Chapter 2
The Environment

2.1 The Tadrart Acacus Massif and Central Sahara

The central Saharan mountains constitute the backbone of the largest desert in the world (Fig. 1.1). Rising from west to east within sand seas, gravel areas and dune fields, these mountains all have their own landscape and history, constituting a natural reservoir of cultural and natural resources, often in discontinuity with surrounding flatlands. Situated along the eastern edge of the Tassili range, the Tadrart Acacus is a deeply dissected mountain range, composed mainly of sandstone. It extends *c.* 150 km north–south and max. 50 km east–west. Altitude ranges from 800 to 1,300 m a.s.l. on the highest peaks rising towards its western part. The Tadrart Acacus is bordered by the *wadi* (litt.: dry river beds or valley) Tanezzuft to its west. This *wadi* runs almost along the international border and divides it from the plateaux of Tassili n'Ajjer (Algeria), and hosts some minor oases, such as Tahala, Barkat and Fewet, and Ghat, the location of a veritable small town. At the NW summit, the mountain is edged by the *erg* (dune field) of Titersine (600 km^2). The *erg* of Uan Kasa (3,500 km^2) is located to the east of the massif.

2.2 Geomorphology

The geomorphology of the Tadrart Acacus has been described in detail in previous papers (Marcolongo 1987; Cremaschi and Frezzotti 1992; Cremaschi 1998). The Acacus massif stretches longitudinally, its eastern and western sides showing different characteristics. In fact, its main geologic structural pattern consists of a monocline characterized by an E–NE-tilted ridge (Cremaschi 1998). The western side features a steep profile, with a vertical slope set along a fault line. It is hardly accessible, except for some steep passageways, the *aqbas* (see Sect. 2.5.4).

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Conversely, the eastern edge tends to slope off, allowing easier access to the inner valleys. The large *wadis* that deeply incise the Acacus, testify to ancient fluvial activity, and today act as channels storing runoff for some weeks after the rains (Marcolongo 1987). At the eastern margin of the Tadrart Acacus, a transitional belt separates the mountain from the dunes of the *erg* Uan Kasa (Marcolongo 1987). Here, an erosive pediment provides favourable conditions for the capture and persistence of rainwater and runoff water and for the formation of phreatic aquifers close to surface. These low areas once hosted lacustrine basins during the wet episodes of the Holocene and today hold the two artificial bored wells of Taluaut and Eminanneia (see Sect. 2.5.2). Marcolongo (1987) provides the only geomorphological map available for the study area so far. It describes some areas where 'large valley floors' feature—in principle—favourable characteristics for resource regeneration (Fig. 2.1). In particular, vegetal coverage should notionally be more developed in such large valleys, creating suitable condition for human occupation.

2.3 Climate

The climate of the Tadrart Acacus is extremely arid. Here, as in the entire northern Africa, climate variability depends on low-altitude pressure and winds over the continents, which are surface expressions of the upper air circulation (Gasse 2000). The climate and palaeoclimate are governed by the seasonal migration of the intertropical convergence zone (ITCZ) in response to changes in the location of maximum solar heating, resulting in the distinctive, fluctuating environmental belts in Africa, ranging from bands of monsoonal climate with summer rains and winter drought in the south, to the increasingly arid Sahel and Sahara.

Few recent historical meteorological data have been recorded for our region. Ghat is the closest village to the Acacus mountains. Here, (Latitude 24°55′N, Longitude 10°12′E; 561 m asl) the mean annual temperature is between 25 and 30 °C, and the mean annual rainfall is between 0 and 20 mm (Fantoli 1937; Walther and Lieth 1960). In the region, precipitations are mostly distributed in spring and summer and regional average annual relative humidity is 17 %; a strong wind activity is registered all over the year, and especially in spring; occasional rainstorms are recorded also in the winter season (Fantoli 1937). However, the concept of mean annual rainfall holds scarce significance in these desert areas: rain frequency is very uneven, and precipitation does not occur every year. A proper alternation between real rainy and dry seasons cannot be envisaged. Generally speaking, almost completely dry years can occur and have occurred in the course of the last 20 years. The erratic degree of the collection of those facts prevents a fully informed reconstruction of the rainfall pattern; it is therefore difficult to match precise precipitation levels with the oral traditions registered, although major events are generally remembered in the region, as well as the rough amount (high or low) of rainfall occurring every year.

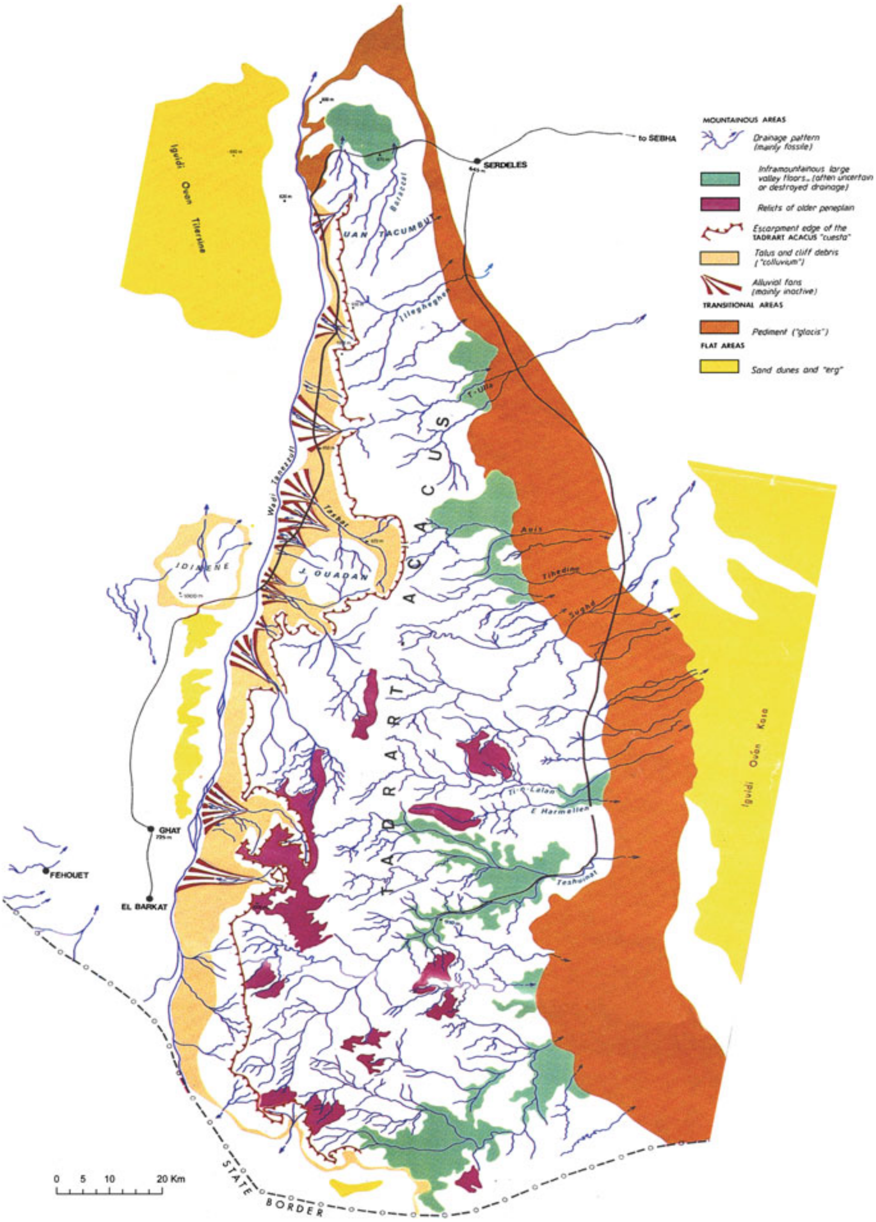

Fig. 2.1 The geomorphological map of the Tadrart Acacus (used with permission from Marcolongo 1987)

2.4 Flora and Vegetation

Despite the low rains, permanent plant cover can still be recorded all year-round along the *wadi* floors, allowing human and animal presence. Even in dry years, water is stored at shallow depths allow vegetation to survive in severe conditions. Mercuri (2008) notes that in the study area both *wadi* vegetation and Saharo-montane vegetation, typical of the Saharan Transitional zone (White 1983), are prevalent. In the *wadi* Teshuinat—one of the main valleys of the Acacus—the *Acacia–Panicum* and *Acacia–Panicum–Zilla* permanent communities (Schmidt 2003: 122–123) are well developed, though their consistency varies from year to year due to the inconstant rain. Hygrophilous vegetation concentrates around the *gueltas* (rock pools where rainwater collects) which are widespread in the area. Generally speaking, it has to be recalled that *wadis* represent one of the main ecosystems in the desert: they acts as drainage systems, collecting water from extensive catchments areas. The water flows underground along sections, surfacing periodically in the *wadi* bed. Steep slopes and surrounding land influence water movement and storage so that water gathers in *wadi* beds.

2.5 Main Features of the Tadrart Acacus Landscape

2.5.1 Valleys and Pastures

In the Tadrart Acacus, drainage systems have formed deep canyons, characterized by different morphologies. Acacus canyons are of widely differing scales. The large valley floors are generally broad (up to 3 km, on the average 1 km), marked by wide stream beds. Yet, smaller *wadis* are widespread as well, shaping the net of minor branches of greater streams (less than 500 m). The width of valleys do not seem to correspond with the height of adjoining cliffs, varying between *c.* 20 and *c.* 100 m. One or more flat structures (‘intermediate’, 1st and 2nd terraces, Cremaschi 1998) are normally located on the top of those cliffs. The Acacus valleys, in fact, normally feature a step-like profile. Similarly, the slope gradients of cliffs are highly variable. These geomorphological facets of the Acacus *wadis* affect present day human occupation, as will be discussed in Chap. 5. Naturally, these valley refugia of vegetation host Kel Tadrart herds and provide indispensable supply of forage for sheep, goats and camels (Fig. 2.2).

The Kel Tadrart Tuareg stock breeding is based mostly upon a few perennial plants whose nutritional value is greatest at specific stages of development. Some plants, in fact, can be used as fodder only when green. This is the case of *tullut* (*Aristida pungens*) grass, and *afezu* (*Panicum turgidum*) likely to be the most common shrubs to be found in the sandy river beds of the Acacus massif. When

Fig. 2.2 *Wadi* Teshuinat seen from the first structural terrace (*photo* the author, used with permission from 'The Archaeological Mission in the Sahara', Sapienza University of Rome)

withered, both plants are of little value as fodder. Communities of *aftzen* (*Zilla spinosa*) are important as well, as the leaves of this herb can be eaten by domestic stock. However, herbs are not the most important fodder species for the Kel Tadrart livestock. Acacia trees are believed to be most effective food for sheep and goats, in the form of their fruits. Both *tamat* (*Acacia seyal*) and *abser* (*Acacia raddiana*) perennially produce very nourishing pods that are eaten by all domestic animals. I have often seen Kel Tadrart herdsmen lowering acacia branches to facilitate herd's browsing. Acacias pods are frequently collected, along with other tender annual plants, and brought to kids, lambs and calves. In Tadrart Acacus, the most important saliferous plant is Tamarix (various species), which is quite common in the *wadis* of the massif.

To date, no actual difference in vegetation has been recorded from one *wadi* to another in the Tadrart Acacus. Beside the above-described 'large valley floors' where geomorphological conditions are potentially favourable for the regeneration of plants, no definite diversification in type of plant coverage has been observed by Mercuri (2008) and Massamba (pers. comm.). This finds some kind of confirmation in the names of places of the Tadrart Acacus: *wadi* names rarely feature terms specifically related to their environmental/vegetation characteristics. Variations in the development of vegetation seem largely determined by the annual distribution of rainfall, which can fall quite unevenly on some different spots of the massif.

2.5.2 Water Resources

It is certainly true that Saharan stock can survive without water for several days, but in arid environments, the management of water resources holds a primary place among the tasks of pastoralists. Two different types of water point can be found throughout the Tadrart Acacus, namely *gueltas* and wells. A first comprehensive study has been recently published (di Lernia et al. 2012). According to this recent paper based on fieldwork in the Tadrart Acacus, *gueltas* are ponds where rainfall accumulates. They are generally located at the beginning of the *wadis*, in their most elevated and narrow part. These pools feature several shapes and sizes, being the result of long-erosional processes. In the Acacus massif, every *wadi* features an interconnected system of irregularly superimposed *gueltas*, created by the action of water flowing from the highest plateaux down to *wadi* bottoms in rainy times. Several falls, cascades, fractures and rock cracks have been shaped by weather effects, mostly in the late Tertiary and early Quaternary, when wet conditions determined the formation of present meander-like morphology (Cremaschi 1998; di Lernia et al. 2012). Water falling from the top of the plateaux has thus created a step-like profile, where several basins can be called *gueltas* but cannot be exploited as water reservoir, due to their inaccessibility. Normally, only the lowest in a series of basins is used by Kel Tadrart, who often dig and enlarge the ponds by hands. From the geomorphological point of view, *gueltas* are almost ubiquitous in the Tadrart Acacus. Yet, Kel Tadrart know what are most reliable in terms of water supply. Indeed while two or three *gueltas* are generally considered to be 'almost perennial', their fill still depends on effective rains. Shaded morphology and a large basin impede evaporation of water. Ephemeral *gueltas* can thus be very important if they are located in a zone where precipitations have occurred. In this perspective, *gueltas* behave not dissimilarly to pastures.

In the mid-eighties, after two major episodes of drought that occurred in the Sahel and the Sahara between late 1960s and early 1980s, the Libyan government bored two wells in the eastern fringes of Tadrart Acacus. The wells of Eminanneia and Taluaut were the first artificial water sources not dependant on rainfall to be used by Kel Tadrart and doubtlessly had a strongly positive impact on their lives. These wells are served by generators that activate mechanical pumps, extracting water from *c*. 400 m. Currently, both wells are used also by tourists and travellers, and host military checkpoints. On a more general level, modern technology has increased the exploitation of (early Holocene) ground water in many other areas of the Fazzan, where pumping allowed the irrigation of crop fields. This intensive use of water raises several issues about the sustainability of the deep aquifers across time, as has recently been stressed by Brooks et al. (2005).

Not far from the well of Taluaut, along the *wadi* of the same name, the natural well of Sughd constitutes another important water source for the Kel Tadrart (Fig. 2.3). It is less than 10 m deep, currently endowed with a concrete edge at its top, erected a few years ago to protect it from being dirtied by the sand. Differently from the artificial wells, it is strongly affected by rainfall. It is believed to be able

Fig. 2.3 Well of Sughd (*photo* the author, used with permission from 'The Archaeological Mission in the Sahara', Sapienza University of Rome)

to supply water for a maximum of three dry years. This place holds major relevance in the Acacus landscape, as demonstrated by the huge amount of Tifinagh engravings that extend over the rocky hillside coming to within a few metres of the well itself (Biagetti et al. 2012). According to the elders (di Lernia pers. comm.), it seems that in a recent past the well was closer to the rock, whose surface indicates the depth of the aquifer. Vertical rows of small circular dots (kind of engraved cups of *c*. 5 cm of diameter) carved in the stone, roughly indicate how many 'men' one should excavate to find water. Unfortunately, it is not possible to date such rock marks with certainty. However, this type of signal is used wherever water is to be found at relatively shallow depths. It can be occasionally observed within small *gueltas* and, perhaps more surprisingly, other rock walls. This is precisely the case of some places where shallow aquifers can quickly rise up to surface if one digs only slightly in the sand. Such water concentration can occur in a large number of places, once peculiar drainages favour the concentration of rainfall running down the cliffs. Although it seems that some locations are quite renown for being particularly affected by this phenomenon, in case of necessity, Kel Tadrart know where these small 'holes in the sand' can be made if needed. However, this system supplies only a limited quantity of water, and such puddles are by no means surrogates of *gueltas* nor wells. Therefore, this kind of measure can be undertaken by a small group of travellers, or one man and few stock needing urgent supply of water, and not by a herder leading a flock at graze. In other words, these ephemeral sources cannot affect the configuration of seasonal movement, as these puddles are not to be considered as veritable water points.

2.5.3 Shelters and Caves

Hundreds of caves and rock shelters open onto the cliffs of the Tadrart Acacus, where human occupation has been intermittently present since at least Middle Pleistocene. These have been the *foci* of archaeological investigation since the mid-1900s (e.g.,: Mori 1965; Barich 1987; Cremaschi and di Lernia 1998; di Lernia 1999; Garcea 2001; Biagetti and di Lernia 2013). Used as dwelling spaces since prehistorical times, rock shelters and caves have been the natural refugia of humans (Fig. 2.4). Yet, many caves and rock shelters bear no other signs of recent use, beside ubiquitous pens and some modern graffiti. Then, there are locations where archaeological deposits (including material debris and burials) seem more visible and immediately recognizable. Such spots are almost inevitably avoided by modern pastoral populations either due to superstition or because they are considered as 'unclean'. This is not trivial as archaeological sites thus 'reduce' the landscape of contemporary pastoralists, excluding a large number of key geographic locations where settlement seems de facto denied. It is therefore important to note that evidence of the past can contribute to shape the perception of the landscape and, consequently, its habitation. For instance, peculiar rock art scenes or exposed Pastoral burials within rock shelters give names to such places and serve as places of 'memory', and geographic landmarks.

Fig. 2.4 The rock shelter of Uan Muhuggiag is one of the most renowned archaeological site in the area (*photo* the author, used with permission from 'The Archaeological Mission in the Sahara', Sapienza University of Rome)

2.5.4 Paths and Passageways

Although contemporary mobility is primarily focused on the dry river valleys of the Acacus, this must be considered as a very recent shift, mainly due to the introduction of cars. The Tadrart Acacus is crossed by hundreds of narrow paths that develop above the *wadis*, on structural terraces. This network of paths is clearly visible and still used nowadays for livestock transhumances. However, two types of paths exist in addition to the wide dried river valleys, namely the *aqbas* (litt. mountain passageways) and the flat trails.

The term '*aqba*' means 'passage', always implying some difference in altitude. Consequently, hundreds of *aqbas* exist in the Tadrart Acacus, where valleys alternate with higher terraces and peaks. Not differently than *gueltas*, in fact, *aqbas* are ubiquitous features of the Tadrart Acacus. Yet, the *aqbas* of the Tadrart Acacus are those located on the western escarpment (Fig. 2.5), the only routes connecting the *wadi* Tanezzuft and its oases (especially Ghat and Tahala) to the Acacus *wadis*. A systematic survey of all known *aqbas* was performed in 2009 by di Lernia and colleagues (see Biagetti et al. 2012), following previous rapid surveys done in the 1990s (Cremaschi and di Lernia 1998). It has been ascertained that the sloping portions of those trails require continuous maintenance, and it can occur that some

Fig. 2.5 The western escarpment of the Tadrart Acacus seen from the *wadi* Tanezzuft (*photo* the author, used with permission from 'The Archaeological Mission in the Sahara', Sapienza University of Rome)

tracks become unusable after heavy rains. Both types of paths are often endowed with adjoining archaeological and historical remains, in the form of stone cairns (burials), *Tifinagh* inscriptions, rock art scenes and stone mounds (landmarks). A dozen *aqbas* are generally recognized to have been used in the past, although it has been very difficult to place them precisely on a map. This is due merely to the fact that the *aqbas* on the western escarpment of the Acacus indicate well-defined areas where the geomorphological characteristics of the terrain allow the passage of humans and livestock, rather than precise trails. It is quite common to see the trails leading to the escarpment splitting at the bottom of the cliff and then rejoining on a higher terrace.

Hundreds of flat trails also constitute an important network of paths, extending over the top of all the structural terraces of the Acacus massif. These paths are nowadays used to reach *gueltas* and other locations, but basically this is the system of routes that since prehistorical times allowed men and livestock to move through the massif, implementing the lower *wadi* connections (di Lernia et al. 2012). Evidence of past tracks along the higher morphologies of the massif were firstly reported in the 1990s (see Cremaschi and di Lernia 1998: 248, Fig. 3). However, it is worth noting that before the introduction of cars, mobility mainly developed along these paths and not merely by dried river valleys. Important trails have been told to exist, for instance, to connect the western edges of *wadi* Teshuinat with the *aqba* of *wadi* Djelco, and farther with the oasis of Ghat. Although modern satellite imagery (Google Earth™) allows the observation of several paths, systematic and informed research is needed to better read this crucial element of the Tadrart Acacus landscape, which is likely to have deeply shaped the landscape perception of its inhabitants.

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