

**TRANSFORMATION AND RESILIENCE PROCESSES IN MOUNTAIN OASES  
AT THE HIGH ATLAS (MOROCCO). THE CASE OF AÏT MRAU, MGOUN  
VALLEY**

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**Keywords:**

Oasis, territory, environmental fragility, ecosystem, cultural identity, water culture, vernacular heritage, earth architecture.

**Abstract:**

**Purpose**

This study aims to present the uniqueness of the mountain oasis at the High Atlas (Morocco), and is part of a more extensive study about the landscape, the architecture, and the tourist development in the Mgoun Valley. Several natural and anthropogenic factors, such as new environmental conditions and socio-cultural realities, are testing the balance of the system and its adaptive capacity. The study of the values of this territory and its transformation vectors constitute a first step for valuing this ecosystem and being able to establish management and conservation policies.

**Design/methodology/approach**

The research is based on the fieldwork carried out over six campaigns, between September 2011 and January 2020, when interviews to the local population and graphic and photographic records of the Aït Mraou oasis were carried out. The work started from the literature review and the study of the origin of the settlement, analyzing the transformation processes both in the cultivated plots and in the built habitat, where the urban evolution of the settlements and the characteristics of the architecture have been analysed.

**Findings**

The study has revealed the existence of social, environmental and economic imbalances that affect the status of the oasis, the landscape and the architecture of the study area. The research has characterized the habitat, and has identified those elements that must be preserved to guarantee the permanence of the heritage values in a way that the future development of the region was not conditioned.

**Originality/value**

The research delves into the study of a case that is paradigmatic in the context of the Moroccan High Atlas, since it shows the dynamics of transformation of a region directly affected by the climate change and by the abandonment of the traditional habitats.

### **Study area description**

The High Atlas is part of the great Atlas mountain range. It is located in the north of Africa, and with a length of more than two thousand kilometres, it reaches its highest altitude in Morocco, being the mount Toubkal (4,167 m) the highest summit. The fourth highest peak is the Ighil Mgoun (4,071 m), whose river system flows along the southern slope, generating the basin where it is located the study area of the present research.

The Mgoun Valley covers an area of around 140,000 ha, and is bounded to the south and east by the Dadès *oued* basin, from which is tributary; to the north, by the Aït Bouguemez Valley; and to the west, by the Hajjaj *oued* basin, which flows into Skoura. It is a medium and high mountain territory, separated from the Sahara Desert by the Jbel Saghro mountain massif.

The climate is highly variable, mainly due to the altitudinal difference up to 2,600 m between the lowest area, where the town of Kelaat M'Gouna is located (1,450 m), and the Ighil Mgoun summit. However, the territory is overall characterized by the low frequency of precipitation, the existence of semi-arid soils, and the presence of strong dry winds, which generates landscapes with scarce vegetation, usually herbaceous, xerophilic, or small shrubs. Climate ranges between the dry warm desert climate in the lowest parts of the valley, the dry cold steppe climate in the intermediate areas, and the "highland" or high mountain climate at the highest parts.

The summer is hot, and is even hotter by "a dry warm sandy wind, coming from the Sahara" (Nogueira et al., 2012, p. 547), known as *chergui* or *sharqi*, which affects the High Atlas Mountains. Up to 1,800 m, the zone where 90% of the population of the area lives, annual rainfalls do not usually exceed 300 mm, a threshold for classifying a climate as desert. This means that it is a territory below the level of evapotranspiration, with low humidity in the atmosphere, which is around 20% outside the oasis. Rainfalls often occur in the form of violent downpours, and water soon disappears by evaporation or by infiltration into the subsoil, which is unable to store it due to the lack of vegetation. However, in the highest areas of the valley, precipitation can exceed 400 mm per year, concentrated in winter, when temperature is below 0 °C, so it is usually solid (snow). The snowfalls are copious and snow remains for several months, serving as a reserve of water for warmer months, when it thaws. For this reason, the Mgoun *oued*, the main river that flows through this territory, with a length of just over 100 km, has an uninterrupted flow of water throughout the year.

These low rainfall levels, which are characteristic of a desert climate, allow us to get an idea of the value that water acquires in this territory. It becomes a precious asset that allows the development of mountain oases in the riverbeds, where human settlements are also located. Thus, the Mgoun River and its affluents support eighty villages, to which numerous nomadic settlements that still exist, mainly located in the middle and upper areas of the valley, must be added.

The extreme climatic conditions of this territory determine the way of life, and they characterized an ecosystem closely related and strongly dependent on water courses and oases, where agricultural productive areas are developed. These fertile lands only occupy 1% of the total area of the valley, and the settlements are concentrated next to them (Plate 1).



Plate 1

Oasis by the Imeskar Eттаhtani *duar* (2,113 m). Enclosed valley between mountains. Ait Ahmed *assif*. Source: Jorge Asencio Juncal (Sep. 2012)

### **The mountain oases in the Mgoun Valley**

On a large scale, the most unique image is the sharp contrast between the oases and the arid environment. A physical environment devoid of vegetation that gives even more value to the oasis, which by contrast, is presented as an explosion of life, endowing these landscapes with a special strength, beauty and identity. It is an anthropic territory, heavily man-made, built with earth, water and vegetation as the main elements of the habitat, which becomes into a cultural landscape on its own; an authentic melting pot of identity.

In this context, three key elements allow us to understand the genesis and historical development of the Mgoun Valley: the social structure, the management of water, and the multiple forms of land uses (Nogueira et al., 2016, p. 90). These three elements make up a territory of high cultural value where the most outstanding elements are the agricultural landscape associated with the exploitation of the oasis and the earthen architecture.

The first of these elements, the social structure, is organized into Berber clans of nomadic origin, which has shepherding activities as the main economic sustenance. These clans have lived in this territory for centuries and they have gradually settled in fertile areas of sedimentary origin along watercourses. This process of sedentariness of the clans has characterized the cultivated areas and they have obtained their main sustenance from them, by organizing the settlements in the riverbanks.

The second element that defines the genesis of the valley is a proper water management, which allows the development of agriculture in such an arid environment. Consequently, this landscape is the very expression of traditional and maximum water efficiency, due to limited water resources. In this place, the contrast between the life-giving power of water and the aridity of the surrounding territory is quite evident. In a soil devoid of vegetation that may help retaining water, the river basins are the only source of water, which not only comes from the snow melting at the high peaks of the Atlas in spring, but also from the typical torrential rains at the beginning of the summer. Within these basins, water slows down and silts and alluvial sediments rich in organic materials are deposited, which are necessary for agriculture. The catchment, transport and irrigation methods are

low-tech, and they use dams and complex networks of open ditches and canals. The presence of small pools indicates a great dependence on the flow of the channels, in the absence of larger storage infrastructures. The distribution of water by gravity inevitably conditions the location, layout and extent of irrigated areas, since it forces them to be placed next to the channels, organized in terraces and topographically below the ditches. Settlements are located in adjacent areas, immediately above the irrigation zone. As a result, a characteristic space combining social interaction and agricultural uses is created closely related with the productive area of the oasis. Historically, the anthropization has entirely depended on the availability and control of water, which has been the subject of age-old confrontations between different tribal groups.

Finally, the third key element for the understanding of the landscape in the Mgoun Valley is the earth, whose texture and colour are omnipresent in the territory. At a regional scale, the area is defined by a rugged naked orography with a continuous earthy chromaticism. At the urban scale, the earth also has a relevant role, since it is the main material of the rammed-earth walls and the adobe, which are constructive techniques that are used in the traditional construction of the houses. Therefore, the rural landscape, represented by walls and flat roofs, is nothing but an expression of the same earth extracted from the territory where the settlement is placed. The earth, the rocks and, to a lesser extent, the wood, constitute the triad of materials that characterize the settlement appearance. Not in vain, these materials are also used in roads, community spaces, ditches and cultivation terracing.

The orographic characteristics of the valley and the different degrees of accessibility, allow us to distinguish several areas or riverbeds that characterize the landscape of the Mgoun Valley (Plate 2). In the upper part of the riverbed, with higher slopes, the landscape units are enclosed, with small villages embedded into the steep slopes. This area has traditionally been the most isolated and inaccessible part, and, therefore, is where the least transformed habitats are located (Note 1). This is the case of El Mrabtin *duar* (2,200 m), a small village settled in the left bank of Mgoun *oued*. Imeskar Ettahani *duar*, Imeskar el Fouqani *duar* and Amejgag *duar* (Plates 1 and 3a-b), placed on the Aït Ahmed *assif*, are examples of areas where cultivated areas are limited to the river surroundings. In the middle riverbed, larger agricultural areas associated with more populated communities can be observed, although the habitat is still scattered. This is the case of the settlements within the Aït Toumert *assif* (Plate 3c), located in the westernmost sector of the basin; of Lhot, next to el Oati *assif* (Plate 4d); or of the Aït Mraou community, located next to Mgoun *oued*, which is the subject of study in this work. Finally, in the lower riverbed, the topography is flatter, the valley is more open and wide agricultural plains can be observed. This sector includes Hdida, Azrou and Kelaat M'Gouna (1,450 m) communities, located at the upper part of the valley, where the river flows into the Dadès *oued*, and next to the N-10 road. The tourist name of the road is the "Route of the Kasbahs", and it connects Ouarzazate and Errachidia. In this sector, the good communications with the rest of the region have eased the urban development and a greater tourist influence, so major transformations of the traditional territorial model have occurred, as it will be analysed below.

### **Transformation processes and imbalances**

Although the evolution of this habitat is continuous in time, it is necessary to establish two different periods for a better understanding. The first is the historical period, which includes the formation and development of this cultural landscape until recent times, whereas the second one identifies the processes of change and the new conditions of transformation that are taking place in recent decades.

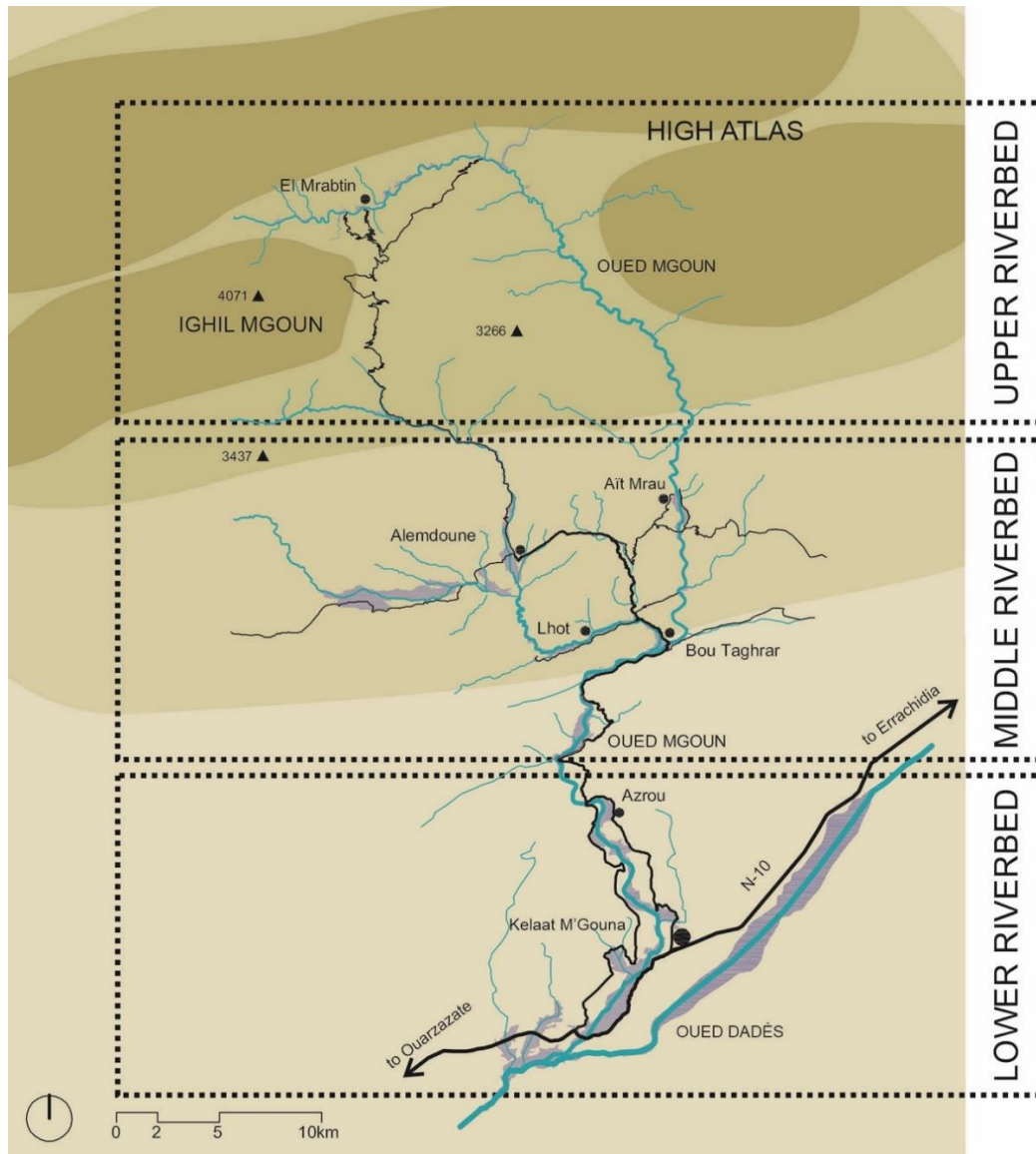


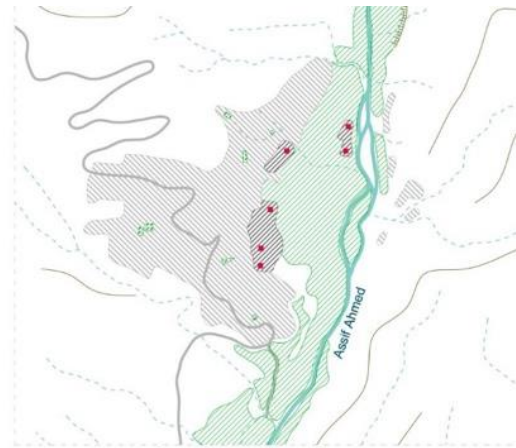
Plate 2  
Scheme of several riverbeds or homogeneous areas in Mgoun Valley

The evolution of settlements and the types of land uses have occurred in the past in a slow, gradual and organic manner, following internal balanced patterns in response to physical, environmental, and social factors, and they have been influenced by the low technological and economic capacity. The transformations "seem to have been adapted to the territory in a process of logical construction and 'negotiated' with natural dynamics" (Nogueira et al., 2012, p. 549). While these processes have had a decisive impact on the development of human settlements in the territory, they have generated a rich cultural landscape where heritage values are evident.

Plate 3 shows four of the villages analyzed in this study. If the current structure of the settlements is analysed, it can be observed how the riverbed is the articulating element of the oasis. The riverbed delimits the water course in summer, and it also indicates the floodplain during the torrential rains period. Above this area, there are agricultural lands, which may also be periodically flooded depending on the dynamics of rivers and watercourses of the basin.



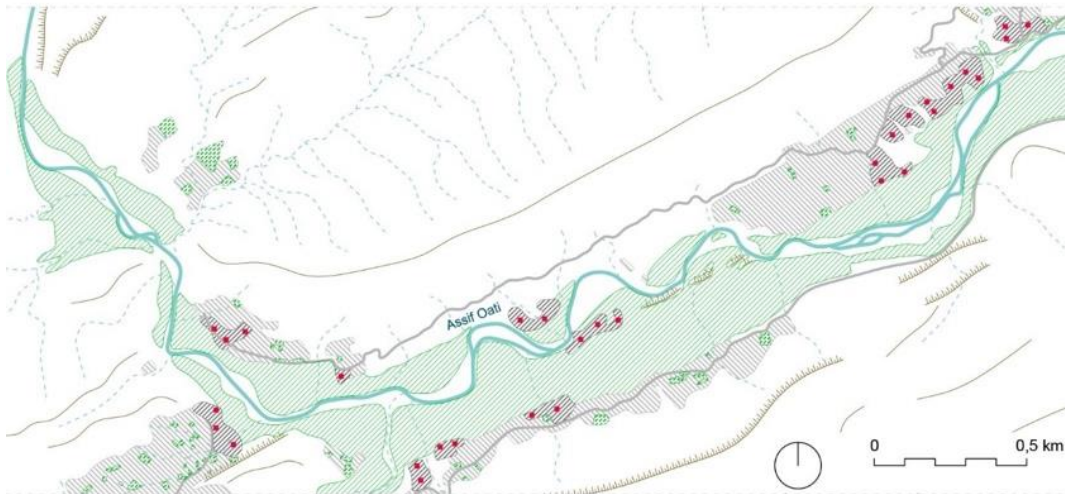
a. IMESKAR EL FOUQANI [Assif Aït Ahmed]



b. AMEJGAG [Assif Aït Ahmed]



c. AÏT TOURMET [Assif Aït Tourmet]



d. LHOT [Assif Oati]



Plate 3

Development of the settlements and organization of the cultivation lands in Mgoun Valley

The foundational cores built next to the original fortified houses, called *tighrematin* (s. *tighremt*) in Berber, or *Kasbahs* (s. *kasbah*) in Arabic (Plate 4) have been highlighted in the map. These buildings are built in earth and they have a square floor plan and four towers in the corners. Around these older compact cores, the new urban growths are organized with a more scattered character, adapting their shapes to the topographic conditions (Plate 5). In this context, it is also noted the presence of agricultural areas outside the oasis, enhanced by the construction of water tanks in the nearby hills, which are fed with pumps that take water from the river.

The urban area is perfectly separated of the agricultural lands. The buildings never occupy the farmland, nor the first fortified houses of the foundational cores, neither the later buildings that compound the present-day villages and occupy the hills or the high plains.

The comprehensive model of the oasis presents a productive and housing ecosystem that preserves the environmental coherence and the authenticity of these landscapes, which has remained mostly unchanged since its creation several centuries ago. However, at present, a number of natural and anthropogenic factors affect the traditional culture, the environmental conditions of the oasis and its social identity. These factors are analysed below, since they are producing alterations in lifestyles, becoming the main drivers of change in the society. Their main consequence is "the loss of traditional values and customs, imposing a new way of understanding the relationship with the environment" (López-Osorio and Asencio, 2018, p. 426).

All these factors challenge the resilience of this territory, which is reaching the limit of its sustainability, so external factors can destroy it or undermine its values. Today, the Mgoun Valley presents a fragile balance that can have irreparable consequences and that deserves further study and attention.

#### *Agents of natural transformation*

Natural factors are a powerful agent of transformation in a territory that has historically tested the viability of settlements and agricultural and livestock activities. Natural processes and hydrology are determining factors in the study area.

The Mgoun Valley is a territory transformed and influenced by anthropogenic factors. The river, which is the source of life and support for the communities, can also become a tough adversary to fight against. Although water is necessary for the development of the oasis, and is the essence of this agricultural-based culture, it can also be the cause of its disappearance due to torrential rains, since they are capable of flooding and razing the cultivation plots (Plate 6). The spring rainfalls, together with the melting snow from the Mgoun high peaks, generate large waterflows that occupy the floodplains and raze the agricultural lands. This natural phenomenon tests the resilience of the system, destroying part of the oasis, which is an artificial space that needs many years of organization and planning. The reversal of the damage implies an important contribution of time and energy for the inhabitants, and it also implies an important economic effort in a territory based on a subsistence economy. A detailed study of the degree of destruction of these natural phenomena will be later documented, when we address the particular study of the Ait Mraoua oasis.



Plate 4

Fortified house (*tighremt*) in Lhot *duar*, Oati *assif*. Source: Jorge Asencio Juncal (Dec. 2016)



Plate 5

Next to the the traditional compact habitat, new forms of urban sprawl start to appear. Lhot *duar*, Oati *assif*. Source: Jorge Asencio Juncal (Dec. 2016)



Plate 6

Comparative image of the Ait Mrau oasis before and after the torrential rains in 2015, Mgoun *oued*. Above photo. Source: Pedro García Sáez (Sep. 2011). Below photo. Source: Jorge Asencio Juncal (Apr. 2015)

Other natural factors that also determine the oasis balance are more recent. Climate change, which currently affects the entire planet, is particularly threatening in a territory like this. According to the data under consideration, the scientific community (Intergovernmental Panel on Climate Change, IPCC. <https://www.ipcc.ch/>) estimates that, at a world scale, the temperature will rise around 3 °C by the end of the century, which is a significant modification of the climate (Note 2). This will lead to increasingly frequent and long-lasting drought seasons and to the disappearance of vulnerable vegetation. According to Miranzo and del Río (2015, p. 33), in Morocco, "a progressive increase in temperatures, both during summer and winter, a greater decrease and a seasonal concentration of precipitation, and an increase in the frequency of extreme atmospheric events" are being observed, which emphasize the extreme aridity and increase the scarcity of water resources. The nearby desert and its pressure is a latent threat.

The Food and Agriculture Organization of the United Nations (FAO) establishes a classification of GIAHS (Globally Important Agricultural Heritage Systems), defining them as aesthetically stunning landscapes that combine agricultural biodiversity with resilient ecosystems, and a valuable cultural heritage (Note 3). In Morocco, this classification includes the Eastern High Atlas region, adjacent to the Mgoun Valley, which share similar characteristics. Therefore, it is recognised as an agricultural system threatened by various factors "including climate change and increasing pressure on natural resources".

#### *Agents of anthropogenic transformation*

In recent decades, especially since the independence of Morocco in 1956, new factors are emerging, mainly of an economic and social nature. These factors are leading changes at a quick pace, and they entail "a deeper change than any at the previous four centuries" (Mimó, 1996, p. 80). Various endogenous and exogenous factors are causing changes in the organization of the territory. Among them, it can be highlight "the establishment and forced sedentarization of tribes, the increase in the quantitative and qualitative needs of the

population after the demographic explosion, the exodus, the national and international migration, the opening to the outside (money, media, greater urbanization, etc.) and the succession of longer drought periods" (Aït Hamza, 2002, p. 3). Other factors that play a crucial role in these dynamics of change, which affect the transformation of the cultural values of the area, are "the important tourist development that has taken place in recent decades" (Asencio Juncal et al., 2020, p. 334), "the presence of economic production structures of an implicitly Europeanised State" (AA.VV., 1998, p. 30), and "the schooling, the television and the development of communication infrastructures" (Pézelet, 1996, p. 133). All these factors, which in some cases imply an upgrade in the quality of life, are joined to transformations that result in the improvement of the habitat, such as the need of better hygienic conditions, services (drainage, electricity, and water), the accessibility, larger spaces, the reduction of maintenance work, etc. However, these aspects mean the abandonment of traditional urban structures and buildings of heritage value, and thus, their consequent destruction.

As Faissal Cherradi states in the prologue of the book about the Skoura oasis (Soriano, 2006, p. 9), "the transformations in Berber society have substantially changed the traditional way of life and the characteristics of its habitat, superimposing, without a break, a modern economy society". Therefore, it is necessary to assess the effects of these pressures, which can be simultaneously considered as positive and negative. Among the positives, the contact with the outside world can be an important way of modernisation, learning and cultural exchange; among the negatives, the adverse aspects of globalization and the processes of cultural uprooting are producing the irreparable loss of local identity and of the material and immaterial values of the traditional habitat (Plate 7). "The abandonment of the *ksar* and *tighremt* due to the limitations of habitability and the loss of prestige of earthen architecture brought with them a transformation process in architecture which materialized as a change of typology and the use of new construction materials" (Asencio Juncal et al., 2020, p. 725).



Plate 7

Deterioration of the urban environment next to the Tighremt Ait Aitcha, Bou Taghrar. Source: Jorge Asencio Juncal (Apr. 2015)

In architecture, global processes involve the introduction of foreign models that break the laws of traditional physical and social construction, which "is putting at risk the

survival of pre-existing types and landscapes already described" (Nogueira et al., 2012, p. 547). In the Mgoun Valley, as in the rest of the pre-Saharan valleys of the High Atlas, the phenomena of change affect the territory and the society that lives a "historical fault, a moment of displacement between tradition and modernity, identity and globalization" (Nogueira et al., 2016, p. 88).

### **The Aït Mrau oasis**

The analyzed agents of transformation trigger a series of tangible transformations, both in the urban and in the architectural scale, that are represented by new developments and by the use of new construction materials, which are altering both the spatial organization and the structure of the settlements, as well as the physiognomy and the final appearance of the villages.

In order to delve into the study of the evolution of the habitat and the urban form of the villages of the valley, a specific study of the Aït Mrau oasis (1,700 m) has been carried out. The Aït Mrau oasis is a community located in the Mgoun middle riverbed, where the orography is not very steep. It is a transition area between the plains at the low riverbed of the valley, and the large geological formations at the high riverbed. The oasis and the villages are built on the wide area after the river flows through the Achabou Gorges.

Its name comes from the union of the Berber prefix *Aït*, which means "son of" and the Berber word *Mrau*, which means "ten". Originally, the community was founded by ten nomadic families who decided to settle in this area in the first decades of the nineteenth century. The foundational core, called Ighrem Aqdim, was created with the construction of eleven *tighrematin* that represented the social and economic prestige of the founding families, and was funded with the money obtained from their herds and flocks. Currently, the community is formed by eight *duars*, seven of them placed on the left bank of the river (Imi N-Ouaqqa, Isusuk, Timerdan, Ighrem Aqdim, Tizguine y Tabarkhoub), and one on the right bank (Issoumar). Administratively, the Aït Mrau community belongs to the Kelaat M'Gouna municipality (López-Osorio et al., 2018, p. 165).

### *Genesis and evolution*

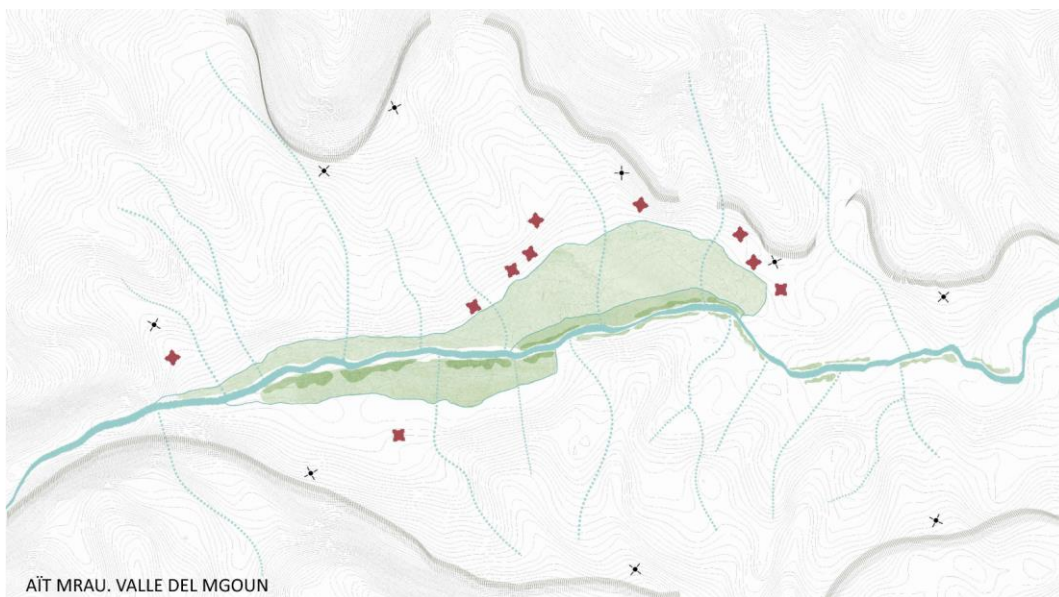
The history of Aït Mrau is similar to the history of most of the mountain oases in the Moroccan High Atlas. In prehistory, this territory was rich in natural resources, which allowed nomadism, with shepherding as the main activity. Progressively, the environment evolved towards a more arid scenario, which would encourage the process of sedentarization and, therefore, the formation of oases.

In the Mgoun Valley, the permanent water in the main river and its tributaries ease the existence of nomadic settlements on the slopes of the mountain and in the surroundings of the river basins, either by digging caves in the rock (*ifrane*) or by the construction of small rock constructions (*izghi* and *afergane*) (Plate 8. Stage 1). This would be the initial state of the site until the process of sedentarization begins with the construction of the first irrigation ditches and farming areas. The first fortified houses were built next to those areas, which served to protect families, food and crops from the attacks of other tribal groups. (Plate 8. Stage 2).

The increase in population and the lower need of protection due to the negotiation with the nomadic tribes implies the construction of new houses and buildings around the fortified houses. They had one or two floors, but always with less relevance than the fortified houses and with a simpler spatial organization. The *tighremt* continued having a symbolic function and served as a refuge in case of attack, since this foundational core was rarely gathered or walled (Note 4). Because of the population growth, the hydraulic structure becomes more complex and the size of the oasis increases for supplying agricultural products (Plate 9. Stage 3).



STAGE 1. River course and pre-existing nomadic settlements



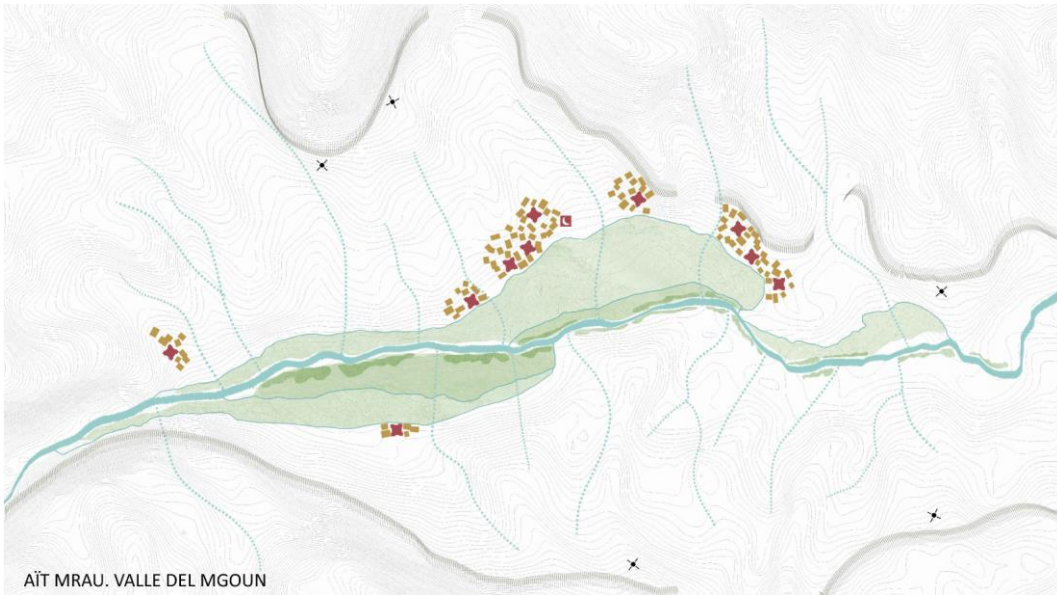
STAGE 2. Construction of irrigation ditches, oasis development and first settlements



PHYSICAL ENVIRONMENT / CULTIVATION AREA	VILLAGE	EQUIPMENT
Rock ledge	Nomadic refuge ( <i>ifrane-izghis</i> )	Small earth mosque
River course	Fortified house ( <i>tighremt</i> )	New concrete mosque
Watercourse	Traditional earth house	Water tank and distribution network
Irrigation ditches	New earth houses	High voltage electricity network
Cultivation plots	New concrete houses	Telecommunications repeater
Private orchards and gardens	New plots	Tourist accommodation

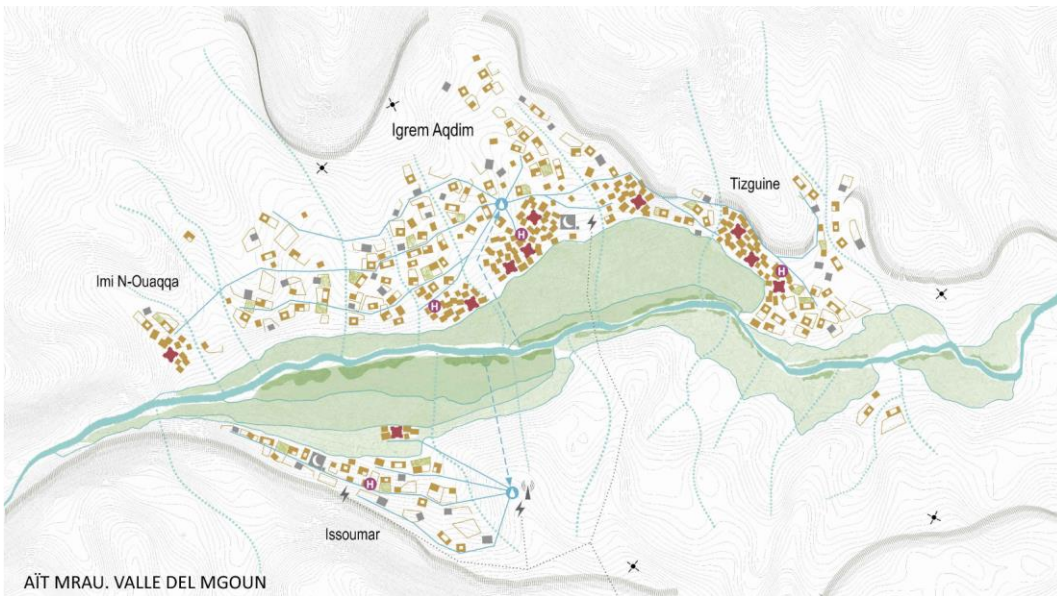
Plate 8

Theoretical evolution of the oasis. Stages 1 and 2. Ait Mrau, Mgon *oued*. Source: own development



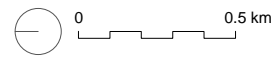
AÏT MRAOU. VALLE DEL MGOUN

STAGE 3. First extensions of the cultivation areas and delineation of the urban core



AÏT MRAOU. VALLE DEL MGOUN

STAGES 4-5. Final status of the oasis with the construction of equipment and infrastructures



PHYSICAL ENVIRONMENT / CULTIVATION AREA	VILLAGE	EQUIPMENT
Rock ledge	Nomadic refuge ( <i>ifrane-izghis</i> )	Small earth mosque
River course	Fortified house ( <i>tighremt</i> )	New concrete mosque
Watercourse	Traditional earth house	Water tank and distribution network
Irrigation ditches	New earth houses	High voltage electricity network
Cultivation plots	New concrete houses	Telecommunications repeater
Private orchards and gardens	New plots	Tourist accomodation

Plate 9

Theoretical evolution of the oasis. Stages 3, and stages 4-5. Ait Mraou, Mgoun *oued*. Source: own development



- |   |  |
|---|--|
| 1. Reinforced concrete Mosque and minaret | 5. Concrete garage                           |
| 2. Traditional earth house                | 6. Wood stacking as the main source of heat  |
| 3. Fortified house ( <i>tighremt</i> )    | 7. Protection against floods in watercourses |
| 4. Reinforced concrete water trunk        | 8. Fencing of plots of new urban areas       |

#### Plate 10

Panoramic view of Ighrem Aqdim, Aït Mrau, Mgoun *oued*. Source: Jorge Asencio Juncal (Sep. 2012)

The next evolution stage is related with the creation of new dams at higher levels of the riverbed, which allowed to increase the altitude of the ditches and to irrigate empty lands. This is the stage in which the feeling of collectivity become stronger and the villages are consolidated. Although they are sort of compact, they continue maintaining a certain autonomy (Plate 9. Stage 4). This collective feeling would be reinforced by the construction of the first community buildings, mosques and the organization of cemeteries, so the Aït Mrau oasis reaches its greater extent. The *duares*, always located outside the productive areas, occupy the slopes and only the ravines or watercourses determine the random pattern they follow. In relation to the built habitat, the transformation processes are adapted, in a balanced way, to the available resources in the territory. The houses are built in earth. They have compact volumes, usually with two floors, and fill the open spaces between the existing buildings. The result is a landscape with a very homogeneous and practically continuous materiality, where the buildings, the rammed-earth walls of the courtyards or corrals, and the paths, have the same texture and color of the land where they are located.

Finally, in the last decades of the twentieth century and in the first decades of the twenty-first century, there are important quantitative and qualitative changes of the villages, all due to the aforementioned agents (i.e. emigration, tourism, new accesses, etc.). The demographic growth causes the expansion of the urban system and the emergence of new infrastructures and equipment: state schools and administrative buildings (Plate 9. Stage 5). The improvement of the communication networks drives the arrival of new materials, such as cement and steel, that allow the construction of houses in reinforced concrete structures and prefabricated blocks, although earth is still used in the scattered

urban sprawl. The ancient *tighrematin* and the foundational cores are progressively abandoned, which is the beginning of its end.

In the case of the equipment, the tendency is to replace the old earthen mosques of the *duares* by new concrete buildings, which allow larger constructions with greater significance, especially for minaret (Plate 10). Thus, the urban landscape, traditionally characterized by the corner towers of the *tighrematin*, is modified. New infrastructures are also emerging, such as water reservoirs that allow housing supply and cultivation of plots outside the oasis. Likewise, this stage coincides with the greatest tourist development, so some commercial establishments are also created.

#### *The agricultural activity and the irrigation system*

The formation of the oasis is only possible thanks to an optimal management of the available water, which is based on irrigation techniques such as channel and irrigation ditches networks. The water distribution by gravity organizes and shapes the oasis. For cultivation in slopes, a terracing system is built, formed by small retaining stone walls. The irrigated area is fragmented into small plots. It is a smallholder system where each family owns one or more plots, intended for self-consumption. Agricultural production is organized through a crop rotation system that integrates both vegetables, cereals and fruits for people and pasture for livestock. If there is surplus production, it is sold or bartered by other products. It is common to observe the subdivision of plots into several quadrants or grids with different crops. This ensures the variety of products and allows crops to be staggered according to the season and the family needs. In the Mgoun Valley, the tradition of growing Damascene rose on the edges of the plots is also maintained. This allows an extra income to the family, since the flower will serve as a basis for manufacturing different cosmetic products, such as the cherished rose water. For this reason, the valley is also known as "Valley of the Roses".

The size of the plots is very variable. In the Aït Mrau oasis, they range between 100 and 2,000 m<sup>2</sup>, and the average is around 250 m<sup>2</sup>. The area of arable land for each family, in either number or size of plots, depends on the number of family members. It is common that as the population grows, so does the area of arable land, for which it is necessary to build higher ditches to take water to higher altitudes, which leads to raise new dams above the existing ones. In these cases, the structure of the irrigation network tends to become more complex. A typical example of this extension is found in the Issoumar *duar* (Aït Mrau), where the foundational urban core was bordering the main ditch, devoted to rainfed land. "Later, when trying to extend the area of the oasis, a new irrigation ditch made possible an extension of the arable area" (García-Ramos et al., 2012, p. 519), leaving the *tighrematins* in an elevated area surrounded by the new cultivated plots.

#### *Recent transformations*

With the aim of studying the recent evolution of the oasis, fieldwork and analysis of aerial images of 2007, 2015 and 2018 have been carried out. Those images show both the changes produced in the cultivation plots and the urban evolution of the built habitat (Plate 11).

In the arable area, the information has a special relevance, since it shows the devastation produced in the spring 2015 because of the Mgoun *oued* swelling, which destroyed much of the cultivated plots. The swelling deposited a thick layer of sediment and alluvial material, a natural phenomenon that already occurred twenty years ago, after the floods in 1995.

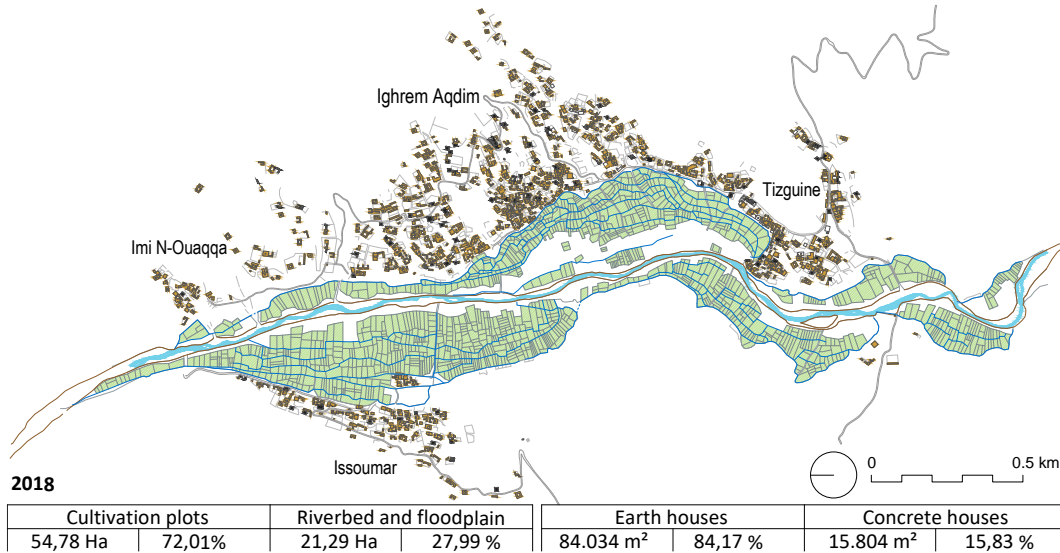
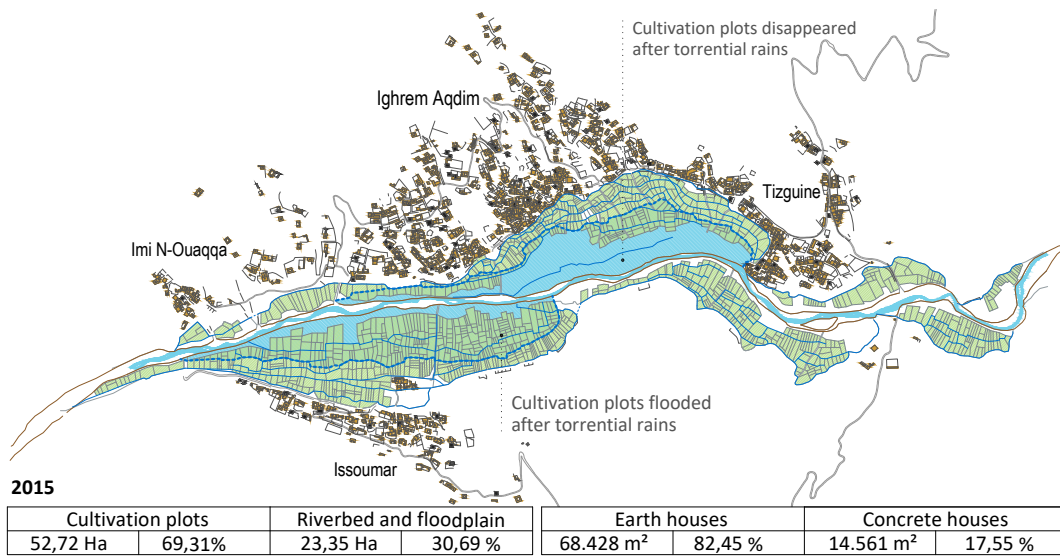
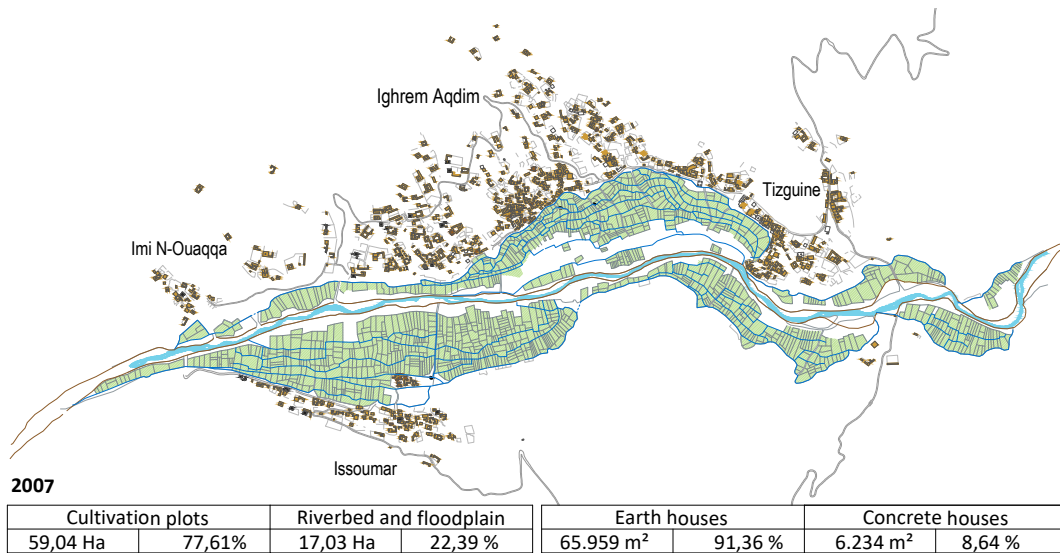


Plate 11  
 Evolution of cultivation areas and urban evolution (buildings made in earth and concrete) in 2007, 2015 and 2018. Ait Mrau, Mgoun *oued*. Source: own development

The recovery of the oasis was carried out by the families themselves through a laborious technique that consists of digging deep wells, until they reach the materials below the level of the old cultivated land, where the new alluvial material has been deposited. During this process, the buried fertile soil layer is extracted and raised, in order to recover the original structure of the oasis and the original boundaries of the plots (Plate 12). In Aït Mrau, these works were manually carried out and involved a great community effort to restore the land structure, the road network and the irrigation ditches.



Plate 12

Above photo: Oasis status in the Agarzaka *duar* (Mgoun *oued*), after torrential rains. The beginning of the recovery process. Alluvial sediments can be observed in the plot boundaries. Below photo: The beginning of the recovery process of cultivation areas in the oasis. Ighrem Aqdim *duar* (Aït Mrau, Mgoun *oued*). Source: Jorge Asencio Juncal (Apr. 2015)

The record taken in 2007 (Plate 11) shows the state of the oasis before the swelling, while the second record is taken in April 2015, immediately after the swelling, and when the recovery of the plots had already begun. The latest record, in 2018, shows the recent state of the oasis, which was not fully recovered since some of the plots were still under the thick layer of alluvial material.

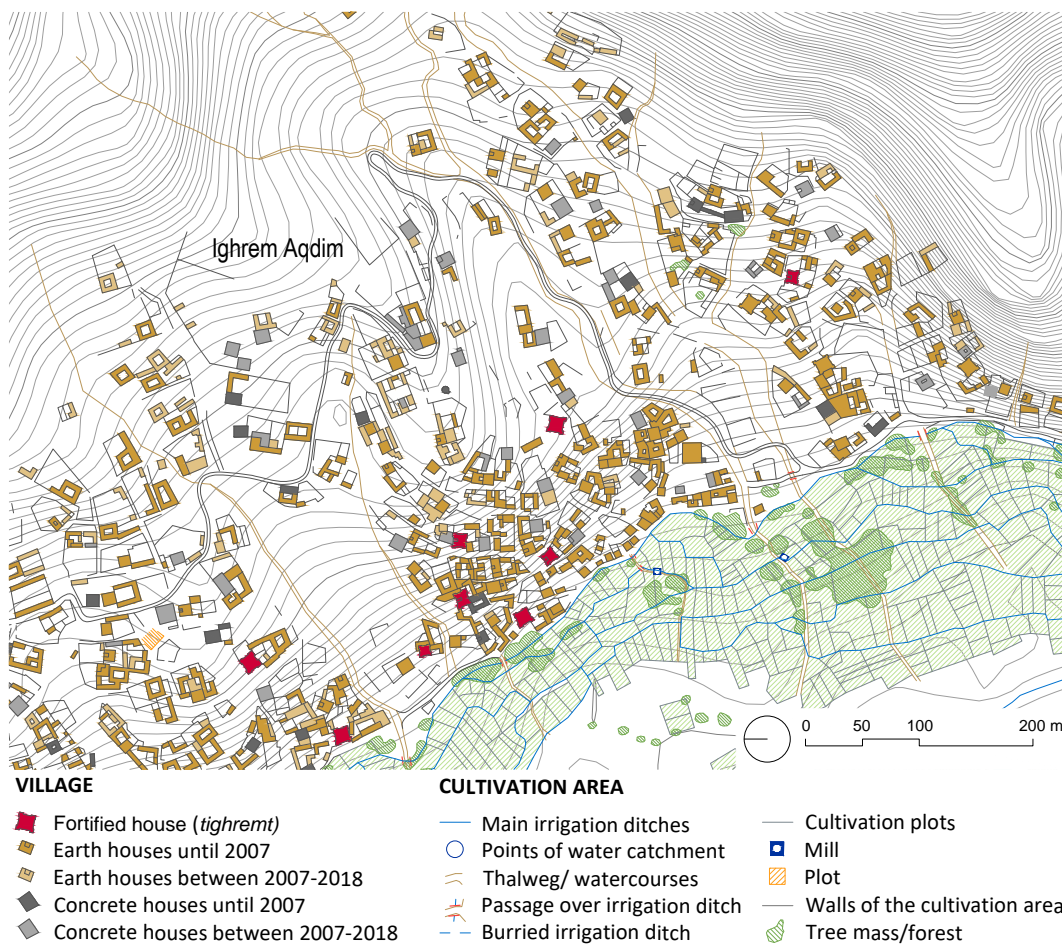


Plate 13  
 New areas in Ighrem Aqdim *duar* (Ait Mrau, Mgoun *oued*). Above image. Source: David Navarro García (Apr. 2015)

The 2007 record shows that in the central area there were some non-cultivated areas, perhaps as a result of the previous flood. The 2015 record displays both the crop plots that disappeared after the swelling and those that only were flooded. An analysis of the data collected during this period shows that 8.3% of the area under cultivation has disappeared (from 59.04 ha to 52.72 ha). The swelling also flooded more than 35 ha, which is a 60% of the total area of the oasis. However, this area was restored for cultivation during that season. The 2018 record displays the partial recovery of the oasis (54.78 ha of cultivated land), which is still below the cultivated area before the swelling. These data show the destruction capacity of this type of events, and the slow pace of the restitution process. These periodic events alters the fragile balance that exists in the Aït Mraou oasis, which is based on a subsistence economy. It also provides and insight of the difficulties that it can entail for the population, since agricultural production is one of its main economic mainstay.

The study of the urban evolution also shows changes in the habitat between 2007, 2015 and 2018 (Plate 11). The figure shows the buildings of Imi N-Ouaqqa, Isusuk, Timerdan, Ighrem Aqdim, Tizguine and Issoumar *duars*. In the case of the formers, all of them located on the left bank of the Mgoun *oued*, there is a tendency to blurring its boundaries. Currently, they are practically connected. The study also considers the differences between the earth and concrete buildings, providing the data of the constructed areas and the respective percentages for each material. Plate 13 provides a photograph taken from the hill where the water tank is located, and a detailed map of the Ighrem Aqdim *duar*, where all the elements of the system are mapped. It also indicates both the date of construction of the buildings and the construction technique, as well as the anthropic and natural elements that form the oasis (i.e. irrigation ditches, water catchment points, watercourses, cultivation plots, mills, plots, etc.).

The analysis of the data shows that in 2007 the houses occupied 72,193 m<sup>2</sup>, that increased to 82,989 m<sup>2</sup> in 2015 (an increase of 10,796 m<sup>2</sup>), which means a 15% rise of the building surface. A 76.3% of this rise belonged to concrete houses, which doubled the area they cover in eight years. When analyzing the construction of houses between 2015 and 2018, it is observed that there is a greater urban development in a shorter period. The area occupied by houses increased from 82,989 m<sup>2</sup> to 99,838 m<sup>2</sup> (increase of 16,849 m<sup>2</sup>), which means a 20% increase of the built area; although in this period construction in earth was 92.6% of the new constructions (15,606 m<sup>2</sup>). These data are extraordinary valuable, since, although it is noted that concrete construction has been strongly used in recent years, construction in earth and traditional techniques is still present and it has an increasing tendency (Note 5).

The detailed analysis of the graphical information also highlight that the urban growth in recent years has been located on the slopes. This model is a scattered low-density urban development model, with large plots located on the periphery of the urban cores, and it has a more porous urban fabric. The dominant, and relatively recent, building type is characterized by single-storey houses formed by four corridors arranged around an open big courtyard (Plate 14). The rammed-earth walls, the wooden slabs and the earth roof with a cane eave are built following the common techniques and materials of the region. When the houses are built in concrete, they are compact blocks with two or three floors, and without having a courtyard. These buildings are constructed both inside the urban cores and in the peripheries, and they are often built during different stages, since they are funded by the remittances of emigrants. Thus, the construction usually takes several years (Plate 15). When the exterior enclosure is completed and they are protected from water, they are covered with mortar, so the gray color of the cement remains for some years until the house is definitely occupied, and they are then painted with earthy or pink colors. Sometimes, the new concrete houses are vertical extension of earth houses, which are previously strengthen with reinforced concrete pillars (Plate 16).



Plate 14  
New house in Aifar *duar*, Mgoun *oued*. Source: Jorge Asencio Juncal (Jan. 2020)



Plate 15  
Evolution of housing in Znag *duar*, Oati *oued*. Source: Jorge Asencio Juncal (Dec. 2016)



Plate 16

Construction of a new upper floor with a reinforced concrete structure. Ighrem Aqdim *duar* (Aït Mrau, Mgoun *oued*). Source: Jorge Asencio Juncal (Jul. 2016)

This new urban style contrasts with the original urban cores, which are more compact and where the presence of fortified houses is prominent. However, it may be considered that if the population growth continues following the current tendency, these new, more porous developments will eventually become denser, since steep slopes and rocky walls limit the area of expansion.

The specific study of the urban development indicates that the community is in full urban growth, although the area of the cultivated plots has not been extended during the analyzed period. This suggests that economic resources come from sources other than agriculture and that family incomes are no longer exclusively dependent on the oasis cultivation. This hypothesis has been confirmed by means of interviews with the inhabitants (Note 6), who report that the incomes for the construction or renovation of many houses mainly come from remittances from emigration and tourism.

Another important fact indicated by the analyses is that the greatest amount of houses built during the analyzed period belong to the settlements located on the left bank, which includes most of the new concrete houses. On the other hand, the development in Issoumar, located on the right bank, is more limited. This is due to the significant difference in the proximity of the *duars* to the nearest big town, since the Mgoun *oued* is an insurmountable barrier during most of the year, and there is any bridge that allows to cross it. Thus, the villages on the left bank of the river are communicated to the east by a 17 km dirt track with Aït Youl, in the Dadès *oued* basin. In the case of the Mgoun *oued* right bank, the distance is longer, since it is necessary to cross a winding 7 km dirt track that, after crossing the Znag *assif*, it is connected with the main road of the Mgoun Valley, a 35 km paved road that leads to Kelaat M'Gouna. This access is longer and more difficult, at least in its initial stretch.

Finally, another aspect that should be evaluated is the transformation of the spatial occupation patterns produced by the large plots located in the perimeters of the settlements. The house, whether of earth or concrete, is built inside the plot that is walled by a rammed-earth wall adapted to the topography. The phenomenon, regardless of the visual impact or landscape effect, has an important environmental effect, since inside the plot, new irrigation areas are frequently implemented and fed by water from private wells or large concrete deposits. This new model allows to cultivate above the altitude of the ditch and, thus, to occupy traditional empty lands. The phenomenon represents a significant modification of the ecosystem, since it has serious alterations in the water table and can lead to overexploitation of the aquifer, with the consequent impact over the sustainable and rational maintenance of the oasis.

## Conclusions

The study carried out in the Aït Mraou oasis has allowed to know the genesis and the processes of natural and anthropogenic transformation occurred in this community, which, overall, can be extrapolated to other oases in the Mgoun Valley as well as to other valleys in the High Atlas that are affected by the same agents of change.

The first consideration is that the recognition of the heritage values of mountain oases is based on the interaction between an extremely arid physical environment, a natural environment anthropized by the creation of cultivation areas, and the development of the settlements that form the urban centres. The balance of these elements constitutes the true value of this habitat, which acquires the dimension of cultural landscape in its broadest sense.

For some years now, international recommendations and regulations (Note 7) have begun to pick up the concept "spirit of the place", defined as the sum of tangible and intangible values that grant meaning, value, emotion and mystery to a place. Likewise, it has been encouraged so that, especially in traditional societies, these values must be safeguarded to guarantee sustainable and social development. To this aim, it is necessary to identify their threats, such as climate change, mass tourism or urban development.

In this context, and following the recommendations of various organizations that recognize the cultural value of the agricultural landscapes, oasis systems and water-related heritage (Note 8), the analysis of the transformation processes and the identification of certain imbalances are particularly interesting in order to check the resilience of the system, given its fragile equilibrium, placed at the limit of its sustainability and dependent on water as the most valuable resource.

In the cultivation areas, a number of natural hazards have been identified, such as periodic floods that force people to invest a lot of effort and time in the recovery of the plots. Likewise, uncontrolled exploitation of the aquifer is taking place, due to the creation of public or private wells that pump water above the altitude of the ditches with the aim of developing irrigated plots outside the original boundaries of the oasis, which consequently damage the environment and the landscape. In the current context, the loss of a balanced agricultural activity and the traditional water culture not only threatens the territorial identity, but also represents a serious risk to the conservation of the ecosystem itself.

The villages are witnessing the destruction of the old fortified houses built in earth, which lack of effective legal protection status, and their replacement by new buildings in accordance with current living conditions. In the first developments, the new homes were still built in earth, but for several decades on, they are built in concrete, which means a higher economic and environmental cost and lower energy efficiency than traditional construction. However, the use of this material represents a higher social prestige. On the other hand, an encouraging data obtained in this research indicates the permanence of the rammed-earth wall technique in the Mgoun Valley, and, under some circumstances, the tendency to partially construct the new houses by using earth, which is the most economic and ecological available material, and it also has an optimal thermal performance in extreme weather conditions.

The conservation of the landscape, and the traditions that can overcome the advance of globalization, supposes an important boost to the tourism, one of the activities with greater future projection in the region and whose optimal development should be made following sustainability criteria. The key aspect is to understand the elements of identity and the endogenous cultural reasons in order to avoid their loss, as well as to assess their capacity to evolve and adapt to the new times. In a territory forgotten by investments, whether public or private, the economic and social improvements that can occur with the arrival of the tourism must revert to the local population, and to the balanced maintenance of a traditional ecosystem model that depends on itself. The landscape, the architecture and the environmental balance, which in some way constitute both the attraction for the visitor and the reasons that give meaning to the population to keep on living in these arid mountains, cannot be destroyed.

## Acknowledgements

This work began as part of the project "Landscape and Heritage in Southern Morocco: Proposal for the development of models of responsible tourism (AP/050921/11), Inter-university Cooperation Program of the Spanish Agency for International Development Cooperation (AECID).

The research is also related to the R&D&i project "RISK-Terra. Earth architecture in the Iberian Peninsula: study of natural, social and anthropic hazards, and management and resilience-building strategies" (RTI2018-095302-B-I00), funded by the Spanish Ministry of Science, Innovation and Universities.

We would like to thank the students and professors who participated in the University Volunteer Program in International Cooperation of the University of Málaga and all the inhabitants of the Aït Mrau community who were interviewed during this research. We also thank Faïssal Cherradi, architect of the Ministry of Culture of the Government of Morocco, and Roger Mimó, Catalan writer and tourist agent who lives in Morocco.

## Notes

1. In 2010, construction began on a paved road which is currently being completed and which allows the highest parts of the Mgoun Valley to be connected to the Aït Bouguemez Valley via the Tizi-n-Ait Ahmed mountain pass (2,910 m), located on the northern slope of the High Atlas. This new infrastructure will improve the access to basic services for the inhabitants of the villages located in the upper valley. However, it will also involve the transformation of a unique high-mountain landscape with a high environmental and cultural value, which is now the natural habitat of nomadic shepherds who have been occupying this territory for several centuries.

2. According to the Andalusian Climate Change Portal, the south of Morocco, like the south of the Iberian Peninsula, are considered to be particularly vulnerable to climate change.

3. GIAHS is a category, in relation to the preservation of heritage, granted by FAO, to communities closely related to their territory, which have a specific culture, agricultural system and physical and social environment.

In the case of the High Atlas of Morocco, it is characterized by the existence of "local communities having to cope with extreme climatic conditions to survive. Despite the scarce water resources, farmers have succeeded in creating adapted systems not only to get food but also to get all the necessary products to survive in this area. Far from the cities, these communities are mostly self-sufficient to afford their needs and have kept their main cultural traits".

<http://www.fao.org/giahs/es/>

4. In the pre-Saharan valleys of southern Morocco, it is common to find fortified settlements, called *ksour* (s. *ksar*), which respond to an urban grid structure surrounded by a perimetral wall, with protection towers on the flanks and at the corners, and with a single access door.

5. In the Aït Mrau community, the rammed-earth construction technique is still present and is used for the construction of houses, as described by López-Osorio et al. (2012).

6. Interviews have been carried out with local population and with tourist agents (tourist guides, owners or managers of tourist accommodations, etc.) in six work campaigns, from September 2011 to the most recent one, in January 2020.

7. Declarations, Recommendations, Meetings and Forums of the UNESCO and the ICOMOS. Special mention should be made to the “Declaration on the preservation of the spirit of the place”, Quebec (2008).

8. The publications on oasis systems on the World Heritage List, the ICOMOS documents on water as cultural heritage, and the Charter of Baeza on Agrarian Heritage should be noted:

<https://whc.unesco.org/en/documents/1279>

<https://whc.unesco.org/en/review/59/>

[https://www.icomos.org/18thapril/2011/18April\\_2011\\_STamwoy\\_essay\\_EN\\_final\\_20110329.pdf](https://www.icomos.org/18thapril/2011/18April_2011_STamwoy_essay_EN_final_20110329.pdf)

<https://www.unia.es/explorar-catalogo/item/carta-de-baeza>

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