Across the Vast Land—Some Aspects on Libya's Geography

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Klaus Braun, Jacqueline Passon, and Aniela Jeworutzki

1.1 Libya at a Glance—Facts and Figures About a White Spot in Northern Africa

Klaus Braun and Jacqueline Passon

1.1.1 Topographical Outline

In a historical context, the term Libya has a really long tradition. Herodotus, for example, used it to describe an area that covers the Northern part of Africa between the Atlantic Ocean in the west and the Red Sea in the east. At that time, Libya was known to be a separate continent, the third one besides Europe and Asia.

Libya, as it is known today, is a country, which represents the central part of Northern Africa between Tunisia and Algeria in the west and Egypt in the east. In the south, Libya is bordered by Niger and Chad and in the south-east by Sudan. It covers an area of nearly 176 million km² and holds around 1200 km of the African Mediterranean coastline. Figure 1.2 shows Libya's main topographic features as they can be seen in the January image taken during the "Blue Marble Next Generation" (BMNG) earth observation programme in 2004 and enhanced by digital elevation data from the "Shuttle Radar Topography Mission" (SRTM) in 2000. Additional information like cities, place names and the road network are taken from other sources like the National Topographic Map of Libya or the populated places datasets from the Natural Earth archive.

With the exception of some comparatively small regions along the Mediterranean coast, Libya is mainly characterised by huge deserts and semi-deserts, which cover around

85–90% of the country. In the satellite image, those regions mostly appear in light red, brown or sandy colours, depending on whether it is a rocky, gravel or sandy desert. Belonging to the so-called Sahara which in Arabic means "the Great Desert", the most famous and well-known landscapes within this area are the tablelands of the Hamadah al Hamra, the gravel deserts of the Sarir Kalanshiyu and the Sarir Tibasti and the huge sand seas of the Idhan Awbari and the Idhan Murzuq.

Tablelands and gravel deserts form large flat plains which dominate much of Libya's topography. While the western part of the Sahara with the Hamadah al Hamra is between 300 and 600 m above sea level, the heights of the Sarir Kalanshiyu and the Sarir Tibasti in the east are mainly between 150 and 350 m. Exceptions are the depression of Sabkhat Ghuzayyil some 150 km south of Ajdabiya with the lowest point of Libya lying 47 m below sea level and the mountainous areas in the south and south-east with the highest point at the peak of Bikku Bitti in the Tibesti Mountains near the border to Chad which is 2266 m above sea level.

Comparably smaller mountain ranges like the Haruj al Aswad, the Jabal Akakus, the Masak Mastafat or the Jabal Bin Ghunaymah in the central or the south-western part of the Sahara disrupt the monotonous vastness and reach more or less a height of 1000 m above sea level. Embedded between these mountain ranges and the southern slope of the Hamadah al Hamra, the Idhan Awbari and the Idhan Murzuq form two of the huge sand seas, which are somehow a symbol of the entire Sahara, even if they do not cover more than 20%. It is not only these sand seas the Sahara is famous for, but also the significant number of oases. They indicate life in the desert. Historically, those oases are directly linked to the presence of water, either as artesian sources or as groundwater levels in reachable depths that allow for the drilling of wells. Usually, these areas can be found in deep-lying areas, in particular along wadis or in basins where fossil groundwater appears at or near the surface.

K. Braun (✉) · J. Passon · A. Jeworutzki
Department of Physical Geography, University of Freiburg,
Freiburg, Baden-Württemberg, Germany
e-mail: klaus.braun@geographie.uni-freiburg.de

J. Passon
e-mail: jacqueline.passon@geographie.uni-freiburg.de

Fig. 1.1 Across the vast land: a single twisted acacia tree and certain small shrubs and herbs located within the mountains of the Jabal Bin Ghunaymah, indicating the course of a wadi system where at least some water is available at or near the surface, either as fossil groundwater or water from occasionally rainfalls captured by the river sands

With regard to the regions along the Mediterranean coastline and especially the mountainous areas of the coastal hinterland in the western and eastern parts of Libya, a quite different environment can be detected. In the satellite image, these regions appear in green and dark green colours, which indicate more fertile conditions. They belong to the mountainous area of the Jabal al Nefusah in the west and the significantly as “Green Mountains” indicated area of the Jabal al Akdar in the east. The winter rain comes mostly from west and northwest; these mountains are characterised by Mediterranean vegetation and agricultural usage. Between these productive zones, there is a stretch of around 500 km between Surt and Ajdabiya where semi-desert conditions extend northward to the Mediterranean Sea. Along this stretch, only a small zone of sparse grassland can be found which separates the Sahara from the coast. Except in the east, where the mountains of the Jabal al Akdar directly reach the Mediterranean Sea, the coastline itself is mostly characterised by an alternating system of coastal oases, sandy areas and salt flats, or Sabkhas as the salt flats are called in Arabic.

A very specific Libyan feature in this context is given by the somehow impressive but disconcerting situation where life in the big agglomerations in the north is dependent on water from the arid desert areas in the south. Due to the technical progress and the availability of sufficient financial means since 1984, a large network of pipes, the so-called Great Man-made River, has been installed to bring fossil

groundwater from the Nubian Sandstone Aquifer System deep below the Sahara to the people who live along the coastline. Although this project ensures a reliable supply of water, it is proposed that the water reserves might be sufficient for not more than 50–80 years.

1.1.2 Population

According to the given conditions, the distribution and density of the population shown in Fig. 1.3 should be of no surprise. About 75% of the nearly 65 million Libyan people reside along the coastal stretch with concentrations on the urban areas of Tripoli and Benghazi and the mountainous hinterlands of these two agglomerations, the Jabal al Nefusah and the Jabal al Akdar. The other 25% are distributed amongst the different oases in the country’s interior and along the main roads connecting the populated places. Although well-known oases like Ghadamis, Sokna, al Fuqaha or al Kufrah or the big number of oases along the Wadi al Adjal owe their origin to the presence of water in a way that it could readily be made available, in recent times modern technologies lead to a larger degree in independence from those natural conditions. That allowed Sabha and the region around it to be developed as the biggest and most important populated area besides the coastal stretch.

An analysis of the distribution of towns and villages that depends upon ground elevation is equally conclusive

Fig. 1.2 Libya's main topographical features

(Fig. 1.4). Almost half of the population lives in settlements in the low-lying areas along the coast. These settlements are on average the biggest in the country. Most of the largest and fastest developing cities, namely Tripoli, Benghazi, Misratah and al Khums, can be found here.

The (on average and in total second largest) group of settlements are at a height between 350 and 600 m above sea level (a.s.l.). They cover, in particular, the hilly landscapes of the mountains in the hinterland of Tripoli and Benghazi. A few more settlements in this height range can be found

Fig. 1.3 Population density

Fig. 1.4 Population analysis

along the big wadi systems in the interior. Whereas Tarhuna in the eastern part of the Jabal al Nefusah shows up as a prosperous city, there are no outliers amongst the settlements in the south. This reflects the fact that there is a considerably slower development beyond the coastal region, where even

historically important oases like Murzuq do not play an important role anymore.

Nearly the same refers to the regions situated in a height range between 50 and 350 m a.s.l. that represent most of the semi-arid desert regions and some smaller depressions in the interior. Due to the natural conditions in these areas, only a small number of settlements and a limited percentage of the population can be found in this range. However, most of the oases in this height range are located in the lower parts and depressions of the desert regions. The most famous amongst them is the famous and historically important oasis of Ghadamis, situated in the Ghadamis basin.

The majority of settlements that lie in a height range of more than 600 a.s.l. can be recognised in the upper parts of the densely populated mountains of the Jabal al Nefusah and the Jabal al Akdar. They are complemented by a small number of oases in the mountainous area of the southwest. Although large in number, the settlements in this range are on average comparably small, and even the historically important oasis of Ghat is no exception to this.

1.1.3 Climatic Conditions

To understand the differences between the distinct regions of Libya such as the spots of activity along the Mediterranean coastline and the huge desert areas, one needs to look at the structures arising from the historical, political, economic and social development of Libya, which will be covered in detail in the next chapter. But there is another important aspect to this: the varying climatic conditions.

As shown in Fig. 1.5, the climatic conditions in the south are characterised by extreme temperature and high aridity. Although annual mean temperatures between 10 °C in mountainous areas and 24–26 °C in the low-lying sand seas appear to be quite tolerable, the daily variation during summer is enormous and ranges from 50 to 60 °C during daytime and 20–30 °C during the night. In winter, night temperatures up to 10–15 °C below zero are possible and not as uncommon as it would be desirable. Minimum temperatures of the coldest month with around zero degrees can be found in the tableland of the Hamadah al Hamra and the Masak Mastafat mountains, whereas maximum temperatures of the warmest month with 40 °C and more are typical for the southern part of the country and especially the sand seas of the Idhan Awbari and the Idhan Murzuq. Due to these circumstances, the temperature annual range is enormous and reaches from around 30 °C in the northern part to nearly 40 °C in the inner parts of the Sahara. Air humidity and precipitation in these desert regions cause at least as much inhospitable conditions as the ones caused by the high

Fig. 1.5 Climatic conditions in Libya

temperature. The air humidity in the Sahara is generally very low and does not exceed 20% relative humidity with a slight decrease from north to south. Such a slight decrease can also be seen in the data for the annual precipitation. Measures indicate an amount of less than 15 mm for the most part of the Sahara. Only in the northern areas between 28 °C and 29 °C, northern latitude up to 50 mm can be expected. In some parts, no rain at all may fall over several years, but then the statistically expected amount for these years may fall in only a few hours.

The predominant wind comes from the northeast and blows nearly constantly throughout the year. Locally, hot winds often lift sand and dust particles from the desert floor, whirl them up and move them over the surface as dust devils or take them south-westward as dust storms. In situations when the wind comes from the south, air masses from the desert called Ghibli reach the coastal region and cause very hot, dry and often dusty conditions.

In contrast to these conditions, the coastal regions are influenced by a Mediterranean-type climate with hot and dry summers on the one hand and mild and wet winters on the other hand. As a result, the annual mean temperature along the coastline mostly shows around 19–20 °C with a spot of 21 °C in the area around Tripoli. Slightly lower temperatures, around 17–18 °C, can be found in the mountainous area of the Jabal al Nefusah and most parts of the Jabal al Akdar. Comparably “low” temperatures of less than 15 °C can be seen in the higher parts of the Jabal al Akdar, thus representing the coldest region of Libya overall. According to the Mediterranean-type climate, the temperature annual range is completely different from the one in the Sahara and shows values of not more than 20–22 °C in those mountains and around 24 °C along the coastline itself. Only along the stretch between Surt and Ajdabiya with its semi-desert conditions, a higher annual range of up to 28 °C can be recorded. Due to the rainy winds coming from the west and northwest, the highest precipitation can be found in the eastern parts of the Jabal al Nefusah in the region between Tripoli and al Khums and in the Jabal al Akdar. Although limited to the period between October and April, the precipitation during this time reaches up to 500–750 mm which ensure the comparably good conditions for agriculture and housing already mentioned above.

1.2 Terrestrial Ecosystems

Klaus Braun and Jacqueline Passon

In line with its topographic and climatic conditions, Libya's terrestrial ecosystems are mainly characterised by the Mediterranean Macrogroups in the north and the Saharan Macrogroups in the south (Fig. 1.6). There is no sharp boundary between these two formations, but rather a transition zone with vegetation influenced by the adjacent both northern and southern Macrogroups. Nevertheless, the boundary between the Mediterranean and the hyper-arid

Fig. 1.6 Terrestrial Ecosystems in Libya

Sahara often follows the southern edge of the occurrence of the halfah grass.

The availability and the distribution of precipitation over the year are the determining factors for vegetation. The Mediterranean part of Libya, with its summer drought and

winter rain, is marked by evergreen sclerophyllous vegetation, which can protect itself from periods of drought and heat thanks to its specific adaptation mechanisms. The plants have small, mostly firm evergreen leaves with low moisture content. Additionally, some of them have an acicular shape,

are coated with a waxy layer or are partially hairy. In order to reduce water evaporation, the leaves can close their pores during periods of drought. Other plants, mostly herbs, do so by depositing essential oils. In addition, some of the plants have an expanded and deep-reaching system of roots to extract sufficient nutritional substances from the nutrient-poor soil. Known representatives of these plants are the olive and laurel trees, the cork oak and numerous herbs, such as rosemary or thyme. On the map that shows Libya's terrestrial ecosystems, these areas are classified as *Mediterranean Lowland Scrub* and *Mediterranean Montane Scrub or Mediterranean Montane Coniferous Forest*.

Low-lying areas along the coastline, where sea water occasionally reaches the surface, are exceptions to this pattern. Due to the high evaporation rates in this region, nearly all of the water evaporates, leaving flat salt pans. These areas, called *sabkhas* in Northern Africa, are characterised by particularly salt-loving varieties, including dense formations of perennial halophile grasses like alkali grasses or the halophyte grass *aeluopus littoralis*. Together, they form the *Mediterranean Coastal Salt Marsh*, which can mainly be found along the coast west of Tripoli, east of Misratah and in the region between Ajdabiya and Benghazi.

To the south, the *Saharan Shrub Steppe* with its shrublands and dry woodlands forms a transition zone between the Mediterranean coast in the north and the hyper-arid Sahara in the south. Wild olive and almond trees can be found here and there, but, above all, briars and undemanding grass varieties, such as halfah grass or drinn. In sediment basins without outlets, infrequent rainfalls form salt flats with no vegetation worth mentioning due to the instantaneous evaporation that leaves saliferous clay.

Despite the minimal and only sporadically occurring rainfall and a soil which, due to the slow soil-building processes, is poor in organic substances, the ecosystems of the Sahara, namely the *Saharan Desert Pavement* and the *Saharan Desert Dune and Salt Plain*, still have a flora with around 1200 different plant species. Over millions of years of natural selection processes, the plants in this region have developed specific survival capabilities. Those include extremely developed root systems, which either reach a depth of up to 35 m, or spread a closely meshed network of roots close to the surface. The root systems are large enough to compensate for the water shortage in the soil. In addition, plants have developed elaborate protection systems against evaporation, namely thick and small leaves which are covered with a waxy layer or plants which have the ability to roll up their leaves, such as grasses.

In the case of other plants, the so-called ephemerals, seeds can remain in the dry subsoil for many years until

there is sufficient rainfall. They suddenly start to grow and reach the blossoming stage and seed maturation within just a few weeks. If the subsoil is sufficiently fertile, the desert can temporarily be transformed into a blooming meadow after such rainfalls. However, adapting to the climate alone still does not guarantee the survival of a plant, because the danger of being eaten is particularly great in regions with sparse vegetation. Therefore, it is an advantage to have thorns, or even to be poisonous. The colocynthis, for instance, is such a typical desert plant from the cucurbit family, which has very eye-catching, yet very bitter green-to-yellow melon-like fruits.

The most beautiful desert plants sometimes are those which tap into the root systems of other plants as parasites. They form yellow or splendidly violet inflorescences which are up to one metre tall and burst out directly from the ground. Even in the sand seas of the Sahara, vegetation might appear when rainfall exceeds a minimum of around 50 mm per year. Usually, the vegetation here consists of various grass types, which are capable of covering their water needs with their extremely long roots. Only the constantly moving, dry and unstable sand dunes, which leave plants with no support, are completely free of vegetation. Additionally, as in other regions of the Sahara, low-lying areas and basins without draining form salt flats that are nearly free of vegetation.

Besides the above-mentioned bush and shrub vegetation, some regions with extra-zonal woody vegetation can be found in the Sahara, namely where a greater amount of water is available. In the ecosystems of the *Northern African Flooded Riparian Woodland* and the *Northern African Alluvial Wash and Riparian Vegetation*, the vegetation typically does not follow the rainwater as much as the groundwater, which it reaches with its roots. Therefore, Acacia trees or tamarisks equipped with this capability do not grow just anywhere in the desert, but along the groundwater currents that often follow dry river valleys, the so-called wadis.

Extra-zonal woodland vegetation can be found in the oases, which quite often have been developed around artesian sources in the Sahara, too. These guarantee enough water supply for humans, animals and plants so that the settlements can permanently be inhabited. Despite being a cultivated plant, most probably introduced by the Arabs, the most typical plant oases are usually associated with is the date palm. An oasis without it is hard to imagine. The main reasons for this are not only the optimal growth conditions with high temperatures and a groundwater level that can be reached by the deep roots, but also the fact that the date palm is usually the main cash crop of an oasis, besides olives and other fruit trees.

Apart from the zonal succession of the terrestrial ecosystems, the mountain chains of Jabal Akakus and Masak Mastafat in the southwest, the Tibesti Mountains in the south and the Jabal Uwaynat in the south-east form the somehow isolated ecosystems of the *Saharan Desert Rock Outcrop* and the *Saharan Herbaceous Steppe*. Due to the higher elevation, these regions usually receive greater and more regular rainfalls and are characterised by cooler temperatures than the surrounding hinterlands. These conditions result in a woody and bushy vegetation of palms, acacias, myrtles, oleanders and tamarisks, as well as the occurrence of some rare endemic species.¹

1.3 Green Spots in the Sand

Klaus Braun, Jacqueline Passon and Aniela Jeworutzki

The plants found during a journey through the Sahara demonstrate that the desert is neither lifeless, nor empty, but rather a diverse habitat. On the one hand, there are meadow plants and grasses. They are a basic resource for the extensive nomadic livestock farming and at the same time they were an important food resource for the caravans. Those plants can typically be found in the numerous oases of the Sahara such as Zillah, Tmissah or Murzuq. On the other hand, there are wild plants, typically growing on the gravel and rubble areas of the Sahara or along the wadis, where the groundwater currents are close to the surface.

There are a couple of plants throughout the Sahara which have been of great importance to the caravan trade. They supplied both humans and animals during their journey. Used as food, raw materials, tanning agents, dyes or medicine, plants have often been crucial for the success of a caravan. Others, like poisoning plants, could pose a substantial risk to the whole undertaking. Therefore, a good

knowledge of plants found along the trade routes was indispensable. The following profiles of typical plants found along parts of the old caravan routes give a brief overview of the green spots in the sand. Their locations are marked in the map of Libya's terrestrial ecosystems (Fig. 1.6).

1.3.1 Glasswort ①

The glasswort is an annual succulent herb with narrow to squamous leaves and small (about 0.5 cm in diameter), white blossoms with reddish to violet colouration (Fig. 1.7). Glasswort is a halophytic plant that accumulates salts in its leaves and stems as an adaptation to its saline habitat. The young leaves of many varieties are used for food, either as vegetables or as salad. In addition, the herb is used as a diuretic and as an anti-worm medicine. In Libya, the glasswort is mainly found in the deep-lying salty areas along the Mediterranean coastline, called *sabkhas*.

The species once was well known due to its use in the production of potash, soda and other alkalis. However, with the use of abraum salts and the soda industry, extraction of potash falls into decline and is now economically insignificant.

Type: *Salsola divaricata*

Family: Amaranthaceae

1.3.2 Date Palms ② ⑬

With up to almost 30 m in height, roots reach down more than 20 m into the underground, and an age of up to 200 years, date palms are likely to be the best known of all

Fig. 1.7 Glasswort found along with the Mediterranean coastline. Only a number of steps away from the sea, there are ideal growth conditions within a flat salt pan or *sabkha*. It is of little surprise that the glasswort has settled here

plants found in Northern Africa (Fig. 1.8). Probably originating from India or the Arabian Peninsula, this cultivated plant was introduced by the Arabs.

The date palm itself is a bisexual woody plant with a frequently branchless trunk. As a cultivated plant, it requires specific attention and has to be nurtured according to guarantee good returns. It needs enough groundwater or has to be irrigated adequately. The female trees have to be pollinated

to be able to produce the valuable dates. To achieve this, male trees are evenly spread over the date grove so that the male flower heads can be picked and put into the female trees by hand. This trick significantly reduces the number of male trees needed for the pollination, because one male tree can usually be used to pollinate up to 50 female trees, a procedure which sometimes is jokingly compared with a harem.

Fig. 1.8 Called the “green gold” of the desert, date palms are known to be the main cash crop of the oases and can be found everywhere where enough water is available

As the date palm not only provides dates, but also fibres, leaves and trunks used for making baskets, ropes, mats, sandals, furniture, building material and agricultural tools, it is also known as the “green gold” of the desert and has always been an important source of trade and nutrition.

Type: *Phoenix dactylifera* L.

Family: Arecaceae (palmae)

1.3.3 Ephedra ③

This light-yellow to yellowish green twig shrub can grow up to 2 m high (Fig. 1.9). The stems are rigid and hardly pliable. Sometimes, they have fine longitudinal grooves similar to box stems, but without thorns or visible leaves. This form of vegetation is present in nearly the entire Sahara, as well as in dry areas of Eurasia and America.

The tea prepared from this herb is known by various names like Mormon tea, herbal dynamite, herbal XTC, ma huang or ephedra, amongst others. What makes it so attractive are the medically active alkaloids contained in this plant, such as ephedrine, norephedrine and N-methylephedrine. These are chemically related to the group of amphetamines and increase the content of the stress hormone adrenalin in the body.

The ephedrine herb was first used in 1923 to treat asthma. In Germany, ephedrine is subject to the Commodities Control Act because it can be misused to produce methylamphetamine.

Type: *Ephedra alata*

Family: Ephedraceae (ephedra plant)

1.3.4 Twisted Acacia ④ ⑨

The twisted acacia, called *talha* in Libya, is a small desert tree with an impressive umbrella crown which can reach 2–8 m in height (Figs. 1.10 and 1.11). The tree develops deep roots and therefore grows in regions where there is water at great depths, which cannot be used by other plants. In the Sahara, those regions usually can be found along dry river valleys, the so-called wadis, or lower-lying basins where the groundwater level is at around 5–10 m.

The twisted acacia forms sharp and rigid thorns, which can grow up to 6 cm in length, thus protecting its young and finely feathered leaves. Unfortunately, this does not prevent the camels from sticking their lips between the thorns and successfully biting the leaves. Mainly from October to December, and also in March and April, the tree forms light-yellow blossoms, which are arranged densely in small globules. The fruits are spiral-shaped husks.

The extremely sturdy wood of the twisted acacia is used as building material by the people in the Sahara. Other species, especially the acacia Senegal, are used to obtain gum Arabic, which is a natural gum consisting of the hardened sap of those trees.

Although the acacias are sometimes used as a symbol for Africa and are quite often described as somehow mythic trees by the early Saharan travellers, they are not only found there. Indeed, there are about 700–800 different species of acacias, with half of them growing in other regions, like Australia and the Pacific Ocean islands.

Type: *Acacia raddiana*

Family: Mimosaceae (mimosas)

Fig. 1.9 Ephedra located between the oases of Zilla and al Fuqaha. This plant can be found almost in the entire Sahara and is well known by the people who live there. It is traditionally used as medicine, or sometimes even as a drug, and plays an important role in the local lifestyle and the traditional caravan trade system. Burning of the ephedra (photograph on the right): after inhaling the smoke, mild physical and mental stimulation can be expected

Fig. 1.10 Twisted acacia found in lower-lying basins within the mountains of the Harudj al Aswad (above) and along a dry wadi within the mountains of the Jabal Bin Ghunaymah (below), where the groundwater levels can be reached by the roots of those trees

1.3.5 Wild Gourd ⑤

The wild gourd or colocynth is a desert plant native to Northern Africa (Fig. 1.12). Most probably, it was already known as a medicinal plant during the time of King

Solomon. Other common names are bitter apple, bitter cucumber, desert gourd or vine of Sodom. The plant's long taproots reach deep into the ground, while its vine-like stems spread in all directions trying to find something to cling on using its auxiliary branching tendrils. The wild gourd has

Fig. 1.11 Thorns of the twisted acacia are very sharp and rigid to protect its highly demanded young leaves

Fig. 1.12 Wild gourd spread out in a small depression at the edge of the mountains of the Harudj al Aswad. Because of their bitterness, the fruits are usually not fit for human consumption, but nevertheless used for medical treatment

large yellow blossoms, and its leaves are pinnately lobed, coarse and hairy. The yellow or sometimes also green-striped fruits are usually as big as a grapefruit. As they are very bitter, they are usually not eaten, but only used as a source of food in bad years. Until today, the dried skin of the immature but full-grown fruits is used for medical treatment.

Type: *Colocynthis vulgaris*

Family: Cucurbitaceae

1.3.6 *Pulicaria crispa* ⑥

Pulicaria crispa (Figs. 1.13 and 1.14) is one of the most common plants throughout the entire Sahara. There are many locally used names, depending on the region, but not a single one which can easily be taken as a common name at all. Typically, it is used as nourishment for the camels and other domestic animals. It has an aromatic, slight taste of

ginger. In the Sahara, it is used for infusions and sometimes for medical treatment.

The plant forms a thick, almost spherical bush that grows up to 60 cm in height. The upper area has many branches with lots of tiny yellow flower heads. The leaves are slim, around 10 cm long, and more or less hairy on the underside. The leaf margins are rippled.

Type: *Pulicaria crispa*

Family: Asteraceae (Compositae, Aster family)

1.3.7 Meru (Sarh) ⑤ ⑩

Meru, or Sarh, as this tree is called in Libya, is an evergreen tree with a spreading, well-branched crown, which reaches a size of up to 10 m (Fig. 1.15). Its oval and fleshy leaves grow directly from the trunk or the branches. It can be found in drier, often sandy areas all over Northern Africa.

Fig. 1.13 Overview of a small depression at the edge of the mountains of the Harudj al Aswad where mainly wild gourds, *Pulicaria crispa* and even twisted acacia can be found. One characteristic of this area is that occasional rainwater accumulates in these depressions or small basins, thus leading to comparably good conditions for plant growth. Used as pasture land, the depressions are called Grar in Libya

Fig. 1.14 *Pulicaria crispa* growing in a small depression at the edge of the mountains of the Harudj al Aswad. As it can be used as nourishment for the camels as well as for preparing aromatic infusions, traditional caravans have always been pleased to find it along their trade routes

The tree is harvested from the wild for local use as a source of food, as any type of material and as a medicinal plant. Although the wood is mostly considered as unsuitable for firewood as it produces smoke with a nauseating stench, there are tribes that live in Libya who fumigate containers with a burning stick and it produces a good smell. In terms of its medical properties, it is reported that it is used by women during their pregnancy, apparently for the induction of labour. The young branches are widely used as chew sticks, especially in Northern Africa.

In Arabic, the tree is called Meru, a name used in the eighteenth century as the source for the genus name *Maerua*.

Type: *Maerua crassifolia*

Family: Capparaceae (Caper plant)

thorny twigs at the end. Its small trunks are 3–6 cm thick, and the leaves consist of three leaf lobes.

Since the wood of this shrub is very sturdy, it is used for the production of any kind of everyday objects, from knife handles to saddle frames. Furthermore, the wood is used to produce charcoal for sometimes very cold winter nights in the desert. The fruits of the sumac tree can be eaten, and the leaves and flower buds are often chewed to banish thirst.

Even if the sumac tree could be found almost everywhere in the Sahara, there are areas in which the shrub has been overused and is nowadays quite rare.

Type: *Rhus tripartitus*

Family: Anacardiaceae (Sumacs)

1.3.8 Sumac Tree ⑦

The sumac tree, called *Ischdari* in Libya, is a shrub which is native to nearly the entire Sahara (Fig. 1.16). It can reach a height of up to 3 m, with densely ramified branches and

1.3.9 Wavy Heliotrope ⑦

The wavy heliotrope is an herbaceous perennial plant that can grow up to 50 cm tall (Fig. 1.17). The plant is densely branched from a wooden base and presents alternate, simple

Fig. 1.15 Sarh tree in a sandy area within the mountains of the Harudj al Aswad. Especially, during dry periods the plant is an important source of nutrition. Camels are fond of the flowering shoots

and frequently bristly, hairy leaves. It is likely to be found in sandy wadis or on calcareous ridges and is sometimes abundant in poor pastures.

In some regions, the dried and powdered plant is added to water and drunk to combat fatigue; while in other regions, it

is applied to treat headaches. Besides its medical use, a macerate of the plant is used as ink in the Western Sahara.

Type: *Heliotropium ramosissimum*

Family: Boraginaceae

Fig. 1.16 The sumac tree, or Ischdari, is known to provide sturdy wood which can be used for many purposes of desert life. Additionally, the green leaves are eagerly eaten by camels and other animals

Fig. 1.17 The wavy heliotrope is one of the Saharan herbaceous plants which are used for medical applications. According to the region, the local knowledge and the tradition, the use varies upon the different diseases treated by medicine based on this plant

1.3.10 Tamarisk (Athel) ⑧

The tamarisk is one of the most frequently occurring plants in the Sahara and can particularly be found in regions where the groundwater level can be reached by the deep-ranging roots (Fig. 1.18). The tamarisk, called Athel in Libya, has

long, slender branches with numerous small, grey-green and scale-like leaves. Clusters of small pink flowers, hanging at the ends of branches or from the trunks, give the plants a feathery appearance.

Because of the mostly sub-optimal growing conditions in the Sahara, the tamarisk quite often develops only into

Fig. 1.18 A Tamarisk (near Tmissah) grows on top of a small elevation formed from its own falling leaves, dry and deadened branches and aeolian sand deposits

bushes or shrubs. In case of comparably good conditions, the plant can grow up to 10 m tall and forms knotty, warped trunks with strong barks.

Together with dry and deadened branches as well as aeolian sand deposits, the falling leaves form a stable, matted wickerwork which over time can reach some 3–5 m, with large clusters of tamarisks on top.

In the Sahara, the wood of the tamarisk is mainly used for carpentry or firewood, while the plant galls may be used to tan sheep or goat skins. The sugary excretions of the *Tamarix mannifera* are collected as manna and used in folk medicine.

Type: *Tamarix*

Family: Tamaricaceae

1.3.11 Goosefoot Plant ⑪

The goosefoot plant (Fig. 1.19) is a woody, stout and much-branched shrub usually 30–70 cm tall, which can be found throughout the entire Sahara, and it favours saline and sandy places (Fig. 1.18). Its leaves are sessile, small (2–4 mm in size) and rounded and often also found in a pyramidal form. They are densely grouped on the thin branches. If there is good water supply, the leaves are very fleshy. Otherwise, they can be hard and crumbly.

The juice of the leaves contains odorous substances (amines) that smell like fish. Without this penetrating fish odour, it could easily be confused with the Mediterranean saltwort or *Salsola vermiculata*. While the latter is often

used as a fodder plant, the goosefoot plant is grazed by camels, but only reluctantly by other livestock animals. According to the people living in the desert, the goosefoot plant is therefore primarily good for making fire or as a certain type of fuel.

Type: *Salsola baryosma*

Family: Chenopodiaceae

1.3.12 Silla (Agul) ⑫⑮

Silla is one of the classic thorn bushes of the Sahara (Fig. 1.20). It can mainly be found in parts of wadi beds that are covered with alluvial deposits. Known as *Agul* in Libya, this plant has light violet flowers with four identical flower petals. The leaves and the shoots have developed into sharp, hard thorns, and the fruits are chickpea-like. It reaches a height of 0.3–1 m and forms a bushy and spherical shape.

After dry years, only light to dark brown bushes remain in the landscape, often entwined by other plants.

Occasionally grazed by camels, silla is mainly used for urinary tract diseases.

Type: *Zilla spinosa*

Family: Brassicaceae

1.3.13 Milkweed ⑭

The milkweed is a 1–4-m-high flowering plant with very large round to heart-shaped leaves which can reach up to 20 cm in diameter (Fig. 1.21). Its bark is light greyish-brown, very

Fig. 1.19 The goosefoot plant can be found nearly everywhere in the Sahara and especially in those places where saline and sandy conditions exist. Grazed by camels, this plant is only reluctantly eaten by other livestock animals

thick, corky and deeply rutted. It forms clusters of violet flowers and red fruits, which can grow up to the size of mangos.

The milkweed is native to Northern Africa and can usually be found at the edge or in the middle of dry river beds. Traditionally, the milkweed was cultivated as an ornamental plant, but it has fallen out of favour because the leaves and stems contain a white, sticky and very poisonous milky juice. Already mentioned in ancient times, this plant is known by a lot of common names, for example apple of Sodom, kapok tree, rubber bush or swallowwort.

Type: *Calotropis procera*

Family: Apocynaceae

1.3.14 Grape Vine ⑩

Being known for loving warm to hot temperatures and adequate water supply, the grape vine is a common plant within the Mediterranean region. There its deep roots are usually able to get to the groundwater and help to withstand

Fig. 1.20 Silla, called Agul in Libya, is a typical thorn bush of the Sahara, which forms sharp and hard thorns, and is quite often entwined by other plants

the dry summers (Fig. 1.22). The grape vine is known to be one of the oldest cultural plants of humankind. Picture representations of its cultivation are known from Egypt, dating around 3500 BC.

When Libya was an Italian colony, the grape vine was one of the most common fruit trees in the oases. In those days and until the 1950s, it was usually cultivated in mixed plantations together with olive, almond, wheat and barley. The grapes were commonly used as a fresh fruit, to produce grape juice, or dried and used as raisins for baking and cooking. While in other countries grapes have mainly been

Fig. 1.21 A milkweed tree near a house in the oasis of Murzuq. Although native to Northern Africa and traditionally used as an ornamental plant, the milkweed has fallen out of favour because of its poisonous sap and is mostly regarded as a weed

used for making wine, this has never been the case in Libya because of the prohibition of alcohol.

Using irrigation and semi-irrigation techniques, the cultivation of grape vine was not only limited to the Mediterranean region, but could also be found in oases in the south. In the 1950s, the cultivation of grape vine declined in favour of citrus plants.

Grape vine can still be found at several places in Libya today, including traditional farmland in the middle of the

Fig. 1.22 Grape vine located at an old farming area near the oasis of Tasawah, west of Murzuq. Although grape vine is not common in Libya any more today, the plant reminds of former times when it was used as an important agricultural crop by Italian colonists

desert. Mostly, however, these are relicts from the past rather than representing important agricultural crops.

Type: *Vitis vinifera*

Family: Vitaceae²

1.4 Human Activity

Klaus Braun

A good opportunity to get an overall impression of human activity at night is provided by the use of satellite information of the earth.

Figure 1.24 shows Libya like it is seen in the “Blue Marble” images recorded by the VIIRS on the Suomi NPP satellite in 2012. This image is overlaid with the SRTM digital elevation model and supplemented by the populated places taken from the National Topographic Map of Libya and the populated places dataset from the Natural Earth archive.

As the night-time lights illustrate in this map, most of the human activity can be observed within the triangle between Zuwarah, Gharyan and Tripoli. Other spots of activity can be found in the Jabal al Nefusah and in the Jabal al Akhdar and also in the south in the region of Sabha. Most of the major oases in the desert region like Ghadamdis and Ghat in the west or al Kufrah in the east can also be detected by their visible light emission and even smaller oases like al Qatrun or Tajarhi in the south glow through the night. Even more surprising than the night-time lights that correlate to human settlements and built-up areas are the large spots of light in regions where no villages exist. This is the case in some

areas along the border with Algeria in the west, in the southernmost part of the Idhan Awbari and in the almost uninhabited region of the Sarir Kalanshiyu. Like in the other areas, the night-time lights here suggest human activity. But in this case, the different “seas of light” are associated with the oil fields and the flaring of gases associated with crude oil production at those sites.

Accepting the fact that the economic development of a country is somehow reflected by changes in the emission of light, differences between appropriate satellite data taken at different times can help to detect and understand

characteristics of spatial development patterns. With this in mind, composites of the NOAA DMSP-OLS Nighttime Lights Time Series from 1994 to 2009 (Fig. 1.23) have been used to analyse those changes for Northern Libya and especially along the coastal stretch where most people live. The result of this comparison is shown in Fig. 1.23 where increasing light emissions are marked by colours that turn from light to dark red. Comparably small changes in situations where high light emissions have already been recorded in the past are marked by yellow and orange colours.

Fig. 1.23 Night-time light emission changes between 1994 and 2009 in northern Libya

Fig. 1.24 Night-time lights in 2012

The predominant impression is that nearly everywhere where people live, light emission has increased, although the differences vary widely. Most of the increase can be seen along the stretch between Zuwarah and Tripoli, in the regions south and south-east of Tripoli and along the connection between Tripoli and Gharyan. East of Tripoli, the coastal road to Misratah appears as some kind of a secondary development axis. Beyond these axes, high increases in light emission are more or less bound to the surroundings of bigger cities along the coastline like Surt, Benghazi or al Bayda or to major oases in the interior like Bani Walid,

Ghadamis or Dirj which appear as somehow isolated development spots in the otherwise almost light free environment. Minor increases in light emission can be found around nearly every populated place, equally whether it is a small village like al Qaryah ash Sharqiyah or medium-sized cities like Mizda or Ajdabiya.

Besides these indications of increasing development, the yellow spots that identify high light emissions today and in the past remain remarkable as they refer to cities and oases with a comparably long history and places of great importance. First of all, this is true for the city centres of Tripoli

and Benghazi, but also for smaller centres like the ones of Zlitan, Misratah, Bani Walid, Ajdabiya, al Bayda or Tubruq. They can be detected as historical spots in an area with otherwise only few urban settlements.

1.5 Libya and Its Regions-Details About the Old Cultural Landscapes of Tripolitania, Cyrenaica and Fezzan

Jacqueline Passon and Klaus Braun

Whereas a more natural landscape-based characterisation of Libya results in a, broadly speaking, fertile and liveable north and a sparse and hostile south, the distribution of the population and the spatial differences in human activity indicate further distinctions. Those include, in particular, the ones between west and east. This leads to a three-way split of Libya into the regions of Tripolitania in the northwest, Cyrenaica in the east and Fezzan in the south, which can be understood as a result of the specific historical conditions in these regions.

With respect to designations used for these regions, it can be seen that even their names reflect somehow the historical development with its long-lasting series of discovery and colonisation. Whereas Tripolitania and Cyrenaica are denominations which are derived from Roman provinces, the name Fezzan is said to come from the Tuaregs' word Taffsania which means "the edge of the hill". Others, however, believe that the name is derived from the Roman word Phasania or Phazania, which may mean "the country of the pheasants" and had been used at the time of the Islamic conquest.

But regardless of the given designations, the historical approach of Libya as a country constituted of three main regions has been maintained to the present day and can be used to reflect in more detail differences not only in the natural landscape but also in the culture and tradition of the Libyan society.

1.5.1 Tripolitania

Starting with the north-western part of the country, the so-called Tripolitania region, the natural landscape is composed by the coastal plains of the Jefara and of the Dafnia, the mountainous escarpment of the Jabal al Nefusah and the adjacent stone desert of the Hamadah al Hamra. A steep slope towards the south leads then to the sand, gravel and scree desert of the southern region called Fezzan.

The coastal plain is a steppe. It is divided into the Jefara in the west, which stretches from Gabes in Tunisia to al

Khums, and the Dafnia in the east, which comprises the narrow coastal strip between al Khums and Misratah. Although named plains, they show significant differences in height. While they are flat near the coast, the land rises gently towards the south and reaches, for example, a height of up to 380 m at the slopes of the Jabal al Nefusah. Overall, the coastal belt is defined at many places by sabkha areas in the south that extend up to 15 km inland.³ A conspicuous morphological element is the few watercourses. In the west, there are only small wadis that end immediately after exiting from the Jabal as their water volume is too low. In the east, on the other hand, where the Jabal approaches the coast, the wadis of Raml, Mzid and Turgut reach the sea.

The Tripolitan highlands are nestled at the Jefara. The Jabal al Nefusah (Fig. 1.25), which is composed of lime, gypsum and sandstone, is a 400-km-long plateau that rises 300–400 m above the Jefara and marks heights around 600 m above sea level. Permeable and soluble rock is characteristic for such karstic areas. The water seeps, flows underground and accumulates in the mountains wherever it meets the solid, impermeable base rock and emerges then as a spring at the edge of the Jabal. These springs are centres of small settlements, where fruit trees flourish and vegetables and cereals are grown on parcels. Due to the location of the Jabal al Nefusah, changes can be determined from west to east. In the eastern part of the mountains, precipitations are higher and the ground is more fertile.

The cultivation of grain and the planting of oil, fig and almond trees have brought along with radical changes in the landscape, particularly in the eastern part of the Jabal since the Italian colonisation. In the western part, the precipitations are too low and the soil layer is too flat for appropriate use. Adjacent to the Jabal in the south, there is a roughly 100–150 km wide belt of steppes and wadis located at 600–700 m above sea level. To the east, it extends until the Greater Syrtis where it reaches up to the coast. In the south, it is joined by the Hamadah al Hamra, the red rock desert. This is a wide basin plain, which is covered with blocky, angular rubble or rock material. The region's name, red rock desert, is derived from the red soil that emerges between the rubble and rock materials. However, the Hamadah al Hamra is no wasteland. Between November and April, the area is used as a pasture for cattle.

The Greater Syrtis is the separating element between the two main settlement areas in the west and east. The "hinterland" of the Syrtis consists of vast stretches of sand with numerous sabkhas, dunes and several wide wadis. After sufficient spring rainfalls, this area is covered by a short-lived vegetation. Owing to the comparatively favourable topographic and climatic conditions, the coast of Tripolitania emerged as one of the most important regions of Libya. The capital of which, Tripoli, became the historical

Fig. 1.25 View from the Jabal al Nefusah to the Jefarah Plain

starting and end point of the trade routes to the south. It has retained the name of the late antique small province of Tripolitania.⁴

The cultural landscape has been shaped by an eventful past. Many traces of ancient settlement activities can be found. The cities of Sabratha and Leptis Magna, which have been awarded with the status of world heritage, are impressive examples. Elements of the traditional Berber cultural landscape can be found mainly in Jabal al Nefusah where the granaries of Nalut and Qasr Hajj provide impressive architectural evidence. Berber tradition can also be found in the oasis of Ghadamis. In addition to the settlement artefacts, traditional forms of agriculture such as rainfed cropping of grain, fruit-tree cultivation and the traditional oasis cultivation can still be found here.⁵

Today, Tripolitania has undergone modern modifications in many parts, especially in the coastal areas. Contributing factors to this were mainly the state colonisation by the Italians in the years between 1922 and 1940, the settlement

projects during the years of the kingly rule as well as the settlement and economic policy of al-Qaddafi. First, the Italian colonists settled in the north of Tripolitania and the Cyrenaica. They established agricultural family businesses and settlements, which were adapted to southern European development standard. Apart from the large concessions with their stately homes and tenant houses, scattered settlements emerged. The Italian settlers took the entire fertile arable land into their possession and pushed the Libyan tribes into the steppe region. They were left with livestock breeding as the only form of economy. In 1959, the Libyan government founded settlement projects to resettle these nomads and landless farmers, who had once been expelled by the Italians, and to turn them into sedentary farmers. Within the wake of al-Qaddafi's decentralisation policy, these projects were expanded further. Today, the coastal strip of Tripolitania is characterised by an almost continuous urban ribbon, which reaches from Sabratha via Tripoli up to Misratah.

1.5.2 Cyrenaica

Characteristic for the second region, the so-called Cyrenaica which covers the north-eastern part of Libya, is the Jabal al Akdar, the karstic mountains called “Green Mountains” with its densely grown slopes. The entire mountainous area, which reaches a maximum elevation of 880 m, is, together with the small coastal strip, another major settlement and agricultural region of Libya (Fig. 1.26). Sufficient winter rainfalls and a relatively mild climate allow for lush vegetation and agricultural use.

The external appearance of Cyrenaica can be divided into three parts: the highlands, the southern slopes of the mountains with the western and eastern foreshore areas and the adjacent desert areas. Only a small coastal strip separates the Jabal al Akdar from the sea. East of Susah, the ancient Apollonia, this strip becomes wider and turns into gentle hills. The coastal strip narrows to an extent in some places that the mountains rise straight from the sea. The rise of the

mountains takes place in two steps. The first, more northerly step, rises steeply up to 300 m above the sea and has an overall length of around 400 km. Short and steep wadis cut through the slopes covered with Mediterranean shrubs. The second, more southerly step, rises somewhat more gently. It is 300 km long and towers above the first level by 150–200 m so that it reaches a height of 500–600 m above sea level. Between the stepped slopes, a plain extends towards the sea that is characterised by depressions and sinkholes. These types of landscapes are created by water accumulation on insoluble sediments and the resulting horizontal erosion.

A very fertile zone extends over large parts of the heavily karstified plateau between the two Jabal levels. So-called poljes, large closed cavities with underground drainage, are typical for karstic areas. One must imagine those as predominantly elongated, partly valley-like winding basins with almost level ground. Poljes offer favourable conditions for agriculture. Therefore, agriculture is limited to plains and wide valleys in the Cyrenaica. In the narrow valleys of the

Fig. 1.26 The settled region of the Cyrenaica is characterised largely by the upland plateau of the Jabal al Akdar

mountains, or even on its slopes, wood is chopped or cattle are grazing. An undulating plateau that slightly slopes to the south joins the second step. South of the watershed starts the flat southern slopes of the Jabal which are covered by steppe.

In line with the common division of Libya, the Cyrenaica comprises, apart from the historic landscape in the north, also the gravel and sand deserts. They join this steppe belt in the south and consist mainly of scree and gravel plains as well as dune seas. Referred to as the Libyan Desert in the border area between Libya and Egypt, this landscape shows all characteristics of the inhospitable and almost uninhabited expanses of the Sahara desert as they are also typical for the Fezzan. Only in the remote south, the oases al Kufrah and al Uwaynat are witnesses of human existence in the otherwise still less developed area.

Particular importance is attached to the desert areas between Jalu and al Kufrah due to the fact that the region is home to a large part of the resources, which are indispensable for the Libyan economy. In addition to crude oil and natural gas, the extracted fossil groundwater, which is pumped with immense effort from the many wells with depths of more than 500 m, supplies the inhabitants of the coastal regions using a gigantic tube system.⁶

The population of the Cyrenaica mainly concentrates on the coast and in the Jabal al Akdar. The main town with the seat of the administration is the port city of Benghazi. Since the onset of the crude oil boom, the city has recorded a steep economic upswing and today is the country's second largest city. The Cyrenaica's cultural landscape has experienced modern modifications, as did Tripolitania. Throughout the area there are numerous traces of ancient settlement, traditional Berber elements, however, are rare. The creation of about 1800 agricultural family businesses in the course of the "Ente per la Colonizzazione della Libia" by the Italians greatly changed the face of the Cyrenaica between 1932 and 1940.⁷ The previous landowners, nomadic and semi-nomadic tribes, who drive their herds from the steppes in the south to the pastures of the Jabal in the hot summer months, were pushed into the barren steppe areas south of the highlands. Attempts were made to revive agriculture after the independence of the country in 1951, as in Tripolitania. However, only the "Jabal al Akdar Project" implemented in the mid-1970s was able to further stimulate the agricultural development of this area.⁸

1.5.3 Fezzan

The Fezzan, as the third Libyan region, can be described as the one, which does belong neither to Tripolitania nor to the Cyrenaica. In short, it can be described as the large remaining part. As part of the Sahara, the landscape is characterised by rocky, gravel or sandy desert areas which

enchant with their wide-open and constantly recurring bizarre terrains.

Amongst the most famous topographic features within this area are certainly the Ergs or Idhans, as the sand dune fields or sand seas are called in Libya. The biggest ones like the Idhan Awbari or the Idhan Murzuq in the western and south-western parts of Libya cover an area of around 50,000 and 80,000 km². The sand dunes themselves appear in a multitude of shapes, depending on the wind conditions and the occurrence of water and vegetation. Some of them are oriented parallel to the direction of the prevailing wind, with a height of a few metres and up to 50 km long. Others look like crescents, with a steeply sloping leeward surface, or like parabolas with convex noses trailed by elongated arms, or like a mixture of both, as they give the dunes the shape of a star. With heights between 5 and 40 m and an extent of around 5–400 m in width and 25–20 m in length, those dunes often move with the wind and tend to migrate 5–100 m a year.

Although the sand dunes are somehow an allegory of the Sahara in general and of the Fezzan, in particular, most of the surface is covered by plateaus, arid mountains, sand- and gravel-covered plains, shallow basins and large oasis depressions.

In the western part and especially along the transient area to the Tripolitanian region, impressive tablelands like the Hamadah al Hamra, which are extending of several hundreds of kilometres and partly dissected by big wadis (Fig. 1.27), shape the landscape. In the central part, huge areas are built up by gravel. In Berber language, such areas are called Serir, meaning wide flat depressions. This then describes the occurrence of those landscapes within large basins and wadis.⁹

Originally called "*Qued*" in North Africa, the wadis refer to a normally dry riverbed that contains water only during times of heavy rain. Initially modelled by large rivers in times when the Sahara region was wet and green, today those dry valleys impress by their huge extent. In cases of sudden heavy rainfall, resulting flash floods can cause dangerous situations so that the crossing of wadis always bears a certain risk. Nevertheless, wadis often tend to be associated with human activities because of the existence of sub-surface water and sporadic vegetation.

Volcanic mountains like the Jabal as Sawda, the al Haruj al Aswad and the Waw an Namus sometimes force a break in the monotony of those plains. The same holds true for the arid mountains of the Jabal Akakus and the Masak Mastafat with their bizarre arches, gorges, isolated rocks and deep ravines. Although affected by one of the harshest living conditions in the world, human activity in the Fezzan has a long history. Traditionally and even today, the basis therefore is the availability and accessibility of fossil groundwater. Especially in low-lying areas and depressions, where it can be found only some tens of metres below the surface,

Fig. 1.27 Wadi system in Fezzan

such groundwater can easily be accessed by digging wells or by using simple pumps. In a usually hostile area like the Fezzan, such places look almost like a miracle. It is of no surprise that such places like the oases of Ghat or Murzuq are associated with a specific kind of mystery and supernaturalism.

In the Fezzan region, most of the oases that depend on fossil water can be found along the three more or less parallel and west-to-east-oriented low-lying areas of the Wadi al Shati, the Wadi al Adjal and the Wadi Murzuq. Whereas the northernmost of these three areas, the Wadi al Shati along with the northern edge of the Idhan Awbari with the oases of Adiri, Tmisan and Birak is said to host nearly 75% of all wells in the Fezzan, the most impressive of all those wadis seems to be the Wadi al Adjal. This region south of the Idhan Awbari between the oases of Sabha and Awbari is characterised by a large number of little villages with green palm gardens and huge sand dunes in the north. Like a miracle in the midst of these sand dunes, a considerable

number of lakes can be found, indicating a groundwater level close to the surface. It is assumed that in times of higher precipitation, a huge number of those freshwater lakes covered this area before they disappeared around 5900 (± 1000) BC. Recent lakes like the picturesque ones of Gaberoun and Umm al-Maa, which means the mother of water, can be seen as relicts of gradually colder and wetter conditions. According to archaeological findings in this area, this allowed for human presence during the Pleistocene and Holocene eras.

The cultural history of the Fezzan is directly connected with the succession of humid and arid climate periods. Climatic and ecological conditions can be recorded for the early Neolithic period, around 10,000 BC, which allowed the repeated encroachment of people to the interior of the Sahara desert. The Epipalaeolithic from the northern edge of Africa is classified as hunters and gatherers just as their predecessors. The diffusion of the rock drawings suggests that these tribes with a semi-nomadic lifestyle spread from the entire

North African coast into deep in today's Sahara desert. Most of these drawings can be found in the Acacus Mountains and Tibesti Mountains in the Fezzan; however, even in Tripolitania rock, drawings were found. The development of live-stock farming and later of hoe cultivation is attributed to their Neolithic descendants. Because of good storage management, the people were able to spread out in large parts of today's Sahara area. The invention of pottery and the spread of terracotta about 6–8 millennia ago marked a profound change in prehistoric times: At that time, the transition from cyclical wandering that depended upon rainfalls and food resources to sedentarism took place. The time around 5000 BC then marked again the beginning of a long-lasting drought in the Sahara desert.¹⁰ This change goes hand in hand with the domestication of cattle, sheep and other livestock. Agriculture, however, never became a dominant form of economy. At the end of the Neolithic period, wherever there was sufficient water, a farming oasis economy was created due to the progressive desertification. Up to 3000 BC oasis, farmers had established themselves in all important parts north of the central Saharan uplands using irrigation techniques. This process led to sustainable ethnic changes and cultural differentiation. The Neolithic period marked the most dynamic phase of human development in the Sahara desert. This period is characterised by the spread of pastoral nomadism, agriculture and the emergence of urban centres. The cattle nomad culture in the Fezzan is interpreted as predecessor culture of the Garamantes.

Another living testimony to the existence of human civilisation in the Fezzan region is the oasis of Jarmah, which today acts as a central point within the Wadi al Adjal. Excavations and historical sources prove that in ancient times, an empire existed there that was able to maintain active trade relations with cultures in Central Africa and the Mediterranean and which could successfully oppose the Roman expansion around 20 BC. Towards the end of the 2nd Millennium BC, Mediterranean peoples had advanced with horses and chariots from the Libyan Mediterranean coast towards the Central Sahara and expelled the negroide population of this area. These were the people of the Garamantes, as first described by Herodotus, whose political and economic centre became the Wadi al Adjal. They are described as farmers and ranchers and worked mainly as traders. The Garamantes controlled the trade routes between the Mediterranean and Africa's sub-Saharan regions. They also built irrigation systems and cultivated date palms.

Despite the imprint left by Arab influences over hundreds of years, the Fezzan shows many traces of this previously existent golden age of the Berber. Apart from the archaeological evidence, especially the numerous *Foggara* conduit systems give evidence about the cultural achievements of the

Garamantes. These "underground tunnels" are a kind of horizontal wells, which are used to tap the groundwater level in the higher mountain regions. The available drinking and service water is then guided to the lower-lying oases. This technique, dating back over 3000 years and probably originating from present-day Iran, permits the establishment of oases where the groundwater level is too low to be reached with conventional wells.¹¹

In addition, there are many so-called *qsur* (desert castles, singular *qser*), castles consisting of clay bricks. The earliest examples in the Fezzan are attributed to the outgoing 1st century BC. Most seem to be assigned to the middle ages (see *On major Trans-Saharan Trails*). The traditional Arabic-Fezzan cultural landscape was strongly altered in the oases by modern Libyan cultural landscape elements, and it must, however, be added that the old settlement areas were usually not covered by superstructures. The set-up of planned villages and agricultural farmland in the course of the decentralisation forced by al-Qaddafi since the 1970s was carried out in the vicinity of the traditional settlements. However, this policy could not prevent that three-quarters of the Libyan population concentrated on the coastal strips, yet it ensured that the inland was not depopulated and not cut off completely from modern developments. An example for this is Sabha, currently the third largest city in Libya and today's centre of the Fezzan. Between 1995 and 2006, the population growth in the region around Sabha was after all almost 3% resulting in the fact that the population in this area tends to grow, although slower than on the coast.¹²

As the inhabitants of today's oases were traditionally deeply involved in trans-Saharan trade, they lived until 2011 more on direct and indirect government support. This support was provided by infrastructure projects such as the construction of schools or universities or large-scale, agricultural projects based on artificial irrigation, which should contribute to the supply of the Libyan population.

Notes

1. Houérou (2008).
2. Bayer and Ritter (2006, 32–45), Zech and Hintermaier-Erhard (2002), Strasburger (2002), Schroeder (1998), Western (1989), Schubert and Wagner (1988), Dittrich (1983), Schiffers (1971), Kassas (1967, 162–181), Suter (1967, 65–123) Interviews with elders from Zillah, al Fugah, Murzuq, al Qatrun and Tajarhi.
3. Hecht, Fürst Klitzsch (1964, 413–470).
4. Baume and Sager (1992, 208–213), Schiffers (1975, 87–121), Ahmad (1969, 24–51), Hecht et al. (1964, 413–470).
5. Weis (1966, 17–24).

6. Braun and Passon (2009, 56–66), Schiffers (1975, 26–133), Ahmad (1969, 24–27), Suter (1967, 65–123), Hecht et al. (1964, 413–470).
7. Ahmad (1969, 24–27).
8. Schiffers (1975, 126–133).
9. Brentjes (1982, 14), Ahmad (1969, 24–27).
10. Brooks et al. (2004, 35).
11. Klenkler (2005, 110–127), Brooks et al. (2004, 35–39), Brooks et al. (2003, 73), Mattingly et al. (2003, 337), Brentjes (1982, 16–34), Ziegert (1969, 49–58), Ergenzinger (1969, 59–81).
12. Braun and Passon (2009, 56–66).

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