# Baseline study of the target landscapes under HERD "Egypt"

2020

Northwestern coast, Matrouh governorate, Egypt

Abou Mazhoud & Al-Gaaween Areas

Editor: R. M. Rizk

Arab Organization for Agriculture Development
**(AOAD)**

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Prepared by

**AOAD**

For

**CEDARE**

Arab Organization for Agriculture Development

**(AOAD)**

**2020**

## Foreword of AOAD

The Arab states are distinguished by the vast pastoral and agricultural lands that are distributed over different regions characterized by great diversity in their ecosystems and plants. The natural pastures are considered some of the most important renewable natural resources in the Arab countries. So, the Arab region is considered eligible for the advancement of the animal husbandry sector as well as the provision of animal products to achieve self-sufficiency and export.

The rangelands cover an area of about 397.05 million hectares, which represents about 29.5% of the total area of the Arab region. The rangelands contribute in the feed of livestock at least 25% in most Arab pastoral environments and providing job opportunities for local communities, which practice grazing and agriculture. It is also a source of livelihood for a great numbers of herders that depend entirely or partially on rangelands for feeding their livestock's and lifestyle. It plays an important role in conservation the dry and semi-dry land that characterizes the Arab world. Rangelands play a political, economic, social and environmental role in most Arab countries.

The pastoral area is considered a huge storehouse for the biological diversity and natural habitats of many animals, as well as for wild plants that are the genetic origins of many food and feed crops. However, these natural resources are generally stressful and subject to large levels of degradation. This negatively affected their biological diversity and consequently led to a lack of production and low quality.

The pastoral area currently faces great challenges that threaten their genetic resources by extinction due to the scarcity of water and climatic changes in addition to frequent droughts. These areas are subjected to desertification and sand encroachment in many cases.

Therefore, there is a strong need to protect and conserve them by any of the available means as possible.

It should be noted that the Arab Strategy for Sustainable Management of Rangeland prepared by AOAD was approved and issued by the organization's Executive Board at its fiftieth meeting held in the Sudanese capital - Khartoum - on December 5, 2019 (Decision No. 15/50 / CE / 2019).

In accordance to the partnership between The Arab Organization for Agricultural Development (AOAD) and The Centre for Environment and Development for the Arab Region and Europe (CEDARE), AOAD achieved a baseline study of target landscapes under HERD-"Egypt" of Abou Mazhoud & Al-Gaaween Areas at Northwestern coast, Matrouh governorate, Egypt. This study is part of implementing the activities of the UNEP-GEF funded project "Healthy Ecosystems for Rangeland Development (HERD): sustainable rangeland management strategies and practices". It has been executed by the International Union for the Conservation of Nature (IUCN), through its Regional Office in West Asia (ROWA). HERD is a multi-country initiative to promote restoration of degraded rangeland ecosystems and revival of sustainable herding practices. With the main goal of protecting the rangelands through sustainable pastoral management in order to promote rangeland ecosystem services, the initiative contributes towards the goal of restoring and sustainably managing rangelands through stronger local governance and increased benefit-capture of the multiple environmental benefits of pastoralism safeguard. The project partners are the Hashemite Fund for Development of Jordan Badia (HFDJB), the Royal Botanic Garden (RBG) in Jordan, the Desert Research Centre (DRC) and the Centre for Environment and Development for the Arab Region and Europe (CEDARE) in Egypt.

While introducing this study, I would like to extend my thanks and gratitude to the CEDARE in providing AOAD with the opportunity to achieve the study. I would also like to extend my sincere thanks and appreciation to Middle Regional office of AOAD as well as the team of experts who contributed to the preparation the study, hoping that it will contribute in the conservation and sustainable managements of the rangeland in the Arab countries.

Prof. Dr. Ibrahim Adam Ahmed El-Dukheri
Director General

**Acknowledgment**

The authors would like to express their special thanks of gratitude to **Prof. Dr. Ibrahim Adam Ahmed El-Doukheri**, AOAD director General as well as **Dr. Kamel Mostafa Elsayed** (head of the Regional Office of the Middle Region, AOAD) who gave us the golden opportunity to do this wonderful a baseline study of target landscapes under HERD- "Egypt" of Abou Mazhoud & Al-Gaaween Areas at Northwestern coast, Matrouh governorate, Egypt.

The authors would like to thank **Eng. Ahmed Yousef** head of the agricultural directorate, Matrouh governorate and all the employees for providing us the data about the plant and livestock population for the duration from 2007 to 2018.

Authors would like really to express their special thanks of gratitude to **Prof. Dr. Essam Shehata**, Agricultural Research Center, Egypt, for his valuable comments, guidance and revising of the study final report.

We thank **Prof. Dr. Tarek Abel Khalek** and **Prof. Mohammed El-Shafie** (Animal Production Research Institute, Agricultural Research Center, ministry of Agriculture, Egypt) for providing us with some photos from the study site and their comments that greatly improved the livestock part of the study.

The views expressed in this study are those of the authors and do not necessarily represent the views or policies of the AOAD. The AOAD and CEDARE are jointly supported through a cooperative agreement.

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## Table of contents

# List of tables

# List of maps

# List of figures

# List of photos

## Executive summary


- The present work is a desk study review, address two consecutive areas of the northwestern Mediterranean coast belonging to Matrouh governorate. Site 1 (Abou Mazhoud) locate at two districts; Barrani and El-Negila. While, site 2 (Al-Gaaween) locate at Marsa Matrouh district.
- The purpose of the study is to provide an in-depth review and analysis of the target landscapes aiming to generate data and information as a baseline for target landscape and local communities that exist in the study area.
- The study depends on the data and information obtained from the governmental agencies, economic statistics and the information collected with the help of local community leaders as well as studies and literatures related to the scope of the study and in line with the study objectives. Data were collected during two field visits to the study area through direct communication with the stakeholders, in addition to visits for some livestock keepers, existing in the study area.
- The results obtained from the study revealed nearly similar trends for climatic conditions, soil type, animal breeds and plants varieties in both studied sites, consequently, which reflected on similarity of the vegetation cover, livestock sector and land use in both sites. These information and data have mentioned and confirmed by pastoralists exist in both study sites (Personal communication).
- Water availability at the northwestern coastal zone is consider the key factor for various development activities. Accordingly, more attention needed to be directed to have more reliable data which could represent the core-stone of water resources evaluation in both

surface and ground water in the study areas. Nowadays the amount of water availability is barely enough for only 15% of settlement. Consequently, technical and financial support would be forward to the settlement of construction for private collecting water works and small desalination units. In addition, increasing the public awareness for utilizing the water resources using renewable energy (solar energy, wind energy, etc.) in governmental and private sectors.

- The vegetation cover in winter is very high in comparison with summer. In winter, the percentage of vegetation cover were 51% and 46% for site 1 and site 2, respectively. While in summer, the vegetation cover was very low; 0.16% in site 1 and 0.27% in site 2. The vegetation cover in winter includes horticulture trees (i.e., Fig and Olive), cultivated crop areas (i.e., Barley and Wheat) and natural vegetation. The barley occupied 24% and 11% of site 1 and site 2, respectively. On the other hand, the natural vegetation represents 27% and 34% for site1 and site2 respectively. The vegetation cover in summer is only trees and shrubs, which depending on the water stored in root zone area.
- The vegetation cover yearly reaches the highest at March and started to decrease in April reaching the minimum point at November. The study areas depend on quantity and its extend over range in winter, while the spring represents the maximum vegetation cover and density. On contrary, the autumn has the minimum vegetation cover and density.
- In general, the vegetation cover in site-1 is slightly better than site-2. The volume of vegetation in the study areas response to rainfall quantity and area. In site-1, the vegetation cover was low in 2017 and 2018, while in 2016 and 2019 was relatively good. In site-2, the

vegetation cover was very low in 2017 and 2018, while in 2016 and 2019 was relatively good.

- The grazing system of the target study area consists of eighty-one species. Out of them thirty-one species are Chamaephytes, two are Geophytes, four are Hemicryptophytes, forty-three are Therophytes and only one is Chamaephytes/Phanerophytes.
- The life span of the species of the target area classified into **forty-two** annual species, **three** biennial species and **thirty-six** perennial. Regarding the rarity status or overall occurrence of the grazing target species, **thirty-one** species are very common, **thirty-three** are common and **thirteen** are rare, while **four** are very rare. Most of the grazing plants of the target area (**Sixty-four** species) have a very common and common status in the target area as well as in the northwestern coastal area. Among them **thirty-five** are annual, **twenty-six** are perennial and only **three** are biennial. Generally, the annual grazing species have the leading of grazing system followed by perennial. Due to that most grazing species are annual as well as most of annual species are very common and common (77.78%), the grazing system at the winter-spring season is more appropriate for the headers. The grazing area must subject to artificial preparation for the grazing season; rehabitation of the grazing species by sowing seeds of selected species, especially the annual and perennial.
- It is necessary to emphasize that the grazing species of the target areas in fact require urgent management action to conserve its threatened. The active cultivation is vital to survival of the grazing system of the northwestern coastal zone and the grazing system could degraded and lost for ever if no regular propagation occurred for the target grazing species under the umbrella of the management strategic plan to develop the target grazing area. Because the human

cultural of local communities have a heritage associated with grazing system, the conservation and sustainable utilization of these area must consider as a societal enthusiastic.

- The grazing system of the target study area contains **seventeen** species of very highly palatable, **eighteen** species of highly palatable, **thirty-two** species palatable and **eleven** species low palatable as well as only **three** species are unpalatable.
- The most important crop is the rain-fed barley. The high barely production is at the rainy season (2015/2016 and 2018/2019). The most important horticulture crop are fig, olive, grapes, date and almond. Rain-fed agriculture is generally risky due to the high spatial and temporal variability in rainfall. The productivity of cultivated rain-fed crops is affected mainly by the amount and fluctuation of precipitation.
- The results obtained from the study revealed that livestock production is the key role in the development activities and income of the study area. It represents a main source of food and its wastes (manure) are useful for soil fertility, It also provides a sizable part of the transportation.
- The extensive agro-pastoral livestock farming system is the mainstay and backbone of livestock production. The livestock population (104767 heads) in the study area represents 21.5% of the total livestock in Matrouh governorate (487264 heads) representing a significant percentage of the total population of the governorate. The livestock population in the study area shows fluctuation with a decreasing trend during the period from 2007 to 2018. The private sector (pastoralists) plays the main role in livestock production as most livestock owned by them while the governmental/public sector owns minor numbers of animals.

- Small ruminant represents more than 90% of the total livestock population (68% sheep and 23% goats). Sheep are the most dominant species, followed by goats, camels (3%), and donkeys (2%). The populations of cattle (less than 2%), buffaloes, horses, and mules are minor (less than 1%). Barki sheep and Barki goats are the main breeds raised in the study area.
- Flock size is between 50 and 200 but it could reach up to thousands on a few cases. The main breeding season is at June–July months. consequently, parturition synchronizes with the beginning of the natural grazing season.
- The main feed resources are natural pastures during the grazing season for a maximum of 6 months, which show marked seasonal variation in availability and quality based on the variation in rainfall distribution. During the rest of the year the livestock fed mainly on concentrate, agriculture by-products, bran, and grains.
- The poor management, low genetic improvement programs applied and inadequate nutrition, diseases outbreaks poor feeding, disease outbreaks, lack of technology applied, poor marketing system and infrastructure are the major constraints for livestock production.
- Unfortunately, there is very poor information about the farm animal genetic resources, which leads to the absence of a wholesome vision to manage the Animal genetic resources in the right way. The pastoralists' ecosystems dominated in the study area is suitable for sustainable indigenous livestock production systems, especially based on local breeds.
- A combined management strategy, at the governorate level, for both plant and animal genetic resources becomes an urgent need. This strategy should be prepared and executed by involving all

stakeholders in a participatory approach including the local community representatives.

- Nowadays in the project area; the livestock sector is facing many and hard challenges in many fields. Decision-makers, research institutions, and extension services have to support livestock activities to cope at best with the loss of production, un-directional cross-breeding activities, and degradation of pasture area; worsening of animal products, and enlargement of land desertification and the worsening of animal health accompanying the effects of the climate change.
- The following actions could help in improving livestock production in the study area: 1) Establishing an annual livestock-stocking rate, 2) Moving animal genetic resources as part of climate change adaptation strategies, and 3) Domestication of new animal species.
- The study recommends some policy as entry points for better management and restoration of rangeland in the study area which should be carried out during the short, medium and long development plans/strategies as follows:
    1. Empowering pastoralists' local communities;
    2. Establishment of environmental pastoral Protectorates (reserves);
    3. Mainstreaming of rangeland restoration and conservation strategies within national and regional development plans;
    4. Support natural resources conservation activities;
    5. Adaptation of new technical options
    6. Promoting legislations, regulations and strategy for the management and sustainable development of rangeland.

## Symbols, acronyms and abbreviations

**AnGR**: Animal genetic resources.

**AOAD**: Arab Organization for Agriculture Development.

**CEDARE**: Center for Environment and Development for the Arab Region and Europe.

**Chamaephytes**: A plant life form in Raunkiaer's system of classification. They are essentially low-growing shrubs, in which the overwintering buds are borne above ground but near the surface to minimize exposure to the wind.

**Geophytes**: A plant life form in Raunkiaer's system of classification. They are herbaceous plants in which the perennating buds are below ground, giving rise to corms, bulbs, rhizomes, tuberous roots, swollen tap roots and the ubiquitous crown.

**Haplocalcids**: Haplocalcids are the Calcids that have a calcic horizon with its upper boundary within 100 cm of the soil surface. These soils do not have a duripan or an argillic, natric, or petrocalcic horizon within 100 cm of the soil surface. Some of the soils have a cambic horizon above the calcic horizon. Haplocalcids are extensive.

**Haplosalids**: Haplosalids are the Salids that are not saturated with water in one or more layers within 100 cm of the mineral soil surface for 1 month or more in normal years

**Hemicryptophytes**: A plant life form in Raunkiaer's system of classification. Hemicryptophytes are typically herbaceous perennials, such as grasses, which produce perennating buds at the soil surface, where the buds are protected by leaf or stem bases.

**Overgrazing:** Overgrazing is defined as the overgrazing of animals, whether domestic or wild animals, which leads to land degradation, soil erosion and desertification, as well as the elimination of some types of plants, which in turn affects the yield of land.

**PGR**: Plant genetic resources.

**Phanerophytes**: A plant life form in Raunkiaer's system of classification. They are large shrubs and trees in which the overwintering (perennating) buds are located high above the ground.

**Rangelands**: The rangelands are uncultivated lands capable of providing environmental habitats for wild and domesticated animals

**Sustainable development:** It is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

**The grazing process**: The process by which animals consume plants for energy and food.

**Therophytes**: A plant life form in Raunkiaer's system of classification. They are annual plants that complete their life cycle in a short period when conditions are favourable and survive harsh conditions as seeds. They are typically found in deserts and other arid regions.

**Torriorthents**: Torriorthents are the Orthents that have an aridic (or torric) moisture regime and have a soil temperature regime warmer than cryic.

**Torripsamments:** Torripsamments are the Psamments that have an aridic (or torric) moisture regime and a soil temperature regime warmer than cryic..

## Scientific team

| | |
|---|---|
| • **Prof. Dr. Reda M. Rizk** | Expert Plant Genetic Resources & Biodiversity, AOAD & Agricultural Research Centre, Egypt. |
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## Report preparation

As a beginning, the team group prepared a detailed plan for executing the study work through three successive meetings. Then each member of the scientific team prepared a detailed and extensive report on the resource under investigation, presenting all the relevant information collected from literature and field visits, and proposed an appropriate and adjusted methodology for implementation including suggestions and consultations. These reports were compiled to form the final report, which includes all the scientific team efforts and the steps taken to collect the required information and carry out all detaillls of the study.

# Introduction

## The Mediterranean coastal land

The Mediterranean coastal land of Egypt extends 970 km from Sallum, in the Libyan-Egyptian border, to Rafah, in the Palestine border. It is a narrow coastal belt assigned to the dry arid climatic zone of Koppen's (1931) classification system (as quoted by Trewartha, 1954) and the Mediterranean bioclimatic zone of Emberger (1955). However, the bioclimatic zone of UNESCO/FAO (1963) indicates that it is a subdesertic warm climate.

Geographically, the Mediterranean coastal land of Egypt can be divided into three sectors (Zahran et al., 1985, 1990): western (Mariut), middle (Deltaic) and eastern (Sinai) sectors. The first two sectors belong to the North African Mediterranean coast while Sinai sector belongs to the South West Asian Mediterranean coast.

## The Northwestern Mediterranean (Mariut)

The northwestern Mediterranean Desert of Egypt is diversified with the coastal area, wadis, depressions and terrain of varying degrees of accessibility. The area encloses different water sources and varied irrigation schemes. Rainwater is the basis of life and economic activity in the coastal territories, with only moderate contributions from underground water. The range of economic activities is substantial, covering rainfed agriculture, livestock raising, trade, tourism, industry, mining, quarries, petroleum and various services (Batanouny, 1999).

## Climate

The prevailing climate can be qualified as an arid Mediterranean with mild winter (UNESCO, 1977). January is the coldest month, while August is the

hottest. The lowest mean minimum air temperature varies between 7.3ºC at El-Dabaa in January and 23.5ºC at Dekheila in August. The highest mean maximum air temperature varies between 17.1ºC at Ras El-Hekma in January and 30.6ºC at Alexandria in August.

The distribution of the mean annual rainfall shows that the amount of annual rainfall decreases sharply from about 150 mm near the coast to 80 mm at a distance of 160 km inland. Most of the rain falls during winter (60% or more from November to February), and the summer is virtually dry. wind in this region is generally strong and violent; dust storms and pillars were not rare. Dry hot dust-laden winds from the south known as Khamasin blow occasionally for about 50 days during spring and early summer. During winter and early spring, winds blow strongly with an average velocity of about 20-23 km hour-1. Wind speed decreases in May and June, but July is windy. The end of summer is characterized by many calm days and the average wind speed drops to 15 km hour-1 (Shaltout, 1983).

**Land use**

The main land use in the northwestern area is grazing and rainfed farming (or irrigated by underground and runoff water). The main annual crop is barley (*Hordeum vulgare* L.). Irrigated agriculture of pasture and grain crops and fruit trees (mainly vines) is spreading after the extension of irrigation canals from the Nile up to 60 km west of Alexandria (Zahran and Willis, 2009). Vegetables such as tomatoes, onions, broad beans and watermelons were cultivated mostly in small plots for local consumption.

Sheep, goats, camels, donkeys and cattle were found in the study area, but animal production is concerned mainly on small ruminants (sheep and goats). The goats mainly used to supply the Bedouins with meat and milk

(Seif El-Nasr and Bidak, 2005). It is observed that land use changes from a structure based on pastoralism to a structure based on multiple uses or on a group of economic activities in which agriculture has an increasing role (El-Kady et al. 1995).

Oil and gas fields with their shipping facilities, and gypsum extraction were among the land use activities (Kassas, 1979). Nowadays, summer resorts and tourist sites occupy the shoreline zone from Burg El-Arab to Mersa Matruh (El- Fahar and Sheded, 2002).

**Species diversity**

The region receives the highest amount of rain during the winter season, which sustains a higher species diversity. About 625 species are recorded in the Mediterranean region, some of these species were recorded along the Mediterranean region from west to east. Recent studies divide this region into three sectors: the western sector (Mareotis), the vegetation of this part include weed assemblages of the rain-fed barley that amounts 584 species (El-Hadidi & Fayed 1994/1995). Middle sector (Delatic sector), the number is 226 species mainly weed assemblages to the cultivated land. The number of recorded species in the eastern sector (Sinaitic sector) is 171 species According to Gibali (1988).

**Rangelands**

Rangelands are spatially defined ecosystems that are dominated by grasses, grass-like plants, combined with various degrees of bushes and trees cover that is predominantly grazed or browsed, and which are used as a natural and semi-natural ecosystem for the production of livestock and safeguarding of wildlife and additional ecosystem services. The definitions

of rangelands are according a merge of the definitions of Blench and Sommer 1999, Allen et al. 2011 and McGahey et al. 2014.

Rangeland ecosystems are co-adapted and co-evolved to increase the land use efficiency under the Egyptian environment that involved native palatable plants that can provide economic continuous forage supply for domestic grazing animals. Although the natural vegetation cover of the Egyptian environment is quite low and scattered, the flora on the northwestern coast is relatively rich and diverse. The Western Mediterranean Coastal land is one of the richest phytogeographical regions in Egypt because of its relatively high rainfall. It contains 50% of the total flora of Egypt. The most important land-use in this area is grazing.

The rangelands play an important role in the maintenance of soil and water that not less than their role in animal feeding. The rangelands act as rainwater harvesting tool and feeding the groundwater reservoirs. This role will increase water conservation with the limited rain and the steady increase in need for drinking water and irrigation of crops. In addition, most grassland plants increase soil fertility and maintenance.

## Purpose of the study

The main aim of the study is to provide an in-depth review and analysis of the target landscapes in order to generate data as a baseline for target landscape and communities that will help in rangeland management, conservation and restoration in the study area.

## Scope of the study

This work is a desk study review, which includes the following:

1. Detailed studies of target landscapes, including drought monitoring, contour mapping, rangeland characteristics, livestock production data and analysis, socio-economic data, the role of Gender in rangeland management and restoration.
2. Documentation of existing community' land use practices (rules and regulations over rangeland resource management: pasture, water, trees, wildlife, livestock, etc.).

## Methodology

The study depends on the information collected from the governmental agencies, economic statistical and studies related to the scope of the study and in line with its objectives. This date concerned with the cultivated area with field crops, vegetative crops, horticulture crops as well as pasture crops, in addition to wild plant genetic resources. Furthermore, it depend mainly on the information gathered, with the help of local community leaders. The second main source of information was derived from literatures and research deal with the northwestern coast as well as the target area in harmony with the study objective (related to biological diversity and grazing). The third main source is 2 field visits to the study area for direct communication with the stakeholders and visit some livestock keepers in the study area.

# Description of the study area.

## General information.

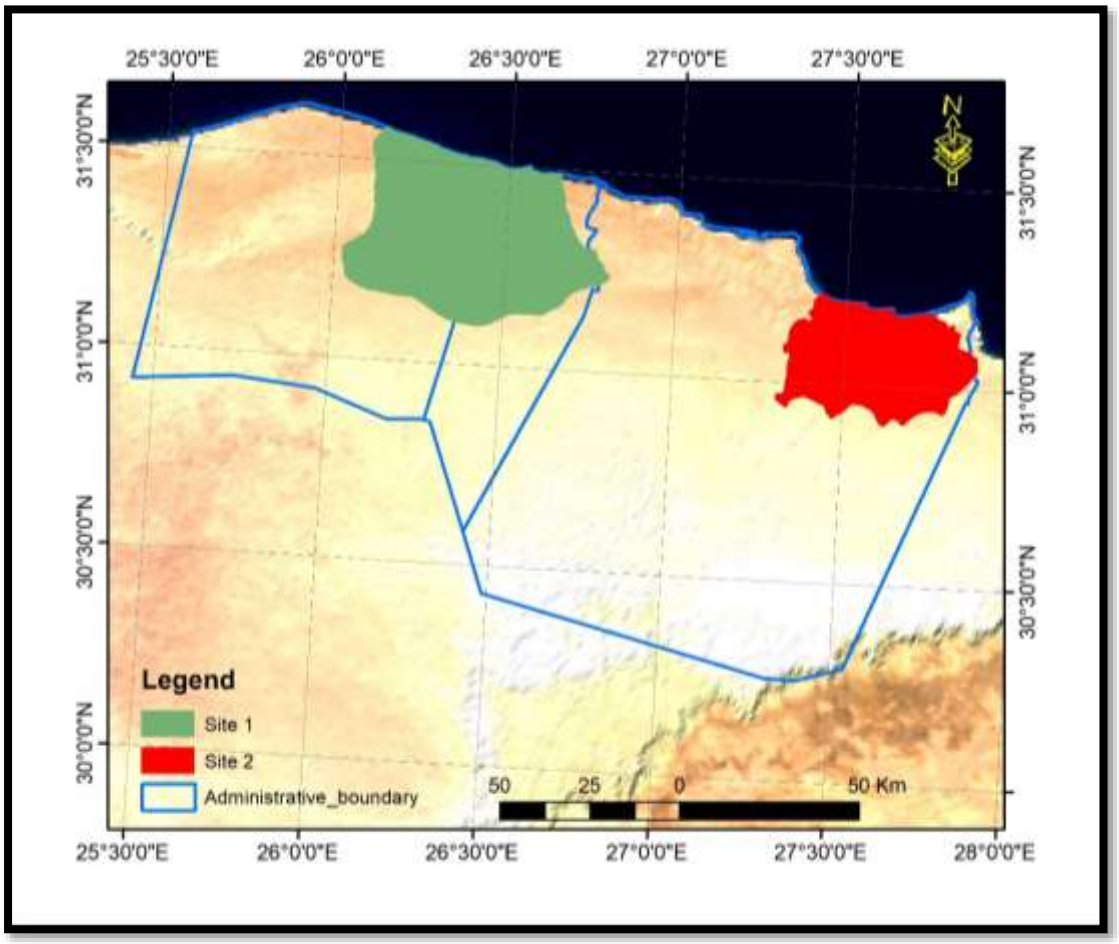
According to Zahran and Willis (2009) the Western Mediterranean coastal zone is one part of three that formed the western desert of Egypt. Matrouh Governorate is located in the far northwest of Egypt, extending from Kilometer 61 west of Alexandria Governorate to the Egyptian-Libyan borders with a length of 450 km along the Mediterranean coast. It extends south in the desert at a depth of 400 km south of Siwa Oasis and its total area is 166563 $km^2$ representing about 16% of the total area of Egypt. Matrouh governorate consisted of eight districts: El-Hamam, El Alamein, El-dabaa, Marsa Matrouh, Al-Nagela, Barani, Salloum and Siwa.

Map 1: Location of Matrouh governorate on the map of Egypt (red color)..

## Description of the study area

### Location:

The present study conducted in two consecutive areas of the Northwestern Mediterranean cost belonging to Matrouh governorate. The geographical location of the study areas is represented in map (2).




Map 2 : Location of the two study sites (green and red colors).

***Table 1: Total area of the sites of interest and their districts.***

| Site | District | Area ($Km^2$) | Settled Area ($Km^2$) (%) | Study Area ($Km^2$) | | Name |
|---|---|---|---|---|---|---|
| 1 | Barrani | 3667.64 | 2758.90 (75.22) | 1532.97 | 2575 | Abou Mazhoud (أبو مزهزد) |
| 2 | Al-Nagila | 1628.40 | 900.01 (55.27) | 1042.28 | | |
| 3 | Marsa Matrouh | 9796.65 | 2692.87 (27.49) | 1373.79 | 1374 | Al-Gaaween (الجعوين) |

***Site 1: Abou Mazhoud***

The site 1 is located at two districts; Barrani and El_Negila. Barrani/ Sidi Barani is a small Egyptian town which located in northwestern Egypt, along the Mediterranean Sea, about 95 km east of the border with Libya (31°36′39″N 25°55′32″E) , the district belongs to Matrouh Governorate. The name is related to Sidi es-Saadi el Barrani, a Senussi sheikh who was a head of its Zawiya (mosque), the village is mainly a Bedouin community. Barrani population is about 28,049 citizen (year 2017) the majority of its population is Arab Bedouin, the town includes a number of villages (Shamas, Abu Stable, Zuweidah, Abu Marzouq, Al-Fakhri, Al-Qatrani, Al-Dhafir, and Abu Mazhoud).

El Negila (Egyptian Arabic: النجيلة pronounced [ˈel niːgeelaˈ]) is a small district. For a long time, the district was depending on underground water in its everyday life. Rain is the main source of water for growing grazing forages and cultivation, but unfortunately the amount of water becomes insufficient. Therefore, groundwater may become the most reasonable complementary resource that is capable to supply or at least to share with the rainwater resource in providing the area with the needed water (Barseem et al, 2013).

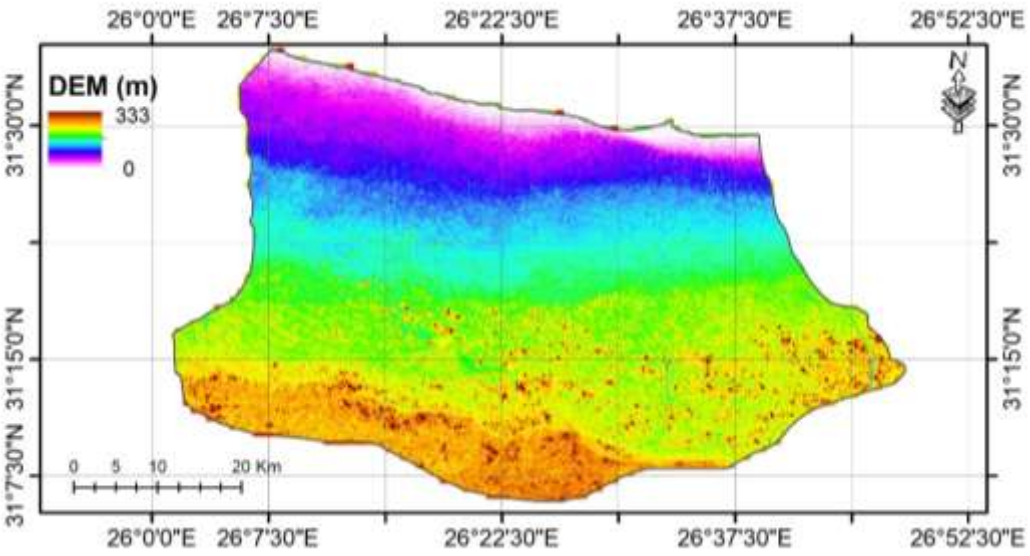
Site 1 includes five villages from both Sidi barani and El-Negila districts and they are Al-Mahafeez, Al-Garari, Abou Mazhoud, Al-Negela and Al-Zewedah as listed above in Table 1.

***Site 2: Al-Gaaween***

Site 2 is located at Marsa Matrouh district and it includes two villages viz.:Al-Gaaween and Al-Seryhat

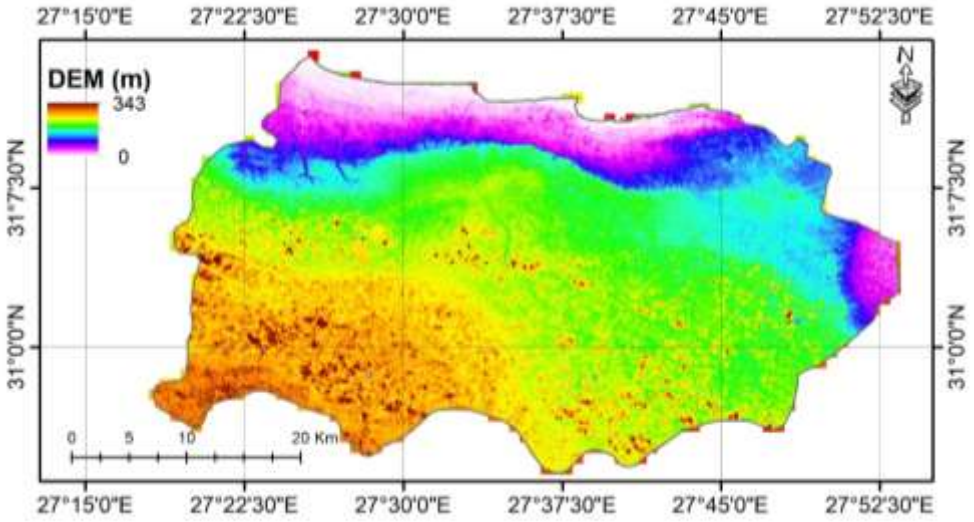
## Digital Elevation Model (DEM)

The digital elevation model (DEM) is based on shuttle radar topography mission (SRTM) data. The elevation of **Abou Mazhoud** (site 1) is ranging from 0 m at the north of the site then increasing gradually southward up to 357 m (map 3).




*Map 3 :The Digital Elevation Model (DEM) of site 1*

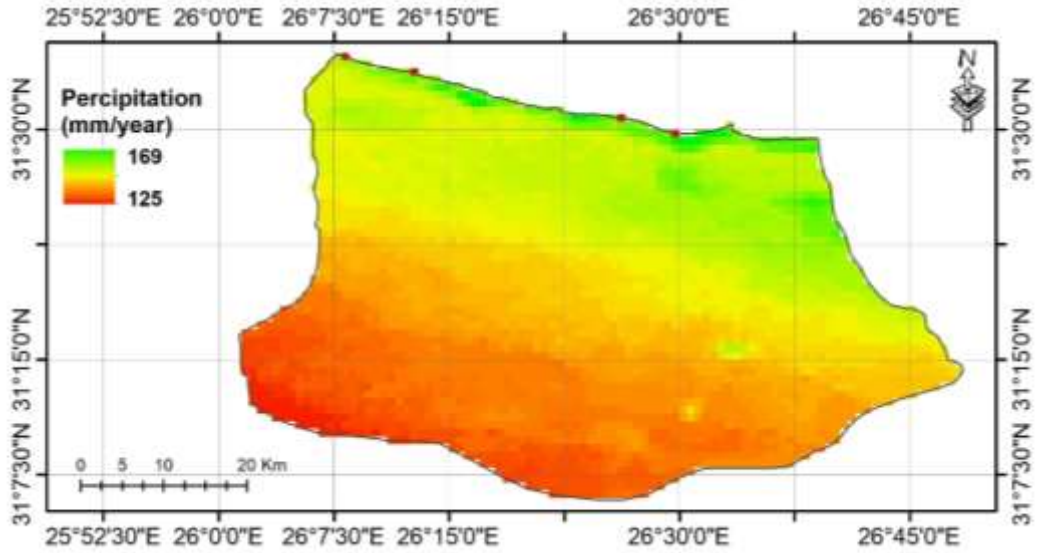
The elevation of **Al-Gaaween** (site2) is nearly similar to site one; ranging from 0 m at the north of site 1 with gradual increase southward reaching up to 343 m (map 4).




*Map 4 :The Digital Elevation Model (DEM) of site 2*

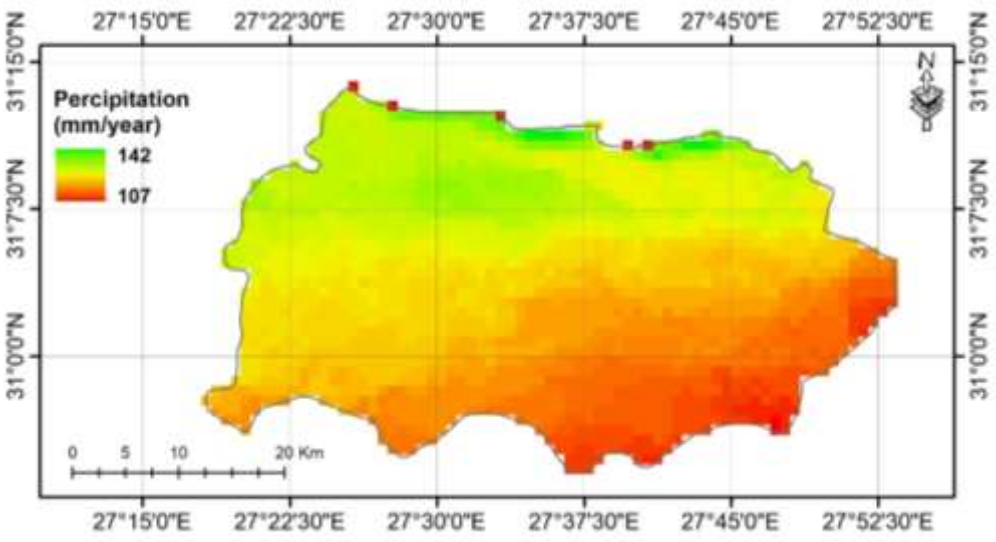
## Precipitation

Based on WorldClim version 2, the average monthly precipitation data for the period 1970-2000 have been used to generate the precipitation maps. The distribution of the mean annual rainfall of **Abou Mazhoud** (site 1) shows that the amount of annual rainfall decreases sharply from about 161 mm near the coast to 125 mm at southward inland. Most of the rain falls during winter (60% or more from November to February), and the summer is virtually dry (Map 5).




*Map 5 : Precipitation map of site 1 (Abou Mazhoud)*

The distribution of the mean annual rainfall of **Al-Gaaween (site 2)** shows that the amount of annual rainfall decreases sharply from about 134 mm northwest near the coast to 107 mm at the southeast. Most of the rain falls during winter (60% or more from November to February), and the summer is virtually dry (map 6).



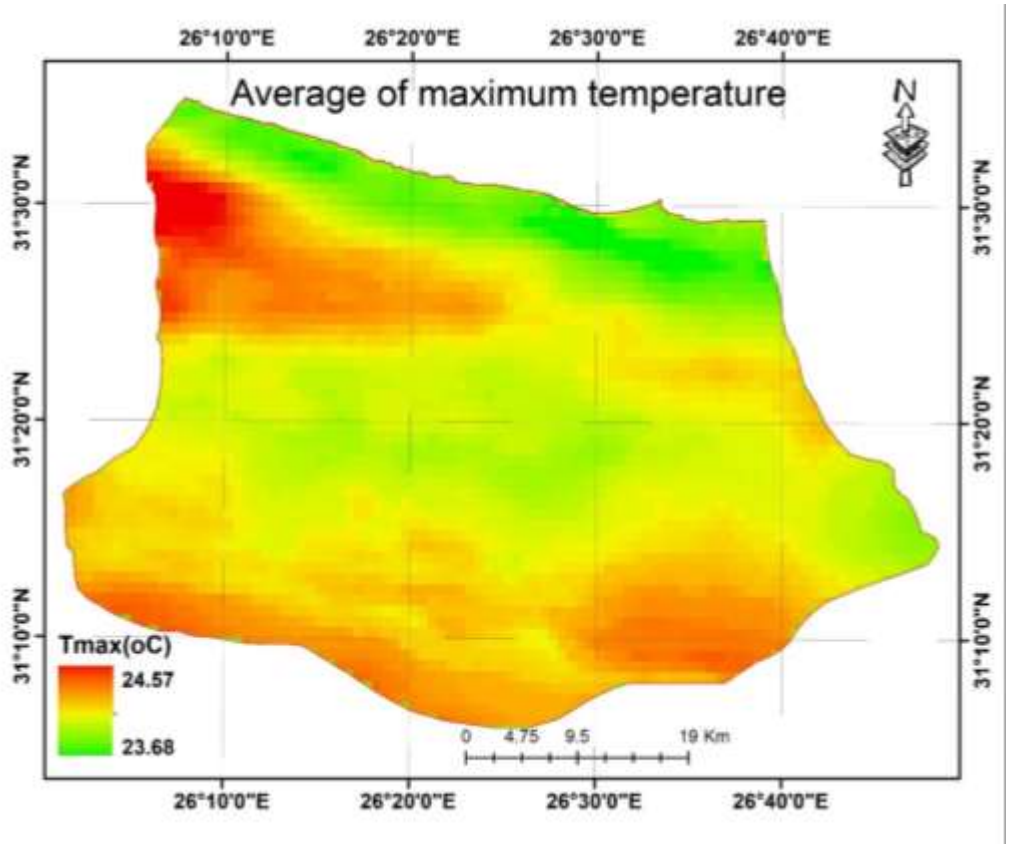

Map 6: Precipitation map of site 2 (Al-Gaaween)

## Average Temperature

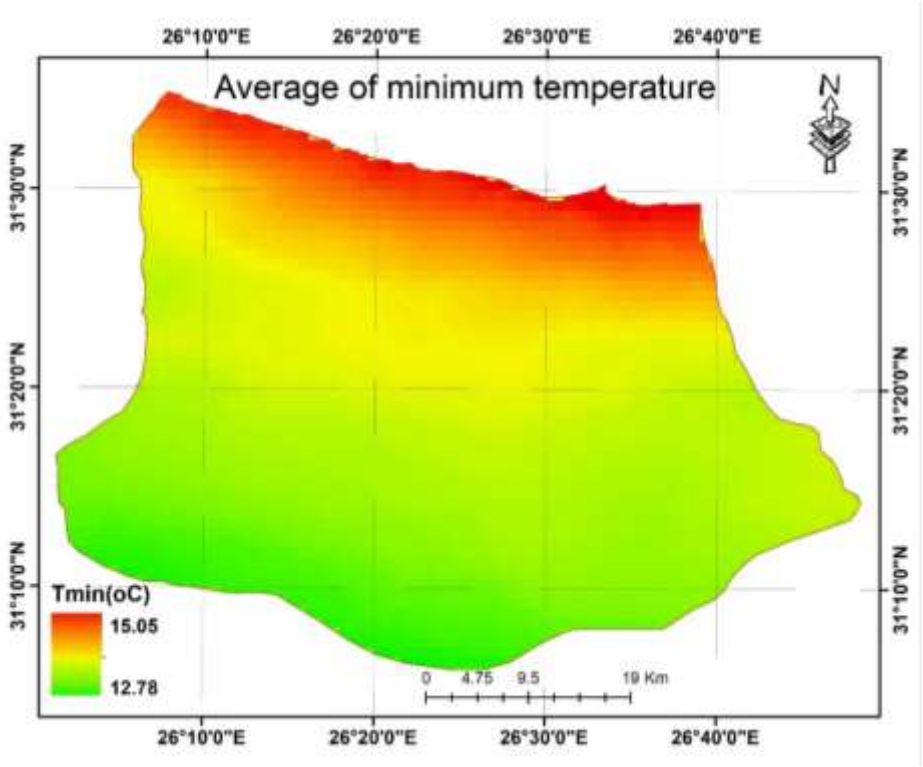
Based on WorldClim version 2, the average temperature data for the period 1970-2000 have been used to generate the average, maximum and minimum temperatures maps.

The average maximum temperature of Abou Mazhoud ranges between 23.68° in the north and raises gradually to 24.57° to the south, while the maximum temperature recorded at the center of the west corner (31°29’0”N, 26°9’0’’E) (Map 7). The distribution of average maximum air temperature shows a fluctuation trend. The average minimum temperature ranges between 12.78° in the south and gradually increased to 15.05° in the

north (Map 8). The average minimum temperatures show more homogenous graduation than average maximum temperature.



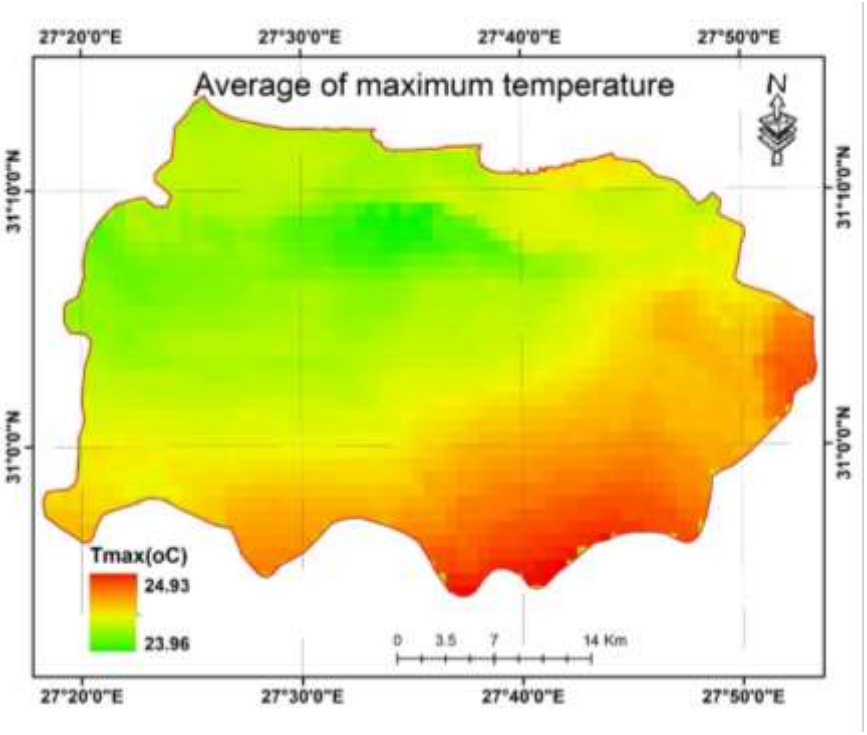

*Map 7 : Average maximum temperature map of site 1 (Abou Mazhoud)*



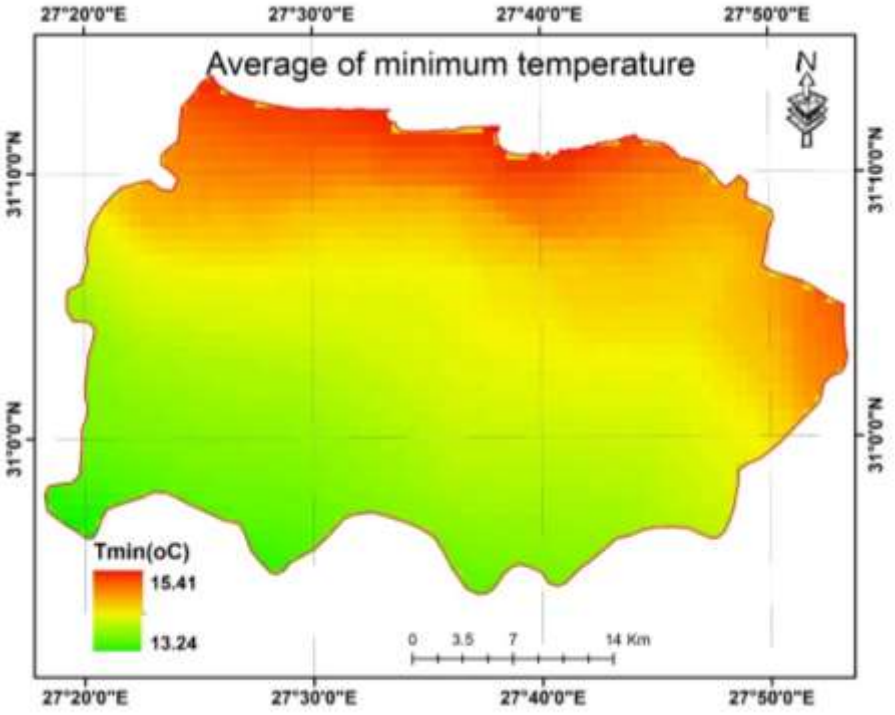

*Map 8: Average minimum temperature map of site 1 (Abou Mazhoud)*

The average maximum air temperature of Al-Gaaween ranges between 23.96° in the northwestern corner and raises gradually to 24.93° to the southeast corner (Map 9). The average maximum temperatures show a homogenous graduation trends from northwest to southeast.

The average minimum temperature ranges between 13.24° in the south and gradually increased to 15.41° in the north (Map 10). The average minimum temperatures show a homogenous graduation trends from south to north.



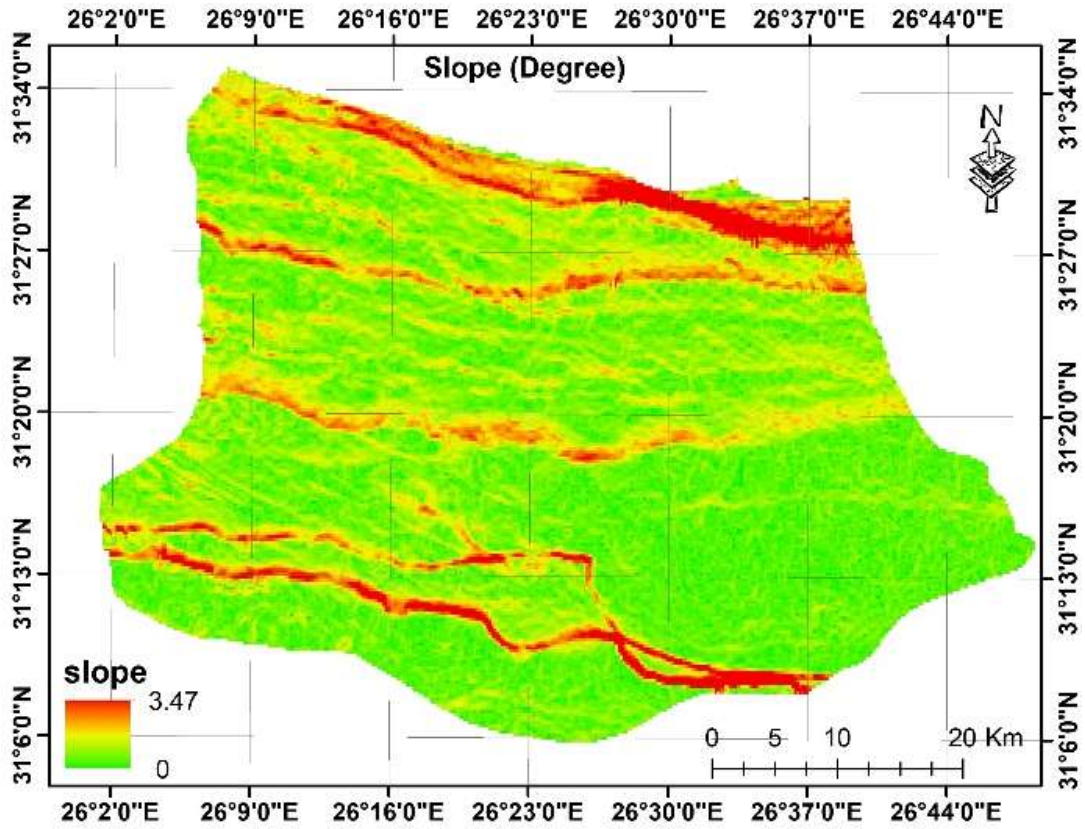

*Map 9: Average Maximum temperature map of site 2 (Al-Gaaween)*



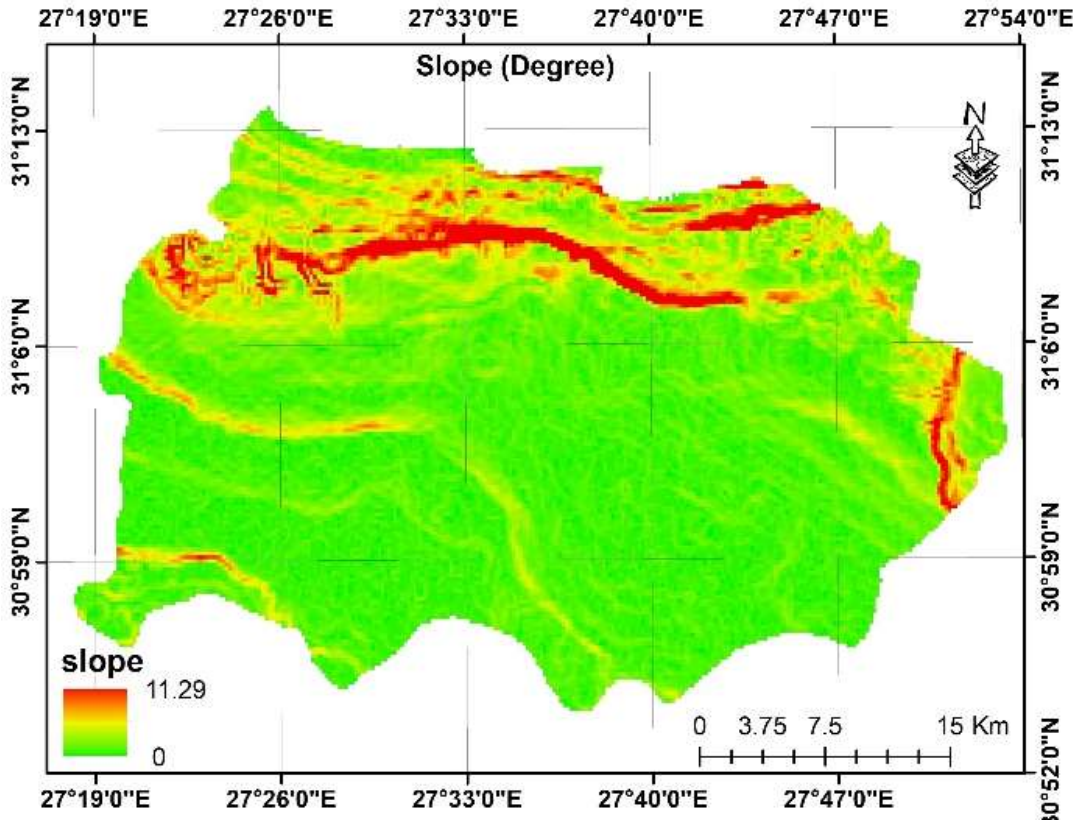

*Map 10: Average minimum temperature map of site 2 (Al-Gaaween)*

## Slope

The slope is an important soil parameter to reflect planting suitability. The soil slope driving the water flow to a specific direction. High slope causes soil erosion and prevent soil to keep sufficient water in the root zone for growing vegetation. In general, the slope in study areas is towards the Mediterranean Sea. The slope in site-1 (0-3.5 degree) is good and suitable for growing vegetation, while slope in site-2 (0-11.5 degree) is relatively suitable because it ranged from flat to moderate slope (maps 11 &12).




*Map 11: Slope map of site-1 (Abou Mazhoud).*




*Map 12: Slope map of site-2 (Al-Gaaween).*

## Soil classification

According to (Wahab et al., 2014), Sidi Barrani area has different soil classification units. The classification units are Typic Haplocalcids, Typic Haplosalids, Typic Torriorthents, and Typic Torripsamments. These soil units represent 9.03, 0.99, 19.13 and 31.91% of the total area, respectively. The rest of the area includes other features i.e. rock outcrops (36.94%) and rock escarpment (2.00%). It is found that the rock outcrops in Sidi Barrani area are concentrated in the southern parts. The soil is divided into four classes according to its depth as very deep soil which represents 30% (864 $km^2$) of the total area. It mainly dominates in the western part of the study area. Deep soil is covers about 44. 9 % (i.e. 1281 $km^2$) of the study area. This class dominates middle of the study area. Moderately deep soil is more susceptible to desertification than very deep and deep soils. It covers only

1.6 % (45.9 $km^2$) of the study. It is mainly located to the middle north part of the study area. Shallow soil covers about 23% (662 $km^2$) of the study. It is located mainly in the southern parts of the study area.

Different soil studies are conducted to the study area, but concentrated on a small scale (i.e., Wadies). It was difficult to collect the study area from literature. The FAO-UNISCO soil map classification is proper for regional or global scale. The FAO-UNISCO soil map classified the study area as one class (Calcic Yermosols). To producing detailed soil map for the study area, it is necessary to do ground truthing to collect represented soil samples.

**Geology**

Abou Mazhoud and Al-Gaaween area is typically a rocky desert with a varying cover of alluvial deposits concentrated within the alignments of the main wadi channels (Map 13). An extensive surface cover of sand dunes occurs within the northern area within the region. Sand dunes cover approximately 10% of the study area.

Geological rocks are represented by sedimentary units belonging to Tertiary and Quaternary age, which are intermittently covered by thin alluvial deposits or sand dunes. The geological units can be described from recent to oldest as follows:

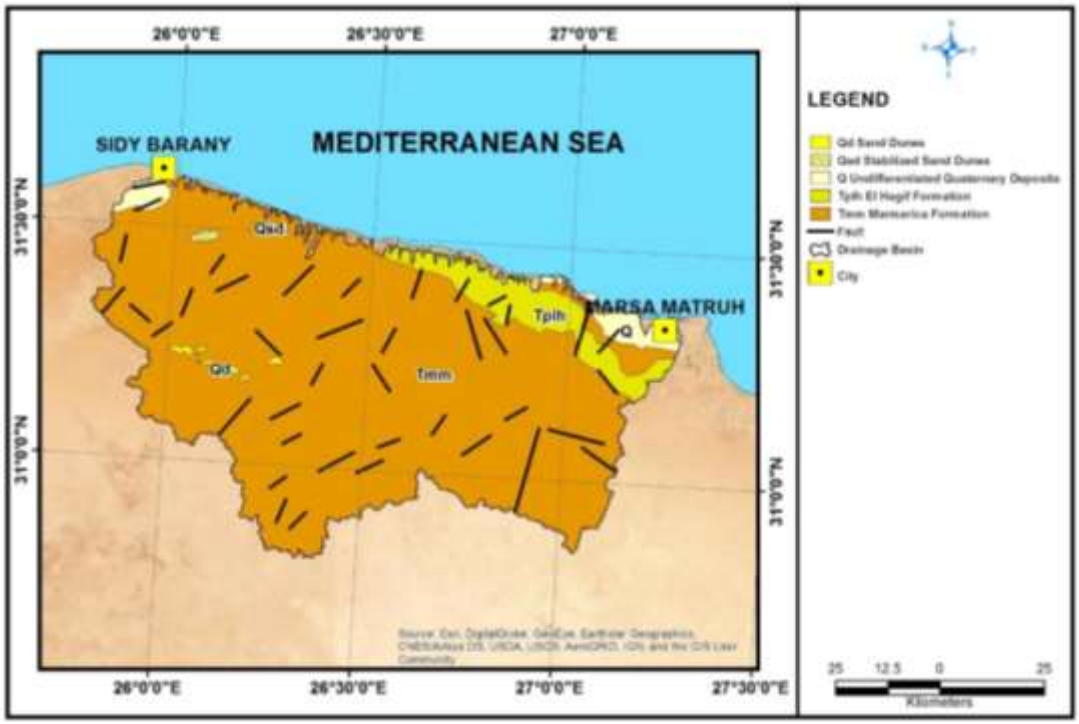
**Quaternary deposits**

**Holocene deposits contain three types of deposits;**

- Coastal deposits cover the coastal strip. It formed of friable calcareous sand grains. This strip is characterized by the presence of a chain of coastal sand dunes, which in turn formed of calcareous

sandstone considered as a natural storage to rainfall percolating during the permeable surface cover.

- Aeolian deposits present as two forms either calcareous intercalated with clay or movable oldest sand from sandstone of some calcareous plateau areas.
- Wadi deposits formed in coastal plain and wadi drainage. They are formed of sand and clay with some gravel and these deposits formed overlying the Miocene limestone strata. The maximum thickness of these deposits reache to 10 m. Sabkha is present in rectangular synclines; where it is formed due to evaporation and deposition of clay intercalated with salts.




*Map 13: Geologic map.*

**Pleistocene deposits present along the north coast and contain two units.**

- Limestone covers large parts of the coast and is considered the main form of Pleistocene deposits which form rectangular synclines and isolated hills along the coastal plain.
- The Calcareous sand stone that forms some rectangular synclines present along the coastal plain and it is formed of cross-stratified sand layers.

**Tertiary deposits**

Pliocene deposits present at limited zones along the northwestern coast and formed of silt, sand, and clay. These deposits lying subsurface unconformable overlying middle Miocene rocks.

Miocene deposits are divided into two rocky units;

- Marmarica Formation covers the greatest part of the northern plateau of the Western Desert which belongs to the middle Miocene age. It is formed mainly of karsitic limestone intercalated with clay and marl.
- Moghra Formation which belongs to the lower Miocene. It is formed of marl, limestone, and clay. This formation is found outcropping at Sallum area with a thickness of 65 m underlying Marmarica Formation.

**Similarity**

As shown in the description maps of the area, there is nearly a similar trend and condition in both study sites, consequently these similarities will reflect on similarity of the vegetation cover and similar land use. These data and information have been mentioned and confirmed by pastoralists in both study sites (Personal communication).

# Detailed studies of target landscapes.

## Land use aspects

### Historical background

The Western Mediterranean coastal land of Egypt is called the Mareotis District, being related to Mariut Lake. In the past, this lake was a fresh-water one. Kassas (1972) states “Strabo (66-24BC) recorded that Lake Marea is filled by many canals from the Nile through which a greater quantity of merchandise is imported”.

De Cosson (1935) reported that the lake was rather deep fresh water and added: “There seems to be little doubt that 2,000 years ago it was of greater extent than in modern times. The Canopic Nile Branch and the other canals that fed the lake gradually silted and its water receded. Thus, Lake Mariut was in Graeco-Roman times a fresh-water lake, the water of which was used for irrigating fields. This source of freshwater gradually diminished and by the end of the twelfth century the lake became saline”.

Kassas (1970) infers that, in this coastal region, agriculture and horticulture established by a resident population of cultivators. The farms depended partly on irrigation from an ancient branch of the Nile (the Canopic) that extended for some distance west of the present site of Mariut, but the location of farms far beyond the reach of this branch indicates that effective methods of dryland farming were used. According to Kassas (1972), the Mareotis district is an area of prosperous cultivation particularly vineyards, that densely inhabited. Good wine was produced in such quantities that Mareotis wine was laid down for keeping over long periods. By the tenth century, the district gradually declined and the vineyards were replaced by desert. It is unlikely that there have been major climatic changes during the last 2,000 years that could cause the deterioration of the area. There is also

evidence that the freshwater of Mariut Lake and its arm extended westward for 79 km used for irrigating farms and orchards fringing the shores of the lakes and banks of its western arm. These strips of irrigated agriculture must be limited in extent because of the topography.

Earlier of this century, some attention was given to Mareotis region. The extension of a railway westward from Alexandria to Mersa Matrouh, and the plantation of vine, olive and date palm at Ikingi (20–25 km west of Alexandria) were "early steps towards regeneration" (De Cosson, 1935).

**Biodiversity**

Several attempts have been done to reintroduce a variety of orchard crops in Mareotis: vine (Vitis vinifera), fig (Ficus carica), date palm (Phoenix dactylifera), olives (Olea europaea), carbo (Ceratonia siliqua), almond (Prunus amygdalus) and pistachio (Pistacia vera) (Kassas, 1972).

At present the main land use of Mareotis is grazing and rain-fed farming (or irrigation by underground and run-off water). The main annual crop is barley (Hordeum vulgare). Figs are successful on calcareous coastal dunes while olives, almonds and pistachio in inland alluvial depressions. Irrigated agriculture of pasture, grain crops and fruit trees (mainly vine) is spreading after the extension of irrigation canals from the Nile up to 60 km west of Alexandria (Ayyad, 1983).

One of the most common forms of land use in the Western Mediterranean coastal region of Egypt is animal production. Its contribution to the livelihood of Bedouin increases from Alexandria to the westward direction and considers the main source of development activities, food security and income. Grazing material for livestock and fire-wood as energy sources are the two major and basic needs of the inhabitants of the western desert of Egypt. The western Mediterranean desert land is one of the richest

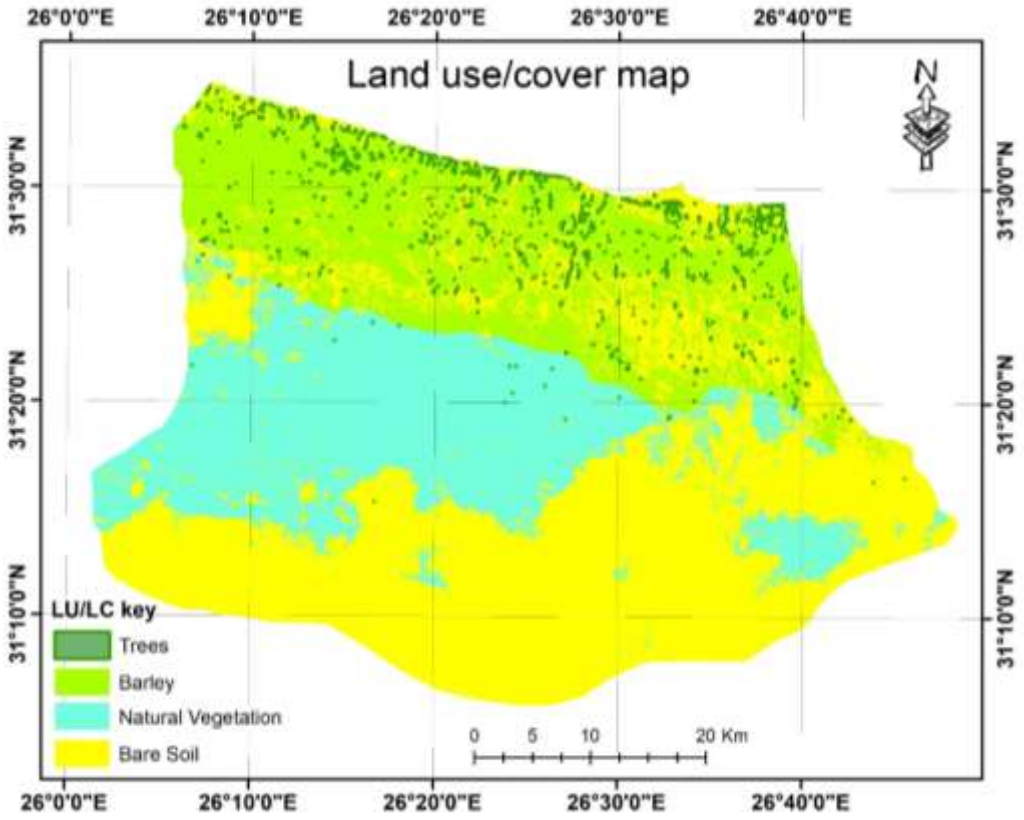
phytogeographical region of Egypt in natural vegetation because of its relatively high rainfall in comparison to other regions. The natural vegetation includes many species of annuals, mostly herbs and few grasses, perennial herbs, shrubs, sub-shrubs, and trees. These species represent 50% of the total flora of Egypt. The botanical composition is spatially heterogeneous depending on soil fertility, topography, and climatological conditions but with sub-shrubs dominating the vegetation (Ayyad and Ghabbour, 1977).

**Land cover**

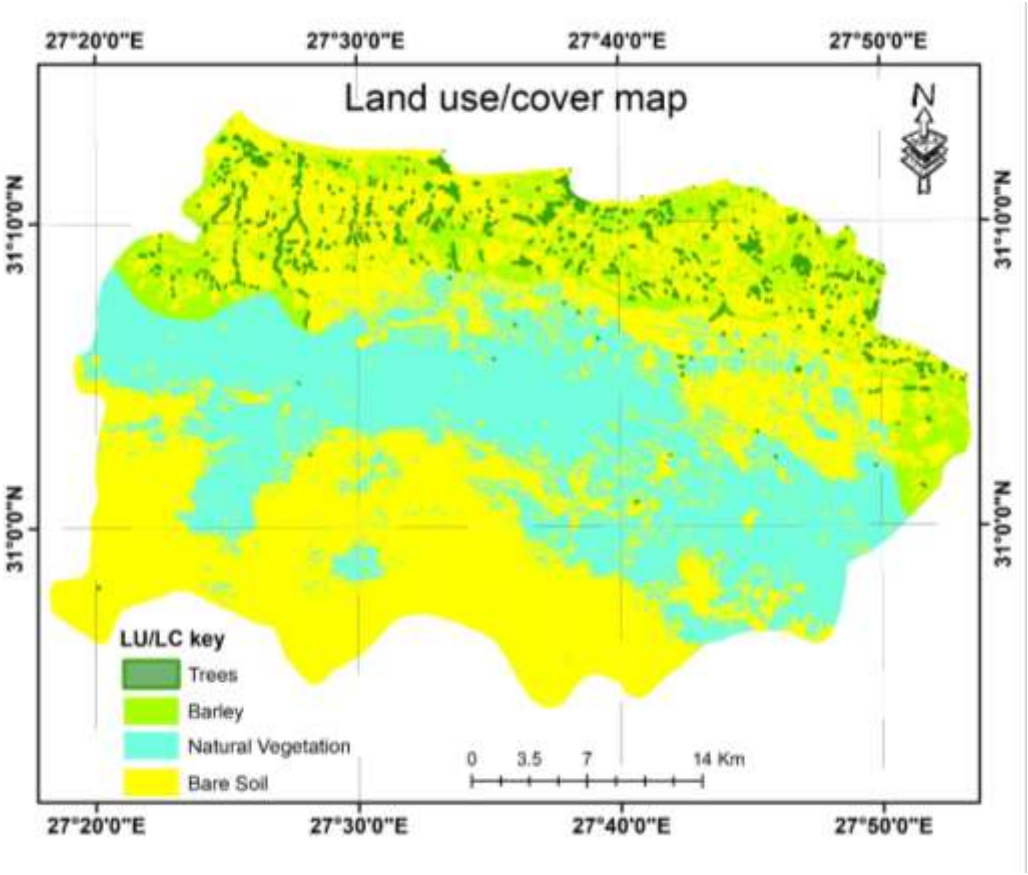
Bands 4 (Red) and 8 (Near-Infra-Red) of sentinel-2 data were used to calculate the Normalized difference vegetation index (NDVI). The NDVI was classified to differentiate between vegetation, bare soil and water in winter 2019 and summer 2019. The vegetation cover in winter was very high in comparison with vegetation cover in summer. In winter, the percentage of vegetation cover was 51% and 46% for site 1 and site 2 respectively. The vegetation cover in winter includs trees (i.e., Fig and Olive), cultivated area (i.e., Barley and Wheat) and natural vegetation. While in summer, the vegetation cover was very low; 0.16% and 0.27% for site1 and site2 respectively.

The vegetation cover in summer is only shurbes and trees, which depend on the water storage in the root zone area. The rainfall quantity, frequency and spread are the main driving factor in changing land use/cover map for the areas of interest. The cultivated areas are distinguished from the rangeland through the shape and location of the field. The northern part of the study area is common to be cultivated area while the southern part is common to be natural vegetation. Besides that, the shape of cultivated areas

has an arranged pattern. The barley occupied 24% and 11% for site1 and site2 respectively. On the other hand, the natural vegetation recorded 27% and 34% for site1 and site2 respectively. Map 14 & 15 shows the land use/cover map for site1 and site2. The results need validation using ground truthing to evaluate the results and calculate the accuracy assessment.




*Map 14: Land use/cover map for site-1(Abou Mazhoud).*




*Map 15:Land use/cover map for site-2 (Al-Gaaween).*

## Water resources aspects

Since the early 1970s, the Government of Egypt has benefited from a period of unprecedented growth and development in various sectors of its economy. Northwestern coast area is characterized by several natural resources that lead to real development. Water demand exceeds water availability and as a result, it is observed stress on investigations of more groundwater, rainfall harvesting, and water desalination as well. However, the efforts still weak compared to resources availabile in the area. The main reason stand against the development is the scarcity of fresh water resources required for various activities.

Various studies and investigations have been performed within the past 30 years and, consequently, considerable data exist relating to the distribution and characterization of different water resources (surface water, groundwater, and desalinated water ….etc.). However, the pressure on water resources will continue to increase as the population growth (forecast to increase from 6.84 million in 2011 to 6 million by 2030). Moreover, agricultural and industrial expansion continues. In light of this pressure the Egyptian Government is faced with the major challenge of developing a sustainable water resource strategy to meet future demands without constraining economic growth.

## Precipitation

### Rainfall distribution

The rate of rainfall over the area ranges between 100 mm/year and 150 mm/year. This rate decreases towards the west and south where it reaches 75 mm/year. The maximum average of rainfall during the years (2004-2014) based on rainfall data of General Meteorological Stations (GMA) is shown in Fig. 1 for Sidi Baranni and Fig. 2 of Marsa Matrouh.

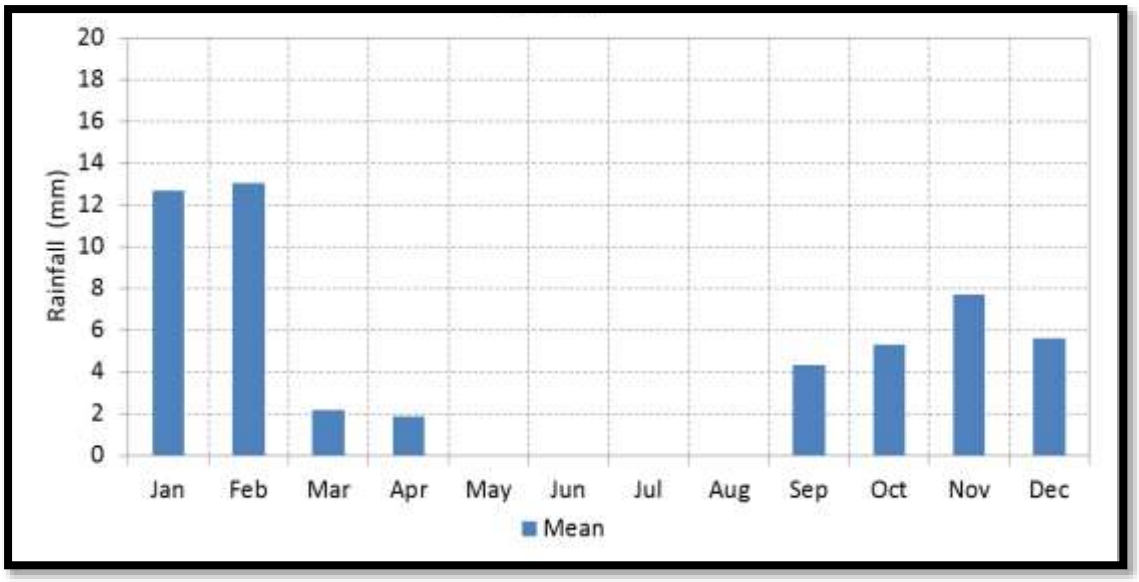



*Figure 1: Rainfall data of Sidi Barrani Meteorological Stations*

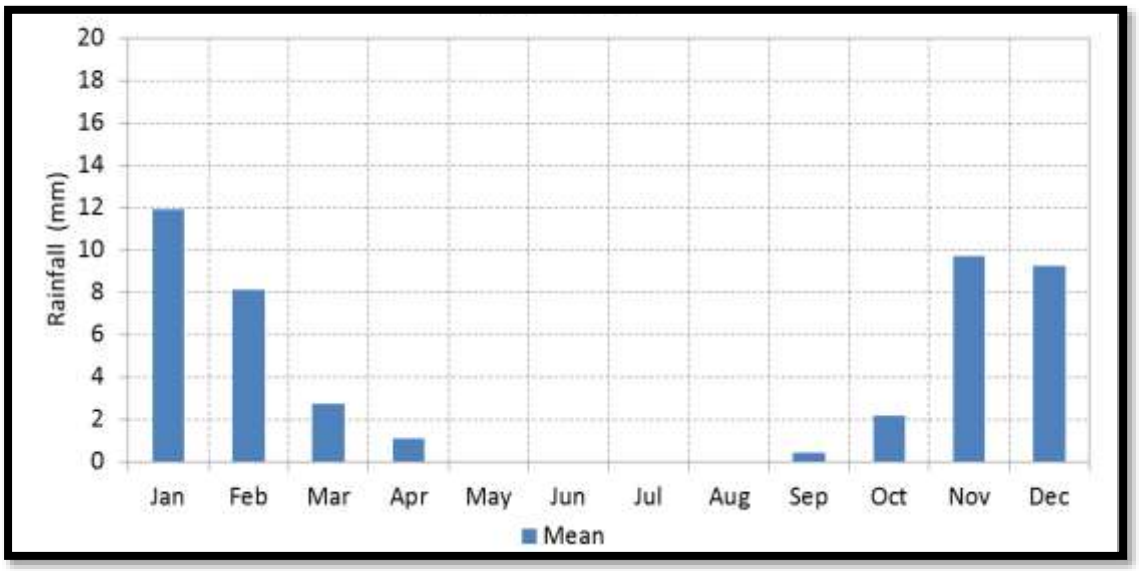



*Figure 2: Rainfall data of Marsa Matrouh Meteorological Stations*

**Rainfall statistical analysis**

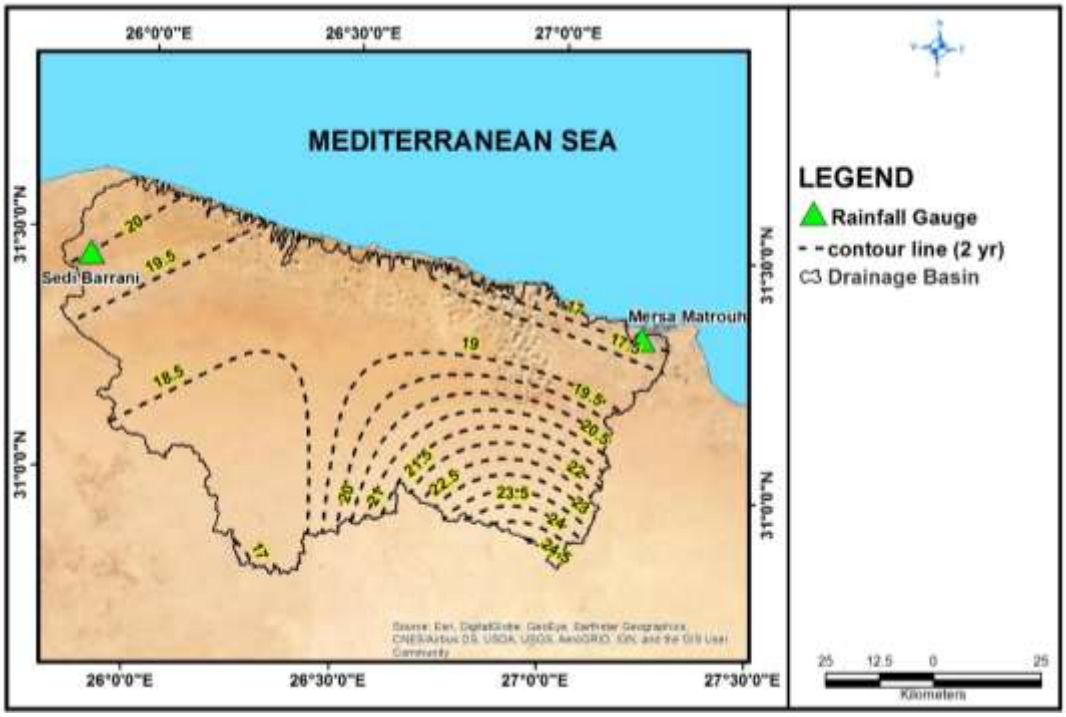
Spatial and temporal distribution of rainfall depends on topographic features and wind directions as well. Rainfall amount determination and future prediction; there are several statistical programs that use rainfall data to analyze the maximum daily rainfall amount. These statistical analyses are beneficial to determine the expected predicted rainfall amount at

different frequency times. The small frequency times, range from 2 to 10 years; represent the availability of surface water resources for sustainable development purposes. However, the high frequency times, range from 25 to 100 years; represent the middle and high flood, which negatively affect the structures within the wadies and their tributaries. The need for several probability distributions to determine the more suitable and accurate ones, therefore the statistical program (HYDROFREQ) is used where it contains several probability distributions. Maps 16, 17 & 18 show the statistical analysis of rainfall distribution during different frequency times at 2, 5, and 10 years. It can be noticed that the maximum rainfall attains at Sidi Barani where it decreases to the east and to the west.

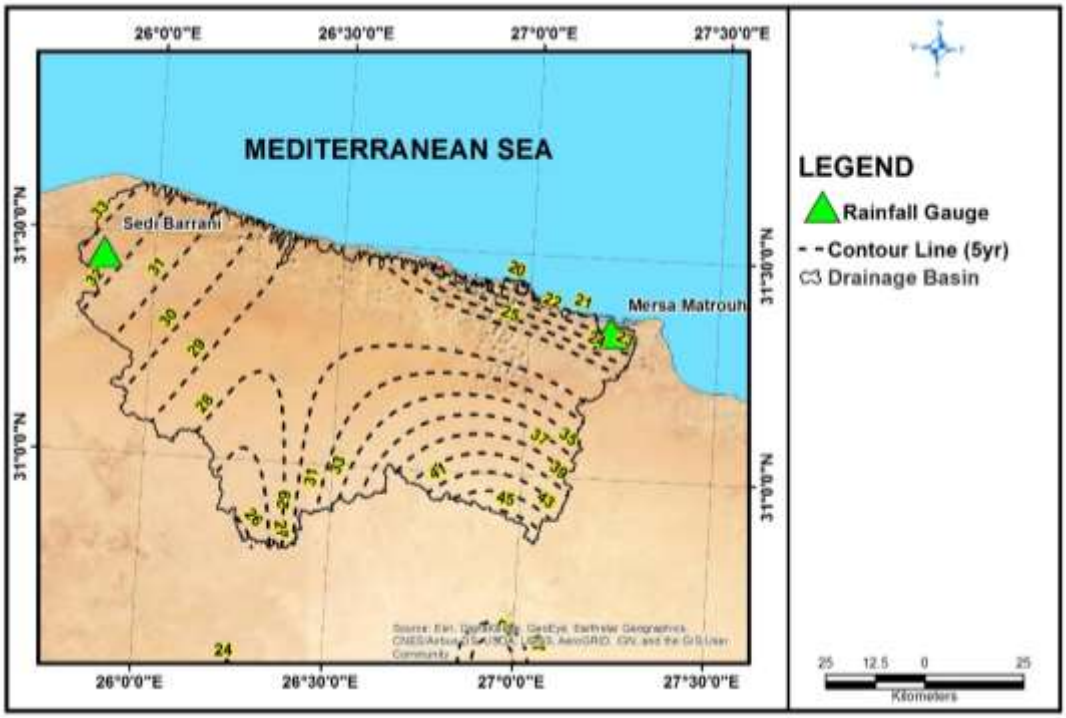
The rainfall distribution of rainfall amount at frequency times 2, 5, and 10 years for GMA stations at Sidi Barani, and Matrouh Table 2. It was noticed that the maximum rainfall amount found at Sidi Barani meteorological station.

*Table 2: Rainfall amount at different frequency times (mm)*

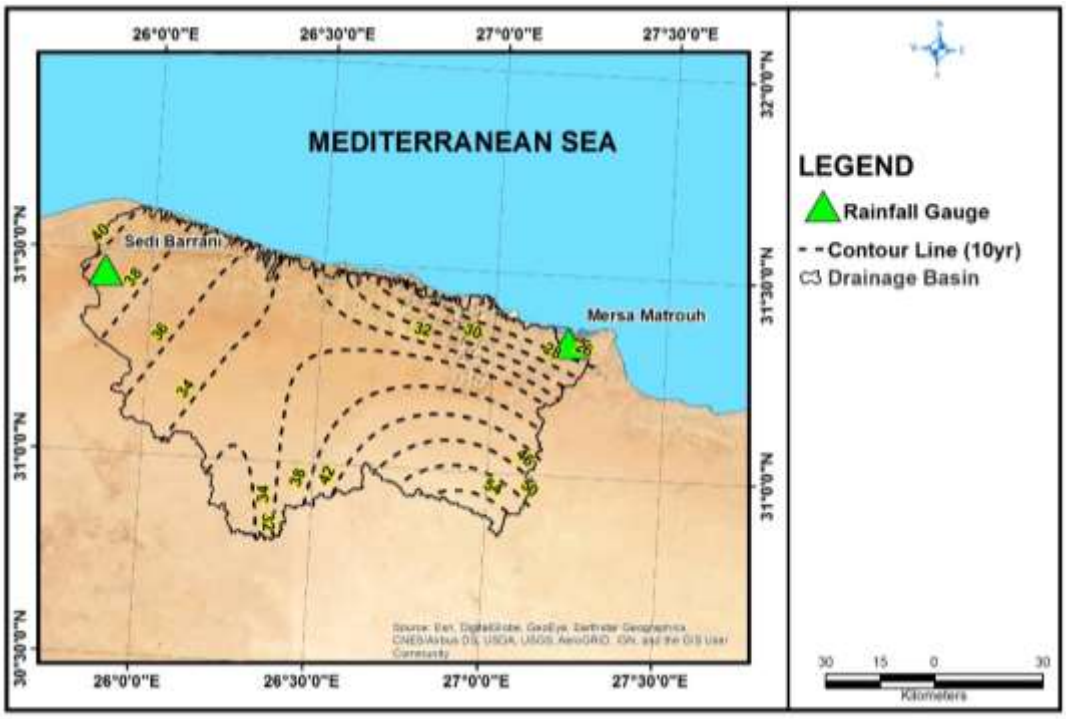
| **Station** | Frequency times (year) | | |
|---|---|---|---|
| | 2 | 5 | 10 |
| **Sidi Barani** | 20.0 | 32.0 | 38.5 |
| **Matrouh** | 17.0 | 23.0 | 26.0 |




*Map 16: Rainfall distribution during frequency times at 2 years.*




*Map 17: Rainfall distribution during frequency times at 5 years.*




*Map 18: Rainfall distribution during frequency times at 10 years.*

## Hydrology

Rainfall is the source of wadi flow in the study area. Wadi runoff is the result of the geology and physical characteristics of the catchment and rainfall intensity and duration. Flood quantities have been estimated at different frequency times, based on meteorological, geological, and topographic information, using Watershed Modeling System. This software helps calculating flood hydrograph with several methods.

## Drainage basins

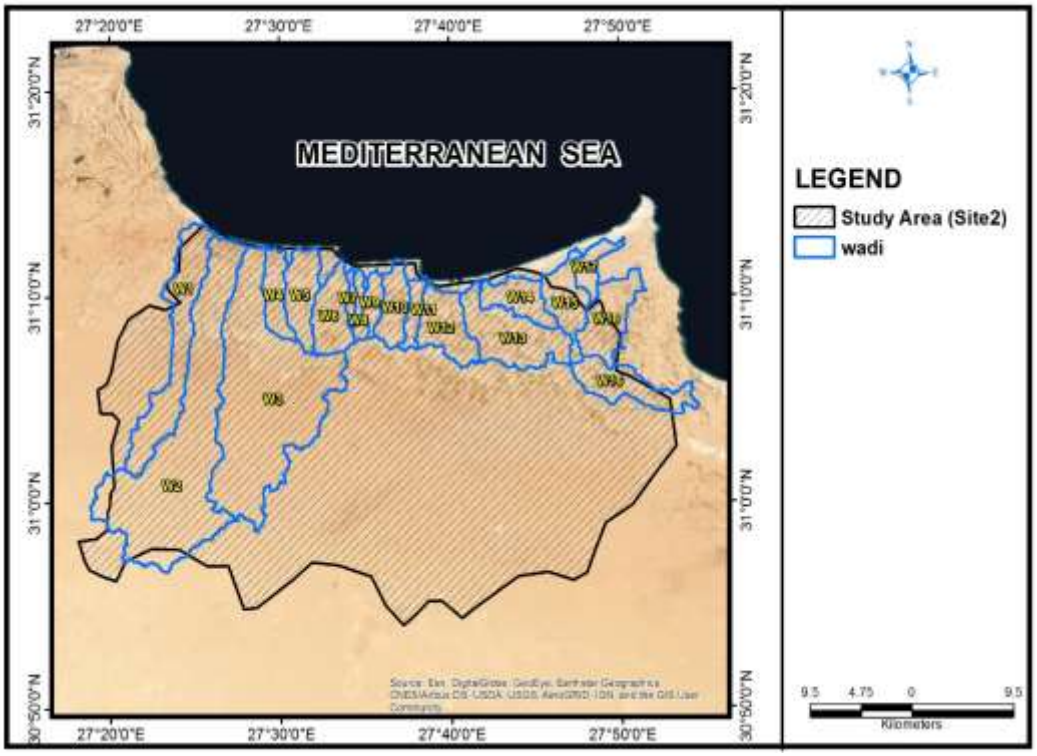
The study area includes many drainage basins. Only 15 basins affect Abou Mazhoud and cover an area range between 19 and 1953 $km^2$ (Map 19) and 18 basins affect Al-Gaaween and cover an area range between 3.3 and 159 km2 (Map 20). The morphological characteristics of the basins are listed in Table 3 for Abou Mazhoud and Table 4 for Al-Gaaween.

*Table 3: Morphological characteristics of Wadis affect Abou Mazhoud (site )*

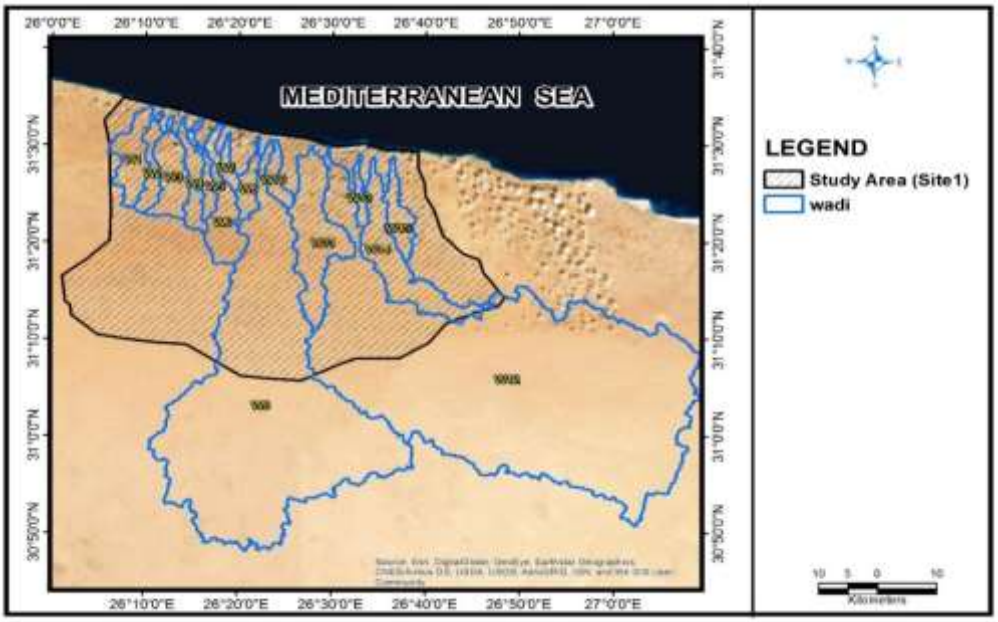
| Wadi | BASINAREA ($km^2$) | Length (m) | Basin Slope | Perimeter (m) | Mean Elevation (m) |
|---|---|---|---|---|---|
| W1 | 54.835 | 23.223 | 0.013 | 73.860 | 99.660 |
| W2 | 155.920 | 30.439 | 0.010 | 113.670 | 150.110 |
| W3 | 159.128 | 25.513 | 0.011 | 98.167 | 140.160 |
| W4 | 15.668 | 8.873 | 0.020 | 26.492 | 57.460 |
| W5 | 22.691 | 9.403 | 0.022 | 29.649 | 62.870 |
| W6 | 22.893 | 8.826 | 0.025 | 27.976 | 104.330 |
| W7 | 3.351 | 5.221 | 0.032 | 13.780 | 74.040 |
| W8 | 6.402 | 6.521 | 0.026 | 18.342 | 96.931 |
| W9 | 7.524 | 6.101 | 0.031 | 17.353 | 74.239 |
| W10 | 17.358 | 7.857 | 0.029 | 25.025 | 76.408 |
| W11 | 8.107 | 6.803 | 0.029 | 22.117 | 74.030 |
| W12 | 26.191 | 8.348 | 0.029 | 29.809 | 69.480 |
| W13 | 42.054 | 11.071 | 0.017 | 47.856 | 86.159 |
| W14 | 18.757 | 8.126 | 0.029 | 29.147 | 56.429 |
| W15 | 22.743 | 10.354 | 0.025 | 36.525 | 79.283 |
| W16 | 27.283 | 11.510 | 0.015 | 43.695 | 80.577 |
| W17 | 10.052 | 6.528 | 0.033 | 23.918 | 47.036 |
| W18 | 28.255 | 9.011 | 0.015 | 35.284 | 95.219 |

*Table 4: Morphological characteristics of Wadis affect Al-Gaaween (site 2)*

| Wadi | BASINAREA ($km^2$) | Length (m) | Basin Slope | Perimeter (m) | Mean Elevation (m) |
|---|---|---|---|---|---|
| W1 | 54.835 | 23.223 | 0.013 | 73.860 | 99.660 |
| W2 | 155.920 | 30.439 | 0.010 | 113.670 | 150.110 |
| W3 | 159.128 | 25.513 | 0.011 | 98.167 | 140.160 |
| W4 | 15.668 | 8.873 | 0.020 | 26.492 | 57.460 |
| W5 | 22.691 | 9.403 | 0.022 | 29.649 | 62.870 |
| W6 | 22.893 | 8.826 | 0.025 | 27.976 | 104.330 |
| W7 | 3.351 | 5.221 | 0.032 | 13.780 | 74.040 |
| W8 | 6.402 | 6.521 | 0.026 | 18.342 | 96.931 |
| W9 | 7.524 | 6.101 | 0.031 | 17.353 | 74.239 |
| W10 | 17.358 | 7.857 | 0.029 | 25.025 | 76.408 |
| W11 | 8.107 | 6.803 | 0.029 | 22.117 | 74.030 |
| W12 | 26.191 | 8.348 | 0.029 | 29.809 | 69.480 |
| W13 | 42.054 | 11.071 | 0.017 | 47.856 | 86.159 |
| W14 | 18.757 | 8.126 | 0.029 | 29.147 | 56.429 |
| W15 | 22.743 | 10.354 | 0.025 | 36.525 | 79.283 |
| W16 | 27.283 | 11.510 | 0.015 | 43.695 | 80.577 |
| W17 | 10.052 | 6.528 | 0.033 | 23.918 | 47.036 |
| W18 | 28.255 | 9.011 | 0.015 | 35.284 | 95.219 |




*Map 20: Main drainage basins affect Site 1 (Abou Mazhoud)*




*Map 19: Main drainage basins affect Site 2 (Al-Gaaween )*

## Flood water

Hydrological modeling has been developed using HEC-HMS to develop the flood hydrographs with the help of flood quantity and maximum discharge at frequency times 2, 5, and 10 years, for W3 as example of site 2 basins (Fig. 3) and for W12, as example of site 1 basins (Fig. 4). The results of hydrological model show that the possible flood volume for the 15 basins of site 1, at different frequency times 2, 5, and 10 years estimated about 0.3, 4.5, and 10.2 million cubic meters respectively, and for 18 basins of site 2, at different frequency times 2, 5, and 10 years estimated about 0.28, 0.55, and 1.2 million cubic meters respectively. The flood volume of the basins at frequency times 2, 5, 10 years is listed in tables 5 and 6 respectively.

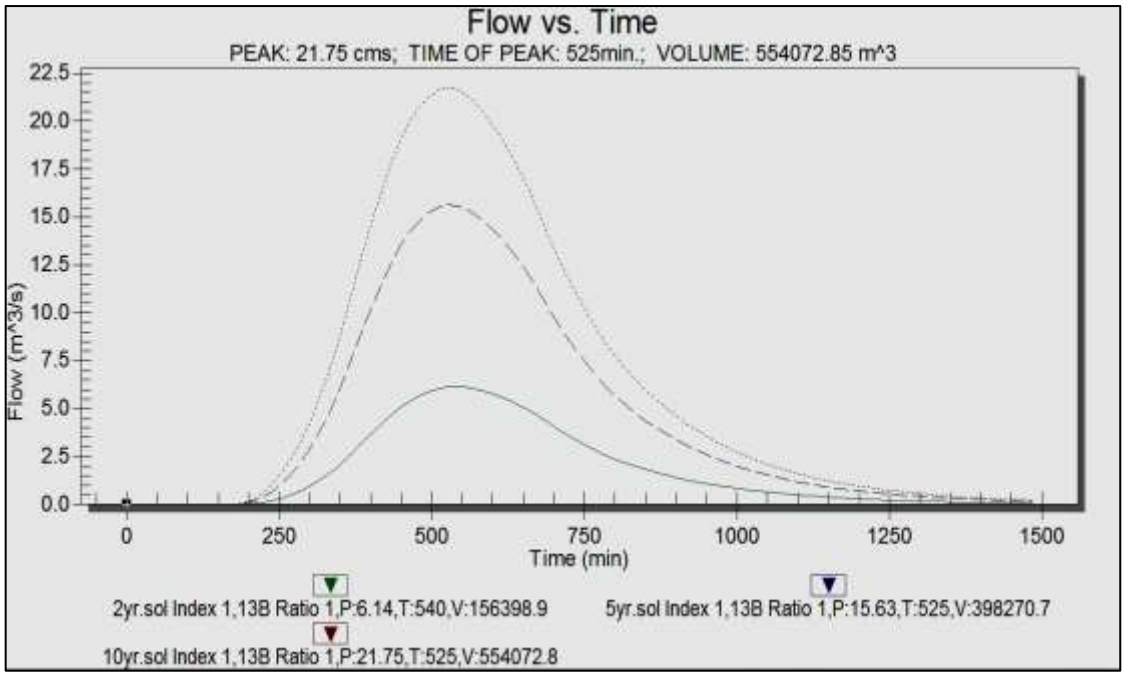



*Figure 3: Flood hydrograph at outlet of basin W3- site 2*

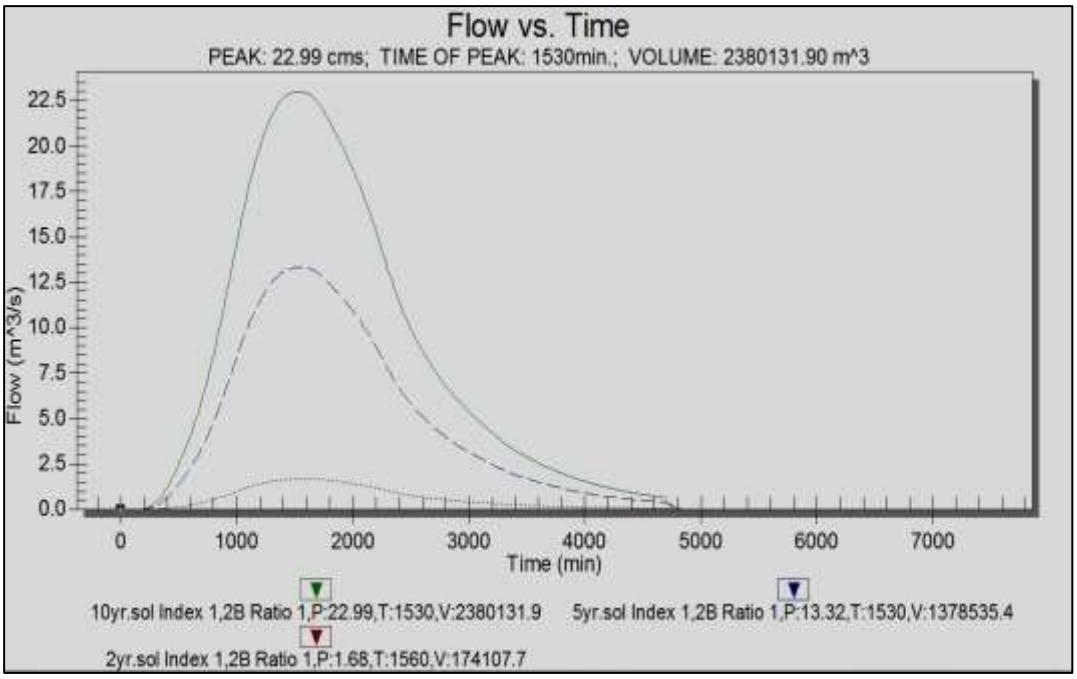



*Figure 4: Flood hydrograph at outlet of basin W12 – Site 1*

Table 5: Flood characteristics at frequency times 2, 5, 10 years for Site 1

| **Wadi** | **2yr** | | **5yr** | | **10yr** | |
|---|---|---|---|---|---|---|
| | $V(m^3)$ | $Q(m^3/s)$ | $V(m^3)$ | $Q(m^3/s)$ | $V(m^3)$ | $Q(m^3/s)$ |
| **W1** | 10178.10 | 0.39 | 186941.70 | 6.78 | 351720.90 | 12.82 |
| **W2** | 5682.60 | 0.23 | 104424.30 | 3.92 | 196470.00 | 7.42 |
| **W3** | 10787.40 | 0.40 | 198186.30 | 7.05 | 372870.90 | 13.32 |
| **W4** | 0.00 | 0.00 | 50375.70 | 1.74 | 121988.70 | 4.19 |
| **W5** | 0.00 | 0.00 | 30544.20 | 1.14 | 73961.10 | 2.76 |
| **W6** | 0.00 | 0.00 | 92509.20 | 2.85 | 224026.20 | 6.84 |
| **W7** | 0.00 | 0.00 | 19596.60 | 0.95 | 47463.30 | 2.32 |
| **W8** | 0.00 | 0.00 | 34816.50 | 1.41 | 84326.40 | 3.39 |
| **W9** | 68225.40 | 0.90 | 1961916.30 | 23.86 | 4389816.60 | 53.40 |
| **W10** | 0.00 | 0.00 | 27936.00 | 1.30 | 67655.70 | 3.16 |
| **W11** | 24484.50 | 0.73 | 449565.30 | 12.85 | 845842.50 | 24.19 |
| **W12** | 174107.70 | 1.70 | 1378535.40 | 13.32 | 2380131.90 | 23.00 |
| **W13** | 0.00 | 0.00 | 0.00 | 0.00 | 1090.80 | 0.10 |
| **W14** | 0.00 | 0.00 | 41106.60 | 0.95 | 91630.80 | 2.25 |
| **W15** | 0.00 | 0.00 | 0.00 | 0.00 | 2862.00 | 0.12 |

*Table 6: Flood characteristics at frequency times 2, 5, 10 years for Site 2*

| Wadi | 2yr | | 5yr | | 10yr | |
|---|---|---|---|---|---|---|
| | V($m^3$) | Q($m^3/s$) | V($m^3$) | Q($m^3/s$) | V($m^3$) | Q($m^3/s$) |
| **W1** | 2351 | 0.11 | 30158 | 1.41 | 55082 | 2.56 |
| **W2** | 109202 | 3.69 | 312287 | 10.55 | 447503 | 15.12 |
| **W3** | 156398 | 6.14 | 398271 | 15.63 | 554073 | 21.75 |
| **W4** | 440 | 0.04 | 7655 | 0.68 | 14380 | 1.27 |
| **W5** | 240 | 0.03 | 8996 | 0.85 | 17847 | 1.68 |
| **W6** | 6289 | 0.19 | 26562 | 0.81 | 41441 | 1.26 |
| **W7** | 4000 | 0.51 | 9574 | 1.27 | 13100 | 1.77 |
| **W8** | 149 | 0.02 | 2993 | 0.32 | 5688 | 0.61 |
| **W9** | 0 | 0.00 | 1261 | 0.16 | 3271 | 0.40 |
| **W10** | 0 | 0.00 | 3937 | 0.39 | 9217 | 0.89 |
| **W11** | 370 | 0.04 | 4537 | 0.49 | 8256 | 0.89 |
| **W12** | 233 | 0.02 | 10064 | 0.90 | 20135 | 1.78 |
| **W13** | 0 | 0.00 | 1994 | 0.14 | 8967 | 0.61 |
| **W14** | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| **W15** | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| **W16** | 5909 | 0.44 | 34139 | 2.48 | 59594 | 4.34 |
| **W17** | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| **W18** | 0 | 0.00 | 0 | 0.00 | 1245 | 0.09 |

## Groundwater Resources

Geomorphological features

- Coastal plain

The plain extended along the Mediterranean coast over 80 km length and the west ranges between 4 and 15 km to the south. It characterizes by constant elevation and general slope to the sea. It also characterizes by low lands filled with clay and evaporites.

- Peidomont

This plain represents the contact between the coastal plain in the north and the southern plateau. The plain is covered by wadi deposits and sand intercalated with gravels. Calcareous rocks are present sometimes transported from small wadies.

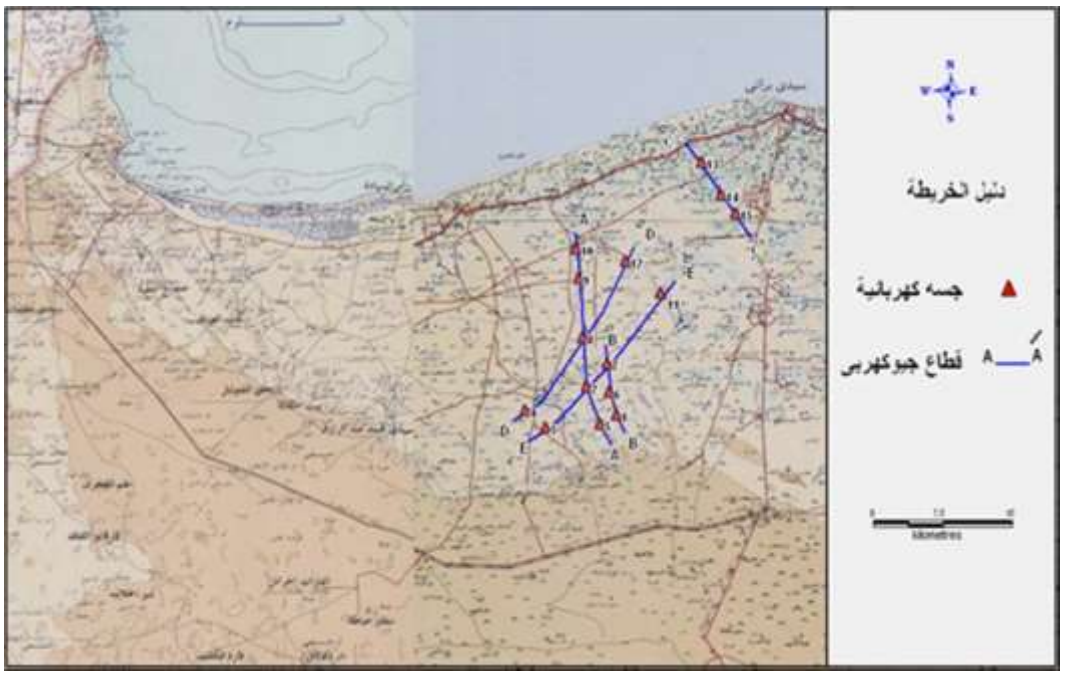
- Southern plateau

The plateau found south of the peidmont and its elevation reaches 125 m. asl. It forms the northern part of the Marmarica plateau which formed of fractured limestone.

Geophysical prospecting

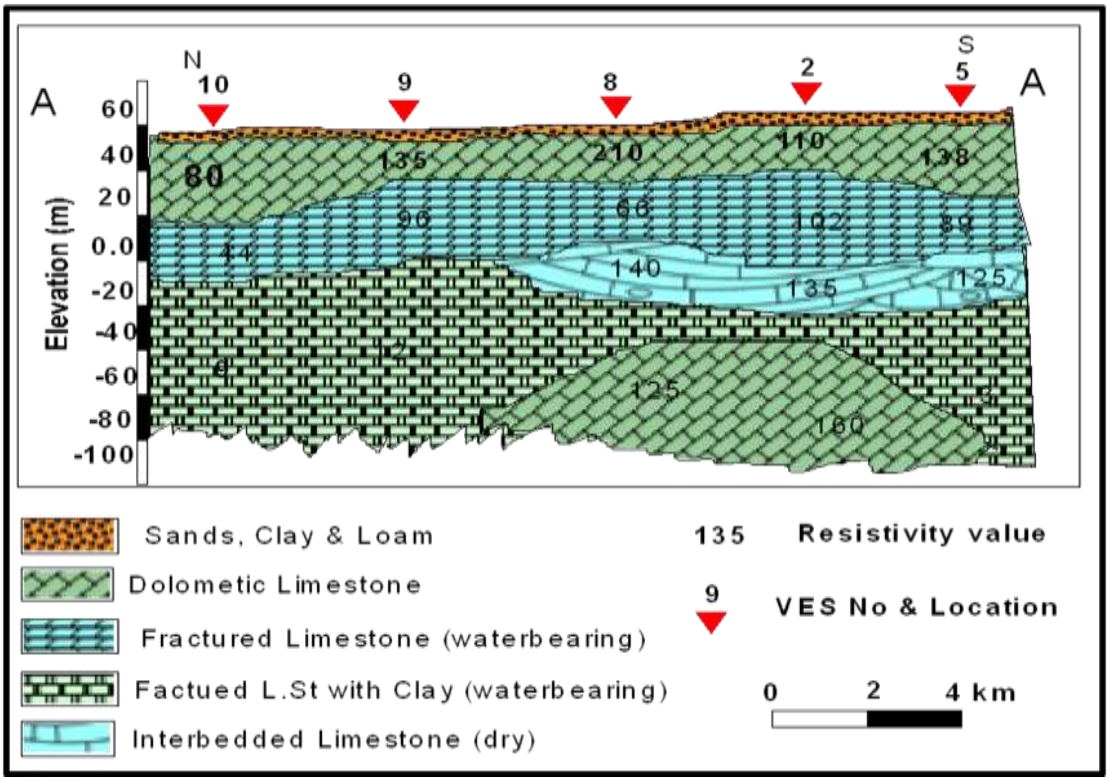
- Geo-electric soundings

Vertical electric soundings (VES) have been conducted to recognize groundwater availability and variation thickness of the deposits. The study includes 15 VES distributed along 5 sections (Map. 21).

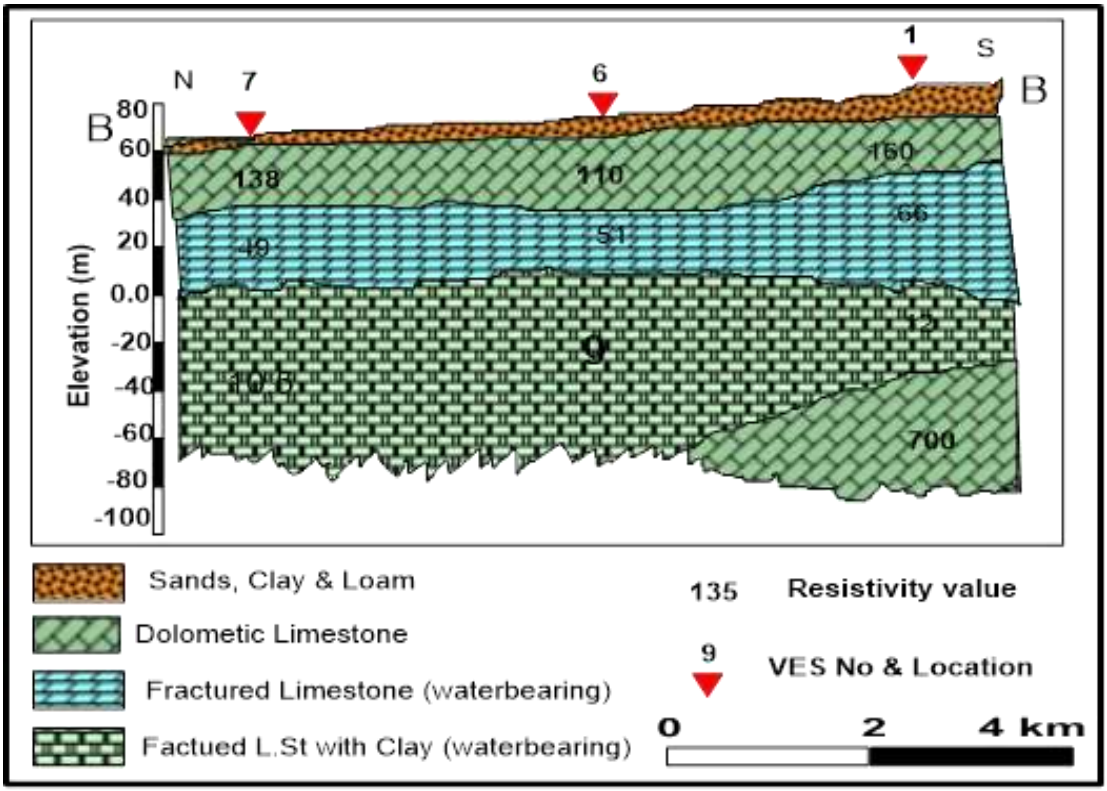



*Map 21: Location of vertical electric sounding and electric sections*

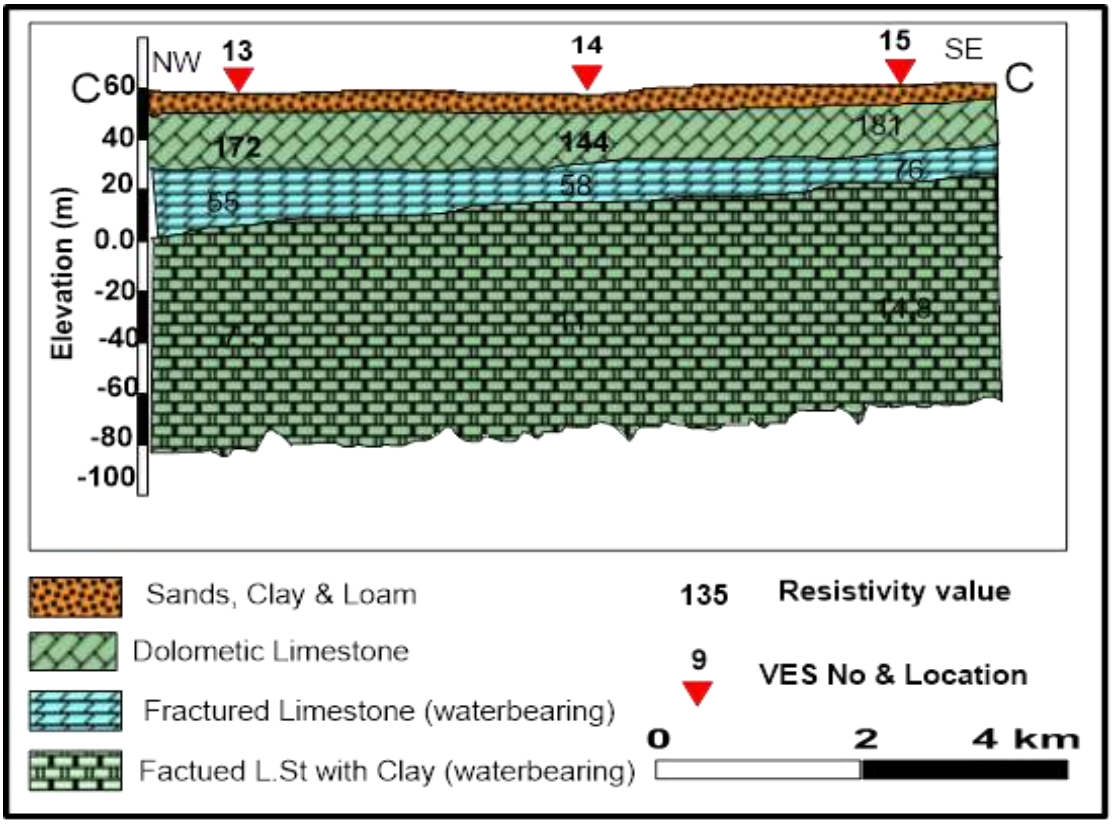
The produced electric sections have been analyzed both qualitatively and quantitatively. The geo-electric interpretation has been done manually as well as using computer programs namely Zohdy 1989, and RESIXP 1996. The analyzed 5 geo-electric sections are illustrated in Maps 22, 23, 24, 25 & 26. The 5 geo-electric sections demonstrate five geo-electric units. The interpretation discloses that the third (fractured limestone) and fourth (fractured limestone with clay) units most likely water units. However, the third unit most probably aquitard while the fourth unit may contain brackish/salt water due to the recorded low resistivity values to this unit.



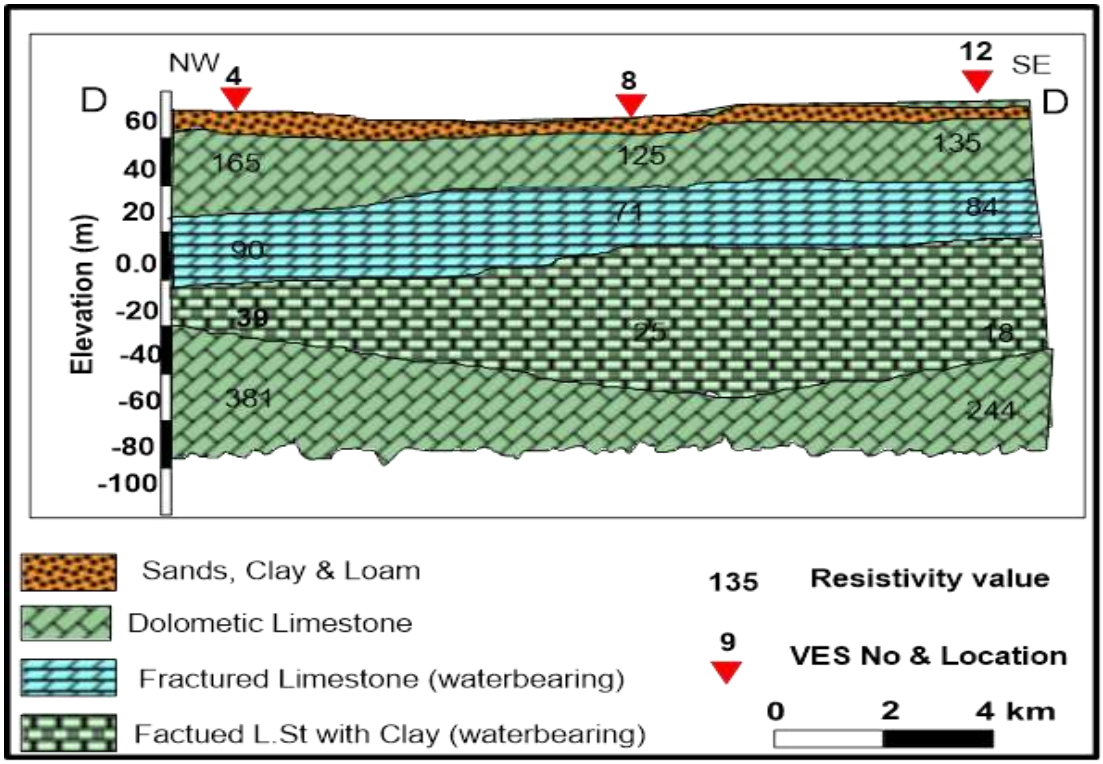

*Map 22: Geo-electric section A-A'*



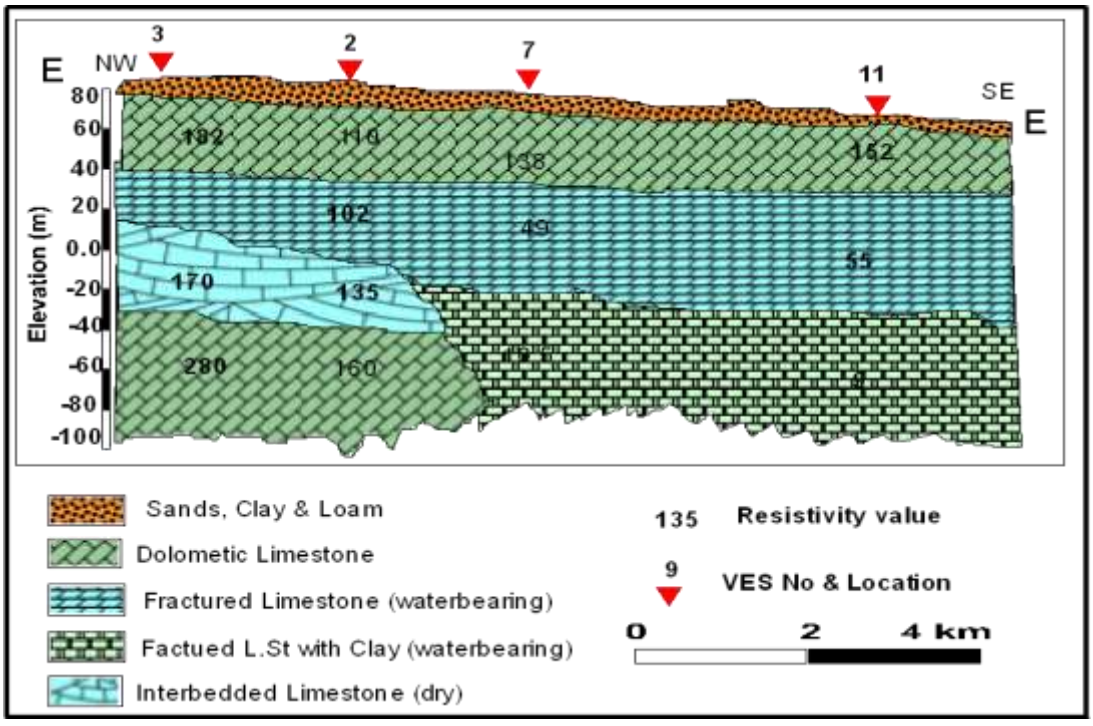

*Map 24: Geo-electric section B-B'*




*Map 23: Geo-electric section C-C'*




*Map 25: Geo-electric section D-D'*




*Map 26: Geo-electric E-E'*

**Hydrogeological characteristics**

- Groundwater modeling

Grid layout: The model grid size attains 400 x 400 m. where the area covers about 16300 $km^2$. The length of the area attains 153 km in the east direction while it attains 116 km in the north direction

**Aquifer geometry**

The aquifers system unit has been simulated using the numerical groundwater model. Further provision can be made to incorporate other units as more confident data become available.

The top and bottom surfaces of model aquifers incorporated into the model are based on the information documented and graphically displayed within the geophysical section and data collected from boreholes in the area.

Aquifer thickness only becomes of any relevance in the event that physical dewatering of the horizon occurs in response to extreme lowering of the groundwater surface. For this event, values for the apparent thickness of the fracture zones in aquifer have been included in the model. Data on the thickness of the fracture zones is very limited and are therefore based on data presented from the geophysical sections as well as borehole data are considered to be the most reliable. The thickness was set for aquifer unit ranges between 20 to 60 m.

**Aquifer properties**

There is no hydraulic data in the area. Therefore, it was suggested the following aquifer properties for modelling: Hydraulic conductivity value 1*10-4 m/s.

**Boundary conditions**

The boundary conditions for the groundwater model are as below.

Recharge:

Direct recharge to the aquifers occurs from rainfall and surface irrigation which represents the main source of recharge. The annual average losses from the rainfall attain a value of 1.76 mm. it was assumed that the recharge rate represents 25% from these losses. Consequently, the annual recharge amount to the aquifer from the rainfall equal 0.44 mm.

Northern boundary:

The northern boundary of the model domain was represented using a constant head boundary for Mediterranean.

**Abstraction data**

The available abstraction data have been collected from the boreholes distributed over the area. It was estimated the amount of abstraction to be about 1200 m3/h. There are uncertainties relating to the actual value and distribution of groundwater abstractions. Such a fundamental deficiency has a great effect on calibration of the model. There are other water wells but some difficulties collecting their information.

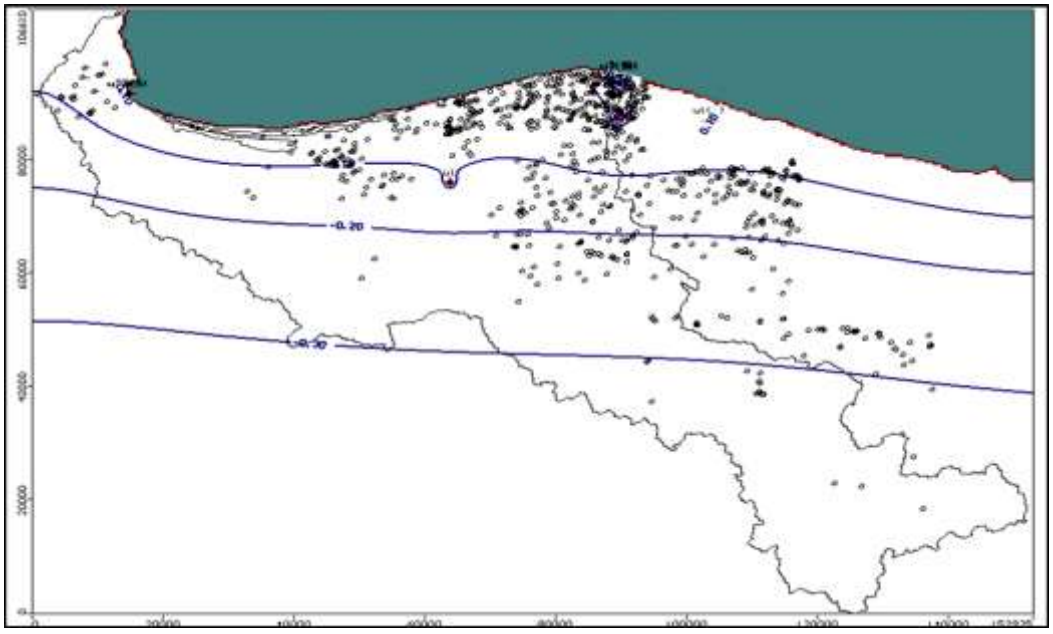
**Initial conditions**

It was assumed that the initial water level equals the zero level (sea level) in the steady state case.

**Groundwater scenarios**

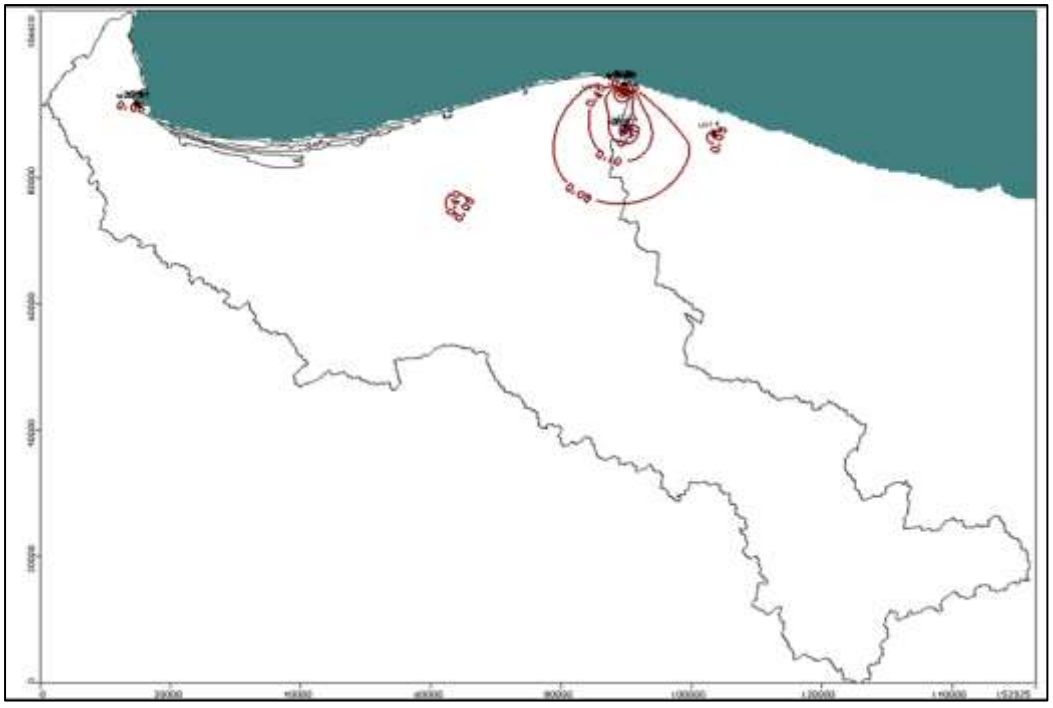
To evaluate the hydrological factors on the groundwater system; the model has been used to evaluate the impact of ongoing abstraction programs and also in case of no recharge. The model was developed for 10 years from

2015-2025. The first scenario assumed recharge of 0.44 mm/year, while the second scenario assumed no recharge. The model results are shown in Maps 27 and 28.



*Map 28: Drawdown at 2025 (scenario 1 include recharge)*

## Water Resources Evaluation



Map 27: Drawdown at 2025 (scenario 2 nd recharge)

This section will demonstrate the present water resources where residents in the area depend on for their water requirements.

**Water resources kinds**

The northwestern coast area depends on 3 main resources for drinking purposes as follows:

- Rain water harvesting via the construction of small ground collection reservoir of low cost (Photo 1). There are also relatively bigger reservoirs that need mechanical tools that cost relatively high (Photo 2).
- Groundwater via drilling water wells (Photo 3). The water salinity varies widely which needs some small desalination units to have water suitable for drinking or irrigation.

*Photo 1: Small ground wayer reservoir*

*Photo 2: Large ground water reservoir*

Groundwater from drilled water wells (Photo 3) usually used for drinking purposes. The depth of the wells reaches to 40 m. The water lift using diesel pump with 2.5-inch diameter.

*Photo 3: Drilled water wells*

- Sea water desalination

Desalination units are existing in Matrouh and Sidi Barani cities with small production rate 5000-6000 $m^3$/day (Photo 4). The inlet to these units is water wells (40 to 60 m. depth) and their water outlet used for drinking and domestic purposes.

*Photo 4: Private desalination unit*

Other desalination units; where sea water is part of the water source. The outlet of these bigger units is provided to the cities such as Sidi Barani and Sallum. The Sidi Barani desalination unit has capacity of 5000 m3/day (Photo 5). The inlet to the desalination unit is an interchangeable of water wells or sea water. The contribution 13200 m3/day from water wells, while

the contribution 15000 m3/day from the sea. There is an old desalination unit with capacity of 1000 $m^3$/day (Photo 6). The outlet desalinated water from both new and old units have been transported to the end users by trucks. The Government has a plan for sea water desalination expansion which, aim to increase the sea water desalination to be 28000 m3/day by 2032.

*Photo 6: Sidi Barani desalination unit*

*Photo 5: Old Sidi Barani desalination unit*

## Present water setting

The hydrological studies show that it can do water harvesting 0.3, 4.5, and 10.2 million $m^3$/year from rainfall based on 2, 5, and 10 years' frequency for site 1, and 0.28, 0.55, and 1.2 million $m^3$/year from rainfall based on 2, 5, and 10 years' frequency for site 2. This amount is not harvesting at present, however, it was infiltrated to the subsurface and recharge the groundwater system, and these amounts can be stored via civil works such as storage dams and artificial lakes, underground Tanks. The groundwater utilization reaches to about 439*103 $m^3$/year. As presented previously, it can be said that the water scarcity attains 85% which already stated in governmental reports (Ministry of Planning, 2011).

## Eco-geographical aspects

### General remarks

The Mariut coast of Egypt extends along the Mediterranean Sea for about 550 km from Sallum eastwards to Abu Qir (about 30 km east of Alexandria). It is the northern coast of the Egypt Western Desert of that narrows or widens according to the position of its southern boundary – the Western Desert Plateau – with average width, of about 20 km. Its remarkable feature is the prevalence of ridges formed of oolitic limestone, often 20 m or more high extending parallel to the seashore for long distances (Ball, 1942). Commonly one line of ridges skirts the coast closely, while another runs parallel to it a few km inland, and there is sometimes a third ridge between the second and the edge of the Western Desert Plateau.

### Climate

The highest rainfall amount usually falls during either January or December and varies appreciably along the coast from 119.7 mm/year in Sallum and 144.0 mm/year in Marsa Matrouh and 192.1 mm/year in Alexandria. The annual mean temperature maximum and annual mean minimum are 25.3, 24.3, 24.9, 13.3, 14.3 and 14.9°C, respectively. Relative humidity is lower in Sallum (mean annual = 69%) than in Marsa Matrouh (67%) and higher in Alexandria (72%). The reverse in true for evaporation being highest in Sallum (mean annual = 7.2 mm/pich??/day) followed by that of Mersa Matruh (6.5 mm pich/day) and Alexandria (3.8 mm pich/day).

Winds along the Mariut coast are generally strong and violent, and dust storms and pillars are ununusually. Dry hot dust-laden winds from the

south known as khamasin blow occassionally for about 50 days during spring and early summer.

There can also be strong, winds blow strongly with an average velocity of about 20–23 km/h during winter and early spring. Wind speed decreases in May and June, but July is windy. Shaltout (1983) stated that, the ends of summer records many calm days and the average wind speed drops to 15 km/h. In Burg El-Arab area (about 50 km west of Alexnadria), Ayyad (1973) estimated the mean annual evapotranspiration to be 995 mm.

It is worth to state that the climate of Mariut coast of Egypt and, according to Murray (1951), has not changed since Roman time (2,000 years ago). Sutton (1947) quotes records of annual rainfall made by Thurnburn (1847–1849) and brought up to 1970 as follows: 1847–1849 = 191 mm, 1881–1886 = 209 mm, 1901–1906 = 47 mm, 1921–1926 = 178 mm, 1939–1941 = 161 mm, 1951–1956 = 187 mm and 1960–1970 = 207 mm.

## Plant cover

### Floristic analysis

The Western Mediterranean coastal belt is by far the richest part of Egypt in its floristic composition owing to its relatively high rainfall. The number of species in this belt constitute about 50% of the total Egyptian flora which is estimated to be about 2,000 (Oliver, 1938) about 2,080 species (Täckholm, 1974), 2,094 species by Boulos (1995). However, Boulos (1999, 2000, 2002, 2005, 2009) recorded a total of 2,145 species of which 44 species are cultivated. Most of these species are therophytes that flourish during the rainy season, giving the coastal belt a temporary flush as a grassland desert. During the long dry period, only the characteristic

woody shrubs and perennial herbs are evident; these constitute the scrub vegetation of the area, scattered sparsely in parts and grouped in denser more distinct patches in others (Tadros, 1956).

Hassib (1951) describes the percentage distribution of both annual and perennial species among the life-forms in this coastal belt as follows: neither mega- and meso-phanerophytes nor epiphytes are represented. But there are the micro- and nanophanerophytes (3.2%), stem succulents (0.1%), chamaephytes by (9.2%), hemicryptophytes (11.7%), geophytes (11.9%), hydrophytes and helophytes (4.0%), therophytes (58.7%) and parasites (1.1%). Maquis vegetation that characterizes the other Mediterranean countries is not represented in Egypt.

The prevailing life-form of perennials is chamaephytes; nanophanerophytes are less. Xerophytes make up about 90% of the total number of species in this coastal belt; most are therophytes (67%), followed by geophytes (11%), halophytes and helophytes (11%), chamaephytes (6.6%), micro-and nanophanerophytes (3%), parasites (1.2%) and stem succulents (0.1%). The common xerophytes include: Achillea santolina, Ammophila arenaria, Anabasis articulata, Euphorbia *paralias, Gymnocarpos decander, Hammada scoparia, Helianthemum lippii, Lygos raetam, Ononis vaginalis, Pancratium maritimum, Plantago albicans, Thymelaea hirsute* and *Thymus capitatus*.

The halophytes include about 45 species. Algae are well developed in the rock coastal areas but apparently absent from the loose soil. The submerged phanerophytes include: Cymodocea major, Posidonia oceanica and Zostera notei. Terrestrial halophytes include *Arthrocnemum macrostachyum, Atriplex spp., Juncus acutus, J. rigidus, Limoniastrum monopetalum, Nitraria retusa, Salicornia fruitcosa, Suaeda fruticosa, S. pruinosa, Tamarix nilotica and Zygophyllum album.*

The helophytes and fresh-water hydrophytes represent about 4% of the total number of flora of this coastal belt. They include: submerged species (e.g. *Ceratophyllum demersum, Potamogeton crispus*), floating species (e.g. *Eichhornia crassipes, Lemna spp*.), reeds (e.g. *Phragmites australis and Typha domingensis*), and sedges (e.g. *Cyperus spp., Scripus spp*.).

**Habitats and vegetation types**

In spite of the relative simplicity of the relief and the apparent uniformity of the climate, the plant habitats in the region present some diversity. For the causal observer, however, the physiognomy of the vegetation seems monotonous over large tracts of land, owing to the prevailing life-form of the perennial plants, being mostly chamaephytes and to a less extent nanophanerophytes with scattered distribution. The only variation in the physiognomy is the change from the short vernal (spring) aspect of the vegetation to the longer aestival (summer) aspect (Tadros, 1956). The distribution of plant communities here is controlled by topography, the origin and nature of the parent material and the degree of degradation influenced by human manipulation (Ayyad and El-Ghareeb, 1984). Generally, the vegetation of this coastal belt belongs to the Thymelaeion hirsutae alliance with two associations:

1. Thymelaea hirsuta, Noaea mucronata association with two variants dominated by Achillea santolina,

2. Anabasis articulata, Suaeda pruinosa association (El-Ghonemy and Tadros, 1970).

The local distribution of communities in different habitats is linked primarily to physiographic variations. According to these variations two main sets of habitats may be distinguished – one on ridges and plateaux and the other in depressions.

Ridge and plateau habitats may be further differentiated into two main types. The coastal ridge is composed mainly of snow-white oolitic (calcareous) sand grains overlained by dunes in most places whilst inland are less calcareous ridges and the southern tableland. The southern tableland is characterized by the dissection of the landscape into an extensive system of wadis which drain into the Mediterranean Sea and form a distinct type of habitat. Inland siliceous dunes are sporadically distributed on the southern tableland and support a community different from that of calcareous dunes on the coastal ridge. Habitats of depressions differ according to the relative proximity of the water-table to the surface and consequently to the level of salinity and extent of waterlogging. Five main types of ecosystems may be recognized (Ayyad and El-Ghareeb, 1984; Zahran and Willis, 1992, 2008; Salama et al., 2005).

1. Sand dunes (coastal calcareous and inland siliceous);
2. Rocky ridges and plateaux with skeletal shallow soils;
3. Saline depressions;
4. Non-saline depressions;
5. Wadis.

**1. Sand dunes**

Along the Western Mediterranean coast lies a chain of intensely white calcareous granular sand dunes. They are formed of loose oval pseudo-oolitic grains, each composed of a series of successive coats of calcium carbonate. These dunes form a fairly continuous ridges with an undulating surface and present a type of habitat notable for its monotony. However, such monotony does not invariably mean that either the soil or the

vegetation lacks variety. Owing to proximity to the sea, the dunes are more humid and exposed to the immediate effect of the northerly winds. They are also reached by sea spray (Ahmed and Mounir, 1982). Certain sections of the coast are devoid of dunes. A short distance from the beach, fresh water is frequently obtained by digging carefully in the sand to a depth of 3–4 m. This fresh water is undoubtedly rain water, which, having a lower specific gravity than saline water below, can form a layer above it; there may be a hard pan of limestone rock underlying the sand which prevents percolation of rain water, the sand acting as a reservoir of fresh water. Plants growing in sand dunes are highly specialized and many have the ability to elongate vertically on a burial with sand (Girgis, 1973). They are also subject to partial exposure of their underground organs, often without being seriously affected. The coarse grain and loose texture of the sand result in poor water-retention because of rapid percolation. Many psammophytes develop extensive superficial roots that make use of dew.

The vegetation of these sand dunes has been studied by Oliver (1945), Tadros (1953, 1956), El-Sharkawi (1961), El-Ghonemy (1973), Girgis (1973), Ayyad (1973), Ayyad and El-Bayyoumi (1979), Ayyad and El-Ghareeb (1984) etc.

Bordering the sea, a community of Ammophila arenaria and Euphorbia paralias can be usually distinguished on the mobile young calcareous sand dunes. Associates include *Lotus polyphyllos* and *Sporobolus virginicus.* The vigorous growth made by Ammophila when sand covers it dominates the mobile dunes. It is a pioneer species in invading mobile coastal dunes and is consequently extensively used for stabilizing sand-dunes. On the older, advanced and higher dunes, where the sand may be consolidated in parts. Crucianella maritima and Ononis vaginalis dominate. Associated species include *Ammophila arenaria, Cakile maritima, Centaurea pumila,*

*Echinops spinosus, Echium sericeum, Elymus farctus, Euphorbia paralias, Hyoseris lucida, Launaea tenuiloba, Lotus polyphyllos, Lygos raetam, Pancratium maritimum, Plantago albicans, Reseda alba,* Salvia *lanigera*, and *Silene succulenta*.

In the more advanced stages of dune stabilization, communities of *Crucianella maritima, Echinops spinosus, Elymus farctus, Euphorbia paralias, Pancratium maritimum* and *Thymelaea hirsuta* become successively more common. When the coastal ridge is fairly exposed a community of *Globularia arabica, Gymnocarpos decander, Helichrysum conglobatum* and *Thymus capitatus* predominate.

The inland siliceous dunes are dominated by communities of *Plantago albicans, P. squarrosa* and *Urginea maritima*.

**2. Rocky ridges**

Two (or sometimes three) ridges run south of the sand dune zone extending parallel to the Western Mediterranean coast of Egypt and are separated from the sea by the sand dunes. These ridges are composed of oolitic sand and shell debris, often 20 m or more high with smooth rounded summits. The outer ridge closely skirts the coast while the second one runs parallel with it at a distance of a few km inland. The third ridge, when present, is between the second one and the edge of the Western Desert.

The vegetation of these rocky ridges is an association of Thymelaea hirsuta and Gymnocarpos decander (Tadros, 1956). However, local variation in the nature of the position and degree of slope lead to parallel variations in the distribution of the vegetation. The characteristic species of this community include *Aegilops kotschyi, Arisarum vulgare, Bupleurum nodiflorum, Carduus getulus, Chenolea arabica, Erodium cicutarium, Limonium tubiflorum, Lotus corniculatus, L. ceticus, Lygeum spartum,*

*Malva aegyptia, Medicago minima, Moricandia suffruticosa, Orlaya maritima, Plantago notata, Reaumuria hirtella, Reichardia orientalis, Scorzonera alexandrina, Stipa capensis, S. parviflora* and *Teucrium polium.*

Rocky sites with low moisture availability are dominated by communities of Globularia arabica and Thymus capitatus while sites with fairly deep soils and high moisture availability are dominated by communities of *Asphodelus microcarpus, Herniaria hemistemon, Plantago albicans* and *Thymelaea hirsuta*. In sites of intermediate rockiness and moisture availability, *Echinops spinosus, Helianthemum stipulatum, Noaea mucronata, Pituranthos tortuosus* and *Scorzonera alexandrinaare* abundant (Ayyad and Ammar, 1974).

These communities extend to the plateau of the south tableland. Two other communities dominated by Hammada scoparia and Anabasis articulata are found on degraded shallow skeletal soils subjected to active erosion. Associate species of this community include *Asphodelus microcarpus, Atriplex halimus, Carthamus mareoticus, Noaea mucronata, Pituranthos tortuosus, Verbascum letourneuxii* and *Zilla spinosa. Salsola tetrandra, Suaeda fruticosa* and *Suaeda pruinosa* are poorly represented.

Bushes of *Capparis spinosa* and *Ephedra alata* often grow in vertical rock.

**3. Saline depressions**

The saline depressions (littoral salt marshes) are a common habitat of the Western Mediterranean coastal belt. Tadros (1953) recognized two series of salt marshes. One is formed from depressions directly adjacent to the dune strips. The salinity of this series results from the evaporation of seepage water, where the water-table is exposed or near the surface and where there is poor drainage. The soil is mostly calcareous-sandy due to

the encroachment of sand from the neighboring dunes. In certain places in these salt marshes, low bushes of Arthrocnemum macrostachyum and Halocnemum strobilaceum, others eventually become buried under moist conditions, forming dense black rotten material from which frequently the smell of hydrogen sulphide can be detected. The second series of salt marshes is formed from the dried bed of Lake Mariut lying between the two ridges. The causes of salinity are essential as in the first series, but the soil texture is different, having a considerable proportion of silt, regarded as having been derived from the Nile during its previous connection with the lake.

The littoral salt marsh vegetation of the Western Mediterranean coast of Egypt has been described by several authors: e.g. Oliver (1938), Hassib (1951), Tadros (1953, 1956), Migahid et al. (1955), Ayyad and El-Ghareeb (1982, 1984), Ahmed and Mounir (1982) and Zahran and Willis (2003).

Apart from the communities of the swamp vegetation dominated by Phragmites australis, Scripus tuberosus and Typha domingensis, the halophytic vegetation is characterized by some 11 communities:

1. Salicornia fruticosa-Suaeda salsa community. This usually occupies the zone on the more elevated banks with less submerged saline soil. Associate species are Phragmites australis and Salicornia herbacea.

2. Juncus rigidus community. This occupies lower parts of the marsh with high moisture content where the calcareous and fraction dominates the soil texture. Associated plants include Halimione portulacoides, Inula crithmoides, Juncus acutus, Limonium pruinosum and Sporobolus pungens. In certain patches of this community, there are societies dominated by Schoenus nigricans.

3. Sporobolus pungens community. This occupies higher parts of the marsh, especially where calcareous sand is plentiful. The associate species are Juncus rigidus and Limonium pruinosum.

4. Halocnemum strobilaceum community. This community occurs over a wide range of fluctuations of salt concentration between the wet and dry seasons where there is a high proportion of fine fractions affecting soil texture. Associate species are Arthrocnemum macrostachyum, Juncus rigidus and Salicornia fruticosa.

5. Salicornia fruticosa – Limonium pruniosum community. This is present in somewhat more elevated and less saline parts than that of the H. strobilaceum community. Common associated species include Inula erithmoides, Juncus rigidus, Parapholis marginata, Plantago crassifolia and Sphenopus divaricatus. Halimione portulacoides and Phragmites australis dominate in some patches, the latter species being associated with depressed areas with high water content.

6. Arthrocnemum macrostachyum-Limoniastrum monopetalum community. This occurs on even more elevated substrates than the S. fruticosa-L. pruinosum community. Characteristic species are Cressa cretica, Frankenia revoluta, Mesembryanthemum nodiflorum and Parapholis marginata.

7. Zygophyllum album community. Z. album frequently forms an almost pure community on saline patches recently covered by drifted sand in shallow layers. It is also found in communities with other species in similar habitats.

8. Lygeum spartum community. This occurs in fewer saline parts with high organic matter content. Associate species are Frankenia revoluta,

Halimione portulacoides, Limoniastrum monopetalum and Limonium pruinosum.

9. Salsola tetrandra community. This community is usually present on the elevated border of the dry saline beds of the marshy valleys. S. tetrandra is very efficient at conserving soil against the wind blowing as well as being a soil builder. The associate species include Anthemis cotula, Coris monspeliensis, Frankenia revoluta, Haplophyllum tuberculatum, Limoniastrum monopetalum, Salicornia fruticosa, Sphenopus divaricatus, Suaeda fruticosa, S. pruinosa and Traganum nudatum.

10. Limoniastrum monopetalum-Lycium europaeum community. This is another community rich in floristic composition. It may follow in succession the community dominated by Salsola tetrandra. Associate species include Asphodelus microcarpus, Bassia muricata, Carthamus glaucus, Cutandia dichotoma, Echinops spinosus, Ifloga spicata, Lotus villosus, Noaea mucronata, Orlaya maritima, Plantago albicans, Reaumuria hirtella and Suaeda pruinosa.

11. Atriplex halimus-Picris radicata community. This is the richest of all communities of the salt-affected land. It occurs on deep sandy loam at the edges and upper parts of valleys where the vegetation covers the soil almost completely. Associate species include Anthemis microsperma, Chenolea arabica, Chrysanthemum coronarium (Glebionis cornaria), Koeleria phleoides, Lolium rigidum, Lycium europaeum, Medicago minima, Picris radicata, Salvia lanigera, Schismus barbatus and Stipa capensis.

**4. Non-saline depressions**

The non-saline depressions (barley fields) are the most fertile areas of the Western Mediterranean coastal belt of Egypt. These depressions are mainly

limited to the plains south of the second ridge in the eastern section of the coast, but are widespread in the valley and plains of the western section. The soils of these depressions (e.g. the Abu Sir depression), are variable (Ayyad, 1976). In some parts, highly calcareous soils are derived from drifted oolitic grains of the coastal ridge; in other parts alluvial, less calcareous, loamy soils are derived from the Abu Sir ridge.

Their depressions provide favorable conditions for cultivation; extensive areas are occupied by barley, figs and olives. Farming operations promote the growth of a considerable number of species, mostly therophytes. Weeds of barley fields are recognized as the Achilleetum santolinae mareoticum association, with subassociation of *Chrysanthemetosum coronariae* and *Arisaretosum vulgare*, composed of the following characteristic species: *Achillea santolina, Anagallis arvensis, Calendula aegyptiaca, Carthamus glaucus, Convolvulus althaeoides, Echinops spinosus, Echium sericeum, Eryngium creticum, Hordeum murinum, Koeleria phleoides, Lathyrus cicera, Muscari comosum* and *Vicia cinerea*.

According to Ahmed and Mounir (1982), there are still other species of different communities occasionally present in the barley fields, e.g. *Atriplex halimus, Trifolium tomentosum* and *Suaeda fruticosa*. These species may indicate possible affinities with other associations. The "accidental" species recorded include: *Anchusa hispida, Anthemis cotula, Asteriscus graveolens, Avena sterilis, Beta vulgaris,Bupleurum subovatum, Crucianella maritima, Echiochilon fruticosum, Emex spinosus, Filago spathulata, Francoeuria crispa, Gagea fibrosa, Helianthemum stipulatum, Hippocrepis bicontorta, Hymenocarpus nummularius, Hyoseris lucida, Ifloga spicata, Koniga arabica, Limonium tubiflorum, Lotus creticus, Malva parviflora, Moricandia nitens, Ononis vaginalis, Orlaya maritima, Ornithogalum trichophyllum, Papaver*

*hybridum, Reseda alba. Salvia aegyptiaca, Scorzonera alexandrina, Silene villosa, Thesium humile* and *Verbascum letourneuxii*.

The vegetation belongs to the Plantagineto-Asphodeletum microcarpae associations. The *Anabasis articulata* community is found on more or less sandy soils with low contents of calcium carbonate, a *Zygophyllum album* community where the soil content of calcium carbonate and salinity are higher. A *Plantago albicans* community occurs where salinity is lower and an *Asphodelus microcarpus-Thymelaea hirsuta* community on fine-textured soils (Ayyad, 1976).

The characteristic species include *Alkanna tinctoria, Brachypodium distachyum, Brassica tournefortii, Bupleurum subovatum, Carthamus glaucus, Centaurea glomerata, Linaria haelava, Lolium perenne, Malva parviflora, Medicago littoralis, Onopordum alexandrium, Orobanche ramosa, Papaver rhoeas, Polygonum equisetiforme, Raphanus raphanistrum, Reseda alba, R. decursiva* and *Zygophyllum album.*

**5. The wadies**

The landscape of the Western Mediterranean coastal land of Egypt is dissected by a drainage system (wadies) originating from a southern limestone plateau lying parallel to the Mediterranean Sea. The plateau reaches a maximum elevation of about 200 m above sea level at Sallum and slopes gently to the coastal plain west of Marsa Matrouh (from 10 to 20 m above sea level). These wadies drain northwards into the Mediterranean Sea.

The vegetation cover of the wadi bed is sparse, but the number of species is high. In this habitat, fine soil material has little chance to settle owing to the high velocity of the water stream during the rainy season. The wadi bed is filled mainly with large boulders, the sparse vegetation being largely

restricted to shallow soil accumulation between rock fragments. Common perennials in the wadi bed are *Allium erdelii, Echium sericeum, Euphorbia terracina and Salvia lanigera. Less common ones include: Allium aschersonianum, A. barthianum, Arisarum vulgare var. veslingii, Cynara sibthorpiana, Lygos raetam, Scorzonera alexandrina, Silybum marianum and Suaeda pruinosa.* Common annuals include*: Astragalus boeticus, Erodium gruinum* and *E. hirtum*. Less common annuals include: *Aizoon hispanicum, Chenopodium murale var. microphyllum, Emex spinosus, Fumaria bracteosa, Mesembryanthemum nodiflorum, Minuartia geniculata var. communis, Polycarpon succulentum, Polygonum equisetiforme, Rumex vesicarius, Spergula fallax, Spergularia diandra* and *Trifolium formosum.* More than two-thirds of the taxa recorded in the wadi bed are Mediterranean. The lower gentle slopes support meadow-like vegetation of annual species; the most common are: Astragalus hamosus, Hippocrepis bicontorta, Medicago littoralis, M. truncatula and Spergula fallax. Perennial associates include: Allium barthianum, Asphodelus microcarpus, Cynara sibthorpiana, Salsola lonifolia, Salvia lanigera, Scorzonera alexnadrina, Silybum marianum and Traganum nudatum.

On the middle slopes the vegetation is dominated by shrubby species including: *Artemisia inculta, Gymnocarpos decander, Limonium sinuatum* and *L. tubiflorum* and grasses such as Hyparrhenia hirta and *Stipa capensis*. Other associates include: *Allium erdelii, Asparagus stipularis var. tenuispinus, Avena sterilis subsp. ludouiciana, Brassica tournefortii, Bromus rubens, Carduus getulus, Erucaria pinnata, Hammada scoparia (= Hyloxylon scoparium), Limonium thouini, Lycium europaeum, Mesembryanthemum nodiflorum, Noaea mucronata, Phalaris minor, Picris sprengeriana, Pituranthos tortuosus, Plantago albicans, P. squarrosa, Reichardia orientalis, Salvia verbenaca, Spergula fallax,*

*Spergularia diandra, Suaeda pruinosa, Traganum nudatum, Trifolium scabrum, T. stellatum* and *Umbilicus horizontalis*.

The upper slopes are usually steep and almost completely devoid of soil cover. They support a typical cliff vegetation dominated by *Asparagus stipularis, Capparis orientalis, Ephedra aphylla, Lycium europaeum, Periploca angustifolia, Phlomis floccosa* and *Umbilicus horizontalis*. Common perennials include: *Allium barthianum, Asphodelus microcarpus, Echinops spinosus, Gymnocarpos decander, Hammada scoparia, Hyparrhenia hirta, Micromeria nervosa, Noaea mucronata, Scorzonera alexandrina* and *Thymus capitatus*. Common annuals include *Echium setosum, Mesembryanthemum forsskaolii (= Opophyllum forsskaolii), Picris sprengerana, Reichardia orientalis* and *Thesium humile var. maritima.* Less common are: *Anagallis arvensis, Arisarum vulgare var. veslingii, Astragalus asterias, Carthamus glaucus, Convolvulus althaeoides, Cutandia dichotoma, Echium sericeum, Fagonia cretica,Globularia arabica, Helianthemum ciliatum, Hippocrepis cyclocarpa, Leontodon hispidulus (= Crepis bulbosa), Limonium thouini, Lotus creticus, Malva parviflora, Medicago aschersoniana, Pallenis spinosa, Plantago crypsoides, Pteranthus dichotomus, Ranunculus asiaticus, Salvia lanigera, S. verbenaca* and *Valantia hispida*.

In the plateau of the wadi, the vegetation is dominated by *Gymnocarpos decander, Hammada scoparia* and *Phagnalon rupestre*. In this habitat the fewest associate a species have been recorded, including *Artemisia inculta. Asparagus stipularis var. tenuispinus, Atractylis prolifera, Echinops spinosus, Ephedra aphylla, Filago desertorum, Globularia arabica, - Helianthemum ciliatum, Lycium europaeum, Micromeria nervosa, Noaea mucronta, Periploca angustifolia, Reichardia orientalis, Reseda decursiva, Rumex vesicarius, Salvia lanigera,* and *Thymus capitatus.*

## Climate

The prevailing climate is desert and semi-desert; however, the Mediterranean climate prevails on the northern coasts. The temperature average in Lower Egypt is 20°C in winter during the day and 10 ºC at night, and in summer it reaches 35 ºC during the day and 23 °C at night. As for Upper Egypt, the average temperature varies between 25°C max. and 8°C min., while in summer it reaches 41°C max. and 24°C min.

### Sidi Barrani

Köppen-Geiger climate classification system classifies its climate as hot desert (BWh), but it is part of the northern coast of Egypt which has moderated temperatures (Table 7).

*Table 7: Climatic data of Sidi Barrani district.*

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average high °C (°F) | 17.9 (64.2) | 18.8 (65.8) | 20.2 (68.4) | 22.2 (72.0) | 24.1 (75.4) | 27 (81) | 28.2 (82.8) | 29 (84) | 28.1 (82.6) | 26.4 (79.5) | 23.5 (74.3) | 19.6 (67.3) | 23.8 (74.8) |
| Daily mean °C (°F) | 13.1 (55.6) | 13.9 (57.0) | 15.3 (59.5) | 17.5 (63.5) | 19.9 (67.8) | 22.7 (72.9) | 25 (77) | 25.5 (77.9) | 24.2 (75.6) | 21.8 (71.2) | 18.6 (65.5) | 14.5 (58.1) | 19.3 (66.8) |
| Average low °C (°F) | 8.4 (47.1) | 9 (48) | 10.5 (50.9) | 12.9 (55.2) | 15.7 (60.3) | 18.5 (65.3) | 21.9 (71.4) | 22.1 (71.8) | 20.4 (68.7) | 17.3 (63.1) | 13.8 (56.8) | 9.4 (48.9) | 15.0 (59.0) |
| Average precipitation mm (inches) | 39 (1.5) | 17 (0.7) | 11 (0.4) | 5 (0.2) | 3 (0.1) | 0 (0) | 0 (0) | 0 (0) | 1 (0.0) | 18 (0.7) | 21 (0.8) | 33 (1.3) | 148 (5.7) |

The warmest month of the year is August, with an average temperature of 25.5 °C. January is the coldest month, with temperatures averaging 13.1 °C.

## Marsa Matrouh

The driest month is July. There is 0 mm of precipitation in July. Most precipitation falls in January, with an average of 36 mm.

With an average of 25.3 °C, August is the warmest month. In January, the average temperature is 13.1 °C. It is the lowest average temperature of the whole year.

The precipitation varies 36 mm between the driest month and the wettest month. The average temperatures vary during the year by 12.2 °C.

*Table 8 : Climate data of Marsa matrouh district.*

| Month | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. Temperature (°C) | 13.1 | 13.6 | 15.4 | 17.9 | 20 | 23.1 | 24.8 | 25.3 | 24.8 | 22.5 | 19.2 | 15.4 |
| Min. Temperature (°C) | 8.4 | 8.9 | 10.6 | 13.3 | 16 | 19.4 | 21.8 | 22.3 | 21.1 | 18.2 | 14.4 | 10.6 |
| Max. Temperature (°C) | 17.9 | 18.4 | 20.2 | 22.5 | 24.1 | 26.9 | 27.9 | 28.4 | 28.5 | 26.9 | 24 | 20.2 |
| Avg. Temperature (°F) | 55.6 | 56.5 | 59.7 | 64.2 | 68.0 | 73.6 | 76.6 | 77.5 | 76.6 | 72.5 | 66.6 | 59.7 |
| Min. Temperature (°F) | 47.1 | 48.0 | 51.1 | 55.9 | 60.8 | 66.9 | 71.2 | 72.1 | 70.0 | 64.8 | 57.9 | 51.1 |
| Max. Temperature (°F) | 64.2 | 65.1 | 68.4 | 72.5 | 75.4 | 80.4 | 82.2 | 83.1 | 83.3 | 80.4 | 75.2 | 68.4 |
| Precipitation / Rainfall (mm) | 36 | 23 | 12 | 2 | 2 | 1 | 0 | 1 | 2 | 14 | 23 | 34 |

## Climate change impact

According to current assessments, most areas of the North-West coast, stretching from the west of Alexandria to Sallum, are considered as being safe from the impact of rising sea levels, thanks to their high altitude. It ranges between +2 and +3 meters above sea level, with the exception of low-lying areas, such as natural and artificial lakes and beaches. This is also due to the presence of continuous and parallel groups of ridges, rocky lime hills and sand dunes near the coast, with heights ranging from +5 and +10 meters above sea level. Emerged or submerged lime barriers function as natural barriers to sea water intrusion. The nature of these rocks protects the area from seawater penetration, which leads to land salinization or the

compression of sediments. The fact that no subsidence or erosion rates have been registered for these areas confirms this view. Local erosion results from construction activities in the coastal zone (Egypt's National Strategy for Adaptation to Climate Change and Disaster Risk Reduction 22).

**Environmental Pressures:**

The coastal zone of the Mediterranean Sea is exposed to multiple environmental pressures. These are mostly due to human activities associated with urban, industrial and agricultural development, producing pollutants of land-based sources. The environmental problems related to coastal development, the alteration of the coastline and borders of the wetlands and watersheds, and the biological threats are all characteristic of this zone.

**Desertification sensitivity index (DSI).**

The assessment of the environmentally sensitive areas (ESA's) to desertification, based on the calculated desertification sensitivity index (DSI), show that it is clearly seen that the highly sensitive areas (very severe) for desertification are found in southwest and south east parts of the northwestern coast, where the soil quality, climate quality and vegetation quality are low (Saleh et. al, 2018).

The sensitive areas are found where the vegetation cover is rather low. The low sensitivity areas are due to the good vegetation cover and soil quality. It is recommended that to apply safety environmental techniques to reduce the sensitivity of desertification in the regions.

## Plant Genetic Resources Aspects

## Vegetation

Land cover detection results (tables 9, 10 & 11) are based on 2019 classification images. Generally, the vegetation cover of summer is very poor, while the wild plant cover is moderately dense (photos 7& 8).

**Barrani** contains 2322.24 $Km^2$ vegetation coverage available in winter, which occupy 63.32 % of the district area, while in summer it contains only 12.46 $Km^2$ vegetation coverage available which occupy 0. 34%.

**Al-Nagila** contains 390.67 $Km^2$ vegetation coverage available in winter, which occupy 23.99 % of the district, while in summer it contains only 1.97 Km2 vegetation coverage available which occupy 0.12%.

**Marsa Matrouh** contains 1901.11 $Km^2$ vegetation coverage available in winter, that occupy 19.41 % of the district, while in summer it contains 14.97 Km2 vegetation coverage available that occupy 0.15%.

As mentioned above, the vegetation cover% in Barrani district (63.32 %) is the highest (more than Al-Nagila (23.99 % )by two folds and more than Marsa Matrouh (19.41) by three folds), consequently, that will reflect positively on the natural fodder which will be available for grazing animals and the income of livestock keepers.

**Abou Mazhoud (site 1)** contains 1308.56 $Km^2$ vegetation coverage available in winter that occupies 50.8 %. From which 989.38 $km^2$ belongs to Barrani district and 316.89 belongs to Al-Nagila distric. In summer 2019, there was 4.0656 $Km^2$ vegetation coverage available of site 1 that occupy 0.16 % of site 1. From which 3.0002 $km_2$ belongs to Barrani and 1.0654 belongs to Al-Nagila districts.

**Al-Gaaween (site 2)** contains 628.08 $Km^2$ vegetation coverage available in winter that occupy 45.7 % of site 2. In summer, there was 3.6677 $Km^2$ vegetation coverage available of site 1 which occupy 0.27 % of site 2.

As mentioned above in both sites, the vegetation cover in summer is very low in comparison to winter (site 1, 0.16 % vs 50.8 % and site 0.27% vs 45.7%). That will reflect negatively on the natural fodder which will be available for grazing animals consequently, the livestock keepers have to provide their animals with other sources of feed like feed concentrates, Agricultural by-products, grains, and etc. (instead of the free feed from the pasture) to cover the feed gap between summer and winter.

*Photo 7: Poor vegetation cover of Barrani in summer season.*

*Photo 8: Wild plant cover (Barrani) in winter season.*

***Table 9: Vegetation cover of the target districts in 2019.***

| Target area districts | | | Vegetation cover | | | |
|---|---|---|---|---|---|---|
| | | | Winter season | | Summer season | |
| **District name** | **Boundary ($Km^2$)** | **Settled ($Km^2$)** | **($Km^2$)** | **%** | **($Km^2$)** | **%** |
| Barrani | 3667.64 | 2758.90 | 2322.24 | 63.32 | 12.46 | 0.34 |
| Al-Nagila | 1628.40 | 900.01 | 390.67 | 23.99 | 1.97 | 0.12 |
| Marsa Matrouh | 9796.65 | 2692.87 | 1901.11 | 19.41 | 14.97 | 0.15 |

***Table 10: Vegetation cover of the study area at winter season in 2019.***

| | Vegetation cover | | | | | |
|---|---|---|---|---|---|---|
| | Study area | | | Part of the area belong to the district | | |
| Site | Name | $Km^2$ | % | $Km^2$ | % | District Name |
| 1 | Abou Mazhoud (أبو مزهزد) | 1308.5620 | 50.813 | 989.38 | 26.98 | Barrani |
| | | | | 316.89 | 19.46 | Al-Nagila |
| 2 | Al-Gaaween (الجعوين) | 628.0787 | 45.719 | 619.59 | 06.32 | Marsa Matrouh |

***Table 11: Vegetation cover of the study area at summer season in 2019***

| | Vegetation cover | | | | | |
|---|---|---|---|---|---|---|
| | Study Area | | | Part of the area belong to the district | | |
| Site | Name | $Km^2$ | % | $Km^2$ | % | District Name |
| 1 | Abou Mazhoud (أبو مزهزد) | 4.0656 | 0. 16 | 3.0002 | 0.007 | Barrani |
| | | | | 1.0654 | 0.08 | Al-Nagila |
| 2 | Al-Gaaween (الجعوين) | 3.6677 | 0. 27 | 3.5721 | 0.04 | Marsa Matrouh |

## Normalized Difference Vegetation Index (NDVI)

Satellite maps of vegetation show the density of the plants. The most common measurement is called the Normalized Difference Vegetation Index (NDVI). The sensitivity of NDVI to chlorophyll concentration is clear. Very low values of NDVI (0.1 and below) correspond to arid areas of rock, sand, or snow. Moderate values represent shrub and grassland (0.2 to 0.3), while high values indicate temperate and tropical rainforests (0.7 to 0.9). Satellite data used to detect the vegetative change from one growing season to other, from year to year, from decade to decade. These types of data help us to understand the ecology of our planet and understand the impact of mankind on our natural biological cycles.

The NDVI, like most other vegetation indices, is calculated as a ratio between measured reflectivity in the red and near infrared portions of the electromagnetic spectrum. These two spectral bands are chosen because they are most affected by the absorption of chlorophyll in leafy green vegetation and by the density of green vegetation on the surface. The NDVI transformation is computed as the ratio of the measured intensities in the red (R) and near infrared (NIR) spectral bands using the following formula:

$$NDVI = (NIR - R) / (NIR + R) \quad (1)$$

The resulting index value is sensitive to the presence of vegetation on the Earth's land surface and can be used to address issues of vegetation type, amount, and condition. Many satellites have sensors that measure the R and NIR spectral bands. The sensor that supplies one of the most widely used NDVI products is onboard the Sentinel-2 satellites. This sensor has 11 channels with channels in the red (channel 4) and near infrared (channel 8) with 10-meter spatial resolution. The average NDVI time series for site-1 and site-2 are represented in figures (5& 6).

Based on figures (5 & 6), the vegetation cover reaches the maximum in March and started to fall in April until the minimum point in November every year. The study areas depend on rainfall quantity and its space range in the winter, while the spring represents the maximum vegetation cover and density, on contrary the autumn remains the minimum vegetation cover and density that means.

In general, the vegetation cover in site-1 is better than site-2. The density of vegetation in the study areas response to rainfall quantity and area. In site-1, the vegetation cover was low in 2017 and 2018, while in 2016 and 2019 it was relatively good. In site-2, the vegetation cover was very low in 2017 and 2018, while in 2016 and 2019 it was relatively good.


*Figure 5: Average NDVI time series on site-1(Abou Mazhoud)*


*Figure 6: Average NDVI time series on site-2 (Al-Gaaween)*

## Wild plant genetic resources

The grazing system of the target study area consists of eighty-one species (Table 13). All plant species of the study area were classified using Raunkairs classification analysis, whose method based on the height of the growing peaks and buds from the surface (**Raunkiaer, 1934**). Out of them, **thirty-one** species are Chamaephytes, **two** are Geophytes, **four** are Hemicryptophytes, **forty-three** are Therophytes and only **one** is Chamaephytes/Phanerophytes (Fig. 7).

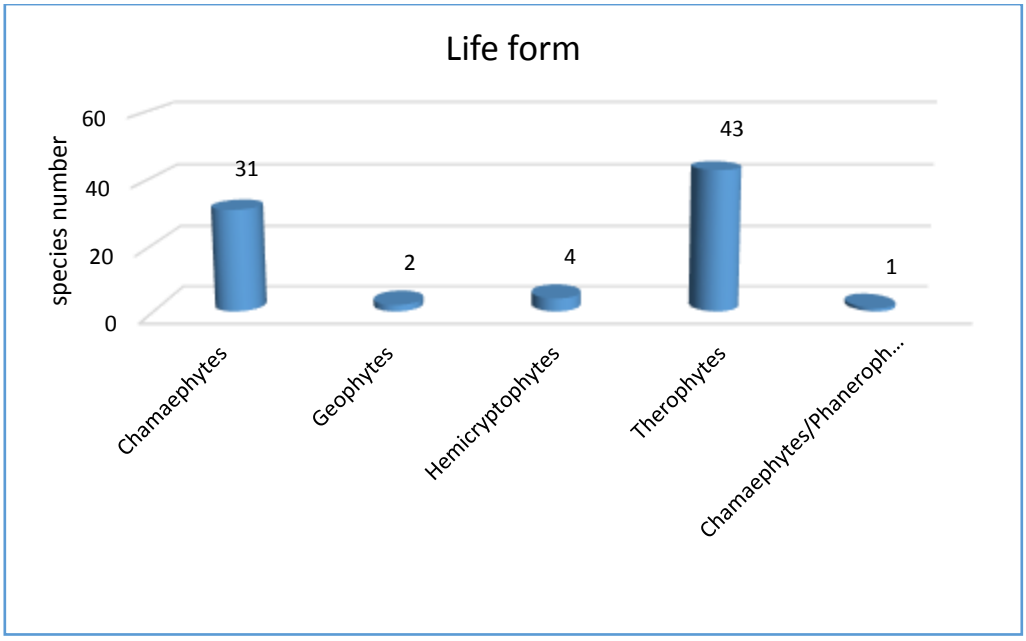



***Figure 7: Life form of the wild plants of the study area.***

The life span of the species of the target area classified into **forty-two** annual species, **three** species biennial and **thirty-six** perennial (Fig. 8). Regarding the rarity status or overall occurrence of the grazing target species, **thirty-one** species are very common, **thirty-three** are common and **thirteen** are rare, while **four** are very rare (Fig. 9). Most of the grazing plants of the target area (**Sixty-four** species) have a very common and common status in the target area as well as in the northwestern coastal area. Among them **thirty-five** are annual, **tweenty-six** are perennial and only **three** are biennial (Table 12, Fig. 10).

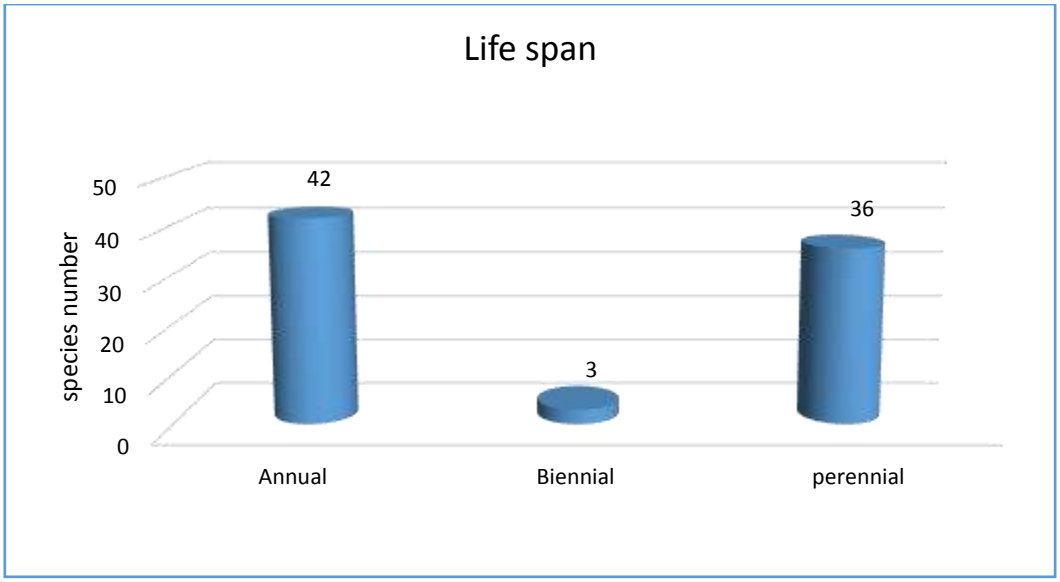



***Figure 8: Life span of the wild plants of the study area.***

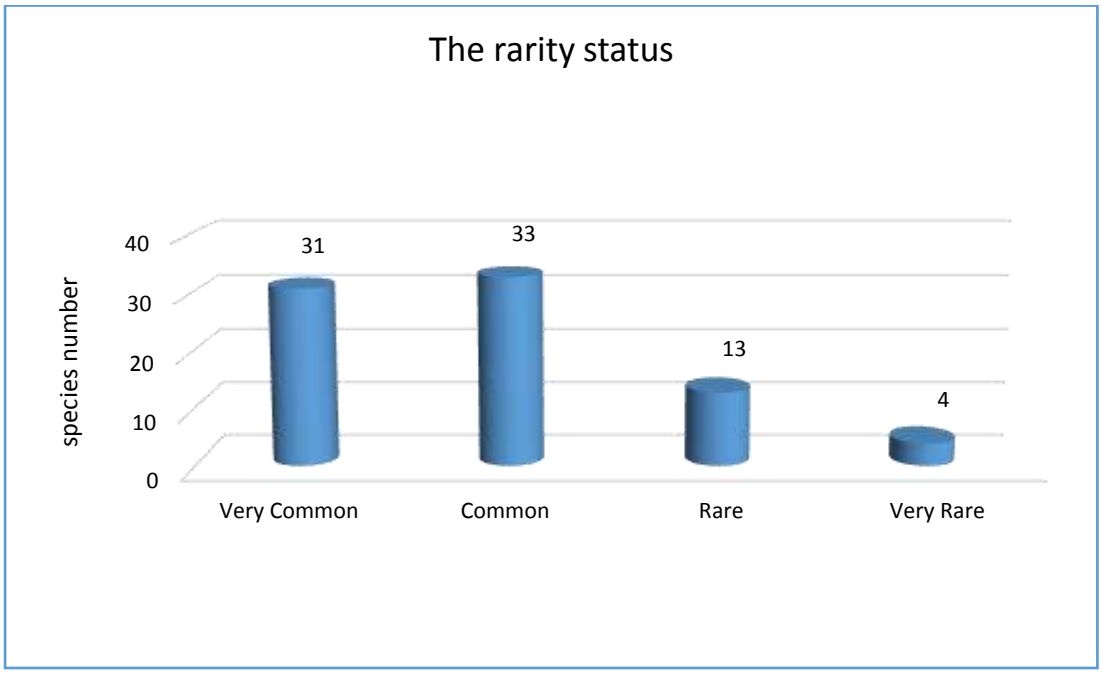



***Figure 9: Rarity status of the wild plants of the study area.***

***Table 12: Life span of the wild plant of the study area versus rarity status***

| | *Annual* | | *Biennial* | | *perennial* | | *Total* | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| *Very Common* | 17 | 37.78 | 1 | 33.33 | 13 | 39.39 | 31 | 38.27 |
| *Common* | 18 | 40.00 | 2 | 66.67 | 13 | 39.39 | 33 | 40.74 |
| *Rare* | 6 | 13.33 | 0 | 0.00 | 7 | 21.21 | 13 | 16.05 |
| *Very Rare* | 1 | 2.22 | 0 | 0.00 | 3 | 9.09 | 4 | 4.94 |
| *total* | 42 | 93.33 | 3 | 100.00 | 36 | 109.09 | 81 | 100.00 |

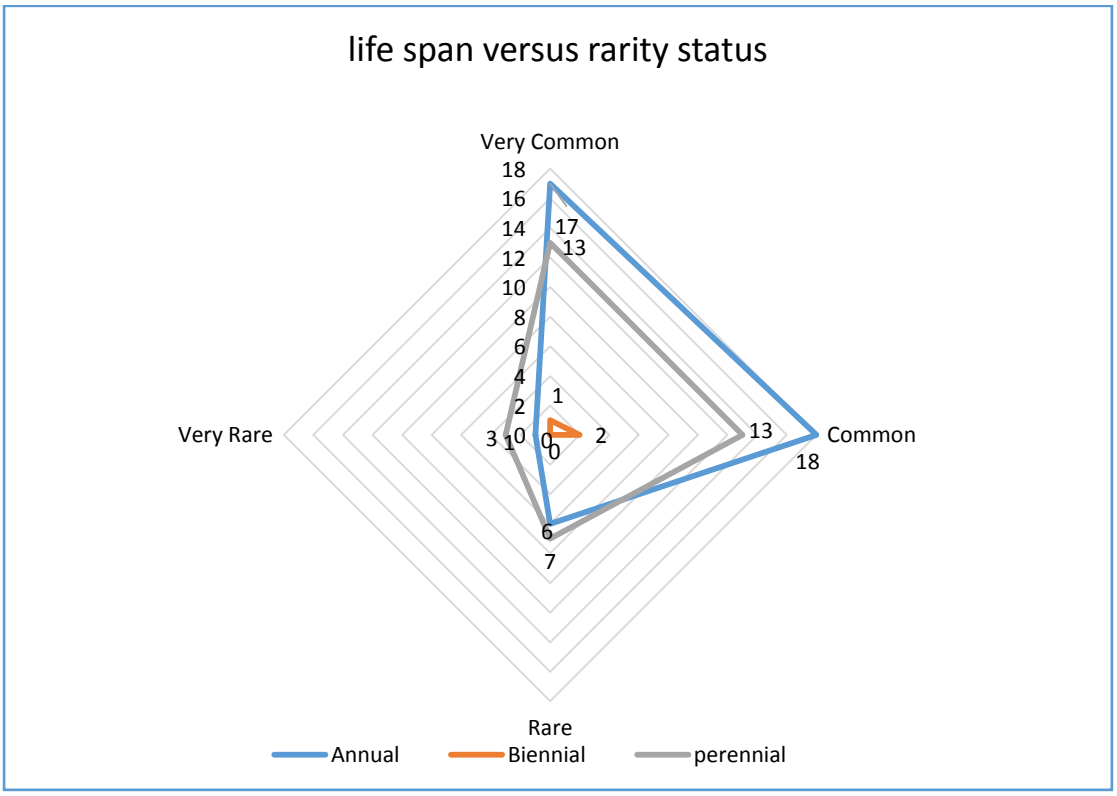



***Figure 10: Life span versus the rarity status of the wild planst of the study area.***

Generally, the annual grazing species lead the grazing system followed by perennial. The density, frequency and plant cover of annual species are highly affected by the rate of precipitation. The Average daily precipitation (mm) of Matrouh Governorate from 2011-2019 is shown in figure (11), it is clear that the precipitation period starts from November to March with the high percentage at January. These annual species are started to appear in the winter season and flowerishing in the spring season (March-May). Due to the most grazing species are annual as well as most of the annual species are very common and common (77.78%, table 12), so the grazing system in the winter-spring season is more appropriate for the headers. The grazing area must be subjected to artificial preparation for the grazing

season; rehabilitation of the grazing species by sowing seeds of selected species, especially the annual and perennial.

It is necessary to emphasize that the grazing species of the study areasdemand urgent management action to conserve its threatened, since grazing species are an important feeding source for livestock and wild animals. The active cultivation is vital to survival the grazing system of the northwestern coast and the grazing system are soon degraded and lost forever if it is not regularly propagated the grazing target species under the umbrella of a management strategic plan to development the target grazing area. Because of the human culture of local communities have a heritage associated with grazing system, the conservation and sustainable utilization of this area must be considered as a societal enthusiastic.

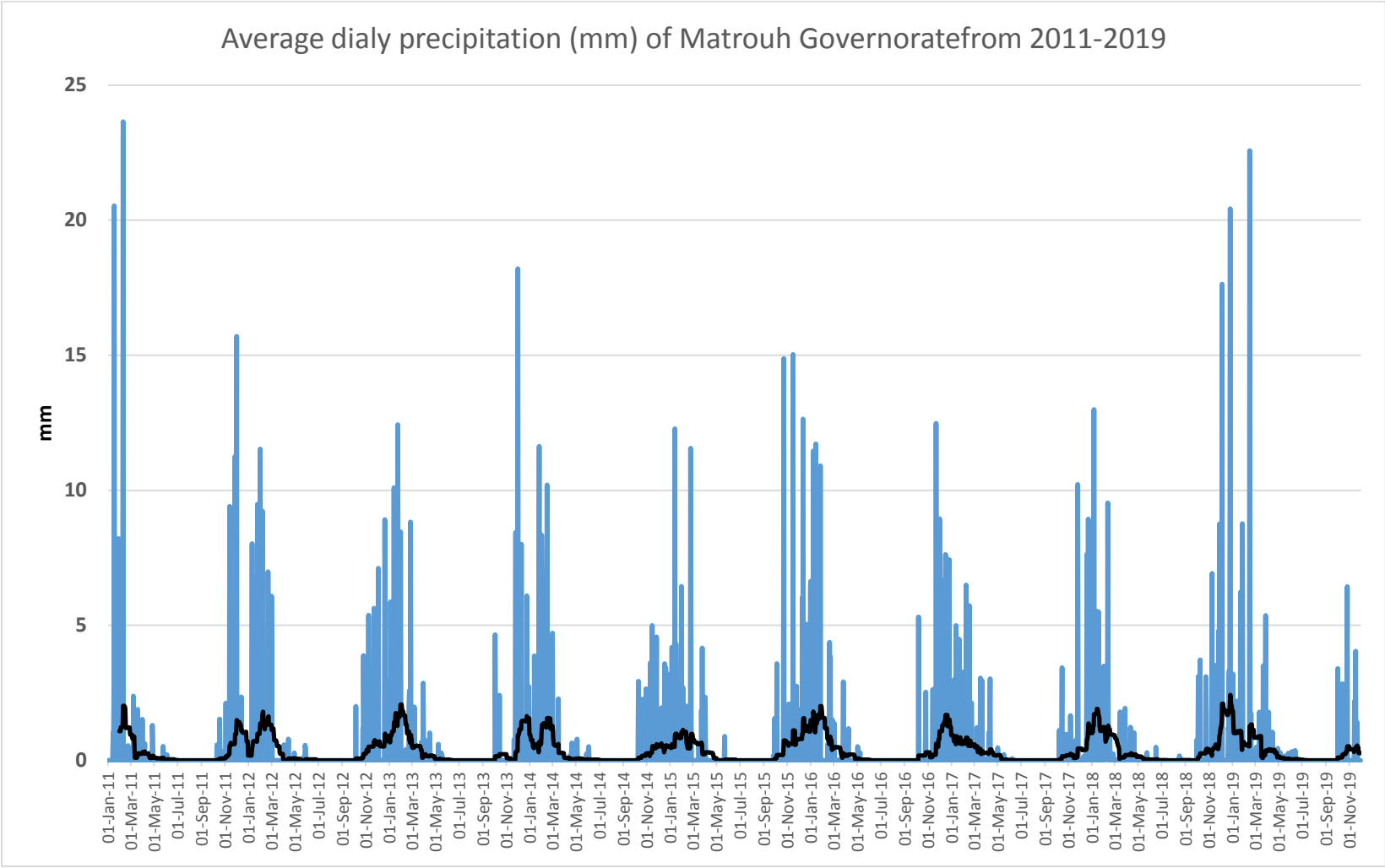



*Figure 11: Average dialy precipitation (mm) of Matrouh Governorate during the period 2011-2019.*

***Table 13: List of wild plants exist in the study area***

| No. | Genus | Species | Family | RARITY Status | Life form | Life span |
|---|---|---|---|---|---|---|
| 1 | Adonis | dentatus Del. | Ranunculaceae | Very Common | Therophytes | Annual |
| 2 | Aegilops | bicornis (Forssk.) Jaub. & Sp. | Poaceae | Very Common | Therophytes | Annual |
| 3 | Aizoon | canariense L. | Aizoaceae | Common | Therophytes | Biennial |
| 4 | Anabasia | atriculata | Chenopodiaceae | Very Common | Chamaephytes | Biennial |
| 5 | Anacyclus | alexandrinus Willd. | Asteraceae | Common | Therophytes | Annual |
| 6 | Anchusa | aegyptiaca | Boraginaceae | Very Common | Therophytes | Annual |
| 7 | Anthemis | microsperma Boiss & Ky. | Asteraceae | Common | Chamaephytes | Perennial |
| 8 | Argyrolobium | uniflorum | Fabaceae | Rare | Chamaephytes | Perennial |
| 9 | Artemisia | inculta Del. | Asteraceae | Common | Chamaephytes | Perennial |
| 12 | Asphodelus | fistulosus L. | Liliaceae | Very Common | Geophytes | Perennial |
| 10 | Astragalus | sieberi | Fabaceae | Common | Chamaephytes | Perennial |
| 11 | Astragalus | spinosus | Fabaceae | Very Common | Chamaephytes | Perennial |
| 13 | Atriplex | halimus L | Chenopodiaceae | Common | Chamaephytes/Phanerophytes | Biennial |
| 14 | Beta | vulgaris L. | Chenopodiaceae | Very common | Therophytes | Annual |
| 15 | Brassica | tournefortii | Brassicaceae | Common | Therophytes | Annual |
| 16 | Bromus | rubens JusI ap L. | Poaceae. | Common | Therophytes | Annual |

| | | | | | | |
|---|---|---|---|---|---|---|
| 17 | Bupleurum | semicompositum | Apiaceae | Common | Therophytes | Annual |
| 18 | Calendula | arvensis L. | Asteraceae | Common | Therophytes | Annual |
| 19 | Carrichtera | annua (L.) | Brassicaceae | Common | Therophytes | Annual |
| 20 | Carthamus | lanatus L. | Asteraceae | Rare | Chamaephytes | Perennial |
| 21 | Centaurea | alexandrina Del. | Asteraceae | Common | Chamaephytes | Perennial |
| 22 | Centaurea | glomerata Vahl. | Asteraceae | Common | Therophytes | Annual |
| 23 | Chenopodium | murale L. | Chenopodiaceae | Very common | Therophytes | Annual |
| 24 | Chrysanthemum | coronerium L. | Asteraceae | Very Common | Therophytes | Annual |
| 25 | Cutandia | dichotoma (Forssk.) Trabut | Poaceae. | Very Common | Therophytes | Annual |
| 26 | Deverra | tortuosa | Caryophyllaceae | Common | Chamaephytes | Perennial |
| 27 | Didesmus | aegyptius (L.) | Brassicaceae | Very Rare | Therophytes | Annual |
| 28 | Echinops | spinosissimus Turra | Asteraceae | Very Common | Chamaephytes | Perennial |
| 29 | Echiochilon | fruticosum | Boraginaceae | Common | Chamaephytes | Perennial |
| 30 | Filago | desertorum Pomel. | Asteraceae | Very Common | Therophytes | Annual |
| 31 | Gymnocarpos | decandrum | Caryophyllaceae | Very common | Chamaephytes | Perennial |
| 32 | Hammada | scoparia (Pomel) Iljin | Chenopodiaceae | Rare | Chamaephytes | Perennial |
| 33 | Helianthemum | lippii | Cistaceae | Very Common | Chamaephytes | Perennial |
| 34 | Helianthemum | kahiricum | Cistaceae | Very Common | Chamaephytes | Perennial |
| 35 | Herniaria | hirsuta L. | Caryophyllaceae | Common | Therophytes | Annual |

| | | | | | | |
|---|---|---|---|---|---|---|
| 36 | Hippocrepis | bicontorta | Fabaceae | Very Common | Therophytes | Annual |
| 37 | Hordeum | leporinum Link | Poaceae | Very Common | Therophytes | Annual |
| 38 | Ifloga | spicata (Forssk.) Sch-Bip. | Asteraceae | Common | Therophytes | Annual |
| 39 | Kickxia | aegyptiaca (Dum.) Nabelek | Scrophulariaceae | Very Common | Therophytes | Annual |
| 40 | Launaea | nudicaulis (L.) Hook. f. | Asteraceae | Very Common | Hemicryptophytes | Perennial |
| 41 | Lobularia | arabica (boiss.) | Brassicaceae | Common | Therophytes | Annual |
| 42 | Lycium | shawii Roem et Sch. | Solanaceae | Very Common | Chamaephytes | Perennial |
| 43 | Lygeum | spartum Loefl. ex L. | Poaceae. | Common | Hemicryptophytes | Perennial |
| 44 | Malva | parviflora L. | Malvaceae | Very Common | Therophytes | Annual |
| 45 | Matthiala | livida (del) dc. | Brassicaceae | Rare | Therophytes | Annual |
| 46 | Medicago | laciniata | Fabaceae | Rare | Therophytes | Annual |
| 47 | Medicago | truncatula | Fabaceae | Common | Therophytes | Annual |
| 48 | Noaea | mucronata (Forssk.) Asch. & Schweinf. | Chenopodiaceae | Common | Chamaephytes | Perennial |
| 49 | Onobrychis | crista-galli | Fabaceae | Common | Therophytes | Annual |
| 50 | Ononis | serrata | Fabaceae | Common | Therophytes | Annual |
| 51 | Paronychia | nivea DC. | Caryophyllaceae | Rare | Therophytes | Annual |
| 52 | Periploca | angustifolia | Asclepiadaceae | Very Rare | Chamaephytes | Perennial |
| 53 | Phalaris | minor Retz. | Poaceae. | Common | Therophytes | Annual |
| 54 | Picris | radicata (Forssk) Less. | Asteraceae | Rare | Therophytes | Annual |

| | | | | | | |
|---|---|---|---|---|---|---|
| 55 | Plantago | albicans L. | Plantaginaceae | Common | Hemicryptophytes | Perennial |
| 56 | Plantago | crypsoides Boiss. | Plantaginaceae | Common | Therophytes | Annual |
| 57 | Plantago | ovata Forssk. | Plantaginaceae | Very Common | Therophytes | Annual |
| 58 | Polygonum | equisetiforme | Polyygonaceae | Very common | Chamaephytes | Perennial |
| 59 | Pseudorlaya | pumia | Apiaceae | Common | Therophytes | Annual |
| 60 | Reichardia | tingitana (L.) Roth. | Asteraceae | Very Common | Therophytes | Annual |
| 61 | Salsola | tetrandra Forssk. | Chenopodiaceae | Rare | Chamaephytes | Perennial |
| 62 | Salsola | tetragona Del. | Chenopodiaceae | Very Rare | Chamaephytes | Perennial |
| 63 | Salsola | vermiculata | Chenopodiaceae | Rare | Chamaephytes | Perennial |
| 64 | Salvia | aegyptiaca | Lamiaceae | Very Common | Chamaephytes | Perennial |
| 65 | Salvia | lanigera | Lamiaceae | Common | Chamaephytes | Perennial |
| 66 | Scabiosa | arenaria Forssk. | Dipsacaceae | Rare | Therophytes | Annual |
| 67 | Schismus | barbatus (Hojer ejusd L. ) Thell | Poaceae | Very Common | Therophytes | Annual |
| 68 | Scorzonera | alexandrina Boiss. | Asteraceae | Very Common | Geophytes | perennial |
| 69 | Silene | voillosa  Forssk. | Caryophyllaceae | Rare | Therophytes | Annual |
| 70 | Spergularia | marina (L.) | Caryophyllaceae | Very common | Therophytes | Annual |
| 71 | Stipa | parviflora Desf. | Poaceae | Common | Hemicryptophytes | Perennial |
| 72 | Suaeda | volkensii | Chenopodiaceae | Very Rare | Chamaephytes | Perennial |
| 73 | Suaeda | pruinosa | Chenopodiaceae | Rare | Chamaephytes | Perennial |

| | | | | | | |
|---|---|---|---|---|---|---|
| 74 | Suaeda | vermiculata | Chenopodiaceae | Common | Chamaephytes | Perennial |
| 75 | Teucrium | polium | Lamiaceae | Common | Chamaephytes | Perennial |
| 76 | Thymelaea | hirsuta | Thymelaeaceae | Very Common | Chamaephytes | Perennial |
| 77 | Trifolium | resupinatum | Fabaceae | Very Common | Therophytes | Annual |
| 78 | Trigonella | stellata | Fabaceae | Common | Therophytes | Annual |
| 79 | Valantia | hispida | Rubiaceae | Common | Therophytes | Annual |
| 80 | Verbascum | letourneuxii Asch. | Scrophulariaceae | Rare | Chamaephytes | Perennial |
| 81 | Zilla | spinosa | Brassicaceae | Very Common | Chamaephytes | Perennial |

The grazing system of the study area contains **seventeen** species of very highly palatable, **eighteen** species of highly palatable, **thirty-two** species palatable , **eleven** species low palatability and only **three** species are unpalatable (Fig. 12).

Most of the grazing plants of the target area (**thirty-two** species) are palatable. Among them, **eighteen** are annual, **thirteen** are perennial and only o**ne** is biennial. Generally, the annual and perennial species grazing have the palatability-leading trend, there are **thirty-two** are edible for each (Table 14, Fig. 13).

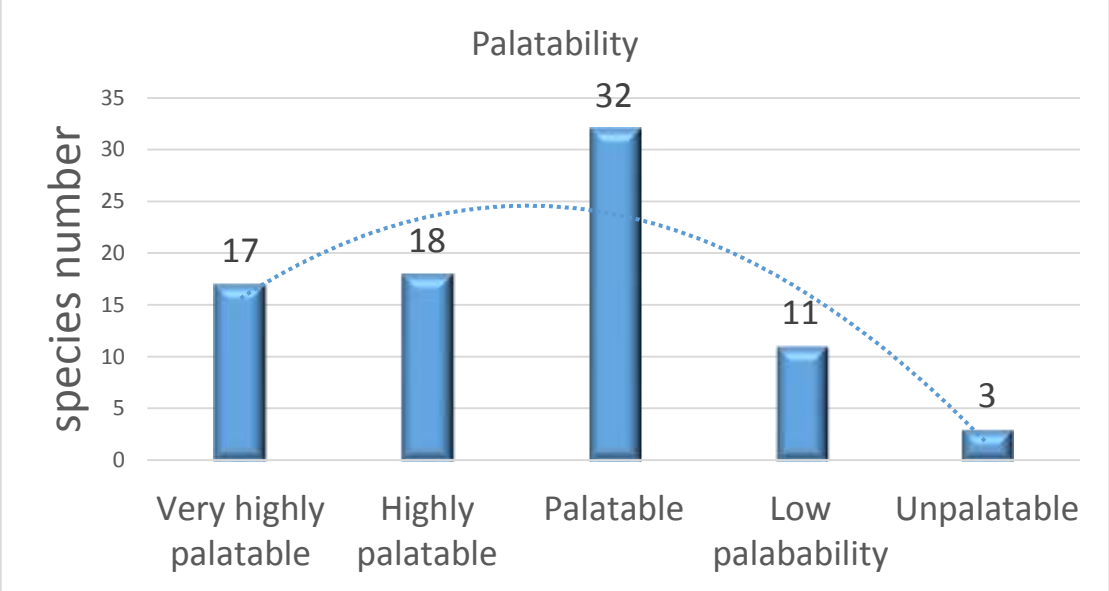



***Figure 12: Palatability of the wild plants of the study area.***

***Table 14:*** *Palatability of the wild plants of the study area versus status*

| | *Annual* | | *Biennial* | | *perennial* | | *Total* | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | **No.** | % |
| *Very highly palatable* | 3 | 6.67 | 1 | 33.33 | 13 | 39.39 | 17 | *20.99* |
| *Highly palatable* | 11 | 24.44 | 1 | 33.33 | 6 | 18.18 | 18 | *22.22* |
| *Palatable* | 18 | 40.00 | 1 | 33.33 | 13 | 39.39 | 32 | *39.51* |
| *Low palabability* | 7 | 15.56 | 0 | 0.00 | 4 | 12.12 | 11 | *13.58* |
| *Unpalatable* | 3 | 6.67 | 0 | 0.00 | 0 | 0.00 | 3 | *3.70* |
| *total* | *42* | *93.33* | *3* | *100.00* | *36* | *109.09* | *81* | *100.00* |

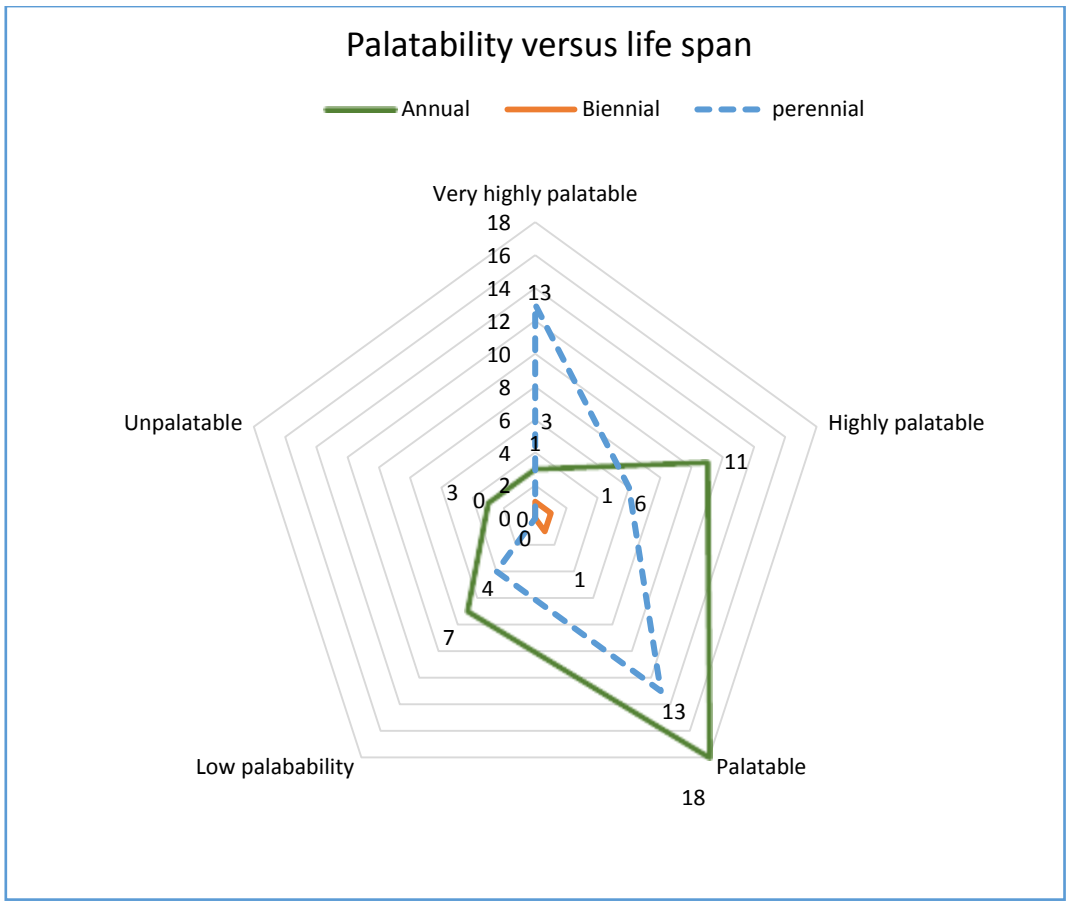



*Figure 13: Palatability versus life span of wild planst of the study area.*

Most of the grazing plants of the study area are (**thirty-one** species) are highly grazing value, followed by very high value (**twenty-four** species) and low grazing value is recorded in **twenty-six** species (Fig. 14).

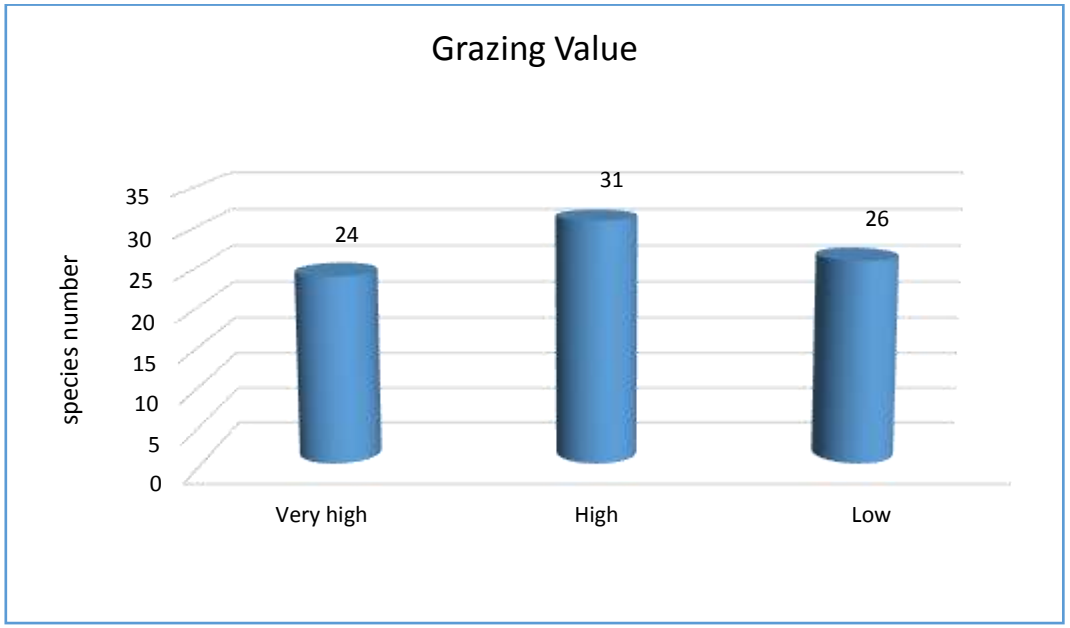



***Figure 14: Grazing value of the wild plants of the study area.***

According to the livestock species, Goat and sheep grazing on the most grazing species of the study area (seventy-eight and seventy-six species respectively), followed by camels for **thirty-three** grazing species (Fig. 15).

Regarding the consumption parts of the grazing plants, the young branches of **thirty-two** species are edible, followed by leaves of **twenty-two** species and flowers of **fourteen** plants. All parts of **thirty-one** species as well as the above ground parts of only **two** species are consumed by the livestock (Fig.16).

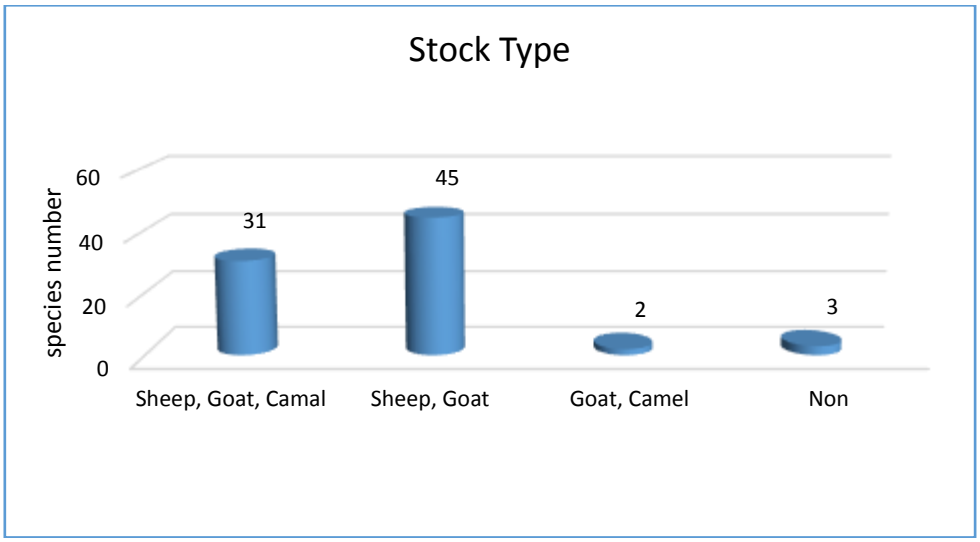



***Figure 15: Livestock species for the wild plants of the study area.***

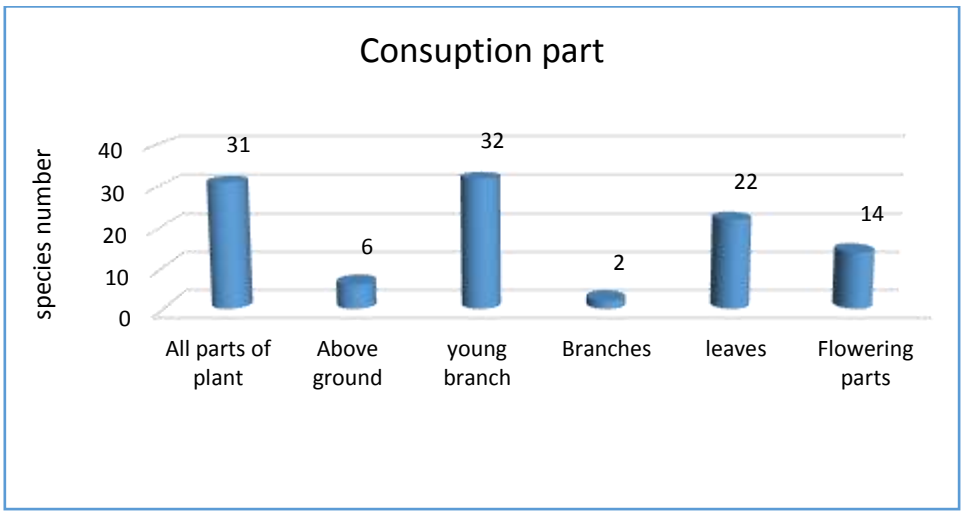



***Figure 16: Consumption parts of the wild plants of the study area.***

## Cultivated plants

Agriculture represents the main economic activity and source of income in Matrouh Governorate. It depends on the water of the coast as well as the water of the river Nile through El-Hamam canal. The area is well known by horticulture cultivation, mainly fig, olive and some other fruits . Barley and wheat are the most important crops in the Governorate. The most important vegetable crops is tomatoes in winter, and tomatoes and watermelon in summer. The production of crops fluctuate according to regions and from year to year along the northwestern coast as it based mainly on rainfall rate and the availability of other sources of water. According to the statistical survey of the agricultural directorate of Matrouh governorate, the low precipitation during summer season of year 2018 at Al-Nagila and Marsa Matrouh districts, led to no vegetables crop plantation in this area. While it reaches a very low cultivated area at Barani district as only 6 Feddan vegetables and 4 feddan melon occured.

The most important crop is the rain-fed barley (Table 15 and, fig. 17). The high barley yield was in the rainy seasons 2015/2016 and 2018/2019. The most barley yield comes from Barrani district (fig. 18). Regarding the wheat crop, the high yield was in seasons 2015/2016 and 2016/2017 (fig. 19). Barani district was the leading production area of wheat.

The most important horticulture crops are figs, olives, grapes, date and almond. The leading area of cultivating horticulture is Marsa Matrouh followed by Barrani and El-Negila (Table 16 and, fig. 20).

Rain-fed agriculture is generally risky due to high spatial and temporal variability in rainfall. The productivity of cultivated rain-fed crops is affected mainly by the amount and fluctuation of precipitation. Ouda et al. (2016) studied the effect of climate change on rain-fed agriculture of Marsa matrouh. They expect that rainfall in Marsa Matrouh will be highly reduced

in 2029/2030. The frequency of rainfall will increase; however, the amount will be much lower. Therefore, the productivity of cereal crops will be highly reduced to the extent that no grain yield will be produced in Marsa Matrouh. Consequently, this will reflect negatively on livestock production (the main land use) in this area. They suggested also that productivity of fruits will be affected at lower rate than field crops. Therefore, a production package should be implemented in this area to increase its resilience to cope with rainfall variability in the future.

According to the impact of climatic change on the rain-fed agriculture, drastic consequences are expected to occur in Marsa Matrouh at 2029/2030, where barley and wheat will not produce any grains as a result of low rain fall (Ouda et al., 2016). The biological yield will be reduced by 85 and 90% for barley and wheat, respectively. Olive yield will be reduced by 56% in Marsa Matrouh.

*Table 15: The cultivated crops areas (Fadden) in the study area*

| District | Season | Rainfed wheat | Rainfed Barley | onion | Tometoes | Marrow |
|---|---|---|---|---|---|---|
| Barrani | 2015/2016 | 15000.00 | 150000.00 | 15.00 | 12.00 | 0.00 |
| | 2016/2017 | 15000.00 | 70000.00 | 0.00 | 0.00 | 0.00 |
| | 2017/2018 | 958.00 | 25000.00 | 0.00 | 0.00 | 0.00 |
| | 2018/2019 | 1200.00 | 155000.00 | 0.00 | 0.00 | 0.00 |
| Al-Nagila | 2015/2016 | 200.00 | 30000.00 | 5.00 | 0.00 | 0.00 |
| | 2016/2017 | 100.00 | 27400.00 | 0.00 | 0.00 | 0.00 |
| | 2017/2018 | 0.00 | 5000.00 | 0.00 | 0.00 | 0.00 |
| | 2018/2019 | 400.00 | 6000.00 | 0.00 | 0.00 | 0.00 |
| Marsa Matrouh | 2015/2016 | 1025.00 | 11380.00 | 78.12 | 54.00 | 14.12 |
| | 2016/2017 | 500.00 | 6000.00 | 80.00 | 180.00 | 20.00 |
| | 2017/2018 | 500.00 | 7500.00 | 50.00 | 80.00 | 35.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 2018/2019 | 1133.00 | 27250.00 | 70.00 | 80.00 | 50.00 |
| Abou Mazhoud | 2015/2016 | 6552.94 | 88241.21 | 10.45 | 5.11 | 0.00 |
| | 2016/2017 | 6471.82 | 52048.48 | 6471.82 | 0.00 | 0.00 |
| | 2017/2018 | 408.15 | 14706.87 | 0.00 | 0.00 | 0.00 |
| | 2018/2019 | 835.71 | 70904.14 | 0.00 | 0.00 | 0.00 |
| Al-Gaaween | 2015/2016 | 334.06 | 3708.87 | 25.46 | 17.60 | 4.60 |
| | 2016/2017 | 162.96 | 1955.47 | 162.96 | 58.66 | 6.52 |
| | 2017/2018 | 162.96 | 2444.34 | 16.30 | 26.07 | 11.41 |
| | 2018/2019 | 369.26 | 8881.09 | 22.81 | 26.07 | 16.30 |

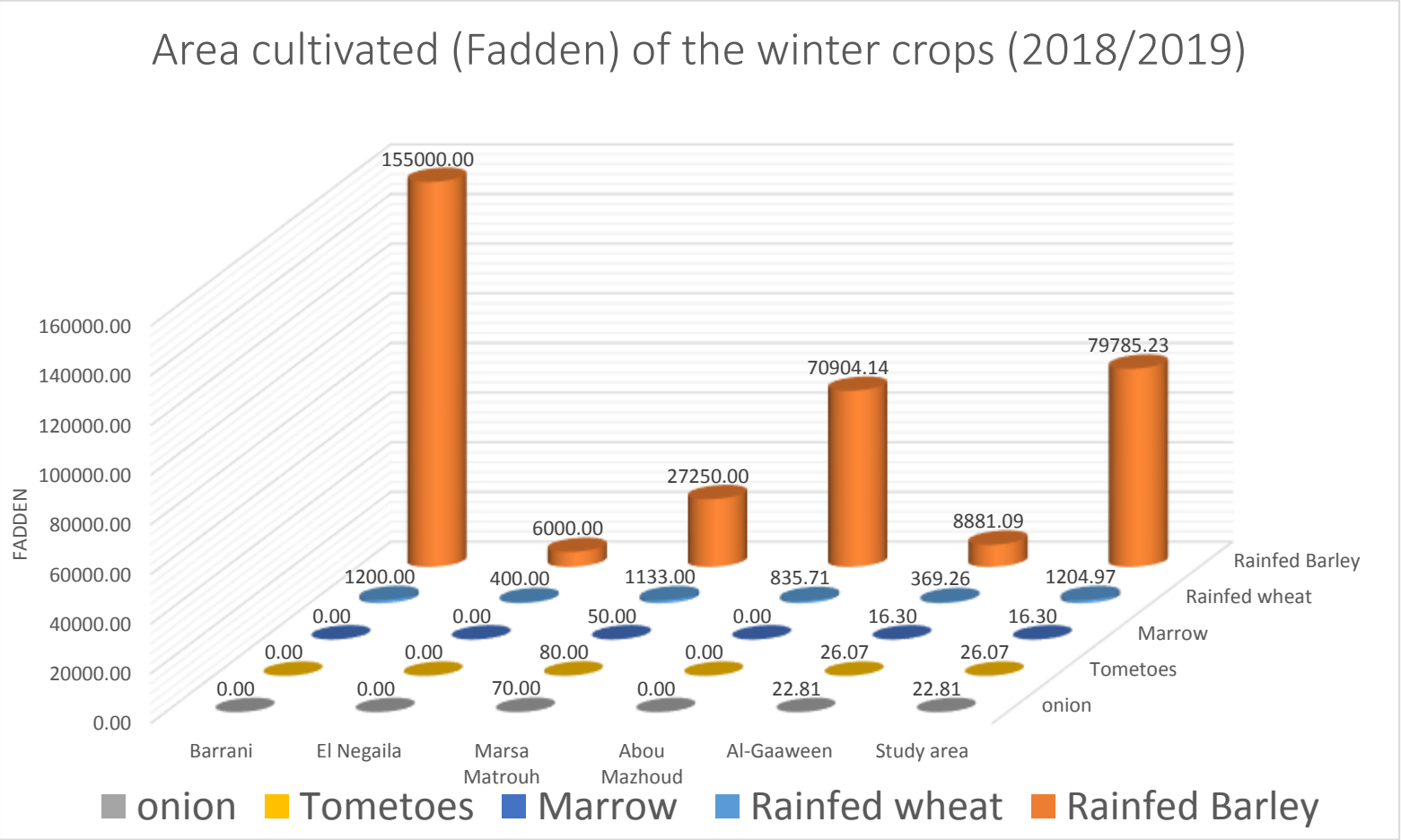



*Figure 17: Area cultivated (Fadden) of the winter crops (2018/2019)*

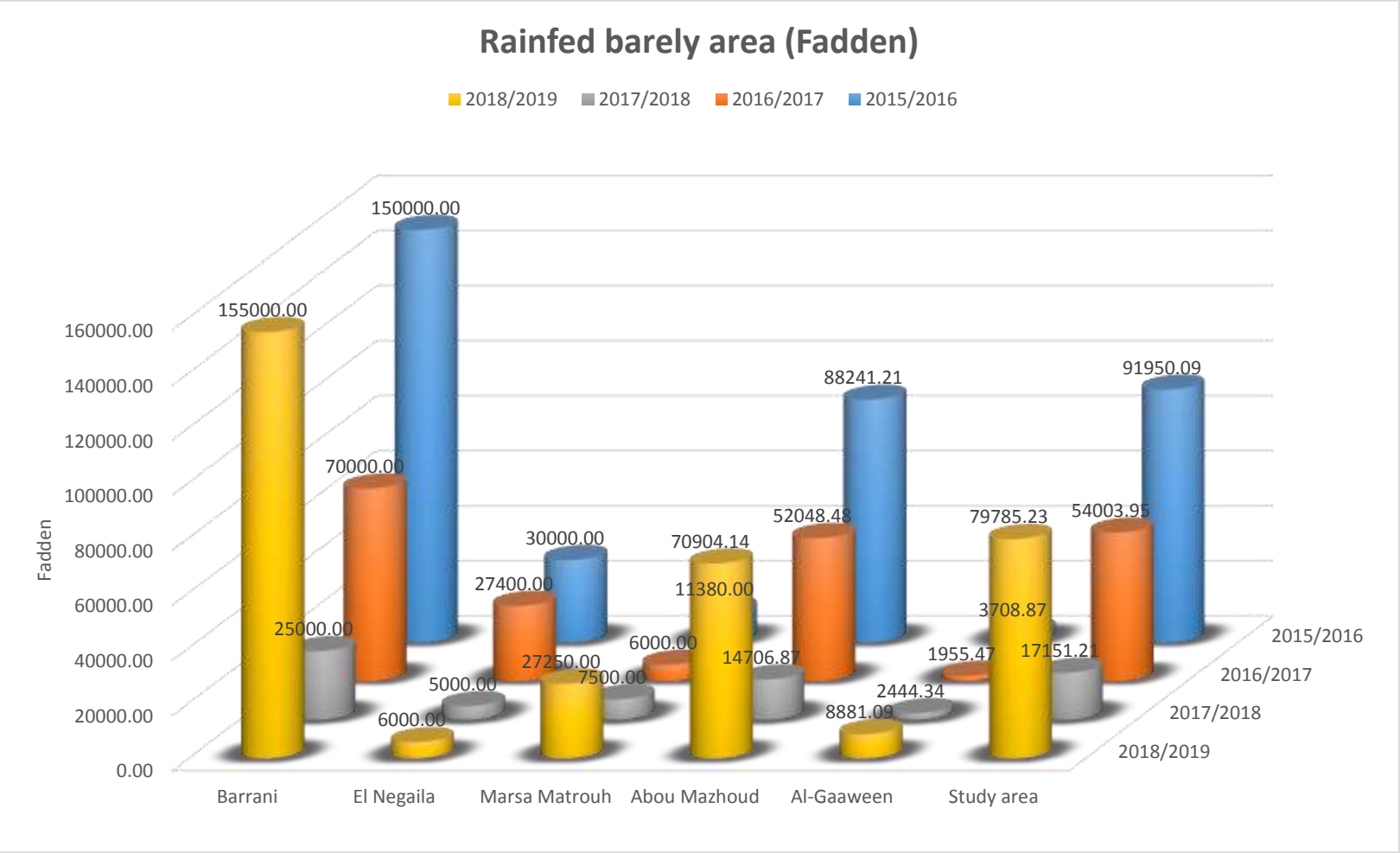



*Figure 18: the rainfed barely cultivated area (fadden) of the study area.*

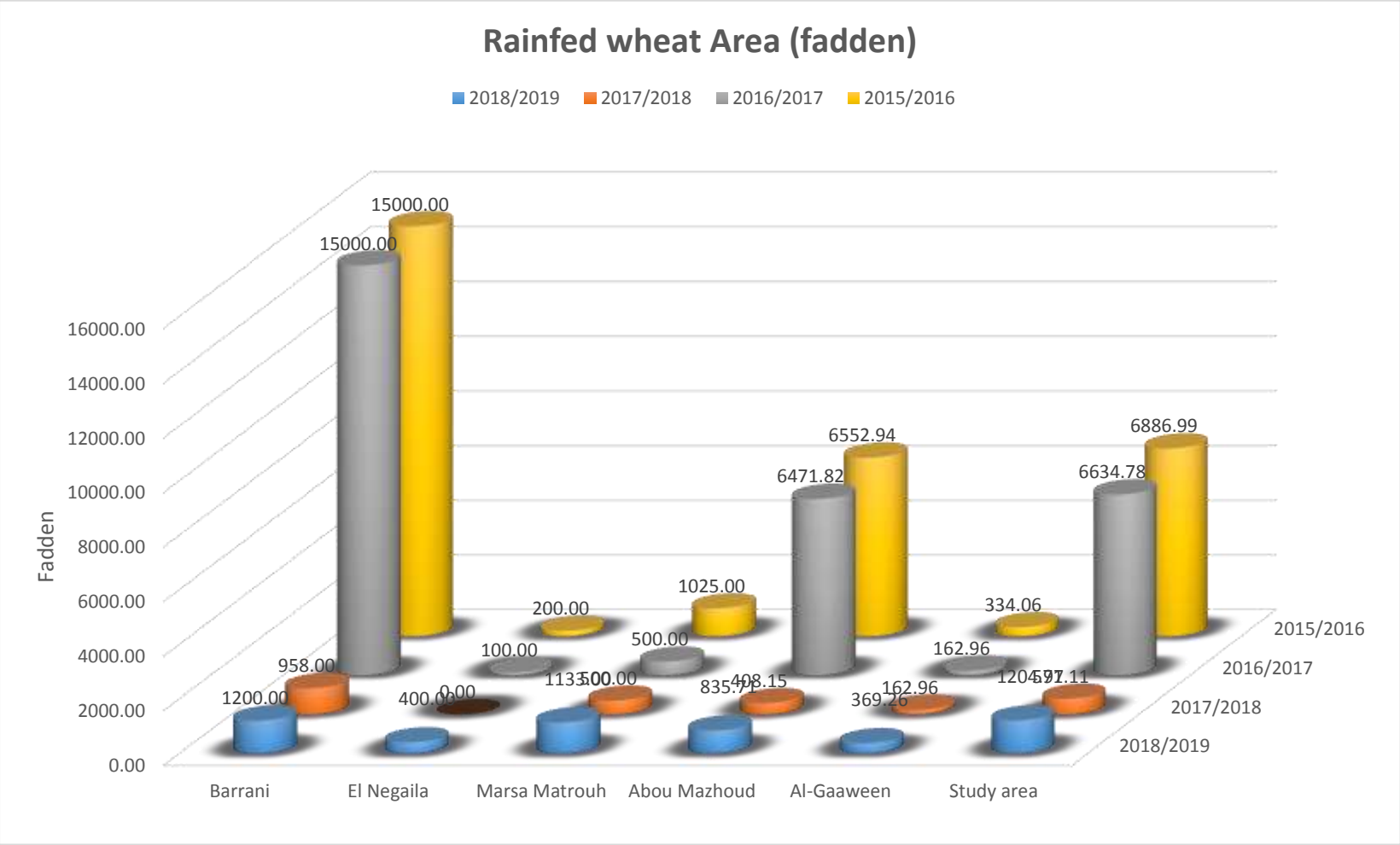



*Figure 19: the rainfed wheat area (fadden) of the study area.(2015-2019)*

*Table 16: The cultivated fruits (Fadden) in the study area.*

| | Season | Fig | Olive | date | Almond | Grapes | Pomegranate | Peach | Carob |
|---|---|---|---|---|---|---|---|---|---|
| Barrani | 2015/2016 | 8910.00 | 4395.00 | 34.33 | 20.00 | 2260.00 | 0.00 | 0.00 | 6.00 |
| | 2016/2017 | 8910.00 | 4395.00 | 34.33 | 20.00 | 2260.00 | 0.00 | 0.00 | 6.00 |
| | 2017/2018 | 8910.00 | 4584.00 | 34.33 | 19.00 | 2260.00 | 0.00 | 0.00 | 6.00 |
| | 2018/2019 | 8910.00 | 4837.00 | 39.33 | 19.00 | 2260.00 | 0.00 | 0.00 | 6.00 |
| Al-Nagila | 2015/2016 | 2400.00 | 2300.00 | 9.00 | 21.00 | 45.00 | 0.00 | 0.00 | 0.00 |
| | 2016/2017 | 2400.00 | 2300.00 | 8.83 | 21.00 | 45.00 | 0.00 | 0.00 | 0.00 |
| | 2017/2018 | 2430.00 | 2345.00 | 8.83 | 21.00 | 45.00 | 0.00 | 0.00 | 0.00 |
| | 2018/2019 | 2455.00 | 2160.00 | 8.83 | 21.00 | 45.00 | 0.00 | 0.00 | 0.00 |
| Marsa Matrouh | 2015/2016 | 27429.00 | 4230.00 | 125.00 | 710.00 | 454.00 | 6.63 | 6.63 | 0.00 |
| | 2016/2017 | 27429.00 | 4230.00 | 130.00 | 667.00 | 408.00 | 6.00 | 6.63 | 0.00 |
| | 2017/2018 | 27429.00 | 4432.00 | 130.00 | 667.00 | 396.00 | 6.00 | 6.63 | 0.00 |
| | 2018/2019 | 27429.00 | 4491.00 | 134.00 | 667.00 | 396.00 | 6.00 | 6.63 | 0.00 |
| Abou Mazhoud | 2015/2016 | 5742.81 | 3738.09 | 21.93 | 25.55 | 999.37 | 0.00 | 0.00 | 2.56 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2016/2017 | 5742.81 | 3738.09 | 21.79 | 25.55 | 999.37 | 0.00 | 0.00 | 2.56 |
| | 2017/2018 | 5767.15 | 3855.12 | 21.79 | 25.13 | 999.37 | 0.00 | 0.00 | 2.56 |
| | 2018/2019 | 5787.42 | 3812.85 | 23.92 | 25.13 | 999.37 | 0.00 | 0.00 | 2.56 |
| Al-Gaaween | 2015/2016 | 8939.43 | 1378.61 | 40.74 | 231.40 | 147.96 | 2.16 | 2.16 | 0.00 |
| | 2016/2017 | 8939.43 | 1378.61 | 42.37 | 217.38 | 132.97 | 1.96 | 2.16 | 0.00 |
| | 2017/2018 | 8939.43 | 1444.44 | 42.37 | 217.38 | 129.06 | 1.96 | 2.16 | 0.00 |
| | 2018/2019 | 8939.43 | 1463.67 | 43.67 | 217.38 | 129.06 | 1.96 | 2.16 | 0.00 |

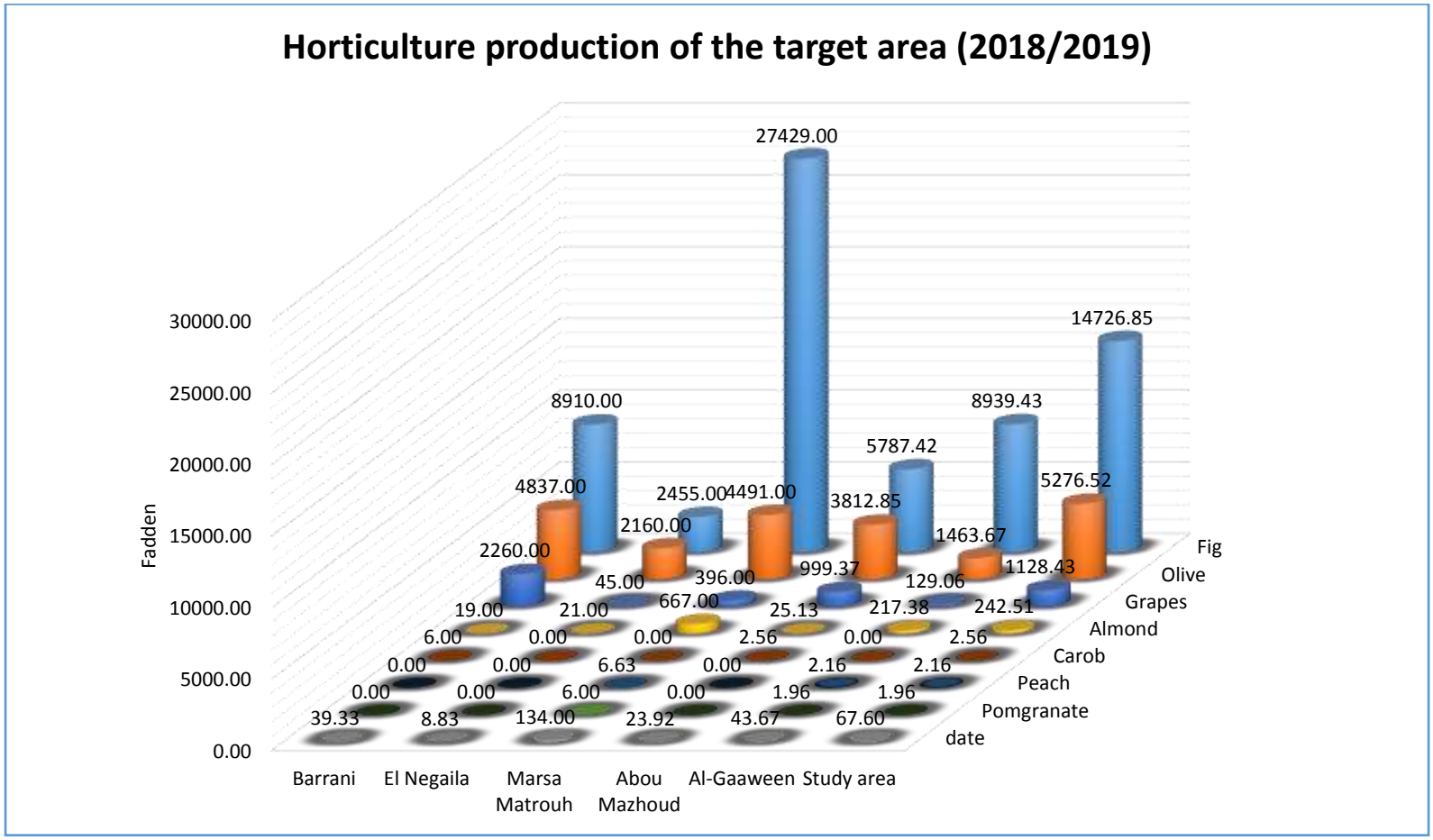



*Figure 20: Horticulture cultivated area of the study area (2018/2019*

## Forage consumption

Feed is the major input cost in livestock production, it is accounting for 65–70% of the total running cost. Poor nutrition of animals has been identified as the major constrain to animal production across the developing world (FAO, 2000). Heneidy (1992) reported that the annual consumption of forage by the grazing animals is about 619 kg/ head (average of 1.696 kg/ head/ day). Taking into consideration that annual therophytes and perennial chamaephytes constitute the bulk of feed of grazing animals. Perennial chamaephytes plants are therefore valuable in tiding over the periods of limited forage supply. The perennial chamaephytes ensure a good supply of standing dead material during the dry period that is selected by grazing animals with even higher priority than the available green (Table17 and Fig. 21). This may reflect the importance of such species in arid rangelands. In the same trend, the very common and common grazing species ensure a good abundance of the grazing species of the study area (Table 18 and Fig.22).

*Table 17: Llife form and the life span of the grazing species.*

| Species | Annual | Biennial | perennial | Total |
|---|---|---|---|---|
| Chamaephytes | 0 | 1 | 30 | 31 |
| Hemicryptophytes | 0 | 0 | 4 | 4 |
| Therophytes | 42 | 1 | 0 | 43 |
| Geophytes | 0 | 0 | 2 | 2 |
| Chamaephytes/Phanerophytes | 0 | 1 | 0 | 1 |
| Total | **42** | **3** | **36** | **81** |

*Table 18: Rarity and life form of the grazing species*

| Species | Very Common | Common | Rare | Very Rare | Total |
|---|---|---|---|---|---|
| Chamaephytes | 11 | 10 | 7 | 3 | 31 |
| Hemicryptophytes | 1 | 3 | 0 | 0 | 4 |
| Therophytes | 17 | 19 | 6 | 1 | 43 |
| Geophytes | 2 | 0 | 0 | 0 | 2 |
| Chamaephytes/Phanerophytes | 0 | 1 | 0 | 0 | 1 |
| Total | 31 | 33 | 13 | 4 | 81 |

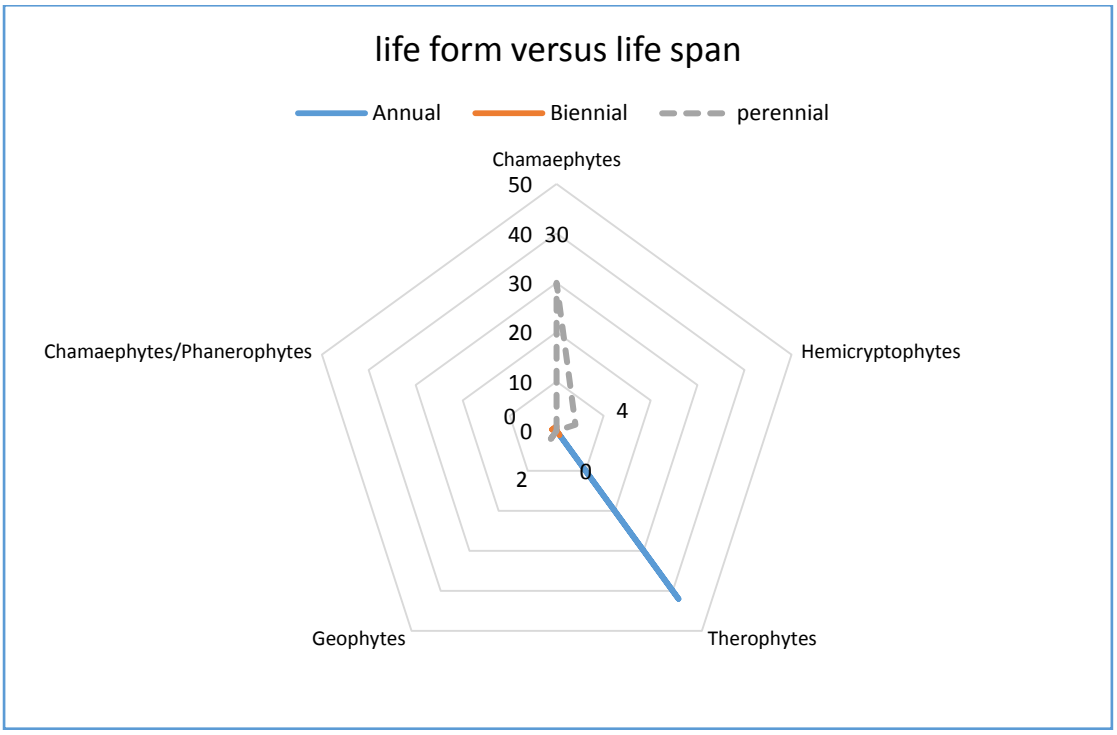



*Figure 21: Llife form versus life span of the study area.*

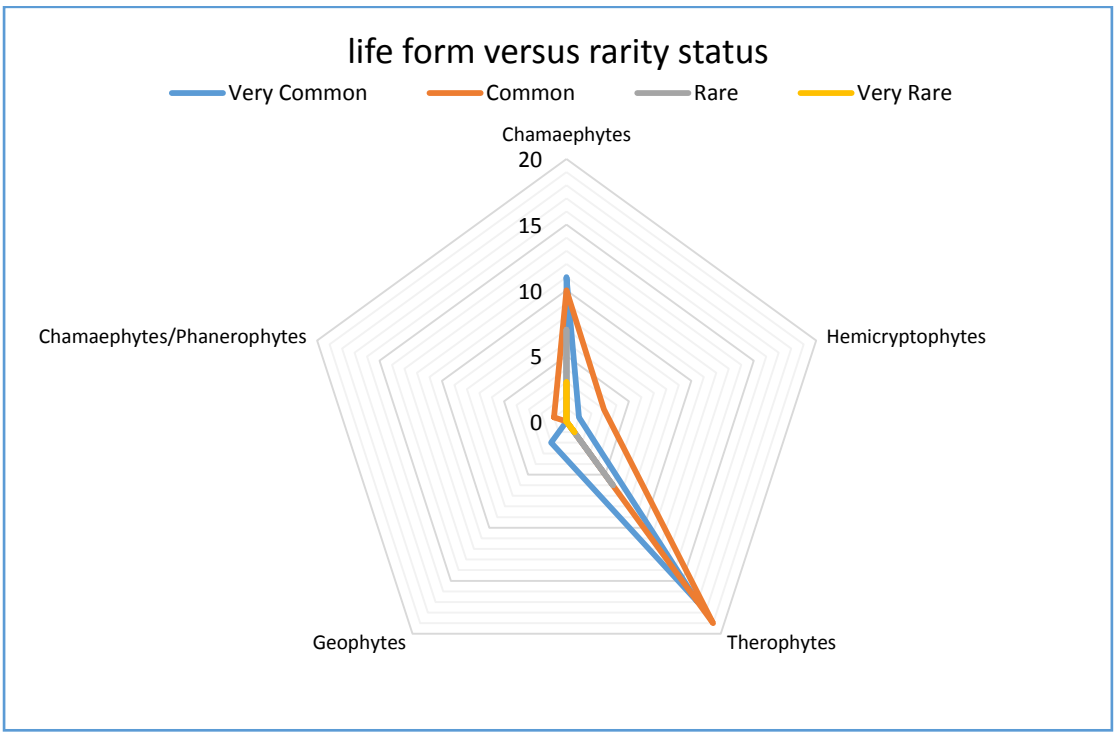



*Figure 22: Life form versus rarity status of the study area.*

Absolutely the stocking rate leads to the problem of overgrazing. Overgrazing has been one of the main factors causing the deterioration of ecosystem productivity in the Mediterranean coastal region. It has resulted severe reduction of perennial cover, soil erosion and formation of mobile dunes (Heneidy, 2002), consequently, that will be reflected negatively on the population, performance, health, and productivity of grazing and wild animals. Noy-Meir (1973) reported that the bulk of primary standing biomass of the community in semi-arid regions is made up of woody life-forms. Most perennial chamaephytes species exhibit their greatest vegetative activity during winter and spring, and they are less active or dormant during summer. Heneidy (2002) and Abdel-Razik et al. (1988 a&b) agrees with this point of view for Marsa Matrouh area and Omayed in the northwestern region. However, some shrubs and sub-shrubs are active throughout the whole year. These species are more conservative in the use of their own resources, especially soil moisture and have developed a root system that is capable of exploiting soil moisture and minerals from a large volume of soil and at depth that is permanently wet, which in-turn enables them to extend their activities under conditions of moisture stress (Ayyad et al., 1983). This behaviour of plant species occurs with some species in the study area. This type of species plays an important role in the sustainable production of the natural forage of the pasture. This means that accessible parts do not depend upon the primary above-ground phytomass, but depend upon the configuration and morphological shape of the species and their life-forms (Heneidy, 1992).

Fritzi and Bradley, (1992) recorded that the production level of herbivores may depend more upon plant architecture than on the -particular species of natural enemies present. The annual average of the primary production in

the western desert was 590 ± 117 kg ha-1yr-1, while the accessible production was 410 ± 39 kg ha-1 yr-1 (Le Houérou, 1972). This value is less than that obtained by Abdel-Razik et al. (1988a) and Heneidy (1992) at Omayed in the coastal region (668 and 720 kg *ha-1* respectively).

There is nearly a similar trend and condition in both target study sites, consequently these similarities will reflect on similarity of the vegetation cover and land use. Meanwhile, these information and data have been mentioned and confirmed by pastoralists in both study sites. So that, the authors suggested the same findings of Omayed in the coastal region as the target study area.

In the dry grazing period, the subsidied concentrates, wheat, barley, bran , straw, agricultrural by-products and onion residuals are supplied to the animals, and supplementary drinking water becomes more necessary (photos 9 & 10). Water consumption by grazing animals depends on five main factors: (1) air temperature, (2) amount of dry matter ingested, (3) water content of the feed, (4) salinity of drinking water, and of feed (Le Houéou & Hostte, 1977and Heneidy, 1992). Heneidy (1992) reported that sheep and goats in the coastal region do not supply with drinking water during winter and spring, since

*Photo 9: Germinating barley has been recently used for feeding animals (Barrani district).*

the water content of the vegetation is sufficient for their water requirement. However, in the other seasons watering of the animals is necessary.

*Photo 10: Germinated barely in the final stage which is ready for feeding livestock as green fodder (Barrani distric)t.*

## Secondary By-products

Agricultural by-products/wastes represent an important source of feed for animals with reasonable cost in addition to decreasing the environmental pollution (photo 11). In Egypt, only 10% is used as animal feed. The remainder is burnt directly on the fields or is used for heating in the small villages, using low efficiency pruners. These wastes as well as the dried wild plants can be used more efficiently as a source of animal feed.

*Photo 11: Collecting dry wild plants as feed resource, and to cover the barley straws below to protect them from wind and rain.*

As an example, date palm leaves can be used to feed livestock. They are used traditionally as a complementary feeding source by oasis dwellers (Medjekal et al., 2011). A date palm tree can produce 13.5-20 kg of dry leaves annually (Chehma et al., 2001; Pascual et al., 2000).

According to the Agricultural directorate of Matrouh governorate, in 2019, the total production of date from Barrani is about 220 tons, 50 tons of El Negaila and 750 tons of Marsa Matrouh.

The trimed leaves of date palm reached 55 tons from Barrani, 12 tons from El Negaila and 188 tons from Marsa Matrouh (Table 19). These leaves byproduct could be used for making silage, especially at the dry season.

Table 19: Estimated quantity and value (Egyptian pounds, LE) of by-products of date palms in target districts.

| Item | Barani | El-Negila | Marsa Matrouh |
|---|---|---|---|
| **The amount of leaves and other waste per ton** | ٥٥ | ١٢ | ١٨٨ |
| **The estimated price / ton (LE)** | ٢٥٠ | ٢٥٠ | ٢٥٠ |
| **The estimated Leaves price / ton (1000 LE)** | ١٣,٧٥ | ٣ | ٤٧ |
| **Date production (Ton)** | ٢٢٠ | ٥٠ | ٧٥٠ |
| **Seed production (10-15% of fruits)** | ٢٢ | ٥ | ٧٥ |
| **The estimated price / ton (LE)** | ٣٥٠ | ٣٥٠ | ٣٥٠ |
| **The estimated seed price / ton (1000 LE)** | ٧,٧ | ١,٧٥ | ٢٦,٢٥ |
| **The estimated by-products of date palm / ton (LE)** | ٢١,٤٥ | ٤,٧٥ | ٧٣,٢٥ |

It is recommended to make silage of raw date seeds mixed with fodder, at rate 5%, as it transferred into more accessible nutritive material physically more beneficial for the animal to ingest. Its materials become softer and more palatable. Meanwhile, it maintain chemical composition with minimal loss due to treatment. Yet, ensiling represents a low cost process, compared to other method, applied to reduce seeds hardness. Thereafter, the positive results attained recommend future research for using date seeds at higher percentage than 5% for ensiling (Saifelnasr et al., 2014). On the other hand, date palm leaves can be converted to silage to be an additional feed source for the livestock (photo 12).

*Photo 12: Stages of silage making from date palm leaves to convert them to an efficient feed source for livestock (El Kharga oasis, New Valley governorate) .*

**Olive**

The by-products derived from the olive trees and olive oil extractions are generally known as olive by-products. They represent an important group

of feed resources for ruminant animals in the Mediterranean region. Noteworthy studies have been conducted in recent years showing the posistive effect of different olive by-products on both animal performance and product quality. Olive leaves provide half the energy and amino acid requirements of farm animals for maintenance and if adequately supplemented, can be used as part of the forage in diets for production. Olive cakes can be preserved by ensiling or incorporation into multi-nutrient blocks to be most successful developed. In addition, the use of olive by-products rich in oil appears to increase the content of mono-unsaturated fatty acids and lower the content of saturated fatty acid in milk. However, more research is needed to maximize the quality of animal products through inclusion of olive by-products in diets of farm animals, especially, under hot summer season of Egypt (Habeeb et al., 2017).

Byroduct of olive trees refers to a mixture of leaves and branches produced from pruning olive trees as well as the harvesting and cleaning of olives prior to oil extraction. The production of olive leaves from pruning has been estimated to be 25 kg per tree, to which can be added 5% of the weight of harvested olives that is collected at the oil mill (Delgado Pertinez, 1998).

Leaves and branches of olive trees are traditionally used fresh and can be a substantial fodder source. Since harvesting and pruning are seasonal, it may be useful to consider preservation of leaves and branches, by drying or ensiling, to spread consumption over a longer period.

According to the Agricultural directorate, Matrouh Governorate in 2019, the total production of olive from Barrani is about 11221.84 tons, 5011.2 tons of El Negaila and 10419.12 tons of Marsa Matrouh.

*Table 20: .The Estimated amount (ton) and value (Egyptian pounds) of by-products from olive in target districts.*

| Item | Barani | El-Negila | Marsa Matrouh |
|---|---|---|---|
| **Total olive production / ton** | ١١٢٢١,٨٤ | ٥٠١١,٢ | ١٠٤١٩,١٢ |
| **The amount of waste of the oil extraction 80% per ton** | ٨٩٧٧,٥ | ٤٠٠٩ | ٨٣٣٥,٣ |
| **The estimated price / tom** | ١٠٠٠ | ١٠٠٠ | ١٠٠٠ |
| **Total value of leaves and seeds and other waste in a million Egyptian pounds** | ٩,٠ | ٤,٠ | ٨,٣ |

Olive cakes consist of olive pulp, skin, stone and water. Different terms may be given depending on factors such as composition and oil content (crude or extracted olive cakes), stones or moisture (fresh or dry olive cakes). The different oil extraction procedures and resulting byproducts have documented by Alburquerque et al. (2004).

According to table (21), there are five olive oil extract factories of actual capacity of 148.21 tons / year. Among them 37.63 tons / year for barani and 11.58 tons / year of Marsa Matrouh. As average, an olive plant produces 20 to 35 kg olive fruits / year, which contain more than 20 % oil. The remaining oil cake is about 80% of the olive production. Actually, the remaining oil cake from the olive factory reached 118.57 tons / year, which could be used to make silage by livestock keepers of Barani and Marsa Matrouh districts.

*Table 21: Oil extract factoury at Marsa Matrouh and Barrani districts.*

| Oil extract factory | district | ownership | Actual capacity (Ton) | |
|---|---|---|---|---|
| | | | Olive | Oil |
| Hamida Israfeel | Barrani | Private | ١١,٧٦ | ٢ |
| Yadem Mostafa Abdel Wanees | Barrani | Private | ١٣,٥٢ | ٢,٣ |
| Mouftah Abdel Raouf | Barrani | Private | ١٢,٣٥ | ٢,١ |
| Agriculture council of Matrouh | Marsa Matrouh | Governorate | ١٠.٥٨ | ١,٨ |
| Development Centre of Matrouh resources | Marsa Matrouh | | ١٠٠ | ١٧ |
| Total | | | 148.21 | 25.2 |

Source: Agriculture Directorate, Matrouh governorate, Ministry of Agriculture, Egypt (2019).

## Ecological stress on the grazing ecosystem

The products of the rangeland are renewable; thus, the ranges are capable to continuously provide goods and services such as forage, fiber, meat, milk, water , areas for recreation and etc. These resources are considered an integral part of their traditional heritage, which adds special importance to their value.

Generally, the grazing ecosystem exposed to different types of stress such as overgrazing, woodcutting, aridity, different types of human activities, and erosion of soil surface. Moreover, aggressive grazing caused ecosystem degradation by various kinds of mismanagement of the land. This include the extensive grazing of livestock and multiple-use of the land to develop tourism.

The rangelands of the studied area are in a poor condition due to pressures of different types of stress that have either altered or destroyed the ecosystem because of overgrazing, uprooting of plants and off-route use by vehicles. These factors have resulted in an almost decrease or complete removal of vegetation cover and speeding up the desertification process in the study area.

Overgrazing is a widespread problem where the meager winter rainfall supports a scant plant cover. Overgrazing is severe in the study area. The problem is increasing as the number of Bedouins and their livestock continues to grow . Unregulated use of off-road vehicles particularly for recreation and tourism has increased dramatically in recent years. This leads to severe degradation of vegetation, disruption of top soil, and long term scarring of the landscape.

Camel grazing does not cause degradation in the rangeland as a result of the non-occurrence of overgrazing of grazed plants. While, sheep or goats cause more damage when grazing because they eat large quantities of

herbal plants especially the newly developed herbs, which are difficult to re-grow. Also, sheep plow the land with their pointed nails while grazing, which leads to the uprooting of the plants from the soil or their weariness as a result of walking.

Bedouins in Maruit region collect wood as fuelfrom the natural vegetation as an essential source of energy. The daily fuel wood collected by a household is about 29 kg. The quantity used was about 24 kg/ha, which equals 8.8 ton/year (Heneidy, 1995). All these activities have their effects on the grazing stem of the target area.

It is important to regulate grazing, the grazing of young plants before flowering make them more vulnerable and threatened and year after year the seed content in the soil will diminish until it extinct. This problem is not hide to anyone interested in the environment and biodiversity, and this appears through comparison of open land and land surrounded by a fence. It is a national problem that needs to be resolved urgently. Therefore, there must be concerted efforts to protect our environment from desertification resulting from unregulated grazing.

## Conservation activities and opportunities on the study sites

The study area has very limited/minor conservation activities. The direct threats should be identified through further field study for sustainable management of the target area.

The causes of degradation of the vegetation in the northwestern coast are mixes of environmental, socio-political and socio-economic. Three main lines may be suggested for the initiation of a long-term strategy for the restoration and conservation of degraded vegetation:

a. Establishment of pilot areas for protection and controlled grazing in each of the main habitats and communities.

b. Initiation of a cooperative system for grazing management between the main social sectors (tribes).

c. Formation of an extensive programme for propagation of endangered species, it is necessary that both decision makers and land-users participate in the planning and execution of the activities along these three lines, and that extension services and incentives be ensured in order to encourage their participation.

There is no consistent range management strategy control the grazing in the area, which varies mainly with the climatic conditions, availability of watering points and availability of supplementary feed.

It is important to initiate programme for the propagation of multipurpose species in the study area and establishment of nurseries as well as demonstration of field experiments.

## Weaknesses of the plant genetic resources in the study area.

Plant genetic resources in Egypt face many challenges and risks resulting from a number of causes such as overgrazing, unsustainable agricultural and grazing practices, urban expansion at the expense of natural environments, pollution, land use changes and climate changes (table 22).

The reasons for the deterioration of rangelands in Northwestern coastal zone are due to natural factors in addition to human intervention and misuse of natural resources.

Maintaining flexible and resilient rangeland systems in the face of increasing challenges of the economic environment is essential to the success of Millennium Development Goal 1 to eradicate extreme poverty and hunger.

*Table 22: Problems and proposed solutions of the plant genetic resources in the study area.*

| Type of problem | Specific problem mentioned | propose solution |
|---|---|---|
| Fluctuation of yearly precipitation and Excessive use of water resources. | • Access to water is a limiting factor when determining the size of herds for many individuals and communities.<br>• Therefore, there is a high risk that competition for water will lead to overuse. This is especially true when considering additional other water needs. | • Store water in reservoirs for the summer.<br>• Rationalize the use of water.<br>• Development of rangelands to reduce the water deficit, as it will reduce the area of agricultural land used for growing fodder.<br>• |
| Overgrazing | • The problem of overgrazing is the exaggerated consumption of the land continuously and without giving an opportunity to these pastures to rebuild themselves, due to the large number of animals grazing in small areas. | • Proper manage animals and use grazing plans to implement periodic grazing.<br>• Proper manage land use by monitoring rainfall patterns and defining seasons of drought.<br>• Store feed for the animals in the spring, so that there will be enough grass in the summer.<br>• Choose suitable lands for grazing. |

| | | |
|---|---|---|
| Legislation | • There is any legislation, regulation and strategy for the management and sustainable development of rangeland of Egypt. | • New legislation is needed for the management of rangeland.<br>• Establish customary law council to protect the rights of communities.<br>• Formulate policies that:<br>1. Provide incentives to herders to maintain biodiversity, environmental system and promote production.<br>2. Integrate rangeland resources into protected areas legislation.<br>3. Protect IPRs over wild and cultivated material of rangeland.<br>4. Regulate access to GRs. |
| Sustainability | • Herders, breeders and producers need to congregate into larger bodies for better business organization.<br>• | • Establish local authority of all herders' stakeholders (union or association) to protect the legal rights of the region/community over range resources.<br>• Grant full authority to local government councils and/communities to manage and protect their rangeland.<br>• Setup a platform (NGO) to ensure full participation of all herders' stakeholders and sustainability of rangelands.<br>• Establishment of a national registry for herders' resources.<br>• Support activities to document traditional knowledge.<br>• |
| Awareness | • Public awareness is key gap that needs to covered. | • Need of a public awareness campaign about rangeland topics. |
| National plan of action. | • There is any national plan of action for the management and sustainable development of rangeland over Egypt. | • Formation of an extensive programme for propagation of endangered grazing species.<br>• Establishment a grazing protectorate ares. |

## Livestock aspects

Food and water security will be one of the priorities for humankind in the 21st century. Over the same period, the World will experience a change in the global climate that will cause shifts in local climate that will impact local regional and global agriculture. As a result, the livestock sector will face hard and complicated challenges in many fields in the 21st century. Consequently, decision-makers, research institutions, and extension services have to support and promote livestock activities to cope at best with the loss of production, worsening of animal products, rangeland degradation, enlargement of land desertification and the worsening of animal health under the effects of the climate changes expected in the next decades (Nardone et al., 2010).

On the other hand, A huge increase in the demand for animal products is expected in the next decades. According to Cohen (2001) in the year 2050, the world population will reach 9.3 billion. It is estimated that by then, global meat consumption will be twice that of today. That means, animal production has to increase in the next decades to satisfy the growing need. Livestock activities are recognized for their multiple roles in reducing vulnerability in fragile environments and their roles in diversification and intensification (Ashley et al., 1999; Alary et al., 2015; 2018) .

Pastoral and agro-pastoral livestock production systems are very important for livestock production worldwide and as well as in the northwestern coastal zone of Egypt. Pastoralism is a complex livelihood system seeking to maintain an optimal balance among pastures, livestock, and people in uncertain and variable environments. Pastoral groups typically inhabit areas where scarce resources, extreme climatic conditions and poor infrastructure which limit options for alternative land use and livelihood systems.

Pastoral systems are important to global society. They support the livelihoods of millions of people living in harsh and uncertain environments where alternative land-use systems are highly risky or not possible. Livestock raised in pastoral systems also contributes significantly to national and regional economies and provides important environmental services such as carbon sequestration, fire prevention, and biodiversity conservation etc.

Data obtained from the Agricultural Directorate of Matrouh Governorate belonging to the Ministry of Agriculture, Egypt (2019) showed that the average livestock population in Matrouh governorate through the period 2007-2019 is 487264 heads with a range of 288821 (2017) to 630453 (2013) heads. Sheep are the most important species followed by goats, camels, and donkeys. The populations of cattle, buffaloes, horses, and mules are very minor (Table 23). The main feed resources are natural pastures during the grazing season for maximum of 6 months (herbaceous vegetation composed mainly of grasses and forbs and browses such as shrubs, tree leaves and pods), which show marked seasonal variation in availability and quality based on the variability of rainfall rate and distribution.

livestock production represents a main source of food and its by-products are useful for keeping soil fertility, It also provides a sizable part of the transport in both sites of the study area. The private sector (pastoralists) plays the main role in livestock production. As most of the livestock population owned by them while the governmental/public sector owns minor/non-numbers of animals for research purposes or raised animals as sire centers for breeding purposes.

Horticulture crops such as figs, olives, date palm and grapes are practiced in limited areas of the rangeland in the study area as a means of economic

diversification (which their by-product can be used as source for feeding livestock) , also growing mainly barley and in some areas wheat in small areas as a source of human and animal food and feed. In the beginning, cultivating barley was for human consumption while herds consumed straw and agricultural by-products. Soon after, pastoralists gradually began to sow barley seed in large areas (including in previous pasture land) with the goal of feeding their herds, especially during periods of drought. Last decades crop failure becomes a common feature because of unreliable rainfall and frequent drought. Thus, role of livestock production increased as key factor of livelihood. Hence, more emphasis should be given to improve livestock productivity and proper management of the rangelands (Bonnet et al., 2014).

The extensive agro-pastoral livestock farming system is the mainstay and backbone for livestock rearing in the study area. Livestock depends on grazing natural pastures which is totally dependent on rainfall for a maximum six months of the year. Sheep, goats and camels are the species raised under this system (photo 13). livestock production is the main source of income and play an important economic and social role in the pastoral communities.

*Photo 13: Sheep and goat raised in the studied area. (the vegetation cover of the pasture is poor in summer as seen on the photo).*

At present, with the challenges and risks facing rangeland in the study area, as mentioned earlier in the study, natural resources need to be maintained and conserved, through improved watershed management, soil conservation in sloping lands and improved range management in pastoral areas. That can be achieved through strengthening local resource-user groups; introduce new technologies (silage making, treatment of the agriculture wastage to enhance their quality, etc.); better care and management of the livestock sector; health better management practices; and improved long-term policies, targeting to reach sustainable resource management.

**Livestock population and trend.**

The mean population of livestock raised in Matrouh governorate through the period 2007-2018 was 487264 heads while the population in the study area was 104767 heads, representing a significant percentage from the total population of the governorate ( 21.5%) (Tables 24, 25 and figures 26, 27 ). This significant livestock percentage in the study area reflects the importance of this agro-pastoral system for raising livestock in the governorate. Livestock population in the study area and Matrouh governorate (including all districts) during the period from 2007 to 2018 showed fluctuation with decreasing trend according to the data from Agricultural directorate, Matrouh governorate, Ministry of Agriculture, Egypt (2019) (Tables 25, 26, 27, 28, 29, 30 and 31).

The majority of the community inhabitants in the study project area depend on the agro-pastoral system. Pastoralism is a free-range livestock production system. It is practiced in both sites; it is the main source of food security and income. Pastoralism has immense potential for reducing poverty, generating economic growth, managing the environment, promoting sustainable development, and building climate resilience. But despite these positive aspects, pastoralists are experiencing rapid changes in their environment and welfare as a result of many reasons; soil and land degradation, water scarcity, prolonged droughts, climate change, livestock overstocking, etc.,. In addition, human population and settlement are increasing, taking up traditional grazing areas and competing for water resources especially the land near the sea line. Pastoralists may also suffer from occasional severe floods. Such upheavals are taking place under an inadequately developed service infrastructure, with poor market linkages and weak, unprepared institutions.

The livestock population raised in the study area during the period from 2007 to 2018 shows that sheep are the dominant species in Matrouh governorate. Sheep numbers represent more than 68% of the total livestock population, followed by goats which represent around 23% which mean that small ruminant occupied more than 90% of total livestock population. Sheep to goats numbers in the flocks varies according to rainfall level and the market. Camels population is around 3% followed by donkeys 2 %, while the cattle population is less than 2%. Finally, buffaloes, horses, and mules are less than 1% (table 24 and figure 25). The total livestock population raised in site 1 through the period 2007-2018 was 82% (85683 heads), while the population raised in site 2 was only 18% (19084 heads) of the total population in the study area (figure 22).

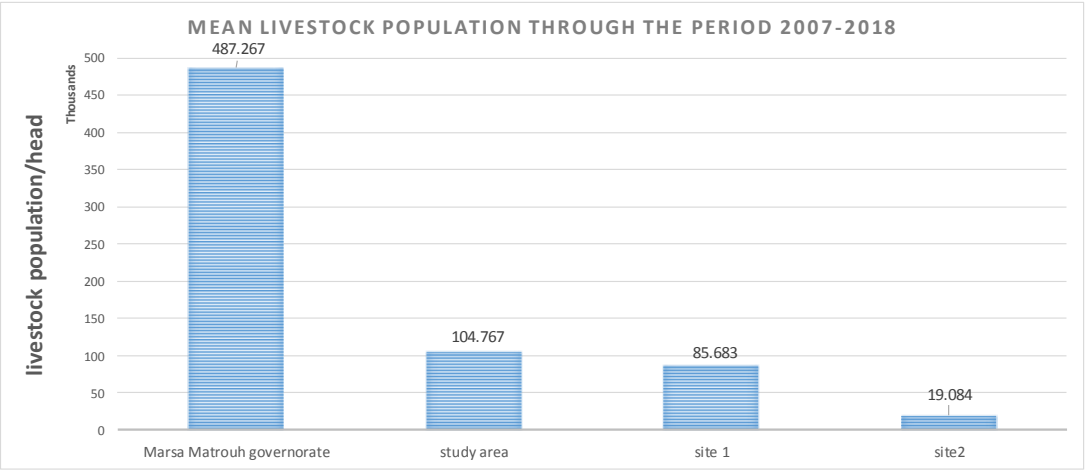



*Figure 23: Mean population of livestock/heads raised in the study area and Matrouh governorate through the period 2007-2018.*

Data source: Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

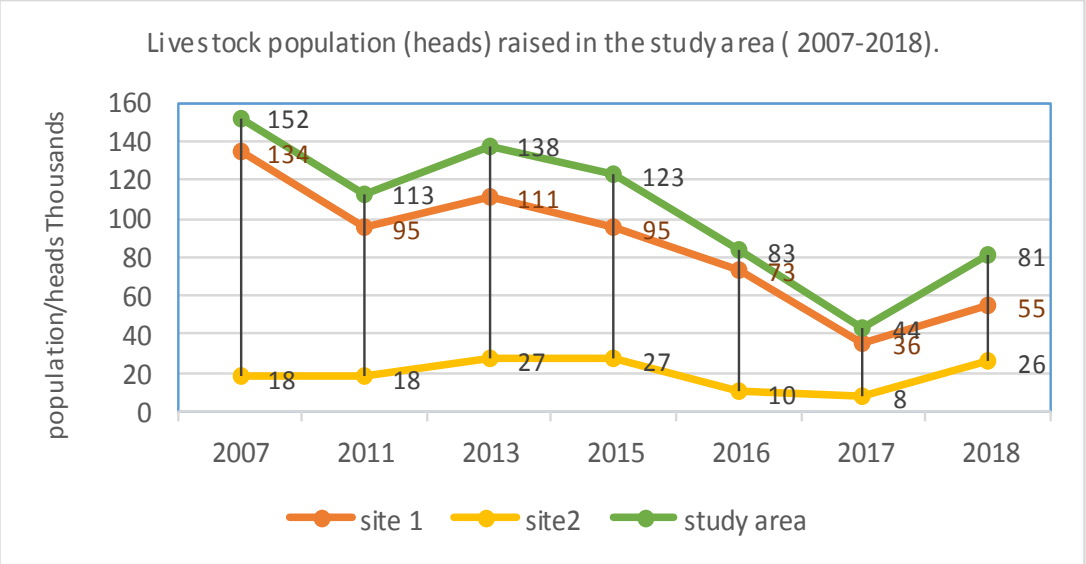



*Figure 24: Mean population of livestock/heads raised in the study area during the period 2007-2018.*

Data source : Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

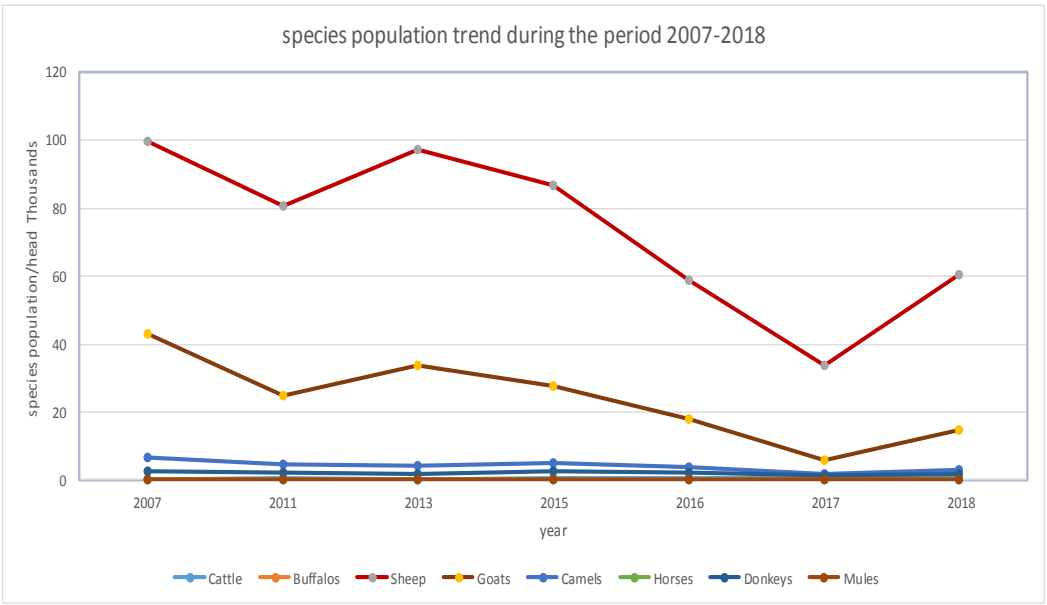



*Figure 25: Species populations/heads and their trends raised in the study area during the period 2007-2018.*

Data source : Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

*Table 23: Livestock population (head) raised in Matrouh governorate and the study area during the period 2007-2018.*

| | Year* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2007 | 2011 | 2013 | 2015 | 2016 | 2017 | 2018 | Mean |
| **Marsa Matrouh governorate** | 588152 | 494108 | 630453 | 566340 | 359967 | 288821 | 483006 | 487264 |
| **Study area** | 152140 | 112911 | 137893 | 122535 | 83240 | 43644 | 81003 | 104767 |
| **Site 1** | 134419 | 95163 | 110866 | 95350 | 73248 | 35618 | 55114 | 85683 |
| **Site2** | 17720 | 17749 | 27028 | 27184 | 9993 | 8026 | 25890 | 19084 |

Data source : Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

Over the past 10 years, both locations of the study have been hit by successive years of drought that badly affect crops, livestock and pasture vegetation, prompting many breeders to sell a large portion of their herds to feed the rest of their animals as described earlier in the study.

*Table 24: Species populations in the study area. during the period 2007-2018*

| Year | Cattle | Buffalos | Sheep | Goats | Camels | Horses | Donkeys | Mules |
|---|---|---|---|---|---|---|---|---|
| **2007** | 263 | 4 | 99578 | 42908 | 6662 | 16 | 2707 | 2 |
| **2011** | 481 | 3 | 80714 | 24714 | 4595 | 39 | 2363 | 2 |
| **2013** | 356 | 10 | 97333 | 33856 | 4340 | 51 | 1943 | 4 |
| **2015** | 564 | 11 | 86855 | 27580 | 4939 | 44 | 2538 | 5 |
| **2016** | 534 | 0 | 58675 | 17781 | 3966 | 100 | 2180 | 4 |
| **2017** | 489 | 0 | 33807 | 5970 | 1649 | 193 | 1536 | 0 |
| **2018** | 548 | 9 | 60595 | 14813 | 2913 | 154 | 1968 | 4 |

Data source : Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

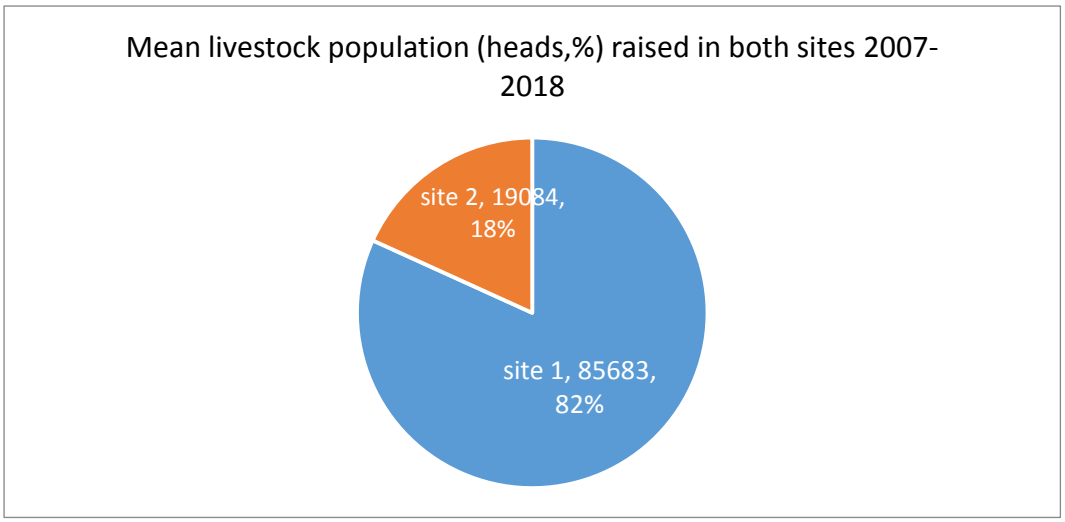



*Figure 26: Mean Livestock population (heads) and percentage raised in both sites in the study area during the period 2007-2018.*

Data source: Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

The population of livestock characterized by fluctuation trend during the period 2007-2018.

Flock/herd size is between 50 and 200 but it could reach up to thousands on a few occasions. Lambs are fattened mainly on grains (mostly barley), feed concentrates and crop by-products. Small ruminants is dominated in the study area, Barki sheep and Barki goats (recently from 2 decades Barki-Damascus cross-bred goats) are the main breeds raised in the area (Heneidy, 1992).

The rangeland area exhibits dynamic changes in livestock activities in connection with livestock keepers' networks which are the prevalent socio-economic actors. A typology of livestock keepers based on mobility and animal performance in the agro-pastoral region shows that only the largest livestock keepers were able to maintain long transhumance during the last 15 drought-years. The rate of profitability remained low due to high lamb mortality , the degradation of available resources and the high cost of the animal feed which become mandatory outside the grazing season. On the other hand, some small and medium-sized livestock keepers have reduced feed supplements (mainly grains), adopting a strategy of maintaining minimum productive livestock, while others have increased feed supplements for maximizing the profitability per animal during drought periods, depending on other sources of income (Alary et al. 2016).

The main breeding season is in June–July months. consequently, parturition synchronizes with the beginning of the natural grazing season which usually extends from November to March. This short grazing season is usually followed by a long dry season during which breeding and pregnancy occur.

*Table 25: Livestock population/species raised in the study area and Matrouh governorate in 2007.*

| District | Cattle | Buffaloes | Sheep | Goats | Camels | Horses | Donkeys | Mules | Total |
|---|---|---|---|---|---|---|---|---|---|
| **El Hamam** | 2979 | 670 | 32172 | 10476 | 820 | 65 | 802 | 23 | 48007 |
| **El Alamein** | 58 | 15 | 23912 | 10391 | 2740 | 54 | 256 | 0 | 37426 |
| **El Dabaa** | 141 | 0 | 39720 | 16912 | 3688 | 3 | 1906 | 0 | 62370 |
| **Marsa Matrouh** | 647 | 25 | 84662 | 34540 | 3026 | 34 | 3415 | 14 | 126363 |
| **El Negaila** | 71 | 0 | 61290 | 37300 | 6850 | 10 | 2120 | 0 | 107641 |
| **Barrani** | 303 | 0 | 115980 | 33949 | 4433 | 10 | 2085 | 0 | 156761 |
| **Sallum** | 232 | 0 | 20362 | 16095 | 1596 | 0 | 285 | 0 | 38569 |
| **Siwa** | 1099 | 113 | 3642 | 2743 | 1170 | 12 | 2225 | 11 | 11015 |
| **Matrouh Governorate** | 5530 | 823 | 381740 | 162406 | 24323 | 188 | 13094 | 48 | 588152 |
| **Site 1** | 172 | 0 | 87706 | 38064 | 6238 | 11 | 2228 | 0 | 134419 |
| **Site2** | 91 | 4 | 11872 | 4844 | 424 | 5 | 479 | 2 | 17720 |
| **Study area*** | 263 | 4 | 99578 | 42908 | 6662 | 16 | 2707 | 2 | 152140 |

Data source: Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

*As shown earlier in table (24) raising sheep is dominant in the study area with a percent of 66% followed by goats (28%), which means that small ruminants occupy 94% of the total livestock population. Camels % is minor, around 4%, then the donkeys' population around 1%. While cattle, horses, and mules together occupy less than 1%. This population trend is very similar to the livestock population in Matrouh governorate.

*Table 26: Livestock population/species raised in the study area and Matrouh governorate in 2011.*

| District | Cattle | Buffaloes | Sheep | Goats | Camels | Horses | Donkeys | Mules | Total |
|---|---|---|---|---|---|---|---|---|---|
| **El Hamam** | 3167 | 786 | 35396 | 11543 | 908 | 82 | 887 | 34 | 52803 |
| **El Alamein** | 77 | 31 | 25904 | 10125 | 2520 | 68 | 410 | 0 | 39135 |
| **El Dabaa** | 155 | 0 | 39486 | 12183 | 2372 | 7 | 1769 | 0 | 55972 |
| **Marsa Matrouh** | 687 | 22 | 85028 | 34767 | 2570 | 49 | 3430 | 14 | 126567 |
| **El Negaila** | 475 | 0 | 63200 | 21250 | 4700 | 42 | 1550 | 0 | 91217 |
| **Barrani** | 193 | 0 | 67797 | 14924 | 2934 | 13 | 2129 | 0 | 87991 |
| **Sallum** | 148 | 0 | 11903 | 7076 | 1056 | 0 | 291 | 0 | 20473 |
| **Siwa** | 2525 | 137 | 9170 | 5942 | 25 | 19 | 2125 | 7 | 19950 |
| **Matrouh Governorate** | 7427 | 976 | 337884 | 117810 | 17085 | 280 | 12591 | 55 | 494108 |
| **Site 1** | 385 | 0 | 68790 | 19839 | 4235 | 32 | 1882 | 0 | 95163 |
| **Site2** | 96 | 3 | 11924 | 4875 | 360 | 7 | 481 | 2 | 17749 |
| **Study area** | 481 | 3 | 80714 | 24714 | 4595 | 39 | 2363 | 2 | 112911 |

Data source: Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

*Table 27:. Livestock population/species raised in the study area and Matrouh governorate in 2013.*

| District | Cattle | Buffaloes | Sheep | Goats | Camels | Horses | Donkeys | Mules | Total |
|---|---|---|---|---|---|---|---|---|---|
| **El Hamam** | 3350 | 879 | 35532 | 11978 | 940 | 323 | 893 | 41 | 53936 |
| **El Alamein** | 87 | 32 | 25674 | 10750 | 2265 | 60 | 325 | 0 | 39193 |
| **El Dabaa** | 154 | 0 | 43081 | 11852 | 3186 | 16 | 1904 | 0 | 60193 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Siwa** | 2549 | 182 | 10560 | 6182 | 20 | 19 | 2035 | 5 | 21552 |
| **Sallum** | 278 | 0 | 19433 | 15420 | 1779 | 0 | 330 | 0 | 37241 |
| **Barrani** | 365 | 0 | 110692 | 32524 | 4944 | 53 | 2415 | 0 | 150992 |
| **El Negaila** | 85 | 0 | 52000 | 19500 | 2600 | 25 | 400 | 0 | 74610 |
| **Marsa Matrouh** | 1065 | 69 | 126818 | 55490 | 4342 | 90 | 4832 | 30 | 192736 |
| **Matrouh Governorate** | 7933 | 1162 | 423790 | 163696 | 20076 | 586 | 13134 | 76 | 630453 |
| **Site 1** | 207 | 0 | 79549 | 26075 | 3731 | 38 | 1265 | 0 | 110866 |
| **Site2** | 149 | 10 | 17784 | 7781 | 609 | 13 | 678 | 4 | 27028 |
| **Study area** | 356 | 10 | 97333 | 33856 | 4340 | 51 | 1943 | 4 | 137893 |

Data source: Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

*Table 28: Livestock population/species raised in the study area and Matrouh governorate in 2015.*

| District | Cattle | Buffaloes | Sheep | Goats | Camels | Horses | Donkeys | Mules | Total |
|---|---|---|---|---|---|---|---|---|---|
| **El Hamam** | 4325 | 1140 | 46154 | 15711 | 1125 | 407 | 1098 | 94 | 70054 |
| **El Alamein** | 95 | 0 | 6000 | 5200 | 1750 | 30 | 90 | 0 | 13165 |
| **El Dabaa** | 495 | 0 | 55231 | 9454 | 1825 | 123 | 1864 | 0 | 68992 |
| **Siwa** | 1760 | 165 | 10510 | 5688 | 20 | 19 | 1795 | 5 | 19962 |
| **Sallum** | 187 | 0 | 11903 | 7076 | 1199 | 0 | 291 | 0 | 20656 |
| **Barrani** | 246 | 0 | 67797 | 14924 | 3331 | 13 | 2129 | 0 | 88440 |
| **El Negaila** | 475 | 0 | 63200 | 21250 | 4700 | 42 | 1550 | 0 | 91217 |
| **Marsa Matrouh** | 1121 | 76 | 128824 | 55203 | 3835 | 84 | 4677 | 34 | 193854 |
| **Matrouh Governorate** | 8704 | 1381 | 389619 | 134506 | 17785 | 718 | 13494 | 133 | 566340 |
| **Site 1** | 407 | 0 | 68790 | 19839 | 4401 | 32 | 1882 | 0 | 95350 |
| **Site2** | 157 | 11 | 18065 | 7741 | 538 | 12 | 656 | 5 | 27184 |
| **Study area** | 564 | 11 | 86855 | 27580 | 4939 | 44 | 2538 | 5 | 122535 |

Data source: Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

*Table 29: Livestock population/species raised in the study area and Matrouh governorate in 2016.*

| District | Cattle | Buffaloes | Sheep | Goats | Camels | Horses | Donkeys | Mules | Total |
|---|---|---|---|---|---|---|---|---|---|
| **El Hamam** | 6725 | 3700 | 39850 | 9250 | 1050 | 845 | 2225 | 375 | 64020 |
| **El Alamein** | 200 | 0 | 11800 | 9120 | 1650 | 60 | 228 | 0 | 23058 |
| **El Dabaa** | 776 | 0 | 46400 | 13000 | 1600 | 121 | 500 | 0 | 62397 |
| **Siwa** | 499 | 26 | 1814 | 1612 | 0 | 0 | 327 | 0 | 4278 |
| **Sallum** | 100 | 0 | 4500 | 2500 | 700 | 0 | 350 | 0 | 8150 |
| **Barrani** | 131 | 0 | 25632 | 5273 | 1945 | 100 | 2560 | 0 | 35641 |
| **El Negaila** | 425 | 0 | 63200 | 21250 | 4700 | 39 | 1550 | 0 | 91164 |
| **Marsa Matrouh** | 1476 | 0 | 53550 | 14090 | 1036 | 235 | 842 | 30 | 71259 |
| **Matrouh Governorate** | 10332 | 3726 | 246746 | 76095 | 12681 | 1400 | 8582 | 405 | 359967 |
| **Site 1** | 327 | 0 | 51166 | 15805 | 3821 | 67 | 2062 | 0 | 73248 |
| **Site2** | 207 | 0 | 7509 | 1976 | 145 | 33 | 118 | 4 | 9993 |
| **Study area** | 534 | 0 | 58675 | 17781 | 3966 | 100 | 2180 | 4 | 83240 |

Data source: Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

*Table 30:. Livestock population/species in the study area and Matrouh governorate in 2017.*

| District | Cattle | Buffaloes | Sheep | Goats | Camels | Horses | Donkeys | Mules | Total |
|---|---|---|---|---|---|---|---|---|---|
| **El Hamam** | 6798 | 3119 | 51700 | 6800 | 200 | 800 | 3350 | 600 | 73367 |
| **El Alamein** | 145 | 0 | 7000 | 3500 | 550 | 50 | 200 | 0 | 11445 |
| **El Dabaa** | 472 | 0 | 56800 | 7000 | 1190 | 104 | 406 | 0 | 65972 |
| **Siwa** | 710 | 50 | 2030 | 1513 | 35 | 0 | 300 | 0 | 4638 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sallum** | 100 | 0 | 4500 | 2500 | 700 | 0 | 350 | 0 | 8150 |
| **Barrani** | 131 | 0 | 25632 | 5273 | 1945 | 100 | 2560 | 0 | 35641 |
| **El Negaila** | 410 | 0 | 26800 | 3200 | 1143 | 211 | 610 | 0 | 32374 |
| **Marsa Matrouh** | 1229 | 0 | 42360 | 12248 | 739 | 115 | 543 | 0 | 57234 |
| **Matrouh Governorate** | 9995 | 3169 | 216822 | 42034 | 6502 | 1380 | 8319 | 600 | 288821 |
| **Site 1** | 317 | 0 | 27867 | 4252 | 1545 | 177 | 1460 | 0 | 35618.4 |
| **Site2** | 172 | 0 | 5940 | 1718 | 104 | 16 | 76 | 0 | 8025.97 |
| **Study area** | 489 | 0 | 33807 | 5970 | 1649 | 193 | 1536 | 0 | 43644.1 |

Data source: Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

*Table 31:. Livestock population/species in the study area and Matrouh governorate in 2018.*

| District | Cattle | Buffaloes | Sheep | Goats | Camels | Horses | Donkeys | Mules | Total |
|---|---|---|---|---|---|---|---|---|---|
| **El Hamam** | 3725 | 952 | 43834 | 14910 | 1050 | 367 | 1021 | 71 | 65930 |
| **El Alamein** | 90 | 0 | 6000 | 5400 | 1750 | 50 | 95 | 0 | 13385 |
| **El Dabaa** | 539 | 0 | 66710 | 6385 | 2607 | 205 | 363 | 0 | 76809 |
| **Siwa** | 1726 | 162 | 10460 | 6170 | 23 | 34 | 1370 | 6 | 19951 |
| **Sallum** | 261 | 0 | 8310 | 4129 | 1440 | 0 | 312 | 0 | 14452 |
| **Barrani** | 343 | 0 | 47333 | 8709 | 4000 | 18 | 2279 | 0 | 62682 |
| **El Negaila** | 410 | 0 | 36800 | 6000 | 1143 | 211 | 610 | 0 | 45174 |
| **Marsa Matrouh** | 1015 | 64 | 123059 | 52293 | 3631 | 78 | 4455 | 31 | 184626 |
| **Matrouh Governorate** | 8106 | 1178 | 342506 | 103996 | 15644 | 963 | 10505 | 108 | 483006 |
| **Site 1** | 406 | 0 | 43338 | 7480 | 2404 | 143 | 1343 | 0 | 55114 |
| **Site2** | 142 | 9 | 17257 | 7333 | 509 | 11 | 625 | 4 | 25890.3 |
| **Study area** | 548 | 9 | 60595 | 14813 | 2913 | 154 | 1968 | 4 | 81003.4 |

Data source: Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

## Impact of stocking rate in the study area

Appropriate stocking rates of livestock in the rangeland play a fundamental role on soil and water conservation, by adding organic matter to the soil and helping to improve the physical construction and properties of soil and ease of water uptake through the pores in it and increase the ability to retain the nutrients. while overgrazing has a negative impact on the soil, direct (trampling) and indirect by reduction of vegetation cover, (Enne et al.,1998). A high number of grazing animals per specific area may cause soil compaction, surface horizon disruption, reduction in infiltration, development of animal trails. The degree of this impact on a specific site depends on the interaction among vegetation, soil, weather, and animals.

Stocking rate control have a significant impact on short, medium and long term sustainability of rangeland resources. Stocking rate influences both

livestock performance and climatically controlled forage production. Thus, livestock stocking rates are a paramount management decision affect the rangeland economy and resource. Based on that, the local authority and policymakers of rangeland constantly face the problem of balancing animal demands with a fluctuating forage supply. Demand to forage must balance with forage available to gurantee effective convert of forage to animal production while the range production capability is maintained or improved. Timely stocking rate adjustments improve economic benefits and minimize over stocking during drought.

Increasing livestock population is one of the main factors responsible of deteriorate the rangelands and decrease their contribution to animal feed. As a result, livestock production increasingly become dependent on heavy use of feed concentrates, cereal grain, and agricultural by-products. Range degradation is exacerbated by increased wrong practices by uprooting of shrubs /logging/felling trees for fuel wood for cocking and increasing transferr of rangeland to cropping, leading to overutilization of the remaining areas of rangeland (especially areas near the coast) which is highly adapted to the prevailing climatic condition.

Natural grazing is the most valuable natural resource for wildlife as well as livestock feed at both locations since ruminants will convert the pasture fodder into different animal products for human consumption. In the pastoral area, flocks depend on range forage in the grazing season. As mentioned earlier in the report, the rangelands in both sites of the study area have been subjected to, periodic and prolonged droughts, overstocking and soil & land degradation in addition to water scarcity which resulting in the deterioration of the quantity and quality of the available forage.

This resulted in the reduction of rangelands in size and production per area unit as well as the acceleration of soil degradation and radical vegetation

changes. Moreover, under heavy overstocking grazing for long periods, highly palatable and productive genotypes of plants have been lost and disappeared which would narrow the plant genetic resource.

On the other hand, the livestock population raised in the area over the pasture capability/capacity to produce forage during the last decade. Consequently, the stocking rate has drastically increased which resulted in additional grazing pressure on the remaining rangelands. Furthermore, and because of the low productivity of rangelands in most areas, pastoralist plough the best areas of rangeland to grow barley and/or wheat production for summer feed and to reduce the high cost of buying the feed concentrates.

Hence, the cultivated area allocated for orchards, barley, and wheat has significantly expanded at the expense of good rangeland. This phenomenon in addition to, the continuous decrease of the grazing capacity/potentiality of the pasture would have a very detrimental effect on the returns of livestock producers.

Nowadays, livestock fed intensively on range fodder areas for a part of the year, and the rest of the year they are fed on the available feed concentrates, grains, straws and other crop by-products.

Rangeland plants provide a good and free feed resource for livestock, and there is a close relationship between the development of pastoral plants and livestock production (to keep a symbiotic relationship between both of them). Consequently, if we need to develop and promote the livestock production it will be extremely important to pay attention to rangeland plants by using and/or applying modern methods to develop the rangeland, as a result of that rangeland will effectively contribute to solving the problem of feed deficiency during the summer months.

Climate change further increases the risk of producing cereals in marginal lands, pastoralists may be in a position to reclaim these areas. Increasing the designated area for cereal production and decreasing the area for livestock production may be not wise. Cereals need high inputs and irrigation and are therefore unsustainable under desert conditions. Cereal production favors the pockets of rich people but does not enhance food security.

**Current situation of Livestock species.**

## Sheep

Sheep are the most important and dominante species raised in Matrouh Governorate as well as in the study area. Barki sheep is the main breed in all villages in the site area. shee occupy around 70% (90922 heads) of all livestock population during the period 2007-2018, sheep population in the study area distributed in both sites as 67% in site 1 and 33% in site 2 (fig. 27).

The population of sheep showed a fluctuating trend during the period 2007 to 2018, the population in 2007 was around 100000 heads, then increased to reach a peak value in 2015 (123000 heads) then dropped to 58000 in 2017 (Fig. 28)

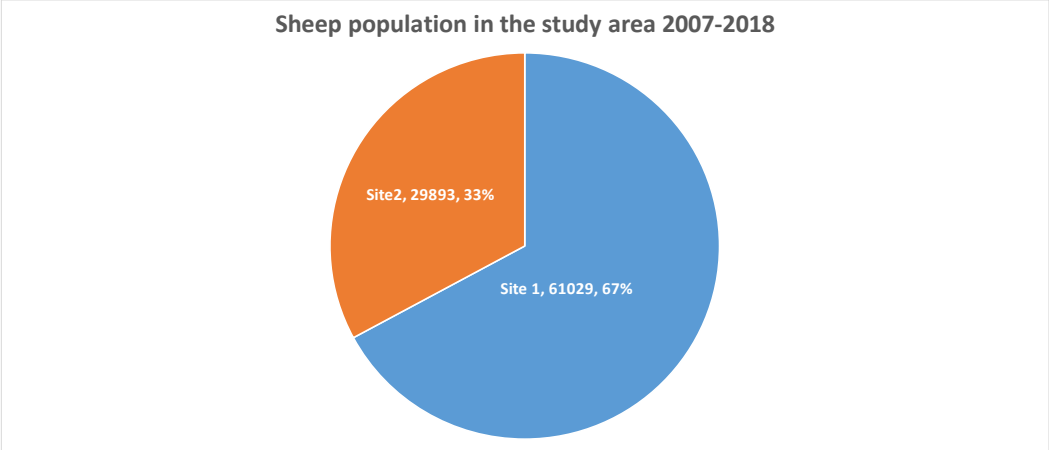



*Figure 27: Mean sheep population raised in the study area during the period 2007-2018.*
Data source: Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

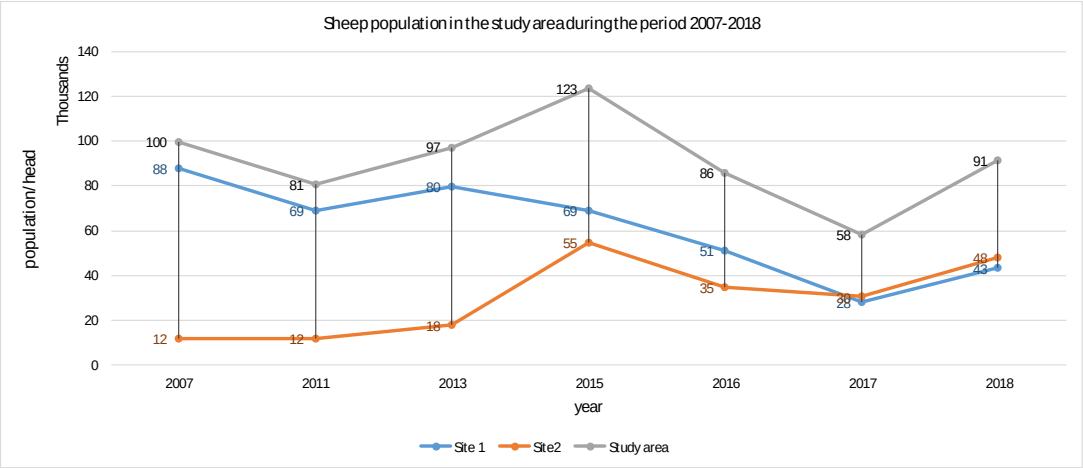



*Figure 28: Population trend of sheep raised in both sites in the study area during the period 2007-2018.*
Data source: Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

Raising sheep in both sites considered the main economic activity of pastoralists living in the area and represent the majority of their income. Rangeland fodder is the main feed source for the livestock population in the rainfall season. However, rangeland has been deteriorated rapidly as a result of drought, poor management, soil degradation, water scarcity and, overgrazing. Consequently, the low productivity of Barki sheep, as well as other local breeds of livestock, is often blamed on low genetic merit. On the other hand, it was clear from our visits to the site area that many sheep animals with high productive performance, some sire rams reached more than 100 kg live body weight with excellent body conformation and good mobility (photos 14, 15 & 16), so we think there is a good opportunity to achieve genetic improvement using appropriate selection program in the herds raised in the study area.

*Photo 14: yearling Barki males in the study area. These males with excellent body weight (70kg) and conformation, good appearance. These males have potential merits to be rams/fathers for the next generations.*

*Photo 15: Barki sheep grazing in the pasture.*

*Photo 16: Barki sheep flock in the backyard.*

Moreover, poor management and inadequate nutrition, diseases are the major constraints preventing the animals from exhibiting their genetic potential. Thus, sheep productivity has been deteriorated as a result of low genetic improvement programs applied, poor feeding especially in the summer season, disease outbreaks, lack of technology applied, poor marketing system and infrastructure. Therefore, there is an urgent need to start an integrated program to improve rangelands and livestock production in the study site and all-district in Matrouh Goverorate. Efforts devoted to improve livestock production are extremely important and would enhance livestock production and in a specific way the possibility to export sheep abroad at relatively higher prices which would contribute to the prosperity of the region.

## Goats

Goats is the second species in numbers raised in Matrouh Governorate as well as in the study area. Barki goat is the main breed in all villages in the site area, with considerable numbers of Barki-Damascus crossbred (photo 17). Recently Barki –Damascus cross animals exist in the study area and have been widely accepted by the livestock keepers, because of its good reproductive and productive traits. Nowadays, Barki –Damascus crossbred goats play an important role by supply the herders with a good quantity of milk as fresh milk or as cheese, which helps them to promote their food security and their health. Goats occupyed 23% of all livestock population during the period 2007-2018. They distributed in both sites as 64% in site 1 and 36% in site 2 (fig. 29).

Goats population showed a fluctuation with a decreasing trend during the period 2007 to 2018, the population ranged between 42908 heads in 2007 and 22063 heads in 2018 with an average 30112 heads (Fig. 30).

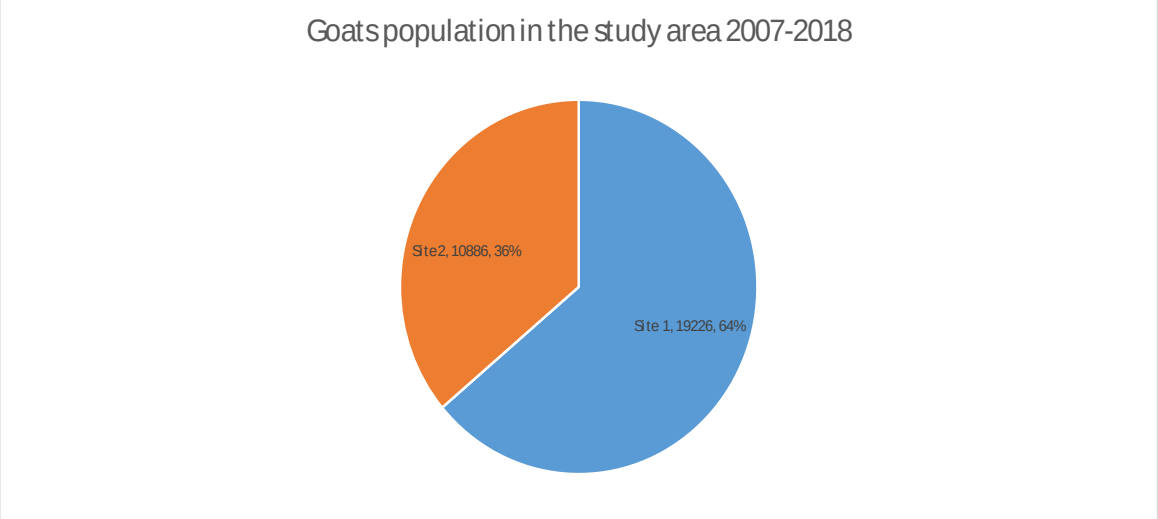



Figure 29: Mean goats population raised in the study area through the period 2007-2018.
Data source: Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

*Photo 17: Goats raised in mixed flocks with sheep in the pasture. Nowadays Barki – Damascus cross goats exist in the study area and have been widely accepted by the livestock keepers.*

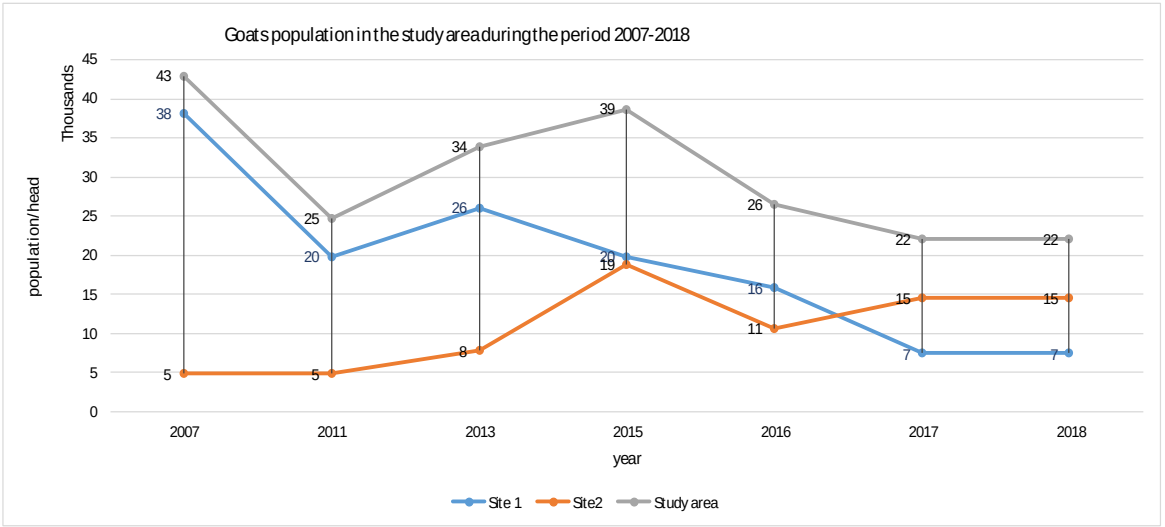



*Figure 30:. Population trend of goats raised in both sites in the study area during the period 2007-2018.*

Data source: Agricultural Directorate,Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

## Camels

Dromedary camels (one-humped) are the third species in population in the study area as well as in Matrouh governorate, but in little numbers compared with sheep and goats. Maghrabi camel is the dominant breed in the rangeland. Camels are used mainly for meat and milk production in adition to textiles (fiber and felt from hair). Also, camels are a vital means of transport for passengers and cargo, especially in the hinterland in the study area and all districts of Matrouh governorate.

Camels occupyed 4% of all livestock population in the study area during the period 2007-2018 and distributed in both sites as 75% in site 1 and 25% in site 2 (fig. 31). The population of camels showed a fluctuation with a decreasing trend during the period from 2007 to 2018, the population ranged between 2457 heads in 2017 and 6662 heads in 2007 with an average 5021 heads during this period (Fig. 32).

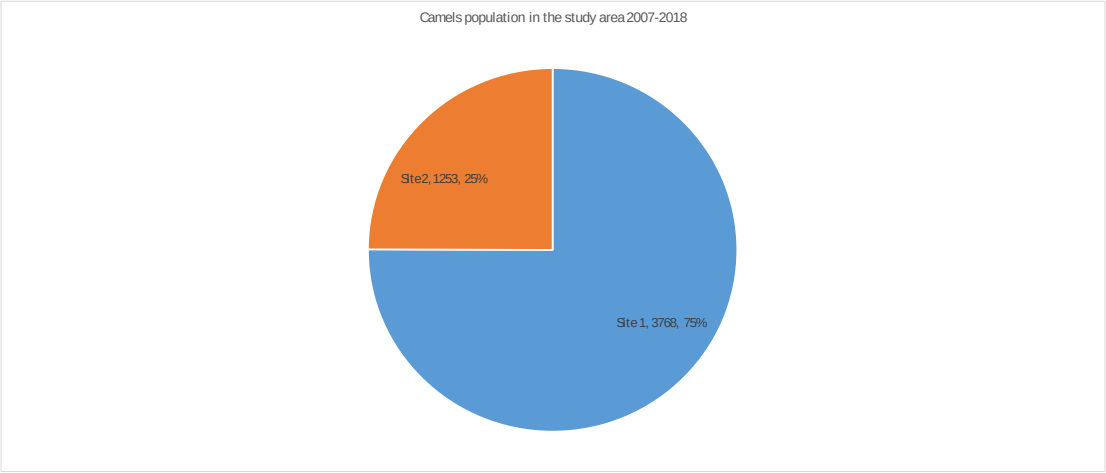



Figure 31: Mean camels population raised in the study area during the period 2007-2018. Data source: Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

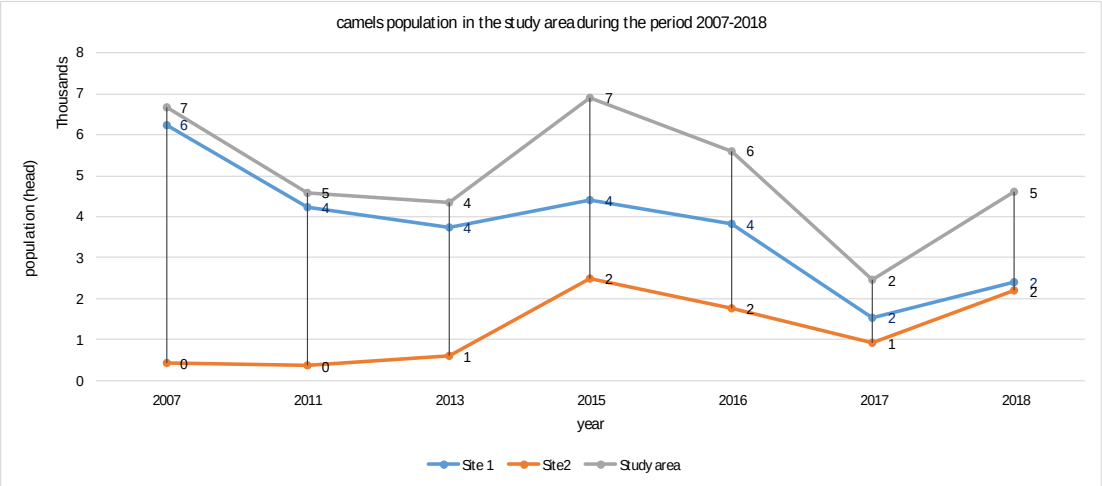



*Figure 32: Population trend of Camels raised in both sites in the study area during the period 2007-2018.*
Data source : Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

## Donkeys

The donkeys are used only as working animals. They are used principally as draught or pack animals. Working donkeys are often owned by those living at or below subsistence levels. The population of donkeys is very little in the governorate and the study area, they represent around 2% of the total livestock population in the study area during the period 2007-2018 and distributed in both sites as 62% in site 1 and 38% in site 2 (fig. 33). The population of camels showed a fluctuation trend during the period from 2007 to 2018, the population ranged between 1934 heads in 2013 and 3265 heads in 2016 and an average during this period 2785 heads (Fig. 34). The breeds raised in the study area is a local breed with no plans for genetic improvement, without any available information about its morphological or productive characteristic/treats, production environment, etc..

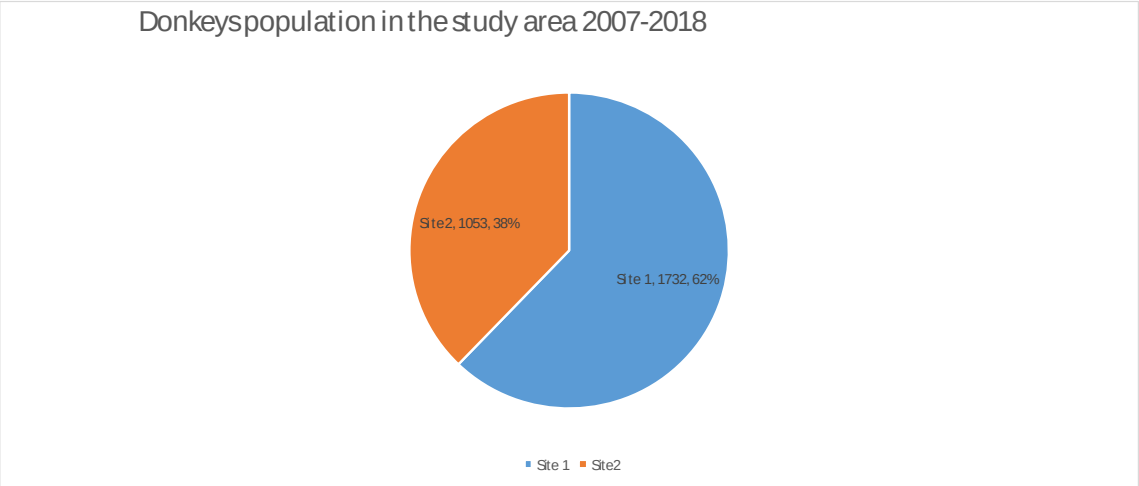



Figure 33: Mean donkeys population raised in the study area during the period 2007-2018.
Data source : Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

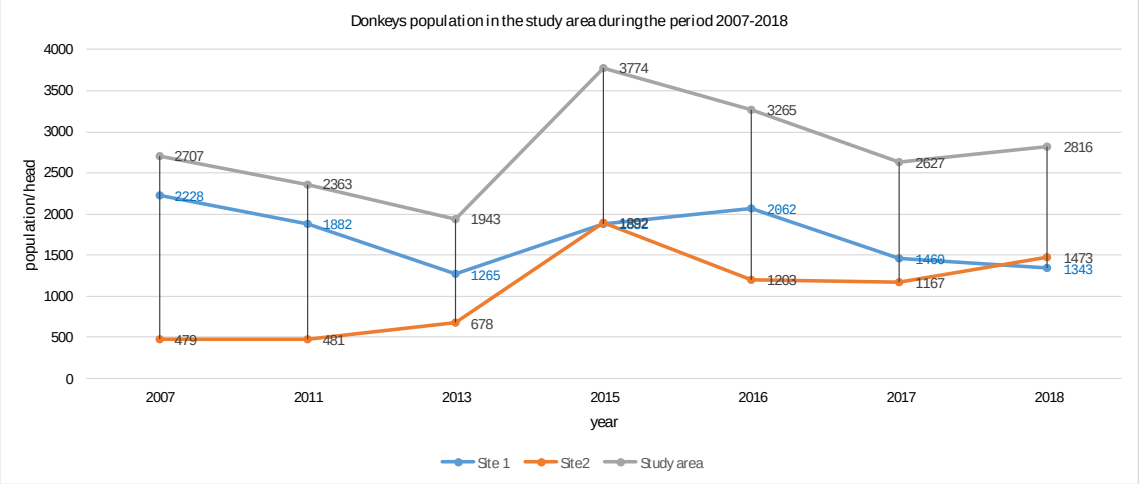



*Figure 34:. Population trend of donkeys raised in both sites in the study area during the period 2007-2018.*
Data source: Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

## Cattle

Cattle population exist in the study area is in very little numbers represents less than 1% of all livestock population in the study area during the period 2007-2018 and distributed in both sites as 72% in site 1 and 28% in site 2 (fig. 35). The population of camels showed a fluctuation with a slight increase trend from 2007 (263 heads) till 2013 (356 heads), then a sharp

increase in the year 2015 (1628 heads) to reach the peak in 2016 (1776 heads) then decreased to 1543 heads in 2018. (Fig. 36).

The main use of cattle is to produce meat and milk, the animal raised is cross breed of Fersian and Baladi cattle breeds. There are very poor data and information about the productive performance, adaption, behavior and other features or parameters of cattle in the study area.

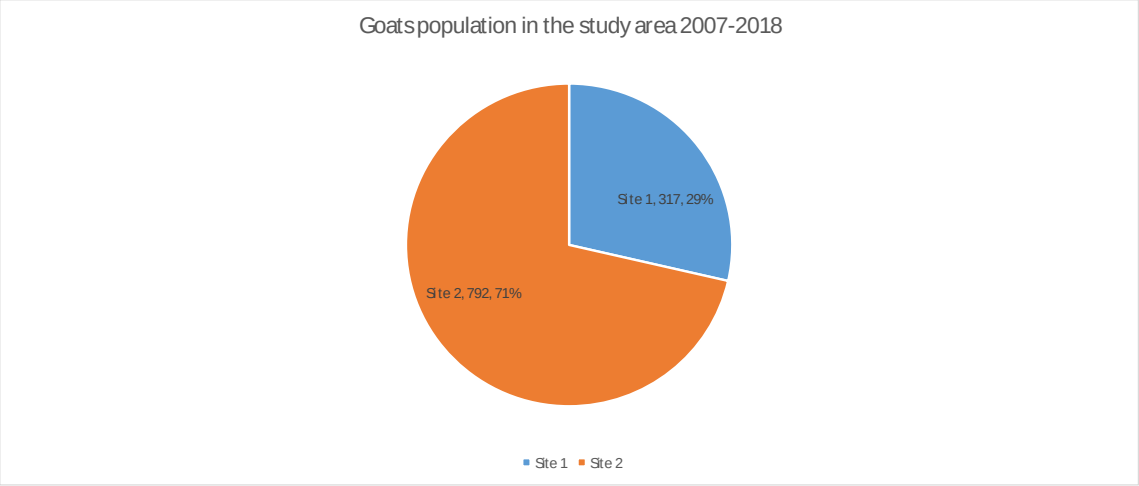



Figure 35:. Mean cattle population raised in the study area during the period 2007-2018.
Data source : Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

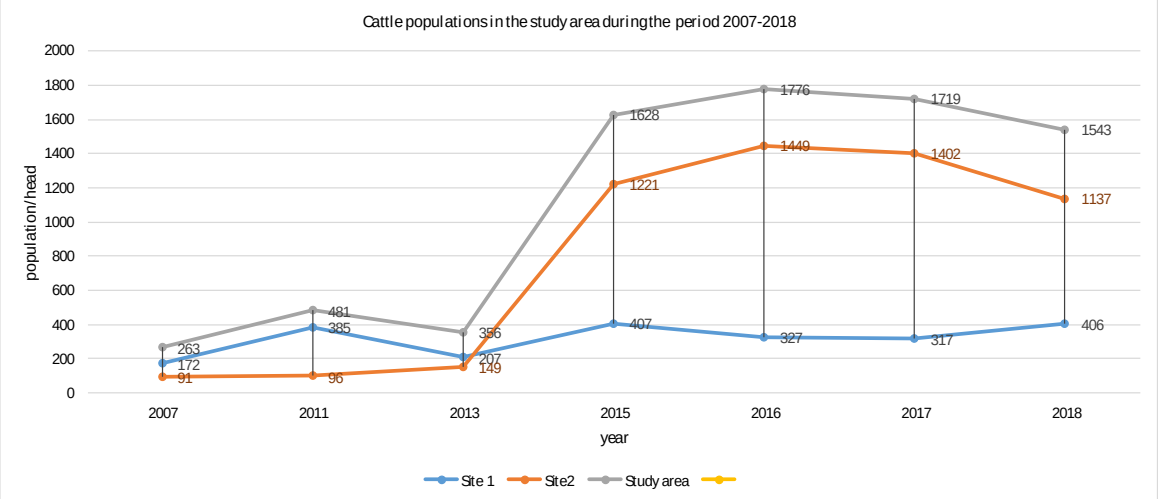



Figure 36: Population trend of cattle raised in both sites in the study area during the period 2007-2018.
Data source : Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

## Buffaloes

Buffaloes raised in the study area are in very minor numbers representing less than 0.20% of all livestock population in the study area during the period 2007-2018, they exist only in site 2 (fig. 37). The population of buffaloes showed an increasing trend from 2007 to 2016 then decreased to 165 heads in 2018 (Fig. 38). The main use of buffaloes is to produce meat and milk, the animal raised is local breeds. As in cattle, also There are very poor data and information about the productive performance, adaption, behavior and other features or parameters of buffaloes in the study area.

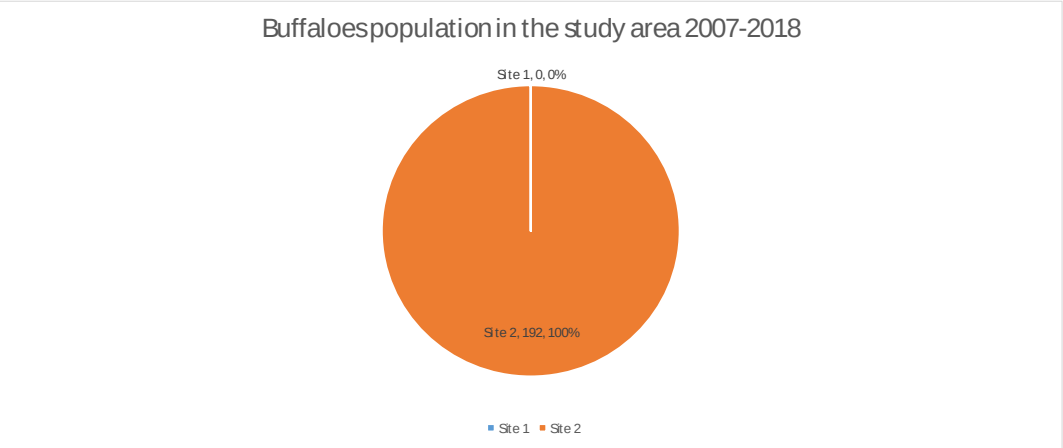



Figure 37: Mean Buffaloes population raised in the study area during the period 2007-2018.

Data source : Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

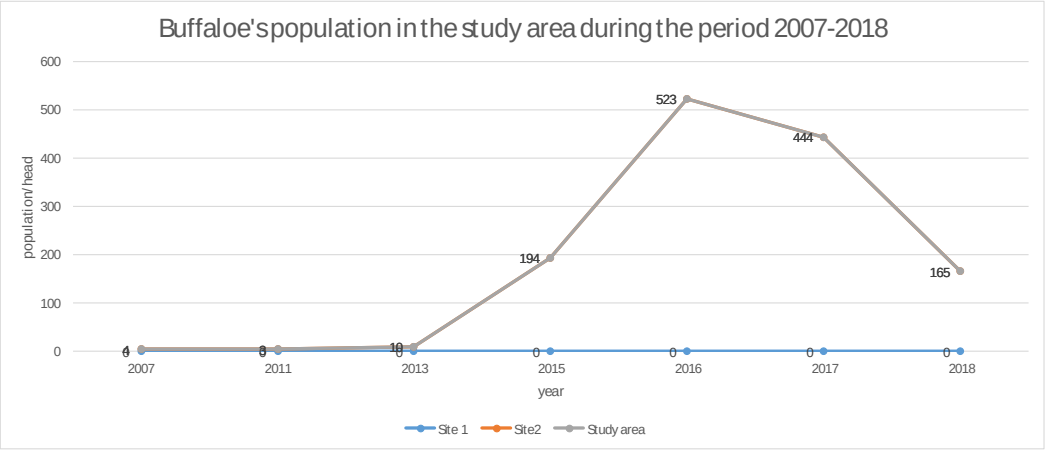



Figure 38:. Population trend of Buffaloes raised in both sites in the study area during the period 2007-2018.

Data source : Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

## Horses

Horses raised in the study area are in very minor numbers represented less than 0.20% of all livestock population in the study area during the period 2007-2018 distributed in both sites as 51% in site 1 and 49% in site 2 (fig. 39). The population of horses show an increasing trend from 2007 (16 head) to 2017 (371 heads) then decreased slightly to 278 heads in 2018 (Fig. 40).

The main use of horses is riding or as draught animals, the animal raised is local breeds. As in cattle and buffaloes, There are very poor data and information about the productive performance, adaption, behavior and other features or parameters of horses in the study area.

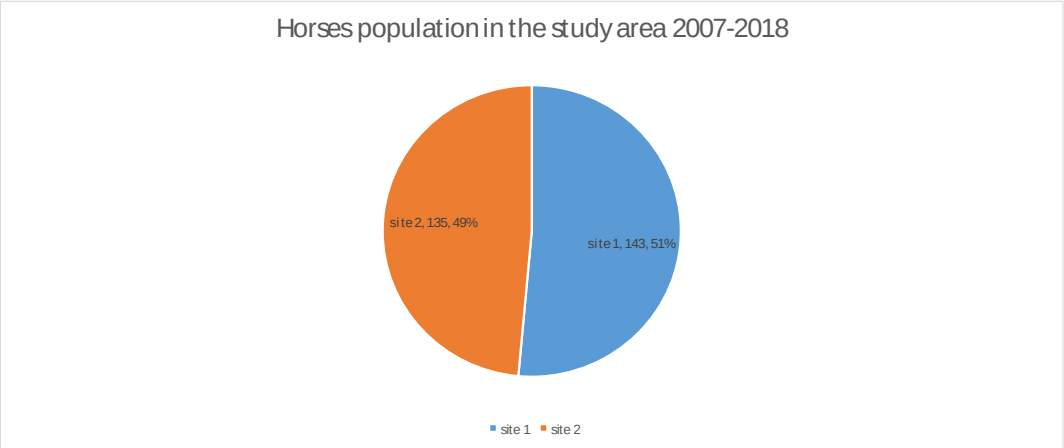



Figure 39: Mean horses population raised in the study area during the period 2007-2018.

Data source : Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

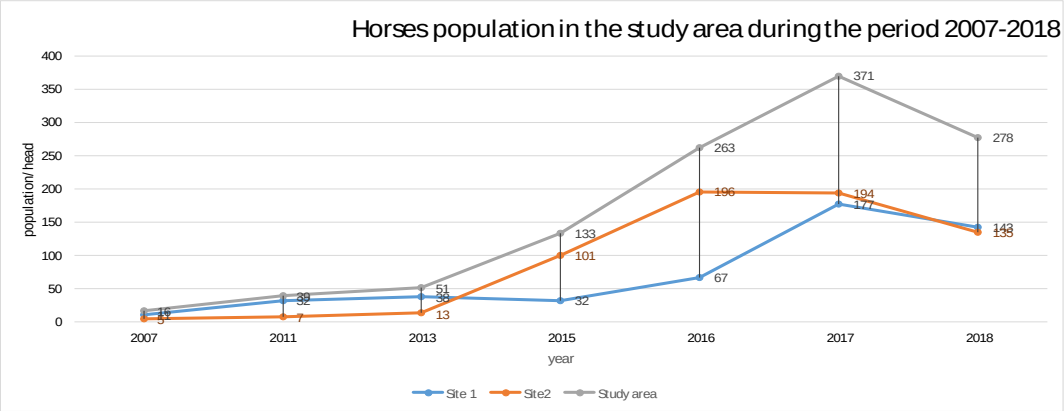



Figure 40:. Population trend of horses raised in both sites in the study area during the period 2007-2018.
Data source : Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

## Mules

Mules raised in the study area are in very minor representing less than 0.02% of all livestock population in the study area during the period 2007-2018 and distributed only in site 2. The population of mules showed an increasing trend from 2007 (2 heads) to 2017 (84 heads) then decreased to 15 heads in 2018 (Fig. 41). Mules are used principally as draught or pack animals.

A As in cattle, buffaloes, and horses, also there are very poor data and information about the productive performance, adaption, behavior and

other features or parameters of mules in the study area.

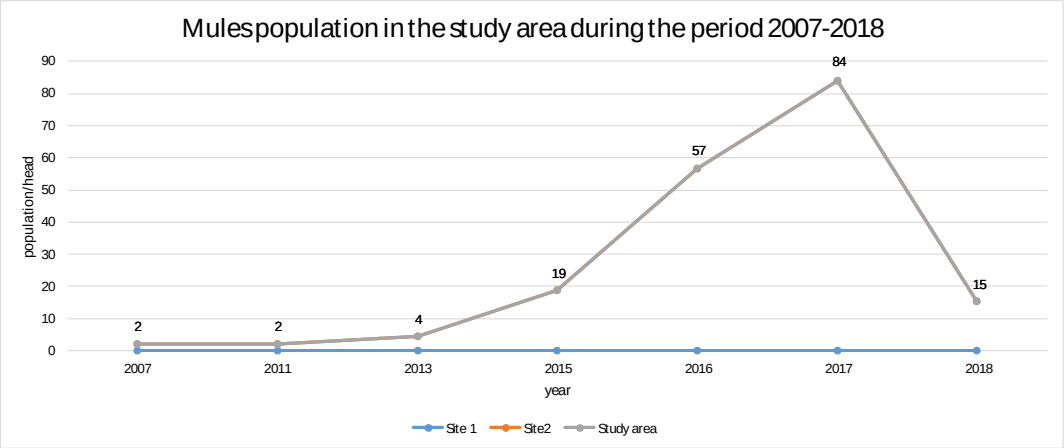



*Figure 41: Population trend of mules raised in both sites in the study area during the period 2007-2018.*
Data source : Agricultural Directorate, Matrouh Governorate, Ministry of Agriculture, Egypt (2019).

## Assessing the current status of farm animal genetic resources (AnGR).

Unfortunately, there is very poor information about the farm animal genetic resources, which leads to the absence of a wholesome vision to manage the Animal genetic resources in the study area in the right way as well as the governorate. The activities of some research institutions were only limited to the morphological, production system. One of the main constrains of conserving these resources that animal population inventory is based on species not on breed base. Furthermore, the lack of monitoring of these breeds made the information static.

Sheep followed by goats are the most common species and the ratio between the two varies with the rain condition and the market. Flock/herd size is between 50 and 200 but it can reach thousands on a few occasions. Lambs are fattened on barley and feed concentrate supplement. Barki sheep and Barki goats are the main breeds raised under agro-pastoral system.

The agro-pastoral ecosystems dominated in the study area are suitable for sustainable indigenous livestock production systems, especially based on local breeds. Pastoralists provide services that have economical and socio-cultural importance to the country. Indigenous livestock breeds can be used by smallholders as a tool against poverty. In addition, livestock activities play multiple roles on reducing vulnerability of fragile environments and their roles on diversification and intensification

**Animal Genetic Resources Management Strategy**

A combined management strategy on the governorate level for both plant and animal genetic resources becomes an urgent need since it is not possible to do that for the study area alone/only. This strategy should be prepared and executed by involving all stakeholders in a participatory approach including the local community representatives. This strategy should include both plants and animals in an integrated approach to avoid clashing between each other, which will help in the balance between the development plans for each, in terms of animal stocking and the status of the vegetation cover. As an example, with long drought seasons, animal stocking rates should be decreased and vice versa.

The following is a proposal for a management strategy to conserve animal genetic resources.

1. Establish an AnGR Advisory Committee.
2. Conduct Resource Assessments regarding AnGR Resource Assessments through the following.
   2.1. Inventory Characterization.
   2.2. Human and Technical Assessment.
   2.3. Livestock Sector Assessment.
   2.4. AnGR Role Assessment.
3. Develop and Implement the Management Strategy and Implement of Action Plans.
   3.1. Advance AnGR Characterization.
   3.2. Species by Species.
   3.3. Training and Capacity Building of Network.
4. Funding and budgeting the activities/programs.

5. Develop a Monitoring Program and prepare progress reports to evaluate animal genetic resources.

Closer collaboration between government and scientists with pastoralists would enhance documentation of the breeds and also support their use. Recognition and participation of pastoral livestock keepers are keys to success.

### Establishing an annual livestock-stocking rate.

Establishing an annual livestock-stocking rate for rangeland is a fundamental factor for efficient rangeland management and restoration plan. On the other hand, it will keep enough forage for feeding livestock in a proper way. Since the Stocking rate affects both livestock performance and climatically controlled forage production. A high number of grazing animals per hectare may cause soil compaction, surface horizon disruption, reduction in infiltration, development of animal trails.

### Moving animal genetic resources as part of climate change adaptation strategies.

Animal genetic resources (AnGR) are important to the subsistence of a large number of people in the world's pastoral and crop-livestock systems, where they also represent an important source of high quality protein and an opportunity for poverty eradication and overall economic development.

Unidirectional cross breeding programs are common in Egypt and in the study area. This is the first threat facing the purity of the local adapted

breeds like Barki goat breed, there is andirectional crossbred program by Damascus goats.

One option for adapting production systems to the effects of climate change is to bring in AnGR that is better adapted to the changed conditions (Pilling and Hoffmann, 2011). These animals are likely to come from production environments where for many years they have been exposed to environmental conditions similar to those now prevailing in the areas to which they are being introduced. If climate change leads to major changes in local agro-ecosystems, at a rate that outstrips the capacity of livestock and their keepers to adapt, such shifts in breed distribution may become increasingly necessary and frequent. Currently, however, the dominant pattern of gene flow on a global scale does not focus on the movement of locally adapted animals into equivalent agro-ecological zones, but on the movement of high-output breeds that need highly controlled production environments. as an example local cattle breeds could perform better than crossbreeds which is exist now in the stud area.

The majority of this gene flow is between the countries of the developed "North" and from the North to the developing "South". The main exception to this pattern during the last hundred years or so has been the movement of tropically adapted cattle from South Asia to Latin America. There have also been some introductions of grazing animals from the South into the hotter parts of developed countries such as Australia and the United States of America (FAO, 2007a).

If development agencies are contemplating introducing a breed into a new area in response to climate change, it is essential that livestock keepers are properly consulted as part of a thorough assessment of the breed's suitability for use in the current and projected future production environment. If the introduction of high-output breeds is being

contemplated, the potential future effects of climate change on the local production environment underline the importance of such assessments (FAO, 2010e).

Another point that should be noted in the context of introducing adapted breeds to new areas is that differences in animal's capacities to thrive in harsh conditions – particularly their feeding behaviour –are not merely matters of genetics but also of learning. Young animals learn from their mothers and other members of the herd or flock (Provenza and Burritt, 1991; Glasser et al., 2009) and in some cases livestock keepers' use specific management practices to promote the development of desirable feeding behaviours among their animals (Krätli, 2008). This is one reason why it is important to maintain AnGR *in situ* in functioning production systems rather than in *ex situ* collections. If international movements of AnGR are required in response to climate change, legal frameworks affecting the import and export of genetic material will come into play (Pilling and Hoffmann, 2011).

**Domestication of new animal species.**

Domesticated animals are considered to be those species that are bred in captivity, and modified from their wild ancestors to make them more useful to humans, who control their reproduction (breeding), care (shelter, protection against predators) and food supply (Diamond, 2002; Mignon-Grasteau, 2005). Animal domestication is a complex and gradual process, which altered the behavioral and morphological characteristics of the ancestral animals.

Among the world's 148 non-carnivorous species weighing more than 45 kg, only 15 have been domesticated. Moreover, only six have become widespread on all continents (cattle, sheep, goats, pigs, horses, and donkeys), while the remaining nine (dromedaries, Bactrian camels, llamas, alpacas, reindeer, water buffalo, yaks, Bali cattle, and mithun) are important in more limited areas of the globe. The proportion is even lower in the case of birds, with only ten species (chickens, domestic ducks, Muscovy ducks, domestic geese, guinea fowl, ostriches, pigeons, quails, and turkeys) currently domesticated out of around 10 000 avian species (FAO,2007).

Although, domestication process is complicated and need long time, it is very important to continue the attempts to domesticate new species especially wild populations (e.g. wild rabbet and deer). Because of their unique adaptive capacity, resistant, tolerance of climate changes and extremes, disease resistant or fluctuating market conditions or changing societal needs.

Gabali Rabbet (Cape Hare) Widespread in North Africa (photo 18). Reproduce 3-4 times per year and give birth to 3-5 offspring. Gabali rabbet wide spread in Egypt (Sinai, North coast, oases of western desert and Eastern desert.

Photo 18: Gabali Rabbet (Cape Hare)

The Gabali Rabbet has highly adaptive characteristics (resistance and tolerance to specific diseases, adaptation to poor-quality diets or to feeding in harsh conditions, and tolerance of climatic extremes especially heat stress). Because of its unique characteristics Animal Production Research Institute, Agriculture Research Center ministry of Agriculture made a successful trail to domesticate the Gabali rabbet.

**Weaknesses in livestock production in the study area.**

Nowadays in the study area; the livestock sector is facing many and hard challenges in many fields. Decision-makers, research institutions and extension services have to support livestock activities to cope at best with the loss of production, unidirectional cross-bred systems, and degradation of pasture area; worsening of animal products, and enlargement of land desertification and the worsening of animal health accompanying the effects of the climate change.

Animal health will be worsening under the effect of climate change, which will increase the occurrence of infectious animal diseases. Occurrence of infectious diseases reduces the stability and resilience of the food supply from livestock, affecting everyone along the production and market chains. They can have four different effects:

- reducing the livestock population through death or culling;
- reducing the productivity of livestock;
- creating market shocks when demand falls and supply contracts in response;

The problems mentioned have been grouped into a number of broad categories as follows:

- Production.
- Feed resources.
- Health care & veterinary.
- Marketing.
- Infrastructure.
- political/institutional.

- environmental.

Problems identified regarding livestock production in the study area presented in table 32.

Table 32: Problems identified regarding livestock production in the study area.

| Type of problem | Specific problem mentioned |
|---|---|
| Production | - Decreasing livestock population because of many reasons (drought, disease outbreaks, high feeding cost, etc.<br>- Lack of suitable land with good vegetation cover for feeding animals.<br>- Poor technology applied in the study area.<br>- Production losses through poor management and internal parasites.<br>-Scientists and policymakers have little knowledge about local feed sources and animal genetic resources to maintain them for making the right policy decisions and establishing good management plans in the rangeland in the study area.<br>- Weak ability to invest in pasture improvement<br>- Lack of genetic tools to select the high genetic merits of animals for production systems.<br>- Little knowledge about local feed sources.<br>- Poor knowledge about the right animal stocking capacity at the rangeland. |
| Feed resources | - Poor quality of rangeland forages at the dry season.<br>- Shortage of feed resources at affordable prices.<br>- Little appreciation of the role of nutrition in production losses. |

| | |
|---|---|
| | - lack of transferring agricultural byproducts to efficient feed resources ( silage making, treatment of straw (physically or chemically), crushing, etc. |
| Health care & veterinary | - Poor veterinary services and disease control.<br>- High animal mortality through infectious diseases.<br>- High Expense of vaccines for some infectious diseases.<br>- Negative effects of diseases both on mortality, reproduction, and productivity.<br>- Pastoralists are reluctant to use vaccines or are unaware of the benefits.<br>- Inadequate and inconsistent supply of vaccines. |
| Marketing | • Poor meat processing and marketing facilities.<br>• Poor marketing systems.<br>• fluctuated/unstable product price.<br>• milk collection and Processing activities have not been developed until now.<br>• a high expense for selling the animals due to payment of high commissions to many middlemen. |
| Infrastructure | - Limited access to capital and loans.<br>- Minimum availability of facilities and extension services.<br>- Inadequate animal health services provided to the animal keepers.<br>- Limited technical support and insufficient proven practical livestock extension |

| | |
|---|---|
| | - There is a general lack of technical knowledge on the application of newer more intensive animal production technologies.<br>- largely inefficiently transport facilities. |
| Political | - Livestock keepers have limited political power and are not well organized to lobby for their rights. |
| Environmental | -Severe degradation in some pasture areas.<br>-Negative effect of climate change.<br>-Long drought seasons<br>-Heat stress in summer season.<br>-Weak ability to adapt to climate change. |
| Political/institutional | Land rights are weak providing little protection to pastoralist communities<br>- Weak bargaining/negotiation power of pastoralists. |

## Existing community land-use practices.

Most of land use practices are subjected to the customary law (URF). It is a set of articles prepared by the tribes versus the official law. The URF law regulates the individual behaviors within the group and among groups, this rules governing those behaviors. Also, it concerns the provisions that are taken against individuals in the event of behavior that violates the group's behavior.

### Document existing governance arrangements among rangeland users.

### Animal health and traditional veterinary treatments

Some herders using garlic cloves by immersing them in the water trough as a nutrient source and anti-organisms to kill the micro-organisms in the water (a way to sterilize water) by using around 20 cloves of raw garlic Wrapped in a piece of cotton cloth then immersing it in the water trough. The herders say that practice reduces the micro-organisms in the water, besides, improving the physical and productive performance of their animals (Photos 19 & 20).

It is well known that Garlic contains compounds with potent medicinal properties. Through ancient history, the garlic main use was for its health and medicinal properties. Most of its health benefits are caused by sulfur compounds also rich in vitamin c, vitamin B6 and manganese. It also contains trace amounts of various other nutrients. based on this information this practice could be effective.

*Photo 19: Herder immerses garlic in the water*

*Photo 20: Prepare garlic cloves in a piece of cloth.*

## Agriculture and grazing

Ali's Suns (Awlad Ali) Tribe follow the custom in the use of pastures like others in the sense of lands where barley is grown that is not owned by individuals but by tribes. Also, anyone pastures a herd in any area of their tribe. In order to benefit from other lands, it is necessary to consult with the elders of this tribe, depending on the success of the commissioners with the elders of this tribe through their peers according to the rules and customs. It was also customary for a whole herd to drink from a well on its way without anyone's approval, but if the use is regular as well as the pastoralism that follows, it requires obtaining approval and even paying the money if requested; the tribal system is still invalid and operates.

According to the article 41 of the traditional law of Ali's Suns (Awlad Ali) Tribe, if animals graze or enter a field at night, the herder guarantees the value of grazing to the owner of the field. However, if animals enter the field or graze during the day, there is no guarantee that the crops should keep during the day by the field’s owner.

## Land ownership

The Egyptian government does not recognize tribal ownership - it describes desert land as wasteland and the state has the right to use it - Law 143 of 1981. The lands were also confiscated by the government for the public benefit. Land ownership is a complex issue that is not related to social dimensions but to environmental factors.

**Water system conservation**

The water scarcity of the area forces the Bedouns of the northwestern area to preserve the water system and regulate the water affars among tribe members. According to the judicial system of the Al-Saadi tribes, anyone is proven to have broken a well or a waterwheel or to backfill it or to throw stones inside it, the perpetrator is obliged to pay twenty golden pounds as a financial penalty to the owner of the property for each well or waterwheel.

**Methods of animal housing and protection**

***Housing***

The majority of livestock shedsare built with limestones blocks obtained from local materials that exist in Matrouh governorate. This animal shed house model are spreading in the study area. The roof is usually made of wood and/or metallic sheets (photo 21).

*Photo 21: Animal shed built by limestone blocks and the roofmade from wood.*

***Protection from wild animals***

The ptotection from the wild animals (wolves) mainly by building fences from limestone blocks and complete the walls and roof with srong metal nets (photo 22).

*Photo 22: keeping and Protection of farm animals from wild animals..*

***Protection from winds***

The open area in the rangeland is characterized by strong winds, herders shelters animals through traditional fences made of Waste plant materials and wooden branches (photo 23) or by build up fences of limestone blocks (photo 24).

*Photo 23: traditional fence to keep and protect the animals from wind.*

*Photo 24: A fence of limestone Blocks for sheep and goats.*

### *Traditional feed and its uses*

Straw of barley and/or wheat is an important feed resource after ending the grazing season in the summer season The livestock keeper cover the straw reserve by a plastic sheet to protect the straw from the wind and rain, also on the top of the plastic sheet there are wild shrubs and rocks to fix the plastic sheet on the straw (Photo 25). Agricultural by-products are a valuable cheap source for feeding flocks at least for six months of the year.

*Photo 25: The straw reserve coverd by a plastic sheet and stones over the sheet .*

Mechanical and chemical treatment methods are used to transform the shape of the by-products into an edible and efficient form. The further addition of supplements can enrich the foodstuffs with the missing nutritional contents. The mechanical treatment method consists of chopping, shredding, grinding, moistening, soaking in water, and steaming under pressure. The mechanical method has been proved to give good results with high digestion by animals but they were never widespread because of high cost and therefore were unfeasible for small farms. Nowadays in the study area, there are some trails to be applied by the agricultural directorate to make demonstration training for the local communities to apply the mechanical and chemical treatments of the agricultural by-products (Photo 26).

Mechanical treatment (chopping) of the agriculture by-products, then the chopping materials will be treated chemically (ammonia or urea) to transfer the by-products to edible and efficient feed for the animals (site 2 of the study area, Marsa Matrouh district, Matrouh governorate, Egypt).

*Photo 26: Mechanical treatments of the agricultural by-products.*

Feed is provided to the flocks in yeards. The yard is usually is simple just a fence and simple animal feeders made of wood for concentrates feedstuffs. After ending the grazing season the livestock keepers have to supply the animals of feed concentrates, grains, bran and agriculture by-products for feeding the animals to overcome the dry season until reaching the next grazing season (Photo 27).

*Photo 27: Sheep yards (pens) near the village at site 1 of the study area, El Negaila district, Matrouh governorate, Egypt.*

Some livestock keepers have more advanced feeding facilities for their flocks. The facility consists of a semi-closed pen to keep the animals, in addition, to open yards surrounded by a fence so the animals can move freely between them according to the climate conditions (Photo 28).

Photo 28: Housing facilities for the sheep flock at site 2 of the study area, El Negaila district, Matrouh governorate, Egypt.

## Rangeland management and restoration

Generally, rangeland management builds on the following basic concepts:

1. Rangeland is a renewable natural resource.
2. That solar energy can be stored by green plants and can only be extracted by animal grazing.
3. The Rangeland provide food, feed and fibre with the use of low-cost energy compared to agricultural lands. Ruminant animals are considered the best animals suitable for feeding on pasture plants.
4. The productivity of rangelands is determined by rainfall level, the characteristics of the soil, topography and climate.
5. There are number of rangeland products that benefit humans including food, fibre, water, picnics, wild animals, minerals and timber.
6. Grazing usually relies on local management systems to achieve sustainable use of wild and domesticated species.
7. Managing grazing lands, especially in the drought areas, is a complex process that requires a balance among the use of water, food, feed, fuel and other materials.
8. When traditional pastoral livelihoods and management practices are replaced or restricted, this is often followed by degradation of local ecosystem services.
9. Many pastoral systems are good examples of applying the ecosystem approach. This approach represents a strategy for the integrated management of land, water and living genetic resources that promotes conservation and sustainable use in an equal manner.

10. In grazing management for the purpose of conserving biodiversity and reducing poverty, it is important to ensure that appropriate policy frameworks are developed to support and preserve local knowledge, innovations and practices.

**Risk Management**

- Pastoral systems actively manage risks (extreme events such as floods, droughts, fires and disease epidemics) thus maintaining a high degree of adaptive capacity.
- In situations where risk management is not practiced and adaptive capacity is eroded, disturbances occur in a cycle of unsustainable use, degradation and poverty.
- The development and support of risk management measures is an important policy tool. The most important method for managing risks is the national union's ALARM Framework for Risk Assessment of the grazing systems.
- Risk management in the pastoral environment should:
    - Benefiting from traditional risk management practices.
    - Provide access to information about the expected risks.
    - Considering the weakness factors as an socio-economic and cultural issue
    - Risk assessment within the framework of ecosystem resilience and adaptation.
    - Considering risks as changing over time.

**Introduction of an early warning system.**

Rangeland restoration efforts should be fostered through the adoption of action plans that address pasture deterioration and climate change issues, and through the development of a national early warning system for

weather forecasts, risk assessment and monitoring of extreme events such as droughts and floods in addition to livestock stocking rate. Establishing an early warning system at the national will increase the efficiency of the restoration process.

**Improving market access**

One of the main challenges to reducing poverty in pastoral and agro-pastoral areas is to ensure that productive goods have sustainable access to markets while maintaining traditional practices and nomadic lifestyles. The marketing of the grazing products (such as dairy products, meat, fiber, etc.) depends on a number of factors including the distance to markets, types of markets (cash versus barter), competition with other producers and demand for products. International trade and tariff systems have been charged for curbing the prices that sponsors expect to obtain from the market and thereby endangering long-term financial sustainability for grazing.

Enforcement access to markets can be supported by:

- Marketing distinctive products;
- Including the sustainability considerations in purchasing decisions;
- Provide support to coordinate the supply chain;
- Facilitating access to credit;
- Capacity building for sponsor producers associations;
- Providing veterinary services to maintain the quality of meat and dairy products.

**Guarantee of land and water rights**

1. The Egyptian government does not recognize tribal ownership - it describes desert land as wasteland and the state has the right to use it - Law 143 of 1981. The lands were also confiscated by the

government for the public benefit. Land ownership is a complex issue that is not related to social dimensions but to environmental factors.

2. Pastoral and agro-pastoral systems depend on sustainable access to land and water resources. When access to these lands is disrupted or usufruct rights are uncertain, overuse and land degradation can often occur
3. Most of the pastoral lands were usually owned in common with institutional, community and governance structures preventing the "public tragedy."
4. Land tenure in the public domain can take many forms: community pastures, community management of high-value lands (such as water sources) or land grants or usufruct rights for traditional presidential bodies that manage land on behalf of the community.
5. Determining individual land ownership can still result in sustainable and productive pastoral systems. When there is a shift away from communal or unspecified land acquisition to individual tenure, some of the following elements must be taken into account:
    - Provisions to facilitate the movement of herds;
    - Equitable division of lands to avoid conflict;
    - Mechanisms to respect women's rights;
    - Legal guidance to local communities to guide them through the process and make them aware of their rights and responsibilities.

**Indigenous and traditional knowledge, innovations and practices**

1. Losing of indigenous and traditional knowledge, innovations and practices can reduce the environmental and economic sustainability of the rangeland.
2. In rangeland management for the purpose of conserving biodiversity and reducing poverty, it is important to ensure that appropriate policy frameworks are developed to support and protect local knowledge, innovations and practices.
3. The Akwé Kon Voluntary Principles of the Convention on Biological Diversity (Convention Secretariat 2004) may be beneficial to the pastoral sector by providing methods and tools to ensure that indigenous and traditional knowledge, innovations and practices do not become extinct as a result of development projects or new policy approaches. Some of these guidelines include:
    a. Establish an agreed process to record the views and concerns of members of the indigenous and local community that may be influencing them;
    b. Identify and provide adequate human, financial, technical and legal resources to ensure the effective participation of the indigenous and local community;
    c. Concluding agreements on mutually agreed terms between the proposed development supporters and the affected indigenous or local communities;
4. Developing a policy to protect, preserve and promote pastoral communities indigenous knowledge and mainstream it into the Governorate's macro-economic framework. Development of the policy will involve identifying, documenting and gathering local traditional knowledge practices from areas including pasture, agriculture, livestock, poultry, housing models, health, culture, and religious beliefs, and then feeding them into a legislative framework.

## Mixed landscapes for conservation and production

Finding a balance between poverty alleviation and the conservation and sustainable use of biological diversity requires a combination of conservation measures and productive activities within the pastoral landscape. Ensuring that these two goals work in synergy, not stirring disputes and conflicts, requires consideration of stakeholder perspectives.

Key management techniques include:

1. Identifying the causes of the conflict:
    - Estimate the effects of different overgrazing on wildlife.
    - Estimate the impact of conservation on the risks for herders.
2. Establishing conflict resolution mechanisms:
    - Ensure that all stakeholders have a voice (including women).
    - Consider the role of mechanisms for settling traditional disputes.
3. Set up solutions for management:
    - Consider regional nomadic needs and ensure a resilience approach to accommodate changing needs in times of flood or drought.
    - Consider options for using shared land and buffer zones.

## Policy entry points for better rangeland management and restoration in the study area.

The primary use of rangelands in the study area is the grazing of natural vegetation by livestock. This form of rangeland use provides the cheapest/free source of feed for livestock. Therefore, the improvement of rangeland management is fundamental for improved livestock production. To sustain the livestock production systems for agro-pastoral communities we have to integrate the available technical, institutional and policy options developed are integrated into a range management scheme that would sustain the production system.

The following is the proposed policy entry points for better management and restoration of rangeland in the study area. Which should be carried out in the short, medium and long development plans/strategies.

### Empowering agro-pastoralists local communities

- One of the most important entry points for the rangeland restoration and better management is empowering pastoralists' local communities; this can be done through the following intervention/mechanisms.
- Involvement pastoralists in the planning and implementation phases of the development plans/project (participatory approach) to ensure that the project is sustainable and answers real and urgent local needs.

1. Formation pastoralist organizations (sheep raising association, goat breed organization, etc.) or producer groups can improve their production, market, and bargaining powers. The main objective of

forming the groups is to target the poorest members of the communities so they can be involved in development activities and gain advantages in economies of scale for input purchases, agricultural crop production, and marketing.

2. Enhancing and promoting the sustainable management of the agro-pastoral resource, which includes agricultural biodiversity, water resources, water and soil conservation, rangeland improvement infrastructure to health and education matters, etc., which correspond to the priority needs of the local community.
3. Collaboration and knowledge sharing among pastoralists can help strengthen their community's capacity for long-term rural development. Knowledge can be gained from modern, scientific research and from the experience of local rural populations.

**Establishmentof environmental pastoral Protectorates (reserves):**

The establishment of pastoral protectorates enable the improvement and sustainable use of the rangeland ecosystem under the supervision of the Ministry of Environment. It will help in:

1. Preserving some distinct pastoral environments that have a special significance.
2. Preserving some rare or endangered plant and/or animal species that have special value.
3. Improving the quantity and quality of pastoral production.
4. Research and Studies.
5. Some of them serve as feed forage for grazing during the dry years.

**Mainstreaming of rangeland restoration and conservation strategies within national and regional development plans**

The mainstreaming of rangeland restoration and conservation, as well as, climate change strategies within Matrouh governorate and national development action plans needs to be fostered.

There is a need for governorate/national policies that provide clear guidelines for integration and implementation of strategies, plans, programs, actions, and activities. Governorate and national economic policies need to be reviewed to ensure that they build the resilience of the poor pastoral members and enhancing their capacity to adapt to the impacts of rangeland deterioration.

**Support natural resources conservation activities.**

Supporting the activities dealing with natural resources conservation activities such as water harvest and rational use, restoration of native grazing species, protect local animal breeds are vital activity sustainable of the rangeland ecosystem.

**Adaptation Technical option (Newly adapted techniques and technologies)**

Technology has a significant role to play in tackling the causes of rangeland deterioration and helping pastoralists adapt to its negative impact. We can develop new, cleaner technologies and breed plants and animals more able to tolerate climate variability and pasture deterioration. A major push in research and development, information exchange, extension, and training, is needed to create farming systems that are more resilient.

Adapting new techniques and technologies offer an efficient solution. Pasture communities in the study area have to develop these jointly. Partnerships with research institutions and extension service centers, non-governmental organizations and private companies will be of utmost importance. As an example, options for alleviating heat stress on summer season include adjusting animals' diets to minimize diet-induced thermogenesis (low fibbers and low protein) or by increasing nutrient concentration in the feed to compensate for lower intake; taking measures to protect the animals from excessive heat load or enhance heat loss from their bodies; or genetic selection for heat tolerance or bringing in types of animals that already have good heat tolerance.

Several other techniques have the potential to effectively alleviate the pressure applied to rangelands. Supplementation is a common practice in the region. Unfortunately, the high cost of conventional feed concentrates prohibits their wide-scale use, especially by small animal keepers. Therefore, it is necessary to find alternative supplements to improve nutrition and thus the productivity of small ruminants. The practice of feed block is gaining popularity.

**Legislations, regulations and strategy for the management and sustainable development of rangeland.**

Objectives, membership, managing and administration systems must accurately and clearly legislate permitting to fairly implement Herders' right on legal frame. Members of herders' associations must include different stakeholders. Right now there is any legislation, regulation and

strategy for the management and sustainable development of rangeland of Egypt. A new proposed legislation must address the following:

- Sustainable management of rangeland.
- Integrate rangeland resources into protected areas legislation.
- Establish customary law council to protect the rights of communities and pastoral communities indigenous knowledge.
- Protect IPRs over wild and cultivated material of rangeland.
- Regulate access to GRs
- Provide incentives to herders to maintain biodiversity, environmental system and promote production.

## Conclusion

Over the last decades, the agro-pastoral systems in the northwestern coastal zone and the study area have faced increasing pressures including strong demographic growth, urbanization, increasing demand for animal and plant products, long drought

seasons, disease outbreaks, poor marketing and infrastructure, climate changes, high competition for land and water and etc.

The primary use of rangelands in the study area is grazing on natural vegetation by livestock. Therefore, the improvement of rangeland management is fundamental for improving livestock production. In this context, pressure on biomass to feed livestock flocks raises many challenges and sometimes high competition in the trade-offs of the use of the rangeland resources (water, land, and nutrients) that can affect the sustainable development of these systems. Meanwhile, the synergies between livestock production and cropping offer many opportunities for a sustainable increase in production, notably by raising productivity and improving resource use efficiency for both households and territories.

At present, with the challenges and risks facing rangeland in the study area, natural resources need to be maintained and conserved, through improved watershed management, soil conservation in sloping lands and improved range management in pastoral areas. That can be achieved through strengthening local resource-user groups; introduce new technologies, better care and management of the livestock sector; health better management practices; and improved long-term policies, targeting to reach sustainable resource management.

Unfortunately, There was very poor data and information about the productive performance, adaption, behavior and other features or parameters of cattle, buffaloes, donkeys, and mules. Also, there is very poor information about the plant and farm animal genetic resources, which leads to the absence of a wholesome vision to manage the plant and animal genetic resources in the study area in the right way. A combined management strategy for both plant and animal genetic resources becomes an urgent need.

Decision-makers, research institutions, and extension services have to support rangeland activities to cope at best with these challenges and weaknesses such as establishing management strategy for animal and plant genetic resources, establishing an annual livestock-stocking rate, Moving animal genetic resources as part of climate change adaptation strategies, Domestication of new animal species able to withstand climate changes.

On the other hand, there is an urgent need for policy entry points for better management and restoration of rangeland in the study area. Which should be carried out in the short, medium and long development plans/strategies. 1)Empowering pastoralists local communities, 2)Establishments of environmental pastoral Protectorates, 3)Mainstreaming of rangeland restoration and conservation strategies within national and regional development plans, 4) Support natural resources conservation activities, 5) Adaptation Technical option, and 6) Legislations, regulations and strategy for the management and sustainable development of rangeland.

Rangeland restoration efforts should be fostered through the adoption of action plans that address pasture deterioration and climate change issues,

and through the development of a national early warning system for weather forecasts, risk assessment and monitoring of extreme events such as droughts and floods in addition to livestock stocking rate, Improving market access, Guarantee of land and water rights protecting and promoting Indigenous and traditional knowledge, innovations and practices.

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