

Resilience in montane range: the case of the Tadrart Acacus (SW Libya)

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Abstract

Between 2003-2011, a research programme in SW Fazzan (Libya) aimed at understanding the resilience of the Kel Tadrart Tuareg, currently inhabiting the Acacus Mts.. By a multi-pronged approach featuring oral interviews, participant observation, mapping of settlements, and localization of natural resources, the Kel Tadrarts' interaction with the landscape was investigated, and traditional (local) ecological knowledge resulted a key factor in the successful adaptation of the Kel Tadrart to erratic rainfall and meager pastures. The study of the Kel Tadrart resilience has fostered new interpretation of the recent past of the region, developed under the framework of the Theory of Resilience.

Key words: Kel Tadrart Tuareg, Tadrart Acacus, pastoralism, arid lands, resilience

1. Introduction

The Sahara hosts a variety of human communities that have been successfully shaping their lifestyles to extreme environmental conditions since the onset of present day aridity (c. 3000 years ago). Although modern technologies have improved the chances of human survival, the resilience of nowadays Saharans is deeply rooted in the past. If there is little doubt that current Saharan pastoralists are at the social and economic periphery of North African states, it is worth stressing that they represent an outstanding example of human adaptation to one of the most inhospitable area of the planet. The legacy of late prehistoric and historical societies that inhabited the Sahara from the Late Holocene onwards, left an impressive – and so far poorly explored – *corpus* of traditional ecological knowledge that is the key to understand the successful adaptation of humans in this region.

As a matter of fact, the focus on the human-environment interactions is the hallmark of North African archaeology. Especially in the last 30 years, scholars have been emphasizing the strong connection between cultural trajectories and climatic oscillations in these regions (DeMenocal et al. 2000, di Lernia 2002, di Lernia 2013, Drake et al. 2011, Gasse 2000, Gasse and Van Campo 1994, Hassan 1996, Hassan 1998, Hoelzmann et al. 2004, Kröpelin et al. 2008, Kuper and Kröpelin 2006, Lézine 2009a, Lézine et al. 2011, McGee et al. 2013). Collapse of societies, or dramatic changes in societal and economic organizations, have been more or less explicitly connected to abrupt arid spells, and the abandonment of regions has been seen as the 'normal' response to the advent of different climatic conditions. However, collapse of societies (or social structures) does not necessarily imply the collapse of culture. Here I argue that central Saharan societies from the last 3000 years were highly resilient and responded in a variety of manners to aridification. In particular, I suggest that the arid – though oscillating - climate of central Sahara in the last three millennia, characterized by cyclical peaks in wetness and aridity, generated an unprecedented experience to be transmitted by social memory through generations. Through this mechanism, communities kept and improved a body of techniques allowing the development of original cultural trajectories in the Sahara. In this paper I wish to propose a new perspective of the available data from the Tadrart Acacus (SW Libya) from the last 2000 years, developed under the broad framework of the Theory of Resilience. The resilience of a given human community can be loosely defined here as its tolerance to disturbance, and its capacity of absorbing shocks. The Theory of Resilience focuses on the source and role

of change within systems seen as adaptive entities (Holling and Gunderson 2002, Redman 2005). Human-environment interactions generate systems that move through adaptive cycles, made of four phases: exploitation; conservation; collapse or release; and reorganization. Those phases does not last the same, nor are likely to always occur. It has been recently applied to some archaeological cases with success (Rosen and Rivera-Collazo 2012), and it gives an alternative and useful perspective to review the history of pastoralism in the Tadrart Acacus in historical times.

Furthermore, this approach may serve as working model to show how archaeologists can successfully engage in the debate around sustainable development in arid lands. The participation of social scientists in the design of sustainable plans is still low, and major involvement has been recently voiced (Field et al. 2012). An ethnoarchaeological approach to resilience in marginal environment may bond practitioners and stakeholder in developing sound and informed strategies to enhance human adaptation in arid lands.



(FIG. 1 HERE)

2. The ethnoarchaeological research programme

2.1 the study area

The Tadrart Acacus is a sandstone massif located at the very SW corner of Libya. It is surrounded by flatlands and dune fields but for its western side, where the wadi Tanezzuft separates it from the Algerian Tassili n'Ajjer. It extends c.150 km north-south and max. 50 km east-west. Altitude ranges from 800 to 1300 m a.s.l.. From a geomorphological point of view, the Acacus includes two main features: the wadi floors and the structural terraces (Cremaschi 1998). Rising over the wadis, the structural terraces are mostly covered by a hammada-like surface, consisting in barren rocky plateaus, almost deprived of soil by deflation and erosion. Conversely, along the wadis a permanent vegetation of the Saharo-montane type occurs (White 1983). Although the effective vegetal cover varies due to the actual rainfall, *Acacia* spp., *Aristida* spp., and *Panicum* spp. are quite common (Mercuri 2008) and represent the primary diet of sheep and goats. Those wadis are the foci of current human occupation.

The climate is currently hyper-arid, and the scarce rainfall (between 0 and 20mm per year) is additionally hardly predictable and rather erratic (Fantoli 1937). Through the detailed studies on the climatic history of central Sahara (DeMenocal et al. 2000, Drake et al. 2011, Francus et al. 2013, Gasse et al. 1990, Hély, Lézine, and contributors 2014, Kröpelin et al. 2008, Lézine 2009b) we know that the process of aridification began at the end of the African Humid Period (c. 5000 years ago), and by 2000 years ago the climate was essentially the same as today. The advent of current dry conditions affected all the Central Sahara, although the effects on specific regions varied according to local geomorphological conditions (Cremaschi and Zerboni 2011, Manning and Timpson 2014).

2.2 Materials and methods

The ethnoarchaeological research programme (2003-2011) focussed on the study of the Kel Tadrart Tuareg, the sole inhabitants of the Tadrart Acacus. The project began in 2003 with irregular interviews and visits to

settlements inhabited by the Kel Tadrart. The core of the data was collected in 2007 and 2009, while in 2010-11, further information was added and the whole data were analysed. Fieldwork included participant observations, oral interviews, and mapping of the Kel Tadrart campsites.

With the support of local informants, the whole Tadrart Acacus massif (c. 5000 km²) was surveyed to detect and map all the inhabited settlements, and to locate natural resources (pasture and water points). Oral interviews were performed by means of a questionnaire, though important data were collected by informal conversations and by participant observation as well. In the course of my visits, several issues were discussed with the Kel Tadrart elders to be found at every settlement, normally the 'head' (the eldest) of the household. Kinship, personal history and memories, perception of the environment and natural resources, by-products trade and trip to market, and the role of government politics were among the most important topics.

Surveys in selected areas were carried out with the aim of studying the remains of abandoned settlements. Transects of different size were surveyed, and all the material evidence of human frequentation of contemporary and modern period was recorded (Biagetti 2014a). Some abandoned campsites were the subject of specific research, in order to analyse the durability and visibility of the material record. Comparative study with inhabited settlements provided fresh data on the formation of the pastoral landscape in the Tadrart Acacus, therefore addressing the widely debated issue of the archaeology of mobile pastoralism (Banning and Köhler-Rollefson 1992, Barnard and Wendrich 2008, Bradley 1992, Cribb 1991, Hole 1979, Robbins 1973, Robertshaw 1978, Sellet, Greaves, and Yu 2006).

2.3 The Kel Tadrart landscape

The study of the Kel Tadrart landscape is a main component of the ethnoarchaeological research programme in the Tadrart Acacus. It has been focused on the study of the Kel Tadrart interactions with natural resources affecting their settlement pattern. From a social point of view, the Kel Tadrart are linked to the Kel Ajjer Tuareg, traditionally occupying the area around the oasis of Ghat, nowadays parted by the international border between Libya and Algeria. According to the reports of 1930s (Gigliarelli 1932, Scarin 1937), the Kel Tadrart had customarily been roaming through the Tadrart Acacus, and frequented also a small village close to Al Awaynat, called Tabarakkat. The Kel Tadrart, who had left the Tadrart Acacus for a certain time, has traditionally inhabited this small centre. Still nowadays, this village is an important centre for the Kel Tadrart, since all the households living in the Tadrart Acacus have close relatives there.

(TAB. 1 HERE)

ID settlement	child (0-11)	youngster (11-17)	young adult (18-25)	adult (26-49)	elder (>50)	total	ovicaprids	camels
ALO_07/1*	-	1	-	2	1	4	80	
IMH_07/1	-	-	1	1	1	3	80	
IMH_07/2	1	1	1	1	1	5	90	
EID_09/1	1	1	1	1	1	5	90	
IMH_07/4	3	-	-	1	1	5	70	
IMM_07/1	3	1	1	2	-	7	130	9
RAH_07/1	-	-	2	1	1	4	90	3

SUG_07/1	5	1	-	2	1	9	60	
SUG_07/2	2	-	-	2	-	4	40	
TES_07/1	-	-	2	-	2	4	110	5
TIB_07/1	1	1	2	1	1	6	130	4
TIH_07/1	4	-	-	2	2	8	230	
total	20	6	10	16	12	64	1200	21

Tab. 1 Kel Tadrart occupation recorded in 2007, with age groups and stock; *indicated the households living in the 'desert' but not in the Tadrart Acacus

The Kel Tadrart have traditionally been the sole dwellers of the whole Tadrart Acacus (Biagetti 2014b). Between 2003 and 2011 twelve Kel Tadrart households inhabited the region, and one of them was settled out of the massif. A total of 64 people were counted, ranging from new-borns to elders (Tab. 1), all belonging to a single extended family bounded by close kinship ties, and therefore described as a single lineage. A slight under-representation of the young adults age group was noted and related to the search of labour in the neighbouring village of Al Awaynat, or to the incorporation in the former Libyan army. In the Kel Tadrart society, the households are the basic economic units, and generally correspond to nuclear families composed by three or more generations. Every household owns a herd of variable size, ranging from 40 to more than 200 smallstock (Tab. 1). Wealthier households own camels as well. Mobility is a viable option for almost all the Kel Tadrart households, and opportunistic and short-term movements may occur, normally within the Tadrart Acacus range (Biagetti 2014c). Traditional ecological knowledge, coupled with occasional trips to market in purchase of fodder and other goods, has allowed the Kel Tadrart to successfully adapt to an arid environment, modulating mobility at the household level.

Kel Tadrart households were dispersed throughout the Acacus Mts.. Each household, or nuclear family, was living in its own settlement, which included a variable number of features (Biagetti 2014d). Main campsites were widespread from north to south, without any evident pattern. All the settlements were located on slightly elevated areas in the vicinity of cliffs, far enough from wadi bottoms and well protected from the cold northern wind that blows in winter. The study of the Kel Tadrart settlement pattern focussed on the interaction with the most relevant natural resources, namely water and pasture.

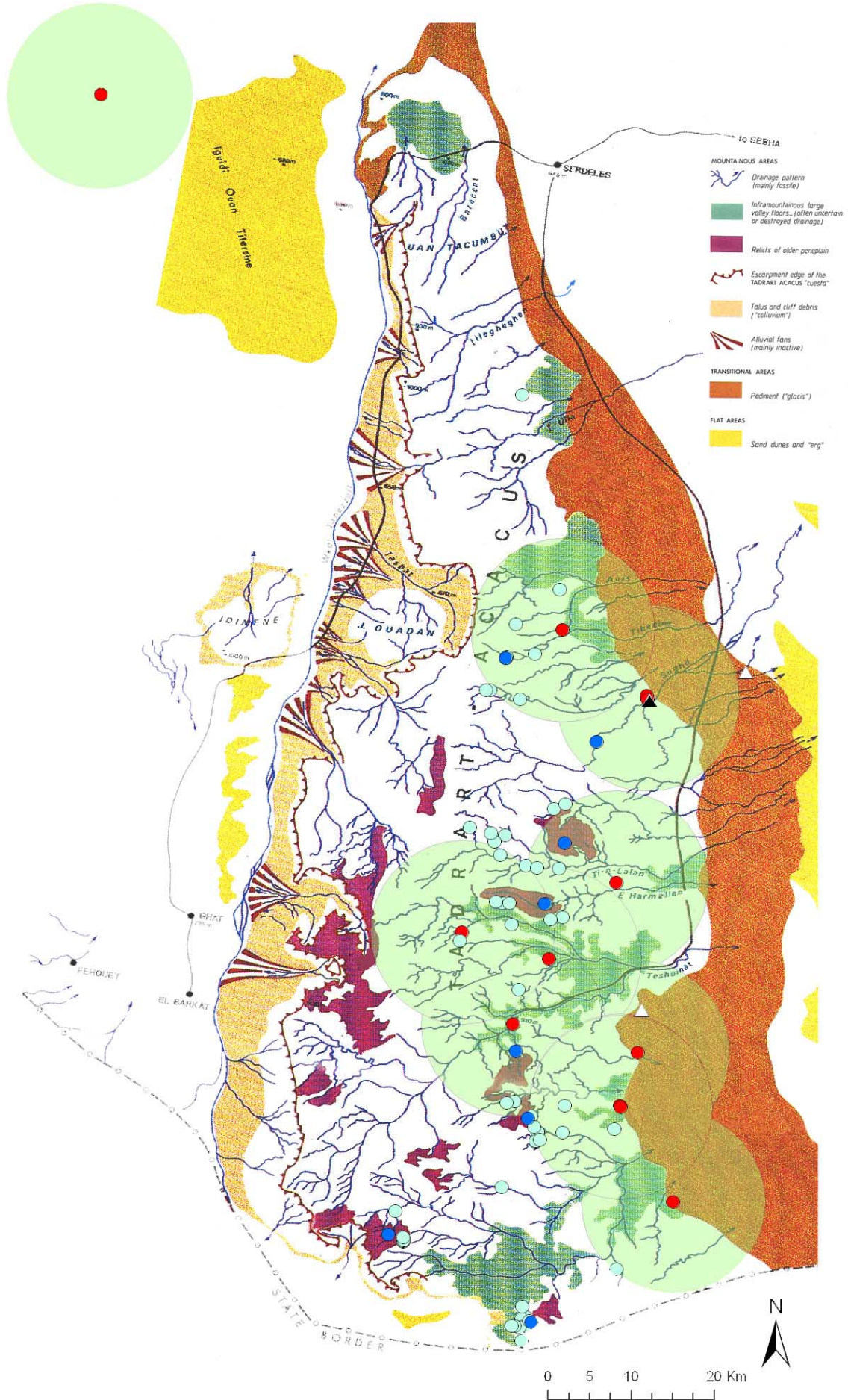
Water points

All the campsites are set in a reachable distance to a water point, being it a well or one or more *gueltas* (rock pools where rainfall is retained for a variable time). Two mechanized wells were bored in the 1980s by the government in the eastern range of the Tadrart Acacus. On the other hand, the non-mechanized well of Sughd appears as a 'traditional' feature of the Acacus landscape. Increased use of water from the two mechanized wells has not diminished the vital role of the *gueltas* (di Lernia, Massamba N'siala, and Zerboni 2012). *Gueltas* are, in fact, widespread throughout the Tadrart Acacus and can be accessed by the Kel Tadrart smallstock during daily graze. The position of *gueltas* plays a role in shaping the settlement pattern of the Kel Tadrart: indeed most of the campsites are placed at short distance from the *gueltas* identified as the most important by di Lernia and colleagues (di Lernia, Massamba N'siala, and Zerboni 2012), and the herds can reach those water points while grazing during the day. The campsites that feature no major *gueltas* in their surroundings are set in the vicinity of wells. As a matter of fact, water can be brought from the wells to the settlements, in case of reduced supply from *gueltas*. Most of the Kel Tadrart own a 4WD vehicle that is suited to the scope. Some Kel Tadrart households own donkeys as well, that are generally

used to transport water from *gueltas*. Cars are not used to collect water from *gueltas*, since most of these are set in hardly accessible locations, where vehicles cannot approach.

Pastures

Kel Tadrart stocks can cover a maximum of 10kms from the settlement every day, and thus grazing areas must be set at a reasonable distance from the settlements. The geomorphological map adopted for this study (Marcolongo 1987) indicates some areas where the water retention capacity of the 'large valley floors' allows higher regenerative capacity of the plant cover. In spite of the variability of rainfall that may yearly affect the actual distribution of vegetation, most of Kel Tadrart settlements resulted located on those areas (FIG. 2), where the stocks can find the necessary intake. Large valleys floors, where pasture is more likely to be found due to their geological characteristics, are major centres of gravity for the Kel Tadrart households. Differently from water, in fact, fodder cannot be easily collected and moved to the settlement. The settlement pattern of the Kel Tadrart is thus primarily affected by the availability of grazing lands that can be daily exploited by households' small stocks. This is a key concept, if we are to understand the Kel Tadrart perception of the landscape. The erratic nature of rainfalls and the absence of a proper rainy season makes the Tadrart Acacus an extremely marginal environment. However, it must be stressed that the Kel Tadrart dryland pastoralism is not a mere survival system. Rather, they aim at raising **wealthy animals by selecting not only the best areas for grazing but occasionally integrating the food supply**. In fact, when the herders wish to increase the number of sheep and goats, or when additional intake is needed due to specific reasons (e.g. occurrence of new-borns), they purchase fresh fodder at the neighbouring market. The Kel Tadrart system is not specifically market oriented, although surplus of by-products such as cheese or butter can be exchanged as well. For similar reasons, the pattern of movement of the Kel Tadrart throughout the year cycle, is extremely variable, and cannot be predicted. The typical explanation of their movement (to Westerners) is "we go where the rain falls", but this must not be taken as if it is the rain that automatically generates the displacement of the households. Green grass is preferred ("*akasa*") to dry shrubs, and even remote locations can be reached and exploited for few days and up to several weeks (Biagetti 2014c). However, the Kel Tadrart are well aware of the effects of rainfall on different areas of the Tadrart Acacus, and this heavily influences the distribution of settlements. Under this viewpoints, the Kel Tadrart – not dissimilarly than other desert pastoralists – escape traditional heuristic classifications based upon mobility, notably one of the most common indicators used to classify pastoral societies worldwide.



3. Resilient pastoralists

An ethnoarchaeological approach based upon the 'Theory of Resilience' allows us to explore the relationships between people and the surrounding environment. Here, I shall propose a micro-scale review, funded on short-term adaptive cycles. Data collected on the field by interviewing the elders on the course of the whole ethnoarchaeological project (2003-2011), are herein combined with ethnohistorical data from early XX century. The pioneering research done by Cremaschi and colleagues (Cremaschi, Pelfini, and Santilli 2006, Cremaschi and Zerboni 2013) produced a fine-grained tracking of climatic oscillations that occurred in the last five millennia by analysing door beam samples made of *Cupress dupreziana* (Tassili cypress) taken from the oasis of Ghat and Barkat. Dendroclimatic reconstruction was made by measuring the tree-ring width, assuming then the larger the wetter (Hughes, Swetman, and Diaz 2011 and references therein). Worthy of note, such reconstruction matched other palaeoclimatic indexes (see Cremaschi and Zerboni 2011 and reference therein), thus resulting a reliable way to track short-term variations in rainfall. According to the Cypress record (Cremaschi, Pelfini, and Santilli 2006, Cremaschi and Zerboni 2013) an unsteady climate dominated in the area in the last 2000 years. Within a century, one/two arid peaks alternated with one/two wet peaks. Although the magnitude of these events might have slightly varied, the rhythm of these oscillations was rather regular. It means that an adaptive cycle of c. 100 years can be traced, by relying upon ethnohistorical data, combined with the results of the oral interviews carried out during the ethnoarchaeological research programme.

According to the colonial age reports (Gigliarelli 1932): 158-159, the Kel Tadrart dwelling in the Tadrart Acacus were 78, provided with 337 small stock and 27 camels. So, the number of persons inhabiting the region was not dissimilar to the one we see today, yet the composition of stock was characterized by a slightly larger number of camels and heavily lower number of small stock. The density of Tadrart Acacus inhabitants fits with those of the other central Saharan mountains, respectively reported as 0,010 and 0,009 inhab/km² for the Tassili and Hoggar (re-elaborated from <http://www.fao.org/ag/AGP/AGPC/doc/Counprof/Algeria/Algeria.htm#4.%20RUMINA>). Drawing upon ethnographic, ethnohistoric, and environmental data, a possible reconstruction of a typical adaptive cycle made of different phases is herein presented, under the framework of the Theory of Resilience.

Phase **r** - growth and expansion increasing resilience (1930-1950). Tribalism and traditional hierarchy reported by colonial age literature. The early 1930s are characterized by rains reported in colonial accounts (Fantoli 1937). Most of Tuareg clans in SW Fazzan had already gained the right of access to camels, once limited to 'noble' clans (Biagetti 2014b, Keenan 1977), which allowed further engagement in trading and facilitate regional movements. Kel Tadrart reported for the first time as the sole dwellers of the Tadrart Acacus, their social status not well defined. Connection with the oasis of Al Awaynat and its surrounding reported, hinting that the Kel Tadrart customary landscape was the same as today.

Phase **K** – conservation and loss of resilience (1950-1970). Those years were characterized by relatively high rains in early 1950s and 1965/1966. Floods reached very high levels and also the surrounding dune fields featured interdune ponds. First systematic contact with Westerners in the area (Italian archaeologists) occurred. Movements towards dune fields took place in case of peaks of rainfall, no other rain of such magnitude having been reported until now. Tribalism and traditional hierarchy based upon elders' prominent role were still active. Demographic expansion remembered.

Phase Ω - release and collapse, reshuffle and loss of resilience (1970-1990). The hard droughts that hit the Sahara and the Sahel in the 1970s and 1980s prompted the government to built artesian wells east of the Tadrart Acacus. This undoubtedly facilitated the life of the Kel Tadrart, since water supply ceased to be a critical issue, although rainfall remained crucial for grassland regeneration. To relief the Kel Tadrart, the government provided additional food supply. In those years, all Kel Tadrart were also disarmed. Pressure to sedentarization in the oasis of Al Awaynat reported, along with progressive drop of the role of traditional tribal rules and mechanisms. Demographic reduction of the Kel Tadrart living in the Acacus Mts. dwellers reported as well.

Phase α - reorganization and increase in resilience (1990-2010). The diffusion of 4WD vehicles enhanced water collection from mechanized wells. Some experiments of cultivation were tried in the vicinity of wells. Major rain have been reported every 3 or 4 years (e.g. 2005 and 2009 personally observed). Increasing tourism in the Acacus led to further diversification and reorganization, Kel Tadrart serving as guides and wageworkers. In these years, the pressure to sedentarization continued. Adoption of motor vehicles made easier the connection between the Tadrart Acacus and the oasis of Al Awaynat (and Tabarakkat) due to motor vehicles. Demographic stability reported.

The above can be described as a rather typical adaptive cycle, lasting few generations, whereas major episodes are remembered and transmitted by the living. New technologies can be integrated and accepted, other element exerting pressure (sedentarization) may produce a variety of effects, although the return to the mountains in case of perceived benefiting conditions is always an option. This cycle goes along with climatic oscillations, which enlarge or reduce the spectrum of choices for the Kel Tadrart. In spite of variable external elements, that may be contingent and non-repeatable, one aspect results as main features of the Kel Tadrart occupation, that is their permanence, no matter of the climatic variability, in the montane range, throughout the above described cycle. This has some implications for the archaeology of the area.

4 The Tadrart Acacus in historical times: some implications

The Tadrart Acacus has not been considered so far a hot spot for human frequentation in historical and present times. Historical archaeology in the Sahara is still poorly developed, and the role of Saharan civilizations in cultural dynamics of historical and modern times is often denied or underestimated, with the remarkable exceptions of the research carried out precisely in SW Libya. Historical archaeology in the regions has focussed on the better-watered areas of the Wadi el Ajal (Mattingly 2013, Mattingly et al. 2007, Mattingly 2003b, Mattingly 2007, Mattingly 2010, Merlo, Hakenbeck, and Balbo 2014, Sterry et al. 2011, Wilson 2012) and the Wadi Tanezzuft (di Lernia and Manzi 2002, Liverani 2005, Liverani 2007, Mori 2013), where substantial evidence of occupation has been recorded for the last three millennia. There, communities of farmers and trader were integrated first in the so-called Garamantian kingdom (800BC-AD700), the earliest state formation in the Sahara, and later were part of southern political entities that intermittently controlled the Fazzan in 'medieval times' and up to the Ottoman conquest (Mattingly 2003a). The Tadrart Acacus, along with other mountains of central Sahara are poorly known, and generally considered as being 'crossed' rather than inhabited in historical times. Due to the rugged nature of its terrain, the absence of permanent watercourses, along with the absence of monumental architecture, the Tadrart Acacus has been dismissed as a minor centre for human activity. The sole evidence regularly reported is the rock art and the rock inscriptions.

According to the analysis reported in di Lernia and Gallinaro (2011) and Gallinaro (2013), the occurrence of rock art sites is concentrated in some specific areas of the Tadrart Acacus. Tifinagh inscriptions are more widespread (Biagetti, Ait Kaci, and di Lernia 2015, Biagetti et al. 2012). In absence of other evidence, it is reasonable to take the rock art evidence as a filter to read the past landscape and infer that the areas where rock art is concentrated may reflect the most frequented areas in the past. As a matter of fact, those areas where rock art is clustered roughly correspond to the best soil areas so far discussed and recognized in the geomorphological map. As a result, the areas featuring the most suited conditions for the regeneration of pastures that have proved to be a determinant component in the Kel Tadrart settlement pattern, are those hosting most of the rock art of the Tadrart Acacus. This demonstrates a strong connection between rock art and grazing area, and may be taken as a clear sign of continuity in landscape exploitation in the course of the centuries: best areas in the Tadrart Acacus are, and were, the foci of human occupations. In the Tadrart Acacus, the archaeological data demonstrates that the model here described might have been working in the past as well. The presence of rock art and inscriptions in the most 'fertile' areas of the mountain, convincingly show that the connection between those soils and human frequentations was active in the historical past. At this stage, it is not possible to exclude that massive abandonments of the Tadrart Acacus might have occurred in the course of the last 2000 years. However, if this was the case, the archaeological and ethnohistorical sources demonstrate that people did come back and repopulated the area. This contrasts with the paradigm "aridity=abandonment" that permeates many reconstructions of past human activities in this and in other arid lands. In spite of theoretical assumptions implying the search for optimal conditions, the Kel Tadrart do not perceive themselves as living in marginal environment, and have often emphasized to me in the course of several conversation the variety of their landscape and its suitability to human life. It is likely that the focus on 'optimal' environmental conditions has prevented the study of reorganization and development in arid times. In addition, this research highlights the high degree of overall adaptation to desert environment on the short scale. Cultural systems are resilient and do not respond linearly to changes in climatic and environmental conditions, since social memory and experience provides a broad range of resources to adapt to new conditions. Societies may collapse, but cultural systems are far more resilient (Rosen and Rivera-Collazo 2012). The experience acquired in desert lands characterized by unsteady and oscillating climate, generate a body of traditional ecological knowledge that can be used to cope with bad and good years. Climatic change may trigger the activation of no longer used technology, and similarly prompt the adoption of new one. Far from being a kind of relic, or a case of living past, the Kel Tadrart are an outstanding example of resilience and flexibility in what we consider a very marginal environment, which should raise awareness among social scientists and stakeholders on the possibilities of human adaptation in arid lands.

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Fig. 2 The geomorphological map, featuring the Kel Tadrart sites (dots), the 10km grazing areas (green buffers), mechanized wells (white triangles), and non-mechanized well (black triangle) (adapted from Biagetti 2014: fig 4.4; original source: Marcolongo 1987). The NW site out of the Tadrart Acacus is that indicated by an asterisk in Tab. 1

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