



Understanding the cultural landscape value of traditional agrarian landscapes of African Sahara Desert: The case of Timimoun, Algeria

Guerrout Chouaib* 

Bahar Baser Kalyoncuoglu** 

Abstract

In 1992, the World Heritage Convention became the first international legal instrument recognize cultural landscapes as a human heritage that must be protected. The Cultural Landscape - Past, Present and Future considers different aspects of man's intervention with natural vegetation and the landscape resulting from a long equilibrium of co-existence. These landscapes are not stable, and the recent and ever accelerating changes in technology and life-style have increasingly affected many ancient landscapes, as old land-use practices are abandoned and traditions forgotten (Birks et al., 1988). Human communities in desert areas formed a special landscape, providing these cultural landscapes within a special ecosystem of sustainable living conditions, which helped to create many social, economic, and cultural systems in addition to preserving biodiversity. Unfortunately, the cultural landscape in the African desert is constantly deteriorating under the influence of urban, economic, and social changes. In the southern Algerian Timimoun city of is one of the most important global desert touristic destination due to the natural cultural landscape characterizes it, but unfortunately this landscape in continuous deterioration. Agricultural landscapes of desert environment, with its remarkable knowledge culture and world of practices, must be seen as a living library where this knowledge is transferred from generation to generation. It seems certain that scientists will need more of the know-how stored in this living library in the near future, especially given the effects of climate change in the world today. This paper aims to identify cultural landscapes in the oasis and analyze their transformation and change in cultural landscape and traditional green infrastructure elements by relying on a historical analysis of spatial images based on quantitative analysis using ArcGIS software with the aim of identifying the real reasons of this deterioration in the urban cultural landscape in desert cites. In conclusion the study will propose an action strategy to prevent this degradation

Keywords: cultural landscape, Ksar ecosystem, social resilience, Timimoun-Africa

*(Corresponding author) Dr., Okan University, Turkey, [✉cetagadrar01@gmail.com](mailto:cetagadrar01@gmail.com),

**Assist. Prof. Dr., Istanbul Medipol University, Turkey, [✉bahar.baser@medipol.edu.tr](mailto:bahar.baser@medipol.edu.tr),

Article history: Received 15 March 2022, Accepted 17 April 2022, Published 30 April 2022,

Copyright: © The Author(s). Distributed under the terms of the Creative Commons Attribution 4.0 International License



1. Introduction

Agricultural activities are man's first form of action in shaping the earth, and they have an ancient origin of knowledge, often guided by the conditions of the natural environment. In extreme environments where natural conditions make it difficult to survive, these actions create special landscape patterns that are highly differentiated from its surrounding texture. Thousands of years, man in the African desert adapted to the harsh climatic conditions, established human settlements, developed irrigation systems and agricultural technology, and built cities and forts that provide him with protection and economic independence. Oasis settlements in Africa's Sahara Desert are a good example of these patterns. In addition to these fertile patterned structure in desert landscape, the social lifestyle they contain is a successful example of the harmonious relationship that man can establish with nature and himself, having lived for thousands of years and survived until today. Agrarian landscapes of desert environment represent the continuum of socio-ecological memory, knowledge transmission to next generations and generate the vital components of humankind' heritage. They provide multiple economic and social benefits, multifunctionality, cultural support and ecosystem services for human societies (ICOMOS, 2017).

UNESCO and ICOMOS defines the rural landscapes as 'organically evolved continuing cultural landscapes' which means the living evidence of human-nature relationship reflecting the evolution of traditional life over time. The practical contact between human and nature in the agricultural heritage landscapes sustains bio-cultural diversity including agrobiodiversity, as well as cultural and spiritual values (ICOMOS, 2017). From this point of view, agricultural heritage, with its remarkable knowledge culture and world of practices, must be seen as a living library where this knowledge is transferred from generation to generation. It seems certain that scientists will need more of the know-how stored in this living library in the near future, especially considering the effects of climate change we are experiencing today.

According to ICOMOS definition, the landscapes of African Sahara, and especially the city of Timimoun reflects the whole characteristics of a second category of cultural landscapes in which agricultural activities shaped the evolution of earth and humankind for some 3000 years.

The definition of "organically evolved continuing cultural landscapes" particularly consistent with the character of the Gourara region because of its major components such as *Ksar*¹, palm groves, *foggara*² system, traditional architecture and agrarian-based social life.

In such cultural landscapes, where mostly agricultural activities are a part of life, the relations established with the contemporary society's culture are extremely important for the sustainability of the heritage site. Thus, in their statement in 2017 ICOMOS-IFLA pointed out that the issues and threats challenging on the agricultural activities within contemporary cultural, environmental, economic, social, and legal contexts. On the other hand, cultural landscapes construct proposes that heritage places are not isolated islands, there is an interdependence between people, social structures, and the landscape.

The aim of this article is to reveal the cultural landscape characteristics of the "*Ksar* ecosystems" as a part of the desert landscape character of the African Sahara region, which has now become more important in terms of measures to be taken against future climate risks, and to discuss the possible threats to the continuation of the global agricultural heritage. In order to define possibilities of intersection between the traditional ancient lifestyle and the contemporary social culture in the region; this study will try to reveal the degree of pressure created by urbanization based on cultural tourism, which would be a bad scenario unless being managed well.

¹ *Ksar* or *qsar*, plural *ksars*, *qsars*, *ksour* or *qsour*, is the North African term for "fortified village," from Arabic *qaṣar*, itself possibly loaned from Latin *castrum*. The term generally refers to a Berber fortified village.

² *Foggara* is local name of ancient irrigation system of African desert, is a system for transporting water from an aquifer or water well to the surface, through an underground aqueduct.

2. Method

Our case is Timimoun Oasis, which is considered one of the most important Sahara oases because of its largest coverage in the region. This oasis dominated by a vast Salt Lake, site specific irrigation system, local traditional settlements and palm groves named as *ksar*, has suffered the impact of the population explosion and the lack of economic and social policies like other Algerian cities. The oasis is experiencing many problems that have led to a decrease in its area, which has led to a reduction in its ecological, social, and economic roles. Considering the critical situations and threats on oases landscapes and *ksar* ecosystem, our study aims to shed light on its status in order to preserve the continuity of this millennium human system. Depending on the case study this research will try to exemplify characteristics and threats on *ksar* ecosystems in African Sahara context.

For this purpose, the study will first try to reveal the tangible and intangible elements that constitute the cultural landscape values in the study area. Our research claimed that the tangible elements of the cultural landscapes in the African desert are *ksar*, *foggara*, *kasbah* and palm groves; and the integration of these elements creates social culture and social resilience in this geography. In the next step the study will try to reveal major threats on the cultural heritage through using the ICOMOS-IFLA (2017)'s approach designated for rural landscapes. The threats on the site will be analyzed under three categories of ICOMOS-IFLA (1) Demographic and cultural threats, (2) Structural Threats (3) Environmental Threats. ARCGIS application was used to understand the quantitative amount of the effects of uncontrolled urbanization and tourism actions on Timimoun's cultural landscape that do not consider the capacity of this special area and the sensitive ecological balances it contains. In the last part, the study will try to draw a road map that will guide the decision makers in order to ensure the continuity of this unique cultural landscape example and to get maximum benefit from it.

3. Cultural Landscape Heritage Characteristics of African Sahara Desert's Ksar

3.1. Ksar Ecosystem Characteristics

North Africa symbolizes a very distinct cultural mix and deep-rooted beginning of human civilization. In this representative environment the desert ecosystem covered a large part of North Africa (Figure 1) and was known for the fusion of North and South African cultures, in which humankind was able to build population groups in very harsh natural conditions known as *Ksar*.



Figure 1 The Satellite image of African Sahara Desert (Google Earth)

Desert *ksar*'s are similar in their urban and social pattern, but there remains a difference in their ecological pattern, where there are *ksar*'s next to valleys, Erg *Ksar*'s and Sabkha *Ksar*'s. It is possible

to make a first typological classification based on the geographical location and the territorial model of implantation wadi ksour; ksour of sebkha and ksour of erg (Laureano, 1987).

The *ksar* is basically a group of non-separate houses. Like the castle, it is surrounded by walls, and sometimes there are structures outside the walls, in addition to a palm oasis. The methods of irrigation differ according to geographical data. Basically, this type of *ksar* consists of three main components, which are the *foggara*, the *kasbah*, and the palm groves. These components make up an integrated ecosystem. Figure 2. shows the principle for the operation of this system.

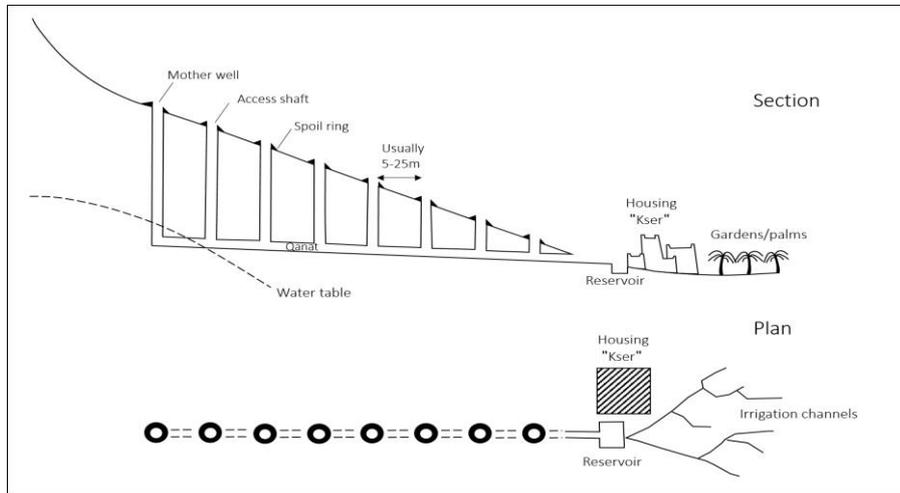


Figure 1 The sectional schema of components of *ksar* ecosystem (adopted by Guerrout, C. from Mobile Technologies in the Ancient Sahara and Beyond)

The size of the *ksar* and the importance of its built space depend on the nourishing capacities of the terroir. When it loses, the *ksar* is abandoned; when, on the other hand, the terroir can develop to receive the population grow, the *ksar* is multiplying.

The ksour are these impregnable fortresses erected on the major caravan courses that connected north and south of sub-Saharan Africa. Their different defensive devices have attracted the interest of researchers as to their historical origins, their modes of construction and the customs of the ethnic groups that created them. These Saharan architectural and urban ensembles are components of Algerian historical heritage.

The “*ksar*” is a blatant example of the cultural landscape representing a clear interaction between human and natural environment. The nested logic of *ksar* reflect precise techniques for the sustainable use of land, considering the characteristics and limits of the natural environment, through a tight regulation of the relationship between water use and cultivated spaces and built spaces, and having specific spiritual relationship with nature. Architecturally, living places constitute a built-in group, closed and hanging.

The *ksour*³ of the regions of Touat, Gourara and Tidikelt represent a unified pattern by relying on the technique of irrigation *foggara*. All *ksar* structures are located within the boundaries of the property and protect the buffer zone its environment. The dirt buildings are very weak due to lack of maintenance and regular reform caused by their population abandoned *ksar*.

4. The analysis of potentials and threats on Timimoun’s Cultural Landscape

4.1. The Elements of Timimoun’s Cultural Landscape

Timimoun is the administrative capital of Timimoun department, also the historical capital of the Gourara region⁴ (Figure 3), in which consists of a group of *ksour*. According to the 2008 census

³ Plural usage of *ksar*, means *ksars*

⁴ Gourara (Gurara) is a Zenati Berber language spoken in the Gourara (Tigurarin) region, an archipelago of oases surrounding the town of Timimoun in southwestern Algeria.

Timimoun has a population of 33,060. The *ksar* is the original urban style of Timimoun, where this settlement style is based on three basic components: the poor, the oasis, and the housing. Together, these components constitute a social and urban ecosystem characterized by urban resilience, self-sufficiency, and sustainability.

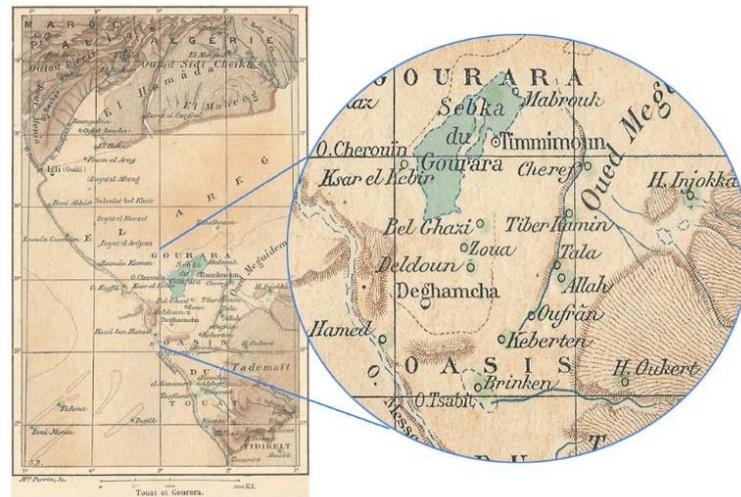


Figure 3 The map of Gourara region in the Algeria map of 1894.

By 1900 Timimoun occupied by French forces and opted as the military post (BORDJ) by French military in order to “protect” and supervise region from attacks. The needs of the French military garrison attracted merchants and traders, who came to settle around new city. The location of Timimoun city as caravans meeting point from all sides, made it a strategic center also contributed to a great extent to the enrichment of the caravans which found a developed market. As a result, Timimoun became a beaming city overall Gourara region. The city, made of earth and local materials, may extend until the inhabitants are able to derive sustenance from the surrounding physical environment. The production system is therefore a constitutive part of the founding act; it is often physically included, and the settlement is already measured depending on the available resources (De Dominicis, 2014). From an urban and architectural point of view, the colonial architecture of the area orients the outset not only for Sahara region but a so-called Sudanese architecture, which imported from sub-Saharan Africa (French West Africa). This style is characterized by colonial urban fabric and conical shapes made from clay. These forms include many decorations; it is still an element in thermal protection of facades. Also, the small openings 20 to 40 cm on the walls are in the form of skylights, holes, mesh, or window, influence indoor temperature regulation (Figure 4).

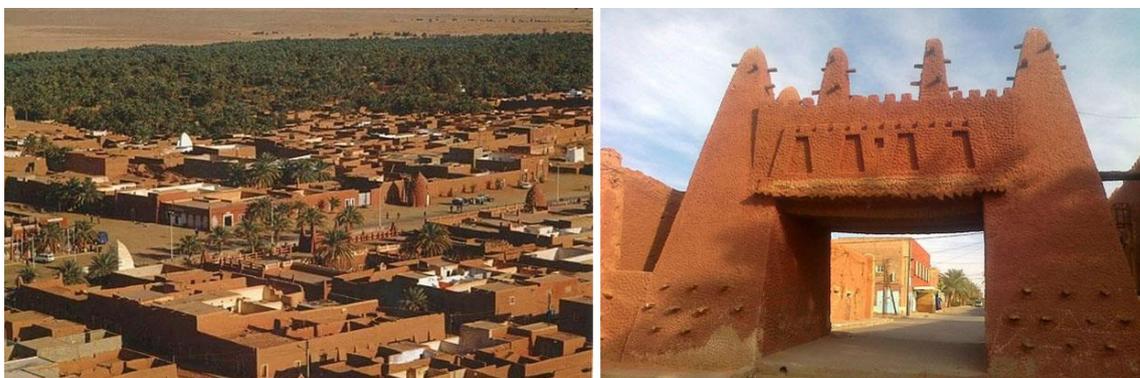


Figure 4 The colonial architectural character of the city in general and detail.

Due to the natural landscape that characterizes the city, Timimoun has become the preferred tourist destination for Europeans, and during this period hotel buildings started to be constructed. After independence (1962), the state's tendency was to develop tourism, considering that

Timimoun has a significant tangible and intangible heritage in addition to the natural landscape. In addition to investing many properties in housing and touristic dormitory, large scale touristic building complex (Figure 5), had been constructed which designed by the icon architect Bernard Pouillon. Also, some residents of the northern regions bought some of the orchards and became the secondary residents use the city to rest in the winter seasons.

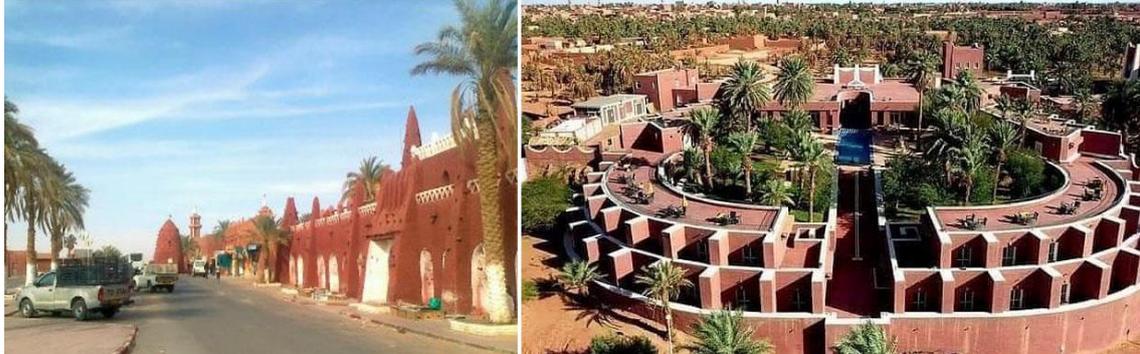


Figure 5 Comparison of colonial(left) and modern(right) archetypes of tourist complexes in Timimoun.

Considering these economic and social changes, the rural domination of the oasis was gradually reduced in favor of new economic activities. Economic diversification and the induced new attraction also played a full role in bringing about a fundamental modification in the social and spatial organization of the oasis which today finds itself facing the problems of managing the fragile interaction between man and its environment. The palm grove, which remains an essential component of the oasis landscape as an identity for Timimoun, is increasingly suffering from the pains of urbanization and the shortcomings of urban management. The deterioration of these landscapes threatens the ecological, social, and economic systems of life. Timimoun's cultural landscape has three remarkable tangible components⁵: "Palm Groves", "Kasbah" and "Foggara" (Figure 6).



Figure 6 (a) The general landscape of Timimoun, (b) Palm groves and orchards, (c) Ksar, (d) the streets of Ksar, (e) Foggara system and water distribution shaft.

⁵ The oasis is a space rich in cultural landscapes elements, but in this research paper i will focus only three main elements of the oasis that constitute particularly landscape of Ksar system.

Timimoun Oasis is considered one of the most important desert oases dominated by a vast Salt Lake (sabkha⁶) (Figure 7). On the edges of sabkha were built dozens of *Kasbahs* (Massin, *Kasbah*, Tela etc.) inclined on the rocky cliffs. The irrigation system (*foggara*) in the oasis is very special this system slightly inclined underground gallery, which drains water from the aquifer upstream to the driest land located downstream, towards the palm grove.



Figure 7 The landscape of Sebkhah; Salt Lake of Timimoun.

The establishment of the Ksour and the oases of Gourara is the result of the presence geomorphological conditions by the existing Meguiden plain and Tadmaït plateau, and also the underground waterflow. All these facts contributed to the construction of the Ksour and formed a chain linking between the north and south of the African continent through the establishment of trade routes for thousands of years. This ancient infrastructure promotes the development of sustainable life systems through irrigation techniques that led to the establishment of oases and make possible cultivation in this arid region.

The *foggara* system is the most common traditional irrigation system in the Timimoun oases, and it is a system that was built thousands of years ago, based on extracting water from the underground water tank in underground corridors with a slight slope that does not exceed one percent. The corridors are interconnected by a series of wells that end with a waterwheel on the face of the earth, and its water is divided among the groves according to a very precise division system. (The section in the Figure 2 shows how the *foggara* system works.)

Compared with other ksour in southern Algeria, Timimoun *ksar* has maintained its architectural connection in terms of composition and materials. In addition to the oasis and the water collecting system, Timimoun *ksar* represents one of the most important shortcomings in terms of architectural excellence. The architectural style has been well maintained and dirt buildings are completely adapted to climatic conditions conveying with the natural and social environment. Also, the *ksar* represent a continuous landscape that maintains an active social role in contemporary society closely linked to the traditional way of life, and in which the evolutionary process is still in progress.

4.2. The Analysis of Threats on Timimoun's Cultural Landscapes

Increasing human populations, urbanization and effects of climate change make agrarian landscapes more fragile to risks of loss, abandonment, or radical changes. According to the declaration of ICOMOS-IFLA (2017); the threats to rural landscapes reflect three interrelated types of change:

⁶ sabkha, also spelled Sebkhah, (Arabic), saline flat or salt-crusted depression, commonly found along the coasts of North Africa and Saudi Arabia.

1-Demographic and cultural threats (population growth in urban areas and depopulation in rural areas, *urban expansion*, intensive infrastructure works, *development pressures*, loss of traditional practices, techniques, local knowledge, and cultures).

2- Structural threats (*globalization*, change and growth of trade and relations, economic growth or decline, intensification of agricultural practices and techniques, change of land and loss of native pastures and of domesticated species diversity).

3- Environmental threats (*climate change*, *pollution* and *environmental degradation* including non-sustainable resource mining, impacts on soil, vegetation, and air quality, and loss of biodiversity and agro-biodiversity).

In the next section the study try to analyze the existence of these changes and possible threats in *Ksour* of Timimoun's.

4.2.1. Demographic and Cultural Threats

The group of Gourara *Ksour* constitutes a regional system that encourages the establishment of an economic life and a mixed social pattern between the Bedouin and the urban system, through which commercial and cultural exchanges are active. Timimoun is the most dynamic shopping center of Gourara. Like the Touat region, this area was favored by trade between the nomads of the High Plains Steppe of Oran region (Despois, 1959).

With the increasing population growth, the food supply of the city started to be obtained from modern agricultural products in the northern regions of the state. Moreover, parallel with this degradation in the Oasis areas, which lost its economic efficiency, a new type of urbanization has been raised with the increase in urbanized population. As a result of two different dynamics feeding each other in this way, the threat of losing the traditional desert life and cultural landscape elements peculiar to Timimoun has emerged in the long term. Furthermore, the city's outsourcing of food supply has led traditional farmers to seek employment in different sectors. Along with this, the farmers chose to sell their gardens and houses, which were considered a good opportunity by tourism investors. In this process, palm groves and traditional settlement pattern began to transform into residences used for touristic purposes, and the traditional socio-cultural structure deteriorated to some extent.

The population of Timimoun seated over the last fifty years, according to the statistics of 3,000 inhabitants in 1954 to 20.607 inhabitants in 2008. The small Saharan village of the 1950s became a full urban agglomeration according to a generalized process, named as Sahara of rural shift to urban (Bisson, 2003). This economic change of the oasis has provided the local population with more job opportunities in the field of tourism, but at the same time it negatively affected to the oasis ecosystem through neglecting the traditional sustainable irrigation system and palm groves in the oasis. It is obvious that, if the policymakers are not considered to take precautions against this progress, it might create irreversible loss of socio-economic and socio-ecological heritage of the region.

Maintenance of *foggara* systems is essential to preserving them in working order. This work was formerly one of the most difficult tasks of the indigenous population and was previously carried out collectively by the Twiza. This process of cooperative work has disappeared, due to the disintegration of traditional social structures, in addition, the low-flow gains obtained after cleaning or stretching the *foggara* channel, and the lack of qualified labor to do this work has exacerbated this phenomenon (Figure 8).



Figure 8 (Above) abandoned and collapsed *foggaras* (Remini et al., 2011) ; (Below), Collective work of maintenance for *foggara* in palm groves of Timimoun (Project *Foggara Amghiar Timimoun*) .

All these problems are the result of a clear neglect to preserve the social ecological memory. The neglect of the oasis system, in addition to the wastewater that is dumped in the marsh, caused the spread of diseases, harmful insects and unpleasant odors, which affected the ecosystem of the oasis in general, in addition to the negative impact on the cultural landscape of Timimoun. Landscapes change constantly from natural and anthropogenic drivers, and land use and land cover changes by humans have been identified as a primary effect of mankind on natural systems. These changes underlie fragmentation and habitat loss, which are the greatest threats to biodiversity and ecosystem services. The complex interactions between development decisions and ecosystems, and how the consequences of these decisions may then influence human values and subsequent decisions is an important area of research interest (Petrosillo et al., 2015).

There exist a great variety of landscapes that are representative of the different regions of the world. As combined works of nature and humankind, they express a long and intimate relationship between peoples and their natural environment (Nofal, 2011). The oasis system and cultural landscapes are the product of the fusion between human work and natural data. Where man worked with the social system to develop oases in harsh natural conditions, and through this, social ecological knowledge was formed by experiences acquired through practice, which is known as socio-ecological memory. It is a well-known fact that any changes on the social system caused disappearance of this knowledge, which directly affected the lack of space in the oasis through neglecting the participatory work and techniques for maintaining irrigation systems and preserving the original plant species and agro-biodiversity. The joint use of micro- and macro- remains underlined once more that the landscape reconstruction depends on both wild and cultivated plants, and the cultural landscape is a complex mixture of indigenous and exotic plant elements. Their development depends on the interaction between human and environmental setting (Sadori et al., 2010).

On another side, the building system is a very important part of the desert ksour, and they have developed throughout history through their compatibility with the natural and environmental data. The *kasbahs* are characterized by distinctive architectural techniques that consider the availability of building materials, natural conditions, and cultural and social needs. Due to the economic and urban changes in the city, the cultural landscapes of *ksar* and *kasbahs* have changed through their incompatibility with the needs of the population. Availability of new materials prompted the residents to use modern construction techniques and materials which negatively affected the original appearance of the *kasbahs* (Figure 9).



Figure 9 An example for the usage of new construction materials in Ksar (Produced from Rouani, 2017).

4.2.2. Structural Threats

In this part of research, the study describes the green surroundings of Timimoun oasis and understand its change during the last 35 years, between 1985 and 2019. A period during which there was a severe shortage of green cover and an increase in urbanization. The analysis proceeded based on images taken from Google Earth images correspond to the following years: 1985, 1906, 2010 and 2019. The images were selected according to the same coordinates. Table 1 lists the characteristics of the images obtained.

Table 1 The features of the images used for LU/LC change analysis.

Image	Date	Spatial coordinate 01	Spatial coordinate 02	Spatial coordinate 03	Spatial coordinate 04
Image 01	1985	29°17'36.68"N 0°14'0.59"E	29°15'37.56"N 0°12'21.61"E	29°16'36.45"N 0°15'36.55"E	29°14'49.62"N 0°14'10.95"E
Image 02	Jul. 2006	29°17'36.68"N 0°14'0.59"E	29°15'37.56"N 0°12'21.61"E	29°16'36.45"N 0°15'36.55"E	29°14'49.62"N 0°14'10.95"E
Image 03	Dec. 2010	29°17'36.68"N 0°14'0.59"E	29°15'37.56"N 0°12'21.61"E	29°16'36.45"N 0°15'36.55"E	29°14'49.62"N 0°14'10.95"E
Image 04	Dec. 2019	29°17'36.68"N 0°14'0.59"E	29°15'37.56"N 0°12'21.61"E	29°16'36.45"N 0°15'36.55"E	29°14'49.62"N 0°14'10.95"E

Classification of satellite data is the most widely used method for extracting spatial information. This method works by assigning a pixel to each land use pattern. Under supervision, a classification method is chosen for this study, considering the knowledge of the field and available documents. Before proceeding with the classification of images, our analysis focused in the first stage on determining the green cover in the original oasis of the city to obtain the area of the oasis with the ArcGIS application. Four thematic maps were extracted with the analysis using the ArcGIS application (Figure 10).

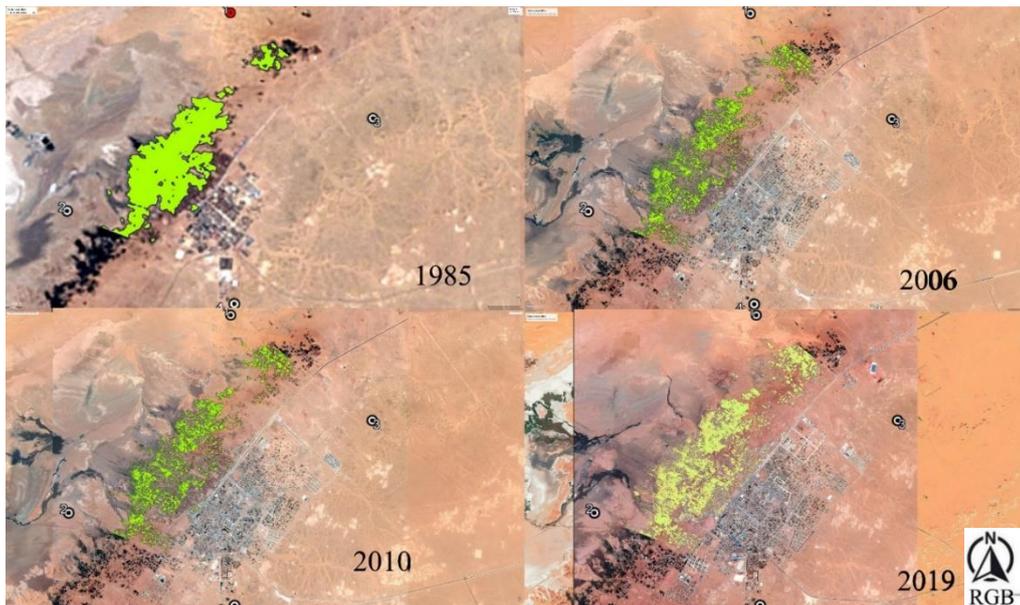


Figure 10 Classification and decreased change of green patches (Palm Groves) in Timimoun by ARCGIS

Through the application of ArcGIS, the study can obtain the amount of change in green cover in the study area, which is the data recorded in Figure 11. It is possible to see that palm grove areas have decreased rapidly over the years and more than 1.5 million square meters of palm grove areas have been lost since 1985. This situation proves that even though having great value of tourism and cultural potentials, Timimoun cultural landscapes are in endangering risks for future sustainability of the region.

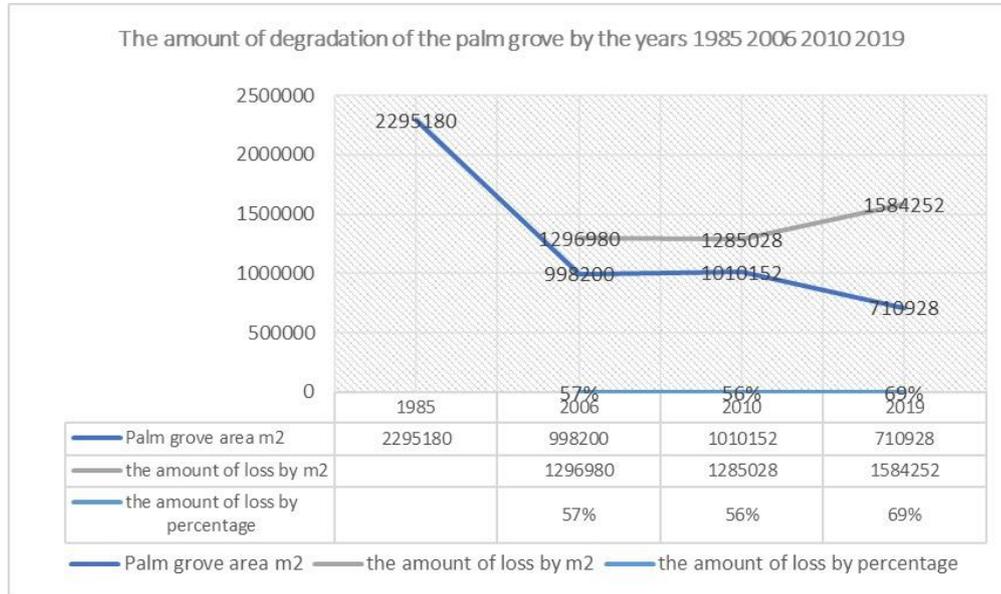


Figure 11 The amount of degradation of the palm grove areas by the years of 1985, 2006, 2010, 2019.

4.2.3. Environmental Threats

The Timimoun Oasis is currently facing with water scarcity because of a drop in the groundwater level, and the extension of the sabkha area gradually expanding toward the palm grove. Several 21 *foggaras* with a length of 53 km of underground galleries cross the urban fabric from southeast to northwest and collect water from the aquifer in the continental region. As a result of the decrease in the groundwater level, the volume of water bottled by blasters decreases because of drilling eighteen wells in the same underground reservoir to supply the city and other ksour belonging to the municipality with potable water. The volume of water in 2007 was assessed at 35,337.6 m³/day, or 409 L/sec, most of which is for Timimoun City (Otmene & Kouzmine, 2011). Locals put a direct relationship between draining blasters and realizing wells. Of course, there is a relationship between the two phenomena, but the problem is also more global and complex. The draining of the *foggara* began long before excavation was carried out by hauling or due to lack of maintenance of the galleries: Amrir of *foggara*, among the largest in Timimoun, which mustered 15 l/s in 1900, had already seen its flow. Decreased to 11.8 liters / sec in 1950.

Today, the world witnesses the gradual disappearance of *foggaras*; there is a loss about one to two *foggaras* per year for over half a century. The discharge of the 250 functional *foggaras* shows a significant drop: 850 l/s in 1960 and 355 l/s in 2001, enough to irrigate 350 ha. The causes of declining *foggaras* are technical, social, and environmental. The exploitation of groundwater affects all regions of the three countries concerned (Algeria, Tunisia, and Libya). Excessive water consumption continues. Timimoun Oasis is one of the type of oases attached to the sabkha the oasis in this type depends on the ecological and social knowledge to control this system by draining the salty water rising from the sabkha through the draining channel.

Urban growth has a negative impact through the increase in the amount of sewage water (24,736 m³/day), which is daily dumped in Sabkha (Salt Lake) of Timimoun and significantly affects the whole system. Besides the problem of the low groundwater level, which pushes the gardens towards the lower areas in order to benefit from gravity irrigation by the *foggara*, the water that

seeps into the corridors of the *foggara* is the sewage of the city drained into the *sabkha*. This phenomenon led to the disappearance of intercropping in orchards in contact with saline areas (Figure 12).

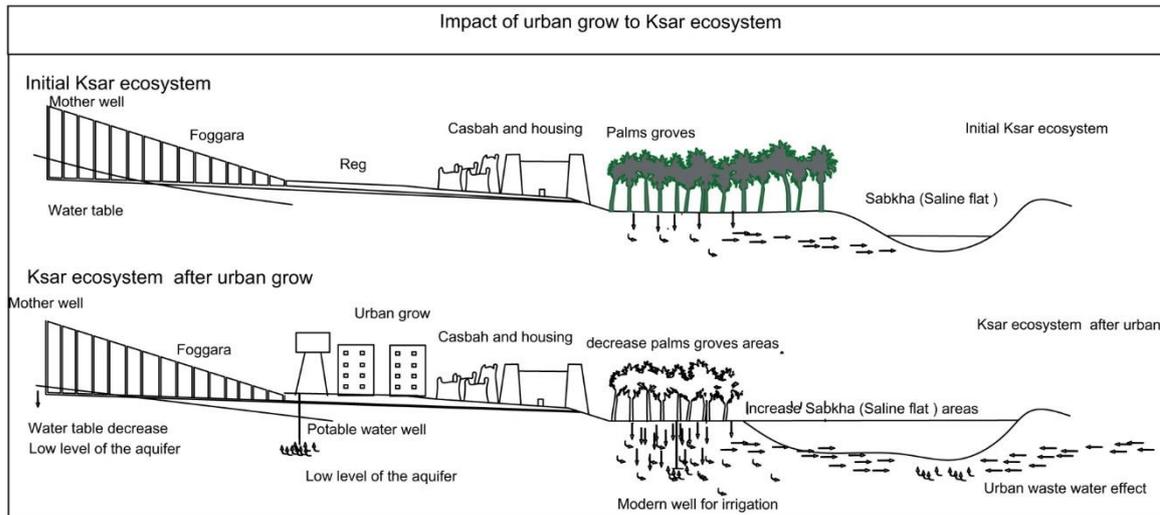


Figure 12 Diagrammatic sectional illustration of negative impact of urban growth to *ksar* ecosystem.

Unfortunately, this phenomenon affected the traditional agricultural system of the oasis, which is a mixture of palm, grain, and horticultural cultivation, and practiced by farmers. In this delicate ecosystem, the relationship between the parts has a wonderful balance. Even though palm groves are the main part of *ksar* ecosystem, monocultural palm cultivation is not supported because it causes salinity in oases, product diversity and agro-biodiversity are one of the elements that provide the balance of this system. Worse than monocultural gardening, because of urban expansion and the increase in the need for land, many farmers prefer build houses in the oasis or sell their lands to foreigners for constructing touristic facilities.

The Timimoun palm grove is clearly suffering from a decline in the green cover and the groundwater level, and the extension of the *sabkha* that gradually feeds on the palm grove, in addition to the invasion of cement buildings. These developments led to several explanatory factors, and clearly raise the issue of sustainability, which is one of the foundational elements of the identity of the desert settlements. On the other hand, investors in tourism projects aimed to exploit the palm groves in the oasis due to their low prices and the natural landscapes that they provide (Figure 13).



Figure 13 New touristic buildings in old *Ksar* of Timimoun, (a) Side View (b) Top view.

5. Conclusion

The desert of Africa especially Sahara is one of the most occupied landscapes in the continent. With its common definition oasis, and the local traditional nucleic settlement type the *Ksar* - with its three components (*Foggara, Kasbah, Palm grove*)- constitute the original identity of this cultural landscape. Unfortunately, these cultural landscapes suffer from obvious threats and imbalances in their ecological system, which have persisted for centuries because of changes in the social, political, and economic systems.

This paper has studied the problem of the gradual decline of the oasis during the last thirty years and presented the reasons for this decrease around the oasis. The oasis ecosystem has remained a key factor in the human presence in Sahara and has preserved through interconnectedly balanced ecosystem the biological diversity and the provision of urban food and the availability of space for social interactions.

Our study showed the effects of population growth and unsustainable urbanization, which is not include the oasis ecosystem in its strategies, cause a real threat to the cultural natural landscapes in the region. It is necessary to take the oasis system within a clear urban strategy, considering it as an essential component of green infrastructure, which ensures its preservation and benefit from it environmentally, socially, and economically. The oasis is a real space and ecological memory carrier, the disappearance of the oasis certainly means the loss of social ecological memory knowledge.

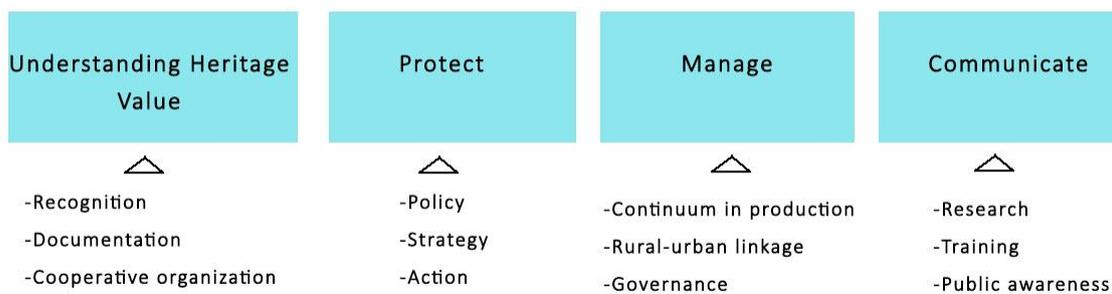


Figure 14 The operational action path for sustaining cultural landscapes (Adapted from ICOMOS, 2017).

Rural landscapes often provide distinct economic and tourism benefits when closely associated with the communication and enhancement of their heritage values (ICOMOS, 2017). We are in a period when the administrative authorities must act strategically for the continuity of the traditional cultural heritage areas that have survived to the present day in a whole of delicate balances interconnected to each other for thousands of years. What the study tried to do in this research was to reveal the threats put forward by ICOMOS-IFLA, which emphasizes the importance of preserving the rural landscape within the world cultural landscape heritages and draw a theoretical path for the action strategies against these threats for Timimoun's *Ksar* Ecosystem as a cultural landscape heritage (Figure 14).

The first step is understanding and recognizing the value of the heritage by making inventories and following changes over time. Second, as the study explain here; it is necessary to determine the potentials, pressures, and threats of the nominated cultural landscape and to develop a political strategy that considers the balance between conservation and use. In order to ensure the continuity of the cultural landscape, a management plan should be implemented, and innovative solutions should be developed for its relations with the city and contemporary life culture due to reinforced it against the pressures coming from tourism and urbanization. At the final stage, creating community awareness through participatory actions is necessary for supporting the transmission of the collective socio-ecological memory. This increases the spread of environmental illiteracy, which is a key factor in impeding all sustainable development strategies in urban settings and destroying cultural landscapes in this part of the world.

References

- Birks, H. H., Birks, H. J. B., Kaland, P. E., & Moe, D. (1988). *The cultural landscape: past, present and future*. Cambridge University Press.
- Bisson, J. (2003). *Mythes et réalités d'un désert convoité: le Sahara*. Editions L'Harmattan.
- De Dominicis, F. (2014). Landscapes of Desert Architecture and city around the Islamic Sahara. *L'architettura Delle Città-The Journal of the Scientific Society Ludovico Quaroni*, 2(3-4-5).
- Despois, J. (1959). L'Atlas saharien occidental d'Algérie: Ksouriens et Pasteurs. *Cah. Géogr. Québec*, 3, 403–415.
- ICOMOS. (2017). *ICOMOS-IFLA Principles Concerning Rural Landscapes as Heritage*.
- Laureano, P. (1987). Les ksour du sahara algerien: un exemple d'architecture globale. *Icomos Information*, 3, 24–35.
- Nofal, E. (2011). Towards Management and Preservation of Egyptian Cultural Landscape Sites—Case Study: Siwa Oasis. *Proceedings of the 5th International Congress "Science and Technology for the Safeguard of Cultural Heritage in the Mediterranean Basin"*, 1, 24–35.
- Otmame, T., & Kouzmine, Y. (2011). Timimoun, évolution et enjeux actuels d'une oasis saharienne algérienne. *Insaniyat/إنسانيات. Revue Algérienne d'anthropologie et de Sciences Sociales*, 51–52, 165–183.
- Petrosillo, I., Aretano, R., & Zurlini, G. (2015). Socioecological systems. *Encycl. Ecol*, 4, 419–425.
- Remini, B., Achour, B., & Albergel, J. (2011). Timimoun's *foggara* (Algeria): an heritage in danger. *Arabian Journal of Geosciences*, 4(3), 495–506. <https://doi.org/10.1007/s12517-010-0139-9>
- Rouani, M. C. (2017). L'architecture de terre et la permaculture, solutions pour une gestion intégrée et durable des Paysages Culturels sahariens. *Cas du Ksar de Timimoun. Aph a Elei*, 41, 117.
- Sadori, L., Mercuri, A. M., & Mariotti Lippi, M. (2010). Reconstructing past cultural landscape and human impact using pollen and plant macroremains. *Plant Biosystems*, 144(4), 940–951.

Resume

Dr. Chouaib Guerrou, he has two decades of experience in architecture, urban design and planning, received engineer degree in architecture from Bechar University, Algeria, in 2000. And master's degree in architecture from USTO Oran, Algeria, in 2017. He holds a Ph.D. degree in Ecological urban design from the Istanbul Okan University, Turkey, in 2021. His areas of research include ecological urbanism, sustainable architecture, mobility, transportation, water management, and heritage architecture.

Assist. Prof. Dr. Bahar Başer Kalyoncuoğlu is a landscape architect and academician. She had the bachelor degree from Department of Landscape Architecture at Istanbul University (1999) and MSc Degree from Landscape Planning Graduate Programme from Department of Urban and Regional Planning at Istanbul Technical University. Her Phd is also from ITU' Landscape Architecture Programme. Since 2002, she has been giving courses to the Architecture, Urban and Regional Planning, Landscape Architecture and Urban Design Departments, at ITU, Okan University and Medipol University in Istanbul, Turkey. Recently, she is an Assistant Professor and Department Chair at Istanbul Medipol University, Department of Urban Design and Landscape Architecture and has numerous publications on a variety of research areas such as urban landscape, urban ecology, urban agriculture, cultural landscapes, socio-ecological memory, green infrastructure, sustainable landscape planning.