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Re-Exploring Vernacular Architecture from the Lens of Regenerative Thinking: a Case Study Gharb Sohail Village in Egypt

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Abstract

Vernacular architecture has always been a source of inspiration for architects worldwide. It has offered meaningful solutions to many contemporary global challenges. On the other hand, the notion of sustainability is undergoing a paradigm shift towards regenerative sustainability, which has gained considerable interest in the last decade among academics, architects, and building professionals due to its holistic, integrated, and creative approach to real-world sustainability practices. Accordingly, the study attempts to answer the question of how far vernacular architecture has applied regenerative sustainability principles. So, the research aims to investigate the manifestations of regenerative thinking within the selected case study, focusing on the principle of whole-systems design integration. The research adopted a qualitative methodology that began with a thorough literature review to explore the distinction between regenerative sustainability and the conventional concept. In the analytical part, Gharb Sohail village was selected as a case study of vernacular architecture in Egypt to be analyzed from the perspective of regenerative sustainability. The findings revealed that vernacular architecture applied regenerative thinking significantly through its integration with the entire system because it is created by and for the context in which it is built and is considered a part of the ecosystem. The study makes a profound contribution by deeply exploring regenerative sustainability applications within the built environment and by offering affordable design techniques that help architects and urban planners, particularly in developing countries, create a resilient and regenerative built environment while conserving their cultural, social, and economic particularities.

Keywords: nubian architecture, regenerative development, regenerative sustainability, sustainability, vernacular architecture.

Introduction

Vernacular architecture has witnessed extensive literature. The world's leading source for studying this discourse is the Encyclopedia of Vernacular Architecture, published by Professor Paul Oliver of Oxford University in 1997 (Oliver, 1998). Another notable source is The Pattern Language: Towns, Buildings, and Construction by Alexander et al. (2017).

The key value of vernacular architecture lies in its ongoing evolution over generations to respond to the continuous change of human needs and to newly emerging challenges in a harmonized and integrated relationship between the built environment, people, and nature. These significant features of vernacular architecture encouraged many authors to define it as an earlier manifestation of contemporary sustainability. Extensive recent academic publications have widely reported on

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and investigated the roots of sustainability as they are incorporated into its three dimensions within the vernacular-built environment. Some studies have focused on the environmental dimension within vernacular architecture (Costa-Carrapiço et al., 2022; Du et al., 2014; Engin et al., 2007; Foruzanmehr & Vellinga, 2011; Indraganti, 2010; Nie et al., 2019; Ozay, 2005; Philokyprou et al., 2017; Rahim, 2022; Salgın et al., 2017; Saljoughinejad & Rashidi Sharifabad, 2015; Shanthi Priya et al., 2012; Singh et al., 2009, 2016).

The ecological impact of vernacular architecture, as a component of cultural heritage and sustainability, was investigated by Kırbaş & Hızlı (2016); Renping & Zhenyu (2006); Zhai & Previtali (2010). Other studies have investigated the influences of social and cultural aspects on the form of the vernacular-built environment (Al-Sallal, 2017; Qtaishat et al., 2020; Rosaleny Gamón, 2020; Tousi, 2020). Analysis of the economic dimension within vernacular architecture was addressed by Giannakopoulou et al. (2011); Porta-Gándara et al. (2002); Samir et al. (2018).

Over the last decade, sustainability has been criticized for its failure to achieve real sustainable development due to adopting anthropogenic and utilitarian approaches that embrace a technical view that yields a separation of humans from nature. Recently, regenerative sustainability has been advocated by many scholars as an evolutionary concept for contemporary sustainability. They consider it a comprehensive approach that aims to re-conceptualize the relationship between humans and nature to manifest the prosperity of living systems in a fully integrated system (Bonyad et al., 2018; Cole, 2012; der Ryn & Cowan, 2007; du Plessis & Cole, 2011; Gibbons, 2020; Kellert et al., 2008; Littman, J. A, 2009; Mang & Reed, 2012; Reed, 2007; Mang & Haggard, 2016; Roös, 2021; Zhang et al., 2015).

This new argument raises a fundamental question, which the current paper seeks to answer: how far could vernacular architecture apply regenerative sustainability? Therefore, the research aims to explore this new notion within vernacular architecture by investigating to what extent it applies the fundamental principles of regenerative sustainability with a focus on the principle of whole systems design integration.

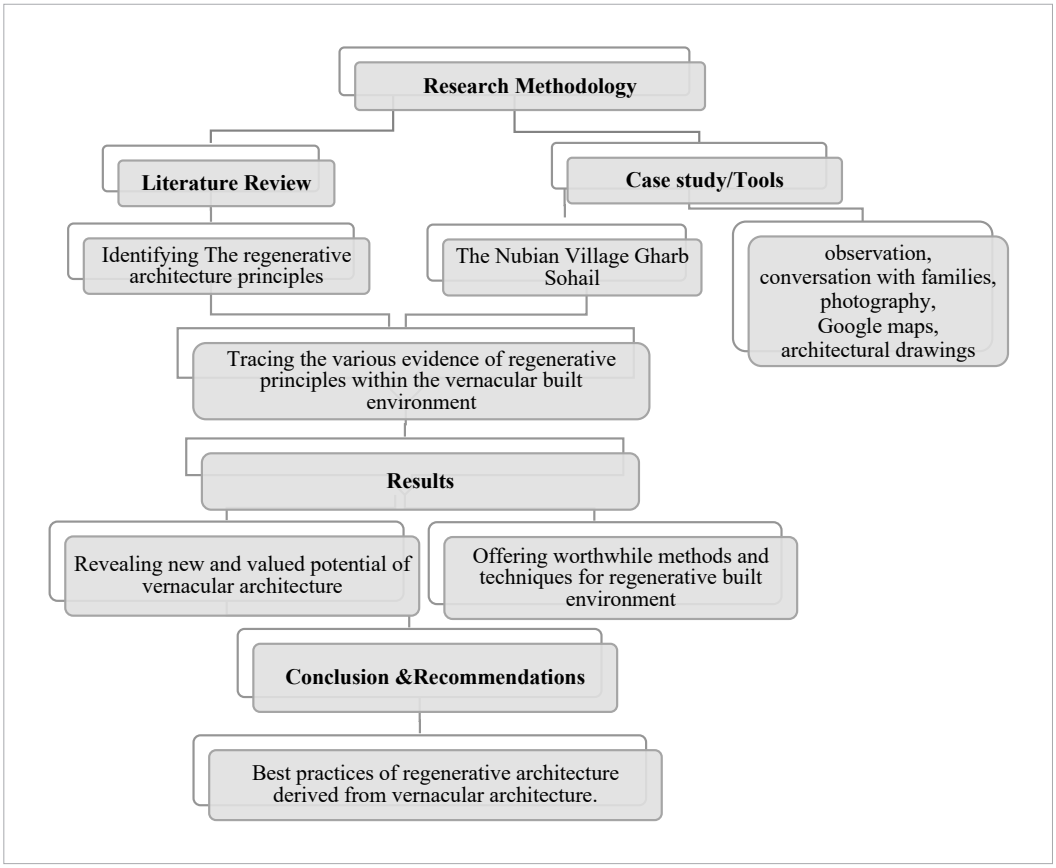
To the best of the authors' knowledge, the relationship between vernacular architecture and regenerative sustainability hasn't been reported before because, as mentioned previously, almost all earlier studies focused on traditional sustainability and its different dimensions within vernacular architecture. Accordingly, the current study covers this knowledge gap in addition to presenting affordable design techniques that help, particularly in developing countries, create a resilient and regenerative built environment derived from its cultural, social, and economic particularities.

Methods

The study adopted a qualitative approach that begins with an in-depth literature review to identify the potential and principles of vernacular architecture as a sustainable built environment and to understand the main principles of regenerative sustainability and its differences from traditional sustainability. The literature search focused on the following keywords: vernacular architecture, sustainability, and regenerative design. Based on the literature review, the research selected the nine principles of regenerative architecture developed by Littman (2009) to investigate its applicability within vernacular architecture.

The study focuses on investigating the evidence of the whole design system integration principle and the other interconnected principles within the built environment of Gharb Sohail village. This village was selected as a case study of vernacular architecture in Egypt because it is characterized by a significant cultural identity, which makes it an important tourist destination in Aswan. The author conducted fieldwork to gather primary data. The tools used were: observation, conversation with families, photography, Google maps, and architectural drawings of some typical houses. Fig.1 illustrates the research methodology and phases.

Fig. 1
The research methodology and phases



Conceptual framework: vernacular architecture

The term vernacular means "domestic, native, indigenous; about home-born slaves," As a noun, it means "the native speech or language of a place" ("Online Etymology Dictionary," n.d.). It also means the buildings that belong to the middle and lower social levels. They were categorized into three types, including residential, agricultural, and industrial buildings, and were typical of an era, region, or group ("Vernacular Architecture," 2021).

Paul Oliver was the first architect to conduct extensive research on vernacular architecture. He defined vernacular architecture as architecture that includes human settlements and other buildings. They are often individual or community-built, adopting traditional techniques depending on their environmental contexts and available resources, aiming to meet human needs while considering cultural values, the economy, and lifestyles. Vernacular architecture is subject to development or change as requirements and conditions change (Oliver, 1998). The definition developed by Oliver encompasses a variety of meanings. Buildings, according to Oliver, are objects that correspond to a certain form of vernacular construction. Furthermore, he saw the vernacular as a process of development and adaptation that might include contemporary materials and constructions as well.

Many scholars have introduced various definitions of vernacular architecture derived from Oliver's (Kırbaş & Hızlı, 2016; Rahim, 2022; Salgın et al., 2017; Singh et al., 2009; Zhai & Previtali, 2010). Based on reviewing these different definitions, the study concluded with the following embedded principles of vernacular architecture:

- Continuous evolution;
- Inherent knowledge through a long period of learning from mistakes;
- Conscious response to the contextual environment and its constraints;

_ Utilizing local and natural resources;
_ Meeting specific needs;
_ Depending on local builders and traditional building techniques;
_ Cultural identity and social norms are the primary determinants of the built environment.

Sustainability and the vernacular architecture

Adopting sustainability as a global strategy to address rising challenges, particularly climate change, has inspired architects, building professionals, and scholars to develop various sustainable solutions at the level of the built environment, which plays a significant role in the utilization of natural resources, energy consumption, and environmental issues. Vernacular architecture, on the other hand, has demonstrated over generations its ability to maintain the balance between the built and natural environments. Its characteristics reflect the sustainability notion and reflect its ability to meet the challenges of globalization and universalization, as reported by (Hidayutun et al., 2016).

In the last three decades, the re-evaluation of vernacular architecture from a sustainability perspective has witnessed an extensive academic effort. Some studies have investigated the complex relationship between environmental and socio-cultural factors and how to derive sustainable design guidelines from vernacular architecture (Qtaishat et al., 2020; Rosaleny Gamón, 2020; Tousi, 2020). Other studies have focused mainly on the environmental dimension (Rahim, 2022; Nie et al., 2019; Salgın et al., 2017). They argue that vernacular architecture meets sustainability standards by responding to local climatic conditions and using natural materials while representing a combination of spiritual, cultural, and human values.

Regenerative sustainability as an evolution to sustainability

The word "sustainability" has become a buzzword, applied mainly to every aspect of our lives; the economy, business, social structures, politics, and the environment (der Ryn & Cowan, 2007). The conventional concept of sustainability, as defined by the Brundtland Report, has been recently criticized by many authors. It is defined as a bias towards anthropogenic and utilitarian approaches based on technical views for the better management and control of nature separated from humans and their habitats. This disconnection between humans and nature endangers cities' physical functions as well as human well-being (Kellert et al., 2008; McDonough & Braungart, 2002).

Sustainable development is also criticized because it seeks to minimize the negative impacts of human activities rather than achieve regenerative outcomes. With the accelerating rate of environmental challenges, this minimization goal has become insufficient (der Ryn & Cowan, 2007). As a result of the traditional sustainability approach's shortcomings, regenerative sustainability has emerged as the next wave of sustainability.

Several scholars argue that the regeneration concept is considered a paradigm shift toward whole-system thinking in which the world is realized as a connected and interdependent living system developed by a multifaceted web of flow patterns and interactions between all the different entities that comprise the system's structure (Bonyad et al., 2018; Cole, 2012; der Ryn & Cowan, 2007; du Plessis & Cole, 2011; Gibbons, 2020; Kellert et al., 2008; Littman, J. A, 2009; Mang & Haggard, 2016; Mang & Reed, 2012; McDonough & Braungart, 2002; Reed, 2007; Roös, 2021; Zhang et al., 2015). Regenerative sustainability differs from traditional perceptions of sustainability in four major ways:

_ Achieving a positive impact instead of minimizing negative impacts;
_ Using living and whole-system thinking instead of mechanical and technical thinking;
_ Producing more than we consume, rather than less or zero consumption;
_ Humans and all other living systems thrive rather than meeting minimum standards;
_ Following a circular and closed-loop process of development instead of the linear process.

Regenerative sustainability in architecture

Ecological and system thinking have catalyzed the emergence of regenerative sustainability (Mang & Reed, 2012). Regeneration is the act of making a place more productive by properly understanding the impact of nature's living systems (Bonyad et al., 2018).

In the architectural discourse, regenerative architecture is grounded on the premise that architecture can produce more than it consumes, as it can provide humans with "food, energy, water, produce oxygen, and capture CO2" (Littman, J. A, 2009). In regenerative architecture, the building needs its context to survive, and the context can benefit from it to evolve. They are both in an interdependent relationship to sustain and grow so humans can integrate with the environment (Bonyad et al., 2018).

Humans are reconnected to their life places via regenerative architecture, which employs the whole systems thinking concept. A holistic architecture is created by and for the context in which it is built and considered a part of the ecosystem, helping to maintain the balance of nature and connecting inhabitants spiritually to the place. Because of this intimate relationship, humans are once again co-partners in the health and success of the places and ecosystems in which we live (Littman, J. A, 2009).

Regenerative Architecture Principles

Since the 1990s, some attempts have been made by many scholars and architects to develop regenerative architecture principles, beginning with Todds' principles of ecological design in 1993, followed by the Hannover principles by William McDonough in 2000, the five principles of ecological design by Van Der Ryn & Cowan in 2003, and the nine principles of regenerative design by Littman in 2009.

The comparative analysis of those different principles by Kabir (2016) showed that the principles of Littman are considered the most comprehensive. Additionally, he developed indicators for each principle, which will substantially assist in the detailed examination of the case study. According to Chidinma and Omoyeni Chidinma & Omoyeni (2019), Littman's principles are geared toward creating a fusion between the human and natural environment and are derived from various interrelated fields of study. For these reasons, the current study selected Littman's principles to trace their evidence within the case study. Table 1 shows the nine principles and their indicators (Littman, J. A., 2009).

Table 1
The nine principles and their indicators were developed by Littman (2009)

The principles of regenerative architecture	The criteria
The first principle: Whole Systems Design Integration."	_ All systems and their elements are integrated into the whole system design. _ All systems are part of communities of mutually beneficial partnerships. _ Multiplicity: Each object inside the system should do more than one function or meet more than one demand. _ Redundancy: each requirement in the system is addressed by more than one solution.
The second principle: Integration into the landscape.	_ The place's features and its landscape are the generators of the design. _ The building and landscape compliance adds a new unit or entity to the mix.
The third principle: Intelligent limits.	_ Every program has a minimum required limit as well as a potentially infinite maximum. _ Reflecting the balance of the program. _ Each material and space is effectively maximized and integrated to make the greatest positive net contribution to the overall system.

The principles of regenerative architecture	The criteria
The fourth principle: Concentration.	_ Less is more. _ Each place has been considered and is required. _ Flexible spaces/programmatic duality.
The fifth principle: Intelligent construction	_ The system is constructed using both natural and artificial means. _ The design is intended to enhance material efficiency. _ Construction and materiality embody the architectural image. _ Prefabrication/rapid prototyping.
The sixth principle: Bold ecology	_ Ecological systems are regenerative. _ Ecological production offers positive outcomes. _ Ecology incorporates all-natural factors as well as manmade elements. _ Energy is transcendent. _ Ecology is an image.
The seventh principle: Community	_ The scale has no impact on the significance of an entity or group. _ The design embodies the sharing of knowledge and social activity. _ Every member of the community participates in and influences the design.
The eighth principle: Experience of place	_ The image of the place creates a favorable experience. _ The perception of the place is powered by a certain systemic form. _ The place is accessible to both individuals and communities. _ The overall impression of the location is positive. _ The place tells a story.
The ninth principle: Culture	_ The design incorporates the social heritage of the place. _ Geological history is promoted and conserved. _ All current cultures are components of the place. _ Cultural resilience is accommodated. _ Design improves the quality of life for people of all cultures. _ The collective awareness of culture is tapped.

Vernacular architecture and regenerative architecture

Comparing the principles of vernacular architecture derived from a previous review of different definitions with Litmman's principles of regenerative architecture, as shown in Table 2, demonstrates theoretically that vernacular architecture incorporated all the principles of regenerative architecture.

Analysis of the case study Gharb Sohail village

Gharb Sohail village was chosen as a model of vernacular architecture in Egypt because it is regarded as a distinguished model of vernacular communities due to its status as a living witness of ancient Nubian heritage while still preserving its cultural identity. How and to what extent Nubian architecture has embodied regenerative sustainability is practically investigated by analyzing the built environment of the village against the principles of regenerative design, with a focus on the first principle of whole system design integration and the other related principles, including the second principle of integration into the landscape, the sixth principle of bold ecology, and the eighth principle of experience of place.

Table 2

Comparing the principles of vernacular architecture with Litmman's principles of regenerative architecture

Vernacular architecture / Regenerative architecture	The Whole Systems Design Integration	Integration into the landscape	intelligent limits	Bold ecology	Concentration	Intelligent construction	Community	Experience of place	Culture
Continuous evolution									
Inherent knowledge through a long period of trial and error									
Conscious response to the contextual environment and its constraints									
Utilizing local and natural resources									
Meeting specific needs									
Built by local builders with traditional building techniques									
The form is influenced mainly by cultural identity and social norms									

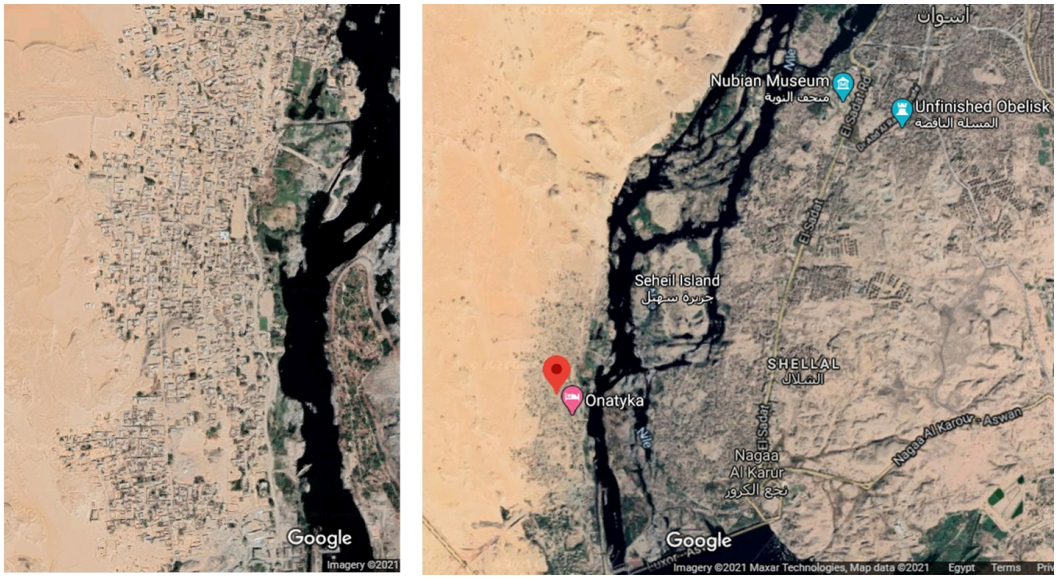
Historical background of Gharb Sohail village

Gharb Sohail village lies on the Nile's western bank, some 15 kilometers south of Aswan, as shown in Fig. 2). It gained its name from its location facing the island of Suhail (Elcheikh, 2018). The village depends on wooden sailboats (felukas) for transporting people and goods from and to Aswan. Gharb Sohail village belongs to ancient Nubia, the land of a great civilization dating back 5000 years (Emberling, 2011).

The inhabitants of Nubia were called Nubians. They were divided into three ethnographic groups: Kunuz, Arabs, and Fadija. They have spoken the Nubian language until now. This language has been spoken but unwritten since the Middle Ages (Hakim, 1993). Gharb Sohail is a Kunuz village that was relocated to a higher level in 1902 after the construction of the Aswan Reservoir (Afifi &

Fig. 2

Location of Gharb Sohail village. (Google Maps, 2021)



Ismail, 2020; Elcheikh, 2018). The village is regarded as one of the most important tourist destinations in Aswan, through which it is possible to visualize the aspects of daily life for Nubians.

Everything related to the ancient Nubian heritage can be found there, including handicrafts that are distinguished by their colors, carvings, herbal products, beads, rafts, Nubian garments, and bazaars that sell local products (Tahseen & Al-Jumaily, 2020).

Regarding the climate, Aswan is one of the warmest regions in Egypt, with an average daily high temperature of 34 degrees centigrade. It is year-round warm or hot (www.worlddata.info, n.d.).

The Nile River plays a significant role in the Nubians' lives, not only because it is their only water supply, but also because it is the core of many of their everyday routines, such as marriage, death, and birth ceremonies. Although most rituals have vanished, the Nile still holds a special place in the souls of Nubians (Hakim, 1993).

Investigating Regenerative Design Principles within the built environment of Gharb Sohail village

The following section will investigate the evidence for each principle of regenerative design. The study will address in detail the first, second, and sixth principles, tracing their criteria at the urban and architectural levels of the village. The other principles will be summarized in Table 1.

The First Principle: The whole systems design integration

a *Criterion 1. All systems and their elements are integrated into the whole system design*

The built environment of the Nubian village was incorporated into and influenced by the ecological, social, cultural, and economic systems (Mahmoud Bayoumi, 2018). For example:

- At the urban level, the value of belonging to the family and Naja, which refers to groups of families who share a common ancestor (Hakim, 1993), compelled Nubians to cluster their houses into groups based on their social relationships.
- This social constraint has been incorporated with the hot climate conditions to create an organic and compact urban form, as shown in Fig. 3 (a).
- At the architectural level, the design of facades expresses environmental, social, and cultural values; it is characterized by minimum voids not only to avoid direct sun exposure but to provide privacy to the residents as well. Fig. 3 (b).
- As shown in Fig. 3 (b), the small upper openings known as "Al Takat" are used for indirect lighting and to allow hot air to exit and cool the house in the summer (Mahmoud Bayoumi, 2018). This design element also expressed an ancient Nubian belief as they formed these openings as a space for the souls of ancestors to live in (Afifi & Ismail, 2020).

(a) (b)

Fig. 3

(a) The organic urban form of the village (Jussaume, 2010). (b) Minimum voids and upper openings in the façade reflected social, environmental, and cultural values (The author)

b *Criterion 2. All systems are part of communities of mutually beneficial partnerships*

The construction of the Nubian Museum in Aswan has revived global interest in Nubian heritage. The Nubians benefited from international attention, transforming their community into an eco-tourism model and a significant tourist destination. (Elchaikh, 2014). Depending on the author's observation, different changes in the built environment have supported this transition, where small ports have been established along the river bank to receive touristic tribes, and new types of buildings, such as hotels, guest houses, bazaars, and restaurants, have also emerged for servicing and accommodating tourists, as illustrated in **Fig. 4**.

Fig. 4

a) New guest houses, bazaars, and hotels in the village and along the river bank LeMay, 2019, b) Moushir, 2015

(a) (b)

c *Criterion 3. Multiplicity: each object should do more than one function or meet more than one demand*

Multiplicity can be seen, for example, in:

- The house has multiple functions where family members, friends, and neighbors are gathered, as well as many social ceremonies, such as weddings and birth rituals, are held (Kamel, D. & Abdel-Hadi, A., 2012).
- Strong belonging to the family as a social value was expressed in the size of the house, which was large enough to accommodate extended family members, roughly estimated at 200 to 1000 m2 (Y. Shedid & I. Hassan, 2019). See **Fig.5 (a)**.
- Recently, many houses have had an economic function where the Nubians either cut space off them or utilized the roof as a bazaar for showing Nubian handicrafts, a coffee shop, or a restaurant for tourists. **Fig.5 (b,c)**.

d *Criterion 4. Redundancy: each requirement in the system is addressed by more than one solution*

Redundancy is embodied in optimizing human thermal comfort as a physical need is met by using different techniques of passive design. For example:

- Using the vault and dome as a roof system is thermally comfortable because the curved surface reduces solar heat gain and thus maintains the internal temperature (Shedid & Hassan, 2019).
- Using the stack effect for cooling spaces in summer as the higher openings enable hot air to exit and are replaced by cold air, while in the winter, the occupants cover them to keep heat. See **Fig.6 (a)**.
- Using mud-brick walls with a high thickness of 50 cm which acts as a thermal mass combined with night ventilation, reverses the temperature extremes by transferring heat received in the daytime into the building fabric at night. So, it lowers the internal temperature and significantly cools the space. This process is reversed at night (Solgi et al., 2017). Thermal mass functions as a natural heating system in the winter because the stored heat within the house is kept in by closing the windows and openings (Krüger et al., 2010). See **Fig. 6 (b)**.

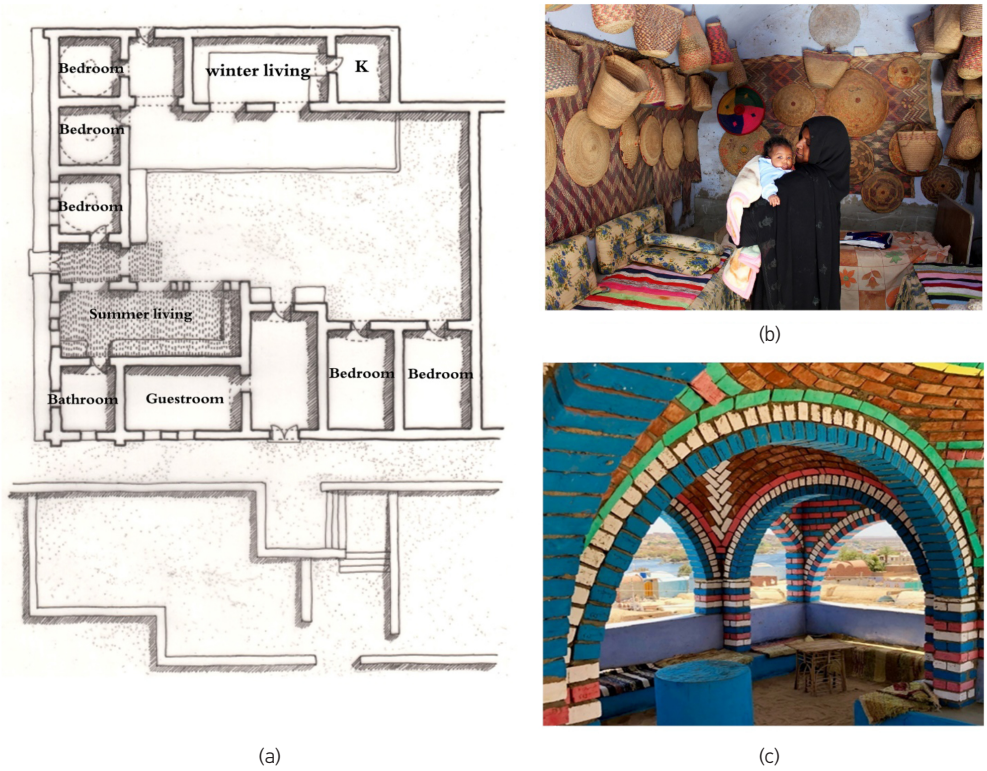


Fig. 5

(a) The Nubian house has a large area with many rooms to accommodate the extended family (the author).
(b) Utilizing the guest room as a bazaar for showing handicrafts (Bronx., 2010).
(c) Making use of the roof as a coffee shop for tourists (Alexander C. Kafka, 2019)

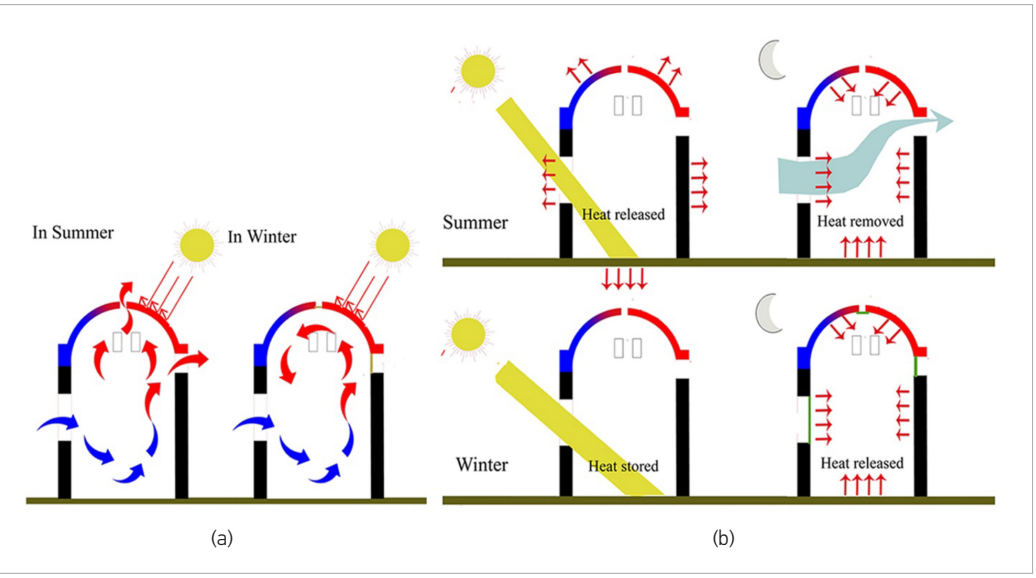


Fig. 6

(a) The roof structure provides natural ventilation, cooling, and heating system.
(b) Utilizing thermal mass as a heating system in winter and as a cooling system in the summer (The author)

- The economical imperative was fulfilled by employing local materials and traditional construction techniques such as vault and dome roofing systems, which are less costly than conventional roofs.
- Implementing passive design strategies, such as the courtyard, which serves as a buffer space or transitional zone where the microclimate is adjusted without the need for a mechanical system, thereby conserving the embedded energy required for cooling, heating, and lighting (Diz-Mellado et al., 2021; Taleghani et al., 2012).

_ Several solutions address privacy as a social need, such as designing the house around a courtyard where all spaces surround, all daily living activities occur inside, and almost all openings are directed. Privacy is also conveyed by physically separating the public and private zones by using a transitional space called Dehleas that leads directly to the guest room while avoiding passing through the private area. Fig.7.

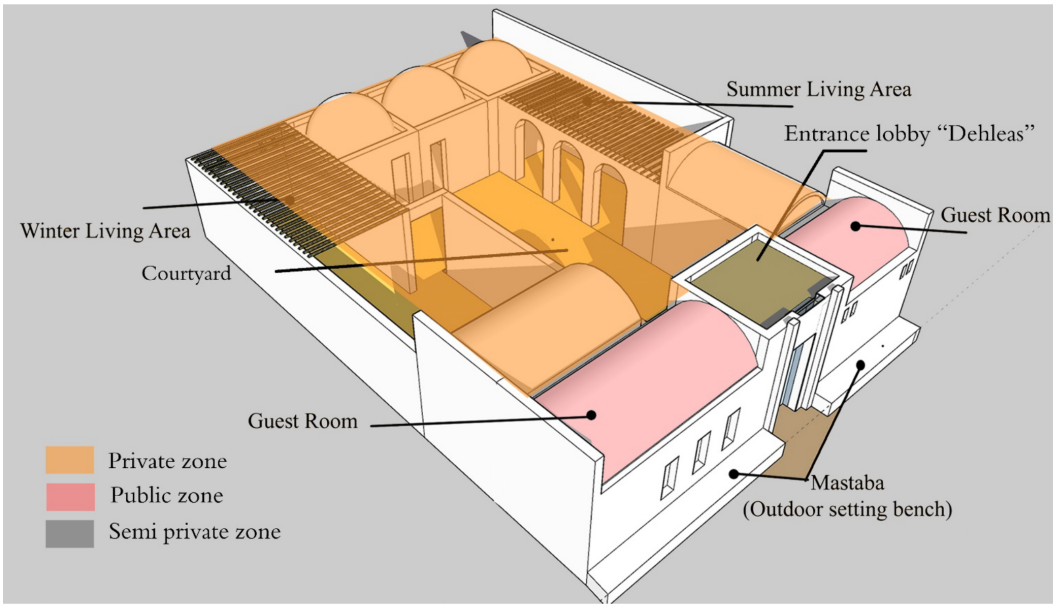


Fig. 7
Traditional Nubian house showing traditional construction techniques, design around a courtyard, and privacy manifestations (The author)

The Second Principle: Integration into the landscape-the natural elements are the generator of the design to create an artificially natural whole entity

The site topography and the Nile were the primary generators of the village's urban and architectural form, as indicated by the following:

_ The homes extend in harmony with the natural features along the Nile in a linear shape more or less parallel to the river, with a restricted expansion to the west owing to the mountains, and the structures respect the steep slope of the environment to create an artificially natural entity.

_ Houses built on sloping terrain have gradual levels to accommodate the topography.

_ The road and pedestrian network are characterized by a natural gradient that follows the sloping landscape. To mitigate the steep slope at some locations, the inhabitants built some stairs along the street. Fig. 8.

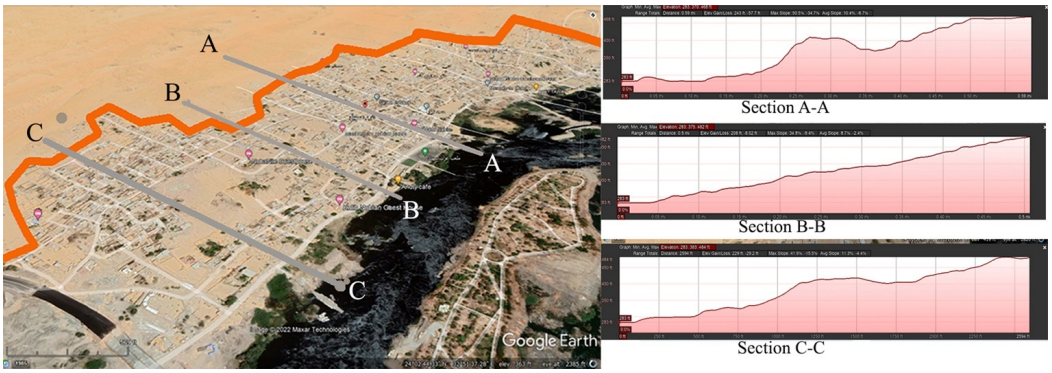


Fig. 8
The linear extension of the village following the steep slope of the topography. (exported from Google Earth Pro, 2022)

_ The Nile significantly affected the village's urban planning, where the main roads were almost parallel to the river bank and the main entrances of houses directly faced the river. Fig. 9 shows various manifestations of integration with the landscape and site features.

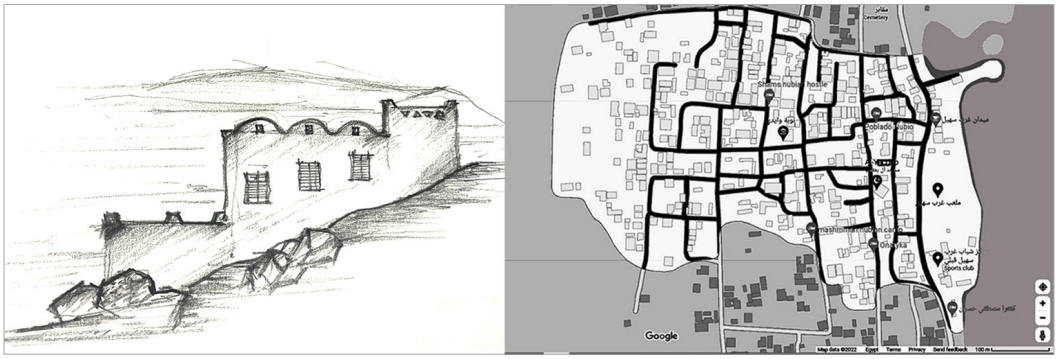


Fig. 9
Integration of the urban form of the village with the landscape features (The author-Google Maps, 2022)

The Sixth Principle: Bold ecology

a *Criterion 1. Ecological systems are regenerative, offer positive outcomes, and incorporate all-natural factors as well as manmade elements*

This criterion can be seen in the following:

_ The Nubians' consciousness of conserving their environment and its ecological systems while developing their built environment is embodied in protecting the Nile River, sandy coasts, natural rocks, alleyways, sloping topography, and native vegetation from pollution or degradation. Fig. 10 (a).

_ The built environment of the village is considered an integrated and interdependent component of the overall ecological system. It generates economic benefits for its residents because it presents a valuable asset in transforming the village into an outstanding international model of eco-tourism. This type of tourism has a wide influence on the community since it provides Nubians with numerous job opportunities, raises their income, and eliminates the unemployment problem (Elcheikh, 2018).

_ Incorporating natural factors can be seen in the use of natural building materials, which are considered rapidly renewable, have high recyclability, and minimize the off-gassing of harmful air emissions.

_ Using recycled materials, such as breed stalks for covering spaces helps minimize waste that harms the environment. See Fig. 10 (b).

_ Vault and dome buildings are carbon-neutral since no building materials are manufactured or transported, and no trees are chopped down.

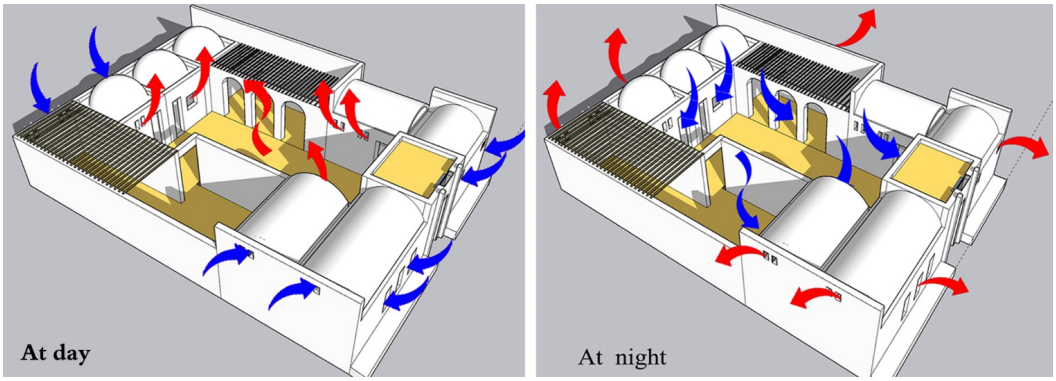
(a) (b)

Fig. 10
(a) Conserving the ecological systems of the village (Otefy, 2017).
(b) Using breed stalk for covering spaces (LeMay, 2019)

b *Criterion 2. Energy is transcendent*

Adopting passive design techniques takes advantage of solar and wind energy, thus decreasing energy consumption through features such as courtyards, thermal mass, shaft ventilation, and minimizing voids in facades. See Fig.11.

Fig. 11
The performance of the courtyard as a passive cooling technique (The author)



The Eighth Principle: Experience of place-the place describes a story, creates a favorable experience, and is powered by a certain systemic form

The village has a distinctive architectural image reinforced by the organic urban form and the buildings' homogeneity with the natural setting. Furthermore, its natural potentials, such as the topography, the Nile River, the mountains, rocks, and dunes, formulate a positive experience for those who visit the village.

The tourists experience the village also through various activities incorporated with nature, such as riding camels, sand bathing, skating, and a Nile picnic by sailboat. Gharb Sohail village also has a significant cultural image resulting from its cultural authenticity, where visitors can visualize the aspects of the Nubians' daily life: their drinks, food, music, dance, handicrafts, and carvings. Fig. 12.

Fig. 12
The distinctive architectural image of the village resulting from its organic urban form and the buildings' homogeneity with the natural setting (Otefy, 2017)

Results and discussion

The accelerated rate of ecosystem degradation due to climate change has driven the emergence of regenerative sustainability as an evolution to sustainability. The study attempted to determine the extent to which vernacular architecture applied regenerative sustainability. Gharb Sohail village was chosen as an example of vernacular architecture in Egypt and evaluated using regenerative design principles. The results obtained from this analysis, as summarized in Table 3, demonstrated that the Nubian vernacular architecture has succeeded in applying the principles of regenerative architecture. The built environment, the place, and the Nubians are in an interdependent relationship where:

- The built environment merges with the natural features of the place and protects ecological systems from degradation or pollution.

_ The place, in turn, enables the built environment to sustain and evolve due to the capabilities of buildings to restore, renew, and revitalize the sources of energy and materials of the place.

_ The Nubians are co-partners in the health and prosperity of their village and nature.

Table 3
Analysis of vernacular architecture against the nine principles of regenerative architecture (The author)

Indicators		Evidence
First Principle: The whole systems design integration	All systems and their elements are integrated into "the whole system design.	_ The built environment is incorporated into and influenced by the village's ecological, social, cultural, and economic systems. _ The urban fabric integrates with social and environmental constraints. _ The architectural elements of the facades integrate with the local climate conditions and embody the social values as well as the cultural beliefs of the Nubian community.
	All systems are part of communities of mutually beneficial partnerships.	_ The transformation of the local economic system of the village into a tourism-based economy has been supported by the built environment by establishing new types of buildings for tourists' services and accommodation.
	Multiplicity" where each object inside the system should do more than one function or meet more than one demand.	_ The Nubian house is distinguished by incorporating multiple social and economic functions.
	Redundancy" where each requirement in the system is addressed by more than one solution.	_ Physical needs such as maximizing the thermal comfort of humans, social needs such as privacy, and economic needs such as decreasing the cost of building a house, have been met by several solutions.
Second Principle: Integration into the landscape	The natural elements are the generator of the design to create an artificially natural whole entity.	_ The urban form of the village has been formed by its harmonization and integrity with the natural features and topography of its site, reflected in the linear form, sloped streets, and houses with multiple levels to create a new unit entity. _ The Nile River has influenced the village's urban planning, so the main roadways have developed parallel to it, and the houses' entrances have faced it directly.
Third Principle: Intelligent limits	Every program has a minimum needed limit and each material/space is effectively maximized and incorporated into the overall system.	_ The spatial organization of the Nubian house has maximized its potential and helped in the integration of all spaces to meet the Nubians' physical, social, and economic needs.
Fourth Principle: Concentration	Each space is necessary and preferred to be flexible.	_ Nubian architecture is distinguished by flexible spaces, such as the village's guest house, which has several functions, and the courtyard, which is utilized in multiple ways.
Fifth Principle: Intelligent construction	The design utilizes natural and artificial methods and enhances material efficiency.	_ The construction of houses maximizes the efficiency of local natural materials, which are considered carbon-neutral, non-toxic, and affordable.
	Construction and materiality embody the architectural image.	_ The significant architectural image of the Nubian house is embodied in using the dome and vault as the main construction system.
	Prefabrication/rapid prototyping.	_ The dome and vault roof systems are characterized by their flexibility as they are applied to different building types.

Indicators		Evidence
Sixth Principle: Bold ecology	Ecological systems are regenerative and offer positive outcomes.	_ Conservation of the ecological system of the village from pollution and degradation has become an asset in turning the village into a significant global model of eco-tourism. _ The tourism sector provides the Nubians with several job opportunities, increases their income, and has vanished the unemployment problem.
	Ecology incorporates all-natural factors as well as manmade elements.	_ Nature has always inspired and governed the Nubians in developing their dwellings and houses. _ Natural building materials have high recyclability, which minimizes the off-gassing of harmful air emissions. _ The dome and vault construction system with mud brick is considered a carbon-neutral system. _ Using recycled materials minimizes waste.
	Energy is transcendent.	_ Adopting passive design techniques has taken advantage of solar and wind energy and has minimized energy use.
Seventh Principle: Community	The scale has no impact on the significance of an entity/ group.	_ The village was socially divided into three units: the family, the naja, and the tribe.
	The design embodies sharing of knowledge and social activity.	_ The houses were clustered into groups based on their relationship, and their areas were big enough to accommodate the extended families reflecting the sense of belonging to the family and the tribe. _ Establishing a community house in each naja reflects the collaboration and the strength of social relationships among Nubians. _ The courtyard empowers the relationship between family members as well as promotes privacy. _ The spatial organization of the house satisfies privacy by separating public and private zones, as well as male and female circulation.
	Every member of the community participates in and influences the design.	_ In the past, all family members have a role in the design and building process. _ At present, community participation changed to include the renovation of houses and making certain modifications to adapt to the house's recent function for attracting tourists. _ Youth and children participate in an annual festival for repainting the houses' facades.
Eighth Principle: Experience of place	The place describes a story, creates a favorable experience, and is powered by a certain systemic form.	_ The village has a distinctive environmental image reinforced by the organic form of the village planning and the buildings' homogeneous relationship with the natural setting. _ Tourists experience the village through various activities such as riding camels, sand baths, skating, and Nile picnics by sailboat. _ The village has a significant cultural image resulting from the Nubians' cultural authenticity, which is reflected in the Nubian architectural character.
Ninth Principle: Culture	The history of the place and its Cultural resilience is accommodated, conserved, and presented in the design.	_ Visitors always portrayed Nubia as not just a land with a rich history but also a place distinguished by the uniqueness of its people's cultural authenticity. _ Nubian cultural identity is considered a fundamental constituent of the village and has been expressed by its architectural character.

Conclusion

The current study explored vernacular architecture from the perspective of regenerative sustainability, which has become an evolutionary concept of sustainability in the last decade. The study reviewed related literature on vernacular architecture and regenerative sustainability, including its definition, principles, and main differences from conventional sustainability. The literature review concluded that regenerative sustainability intends to re-conceptualize the relationships among human, ecological, economic, and social systems as the next wave of sustainability. Through regenerative sustainability, architecture is considered a system with the ability to evolve, regenerate, and produce more than it consumes in an integrated relationship with other living systems, allowing it to keep pace with the current degradation of ecosystems while also improving human well-being. The current study argues that vernacular architecture plays a significant role in thoroughly understanding regenerative design and how to apply it constructively. To examine this significance, the research investigated the built environment of Gharb Sohail village as a case study, following the principles of regenerative design.

The findings revealed that vernacular architecture embodied regenerative sustainability and its principles in several ways particularly, its ability to evolve and regenerate over centuries to adapt to the ever-changing needs of humanity, and its ability to face newly emerging challenges in a harmonized, integrated, and interdependent relationship between the built environment, people, and the entire ecosystem.

Based on this finding, the study suggests a variety of design methodologies and techniques to assist in the creation of resilient and regenerative built environments that are derived from vernacular architectural knowledge and adapt to cultural specificities, particularly in developing nations.

The study recommends conducting further studies of regenerative development within vernacular architecture by selecting case studies at different urban scales and contexts to gain a variety of methods and techniques for applying and practicing regenerative design. In addition to developing educational programs concerning studying the potential of local vernacular architecture among students and architects and incorporating it with contemporary national and global demands such as the global sustainable development goals 2030.

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