General overview

Algeria is a North African country with a coastline of approximately 2,148 km (1,200 km in a straight line) along the Mediterranean Sea. With an area of 2,381,741 million km², it is the largest country in Africa and the Mediterranean region. The country stretches from north to south for more than 2,000 km.

Due to its geographical location, and subsequently its history and culture, Algeria has always been a crossroads of various civilizations (Phoenicians, Romans, Vandals, Byzantines, Muslims, Ottomans, and French) throughout its history and a communication route between Europe and Africa and between the Mashriq (Arab East) and the Maghreb (Arab West).

Because of this geographical location, its soil diversity and its orotopographical contrasts, including coastal areas, plains, mountainous areas, steppe areas, Saharan or desert areas occupying most of the territory, etc., Algeria also has a wide variety of climates, as it encompasses all Mediterranean bioclimatic zones, from humid to Saharan, and, as a result, a wide variety of fauna and flora.

The northern part of the country, or *Tell*, is confined to a relatively small area, 100 to 200 km wide, bounded to the south by a mountain range, more or less parallel to the coastline, the Tell Atlas, which regularly exceeds 2,000 m in the east, particularly in Kabylie, and stretches from the Algerian-Moroccan border in the west to the Tunisian border in the east. This part consists of fertile plains where the majority of the Algerian population is concentrated, valleys, and a succession of mountains.

Tessala Plains (Sidi Bel Abbès, northwest)

Moving south, there is a large area of steppe plains and semi-arid highlandsstretching from east to west. The landscape, which is mostly flat, is marked by numerous depressions, known as *chotts*, which turn into salt lakes after the rainy season. These steppes are bordered on the south by a

mountain range, the Saharan Atlas, which includes the *Ksour*, *Ouled-Naïl*, *Zibans*, and *Aures* mountains, which rise to over 2,300 m. At the foot of these mountains is a string of oases that mark the entrance to the Sahara.

Oasis in Tiout (south of Naama)

The Tellian Atlas in the north and the Saharan Atlas in the south divide the country into three types of environments that are distinguished by their relief and morphology, but also by their remarkable climates. From north to south, we can distinguish the Tellian system, the Highlands, and the Sahara. The latter, one of the largest deserts in the world, covers more than 2 million km², or 84% of the territory.

Algeria, a country subject to the combined influence of the sea, relief, and altitude, has a Mediterranean-type climate, characterized by a long period of summer drought varying from 3 to 4 months on the coast, 5 to 6 months in the Highlands, and more than 6 months in the Saharan Atlas.

This great diversity of terrain and climate is matched by a diversity of ecosystems, more or less typical of the different bioclimatic zones which, from north to south, are: humid, sub-humid, semi-arid, and arid. The *Tell* is located in the humid and sub-humid bioclimatic zones, which receive annual rainfall of 400 to 600 mm, mainly in winter (October to March). The rainiest areas (Jijel and El-Kala), located in the eastern part, receive more than 1,000 mm of rainfall annually. The Highlandsare mainly located in the semi-arid zone, characterized by moderate rainfall in winter, harsh winters, and hot, dry summers. The Sahara has a predominantly arid desert climate.

Main types of ecosystems in Algeria

There are two types of ecosystem classification: according to biotope (set of physical and chemical conditions, relatively homogeneous over a given geographical area at a given time) or according to

biocoenosis (set of living beings). The most widely used classification method is based on biotope, in other words the environment.

There are six main types of natural ecosystems in Algeria:

1. Marine and coastal ecosystems

These are a mosaic of terrestrial and aquatic ecosystems. The marine ecosystem itself remains little known in Algeria. However, it is a reservoir of very rich biodiversity.

The terrestrial parts are either in direct contact with the sea, forming coastal dunes and rocky cliffs, or in contact with brackish aquatic ecosystems: coastal lakes and ponds. They are home to a rich and highly specific fauna and flora as a result of their characteristic microclimatic, topographic, and edaphic features. The Algerian coastline is one of the world's 36 biodiversity hotspots.

Coastal landscape in the northeast occupied by *Juniperus oxycedrus* subsp. *macrocarpa*

2. Forest ecosystems

The climate and environmental conditions of the *Tell* region allow for the development of forest formations (forests, scrubland, and reforestation), which cover more than 16% of northern Algeria.

The total current forest area, including scrubland, is estimated at over 4 million hectares, or nearly 2% of the national territory. True natural forest and reforestation account for only 1.7 million hectares.

Forest ecosystems consist mainly of natural formations, but also of more or less recent plantations of deciduous and coniferous trees, mainly in mountainous areas, but also along the green dam (a forest belt 1,500 km long and 20 km wide):

-Forest of holm oaks (*Quercus ilex*) and downy oaks (*Quercus pubescens*), preferably on limestone soil, in areas where drought lasts less than three months. Semi-evergreen, low forest (< 10 m). Holm oak is found mainly in the north of the country but also in the Saharan Atlas, although in less dense and more scattered stands.

-Cork oak forest (*Quercus suber*), strictly on non-calcareous soils in the humid and sub-humid bioclimatic zone, mainly located in the northeast of the country (El-Kala, Kherrata, Guelma, Souk Ahras, etc.), rare and scattered in the west (Tlemcen and Mascara).

Cork oak forest (*Quercus suber*) in El-Kala

-The Zeen oak (*Quercus canariensis*) and the Afares or Techt oak (*Quercus afares*) colonize the eastern regions of the country, from Kabylie to the Tunisian border, in regions receiving more than 800 mm of rainfall.

-Kermes oak forest (*Quercus coccifera*) where drought is more pronounced (dry season > 3 months), very low (3 m) evergreen forest.

-Tree junipers, Phoenician juniper (*Juniperus phoeniceae*), Spanish juniper (*J. thurifera*) and prickly juniper (*J. oxycedrus*) are found in the Aures and Saharan Atlas mountains, particularly in Djelfa and Bousaâda, where they cover large areas.

-Stands of Aleppo pine (*Pinus halepensis*), umbrella pine (*P. pinea*), maritime pine (*P. maritima*), which are more localized in the northeast, where they cover 32,000 ha, and a few black pine trees (*P. nigra* subsp. *mauretanica*) are also found in the Djurdjura in the supra-Mediterranean zone.

Aleppo pine is confined mainly to the semi-arid zone, requiring only 350 mm of rainfall and adapting to any type of soil. Occupying the largest area in Algeria, Aleppo pine constitutes the largest single mass. It is mainly confined to the center (Ouarsenis), the west of the country (Tlemcen Mountains, Daia Mountains, and Saïda forests) and, to a lesser extent, the Constantine *Tell* (Bibans). In the

Saharan Atlas, the largest pine forests are found in the Oued Naïls (Djelfa Mountains). The Aleppo pine is the forest species most favored for reforestation, whether in the green dam or in the green belts along national roads. Apart from fires, its main threat is the processionary caterpillar (*Thaumetopoea pityocampa*).

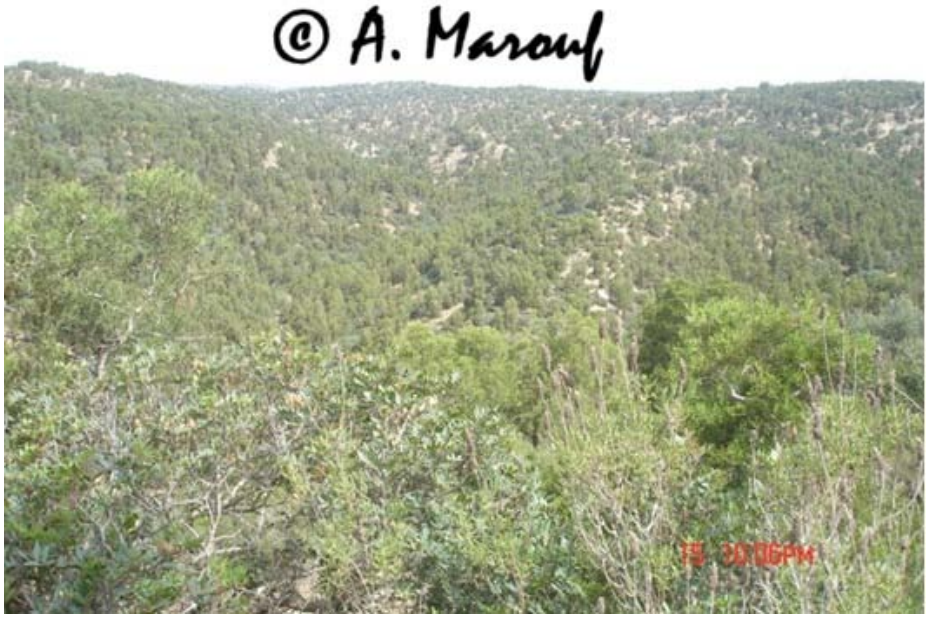
The umbrellapine is found on the central and eastern coastline, in the form of reforestation.

Pinus pinea in the El-Kala region (northeast)

The maritime pine occupies the Constantine coastline and the Kabylie coastline.

Edge of a *Pinus maritima* forest

-Thuja (*Tetraclinis articulata*) is a species found in western Algeria, forming coppices between Oran, Mascara, Tiaret, and Saïda. It thrives in arid terrain and requires only 250 to 300 mm of water.



Tetraclinis woodland near Oran

-The Atlas cedar (*Cedrus atlantica*) is mainly found in mountainous areas at altitudes of 1,400 to 2,800 m, growing in humid and cold conditions where it forms large forests scattered over 16,000 ha in discontinuous patches. The cedar is found in the Aures, Djurdjura, and Blida Atlas mountains, as well as in Teniet El Haad (Ouarsenis).

Mixed forest of *Cedrus atlantica* and *Pinus halepensis*

-The Numidian fir (*Abies numudica*), a high mountain species, is endemic to the Babors and Tababort Mountains (northeastern Algeria).

-Among the introduced species, eucalyptus (*E. camaldulensis* and *E. globulus*) occupies more than 40,000 hectares in the north and especially the east of the country.

A significant part of the forest ecosystem consists of degraded areas (maquis, garrigue, grasslands) and reforestation areas, as well as unproductive land with forestry potential. The dominant flora of the maquis consists of *Calycotome*, broom, rockrose, heather, arbutus, phyllirea, etc. In the scrubland, it is Kermes oak, dwarf palm or *doum* palm, oleander, thyme, rosemary, rockroses, etc. The mountain foothills are home to forest plantations of olive trees, carob trees, etc. The forests are part of the public domain of the State.

Garrigue near Oran (northwest)

Degraded grassland invaded by *Asphodelus microcarpus* and *Urginea maritima*. There are also mastic trees and lavender (*Lavendula dentata, L. stoechas,* and *L. multifida*)

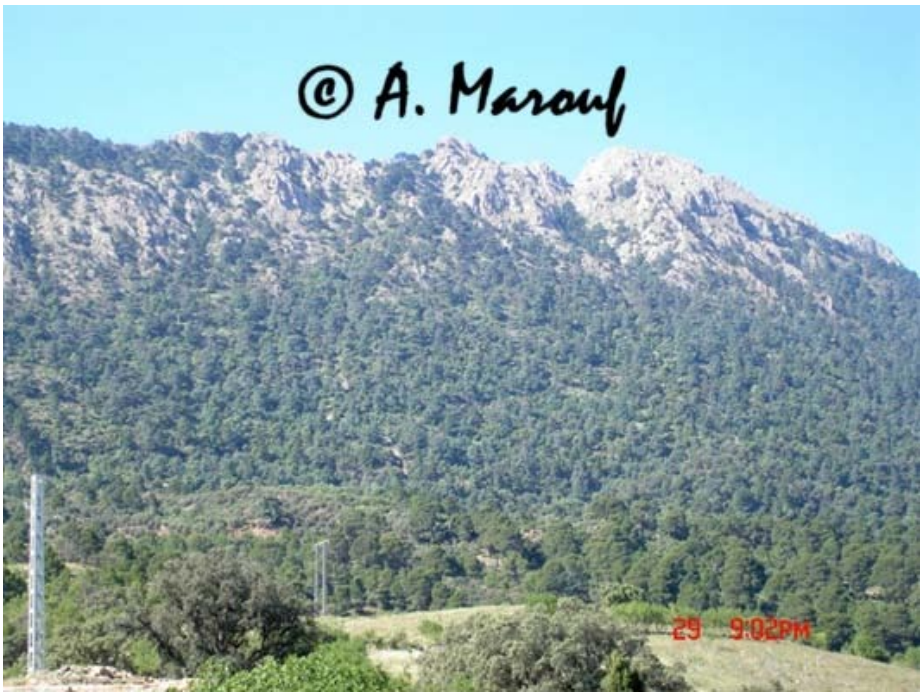
The forest trails are formed by scrubland consisting of cork oak, zeen oak, and garrigue, which cover vast areas.

These forest ecosystems are home to a rich biodiversity in terms of fauna and flora. The flora of Algerian forests is rich in species of shrubs and herbaceous plants, many of which are endemic or of medicinal and aromatic interest. The forest fauna is also very diverse and rich in bird species

(passerines, eagles, falcons, etc.), mammals (genets, porcupines, wild boars, red foxes, Barbary macaques (forests of the Blida Atlas and Kabylie), Barbary deer (El-Kala forests), striped hyenas, etc.) and reptiles.

3. Mountain ecosystems

Mountain ecosystems occupy a wide variety of bioclimates, from the humid zone to the Saharan zone.



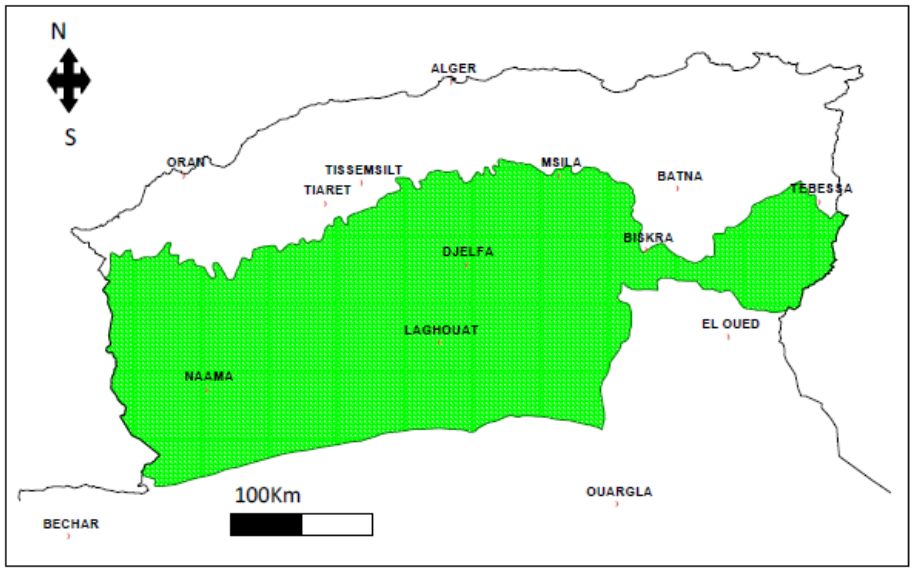
Mountain in the Ouarsenis

Algeria's mountain ranges are home to significant biological diversity. Among the species of flora, Algeria has a large number of trees and shrubs. Of the 70 tree taxa in Algeria's spontaneous flora (Quezel and Santa, 1962), 52 species are found in mountainous areas, some of which are endemic, such as the Numidian fir and the Afares oak in the north and the Tassili cypress and Laperrine olive tree in the Sahara. In the southern part, the Central Sahara massifs are composed of three floristic elements of different biogeographical origins: Saharo-Arabian, Mediterranean confined to altitudes above 1,500 m, and tropical located in the wadis and surrounding valleys.

Djebel Aissa mountain (Naama)

4. Steppe ecosystems

Bordered to the north by the Tellian Atlas, marked by the 400 mm isohyet, which coincides with the extent of dry cereal crops, and to the south by the Saharan Atlas, coinciding with the 100 mm isohyet, which represents the southern limit of the extent of esparto grass, the Algerian steppes occupy these areas known as the Highlands (1,000 to 1,400 m above sea level) and cover 20 million hectares (8.4% of the country's surface area), but the area of pastureland is decreasing dramatically year on year.



Location of the steppe area (Nedjraoui and Bedrani, 2008)

Steppe ecosystems are dominated by tufted xerophytes and by specific plant formations, either herbaceous (grasses) or woody (subshrubs):

✓ Alfa or Halfa (*Stipa tenacissima*) formations: estimated at over 4 million hectares in the last century, they now cover only 2 million hectares, at altitudes of 400 to 1,800 meters. The soils are skeletal with a limestone crust; Aflou region, Djebel Amour, Saharan Atlas. These formations are in an advanced state of degradation.

Steppe with *Stipa tenacissima*

✓ Formations with Sparte or *Sennagh* (*Lygeum spartum*): 2 million hectares. The soils are skeletal with a limestone crust; region of Aflou, Djebel Amour, Saharan Atlas.

Steppe with *Lygeum spartum*

✓ White wormwood or *Chih* (*Artemisia herba-alba*) formations, with a potential area of 3 million hectares, where rainfall varies from 100 to 300 mm. These are considered to be the best grazing lands. The soils are skeletal with a limestone crust, more or less silty.

Steppe with *Artemisia herba-alba*, near Aricha (southwest)

✓ Remt (*Hammada scoparia*) formations: 3 million hectares, of lesser pastoral interest.

Steppe with *Hammada scoparia*, near Labiadh Sid Echeikh (southwest)

✓ Degraded *Noaea mucronata* (*Chobrok*) formations, associated with *Thymelaea microphylla* (Methnane), *Astragallus armatus*, *Peganum harmala* (Harmel), etc.

✓ Azonal formations with psamophytes such as *Stipagrostis pungens* (Drinn).

✓ Azonal formations with tree halophytes such as Tamaris or *Tarfa* (*Tamarix*) or herbaceous halophytes (*Suaeda fruticosa*, *Atriplex halimus*, *Frankenia thymifolia, Arthrocnemum, Salicornia* and *Salsola vermiculata*, mainly) giving rise to very sparse formations in environments rich in sodium chloride and gypsum (Chotts and Sebkhas), 0.5 million ha, as well as tree and shrub formations in the Dayas with Atlas pistachio or Betoum (*Pistacia atlantica*) and jujube or Sedr (*Zizyphus lotus*).

Halophytes in the area around a brackish water spring Fritissa (Naama, southwest)

Daya populated by *Pistacia atlantica* from the Atlas Mountains and *Zizyphus lotus*

In recent decades, there has been a change in vegetation cover. Vegetation types that characterized certain regions have virtually disappeared and been replaced by others. Thus, the steppes of *Stipa*

tenacissima, Lygeum spartum, and *Artemisia herba-alba* have been replaced by species such as *Atractilys serratuloides, Peganum harmala, Salsola vermiculata, Thymelaea microphylla*, and, in recent years, *Cleome arabica* and *Onopordum arenarium*.

The Highlandsare covered with tree steppe vegetation, including the Atlas pistachio, Phoenician juniper or Aarar (*Juniperus phoenicea*) and prickly juniper or *Tagga* (*J. oxycedrus*).

The climate is Mediterranean, semi-arid to arid, with dry periods lasting from 7 to 12 months. Prolonged periods of drought are recurrent. Winters are harsh.

Winter landscape in the Naama steppe

Steppe soils are characterized by the presence of limestone accumulation, low organic matter content, and high sensitivity to erosion and degradation. Renewable water resources are scarce and unevenly distributed.

The northern part of the highlands (Saida, Tiaret in the west and Batna, Setif, etc. in the east) is also known for cereal farming, particularly the cultivation of durum wheat, barley, and oats.

In the steppe, pastoral livestock farming (particularly sheep and, to a lesser extent, goats) and rain-fed cereal farming, which is often associated with it, still represent the main economic activities of some of the indigenous population. The steppe is home to 25% of the Algerian population.

Among the characteristic fauna, there are still small and large mammals such as the Dorcas gazelle (*Gazella dorcas*), Cuvier's gazelle (*Gazella cuvieri*), Barbary sheep (*Ammotragus lervia*), golden jackal (*Canis aureus*), red fox (*Vulpes vulpes*), European hare (*Lepus capensis*).

Reptile species include small lizards, various agamas, whiptail lizards (*Uromastix acanthinurus*), desert monitor lizards (*Varanus griseus*), common chameleons (*Chameleo vulgaris*), common tortoise (*Testudo grecca*) and snakes such as the Algerian whip snake (*Haemorrhois algirus*), Mauritanian viper (*Macrovipera mauritanica*), etc.

Common birds of open habitats (steppes, wadi beds, and dune ridges) include the sand courser (*Cursorius cursor*), greater hoopoe-lark (*Alaemon alaudipes*), calandra lark (*Melanocorypha calandra*),

Dupont's lark (*Chersophilus duponti*), Brown Crow (*Corvus ruficollis*), Kestrel (*Falco tinnunculus*), Houbara Bustard (*Chlamydotis undulata*) and various species of sand grouse (*Pterocles* sp.), Cochevis (*Galerida* sp.) and Wheatear (*Oenanthe* sp., etc.).

Characteristic forest birds include the Blue Tit (*Parus caeruleus*), Spotted Flycatcher (*Muscicapa striata*), Chaffinch (*Fringilla coelebs*), Eurasian Jay (*Garulus glandarius*), Scops Owl (*Otus scops*), Southern Grey Shrike (*Lanius meridionalis*), Redstart (*Phenicuru sphenicurus*), Goldfinch (*Carduelis carduelis*), Linnet (*Carduelis cannabina*), Atlas Warbler (*Sylvia deserticola*), Melodious Warbler (*Hippolais polyglotta*), Blackbird (*Turdus merula*), Blue Rock Thrush (*Monticola solitarius*), Turtle Dove (*Streptopelia turtur*), Red-footed Buzzard (*Buteo ruffinus*), Bonelli's Eagle (*Hieraaetus fasciatus*), Booted Eagle (*Hieraaetus pennatus*), Lanner Falcon (*Falco biarmicus*), Hoopoe (*Upupa epops*), Red-headed Bunting (*Bucanetes githagineus*), Striated Bunting (*Emberiza striolata*), Wood Pigeon (*Columba palombus*), etc.

Water birds encountered include: Ruddy Shelduck (*Tadorna ferruginea*), Common Coot (*Fulica atra*), White-headed Duck (*Oxyura leucocephala*), Marbled Teal (*Marmaronnetta angustirostris*) and Ferruginous Duck (*Aythya nyroca*), etc.

Among the birds of prey characteristic of the steppes, we note the presence of the Egyptian Vulture (*Neophron percnopterus*), Bearded Vulture (*Gypaetus barbatus*), Black Kite (*Milvus migrans*), Short-toed Snake Eagle (*Circaetus gallicus*), Marsh Harrier (*Circus aeroginosus*), Hen Harrier (*Circus cyaneus*), Long-legged Buzzard (*Buteo rufinus*), Booted Eagle (*Hieraaetus pennatus*), Bonelli's eagle (*Hieraaetus fasciatus*), kestrel (*Falco tinnunculus*), hobby (*Falco subbuteo*), Eleonora's falcon (*Falco eleonore*), lanner falcon (*Falco biarmicus*), peregrine falcon (*Falco pelegrinoides*), etc.

There are also nocturnal birds of prey, represented by at least five species: the tawny owl (*Strix aluco*), the barn owl (*Tyto alba*), the little owl (*Athena noctua*), the scops owl (*Otus scops*), the long-eared owl (*Asio otus*) and the eagle owl (*Bubo ascalaphus*).

During migration and wintering periods, other birds can be observed in the wetlands of the steppes (Youcefi and Marouf, 2022).

5. Wetlands

In wetlands, water is the determining factor for both the functioning of these natural areas and for animal and plant life. Land submersion, water salinity (fresh, brackish, or salty), and the nutrient composition of these areas undergo daily, seasonal, or annual fluctuations. These variations depend on climatic conditions, the location of the area within the watershed, the geomorphological context (geography, topography), and human activity.

These wetlands are very diverse in type: freshwater lakes, ponds, marshes, chotts, sebkhas, floodplains, caves, peat bogs, dams, and hill reservoirs, etc., whether natural or artificial, with permanent or temporary water, and whether freshwater, brackish, or saltwater. They are veritable reservoirs of biodiversity of great economic, cultural, scientific, and recreational value, but they are very fragile and currently face growing challenges due to climate change and various forms of pollution, particularly industrial, urban, and agricultural pollution resulting from the excessive use of

pesticides. They require special protection. The Ramsar Convention came into force in Algeria on March 4, 1984. In 2017, the country had 2,375 wetlands, including 50 Ramsar sites of international importance, comprising 2,056 natural wetlands and 319 artificial wetlands, according to the Directorate General of Forests (DGF). A more recent study (Saïfouni and Bellatreche, 2020) using criteria not yet taken into account in the Ramsar typology reports 5,404 wetlands, of which 4,252 are natural and 1,152 are artificial. These sites cover nearly 50% of the total estimated area of wetlands in Algeria. In terms of numbers, the north-eastern ecological region (around El Kala, Annaba, Skikda, Jijel, etc.) ranks first, followed by the north-central region (Bejaia, Algiers, Tipaza, Boumerdes), the highlands region (Batna, Djelfa, Laghouat, Setif, Naama), the South region (Adrar, El-Oued, Tamanrasset, Ouargla, etc.), and finally, the North-West region (Oran, Tlemcen, Ain-Temouchent).

Oglat Eddaira (Naama, southwest)

Cirque of Ain Ouarka (Naama, Southwest)

In terms of classified area, Algeria ranks first among North African countries, third in Africa after Botswana and its famous Okavango Delta, which covers 6.8 million hectares, and Tanzania with 3.5 million hectares, and eighth worldwide.

The wetlands are home to a rich flora, represented by more than 780 known aquatic plant species.

From an ornithological point of view, these environments are home to 70 species of water birds (grebes, herons, flamingos, geese, ducks, etc.), which use these sites as places to rest, breed, and winter. They are also a transit point for many migratory birds; nearly 240 species of birds can be observed in or around the wetlands of Algeria.

6. Saharan ecosystems

Saharan ecosystems, the largest ecosystems in Algeria in terms of surface area, cover approximately 85% of the Algerian territory, where sand dunes (the eastern and western *Ergs*) alternate with superb oases, volcanic landscapes (the Hoggar massif) and lunar landscapes (Tassili N'Ajjer), and stone plains or *Regs*. They harbor an unexpected biodiversity. However, this biodiversity is severely threatened by bioclimatic conditions and the rise of human activity. The distribution of vegetation is determined by three main factors: water, temperature, and soil.

Eastern Erg (near El-Golea)

The Sahara forms a large barrier separating the Mediterranean region in the north from the tropical region in the south. The determining factor is water. The climate is characterized by aridity (less than 20 mm of rainfall), high temperatures (20°C to over 45°C), and significant annual (30°C) and daily temperature variations. Rainfall varies in terms of both location and timing. The southern part of the country receives tropical rains during the hot season (May to September), unlike the northern part, which receives rains during the winter season (October to April) from the northern "polar front." Unlike the north, where surface water resources are relatively abundant, the south is better endowed with groundwater, particularly deep and fossil water.

In terms of flora, Saharan ecosystems are home to 2,800 taxa with a high rate of endemism. The oases are home to several local varieties (date palms and market gardening crops) maintained by ancestral farming practices.

Pre-Saharan and Saharan rangelands are not very productive and barely meet half of the overall demand. Vegetation cover is very low (0 to 20%). *Ergs* are rather poor in both plant and animal species. The *Regs* are often occupied by very sparse chamephytes, particularly *Anvillea raddiata, Daucus sahariensis, Neurada procumbens, Farsetia hamiltonii, Thymelaea microphylla*, various species of *Euphorbia*, *Launaea arborescens, Zygophyllum, Limoniastrum feei, Fredolia aretioides, Helianthemum lipii, Limonium, Fagonia*, etc. Only a few remnant forests remain, with Acacia (*Acacia raddiana, A. seyal, A. tortilis*), Tamarix, Argan (*Argania spinosa*) confined to the Tindouf region (southwest), *Callotropis procera, Balanites aegyptiaca, Rhus tripartitum*, and endemic species such as the Tassili cypress (*Cupressus dupreziana*), the Sahara olive tree (*Olea laperinii*), and myrtle (*Myrtus nivelli*).

Acacia radiana in a valley near Taghit (Southwest)

In the oases, terraced cultivation is practiced, centered around the date palm (*Phoenix dactylifera*), under which fruit trees such as citrus, fig, apricot, olive, pomegranate, apple, and pear are grown, along with vegetables.

Although farmers in the oases make great efforts to preserve rare varieties and cultivars, many of them have disappeared or are becoming scarce.

In terms of fauna, birds and mammals are particularly abundant. For example, there are more than 150 species of birds and around 40 mammals within the geographical boundaries of the Tassili N'Ajjer (Illizi Province) and Ahaggar (Tamanrasset Province) national parks. There are also Sahelo-Saharan antelopes such as *Addax nasomaculatus, Oryx dammah*, and a few species of gazelle. The presence of cheetahs has been confirmed in Algeria.

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