

**The Architecture of Palaces in Wadi Righ and souf
A Study of the Impact of the Environment on Design
and Construction Techniques**

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Abstract: The Wadi Righ and Wadi Souf regions are characterized by harsh environmental conditions resulting from extreme climatic and geological factors. Despite these constraints, local communities have historically developed architectural solutions that enabled sustainable settlement within these desert environments. The palaces constructed in Wadi Righ and Wadi Souf constitute a distinctive architectural response, reflecting both environmental adaptation and historical continuity within the context of Islamic architectural heritage.

This study aims to analyze the impact of environmental factors on the spatial organization and construction techniques of these palatial complexes, based on a field-based investigation that included site visits to a group of palaces in Wadi Righ and the Al-A'shsh quarter in Wadi Souf, with reliance on direct observation for documenting and analyzing architectural features and building practices. Adopting a descriptive–analytical methodology, the research highlights the role of climate, locally available materials, and specific environmental conditions in shaping architectural design, construction systems, and settlement patterns. The findings contribute to a deeper understanding of traditional desert architecture and its adaptive strategies in arid regions, particularly within the framework of Islamic architecture and archaeology.

Keywords: desert environment; Wadi Righ; Wadi Souf; desert palaces; construction techniques.

Introduction:

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Desert palaces represent some of the most distinctive architectural and historical expressions in the regions of Wadi Righ and Wadi Souf. Through their spatial configurations, construction systems, and choice of materials, these structures embody architectural responses that evolved in direct interaction with the constraints and opportunities imposed by the Saharan environment. Preliminary observations indicate that, although the palaces in both regions share common architectural and structural characteristics, they also display notable differences in form, function, and spatial organization. These variations reflect diverse patterns of environmental adaptation as well as local socio-cultural conditions. Traditional builders in these regions faced severe climatic challenges, including extreme temperature fluctuations, limited natural resources, and persistent environmental pressures. Such conditions necessitated the development of innovative planning strategies, environmentally responsive design solutions, and vernacular construction techniques capable of mitigating thermal stress and ensuring structural durability. Consequently, desert palaces offer valuable insights into the ways in which architecture can respond creatively to hostile environmental contexts.

Despite their historical, cultural, and touristic significance, academic research that explicitly examines the relationship between environmental factors and architectural practices in Wadi Righ and Wadi Souf remains relatively limited. Existing studies often adopt descriptive or historical perspectives, with insufficient emphasis on analytical evaluation of environmental influence on spatial organization and construction techniques. This research gap highlights the need for a systematic and comparative investigation of the role of the Saharan environment in shaping palace architecture in these regions.

Accordingly, this study addresses the following central research problem: **to what extent has the Saharan environment in Wadi Righ and Wadi Souf influenced the architectural layout and construction techniques of traditional palaces?** To address this issue, the research seeks to answer several key questions: which environmental variables have exerted the greatest influence on palace architecture; how these variables are reflected in the planning, organization, and functional distribution of spaces; what materials and construction techniques were adopted in response to

desert conditions; and how adaptive strategies in Wadi Righ compare with those observed in Wadi Souf.

The study is guided by three main hypotheses. First, the desert environment constitutes the primary determinant shaping planning principles and construction practices in traditional palaces. Second, adaptive architectural strategies vary between Wadi Righ and Wadi Souf due to differences in natural, topographical, and socio-cultural conditions. Third, vernacular construction innovations—particularly the use of adobe and other locally available materials—played a decisive role in enhancing the environmental performance of traditional architecture.

The objectives of this research are to analyze the influence of environmental conditions on the planning and construction of palaces in both regions; to identify the architectural mechanisms and adaptive strategies developed by local communities to cope with harsh desert environments; to conduct a comparative assessment highlighting similarities and differences between Wadi Righ and Wadi Souf; and to contribute to a deeper understanding of traditional Saharan architecture within its ecological and cultural context.

Methodologically, the study adopts a multi-method research framework. The historical method is employed to review and document information from historical sources, references, and previous studies related to building materials, construction techniques, and general planning principles of traditional palaces. The descriptive method is used to record, classify, and analyze architectural features, spatial layouts, and construction systems. In addition, an analytical approach—drawing on both deductive and inductive reasoning—is applied to interpret the relationship between environmental factors and architectural responses and to derive broader conclusions. Based on this framework, the article is structured to include a conceptual clarification of key terms, an analysis of environmental influences on palace planning, an examination of construction materials and vernacular building techniques, a comparative evaluation of architectural characteristics in both regions, and a synthesis of the main findings.

I. Geographical Location and Its Characteristics:

I.1- Geographical Context of Wadi Righ: Wadi Righ, also referred to as the land of Righ or the small Zab, is located in the

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northeastern part of the Algerian Sahara, approximately 600 km from Algiers. The region is bordered by Wadi Souf to the east, Wadi M'zab to the west, the Zab region to the north, and the Ouargla oases (Wadi Miya) to the south¹. Geologically, Wadi Righ comprises a series of shallow depressions and salt flats interspersed with chalky plateaus, forming a large, coordinated basin of approximately 12,000 km², situated between 32°54'E longitude and 34°09'N latitude².

The region lies within the **low desert** of the Algerian Sahara, characterized by artesian groundwater and fertile zones that support oasis formation. Wadi Righ occupies the northeastern part of a rectangular lowland about 160 km in length and 30–40 km in width. Its terrain is generally flat, with gentle slopes from south to north, elevations averaging 35 m above sea level, and occasional heights exceeding 300 m. Key features include clay-rich soils, seasonal agricultural plains, false wadis, saline marshes, sandy and silty soils, and calcareous deposits³.

The climate of Wadi Righ is arid and continental, with hot summers, cold winters, and minimal rainfall. Wind patterns are significant environmental factors affecting local architecture. Three main types of winds prevail⁴:

As for the climate of the region, it is similar to that of other desert areas, dominated by a dry continental climate, cold in winter and hot in summer. The winds experienced in the Wadi Righ area vary in type and direction throughout the year, particularly in spring when strong winds carry large amounts of sand, reaching speeds of over 50 km/h. There are three main types of winds known in Wadi Righ:

1_ The "Tahrawi" (desert) winds, which occur in spring (March, April, May) and blow from the northwest to the southeast.

1 - Shirmer Henri. Le Sahara, 1893, p.19.

2_ Yamina Ben Saghir Hadri, The Palaces of the Wadi Righ Region: The Old Palace of Tmrana as a Model (8-13AH/14-19 AD), Doctoral Thesis in Islamic Archaeology, Part One, University of Algiers 2, 2014, P.16.

3 _ Schirmer Henri, Op -Cit, p.p. (20-21).

4_ Abdelhamid Kadri, Introduction to Oued Righ, Al-Wafa Association Publications, Touggourt, 1998, P.P (1_2).

2_ The "Chihili" (sirocco) winds, prevalent in summer (June, July, August), also known as "poison winds," are dry, scorching, and very intense, blowing from the south.

3_ The "Bahri" winds, which sweep through the region from the north to the northeast in autumn (September, October, November), coming from the sea.⁵.

These environmental conditions—extreme temperatures, scarce precipitation, variable soils, and strong seasonal winds—have directly influenced architectural planning, construction techniques, and material selection in the palaces of Wadi Righ. Understanding the geographical and climatic context is therefore essential for analyzing the adaptive strategies employed in traditional palace architecture.

I.2- Geographical Context of Wadi Souf: The Wadi Souf is located in the northeastern part of southern Algeria, approximately 620 km from Algiers, stretching from the Wadi Righ area eastward to the Tunisian border. The region extends between 6°–8°E longitude and 31°–34°N latitude⁶, and it includes two zones that differ in soil types, settlement history, and socio-cultural traditions. Wadi Souf is naturally bordered by salt flats, including Wadi Righ to the west, Marouana and Melgigh to the north, and Chott el Jerid to the east⁷.

The name "Wadi Souf," derived from the Berber dialect and historical sources, originally referred to a flowing river ("Wadi Azouf") that traversed the area from north to south before disappearing into the desert⁸. Historical references to the term date back to Al-Aghwathi (~1829) and were documented in subsequent travel accounts and French colonial reports⁹.

Topographically, Wadi Souf is dominated by three main features:

5_ Yamina Ben Saghir Hadri, *The Palaces...*, Op_Cit, P.P (30_31).

6 _ Abdelaziz Hassouna, *The Urban Fabric of the City of Gmar in the Souf Region from the 10AH, 16 AD: An Archaeological and Architectural Study*, Master's Thesis, Institute of Archaeology, Algeria 2, 2010, P.10.

7 _ Ali Ghanabzia, *The Society of Wadi Souf through Local Documents in the 13AH / 19 AD*, Master's Thesis, University of Algiers, 2001, P.11.

8 _ Abdelaziz Hassouna, *The Urban Fabric of the City of Gmar...*, Op_Cit, P.11.

9 _ Ali Ghanabzia, Op_Cit, P.11.

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:1 _Sand Dunes: These cover the majority of the Souf region, as well as the eastern and southeastern parts of Wadi Righ This area belongs to the Great Eastern Erg¹⁰.

2_Rocky Plateau: Currently, this is the area adjacent to National Road No 16 and extends to the south.

3_Depressions and Valleys: This includes the wetlands located north of the province, extending to the east, as the Souf area is the lowest point in the Great Eastern Erg¹¹.

The geology comprises Quaternary continental formations and modern sand layers, including locally available construction materials such as “tarsha”, gypsum, loess, and tafza (gypsum stone). These materials have been historically used in palace construction, enabling adaptation to extreme desert conditions. Hydrologically, three aquifers are present at varying depths, providing abundant groundwater resources essential for settlement and agricultural activity¹².

Climatically, Wadi Souf experiences an arid desert climate with hot summers, cold winters, minimal rainfall, and significant diurnal temperature variations. Wind patterns—including the Tahrawi (north/northwest, February–April), Bahri (east, August–October), and Shahili (south, summer)—play a crucial role in architectural design, influencing orientation, ventilation, and structural adaptation in traditional palace construction¹³.

The combination of extreme temperatures, sandy soils, limited precipitation, and strong seasonal winds has directly shaped the planning, construction techniques, and material choices of Wadi Souf palaces. Understanding these environmental factors is essential for analyzing how traditional architecture responded effectively to harsh desert conditions.

10 _ Ahmed Lam’a, Monitoring the Developments of Desert Urbanization and Exploring its Future Practices: The Case of the City of Ouargla, Master’s Thesis in Urban Technology Management, Salah Boubnider University - Constantine 3, 2019, P.118

11 _ Ali Ghanabzia, Op_Cit, P.09.

12 _ Ahmed Lam’a, Op_Cit, P.120.

13 _Ibid, P.P (124_ 130).



https://drive.google.com/file/d/1AkVROq_a9zRd2qnj25v5NKge_MVdqgCX/view?usp=sharing

Map 01 Distribution of Traditional Palaces in Wadi Righ and Wadi Souf: Geographical Locations.¹⁴

II. Environmental Adaptations in the Planning of Desert Palaces:

Environmental and climatic factors played a decisive role in shaping the spatial organization and structural treatments of desert palaces in Wadi Righ and Wadi Souf. Islamic desert settlements traditionally employed integrated planning at two levels: the overall city layout—including walls, gates, and main streets leading to the congregational mosque—and detailed planning at the level of secondary streets and residential units.

Site Selection and Spatial Planning :The selection of palace sites in both Oued Righ and Oued Souf underscores the critical

¹⁴ _ Prepared by the researcher: The map illustrates the geographical locations of traditional palaces in Wadi Righ and Wadi Souf, highlighting their spatial distribution relative to wadis, grazing areas, and settlements. It provides insight into the relationship between **environmental context and architectural planning**, reflecting site selection strategies and adaptation to desert conditions.

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importance of water resources and their connection to pastoral activities, highlighting the intimate relationship between the desert environment and human settlement. In Oued Righ, palaces were often constructed along wadi banks or near wells, facilitating the formation of seasonal residential clusters and supporting pastoral livelihoods. In contrast, site selection in Oued Souf exhibited relatively greater flexibility, taking into account not only water availability but also topography and soil conditions, which influenced the spatial distribution and layout of palaces within settlements. Field analysis of palaces in both regions indicates that geographic location was a decisive factor in determining the palace form and spatial extent. Some palaces were built on natural elevations to provide protection and surveillance, while others extended along wadis to ensure access to water and allow gradual expansion. Comparative observation reveals differences in architectural adaptation strategies: palace design in Oued Righ tends to integrate with the natural course of the wadis, whereas in Oued Souf, greater attention is paid to the spatial organization of architectural elements in response to local topography and the variability of water resources¹⁵.

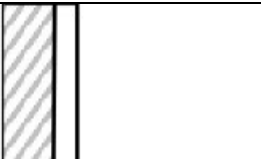
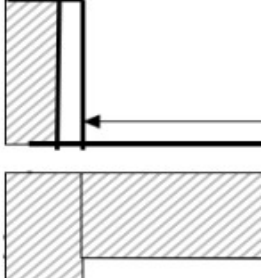
This study, based on field observations of palaces in Oued Righ and the Hayy Al-Ashash area of Oued Souf, provides an analytical framework for understanding similarities and differences in site selection and spatial planning, emphasizing the pivotal role of the local environment in shaping traditional architectural adaptation strategies.

Building Configuration and Street Planning: The palaces in both Oued Righ and Oued Souf exhibit compact layouts with closely clustered structures, aimed at minimizing direct exposure to sunlight and sand-laden winds. Variations in building heights create shaded areas on rooftops while maintaining household privacy. The orientation of streets and buildings plays a central role in enhancing natural ventilation and thermal comfort, as streets are typically

15 _ Yamina Ben Saghir Hadri, The Water System in the Palaces of the Central Southern Maghreb: The Palaces of Wadi Righ and Touat as a Model, Rawafid Journal for Research and Studies, Issue 8, University of Ghardaia, June 2020, P.P(131_154) and Yamina Ben Saghir Hadri, Factors Influencing the Morphology of Palaces: The Palaces of the Wadi Righ Region as a Model, Al-Wahat Journal for Research and Studies, Vol. 8, Issue 2, 2015, P.859. and

narrow and winding to reduce wind velocity and solar exposure. Small courtyards often retain cool night air, and north–south street alignment mitigates the effects of hot summer and cold winter winds. In Oued Righ, the street network is characterized by narrow, winding, and shaded alleys, where long, branching paths create extensive shadowed surfaces on building façades, helping to maintain cooler air within residential clusters, enhance privacy, and reduce the impact of strong winds and drifting sand. These features reflect a deliberate strategy for adapting to harsh desert climatic conditions and highlight the distinctiveness of the urban fabric in this region. By contrast, in Oued Souf, the urban layout demonstrates relatively greater flexibility, balancing access to water resources with the spatial organization of residential units. While it maintains the same fundamental principles for minimizing sun and wind exposure, it lacks the characteristic narrow, winding, and heavily shaded alleyways that define Oued Righ’s settlements.

This comparative analysis illustrates how traditional desert urban planning and compact building configurations effectively adapt to extreme climatic conditions, while highlighting the key differences between Oued Righ—with its predominance of narrow, shaded, and winding streets—and Oued Souf, where a more flexible spatial organization prevails, yet still maintains thermal adaptation principles.

Form	Dimensions	Characteristics	Space
	10–20+ m	Straight; generally two stories; large scale	Street and pathway
	~3 m wide	Winding; sometimes covered; allows passage of pack animals	Alley

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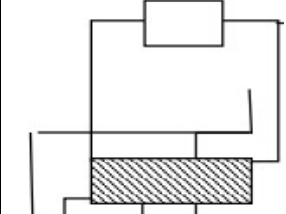
	m width; 5–10 m length	Shared by 3–5 families; semi-private; includes covered/uncovered sections	Lane (Darb)
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Table 1 summarizes the main characteristics of passageways in the old quarter of Al-A‘shāsh, El Oued.”¹⁶

Analysis: Streets provide movement and connectivity, while alleys and lanes are semi-private, shaded, and protected from wind and sand. These spatial configurations reflect deliberate environmental adaptation and social organization



Image 01: Represents a model of compact fabric (the clustering of houses) in one of the palaces of Wadi Righ¹⁷.

¹⁶ _ Prepared by the authors.

¹⁷ _ Splendid Heritage of Ouargla, Report by the Directorate of Culture of Ouargla Province, Algeria, 2013, P.50.



Image 02: A model of the narrow and winding streets in one of the palaces of Wadi Righ¹⁸.

Key architectural solutions include the Sabat system—covered passageways constructed with arches or domes supported by palm wood—which provided shade for pedestrians and improved air circulation. Building facades were oriented to avoid direct sunlight, with main openings facing north or south. Horizontal shading devices further reduced the impact of summer heat and sandstorms. These strategies demonstrate a careful adaptation to the natural characteristics of each wadi, reflecting the broader principles of Islamic desert architecture aimed at creating a livable interior environment despite harsh climatic conditions.

III. Environmental Adaptations in Architecture: Comparative Study of Materials and Construction Techniques in Wadi Righ and Wadi Souf: In the desert regions of Wadi Righ and Wadi Souf, traditional palaces exhibit architectural adaptations closely linked to local environmental conditions. Construction relies primarily on locally sourced materials and techniques optimized for thermal comfort, structural stability, and durability under Saharan climate stress.

III.1 Materials and Their Environmental Function

- Clay and Adobe: The main building material in both regions, chosen for its thermal insulation, availability, and workability. Sun-dried bricks reinforced with palm fibers are widely used, with variations in size and preparation

¹⁸ _ Mohamed El Hafidh Barbah, Report on Témacine, Association for the Preservation of the Old Palace of Témacine, Touggourt Province, 2021, P.24.

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depending on local conditions. In Wadi Righ, raw and fired bricks are mainly applied in low-rise ksour, while in Wadi Souf, bricks are used extensively, particularly in multi-domed structures.¹⁹.

- Stone: Wadi Souf utilizes loess, tafza, and limestone in foundations, walls, and roofing systems, whereas Wadi Righ restricts stone largely to foundations, occasionally supplemented by imported stone.
- Lime and Quicklime: Used as binding and finishing materials to enhance thermal performance and durability, with more pronounced application in Wadi Souf, especially in roofing and domes.
- Palm Wood: Extensively employed for roof frameworks, beams, and structural supports.²⁰.

III.2 Roofing Strategies

- Wadi Righ: Predominantly flat roofs supported by palm trunks and clay layers.²¹.
- Wadi Souf: Domed or barrel-vaulted roofs improve wind resistance, sand shedding, and thermal comfort, demonstrating advanced adaptation to local climatic pressures.²².

III.3 Construction Techniques and Structural Adaptation

- Wadi Righ: Brick-bonding methods such as al-diya and al-shanāwī, along with layered masonry, strengthen wall cohesion and load-bearing capacity.
- Wadi Souf: Hybrid construction combines stone and brick, with extensive use of lime. Architectural openings are smaller and inward-facing to reduce heat gain.²³.

III.4 Courtyards, Sabāṭ, and Rooftops

19 _ Moubarak Kbabla, The Development of Construction Materials and Techniques in Desert Architecture, Master's Thesis, University of Biskra, 2010, P.80.

20 _ Abdelaziz Hassouna, Residential Architecture in the Wadi Souf Region, Manbar al-Turath al-Athari Journal, Tlemcen, Vol. 4, Issue 1, 2015, P.137. and _ Abdelaziz Hassouna, Architecture and Urbanism in the Souf Region (10-13AH / 16-19AD): An Archaeological and Urban Study, Doctoral Dissertation, University of Algiers, 2019, P.164.

21 _ Moubarak Kbabla, loc _cit, P.P(105_ 154).

22 _ Abdelaziz Hassouna, Residential Architecture ..., Op _Cit, P.143.

23 _ Ibid, P.164.

- Courtyards are central to natural ventilation and thermal regulation, absorbing solar heat during the day and releasing it at night while storing cool air.
- Al-Sabāṭ structures (vaulted or semi-open passageways) provide shaded spaces for daily activities, enhancing airflow and creating a comfortable indoor microclimate. In Wadi Souf, sabāṭ structures often incorporate domes and arches, reflecting a more sophisticated adaptation to climatic challenges and larger living spaces.
- Rooftops complement courtyards as open-air spaces for evening and nighttime use during high temperatures. Together, courtyards, sabāṭ, and rooftops form an integrated system for spatial organization, airflow management, and thermal comfort.²⁴.

The selection of materials and construction techniques in both regions demonstrates an advanced understanding of environmental constraints. While both Wadi Righ and Wadi Souf share common principles—compact layouts, courtyards, and passive cooling strategies—Wadi Souf exhibits greater elaboration, particularly in roofing, domes, and hybrid masonry, reflecting adaptive responses to local ecological conditions and resource availability.



Figure 01: Brick Construction Methods in the Low Desert²⁵.

²⁴ _ Ali Hemlawi, loc _cit, P.61.

²⁵ _ Ibid, P.164.

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Image 04: An example of foundation construction techniques in low desert architecture²⁶.



Image 05: Illustrates flat roofing using palm trunks in one of the palaces of Wadi Souf²⁷.

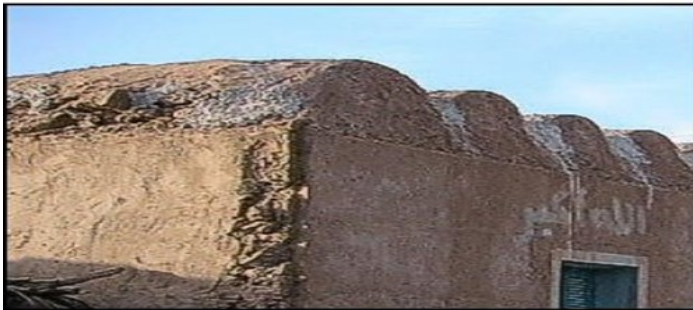


Image 06: A model of barrel vault roofing in Wadi Souf²⁸.



26 _ Moubarak Kbabla, Op_Cit, P.168.

27 _ Ibid, P.165.

28_ Mohamed Salah Ben Ali, The Aesthetics of Traditional Architecture in Wadi Souf: The Aachache Neighborhood as a Model (1400-2011 AD), A Descriptive Historical Study, Vol. 1, Directorate of Culture – El Oued, 2012, P.20.

Image 07: A model of openings in low desert architecture²⁹.



Image 08: A model of a porch in Wadi Souf³⁰.

Conclusion

This study demonstrates that the traditional palatial architecture of Wadi Righ and Wadi Souf results from a dynamic interaction between local communities and the Saharan environment. Climatic factors—including extreme heat, strong winds, water scarcity, and soil variability—emerge as the primary determinants shaping palace planning, spatial organization, and construction practices.

While both regions share core architectural features of the broader Saharan tradition, the analysis reveals distinct adaptive strategies reflecting environmental, topographical, and socio-cultural differences. In Wadi Righ, palace layouts are closely linked to the presence of watercourses, influencing the formation of compact architectural fabrics. In contrast, Wadi Souf demonstrates solutions aimed at mitigating shifting sands and harsh “Chergui” winds, resulting in differentiated spatial organization, material usage, and construction techniques.

The study highlights the critical role of locally sourced materials—adobe, stone, and palm wood—which were selected not only for availability but also for their effectiveness in enhancing thermal performance and structural resilience. Courtyards, sabāṭ structures, and rooftop spaces collectively form an integrated system that regulates airflow, temperature, and privacy, exemplifying centuries of accumulated environmental knowledge embedded in traditional design.

29_ Moubarak Kbabla, Op_Cit, P.P(176_177).

30_ Abdelaziz Hassouna, Architecture..., Op_Cit, P.139.

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These findings support the hypotheses that (1) the desert environment is the dominant factor shaping planning and construction principles, and (2) local variations in natural and cultural conditions produce distinct architectural adaptations within a shared Saharan framework.

Overall, this research underscores the importance of examining traditional Saharan architecture within its environmental, social, and economic contexts, offering insights relevant to contemporary sustainable design in arid regions. Future studies could further investigate the climatic performance of vernacular materials, the efficiency of indigenous adaptive techniques, and their potential integration into modern architecture to address emerging environmental challenges.

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1 - Shirmer Henri. Le Sahara, 1893.