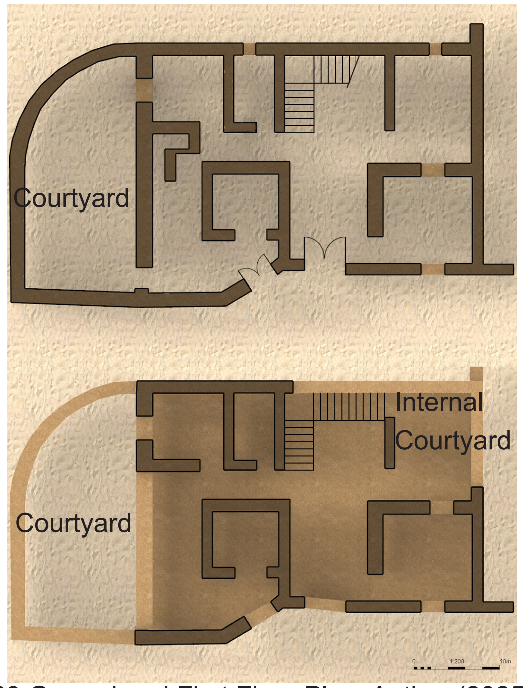


Fig. 29 Ground and First Floor Plan. Author (2025).

Fig. 30 Dakhla Solar Shading in Streets. Nelemans, W. (2012).

Day - Wind scoop and courtyard catch prevaling winds for cooling. Hot air rises out of the couryards.

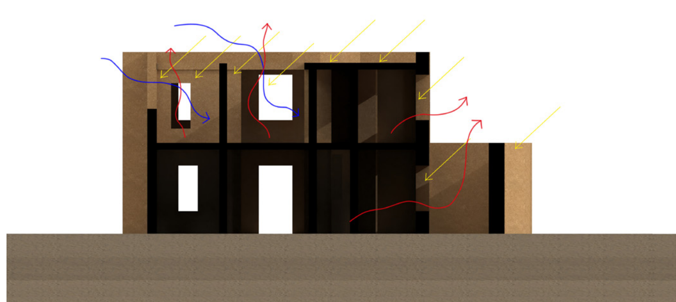


Fig. 31 Sectional Ventilation Analysis, Day. Author (2025).

Night - Cool air from roof sinks into the courtyards. Heat loss by out-going radiation.

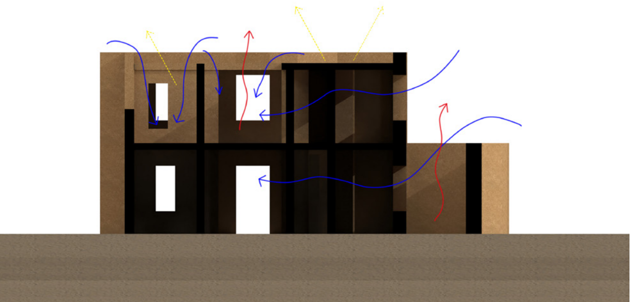


Fig. 32 Sectional Ventilation Analysis, Night. Author (2025).

Using my vernacular typology matrix, see Fig. 16 I have analysed the architectural characteristics of vernacular architecture in Deserts. Gathering information from the Dakhla and Kharga case studies such as small square and rectangular windows (1C, 2C), mud and clay structures (3F), timber, palm leaf and mud roof (3H) and a mix of horizontal and domed shaped roofs (1I, 5I), see Fig. 33. This reflects the use of efficient design maximising solar shading, ventilation and use of local resources. I will use this matrix as a transferable analytical tool, allowing comparison across deserts, polar zones and rainforests. It will allow the identification of qualities that create efficient architecture in order to be imitated in modern design today.

	1	2	3	4	5	6	7	8	9
A								X	
B						X			
C	X	X							
D				X					
E	X								
F			X						
G					X				
H			X						
I	X				X				

Fig. 33 Vernacular typology matrix of Dakhla and Kharga desert architecture. Author (2025).

Using Mahoney's Table framework see Fig. 17 I analysed environmental data from Egypt to evaluate if vernacular architecture in the region responds effectively to local climatic conditions. The environmental graphs, see Figs. 34,35,36 show a big fluctuation in air temperature in January, February, December as temperatures decrease while temperatures significantly increase from May to September. Humidity percentage follows the opposite pattern, in colder months humidity increases and in warmer months humidity decreases. There is a lack of rainfall throughout the year in Egypt with a maximum of 6mm falling in march, confirming the extreme nature of the climate.

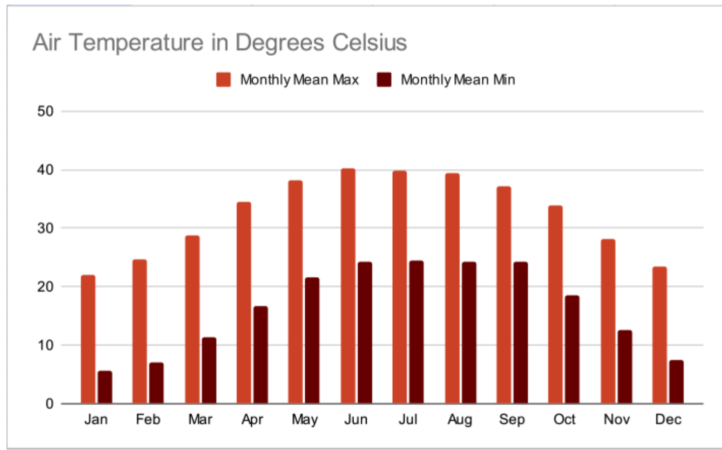


Fig. 34 Egypt Air Temperature Bar Chart. Author (2025).

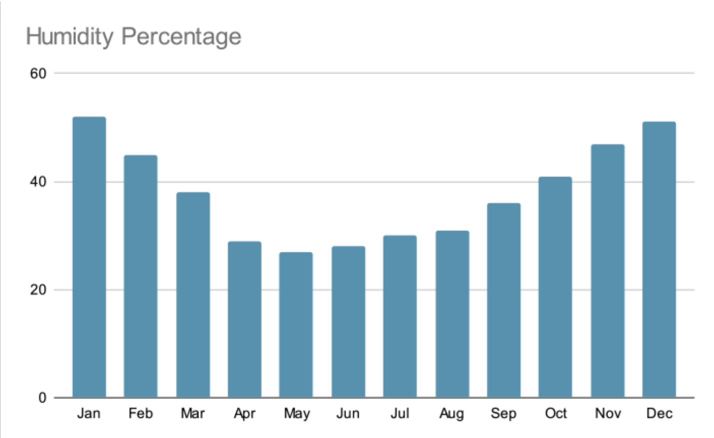


Fig. 35 Egypt Humidity Bar Chart. Author (2025).

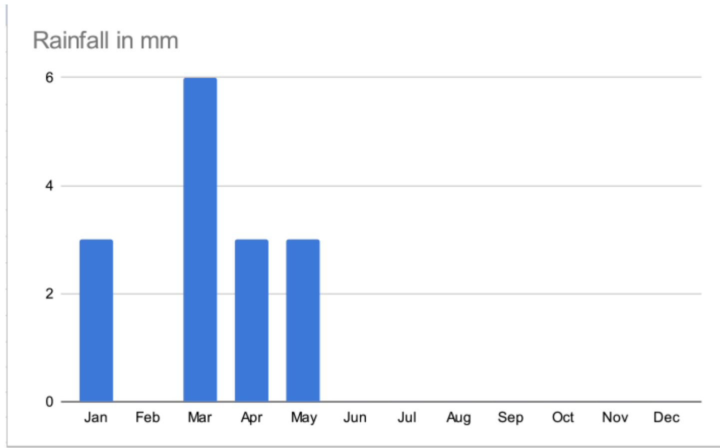


Fig. 36 Egypt Rainfall Bar Chart. Author (2025).

All data for graphs gathered from:
(Global Wind Atlas, 2024),
(Weather Atlas, 2020),
(Weather Spark, 2020).

Applying Mahoney's methodology to this dataset see Fig. 17 the thermal stress analysis in Egypt, see Fig. 38 suggests that during the day conditions are too hot for most months while at night time conditions are too cold. Based on these findings, I produced a final table of design recommendations see Fig. 39. These recommendations coincided with vernacular building techniques observed in the Dakhla and Kharga Oases, including use of small openings, heavy external and internal walls and compact courtyard planning. This suggests that vernacular architecture in Egypt's desert Oases respond to the environment successfully creating spaces that are thermally comfortable despite the extreme climate.

Months	Wind, Prevailing	Wind, Secondary	Monthly Mean Humidity	Humidity group	Monthly Mean Max Temp	Monthly Mean Min Temp	Range	Monthly Mean Rainfall	High	Low
Jan	NW	SE	52	3	22.1	5.6	16.5	3	40.2	5.6
Feb	N	S	45	2	24.7	7.1	17.6	0	AMT	AMR
Mar	N	S	38	2	28.8	11.3	17.5	6	22.9	34.6
Apr	N	S	29	1	34.5	16.7	17.8	3		
May	N	S	27	1	38.2	21.5	16.7	3		
Jun	N	S	28	1	40.2	24.2	16	0		
Jul	NW	SE	30	2	39.9	24.4	15.5	0		
Aug	N	S	31	2	39.5	24.2	15.3	0		
Sep	N	S	36	2	37.1	24.2	12.9	0		
Oct	N	S	41	2	33.9	18.5	15.4	0		
Nov	N	S	47	2	28.1	12.5	15.6	0		
Dec	N	S	51	3	23.5	7.4	16.1	0		

Fig. 37 Egypt Climate Data. Author (2025).

Months	Monthly Mean Max Temp	Day Comfort Upper	Day Comfort Lower	Monthly Mean Min Temp	Night Comfort Upper	Night Comfort Lower	Thermal Stress Day	Night
Jan	22.1	29	23	5.6	23	17	C	C
Feb	24.7	31	25	7.1	24	17	C	C
Mar	28.8	31	25	11.3	24	17	O	C
Apr	34.5	34	26	16.7	25	17	H	C
May	38.2	34	26	21.5	25	17	H	O
Jun	40.2	34	26	24.2	25	17	H	O
Jul	39.9	31	25	24.4	24	17	H	H
Aug	39.5	31	25	24.2	24	17	H	H
Sep	37.1	31	25	24.2	24	17	H	H
Oct	33.9	31	25	18.5	24	17	H	O
Nov	28.1	31	25	12.5	24	17	O	C
Dec	23.5	29	23	7.4	23	17	O	C
						H=Hot	O=Ordinary	C=Cold

Fig. 38 Egypt Thermal Analysis Climate Data. Author (2025).

Months	H1	H2	H3	A1	A2	A3	Results
Jan				X		X	Orientation North and South
Feb				X		X	Compact courtyard planning
Mar				X			Rooms double banked
Apr				X			Temporary provision for air movement
May				X	X		Very small openings
Jun				X	X		Heavy external and internal walls
Jul				X	X		Heavy roof, over 8 hour time-lag
Aug				X	X		Space for outdoor sleeping requried
Sep				X	X		Openings in internal walls
Oct				X	X		
Nov				X			
Dec				X			
	Total 0	0	0	12	6	2	

Fig. 39 Egypt Climate Response Data. Author (2025).

Knowledge in the Dakhla and Kharga Oases continues to be preserved through their architecture, these long lasting structures still remain present today. This allows for many researchers to visit, observe and interact with locals to learn more about their culture and construction. Herbert Winlock visited each Oasis observing that appearances are unchanged over the last 90 years (Wolf Schijns, Kaper and Kila, 2008). Traditional construction relies on skilled local builders who understand material behavior and environmental conditions learnt through practice (De Filippi , 2005). Furthermore, Esmail and Tawfik argue that desert communities have "full self-containment" allowing them to depend on trade, craft and agriculture within the city. This results in less need to look external for contemporary construction materials.

Conclusion

In conclusion, this chapter has demonstrated that the vernacular architecture of the Dakhla and Kharga Oases responds efficiently to extreme desert conditions by using local materials, passive cooling strategies and form. Through applying vernacular principles, my vernacular typology matrix and Mahoney's table framework, it highlights the use of climate responsive design such as thick adobe walls, shaded streets, ventilation systems and compact courtyards. While the community could integrate itself further with flora and fauna creating habitats for more than humans, the case studies show how vernacular knowledge offers valuable lessons for the future of climate adaptive design and efficient resource use.

2.3

Case study 2: Polar zones
Ne'en Kan, Goahti and Igloo architecture, Canadian and Scandinavian Arctic

Polar regions are among the most extreme environments on Earth, characterised by sub-zero temperatures, limited daylight and scarce vegetation (Chapman, 2024b). Despite these challenges, indigenous communities have a population of more than 1 million across the Canadian and Scandinavian Arctic and have developed architectural techniques to adapt to extreme conditions (The Arctic Council, 2023). Although, due to rising global temperatures, ice caps are melting in arctic regions "altering the availability of resources and presenting new challenges" (Chapman, 2024) for indigenous communities.

This chapter focuses on vernacular architecture of the Inuit and Sami communities, such as Ne'en Kan, Goahti and Iglus, analysing them through the four vernacular principles discussed in chapter 2.1. Based on my methodology in chapter 1.4, I will use my adapted vernacular typology matrix to plot building techniques and materials to identify features relevant to my other case studies.

To deepen analysis I will also apply Mahoney's table to evaluate how climate conditions shape design responses. Together, these tools will create a systematic evaluation of how vernacular architecture adapts to extreme environmental conditions and what lessons it offers for climate design in the future.

Challenges of extreme cold and wind, isolation and limited resources contribute to difficulty building in extreme arctic climates (Murray, 2025.) Ne'en Kan and Iglu vernacular architecture originates from the Canadian Arctic, whereas Goahti architecture originates from the Scandinavian Arctic (Mackin. 2016). Arctic climates are extreme environments with temperatures dropping as low as -28°C annually, furthermore the amount of sunlight monthly can drop to a minimum of 12 hours (Weather Atlas, 2020).

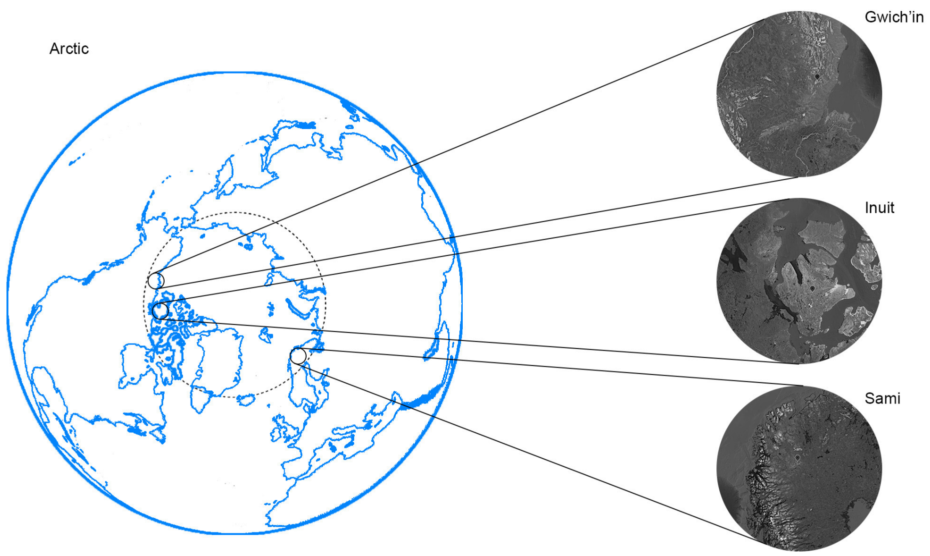


Fig. 40 Location Map of the Gwich'in, Inuit and Sami Communites. Author (2026).

Vernacular architecture of the Inuit, Gwich'in and Sami communities have evolved to combat these challenges through material choice, form and heating systems. Their architecture reflects centuries of adaptations using features such as insulation techniques, lack of window openings and wind breakers (Inuit Dwellings: Indigenous Designs for the Arctic, 2024). Research on these case studies will offer insight into climate adaptive, sustainable design relevant to global climate resilience.

Arctic vernacular architecture is deeply rooted to the environment following animal cycles and minimising flora and fauna disturbance. Among Sami communities, Beach researches reindeer herding patterns where herders follow seasonal shifts of reindeer, see Fig. 41, adjusting routes to snow conditions and grazing availability as well as the need to protect them from predators. To prevent overpopulation reindeer hide and meat is a large part of Sami clothing and cuisine (Go to Sápmi, 2019). These management strategies require a great understanding of ecological systems, in which Sami are experts (Beach, 1981). "The symbiotic relationship between the Sámi and their reindeer is a testament to their adaptability and resilience in the face of challenging conditions" (Go to Sápmi, 2019). The architectural structures of natives are small and temporary, ensuring a lack of ecological disturbance. Collectively, these practices demonstrate environmental awareness taking into account ecological systems.

Aporta. C argues that arctic trails, see Fig. 42 are how knowledge is transmitted and preserved. These trails link camps, hunting grounds and fishing sites resulting in an extensive understanding of the environment. Children often accompany elders on journeys learning information about construction techniques, material harvesting and the environment through observation (Aporta, 2009). Apprenticeships reinforce this process, ensuring knowledge is remembered through hands-on labour, resulting in better transference of knowledge.

The technical demands of many Arctic structures make this transmission of knowledge vital. Iglu's rely on the precise spiraling of snow blocks, while Goahti construction requires birchbark removal and installation skills (Mackin. 2016). Without knowledge being passed down to children or apprentices, these crafts risk being lost (Mackin. 2016). Across Inuit and Sami Arctic traditions, construction knowledge is therefore preserved through practice, storytelling and communal work, ensuring cultural traditions and environmental expertise doesn't disappear.

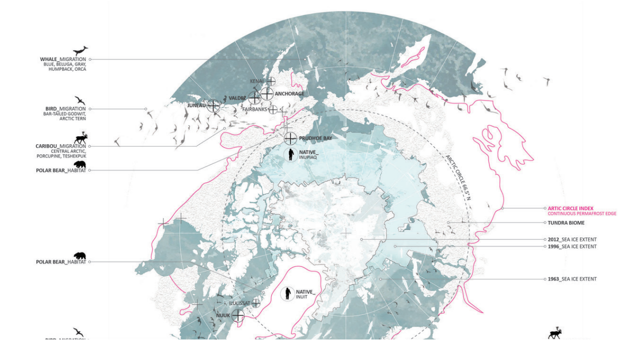


Fig. 41 Aman, A. (2020). Gallery of Architecture of the Arctic Circle.

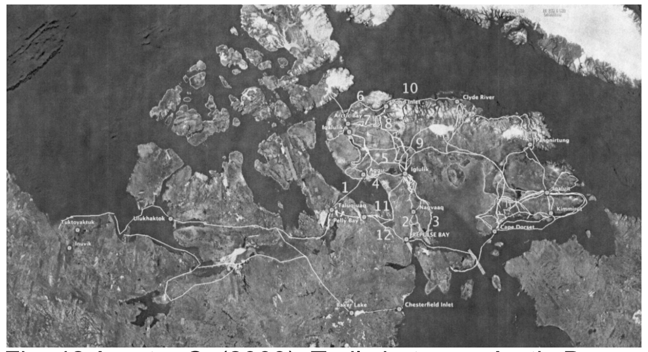


Fig. 42 Aporta, C. (2009). Trails between Arctic Bay and Iglulik.

Vernacular architecture in arctic regions rely on locally available materials due to the lack of transport connections and need for site responsive construction. Indigenous people of Scandinavia (Sami) build Goahti houses out of birch timber and bark, turf, flat stones and reindeer hides, see Fig. 43 (Holloway, 2020) (Architravel Guide, 2025). These materials are sourced from local surroundings with curved wooden beams found growing on hillsides shaped by gravity, while turf and bark are collected from nearby ground layers and forests. (Hamlet and Oliver, 2020). Due to a lack of infrastructure and transport, materials are carried short distances by hand, sled or skin-covered boats (Freeman, 2007), reflecting a low carbon harvesting approach.

In the Canadian Arctic, following N.P Mackin's research Gwich'in communities similarly use locally accessible birch for A-frame Ne'en Kan structures with moss insulation, see Fig. 44. Stunted trees growing near waterways are locally and selectively harvested whilst moss is collected in lightweight bundles by hand. In regions with high amounts of snow and lack of trees, Iglu's are constructed from consistent and dense snow, eliminating the need for material transport see Fig. 45 (Mackin. 2016).

Across this range of environments, selective timber harvesting techniques are vital for protection of biodiversity (Watson, 2025). Due to all these materials being locally sourced and minimally processed, repairs and adaptations can be easily made. At the end of their life cycle materials can either biodegrade naturally, such as timber, bark and moss, or melt back into the environment like snow. Lack of transport connections reduce the need for industrialised materials, resulting in a low carbon footprint. This material cycle reinforces the regenerative qualities seen in vernacular Arctic building traditions.

Fig. 43 Goahti (turf home). Hamlet, G. and Oliver (2020).

Fig. 44 Ne'en Kan Architecture. Mackin, N.P. (2016).

Fig. 45 Kelso (2015). Iglu Home.

Solar conditions in polar regions are extreme, with long periods of darkness and low-angle sunlight see Fig. 46 These constraints create a fundamental need for efficient heating strategies and compact forms. As Mackin argues, vernacular Arctic structures adapt to conditions through materials, passive heating and wind protection. The Iglu is an example of this due to its domed shape, effective against wind but if not built with the spiralling of snow block correctly, it fails. To improve structural strength snow aprons are at the base of structures which anchor the form to the ground (Mackin, 2016). Despite external temperatures reaching -45°C, the Iglu's thick snow walls provide a high thermal mass, allowing internal temperatures to rise to 16°C (Torem, 2012). Below surface entrances and tunnel systems further reduce heat loss through openings, allowing warm air to remain in the living space, see Fig. 47 hot air rises and gets trapped inside whilst cold air falls into a sump in the tunnel (Mackin. 2016) (Gardiner, 2022).

Other dwellings, such as Goahti and Ne'ek Kan structures both use layers of animal hides, moss and bark to create thermal insulation (Holloway, 2020). Goahti structures use central fireplaces and small roof vents for smoke to escape and provide ventilation (Nango, 2021), while Ne'en Kan structures position fireplaces near the open end, allowing for smoke to escape efficiently (Mackin. 2016). These structures are deliberately small, with minimal openings and orientations that avoid winds, Goahti entrances often face East or Southeast to capture morning sunlight and avoid prevailing winds (Architravel Guide, 2025). Altogether, these strategies demonstrate extensive understanding of Arctic climates and thermal performance creating more comfortable spaces for living.

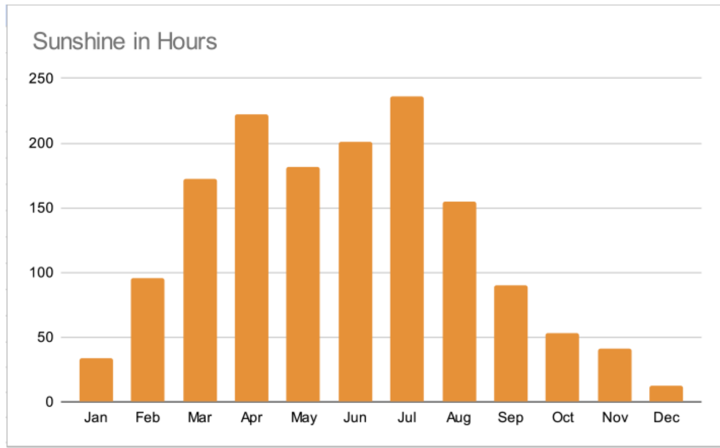


Fig. 46 Nunavut Sunlight Hours Bar Chart. Author (2025).

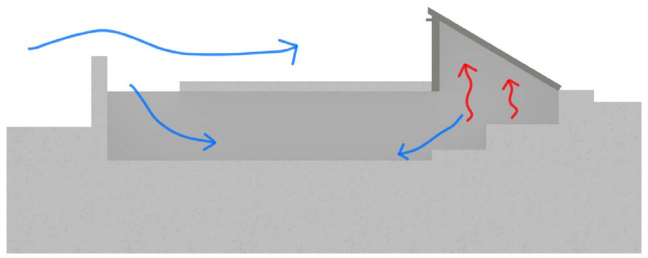


Fig. 47 Passive heating technologies in traditional Arcitc dwelling.

Using my vernacular typology matrix, see Fig. 16 I have analysed the characteristics of vernacular architecture in Arctic climates. Gathering information from the Canadian and Scandinavian Arctic case studies such as having no windows in Neen'kan and Iglu's (7B), a timber structure in Neen'kan and Goahti (4F), a low semi-circular arched doorway in Iglu's (7E), spiral snow stacking in Iglu's (7G) and a domed roof for Goahti structures (5I), see Figs. 48,49,50. This reflects the use of efficient design maximising thermal mass, and use of local materials. My matrix is a broad analytical tool allowing me to compare vernacular architecture across deserts, polar zones and rainforests but it does not take into account all characteristics of construction, reflected in row 9 (none applicable) of my tables.

	1	2	3	4	5	6	7	8	9
A									X
B							X		
C									X
D						X			
E									X
F				X					
G		X							
H									X
I				X					

Fig. 48 Vernacular typology matrix of Ne'en kan Arctic architecture. Author (2025).

	1	2	3	4	5	6	7	8	9
A							X		
B							X		
C									X
D									X
E							X		
F							X		
G							X		
H							X		
I					X				

Fig. 49 Vernacular typology matrix of Igloo Arctic architecture. Author (2025).

	1	2	3	4	5	6	7	8	9
A		X							
B	X								
C	X								
D	X								
E	X								
F				X					
G	X								
H									X
I					X				

Fig. 50 Vernacular typology matrix of Goahti Arctic architecture. Author (2025).

Using Mahoney's Table framework, see Fig. 17 I analysed environmental data from Nunavut, Arctic to evaluate if vernacular architecture in the region responds effectively to local climatic conditions. The environmental graphs see Figs. 51,52,53 show an extremely cold air temperature from January through to May which rises briefly until September and then decreases again. Humidity remains relatively high and consistent throughout the year and rainfall increases during warmer months.

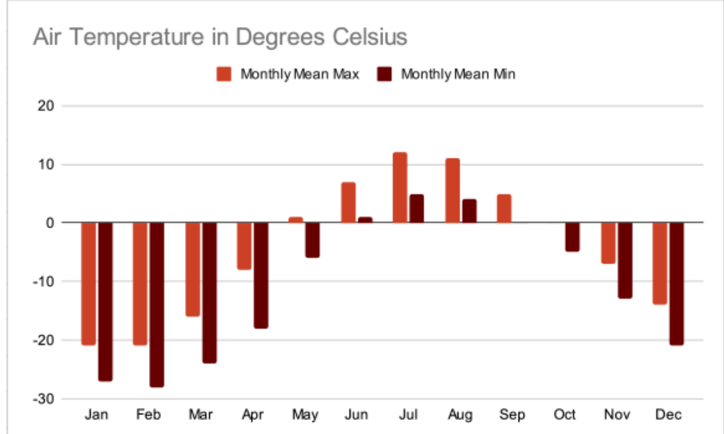


Fig. 51 Nunavut Air Temperature Bar Chart. Author (2025).

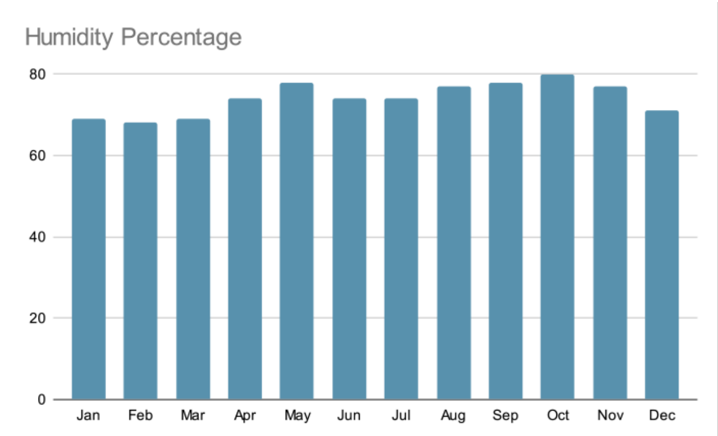


Fig. 52 Nunavut Humidity Bar Chart. Author (2025).

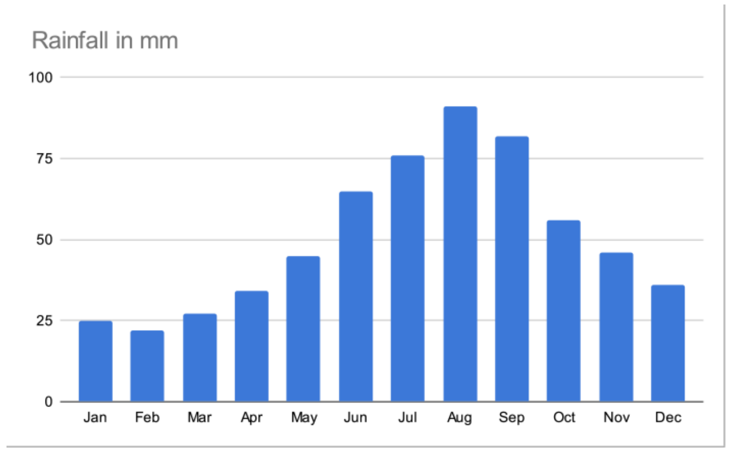


Fig. 53 Nunavut Rainfall Bar Chart. Author (2025).

All data for graphs gathered from:
(Global Wind Atlas, 2024),
(Weather Atlas, 2020),
(Weather Spark, 2020).

Applying Mahoney's methodology to this dataset, see Fig. 17 the thermal stress analysis in the Arctic see Fig. 55 suggests that during the day and night conditions are too cold for all months of the year. Although Mahoney's framework is not adapted to extremely cold climates some design recommendations see Fig. 56 can be applied to vernacular architecture in Polar zones, such as having light reflective surfaces, thermally insulated roof and minimal air movement. On the other hand, the framework suggested having light low thermal capacity walls with a short time lag, a lightweight roof and medium openings, these methods wouldn't achieve thermal comfort in freezing conditions due to insufficient thermal mass and risk of drafts through openings. This reflects a key limitation of Mahoney's tables, without considering the extreme cold climate of Arctic regions.

Months	Wind, Prevailing	Wind, Secondary	Monthly Mean Humidity	Humidity group	Monthly Mean Max Temp	Monthly Mean Min Temp	Range	Monthly Mean Rainfall	High	Low
Jan	NW	E	69	3	-21	-27	6	25	12	-28
Feb	NW	SE	68	3	-21	-28	7	22	AMT	AMR
Mar	NW	E	69	3	-16	-24	8	27	-8	40
Apr	NW	E	74	4	-8	-18	10	34		
May	N	E	78	4	1	-6	5	45		
Jun	N	SE	74	4	7	1	6	65		
Jul	N	SE	74	4	12	5	7	76		
Aug	N	SE	77	4	11	4	7	91		
Sep	NW	E	78	4	5	0	5	82		
Oct	NW	E	80	4	0	-5	5	56		
Nov	NW	E	77	4	-7	-13	6	46		
Dec	NW	E	71	4	-14	-21	7	36		

Fig. 54 Nunavut Climate Data. Author (2025).

Months	Monthly Mean Max Temp	Day Comfort Upper	Day Comfort Lower	Monthly Mean Min Temp	Night Comfort Upper	Night Comfort Lower	Thermal Stress Day	Night
Jan	-21	26	19	-27	19	12	C	C
Feb	-21	26	19	-28	19	12	C	C
Mar	-16	26	19	-24	19	12	C	C
Apr	-8	24	18	-18	18	12	C	C
May	1	24	18	-6	18	12	C	C
Jun	7	24	18	1	18	12	C	C
Jul	12	24	18	5	18	12	C	C
Aug	11	24	18	4	18	12	C	C
Sep	5	24	18	0	18	12	C	C
Oct	0	24	18	-5	18	12	C	C
Nov	-7	24	18	-13	18	12	C	C
Dec	-14	24	18	-21	18	12	C	C
						H=Hot	O=Ordinary	C=Cold

Fig. 55 Nunavut Thermal Analysis Climate Data. Author (2025).

Months	H1	H2	H3	A1	A2	A3	Results
Jan						X	Orientation North and South
Feb						X	Compact lay-out of estates
Mar						X	Rooms single banked
Apr				X		X	No air movement required
May						X	Medium openings
Jun						X	Light walls, short time-lag
Jul						X	Light, insulated roof
Aug						X	Openings in internal walls
Sep						X	Light low thermal capacity walls
Oct						X	Light, reflective surface, insulated roof
Nov						X	
Dec						X	
	Total 0	0	0	1	0	12	

Fig. 56 Nunavut Climate Response Data. Author (2025).

Conclusion

In conclusion, this chapter highlights that Arctic vernacular architecture is based on deep environmental knowledge and adaptation. Inuit Gwich'in and Sami structures respond directly to extreme cold temperatures, winds, limited daylight and scarce resources through thermal insulation, natural material selection and passive heating strategies. These structures reflect use of minimally processed materials that biodegrade protecting existing ecology. This chapter also demonstrates the importance of knowledge transmission, where trails, apprenticeships and communal construction propel the survival of traditional crafts. Using vernacular principles, my vernacular typology matrix and Mahoney's tables I analysed case studies presenting information for the future of climate adaptive and regenerative design in the face of climate change.

Fig. 57 Sami Lavvu Structures, Finnmark, Norway Manet, 2015.

2.4

Case study 3: Rainforests
Maloca architecture, Northwestern Brazilian Amazon

Rainforest regions are among the most extreme environments to inhabit, characterized by hot and humid temperatures and a maximum of 3000mm of rainfall annually (Internet Geography, 2025). The Amazonas River experiences periods of drought and extreme rainfall, this can cause fluctuations of around 10 metres over the year (Khoury Gregorio, 2020). Indigenous communities combat this through floating structures or stilts. Human deforestation and forest fires from rising temperatures caused by climate change, unbalance the equilibrium of the environment therefore, adaptation must continue (Climate Cosmos Team, 2026). Despite these challenges, indigenous communities have developed architectural techniques to adapt to these extreme conditions.

This chapter focuses on vernacular architecture of indigenous Amazon communities such as Maloca houses, analysing them through the four vernacular principles discussed in chapter 2.1. Based on my methodology in chapter 1.4, I will use my adapted vernacular typology matrix to plot building techniques and materials to identify features relevant to my other case studies. To deepen analysis I will also apply Mahoney's table to evaluate how climate conditions shape design responses. Together, these tools will create a systematic evaluation of how vernacular architecture adapts to extreme environmental conditions and what lessons it offers for climate design in the future.

Challenges of high humidity levels and extreme amounts of rain contribute to difficulty building in extreme rainforest climates (Starner, 2025). Maloca Vernacular architecture originates from the Northern and Northwestern Brazilian Amazon where humidity levels can maximum at 80% monthly and rainfall can reach 250mm monthly (Weather Spark, 2020). The Amazon rainforests are considered one of the most diverse places on Earth with over "3 million species… and over 2,500 tree species" (Thomson, 2020), most soils have lots of nutrients therefore creating great fertile land for plant growth (Schultz and Parsons, 2018). Indigenous people use this fertile land for farming as

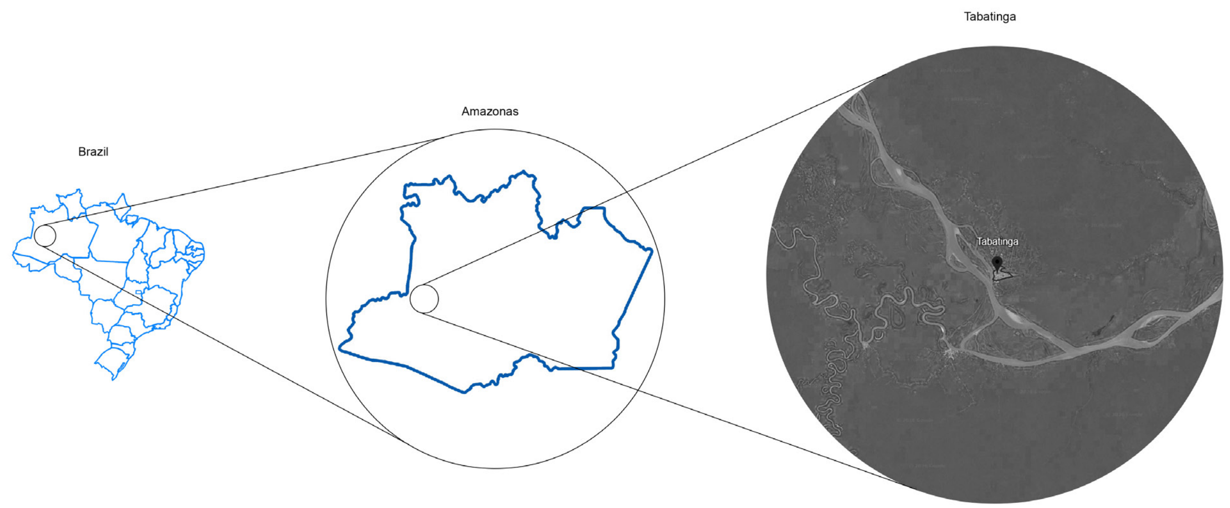


Fig. 58 Location Map of Indiginous Amazon Communites. Author (2026).

well as fishing, hunting and gathering, see Fig. 59 (Schultz and Parsons, 2018). These regions have evolved to combat extreme conditions through material choice, form and ventilation techniques. Vernacular architecture of indigenous communities reflect centuries of adaptation using features such as raised floors, cross ventilation techniques and gabled roofs (Anjos, Marcicielo Celis and Karina Rodrigues, 2022). Research on these case studies will offer insight into climate adaptive, sustainable design relevant to global climate resilience.

Fig. 59 Amazonia Indigenous Communities. Rainforest Foundation US (2024).

The relationship between vernacular architecture in the Northwestern Amazon and its surrounding ecosystems are deeply interconnected, seen through local material choices and the coexistence of human dwelling with flora and fauna (Ichioka and Pawlyn, 2021). These open structures, built from biodegradable natural materials, create habitats for humans and accommodate insects, birds and plants, see Fig. 60 (Danielle Khoury, 2022). Elevated construction reduces disturbance to animals and plants such as snakes and insects, protecting the forest floor (Anjos, Marcicielo Celis and Karina Rodrigues, 2022). This lightweight structure minimises ecological disturbance allowing vegetation to grow around dwellings and offering flexibility of moving sites allowing disturbed areas to regrow (Khoury Gregorio, 2020).

Furthermore, Gutierrez states that species of palm "have often been vested with local cultural values… which means usage and conservation of palms may be complementary" (Gutierrez, 2019, pp. 1-24). This suggests that regenerative palm leaf harvesting is promoted by cultures, due it holding symbolic and practical value, supporting sustainable construction. Palm weaving is a skilled craft requiring indigenous knowledge to be maintained, see Fig. 61. Overall, the relationship between architecture and the environment demonstrates a regenerative approach to living in harmony.

Fig. 60 Amazonia Indigenous Architecture. Rainforest Foundation US (2024).

Fig. 61 Detailed View of a Cricket Leg Weave. Gutierrez, M.P. (2019).

The passing down of knowledge in Northwestern Amazon occurs through intergenerational practice. Malocas are constructed communally where learning to build is also learning to understand cultural identity, techniques are "passed from generation to generation to preserve the community's traditional knowledge" (Gómez-García, 2024, pp). Gutierrez emphasises the importance of continuous renewal of knowledge as the decline of palm weaving traditions in the 20th century demonstrates the disruption of industrialization on material choices (Gutierrez, 2019). Together, these dynamics highlight the resilience of vernacular knowledge systems, continuity to adapt and maintain connections to cultural identity.

Material selection in rainforest vernacular architecture is often natural and locally sourced. Mainly palm leaves, timber, bamboo and straw are used for materials due to their abundance in the local environment, low embodied carbon and climatic performance, see Fig. 62 (Anjos, Marcicielo Celis and Karina Rodrigues, 2022). Gutierrez argues that palm weaving is the "root of construction ethos" (Gutierrez, 2019, p. 1) with many layers, replying water and creating insulation. These properties make gabled, palm thatched roofs ideal for heavy rainfall and high humidity climates (Gutierrez, 2019).

Paxiuba wood grows in the igapos (very flooded areas), creating a solid structure for stilted buildings with resistance to water (Khoury Gregorio, 2020). Bamboo is a rapidly growing structural plant providing flexibility for long stretching structures (Ferreira, Kalliola and Ruokolainen, 2020). The life cycle of these materials are intentionally short, embracing seasonal reconstruction and creating flexibility for changes and relocation. (Khoury Gregorio, 2020). Additionally when relocating or rebuilding materials can either be left to biodegrade or are brought to new sites due to their light nature. Use of natural local materials reinforces sustainable and regenerative design where external pressures of industrialised construction are ignored, lowering carbon footprints (Gutierrez, 2019). Altogether, vernacular architecture demonstrates the value of local materials giving indigenous communities the ability to adapt efficiently to the environment.

Fig. 62 Timber and Palm Thatched Maloca. Schandorff, K. (2014).

Solar exposure in dense rainforests is limited, with most light arriving through diffused layers of the canopy (Canham et al, 1990). Gutierrez highlights how the maloca, inuit dwellings, respond to this through a steep thatched palm roof, which efficiently repels rainfall and creates a thermal barrier for interiors to stay cool, see Fig. 63 These large overhanging roofs also shade walls and opening throughout the day. To optimise sunlight, semi-permeable bamboo walls and open plan interiors allow light to diffuse inside (Gutierrez, 2019). Structures are elevated and oriented in mind of openings for cross ventilation with gabled roofs having open attics for cooling and airflow (Anjos, Marcicielo Celis and Karina Rodrigues, 2022). This reflects a climate logic where airflow is more important than thermal insulation due to high levels of humidity and natural shading from canopies. The use of lightweight and low thermal mass materials like bamboo, reduces heat being stored inside leading to cooling at night (Koenigsberger, 1974). Overall, these strategies demonstrate a knowledge of solar and thermal logic through generations of climate responsive design.

Cold air and sunlight enters through semi-permeable walls, hot stale air rises into open roof.
Rain and sunlight is deflected by palm thatched roof.

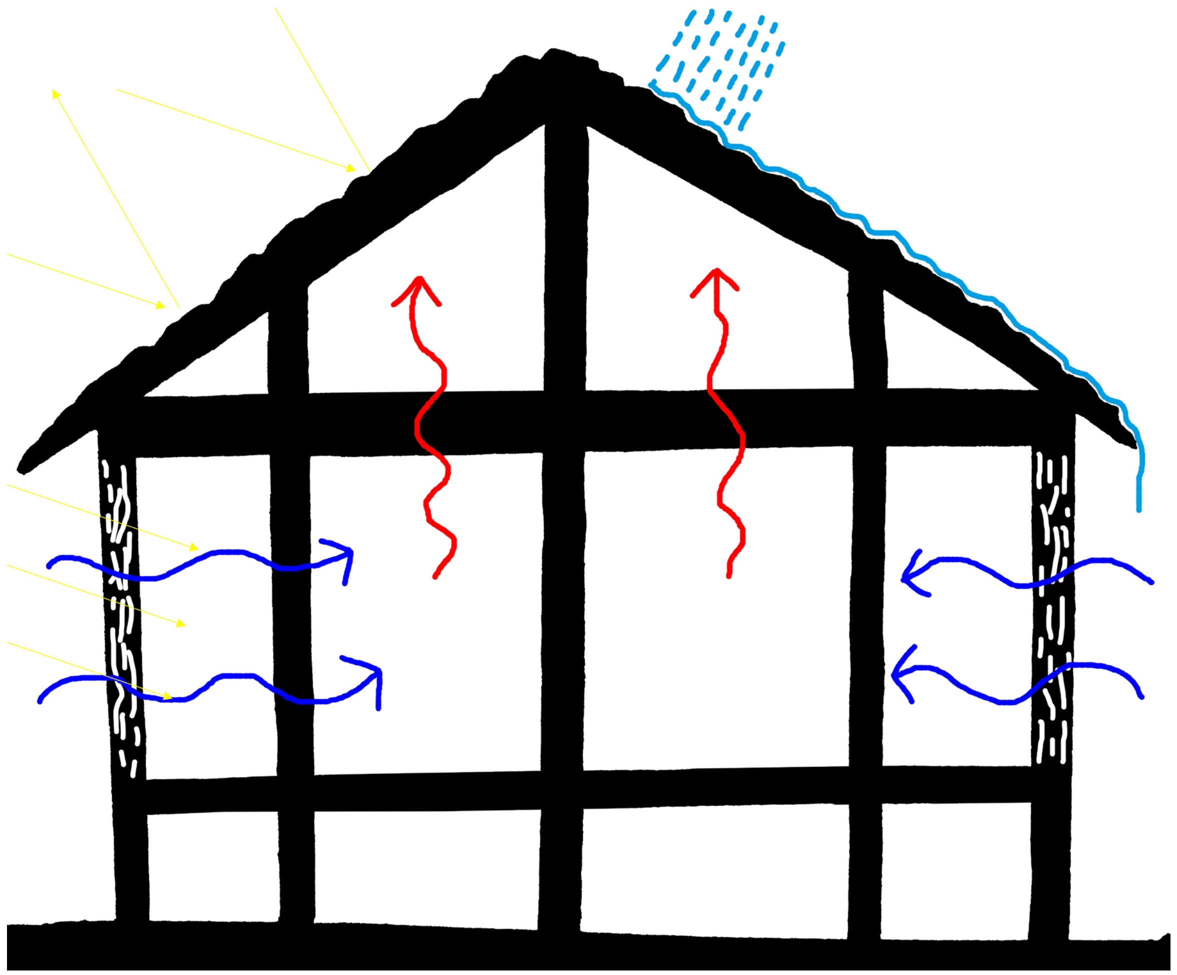


Fig. 63 Sectional Environmental Analysis of Maloca. Author (2026).

Using my vernacular Using my vernacular typology matrix, see Fig. 16 I have analysed the architectural characteristics of vernacular architecture in Rainforests. Gathering information from the Amazon rainforest case studies such as palm leaf thatched roof (2H), palm made window frames (5A), palm leaf doors (2D), bamboo walls (5F) and vaulted or conical roofs (5I, 7I), see Fig. 64. This reflects the use of efficient design maximising rainfall protection, ventilation and use of local materials. This matrix is a transferable analytical tool, allowing comparison across deserts, polar zones and rainforests. It will allow the identification of qualities that create efficient architecture in order to be imitated in modern design today.

	1	2	3	4	5	6	7	8	9
A					X				X
B			X				X		
C	X								
D		X							
E	X								
F					X				X
G									X
H		X							
I				X			X		

Fig. 64 Vernacular typology matrix of vernacular amazon rainforest architecture. Author (2025).

Using Mahoney's Table framework see Fig. 17 I analysed environmental data from the Amazon, Tabatinga to represent vernacular architecture and to evaluate if the region responds effectively to local climatic conditions. The environmental graphs See Figs. 65,66,67 show a consistent air temperature through the year of around 30°C, humidity following this pattern is very high resulting in uncomfortable conditions. Rainfall is annually high with a dip in summer months, altogether contributing to the humidity and extremes of this climate.

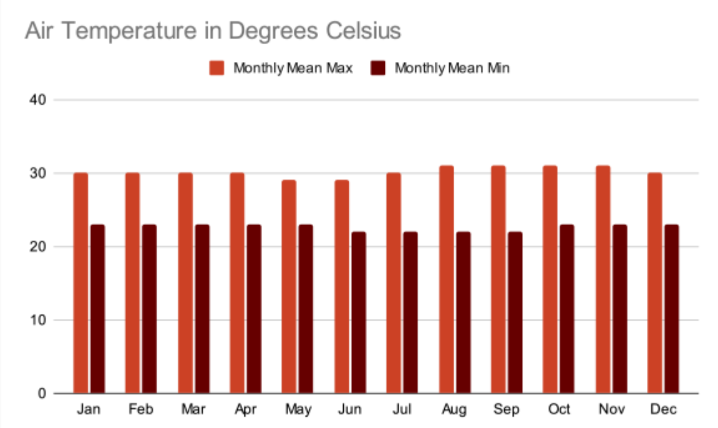


Fig. 65 Tabatinga Air Temperature Bar Chart. Author (2025).

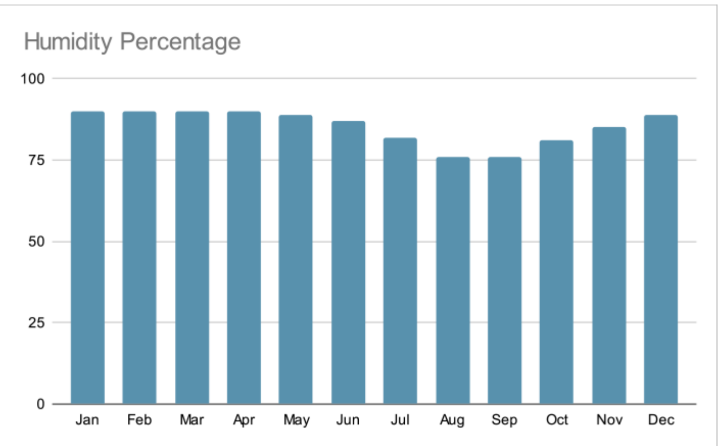


Fig. 66 Tabatinga Humidity Bar Chart. Author (2025).

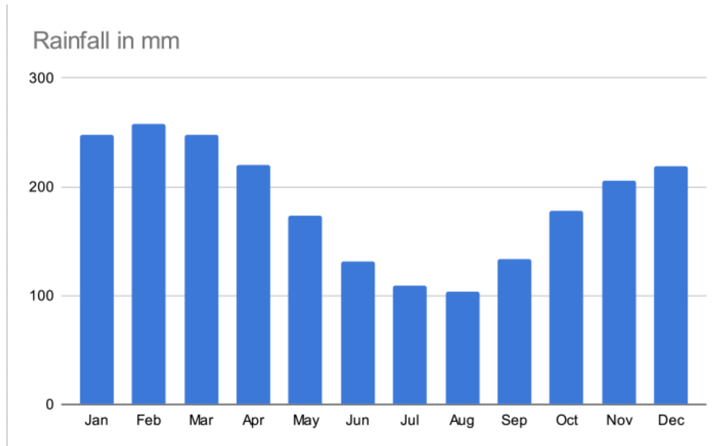


Fig. 67 Tabatinga Rainfall Bar Chart. Author (2025).

All data for graphs gathered from:
(Global Wind Atlas, 2024),
(Weather Atlas, 2020),
(Weather Spark, 2020).

Applying Mahoney's methodology to this dataset see Fig. 17 the thermal stress analysis in the rainforest see Fig. 69 suggests that during the day and night conditions are too hot for all months of the year. Based on these findings, I produced a final table of design recommendations see Fig. 70. These recommendations coincided with vernacular building techniques observed in the Northwestern Amazon, including large openings for ventilation, light walls for a short lag time, open spacing for breeze penetration and protection from heavy rain. This suggests that vernacular architecture in rainforest regions respond to the environment successfully creating spaces that are thermally comfortable despite the extreme climate.

Months	Wind, Prevailing	Wind, Secondary	Monthly Mean Humidity	Humidity group	Monthly Mean Max Temp	Monthly Mean Min Temp	Range	Monthly Mean Rainfall	High	Low
Jan	NE	NW	90	4	30	23	7	248	31	22
Feb	NE	NW	90	4	30	23	7	258	AMT	AMR
Mar	E	N	90	4	30	23	7	248	26.5	9
Apr	E	NE	90	4	30	23	7	220		
May	E	E	89	4	29	23	6	174		
Jun	S	SE	87	4	29	22	7	131		
Jul	S	E	82	4	30	22	8	109		
Aug	NE	SE	76	4	31	22	9	104		
Sep	N	E	76	4	31	22	9	134		
Oct	N	E	81	4	31	23	8	178		
Nov	N	E	85	4	31	23	8	206		
Dec	NE	N	89	4	30	23	7	219		

Fig. 68 Tabatinga Climate Data. Author (2025).

Months	Monthly Mean Max Temp	Day Comfort Upper	Day Comfort Lower	Monthly Mean Min Temp	Night Comfort Upper	Night Comfort Lower	Thermal Stress Day	Night
Jan	30	27	22	23	21	17	H	H
Feb	30	27	22	23	21	17	H	H
Mar	30	27	22	23	21	17	H	H
Apr	30	27	22	23	21	17	H	H
May	29	27	22	23	21	17	H	H
Jun	29	27	22	22	21	17	H	H
Jul	30	27	22	22	21	17	H	H
Aug	31	27	22	22	21	17	H	H
Sep	31	27	22	22	21	17	H	H
Oct	31	27	22	23	21	17	H	H
Nov	31	27	22	23	21	17	H	H
Dec	30	27	22	23	21	17	H	H
						H=Hot	O=Ordinary	C=Cold

Fig. 69 Tabatinga Thermal Analysis Climate Data. Author (2025).

Months	H1	H2	H3	A1	A2	A3	Results
Jan	x		x				Orientation North and South
Feb	x		x				Compact courtyard planning
Mar	x		x				Open spacing for breeze penetration
Apr	x		x				Rooms single banked
May	x						Large openings
Jun	x						Light walls, short time lag
Jul	x						Light, insulated roof
Aug	x						Protection from heavy rain
Sep	x						Windows at body height, North or South
Oct	x						Exclude direct sunlight
Nov	x		x				Low thermal capacity walls
Dec	x		x				Adequate rainwater drainage
	Total 12	0	6	0	0	0	Light, reflective roof surface

Fig. 70 Tabatinga Climate Response Data. Author (2025).

Conclusion

In conclusion, this chapter has demonstrated that vernacular architecture in the Northwestern Brazilian Amazon responds effectively to the environment and adapts to extreme rainforest conditions. Through an analysis using vernacular principles, typology matrix and Mahoney's tables, it shows that indigenous design solutions such as raised structures, permeable walls, gabled thatched roofs and natural materials, respond to climatic challenges of high humidity, temperatures and rainfall. Vernacular architecture reflects traditional cultural knowledge transmission and relationships with local ecosystems. Use of case studies highlight how material choices, form and construction techniques create thermally comfortable, ecologically resistant and adaptive structures with respect to the environment. By comparing these findings across different extreme environments, this chapter reflects rainforest vernacular architecture as a key source of insight for future generations.

3.1

Solutions Improving Resilience to the Effects of Climate Change

Vernacular architecture encompasses use of local materials, environmental adaptation and cultural traditions. Due to the rapid acceleration of climate change, these principles are increasingly relevant to the future of architecture. As global temperatures and extreme weather events rise, the built environment must transition to adaptive, climate resilient and regenerative approaches. This chapter examines how extreme vernacular architecture principles discussed in the previous case studies can be applied to contemporary design arguing that vernacular knowledge offers an important lesson for the future. Vernacular architecture follows an eco-centric perspective however, Andino argues, modern architecture follows an "anthropocentric" perspective “placing the human at its center and renders other species invisible” (Andino, 2025). This contrast highlights a shift from cohabitation and harmony amongst spices to human exclusive design, suggesting that modern contemporary architecture has become untuned from traditional vernacular method of design (Andino, 2025).

Modern architecture has prioritised technology and industrial materials, enabling rapid construction, with little acknowledgement of its impacts. The built environment contributes to around “42% of global CO2 emissions globally” (Amjad, 2024) causing almost irreversible damage to habitats and ecology. Contemporary buildings are becoming less habitable due to climate change (Aysha and Monto, 2024) whereas vernacular architecture provides a low carbon, climate responsive and environmentally adaptive solution.

Vernacular architecture relies on locally sourced natural materials such as earth, timber, stone, bamboo and palm. Francis et al claims that when adopting vernacular techniques and material logic embodied carbon emissions are lowered by over 30% compared to industrial methods (Francis et al, 2024). “In an era dominated by cement, steel, and demolition-driven redevelopment, these earlier material cultures demonstrate a quiet circularity that feels radical again” (Nayak, 2025). Contemporary architects are increasingly exploring bio-based materials inspired by vernacular architecture's connection to the natural environment. Bio-based materials offer a way forward against the destruction of conventional construction materials like steel and concrete (Smith, 2024). For example, rammed earth construction based on desert vernacular architecture has been reintroduced into contemporary projects such as Catimbau House designed by Azul Pitanga architects see Fig. 71 (Moreira, 2025). Rammed earth, with its high thermal mass and low carbon footprint provides a great material for hot climates.

Fig. 71 Catimbau House / AzulPitangaMoreira, S. (2025)

Another example of contemporary vernacular architecture is the Wind and Water Cafe designed by Vo Trong Nghia in Vietnam, see Fig. 72. It's located in a tropical climate using bamboo and steel tensile membranes to form a protective roof with great ventilation (VTN3, 2021). The positives of natural materials are becoming increasingly apparent, reducing environmental damage and connecting architecture with local ecology.

Fig. 72 Wind and Water Café. VTN3 (2021).

Material life cycles also offer lessons for contemporary architecture, vernacular principles included reparable, reusable and biodegradable materials. Hu argues that local cultural knowledge of natural materials enables them to be used to their full potential (Hu, 2023). Contemporary architecture should adopt similar principles thinking about materials in each stage of their life cycle. This approach aligns with regenerative design promoting ecological restoration.

While vernacular architectural principles offer valuable insights, their global application must be approached carefully. Vernacular architecture is culturally specific to each location, shaped by materials, climates and traditions, therefore direct replication of vernacular forms in different contexts risks cultural appropriation. Instead, contemporary architecture should use the principles discussed in this dissertation for example, passive design, material cycles and ecological integration, and adapt them to new local conditions.

The suggestion of living in iglus, or mud houses would seem very ridiculous in modern society, regulations and modern expectations for architecture exceeded that of vernacular buildings. Vernacular architecture is often on a smaller scale with a lack of regulations, whereas contemporary architecture must meet safety standards and accommodate large populations. To respond to this, contemporary design should use the vernacular principles discussed in this dissertation to create a hybrid approach to meet modern standards.

Conclusion

In conclusion, this dissertation presents contemporary architecture with distinct principles based on extreme vernacular architecture to introduce more climate responsive and regenerative design in response to the climate emergency. This chapter demonstrates that vernacular architecture does not have to be regionally defined but also a vital resource for the future of global climate adaptation.

3.2

Conclusion

In conclusion, this dissertation has examined vernacular architecture principles in extreme environments and demonstrated their global relevance for climate adaptive design. Focusing on deserts, polar zones and rainforests, this research has shown that vernacular architecture has a deep understanding of the environment. Through a qualitative methodology, combining literature review, case studies, theoretical vernacular principles, an adapted typology matrix and Mahoney's climate analysis tables, this dissertation has demonstrated that vernacular architecture provides climate responsive and adaptive design principles using locally available materials, cultural knowledge and ecological awareness. By examining three different case studies of vernacular architecture in extreme environments, I can compare how different cultures adapt to harsh climates, creating fundamental principles that apply broadly to regions experiencing extreme heat, cold or heavy rainfall. Vernacular architecture responds effectively to its environment, using local materials, cultural knowledge and thermal strategies. This demonstrates the relevance of vernacular principles in shaping contemporary design as climate change intensifies.

Vernacular architecture across desert, polar zones and rainforests demonstrate globally relevant principles and strategies for the future of contemporary design. Its sustainability comes from use of locally sourced, low-carbon materials that are biodegradable or recyclable to support cyclical material life cycles. Vernacular construction offers valuable knowledge for reducing embodied carbon in contemporary architecture (Francis et al, 2024). Use of passive thermal design, natural insulation, ventilation and shading techniques are important strategies as climate conditions intensify and solutions are sought after (Hayles, 2022). Indigenous communities design in response to intricate ecosystems in mind of environmental cultural knowledge by using selective timber techniques, water responsive design and elevated structures to protect and regenerate biodiversity. This research is a way of maintaining this knowledge to provide insights into climate adaptive design for contemporary architecture and the future of the built environment.

Across all three extreme environments discussed in this dissertation, vernacular architecture demonstrates a great understanding of local climatic conditions and ecological systems. In desert regions such as the Dakhla and Kharga Oases, communities have developed architecture to endure extreme heat, solar exposure and lack of rainfall. Thick adobe walls, shaded streets, compact courtyards and wind towers collectively create thermally comfortable spaces in harsh conditions (Gabr and El-Assal, 2022). Analysis of the Mahoney Table aligns with these vernacular strategies recommending similar design choices, demonstrating the effectiveness of passive cooling and thermal mass. These design choices promote regenerative design and low-carbon responses to architecture that remains relevant today.

In polar zones, vernacular architecture endures contrasting environmental conditions, including sub-zero temperatures, limited daylight, strong winds and a lack of vegetation. Inuit Gwich'in and Sami communities have developed building techniques that prioritise insulation, compact forms and passive heating. Structures such as Iglus, Goahti and Ne'en Kan dwellings use snow, moss, animal hides and birch timber and bark to create thermally efficient structures to endure extremely cold temperatures (Mackin. 2016). These design principles offer valuable knowledge for contemporary design in colder climates, demonstrating how local materials and environmental knowledge can create low-carbon and regenerative design.

In rainforest environments, vernacular architecture adapts to extreme climate conditions such as, high humidity, heavy rainfall and lack of direct sunlight. Indigenous communities in the Northwestern Amazon have developed raised malocas, permeable bamboo walls, gabled palm thatched roofs and open plan interiors, for ventilation, indirect sunlight and protection from moisture (Gutierrez, 2019). The Mahoney Table analysis confirms that vernacular strategies in rainforest regions respond to climatic conditions, design recommendations such as large openings, use of lightweight materials and cross ventilation align rainforest vernacular architecture. These findings highlight the importance of ventilation and moisture control in humid climates, demonstrating the effectiveness of lightweight, biodegradable materials supporting environmental regeneration.

Using my adapted typology matrix for all three case studies, deserts, polar zones and rainforests, I can evaluate that each climatic condition has its own architectural responses to their environment in terms of changes in form, material choices. For example, Egyptian vernacular architecture relies on mud brick and courtyard layouts, Canadian and Scandinavian traditions use birch, snow and turf in dome shaped structures, and Amazonian design uses bamboo, palm leaf and open vaulted forms. This matrix provides a concise way to identify indigenous strategies in order to reproduce vernacular design principles into contemporary contexts globally. The urgency of applying these principles can't be ignored due to recent climatic events. In the summer of 2021 temperatures in India reached 50°C, while Australia and Mexico have experienced extreme droughts in the last 5 years and Mozambique suffered extensive flooding in 2019 (Pottino, 2025). As extreme weather becomes more frequent, the need for adaptive, low-carbon and regenerative design strategies becomes vital.

The application of vernacular architecture in contemporary contexts can already be seen across the world, discussed in section 3.1 therefore applying vernacular principles further can shape a more regenerative future for the built environment. Comparative analysis of vernacular architecture across different extreme environments is place specific, yet its design principles and strategies are globally transferable. These principles discussed in this dissertation include, material choices and life cycles, passive thermal design, ecological integration, community construction and cultural knowledge and adaptation to climate conditions. This can inform contemporary architecture by creating a framework for modern design rather than directly replicating vernacular forms. "Today more than ever a debate about indigenous identity and culture from a contemporary perspective is necessary" (Nango, 2021). As climate change accelerates, the built environment must shift from industrialised materials and methods of construction to instead follow historical knowledge that has evolved to extreme climates for centuries.

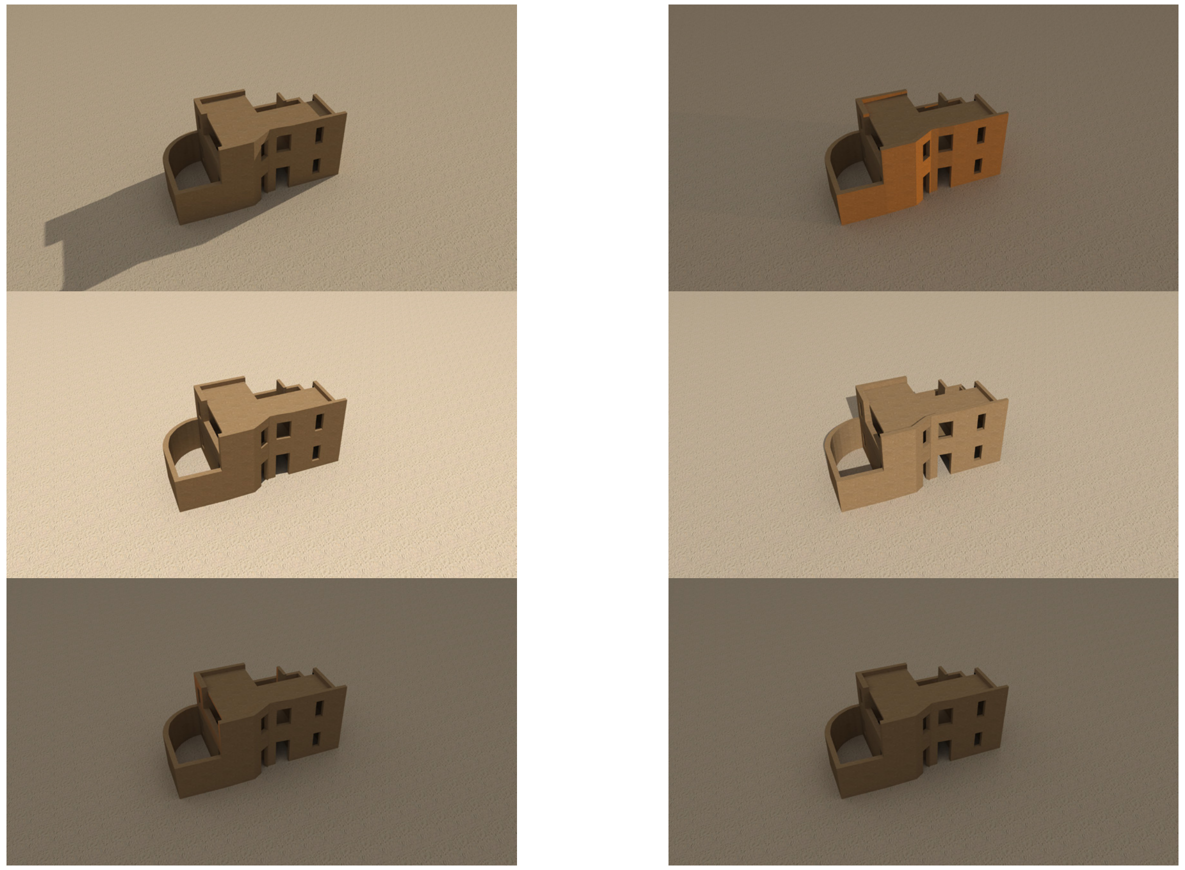
In conclusion, this dissertation presents vernacular principles from extreme environments, offering a foundation for global climate adaptation. By analysing case studies across desert, polar zones and rainforests, I have highlighted the extensive intelligence and adaptation of traditional vernacular architecture. These principles discussed can stand as a framework for contemporary architecture, leading the built environment down more sustainable, regenerative and climate responsive paths. Vernacular architectural principles can't simply be transferred globally as solutions, instead they shed light on more sustainable alternatives to contemporary architecture. Van der Ryn argues that as a collective "we have been late to acknowledge that the environmental crisis is also a crisis of design" (Der Ryn and Cowan, 1995, p.10). Therefore, this dissertation concludes that vernacular architecture principles can be applied globally, not as direct replicas but as adaptable frameworks that enhance resilience to climate change across changing environments.

3.3

Appendix

Months	Monthly Mean Max Temp	Day Comfort Upper	Day Comfort Lower	Monthly Mean Min Temp	Night Comfort Upper	Night Comfort Lower	Thermal Stress Day	Night
Jan	-21	20.7		-27	12	19	C	C
Feb	-21	20.7		-28	12	19	C	C
Mar	-16	20.7		-24	12	19	C	C
Apr	-8	20.2		-18	12	18	C	C
May	1	20.2		-6	12	18	C	C
Jun	7	20.2		1	12	18	C	C
Jul	12	20.2		5	12	18	C	C
Aug	11	20.2		4	12	18	C	C
Sep	5	20.2		0	12	18	C	C
Oct	0	20.2		-5	12	18	C	C
Nov	-7	20.2		-13	12	18	C	C
Dec	-14	20.2		-21	12	18	C	C
						H=Hot	O=Ordinary	C=Cold

Fig. 73 Trial of Mahoney’s table adapted to arctic conditions rather than hot conditions. Venables, F. (2025).



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3.4

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OXFORD BROOKES UNIVERSITY

Faculty of Health, Science and Technology - Ethics Review Form E1(Arch)

- This form should be completed jointly by the **Supervisor and Student** who is undertaking a research/major project which involves human participants. Note: if the supervisor is an Associate Lecturer, the Module Leader (permanent member of staff) must co-sign as an additional supervisor.
- It is the **Supervisor(s)'** responsibility for exercising appropriate professional judgement in this review.
- Before completing this form, please refer to the University **Code of Practice for the Ethical Standards for Research involving Human Participants** and to any guidelines provided by relevant academic or professional associations.
- Note that the ethics review process needs to be fully completed and signed **before fieldwork commences**.

(i) Project Title: Architecture in Extreme Environments: Adaptive Materials, Solar Strategies and Vernacular Innovations.

(ii) Name of Supervisor(s) and School in which located:

(iii) Name of Student and Student Number: Florence Venables 19255945

(iv) Brief description of project outlining where human participants and/or their data will be involved (approx. 250-500 words) *(include details about: identified risks to participants and researchers and how they will be mitigated through the research design; participant recruitment and how personal data will be managed if relevant; how any participant consents will be recorded; whether and how data will be anonymised)***:**

I am going to analyse case studies to research how adaptive materials, solar strategies and vernacular innovation create spaces in extreme environments. There will be no interviews and therefore no risk to participants. I will reference case studies, and quotes using Harvard reference techniques. I may include data from books, websites, thesis's, etc and I will gain consent from participants if necessary.

(v) Attached Documents Checklist

If you are using one of the following methods listed below in your research, you must include in your E1 paperwork the following additional documents to ensure informed consent of participants. All documents should have the Brookes logo on the top right-hand corner:

For interviews/focus groups:

Participant information sheet; list of interview questions; consent form or verbal consent script; recruitment letter or advertisement and gatekeeper approval letter as relevant (see the HST/TDE templates).

For site observations (including sketching, photography, audio and visual recordings):
Participant information sheet; advertisement and gatekeeper approval letter as relevant (see HST/TDE templates).

For surveys and administered surveys:
Survey that includes participant information, including data protection information, (or verbal consent script for administered surveys) and checkboxes for informed consent to use the data and 18+ age declaration (see HST/TDE templates)

All other methods: If there are any other forms of 'research instruments' being used in the study (e.g. aide memoires; observational checklists; participant instructions for an interactive game, etc.) please include a copy with your E1 form.

		Yes	No
1.	Does the study involve participants who are unable to give informed consent (e.g. children, people with learning disabilities)?		X
2.	If the study will involve participants who are unable to give informed consent (e.g. children under the age of 18, people with learning disabilities), will you be unable to obtain permission from their parents or guardians (as appropriate)?		X
3.	Will the study require the cooperation of a gatekeeper for initial access to groups or individuals to be recruited (e.g. students, members of a self-help group, employees of a company)?		X
4.	Are there any problems with the participants' right to remain anonymous, or to have the information they give not identifiable as theirs?		X
5.	Will it be necessary for the participants to take part in the study without their knowledge/consent at the time? (e.g. covert observation of people in non-public places?)		X
6.	Will the study involve discussion of or responses to questions the participants might find sensitive? (e.g. own traumatic experiences)		X
7.	Are drugs, placebos or other substances (e.g. food substances, vitamins) to be administered to the study participants?		X
8.	Will blood or tissue samples be obtained from participants?		X
9.	Is pain or more than mild discomfort likely to result from the study?		X
10.	Could the study induce psychological stress or anxiety?		X
11.	Will the study involve prolonged or repetitive testing of participants?		X
12.	Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants?		X
13.	Will deception of participants be necessary during the study?		X
14.	Will the study involve NHS patients, staff, carers or premises?		X

Signed:	SS Akerkar	**Supervisor(s)**
Signed:	Florence Venables	**Student**

Date:	21/10/25	

What to do now:

1. If you have answered **'no'** to all the above questions:

   (a) The student must **send** the completed and fully signed E1 form to the relevant **Module Leader** (permanent member of staff).
   (b) The student must keep a copy of the E1 form which must be included in the submission of the relevant coursework (e.g. dissertation, portfolio or assignment) as an appendix, including any attached documents. **Do not include any signed paperwork from participants in your submission.**
   (c) The supervisor must keep a copy of the E1 form as they are responsible for monitoring compliance during the fieldwork.

2. If you answer **'yes' for question '3' (the 'Gatekeeper question') but 'no' to every other question:**

   This research may still be considered as 'low risk' and processed under the E1 form as above in point 1 at the discretion of the supervisory team. A Gatekeeper is someone who has to give permission for potential participants to be approached to take part in the research, and/or for the research to take part in their organisation or on their premises. Note that this may, or may not, be the same person approached to disseminate information on behalf of the researcher to potential participants.

   (a) After discussing your research with your supervisor and/or relevant Module Leader (permanent member of staff), and using the HST/TDE template, approach your Gatekeeper and obtain a letter of approval for the work as described in your E1 form.
   (b) The student must **send** the completed and fully signed E1 form to the relevant **Module Leader** (permanent member of staff) with the Gatekeeper approval letter and any other relevant attachments included.
   (c) The student must keep a copy of the E1 form which must be included in the submission of the relevant coursework (e.g. dissertation, portfolio or assignment) as an appendix, including any attached documents. **Do not include any signed paperwork from participants in your submission.**
   (d) The supervisor must keep a copy of the E1 form as they are responsible for monitoring compliance during the fieldwork.

3. If you have answered **'yes'** to **any** of questions **1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14**:

   (a) The supervisor and student must complete the HST/TDE E2 form.
   (b) Note that the information in the E2 must be in **sufficient detail** for the ethical implications to be clearly identified.
   (c) The signed E2 and signed E1 Form must be emailed to Tim Jones (tjones@brookes.ac.uk) who is the Faculty Research Ethics Officer (FREO) for review. Please allow **at least two weeks** for this review process.
   (d) If/when approved the FREO will issue an E3 Ethics Approval Notice.
   (e) The student must send the E1, E2 and E3 Notice **to the relevant Module Leader** (permanent member of staff).
   (f) The student must also keep copies which must be included in the submission of the relevant coursework (e.g. dissertation, portfolio or assignment) as an appendix, including any attached documents. **Do not include any signed paperwork from participants in your submission.**
   (g) The supervisor must keep a copy of documentation to monitor compliance during fieldwork.

4. If you answered 'yes' to any of questions 1-13 and 'yes' to question 14, an application must be submitted to the appropriate NHS research ethics committee. This is an onerous and time-consuming process so the supervisor should liaise early with the FREO if the student is considering this.