SOCIO-ECONOMIC STUDY OF THE COASTAL AND MARINE AREA OF THE GULF OF SIRTE

This publication has been produced within the framework of the IMAP-MPA project implemented by the UNEP/MAP-Barcelona Convention with the financial support of the European Union. Its contents are the sole responsibility of SPA/RAC and do not necessarily reflect the views of the European Union.

In charge of the study at SPA/RAC
Mr. Atef LIMAM, IMAP/MPA Project Officer - MPA component
Mr. Wassim GAIDI, IMAP/MPA Project Consultant-Assistant

In charge of the study at the Ministry of Environment
Mr. Elmaki Ayad ELAGEEL, Director of Nature Conservation Department Ministry of Environment – Libya
Mr. Salih DIRYAQ, Head of the local administration of the Environment in Sirte

Consultant in charge of the study
Mr. Almokhtar SAIED

For bibliographic purposes, this document may be cited as:
SPA/RAC–UN Environment/MAP, 2021. Socio-economic study of the coastal and marine area of the Gulf of Sirte. By Almokhtar Saied, Salih Diryaq and Atef Limam. Ed SPA/RAC. IMAP-MPA Project, Tunis. 74 pages + annexes.

Cover photos credit:
© Bashar Shglila

The present report has been prepared in the framework of the IMAP-MPA project financed by the European Union.

Available from
www.spa-rac.org

SOCIO-ECONOMIC STUDY OF THE COASTAL AND MARINE AREA OF THE GULF OF SIRTE

List of Contents

Executive summary 1

Introduction 2

2. Methodology 4

2.1 Field Methods 4

2.2 Secondary data 4

2.3 Primary data 4

2.4 Data analysis 5

3. Territorial Dynamics 5

3.1. Historical development 5

3.2. Geographical location 8

3.3. climate 9

3.4. Oceanography 10

3.5. Water and groundwater sources 12

3.5.1 Water consumption in Sirte 13

3.5.2 Sewage water treatment 14

3.6 Landscape 15

3.7 Industry 16

3.7.1. Oil production 17

3.8 Biodiversity 18

3.8.1 Fossil Studies 18

3.8.2 Vegetation 20

3.8.3 birds 23

3.8.4 Alien species 24

3.8.5 Sea turtles 24

3.9 Tourism 26

4. Economic activities and Livelihoods 27

4.1 Population development in the region: 27

4.2 Education 29

4.3 Agriculture 30

4.3.1 The artificial River 32

4.4 Land use in the city of Sirte 35

4.4.1. Residential use 35

4.4.3. Hygienic use 36

4.4.4. Administrative and service use 36

4.4.5. Industrial use 36

4.4.6. Commercial use 37
4.4.7. Transport services 37
4.4.8. Recreational use 37
4.5 Environment 37
4.5.1. Desertification 37
4.5.2. Municipal Solid Waste 38
4.5.3. Environmental awareness 40
4.6 Cultural value 41
5- Results: 44
5.1 Key Informants Interviews 44
5.2. women's role in the society 45
5.3. The environmental state of the Gulf of Sirte 45
5.4. Survey methodology 46
5.5. Age Categories 47
5.6. Family members 49
5.7. Fishing Experience 51
5.8. Factors affecting the selection of the fishing area 51
5.9. Main targeted species of fish: 56
5.10. Annual quantities for the main species: 59
5.10.1. Annual quantities for Professional fishermen 59
5.10.2. . Annual amounts for recreational fishermen 61
5.10.3. Main types of diving fishers: 62
5.11. Impact of the proposed marine Protected area on fishing activity 63
5.12. The impact of the proposed Marine Protected area 65
5.13 Hotspot areas in the Gulf of Sirte 66
6. Recommendations 69
6.1. community awareness Promotion 69
6.2. Empowering women in society and enhancing their role: 69
6.3. Development of research and scientific centers 69
6.4. Local maritime decisions and laws 70
6.5. Supporting and improving livelihoods for fishers 70
6.6. Protecting ecosystems 70
References 72
Appendices 75

List of acronyms

ARC	Agricultural Research Centre
BSC	Bureau of Statistics and Census
DG NEAR	Directorate General for Neighbourhood and Enlargement Negotiations
EcAp	Ecosystem Approach
EE	Environmental Education
EGA	Environmental General Authority
ENI	European Neighbourhood Instrument
EU	European Union
GAC	General Authority for Culture
GES	Good Environmental Status
GIA	General Information Authority
GMMRA	Man-made River Authority
GMMRP	Man-Made River Project
GMRWUA	Man-made River Water Utilization Authority
IMAP	Integration of the Monitoring and Assessment Programme
IRC	Industrial Research Centre
KIIs	Key Informants Interviews
LNMC	Libyan National Meteorological Centre
LOOPS	Libyan Organization for Policies and Strategies
MAP	Mediterranean Action Plan
MED POL	Marine Pollution in the Mediterranean Region
MPAs	Marine Protected Areas
MSW	Municipal Solid Waste
SPA/RAC	Specially Protected Areas Regional Activity Centre
UNEP	United Nations Environment Programme
UPA	Urban Planning Authority
WHO	World Health Organization

List of Tables

Table 1. Average temperature, relative humidity, wind speed and rain amount in Sirte from 2005 to 2009 9
Table 2. Dams in Sirte region 13
Table 3. Transformative Industries in Sirte city 2006. 16
Table 4 The production of gas in Libya and its uses during 2005 and 2006. 17
Table. 5. Plant species in Swawa (To be checked!) 21
Table. 6 nesting activity of the *Caretta caretta* on the Thalatheen and Gbaiba beaches 24
Table. 7 Number of nests and hatching success west of Sirte in 2017. 25
Table. 8 Number of nests and hatching success west of Sirte in 2018. 25
Table 9. Number of nests and hatching success west of Sirte in 2019. 26
Table 10. Tourist attractions in Sirte. 27
Table 11. Number of hotels in Sirte. 27
Table 12. The Population and Growth 28
Table 13. Number of students and teachers in primary and secondary schools. 29
Table. 14 Number of students at the University of Sirte (2014 -2015) 30
Table 15. Number of Staff at the University of Sirte (2014 -2015) 30
Table. 16 The total production in the agricultural sector in the Sirte region (2005) 31
Table. 17 The area of Rainfall lands and Irrigated lands in Sirte region (1974 – 2007). 31
Table 18. large farm projects and agricultural projects. 34
Table. 19 groundwater level in Al-Thalatheen region 38
Table 20. analysis of ground water samples from Al-Thalatheen region. 38
Table 21. Current Waste Generation Per Capita in NA Countries 39
Table 22. estimation of the percentages of MSW components in Sirte 39
Table 23. Boats in Tripoli, Sirte and Green Mountain 43
Table 24. Central and primary Health Care Centers in Sirte 44
Table 25. Private and Government participatory Clinics in Sirte 44
Table 26. the number of KIIs according to their institutions 44
Table 27. the role of women in the sectors 45
Table 28. the age variable of Fishers 47
Table 29. fishers age groups 48
Table 30. Distribution of the number of family members according to groups 50
Table 31. Fishing experience 51
Table 32. Factors affecting the selection of the fishing area 52
Table 33. coordinates of influencing factors 53
Table. 34 The factors affecting the selection of the fishing area for diving fishers 55
Table. 35 The main species targeted by fishers in the Sirte region 58
Table 36 Average annual quantities of the main target species 59
Table. 37 Average annual quantities of the main target species (recreational fishers) 61
Table 38 Average quantities of the main species targeted by diving fishers 62
Table 39 fisher's expectations about the impact of the proposed reserve on their fishing activity. 63
Table. 40 Five points Likert scale 64
Table 41 Fisher's expectations about the effect of the proposed reserve on fishing activity by type of fishing 64
Table 42 Cronbach alpha coefficient of reliability 65
Table 43 mean responses about the impacts of marine protected areas 65
Table 44 Frequencies of responses on the impacts of marine protected areas. 66

List of Figures

Figure 1 : Saffron Palace. (Photo. © General Authority for Culture (Sirte Office) 7
Figure 2. Bathymetric Chart of the gulf of Sirte. (Source: Geological researches & mining department, Industrial Research Centre "IRC" Libya) 12
Figure 3. water basins in the planning sub-region of Sirte 12
Figure 4. The study team visits the sewage treatment plant. (Photo.©.SPA/RAC. A. Saied, 2020) 15
Figure 5. Aerial view of Sirte city. (Photo.©. A. Hammadi, 2018) 15
Figure. 6 Geographic location of the Sahabi paleontological locality. Artwork by D. A. Iurino. 18
Figure 7 skull of Crocodylus checchiai 19
Figure. 9. Cheetah (Acinonyx jubatus) 20
Figure. 8. Caracal lynx (Felis caracal) 20
Figure. 10. Swawa Area Location 21
Figure 11. Archaeological site in the Giza district. 26
Figure 12. The 5 phases of the Great Man-Made River Project (GMRP). 33
Figure 13. Subsurface water potential of basins in eastern Libya compared with the volume of the great lakes. (CIA. A research paper declassified in part. 1987) 33
Figure 14. Aerial view of the large Al-Qordhabiya reservoir. (Google Earth imagery) 34
Figure 15. Public landfill for the city of Sirte. 39
Figure 16. Education activities in Sirte schools. (Photo.©. S.Diryaq. LibSTP) 40
Figure 17. Education activities on beach in Sirte. (Photo.©.A.Alhrary: LibSTP) 41
Figure. 18 normal distribution of the ages of fishermen 48
Figure 19. the normal distribution of the ages of fishers 48
Figure 20. The direct relationship between the number of fishers and their age groups 49
Figure 21 Distribution of the number of family members 50
Figure 22. Number of family members by categories 51
Figure 23. linear fit data 54
Figure 24. Factors affecting the selection of the fishing area 54
Figure 25 Factors affecting the selection of the fishing area according to the type of fishing 55
Figure. 26 Distribution of factors affecting the choice of work area for diving fishermen 56
Figure 27 The main target species according to the fishing type 62
Figure 28 the data box diagram for the average annual weight of the main target species 60
Figure 29 Annual quantities of the main target species 61
Figure. 30 The average annual weight of the main target species (recreational fishers) 62
Figure 31 Average weight of the main species targeted by diving fishermen 63
Figure 32 Fisher's expectations of the impact of the proposed reserve on fishing activity according to their numbers and type of fishing 65
Figure 33 group interviews with local comunity in Thalatheen area 67
Figure 34 Lewaija area 68
Figure 35 Ras Al-Ghara 68

Executive summary

The socio-economic study of the Gulf of Sirte coast aims to help stakeholders and local people understand the means of sustainable management of the Marine Protected Area (MPA) and guide them towards optimal dealing with coastal and marine ecosystems in a way that achieves mutual benefits and reduces negative impacts on the ecosystem.

In order to gain access to the largest possible amount of data and information, the study included several different and parallel aspects at the same time, such as collecting, sorting and analysing quantitative and qualitative data through interviews with stakeholders and local partners, where 21 interviews were conducted with those involved in the management of coastal and marine economic resources, and secondary data were collected, sorted, reviewed and evaluated, and group interviews were conducted with 24 active local comunities in the vicinity of the proposed MPA to discuss ways to develop economic conditions in light of the positive impact of the MPA on the area. As for the preliminary data, the focus was on the marine fishing sector by distributing 48 questionnaires in a personal distribution method in order to collect the complete respones in a short period of time, to clarify any queries and to revealany ambiguities related to the questions to the respondents in addition to clarifying the subject of the study to the respondents and motivating them to give honest answers that serve the objectives of the research with all objectivity. The questionnaires were analysed and looked for positive and negative correlations and relationships, focusing on the aspects that serve the study and its objective.

The personal distribution of the questionnaire gave the researchers an opportunity to meet the fishers, to collect secondary data, to understand the relationship between fishers and marine ecosystems, as well as to understand the main problems facing the marine fishing sector. Through the information, data and questionnaires, the environmental condition of the Sirte coast and its marine depth can be diagnosed as a region rich in economic species. It is also characterised by an abundance of important species such as cartilages and molluscs, in addition to the beaches of Sirte, which are considered one of the most important beaches in the Mediterranean for sea turtles nesting (Caretta caretta).

The presence of marshes scattered along the Gulf coast, such as the marsh of Tawergha, the marsh of Al-Hesha and Al-Washka, the marsh of Al-Khamseen, the marsh of Sultan, the Red Valley, and others, which make the region an important area for migratory birds and rich in endemic species. However, in the other side, is the spread of illegal hunting, such as the use explosives and sea dredges, and the failure to apply the hunting legislation in light of the conditions the country is going through, which has increased the suffering of the marine fishing sector, as the cost of fishing equipment has quadrupled compared to years ago due to the economic crisis associated with the ongoing wars.

In addition to fishing, the Sirte region is a promising area in a number of sectors such as tourism, as it has clean and rich beaches that can be used for ecotourism if properly managed , along with the ancient city of Sultan, the archaeological region of Garza, the reservoir of Al-Qordabiya artificial river reservoir and others, and this is what makes The city could have important economic potential if it is properly exploited with the participation of all spectrums of society, including women, and encouraging them to enter the labour market and Marine Protected Area their place in various professions, including leadership positions.

Introduction

The Specially Protected Areas Regional Activity Centre (SPA/RAC) of the Mediterranean Action Plan (UNEP/MAP) has been designated as co-executing agency in the framework of the regional project "Towards achieving the good environmental status of the Mediterranean Sea and coast through an ecologically representative and efficiently managed and monitored network of marine protected areas" ("IMAP-MPA Project"). The "IMAP-MPA" Project is funded by the European Union (EU) - Directorate General for Neighbourhood and Enlargement Negotiations (DG NEAR) and the European Financial Instrument of the 2018-2022 Green MED III: The European Neighbourhood Instrument (ENI) South, for Water and Environment. It is coordinated and implemented by the UNEP/MAP Secretariat and executed through its Programme for Assessment and Control of Marine Pollution in the Mediterranean Region (MED POL) and the Regional Activity Centre for Specially Protected Areas (SPA/RAC) for the benefit of six countries (Algeria, Egypt, Lebanon, Libya, Morocco and Tunisia) with regards to the MPA component exclusively executed by SPA/RAC.

The IMAP-MPA Project aims at contributing to the achievement of the Good Environmental Status (GES) of the Mediterranean Sea and coasts. Thus, it proposes to consolidate, integrate, and strengthen the Ecosystem Approach (EcAp) for the management of Marine Protected Areas (MPAs) and their sustainable development, which will be achieved by monitoring and assessing the ecological status of the Mediterranean Sea and its coastline, including MPAs, in a comparative and integrated manner.

More specifically, the project aims at improving MPA management through the coordinated implementation of the Barcelona Convention Roadmap for a comprehensive and coherent network of well-managed MPAs to achieve Aichi Target 11 in the Mediterranean and to strengthen the integration of the Monitoring and Assessment Programme (IMAP) into this process. Hence, it will consolidate and further develop the Mediterranean network of ecologically representative, interconnected and effectively managed and monitored MPAs, through the improvement of national biodiversity governance and policies; the preparation and implementation of MPA management plans and the improvement of MPA management with targeted actions.

In Libya, SPA/RAC has collaborated with the Environmental General Authority (EGA) in the elaboration of the national strategy for the development of an MPA network. This strategy has already listed the Gulf of Sirte as a potential site to be declared as MPA. The current project will therefore support the elaboration of the management and business plans of the Gulf of Sirte. Besides its high conservation value, the proposed area is one of the most important nesting sites for the loggerhead sea turtle in Libya and in the Mediterranean.

It is worth mentioning that SPA/RAC and EGA will collaborate together and lead the elaboration of the management plan of the future MPA of gulf of Sirte, in a participatory and concerted process. This process will be jointly carried out with the national authorities responsible for protected areas and in consultation with other relevant governmental bodies, civil society and socio-professional and economic actors, based on national/local consultation approach and process. It will be based on running complementary ecological and socio-economic studies, to ensure that the final versions of the management plans will be produced and will consider both conservation objectives and the requirement that the future marine protected area needs to be integrated within its economic and social environment. For that

purpose, SPA/RAC and EGA have launched a study aiming at drafting a socioeconomic assessment of the coastal and marine environment of the Gulf of Sirte.

2. Methodology

The study report responds to several questions about the dynamics of the region's socio-economic relations, such as human activities and resource use, land evaluation, land use planning and resource management, the effects of local, national and regional development projects on the annual income of local community and employment methodologies, and the relationships and overlaps between planning and decision-making tools in the region.

The study methodology was based on a strategy of combining primary and secondary data. The primary data were collected by researchers using to models, interviews and questionnaires designed to provide data that lead to forming a clear picture of the relationship between the social characteristics of the study area and the economic sectors with a focus on sea fishing and coastal economic activities. As for the secondary data, they were collected by researchers from previous studies of the region or from governmental or non-governmental centres and agencies through official statistics, local government documents, in addition to the technical reports from many institutions and research activities. The quality of the collected documents and updated information is assessed through field visits including interviews and meetings in the study area.

2.1 Field Methods

The methodology of the study combines quantitative and qualitative research methods. The quantitative research is based on the statistical method in collecting and analysing information through questionnaires that have been reviewed and to ensure their objectivity using measures of validity and consistency, and to understand and study the relationship between the various variables in order to choose the hypotheses that have been identified from the beginning, then we reach the stage of collecting, arranging and analysing data for statistical analysis to achieve the desired results. As for qualitative research, it depended on the exploration of behaviours and experiences using several methods such as interviews, observation, and analysis of records and documents, in order to reach the depth of the phenomenon, to study it, analyse it, and know its details without collecting its data.

2.2 Secondary data

Secondary data consisted of the available literature on the Gulf of Sirte and included previous studies, reports, statistics, official publications, and local, national and international documents, and to review, audit, analyse and select what is appropriate from them after identifying biases, gaps, and the social context to serve the study objectives, in addition to using secondary data to form a clear picture, understand the study area from different angles and viewpoints, and take this into account while collecting and analysing primary data.

2.3 Primary data

The researchers used several methods to collect the primary data, which are as follows:

4

a. Collecting data on the various aspects related to the marine fishing sector through a questionnaire that targeted three types of marine fishing, namely professional fishing, recreational fishing, and diving fishing, through direct and personal distribution of the questionnaire to interact with respondents to access more accurate and reliable information. Researchers have developed a questionnaire for each type of fishing that focuses on socio-economic aspects, relationships and interactions between respondents and ecosystems.

b. Personal interviews with local partners and stakeholders, based on their experiences and information related to the study area.

c. Field work and direct monitoring of the study area with a focus on the marine fishing sector (ports and harbours, ancient and historical ports, main fishing sites) and considering the tourist attractions, the cultural value of the area, and the role of women in various vital sectors of direct and indirect relationship to the study area.

2.4 Data analysis

Data analysis is the process of bringing order, structure and meaning to the mass of collected data. It is described as messy, ambiguous and time-consuming, but also as a creative and fascinating (Marshall and Rossman 1999). the purpose of conducting a study, is to produce findings, and to do so, data should be analysed to transform data into findings. In this study, data will be analysed using both the qualitative and quantitative method by the following techniques:

- Data classification and tabbing and identifying techniques for analysis of various variables and finding aspects of correlations and discrepancies between them.
- Conducting stability, normal distribution, and randomization tests on the data.
- Use of assistive programs for statistical analysis of data after understanding the data and defining frameworks for analysis of the variables and correlations they collect.
- Mental analysis of the results and highlighting the strengths regarding the relationships between the variables to extract logical and coherent results that serve the objectives of the study.
- Displaying the results of the analysis on several graphic outputs including graphs, tables, and illustrative maps.

In this study, the following applications were used to produce the results and show them in their final form:

IBM SPSS Statistics Subscription v. 25.0.

Microsoft Excel 2010.

QGIS v. 2.18.0.

Adobe Illustrator CC 2018

3. Territorial Dynamics

3.1. Historical development.

References indicate that the ancient city of Sirte is the city of Sultan, which is located about 50 km to the east of the present-day city of Sirte, but it was known by other names before that, are respectively: the Ancient Greek (Súrtis), then the Phoenician Charax, then the Roman

Iscina, and finally the Fatimid Sultan, and The bay extending between Kefalay Promontum (Ras Qasr Ahmed) in Misurata, and Burium (Ras Taeyounes) in Benghazi was called the Gulf of Sortus Mayurus (the Great Gulf of Sirte) to distinguish it from Syrtus Minorus (the small Gulf of Sirte = Gulf of Gabes now). The Great Bay of Sirte was also called Syrtica, and the city of Sultan was mentioned by various names since the earliest times, it was described by Strabo it in the first century BC as being located east of Turris Euphiranta, which formed during the period of Ptolemaic rule (321 - 96 BC) The boundaries between the area of influence of the Phoenicians of Carthage and the sphere of influence of the Greek Cyrenaica, which is the current territory of Cyrene Shahat, he also mentioned that charax was used by the Carthaginians as a station or marketplace (Emporia), where wine was replaced by Silphium and its juice from smugglers from Cyrenaica.

Ptolemy, the geographer, in the second century AD gave the name (Pharax) to the same region. Then the name of Eskina appeared in the route guides of the Roman travellers who ruled the territory of the three cities (Tripolitania) after the fall of Carthage during the third Roman-Carthaginian war (149-146 BC), and the name of Sirte appeared among Muslim geographers and historians, such as al-Bakri (in the 11th century) Al-Idrisi (in the 12th century CE) and Ibn Saeed (in the 13th century CE.(

But for the present-day city of Sirte, its name changed more than once, as it was known by Strabo as Turris Euphiranta , then it appeared in the guides of the Roman traveller's routes as Macomades, and al-Bakri mentioned it as Magmdas in the eleventh century AD, and then the site was known after that as the well of Saffron, where the Saffron Palace was built by the Turks in 1842. (Fig.1). and then it was called Sirte Palace, then became known as Sirte. after the Italian occupation, the Sirte Palace was restored by the Italians (A. Shallouf, 2013).

Due to the importance of the location of the city of Sirte, it was occupied by the Italians on 31 December 1912 after the signing of the Treaty of Lausanne.

On 17 December 1941, in the Gulf of Sirte, an accidental clash took place between the British and Italian royal navies, which was known as the (First Battle of Sirte), followed by the Second Battle of Sirte on 22 March 1942, both battles took place within the battles of World War II.

Since its independence in 1951, Libya has always considered the Gulf of Sirte, with its geographical and strategic dimensions, as an inland sea, where more than a third of its population lives in the areas bordering it, as well as penetrates deeply into Libyan territory and controls strategic and vital areas in the centre of the country.

6

Figure 1 : Saffron Palace. (Photo. © General Authority for Culture (Sirte Office)

On 10 October 1973, the Libyan authorities issued an official document, which they sent to the United Nations and the international organizations concerned, declaring that the Gulf of Sirte is a historic bay under to the Libyan Arab sovereignty. The document reads as follows : The Libyan Arab Republic declares that the Gulf of Sirte, which is located on its territory and which is bordered in the east, south and west by the Libyan mainland, extending northward at latitude 32 degrees and 30 minutes, is considered an integral part of its territory and is subject to its full sovereignty as an internal water from which its territorial sea starts from after it, given its penetration into its territory, Its interference in it, and its exercise of the rights of sovereignty throughout its long history without contesting it as its property in addition to its vital for the security of the republic and the need to fully supervise it to ensure the security and safety of the country, given its geographical description that oversees the heart of the country, and one of the most prominent events in that period was the occurrence of an air battle between US Air Force and Libyan Military Aviation on August 19 1981 (Karkara Salem, 2013).

In the late 1990s, the city witnessed two most important events in its history, the declaration of the African Union on 9 September 1999, in the Ouagadougou halls complex, which is one of its famous landmarks, and the signing of the Great African Lakes Peace Agreement, also the Libyan General People's Congress meetings were held regularly in these halls, and regional and international conferences were also organized. It also hosted the twenty-second Arab summit, and was chosen as the capital of Arab culture in 2011.

In 2011, during the Libyan revolution, the city of Sirte witnessed the last battles between the rebels and the forces of the former regime, which ended with the death of Gaddafi in Sirte on October 20, 2011.

At the beginning of 2015, the organisation of Islamic State in Iraq and Sham"ISIS" took control of Sirte and declared it an emirate, and it continued until May of 2016, when the "Al-Bunyan Al-Marsous" operation was launched, leading to the liberation of the city from the organisation in December of that year.

Recently, the city witnessed the opening of the headquarters of the Joint Military Committee (5 + 5) and the convening of a meeting of the committee under the auspices of the United Nations to resolve the Libyan crisis.

3.2. Geographical location

The Gulf of Sirte covers the area extending from the Rass Elburj in the west to Tukra in the east, and the length of its coast is about 920 km, while the width of its opening is more than 450 km, and its southeastern part extending between the port of Sidra and the port of Zueitina is known as Sidra Bay, and it penetrates into the Libyan territory by two and a half degrees of width to reach the southernmost point of the Mediterranean stretch (Hussein Abu Medina, 2008).

This southern extension has made the area very important for many marine species such as tuna (Thunnus thynnus) and many cartilaginous fish species, including those listed as endangered in the Annex II of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol).

The western part of the Gulf coast, extending from Rass Elburj to Albwirat, is very straight and has no inlets or significant heads, except for the Merssa Albwirat, which is located in a place protected by submerged rocks that extend for a distance of 1.25 nautical miles into the sea, which is a low sandy beach that is covered in many places by thick formations of seaweed (Posidonia) that were deposited by waves on the shore, we can also see submerged rocks in the sea water spread along the coast, and there are also the marsh of Tawergha, the marsh of Qasr Ahmed, and the marsh of Al-Washaka, in which there is a salt plant, as well as located within its scope Al-Hesha Reserve, and there is no such important ports in this part of the coast, while in the central part of the Gulf, which extends from the Albwirat Marina to the Zueitina oil port, it includes four large oil ports, which are the port of Sidra, the port of Ras Al-Anuf, the port of Brega and the port of Zueitina in addition to many fishing ports. This part of the Gulf is characterised by a low sandy beach, , some parts of which are covered with thick layers of seaweed that extend for tens of kilometres,, and some small rocky islands such as Al-Qarah Island (which is considered one of the most important nesting areas for the crested tern in the Mediterranean), Abu Shafah Island, and Al-Awija Island, and marshes are spread in many parts of it, the most important of which are Sabkhat al-Khamseen marsh and Sultan marsh.

As for the eastern part of the Gulf, which extends from the port of Zueitina to Tukra in the east, there are no inlets except for Ras Karkoura, south of Benghazi, about 75 km, and Ras Juliana, in which the port of Benghazi is located. The marshes extend along most of the coast, and the most important of them are the sabkha of Karkoura and the sabkha of Al Kouz (that are considered as Important areas for the comfort and feeding of migratory birds). It also includes a number of lakes that are fed by groundwater and partially connected to the sea, such as Lake Zayana and Lake Budazira (Hussein Abu Medina, 2008).

This distinctive location of the Gulf, as well as the small number of population and human activities, made it a magnet for many species that have taken from these environments as habitats for their various activities, as the coasts of the Gulf are considered one of the most important nesting areas for sea turtles on the shores of the southern Mediterranean, and also one of the most important places for the reproduction of cartilaginous fish and Blue fin tuna fish in the area.

3.3. climate

In terms of climate, the Sirte weather station was established in 1945 and measures rainfall, wind speed and direction, humidity, average daily and monthly temperatures, and average air pressure. There are also a few other stations, but they are only used to measure rainfall and are called substations.

If we Look at the location of the city of Sirte on the Gulf, we find that it overlooks the sea from the north, east and west sides, and the southern part remains on land and is affected by the desert, as it is mostly subject to marine influences, while the interior areas are subject to desert influences, and if we compare the marine and desert climate influences of the city of Sirte with its neighbouring areas, we find that they are More moderate than the desert areas and even some coastal and mountainous areas due to the deepening of the Gulf. Given the higher and lower temperature range, it was found that the city of Sirte experiencesthe highest temperature in August by 26.5 °C, surpassed by Misurata by one degree, 27.5 °C, just as Tripoli surpassed it by 2 °C and Benghazi 1 °C, as coastal areas, while Sabha exceeds it 4.5 °C , and Kufra is the same, but Qaryat as a transitional area between the desert and the mountain is more than 3.4 °C, and even Jadu as a mountain city came more than Sirte, with an increase in temperature of 1.4 °C, and the record of the air station in Tripoli showed that the lowest temperature is in the month of January, as the city of Sirte is a rather warm region, where the rate is 13.5 °C , noone of the aforementioned cities shared the same pattern, so that the average daily temperature range in Sirte is 13 °C.

The following table (Table. 1) shows the temperature, relative humidity, wind speed and rain amount in Sirte for the years from 2005 to 2009

The moderate climatic conditions in terms of temperature and their extent in the city of Sirte and its surrounding areas is due to its location on the Gulf, which made it the coastal area most affected by marine conditions, and this effect extends inland more than other coastal areas (Muhammad Al-Fitouri, 2009).

Table 1. Average temperature, relative humidity, wind speed and rain amount in Sirte from 2005 to 2009

Year		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2005	Temperature °C	13.3	14.2	17.3	19.6	22.3	23.7	27.6	27.5	27.2	24.2	19.7	**16.1**
	Humidity %	72	67	74	67	72	81	78	78	74	73	70	**69**
	Wind speed (knots)	8.3	6.9	7.1	9.2	7.1	5.6	6.4	6.3	6.9	6.0	5.5	**7.7**
	Rainfall (mm)	87.1	19.2	11.4	0.0	0.0	8.2	0.0	0.0	4.0	6.0	12.4	**44.9**
2006	Temperature °C	12.7	14.8	17.4	20.0	21.8	23.4	26.6	29.4	27.6	24.1	18.6	**16.2**
	Humidity %	70	71	68	69	75	74	74	70	70	74	74	**73**
	Wind speed (knots)	6.9	8.6	8.9	8.4	6.0	5.3	4.7	6.1	6.3	5.8	4.2	**5.3**
	Rainfall (mm)	82.6	44.2	2.0	4.5	0.0	0.2	1.6	0.0	0.8	42.1	30.8	**27.0**
2007	Temperature °C	15.8	16.0	17.4	19.8	21.5	25.9	27.1	28.3	27.2	25.0	19.8	**14.8**
	Humidity %	77	70	70	82	79	75	80	74	71	63	62	**71**
	Wind speed (knots)	7.2	9.0	6.1	7.9	7.0	5.9	5.8	5.5	5.4	6.4	6.0	**5.8**
	Rainfall (mm)	24.7	31.9	21.5	1.8	17.8	0.0	0.0	0.0	0.0	2.3	8.2	**6.5**
2008	Temperature °C	14.1	13.5	17.7	22.2	24.0	23.8	27.6	27.6	27.7	24.5	21.5	**15.2**
	Humidity %	78	76	72	64	72	81	75	80	74	72	82	**71**
	Wind speed (knots)	6.5	6.6	6.6	9.0	9.5	8.3	7.5	7.1	8.3	8.2	7.6	**8.9**
	Rainfall (mm)	65.0	60.4	0.0	17.3	0.5	0.0	0.0	0.0	0.5	28.5	1.9	**76.6**

9

2009	Temperature °C	15.1	15.5	17.0	19.8	21.2	25.2	28.1	27.7	27.9	24.2	19.0	**17.8**
	Humidity %	68	64	67	75	79	79	73	78	78	75	72	**62**
	Wind speed (knots)	9.5	10.5	10.0	9.6	8.8	8.2	7.9	7.5	9.0	9.5	7.4	**10.5**
	Rainfall (mm)	1.0	10.9	1.2	0.0	5.0	0.0	0.0	6.0	10.5	77.8	13.5	**41.5**

Source: Libyan National meteorological Centre (Sirte Station)

3.4. Oceanography

The area close to the shoreline and extending along the shores of the Gulf of Sirte is considered a continental shelf area whose depth does not exceed 200 metres below sea level.

The Sirte submarine Valley starts from the continental shelf of the cities of Ajdabiya and Marsa Brega, where it begins to deepen from the depth line 200 m and gradually until we reach the depth line 600 m depth line, then the valley begins to widen and the contour lines move away from each other, indicating that the bottom of the Gulf is somewhat flat, and the depth slowly increasses towards the northwest until we reach the depth line 1800 metres depth line. Thus, we reach the Sirte submarine basin, which forms the estuary of the sub-sea Sirte Valley.

The submarine basin of Sirte is the widest and deepest area in the Gulf of Sirte, where the depth reaches 2,200 mteres depth line, and we can classify it within the abyssal basins of submarine terrain that contain the vast plains of deep depth.

The Sirte Valley and the Sirte submarine basin divide the Gulf into two asymmetric regions. To the east of them there are mountain ranges that run from the south-east to the north-west parallel to the extension of the submarine Sirte Valley, rising hundreds of meters from the surrounding area and reach the average depth within 1100 m below sea level. These chains enclose valleys between them, the most important of which is the Benghazi Valley, with an average depth of 1450 metres below sea level.

The contour lines converge to the west of the sub-sea Sirte Valley to form a medium steep and winding area with hills perpendicular to the shoreline such as the Sirte and Tawergha hills that extend from the depth line 300 m to 1500 m below sea level, these hills have a mean depth of 900 m below the sea level.

The continental shelf adjoins the beach area in the Gulf of Sirte along the coastline from Darsiyah to Misurata, with a length of about 900 km. Starting from the west, the the continental shelf extends from the area to the northeast of the city of Misurata, reaching its maximum width between Misurata and Sirte, where its extension reaches 60 km and that of the area in front of Al Bwirat Al-Hassoun. Then it narrows slightly in front of the city of Sirte to reach about 30 km, and to the east towards the continental shelf in front of Bin Jawad and Ras Al-Anuf, then widens again to reach 45 km until we reach the continental shelf of Marsa Brega, where it narrows slightly until we reach the continental shelf Ajdabiya, then expand to the north Towards Zueitina and Qumince, so that its extension in the open sea reaches about 45 km.

The underwater Valley of Sirte extends from the southeast to the northwest, and the continental shelf area between Ajdabiya and Marsa Brega forms the beginning of this valley, whose extension reaches about 160 km from the depth line 200 m to 1500 m below sea level. While the width increases, starting from the southeast, when it reaches 30 km in width, then gradually increases until we reach its maximum width in the estuary of the Sirte sub-sea basin, where it reaches 100 km.

10

Thus, the submarine Sirte Valley divides the Gulf of Sirte into two asymmetric parts, an eastern section in which mountain ranges and valleys abound, and a western section with many meanderings and hills.

The Sirte Valley is geomorphologically an extension of the wild valleys of the continent, as it forms an estuary area for the river valleys that flowed into it in the past (in geological times), The sediments gathered at the beginning of the valley are clear evidence of the existence of those river valleys that in the past brought millions of tons of dredges and deposited them in the underwater valley of Sirte.

We can see that the slope from the continental shelf area of Ajdabiya and Marsa Brega is gentle and reaches 1 ° and then increases slightly and weakly until the depth of the valley does not exceed 7 °. Consequently, the sediments accumulated with the passage of time and formed the region characterized by weak slope.

Meanders are common on both sides of the submarine Sirte Valley, with an average slope of about 19 ° in most of its destinations. It is possible that these many meanderings along both banks of the valley were formed by the activity of the hydrological network surrounding the Gulf of Sirte in the past. Also, marine currents coming from the west along the left edge of the valley could have a role in forming these meandering, then forcing these currents to change their direction in the valley towards the north along the right edge of the valley.

As for the submarine basin of Sirte, it is a very wide basin with dimensions reaching hundreds of kilometres, with a length from east to west about 300 km, and an average width of about 100 km. This basin contains abyssal plains that go deeper to more than 2,200 meters below sea level, while the slope is weak in most of its directions and does not exceed 10 °. The submarine basin of Sirte constitutes the estuary of the Sirte Valley, as well as of the valleys coming from the continental shelf area of the Gulf of Sirte by moving towards the eastern section of the Gulf of Sirte, We notice the presence of mountain chains extending from the southeast towards the northwest, parallel to the submarine Sirte Valley, and the most important of these chains is the Western Benghazi Chain, which extends for about 60 km and a width not exceeding 15 km, while the average depth of this chain is about 1300 m below sea level, and it rises About 500 m adjacent to it.

Moving to the western region, to the west of the submarine Sirte Valley, we notice the expansion of the continental shelf between Sirte and Misurata in the area opposite Bwirat Al-Hassoun, where its maximum breadth in the Gulf of Sirte ranges from 60 km to the depths of 200 m. Then we find a low-rise slope area after the continental shelf of Misurata, as it does not exceed 25 meters in height, then we reach a semi-flat area with a weak slope that extends in an arched form from Misurata until Sirte with a length of 210 km, and a width not exceeding a few kilometres.

The area descends with a moderate to steep gradient after the previous area, and its height is about 350 m relative to the slope of Misurata (Fig. 2), while it does not exceed 205 m near the hills of Sirte. Then the area returns to level after the previous decline, interspersed with many hills extending transversely to its extension, such as the hills of Sirte and the hills of Tawergha. The width of this area shall be about 30 km, and its extension shall be the same as that of the previous region, of 210 km. The bottom of this area is somewhat flat, but it has a weak and gradually deepening slope until it reaches a depth line of 1500 metres below sea level, at which point the Sirte submarine basin begins to emerge (al-Dakhil, 2013).

11

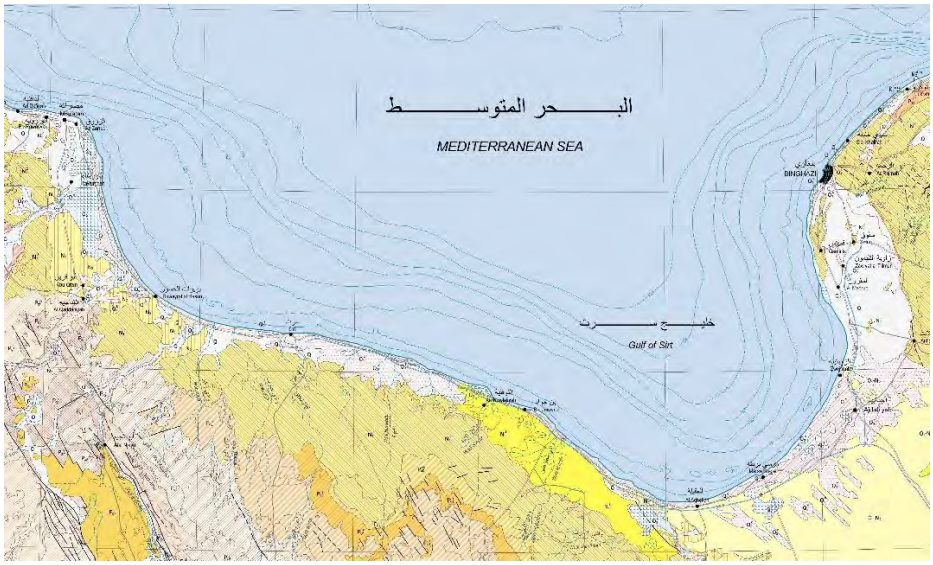


Figure 2. Bathymetric Chart of the gulf of Sirte. (Source: Geological researches & mining department, Industrial Research Centre "IRC" Libya)

3.5. Water and groundwater sources

The Sirte planning region is fed by the following water basins: Hamada Al Hamra Basin, Murzuq Basin, and Al Sarir Basin - Sirte, and the map (Fig. 3) shows the water basins in the Sirte planning sub-region.

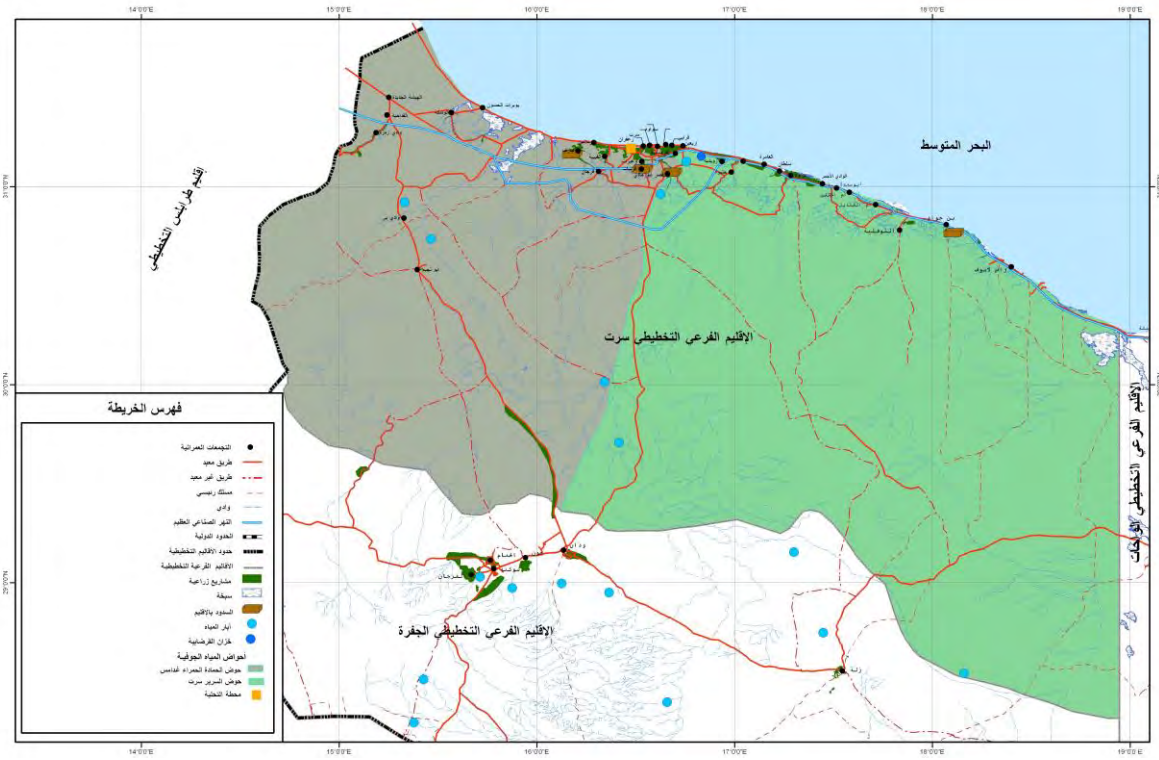


Figure 3. water basins in the planning sub-region of Sirte

Total groundwater resources in the region are about 2000 million cubic metres per year, or about 11.4% of the national resources. The rate of water extraction per capita in the region is about 1784 cubic metres compared to 803 cubic meters per person at the Libyan level.

12

Therefore, the Sirte planning sub-region is experiencing a water exploitation that cannot be ignored, at least in the Hamada Al-Hamra and Murzuq basins, which are experiencing a depletion of their water reserves and represent a distant equilibrium in relation to Tripoli and Fezzan subregions.

As for the Sarir Basin - Sirte, which is located to the east of Wadan and the oil field chain, and consists of three water layers spread over a wide area in upper and lower water levels, the thickness of the upper layers exceeds 210 metres and the thickness of the lower layers ranges from 150 to 180 metres, and the water quality of these areas is considered acceptable due to its moderate salinity, which reaches 5 grams per litre, and it is expected that this water will be available for a period of fifty years to come, at a consumption rate of 800 million cubic metres per year, knowing that the current rate of water consumption is 520 cubic metres per year.

The region is also supplied by the water of the artificial river (the first stage), which is the largest of the stages, transporting 2 million cubic metres per day over 1,200 km. From Sarir and Tazirbo to Benghazi, And the city of Sirte through the Ajdabiya reservoir, which was officially inaugurated in August 1991. From Sarir there are two parallel pipelines with a diameter of four metres that transport chlorinated water to the Ajdabiya reservoir, which has a capacity of 4 million cubic metres and has a diameter of 900 metres, after which the water flows through two pipelines, one of which heads north towards Benghazi and west towards Sirte to pour into a circular tank (Al-Qaradabiyah reservoir) with a storage capacity of 6.8 million cubic metres.

The average rainfall in the northern part of the region ranges between 20 to more than 300 mm per year, of which 1% reaches the sea, and 10% seeps into the land while the rest evaporates and covers the need for plants. The dams in the region, which are Bin Jawad Dam, Jarf Dam, Al Zahwiya Dam, Al Zaid Dam, (Table. 2) shows the dams in the Sirte region in 2006 including capacity of the dams and the annual rate of storage.

Table 2. Dams in Sirte region

Name	Area of Rain collection (km2)	Annual rate of rainfall /mm3	Capacity of the dam/ mm3	Annual rate of storage/ mm3
Ben jawad Dam	54	110	0.34	0.30
Jaref Dam	1000	116	2.40	0.30
Al-zahawiya Dam	50	120	2.80	0.70
Al-zeed Dam	45	120	2.60	0.50
Total	-	-	11.79	2.19

Source: Urban Planning Authority, Libya, The third-generation scheme project. 2007.

3.5.1 Water consumption in Sirte

The study team made a field visit to the water company in the city of Sirte, and through an interview with the director of project management in the company it became clear that the

13

average daily water supply to the city is 46,860 cubic metres, where the artificial river water system supplies the city with 94.3%, while the remaining percentage (5.7%) represents groundwater supply (wells and springs). There are nine chlorination systems in the city, of which five operate normally and four are out of order. The average monthly consumption of chlorine powder is 170 kg.

The city is supplied with water by 53 pumps, ten of which are out of order. The company's employees carry out regular and emergency maintenance on the remaining pumps (Sirte Water Company, unpublished report).

3.5.2 Sewage water treatment

Due to the lack of a sewage network in the city of Sirte in the past. Sewage water is disposed of through black wells within the range of each house, then the first sewage network was implemented in the city centre in 1966, with a length of 3000 metres, and with the development of the city and the increase in the population, the need to increase the network became urgent, as in 1978 the beginning of the implementation of the second network in the first, second and third residential areas, which are modern residential areas built in the form of residential neighbourhoods.

In 1990, the implementation of the integrated utilities project was initiated, where a network of pipes with a length of 400 km was designed and implemented, of which 160 km were main pipes and 240 were branch pipes, to transport wastewater to the sewage treatment plant in the west of the city.

And through the study team's visit to the sewage treatment plant (Fig. 4) and the interview with its director, and listening to a full explanation by the engineers supervising the work who reported that the plant was designed and constructed to receive 20,000 cubic metres per day and is fully treated according to different stages (triple treatment)

It includes primary treatment, secondary treatment, with its biological and chemical stages and primary sedimentation, then comes the tertiary treatment phase and is divided into chemical treatment basins, sand filter stage and a chlorine injection stage, and there is also a laboratory at the station to carry out the necessary tests before and after treatment in order to determine the levels of ammonia, chemically dissolved oxygen and biological oxygen, pH and electrical conductivity,, through a field visit to the station it became clear that the station had been subjected to acts of sabotage during the events that the city of Sirte had gone through, where some of it have been repaired by technical staff according to the available capabilities, and work is still ongoing to maintain the station. (Fig.4).

The station official confirmed that the treated water is being discharged the sea off Sirte, and hopes that in the future it will be used to irrigate the city's green areas and forests.

Figure 4. The study team visits the sewage treatment plant. (Photo.©.SPA/RAC. A. Saied, 2020)

3.6 Landscape

The city of Sirte is situated on the plain that stretches out along the Gulf, known as the Sirte plain. This plain extends to the south, so that its border is difficult to determine due to the overlapping of desert conditions and the gradual rise of the plain from north to south, with no mountain or hill barriers in this direction hindering the desert effects. This plain is characterised by a low sandy beach interspersed with sand dunes of varying heights, as well as marshes of various sizes fed by rainwater through valleys, Also, seawater seeping in from the north. (Fig. 5)

Figure 5. Aerial view of Sirte city. (Photo.©. A. Hammadi, 2018)

Many valleys descend into this plain from different directions, long valleys of varying depths, wide in some areas and narrow in others, and the most important valleys are Wadi Tilal, Jarf, Al-Zaid, Tamt, Azkir, Al-Haneweh, Al-Wadi Al-Ahmar, Harawa, Zamzam, Bi Al-Kabeer, Souf Al-Jin And Wadi Al-Faregh, most of which face north, while the three valleys Al-Jin, Bi Al-Kabeer and Zamzam are the largest surface water basins. It is expressed as the Qibla area, which is a region with a surface that helps natural plant growth to be a grazing and cultivation area on which the city of Sirte and its surroundings depend.

The height of the surface of the Sirte region does not exceed250 metres above sea level, although the city of Sirte has a height ranging from 15 to 22 metres and may be slightly higher in some areas towards the south.

It should be noted that the centre of Sirte, which is located on a high plateau, gradually descends towards the north gradually until the height in the north approaches the level of the sea level and increases towards the south (Muhammad Al-Fitouri, 2009).

3.7 Industry

The industrial use of the city of Sirte is old, as the traditional industries such as hand-made shoes, wool, lint and baskets, leather dyeing, and simple metal industries represented in drawing and hammering metals in addition to repairing machinery and equipment, and most of the raw materials are agricultural, or animal, and they come from the neighbouring region for the city of Sirte.

The industrial zone, which includes workshops and small factories, was included in city plan in 1966, directly south of the residential area, then it was transferred to the east of the city on Benghazi Road at the end of the plan in 1978, and then it was completely removed in 2002 outside the city plan in the Saffron area, 7 km west Sirte, where the soil is marsh and the area is sufficient for the development of the industrial zone, Taking into account the environmental and public safety restrictions and not allowing residential construction near this area, However, through the general observation of the trend of development and growth of the urban and residential area of the city of Sirte outside the scope of the third generation scheme project, we notice that there are residential buildings growing haphazardly in the west of the city and may reach and adhere to the industrial area again, which is contrary to the principles of sound planning. (Basheer Al-Subaie, 2009).

The (Table. 3) shows that there is a group of food, chemical, engineering and building materials industries in the city of Sirte in 2006, the total number of industrial establishments is 309, and the number of workers in the industrial field is 774 workers, noting that all workers in the workshops and factories built outside the city plan are Residents of the city of Sirte and contribute to the city's economy.

Table 3. Transformative Industries in Sirte city 2006.

Industry	No. of establishments	No. of workers
Food	94	144
Spinning & weaving	24	299
Paper and Furniture	26	66
Chemicals	8	10
Engineering	97	63
Building Materials	54	192
Total	303	774

Source: B.Al-Subaie, 2009

Some factories were built in the eighties of the last century, as a factory for shoes and clothes of all kinds was established, in addition to factories of rubber, plastic, pipe manufacturing, and simple food industries. However, these factories were closed down due to the lack of raw materials and high costs.

The number of workers in industrial activities reaches 774 persons, which represents (3%) of the total number of economic workers in all activities, which amounts to 26066 persons. Here we notice the low percentage of this activity due to the fact that the industry does not play a big role in the jobs offered by the city of Sirte compared to other jobs (Ibid. p. 181).

3.7.1. Oil production

Oil exploration began in Libya in 1955 and the first oil was discovered for the first time in Libya in 1959 (in the Amal and Zelten fields) and oil exports began in 1961, accounting for about 94% of the country's resources. Its main characteristic is the abundance of wells extracted from it, and its proximity to the export ports.

The Libyan oil production was estimated at (1.6) million barrels per day in 2004, and oil and gas production is the country's main source of income. The Gulf of Sirte region contains most of Libya's oil and gas fields. There are five major sedimentary basins in Libya, two of which are in the proposed Gulf region. These two basins Sirte and Kufra are the two most actively explored for oil and gas.

Oil reserves in Sirte amount to 206 billion barrels, of which 60 billion are recoverable. New discoveries have estimated that the basic rocks that make up the Sirte Basin contain an additional 100 billion oil, and there are more than 236 oil and gas fields and more than 1,800 wells in the Sirte Basin, 16 of which are very large. Eight international companies operate in the Sirte Basin, and the National Oil Company owns most of the shares in these companies.

The amount of natural gas that covers the needs of the national economy now stands at 70 billion cubic feet, and it will increase to 115 billion cubic feet in 2025.

The daily production of natural gas is estimated at 1.438 million cubic feet (Table 4), and the planning Gulf region produces 20%, most of which is produced from the Sirte Basin, and the most important uses of gas are:

- As fuel in oil fields
- In the injection of oil wells
- Fuel in power plants, Iron & Steel Company, Misurata, and the cement factory in AlKhums.
- In the manufacturing processes of urea, methanol and ammonia in Brega and Zweitina.
- In the liquor labs in Brega. (UPA, Libya, The third-generation scheme project. 2007)

Table 4 The production of gas in Libya and its uses during 2005 and 2006.

production			Total	Type of use						
Product type	Mixed gas	Free gas		industry	Oil field	Light industry	Coast line	Man-made river	fuel	total
Million feet	1,060	378	1,438	338	371	120	156	80	373	1438
%	74	26	100	23	25	8	11	6	26	100

Source: Urban Planning Authority, Libya, The third-generation scheme project. 2007

17

3.8 Biodiversity

3.8.1 Fossil Studies

Late Miocene reptile species have been discovered at a site called Sahaby in Libya (Fig.6) since the first decades of the last century when D'Erasmo (1933-1934) announced the existence of the remains of crocodiles, turtles and snakes, and since that time, the knowledge of the Sahaby reptiles has increased greatly and the list now includes several species, including: the crocodylians Euthecodon sp. and Crocodylus checchiai Maccagno 1947, the chelonians Trionyx triunguis and Centrochelys aff. C. sulcata and a booid snake, probably belonging to genus Python (Maccagno, 1947, 1952; Hecht, 1987; Wood, 1987; de Lapparent de Broin, 2000). The presence of some other taxa, such as unidenfied emydid turtles, the alligatoroid Diplocynodon, and longsnouted crocodylid tomistomines (Tomistomidae indet.), has not been confirmed by subsequent analyses (D'Erasmo, 1933, 1934; Boaz et al., 1979; Delfino, 2008, and references therein (Delfino 2008).

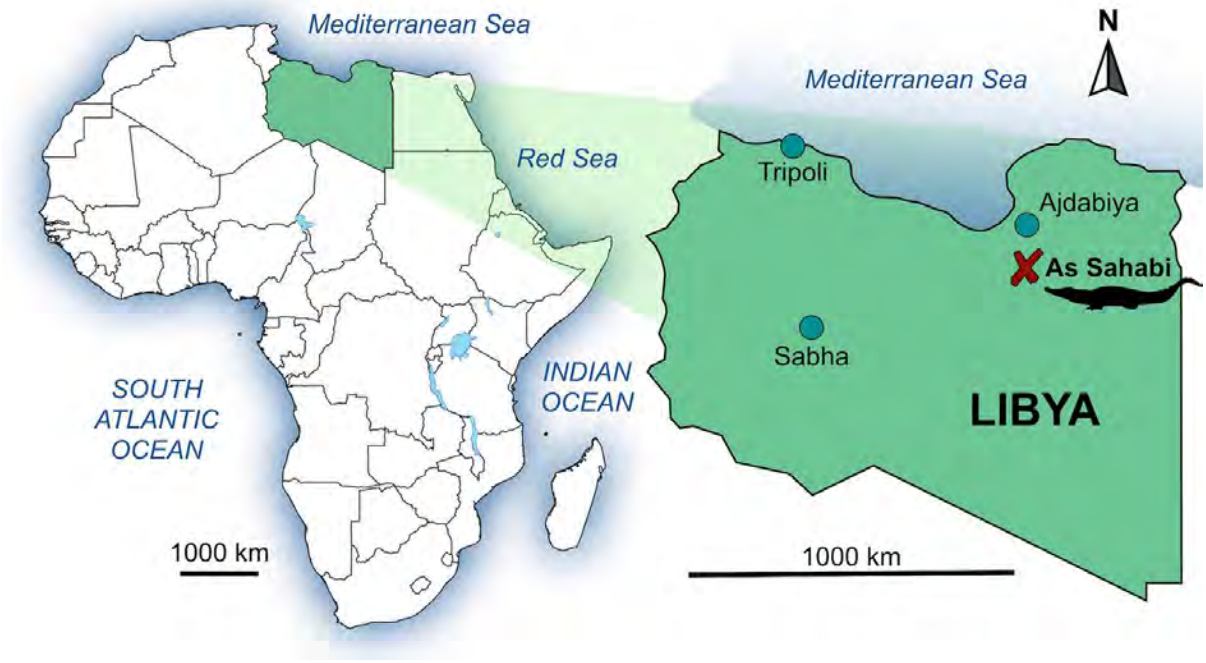


Figure. 6 Geographic location of the Sahabi paleontological locality. Artwork by D. A. Iurino.
Source: Delfino, et. al. 2020

Since the beginning of the last century, some Italian geologists and palaeontologists have been interested in sending scientific expeditions to Libya to explore the Libyan desert, in particular the "Sahabi" site, which is located 140 km south of the city of Ajdabiya. In 1938 Carlo Petrucci carried out numerous excavations at the site anddiscovered a large number of fossils belonging to mammals, fish and reptiles, including five perfectly preserved crocodile skulls, which were transferred to the Natural History Museum in Tripoli. Many of these fossils were lost during the second World War, but a single crocodile skull survived and was transported to Rome in 1947.

18

About a century after these discoveries, a group of Italian palaeontologists resumed the study of the only "survivor" of this group preserved in the University Museum of Geosciences of the University of Sapienza in Rome (Museo Universitario di Scienze della Terra (MUST) della Sapienza di Roma). The specimen was identified as Crocodylus checchiai (Fig. 7) and is currently the best-preserved skull of this species, which lived in the Africa during the Miocene epoch (more than 7 million years ago) in Africa, when the desert was a completely different area from today, inhabited by large mammals. Rich in vegetation and waterways.

Decades ago, excavations of Libyan fossil sites resumed in the Sahaby region (late Miocene period) and produced a huge diversity of vertebrate fossils, including fish, and many duplications of fossil fish species were recorded for the first time on the African continent. The increasing knowledge of Libyan ichthyofauna allows accurate reconstructions of ancient environments in their immediate vicinity at the time of their sediments deposition (Argyriou, 2014).

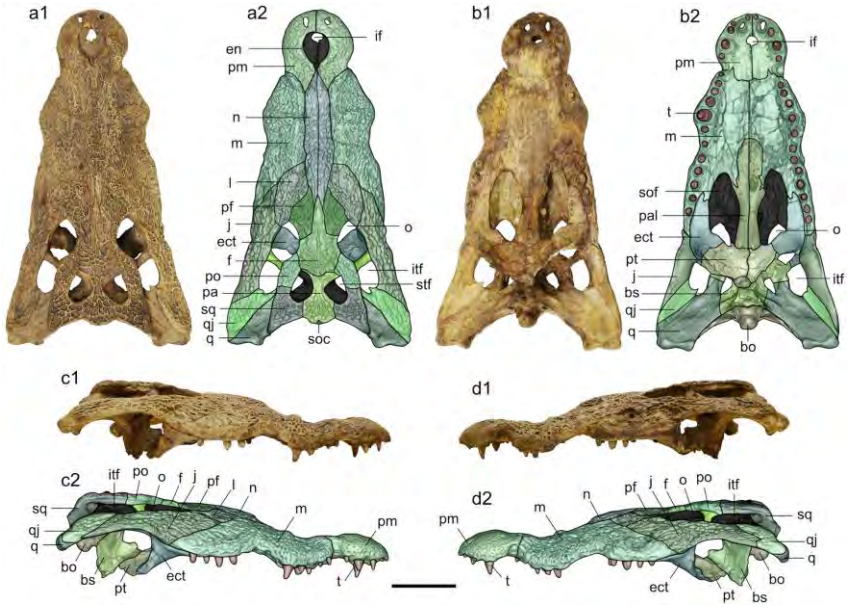


Figure 7 skull of Crocodylus checchiai

Source: Delfino, et. al. 2020

In the middle of the last century, many endangered wildlife species were recorded, as Hufnagel (1972) mentioned in his book (Libyan Mammals) that one of the best places to see hyenas sometimes even in broad daylight is the area located 65 km north of Jalu and El Agheila east of the road leading to Ajdabiya. As a result of widespread hunting in Libya in the sixties of the last century, which affected wildlife in general, leding to a decrease in the number of deer and thus affecting other mammals such as the cheetah, *Acinonyx jubatus* (Fig.9), which was hunted more than once, where a case of killing an adult female was recorded near Al-Dhara field, south of Sirte, on 1 January, 1968, and it was confirmed that there were three specimens of *Felis caracal* (Fig. 8) in the Tripoli Museum, one of these specimens was obtained from Sirte in 1946 (Hufnagel E, 1972).

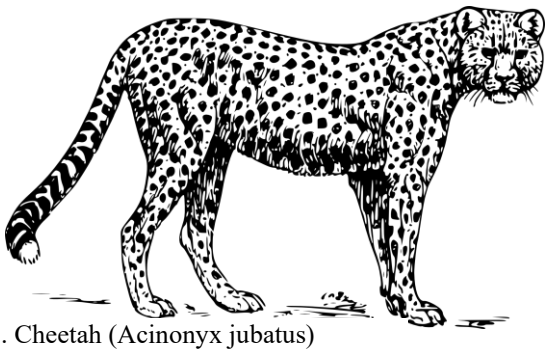


Figure. 8. Cheetah (Acinonyx jubatus)

Source. Hufnagel, et. Al. 1972

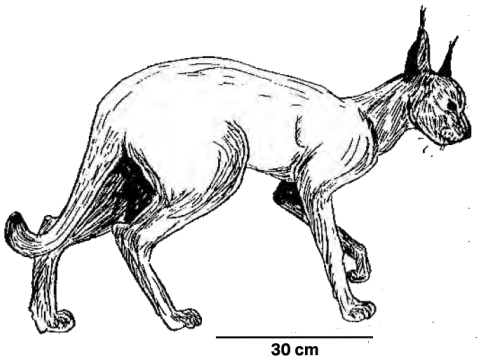


Figure. 9. Caracal lynx (Felis caracal)

3.8.2 Vegetation

The surveys conducted by a team from Sirte branch of the Environment General Authority, , in the Swawa area near the city of Sirte (Fig. 10), indicate the presence of plant diversity in the area, according to the unpublished study carried out in February 2009 on 370 frameworks of 4 square metres, 75 plant species were recorded, 5 of which are considered regionally rare (Table.5). The species belong to 67 genera and 32 families, and the species richness varied in 4 square metres from 5 to 27 species with an average richness of 15.17.

20

Figure. 10. Swawa Area Location
Source: EGA, Sirte branch 2009

The study area was divided into 9 parts and 40 random sample frames were collected from each part, then the Shannon Biodiversity Index and the Simpson Index for the study area were measured, the Shannon index was 0.668, while the Simpson index was 0.733, and the two indicators for the nine parts were also measured and compared.

Table. 5. Plant species in Swawa (To be checked!)

No.	Species	Vernacular name	Genus	Family
1	*Malva sylvestris*	khobaiz	Malva	Malvaceae
2	*Echium angustifolium*	Abat Elgula	Echium	Boraginaceae
3	*Brassica tournefortii*	Shultam	Brassica	Brassicaceae
4	*Astragalus ibrahimianus*	Shaewit Erraie	Astragalus	Fabaceae
5	*Allium subhirsutum*	Ghazul	Allium	Amaryllidaceae
6	*Glebionis coronaria*	gehwan	Glebionis	Asteraceae
7	*Mesembryanthemum crystallinum*	Chasoul	Mesembryanthemum	Aizoaceae
8	*Retama raetam*	Rettam	Retama	Fabaceae
9	*Deverra denudata*	Gezzah	Deverra	Apiaceae
10	*Chenopodium murale*	Effena	Chenopodium	Amaranthaceae
11	*Polygonum equisetiforme*	Gurdhab	Polygonum	Polygonaceae
12	*Centaurea dimorpha*	Belalla`	Centaurea	Compositae
13	*Oxalis pes-caprae*	Hummaidh	Oxalis	Oxalidaceae
14	*Rumex dentatus*	Henzab	Rumex	Polygonaceae

21

15	*Reseda alba*	Dhail Elholi	Reseda	Resedaceae
16	*Medicago littoralis*	Nefall	Medicago	Leguminosae
17	*Helianthemum lippii*	Lerga	Helianthemum	Cistaceae
18	*Salvia lanigera*	Sag Ennaga	Salvia	Lamiaceae
20	*Plantago albicans*	Lanam	Plantago	Plantaginaceae
21	*Anacyclus monanthos*	Sorret Elkabesh	Anacyclus	Compositae
22	*Artemisia campestris*	Togoft	Artemisia	Compositae
23	*Cynara cardunculus*	Kharshoof	Cynara	Compositae
24	*Echinops spinosissimus*	Libid	Echinops	Compositae
25	*Podospermum laciniatum*	Adheeda	Podospermum	Compositae
26	*Orobanche schultzii*	Tartoot	Orobanche	Orobanchaceae
27	*Pancratium maritimum*	Possaila	Pancratium	Amaryllidaceae
28	*Cutandia dichotoma*	Zewahn Rukba	Cutandia	Poaceae
29	*Cynodon dactylon*	Najem	Cynodon	Poaceae
30	*Phalaris minor*	Zewan	Phalaris	Poaceae
31	*Stipa capensis*	Behma	Stipa	Poaceae
32	*Anthemis secundiramea*	Eghraira	Anthemis	Compositae
33	*Amaranthus viridis*	Buzinzir	Amaranthus	Amaranthaceae
34	*Astragalus boeticus*	Kharamboosh	Astragalus	Leguminosae
35	*Vicia peregrina*	Jileban	Vicia	Leguminosae
36	*Solanum nigrum*	Anab ElDeeb	Solanum	Solanaceae
37	*Thymelaea hirsuta*	Metnan	Thymelaea	Thymelaeaceae
38	*Euphorbia paralias*	Lebbaina	Euphorbia	Euphorbiaceae
39	*Cenchrus ciliaris*	Sabatt	Cenchrus	Poaceae
40	*Ononis natrix*	Shedeeda	Ononis	Leguminosae
41	*Matricaria chamomilla*	Eflaia	Matricaria	Compositae
42	*Neurada procumbens*	Sadan	Neurada	Neuradaceae
43	*Asphodelus tenuifolius*	Tazia	Asphodelus	Xanthorrhoeaceae
44	*Matthiola sinuata*	Eshgara	Matthiola	Brassicaceae
45	*Teucrium polium*	Jaada	Teucrium	Lamiaceae
46	*Gymnocarpos decander*	Gajrood	Gymnocarpos	Caryophyllaceae
47	*Verbena officinalis*	Lessles	Verbena	Verbenaceae
48	*Lycium europaeum*	Awsaj	Lycium	Solanaceae
49	*Citrullus colocynthis*	Handhel	Citrullus	Cucurbitaceae
50	*Ricinus communis*	Kherwa`	Ricinus	Euphorbiaceae
51	*Onopordum arenarium*	Shook Elbel	Onopordum	Compositae
52	*Erodium glaucophyllum*	Rogma	Erodium	Geraniaceae

No.	Species	Vernacular name	Genus	Family
53	*Taraxacum bessarabicum*	Hodhelan	Taraxacum	Compositae
54	*Eruca sativa*	Jerjeer	Eruca	Brassicaceae
55	*Daucus carota*	Jazar Barry	Daucus	Apiaceae
56	*Linaria tenuis*	Makhbesh Eldejaja	Linaria	Plantaginaceae
57	*Euphorbia terracina*	Lebbaina	Euphorbia	Euphorbiaceae

58	*Carlina lanata*	Tafgha	Carlina	Compositae
59	*Astragalus caprinus*	Kharanboosh Hameer	Astragalus	Fabaceae
60	*Carduus meonanthus*		Carduus	Asteraceae
61	*Raphanus raphanistrum*	Fejal Barry	Raphanus	Brassicaceae
62	*Phagnalon rupestre*	Oshbet Elarnab	Phagnalon	Asteraceae
63	*Filago pyramidata*		Filago	Asteraceae
64	*Cressa cretica*		Cressa	Convolvulaceae
65	*Carlina involucrata*	Shook Logah	Carlina	Asteraceae
67	*Lagoecia cuminoides*	Kammon Barry	Lagoecia	Apiaceae
68	*lotus creticus*	Eshfaisha	Lotus	Leguminosae
69	*Echium humile*	Bomessas	Echium	Boraginaceae
70	*Anagallis arvensis*		Anagallis	Primulaceae
71	*Papaver hybridum*		Papaver	Papaveraceae
73	*Erigeron Canadensis*		Erigeron	Compositae
74	*Anabasis articulata*	Ajram	Anabasis	Amaranthaceae
75	*Agaricus bisporus*	Fegga`	Agaricus	Agaricaceae

Source: EGA, Sirte branch 2009

3.8.3 birds

From Misurata to Sirte, the Gulf of Sirte forms a deep gateway into the North African coast, with low coastal dunes, and behind them vast salt lakes, where water levels vary greatly depending on the annual rainfall. The south of Misurata is a huge complex of these lakes called the Tawergha marshes. It is about 100 km long and extends up to 20 km inland. It covers an area of about 250,000 hectares, making the "Tawergha complex" one of the largest wetlands in the Mediterranean. This complex is divided into several different sectors: the Qasr Ahmed marsh, the Tawergha marsh, the Umm al-Adham marsh, and the Al-Hesha marsh, and the bird numbers were recorded for each of these sectors.

In Ain Tawergha, 284 waterbirds of 29 species were observed in 2005 and about 407 waterbirds of 33 species were observed in 2006.

In Al-Hesha Springs (part of Al-Hesha Nature Reserve, established in 1992), 856 birds of 28 species were seen in 2005 and 1009 birds of 24 species were recorded in 2006.
Both sites had unexpectedly large groups of wintering Eurasian Crane Grus grus (over 100 at each site in 2005, and roosts at both sites in 2006 when 308 were recorded at Al Hesha (Azafzaf et al, 2006).
The Crested Tern is one of fifteen species included in the SPA / RAC Action Plan for Birds. A small, native group of the endemic subspecies *Sterna bengalensis emigrata* breeds in the Mediterranean Sea, which is centred on two coastal islands: Al Qarah Island and El Elba Island. The last survey to estimate the breeding population of the Tern in Libya (in the Gulf of Sirte) was conducted in July 1993. Meininger estimated the number of this bird on the island of Al-Qarah at about 1700 pairs, and in 2006, the breeding of the species was recorded in Al-Qarah and El-Elba Island, the importance of which was confirmed by the results collected during this mission, as the presence of 3102 Crested Terns was recorded on the island of Al-Qarah located in the Gulf of Sirte (Tern Report, 2006). In 2007, 13 islands were visited, and this species was found only in three places (Al-Qarah and El-Elba) and proved its presence in Benghazi, and through this study it became clear that there was a slight increase

23

in the increase of the colony of Benghazi, where the number reached from 1633-2083 couples, by 89% in Al-Qarah (1500-1800 couples), 9% in Benghazi (110-250 couples), and 2% in El-Elba (23-33 couples).

3.8.4 Alien species

The number of marine invasive species in Libyan waters increased from 63 (known by the end of 2013) to 73 in 2019. The highest percentage were fish (32.88%), followed by large plants (21.92%), molluscs (16.44%), crustaceans (13.70%) and parasites (9.59%). Some of these species have successfully adapted themselves to different terrains and habitats on the Libyan coasts (Shaqman et al., 2019).

3.8.5 Sea turtles

Sea turtles are reptiles that have lived in the seas and oceans since for over a hundred million years ago, and there are seven species of sea turtle in the world, three of which are found in the Mediterranean: the loggerhead turtle (*Caretta caretta*), the leatherback turtle (Dermochelys coriacea) and the green turtle (*Chelonia mydas*), and studies indicate that only two species, the loggerhead and green, nest in the Mediterranean (Demetropoulos, 1995), and one species nests on the shores of Libya, the loggerhead sea turtle, *Caretta caretta*.

The shores of the Gulf of Sirte are considered to be the most important nesting sites for the loggerhead sea turtle, as the shores of the Gulf attract a large number of turtles every year, and through studies conducted by the Libyan Sea Turtles Program (LibSTP)on a part of the shores of the Gulf have shown that the number of turtle nests exceeds 500 nests in some years. In 2015 a detailed study was conducted in two areas of the Gulf of Sirte (Gbaiba and Thalatheen) with the aim of monitoring the nesting behaviour of loggerhead sea turtles and the influence of some environmental and biological factors on nesting activity. The study showed that the nesting period of this species extends from the end of May to the beginning of August, while the nest hatching continues until the end of September (Saied, 2015).

This study showed a variation in nesting density between the study seasons in Gbaiba area, so that the highest percentage was in the 2006 season (27.2 nests / km) and the lowest percentage was in the 2010 season (6.6 nests / km). These results indicate a significant difference in the nesting intensity in Gbaiba area, and this difference is due to the construction of a power station in the area in 2007 (Table. 6) (Saied, 2015).

Table. 6 nesting activity of the *Caretta caretta* on the Thalatheen and Gbaiba beaches

year	Study area	Track type			Total tracks
		UCT	FCT	NCT	
2006	Gbaiba	291	103	52	136
	Thalatheen	145	50	28	67
2007	Gbaiba	228	37	38	153
	Thalatheen	120	22	31	67
2009	Gbaiba	116	17	18	81
	Thalatheen	92	19	24	49
2010	Gbaiba	61	9	17	35
	Thalatheen	124	16	43	65
Total		1160	269	244	647

Source: Saied. A, 2015

Saied et al. (2012) highlighted the uniqueness of the Libyan nesting population of loggerhead sea turtle (Caretta caretta) in the Gulf of Sirte that needs a seeting up of a management unit

24

for this specie since the protection of this nesting stock is fundamental to managing the Mediterranean loggerhead turtle population.

In 2017, the area extending from Albwirat in the west to the beach 17 km east of the city of Sirte, which is a sandy beach interspersed with some rocks in some parts of it, was surveyed, with a length of about 88 km, where 281 nests were recorded, 4,935 small turtles emerged from these nests to the sea, with a success rate of 84.37% (Table.7).

Table. 7 Number of nests and hatching success west of Sirte in 2017.

Beach	No of Nests	Hatched Nests	Total Eggs	Hatched Eggs	Hatching success %
Swawa	6	3	218	163	74.77
Zafaran	9	1	78	73	93.59
Gbaiba	28	14	845	661	78.22
Thalatheen	50	34	2842	2384	83.88
West Camp	31	8	547	504	92.14
Shash	49	13	951	765	80.44
Tamet	29	3	153	89	58.17
Khamseen	42	4	341	296	86.80
Nakhla	17	0	0	0	0
Albwirat	20	0	0	0	0
Total	281	80	5975	4935	84.37

Source: Saied. A, 2017

In 2018, the area extending from Albwirat in the west to Zafaran in the east was surveyed, where the total number of nests reached 374, out of which 12,403 small turtles hatched, and the success rate of hatching was 79.55% (Table. 8).

Table. 8 Number of nests and hatching success west of Sirte in 2018.

Beach	No of Nests	Hatched Nests	Total Eggs	Hatched Eggs	Hatching success %
Swawa	12	3	191	144	75.39
Zafaran	13	6	321	237	73.83
Gbaiba	43	22	1601	1347	84.13
Thalatheen	72	58	4589	3666	79.12
West Camp	35	23	1701	1298	76.31
Shash	66	53	4230	3600	85.11
Tamet	61	13	959	613	63.92
Khamseen	64	25	1666	1332	79.95
Nakhla	1	0	0	0	0
Albwirat	7	3	169	166	98.22
Total	374	206	15427	12403	79.55

Source: Saied. A, 2018

25

In the 2019 season, 395 nests were recorded on the study beaches, of chich 158 nests were followed up until hatching, 85 nests were protected from predators by installing protective windows, and 9276 eggs, with a hatching success rate of 76.11% (Table. 9).

Table 9. Number of nests and hatching success west of Sirte in 2019.

Beach	No of Nests	Hatched Nests	Total Eggs	Hatched Eggs	Hatching success %
Zafaran	20	8	674	462	70.03
Gbaiba	22	12	875	686	78.4
Thalatheen	45	27	2132	1606	75.33
West Camp	41	20	1511	1273	84.25
Shash	70	37	2992	2480	82.89
Tamet	67	27	2138	1633	76.38
Khamseen	78	15	1046	574	54.88
Nakhla	21	1	72	67	93.06
Albwirat	31	11	696	486	69.83
Total	395	158	12136	9276	76.11

Source: Saied. A, 2019

3.9 Tourism

On the 12th of November 2005, while workers from the Indian company DS were working to connect the sewage system to the "Al-Giza Albahriya" neighbourhood in Sirte, in preparation for paving the streets as part of the Integrated Facilities Project, and after their digging to a depth of three and a half metres, the ground collapsed under their feet and equipment and a tunnel appeared, leading to a group of artificial tunnels, caves and tombs, containing skeletons, pottery vessels, turtle remains and the bones of what appeared to be a giant bird.
A team of experts from the Antiquities Authority suggested that the site dates from the Byzantine period and is more than 1,400 years old (Fig. 11). The site was buried, and these antiquities have not been excavated until today (General Culture Authority (GCA), Libya, Sirte Office, unpublished report).

Figure 11. Archaeological site in the Giza district.
(Photo.©. General Authority for Culture Sirte office)

This untapped tourist attraction, together with many historical monuments and landmarks of a modern character, provides an excellent basis for tourist attractions in the Sirte region. There are 11 sites classified as tourist attractions (Table. 10), and the beaches of the city of Sirte itself are considered among the most important tourist attractions, as most of them are still pure and in their natural state.

Table 10. Tourist attractions in Sirte.

Site	Type	Category	Description
Sultan	Historical city	2	Historical Islamic city
Hassan Palace	Historical Palace	3	Historical Palace and building
Philaeni brothers	Bronze statues	3	Bronze Italian statues
Abu Njaim Fortress	Ottoman Fortress	3	Castle built in the Ottoman era
Roman Village	Historical Village	2	Historic Byzantine buildings
Ouagadougou Halls complex	Modern buildings	4	Modern conferences halls
The Christian cemetery	Historical cemetery	2	Christian cemetery from 5th century AD
Al-Qordhabia	Memorial	4	A memorial to the martyrs of Al-Qordhabia battle
Al-Qordhabia	Enormous water reservoir	4	Man-Made river water reservoir
Girza	Historical Village	3	Small village from Roman Period
Girza	Stunning nature	1	Cold water spring

Source: Urban Planning Authority, Libya, The third-generation scheme project. 2007.

Despite the location of Sirte as a transit point between Tripoli, Cyrenaica and Fezzan, the structure of the tourism sector is somewhat weak due to the security situation and the repeated wars that the city has experienced, as the number of hotels in the city has decreased from 11 hotels in 2007 to only two hotels in 2020. The (Table. 11) shows the decline in the number of hotels in Sirte over the last decade.

Table 11. Number of hotels in Sirte.

	1 star motels	**2 stars motels**	**3 stars motels**	**1 star hotels**	**2 stars hotels**	**3 stars hotels**	**4 stars hotels**	**5 stars hotels**	**Total**
2007	2	1	1	0	1	4	1	1	11
2014	1	1	2	1	0	0	0	0	5
2020	0	1	0	0	1	0	0	0	2

Source: 1- Urban Planning Authority, Libya, The third generation scheme project. 2007.
2- Bureau of Statistics and Census (BSC), Libya, The Statistical book 2014
3- Study team, Field visits.

The tourism sector is one of the most promising sectors in the Sirte region, but it is necessary to develop the infrastructure of the sector and to spread the culture of dealing with tourists, with emphasis on protecting the cultural and historical heritage of the region according to Law No. (2) of 1983 and Law No. (3) of 2001, which provide the legal basis for protecting Museums, archaeological and historical areas as special areas.

4. Economic activities and Livelihoods

4.1 Population development in the region:

Population growth is one of the most important variables that explain the evolution of the population during the census periods, the population of Sirte Center, which is the area within

the scope of the approved plan, which was called Qasr Sirte or Sirte Market in 1954 AD, 4877 people and became 6423 people in the year 1964.

In the year 1973 the population of the city reached 8408 people, and in the year 1984 there was a significant increase in the number of inhabitants, reaching 18,395 people, and this period is considered one of the highest rates of population growth, and in the 1995 census, the city's population reached 27,700 people.

Between 1995 and 2006, the population increased (104.6%) to reach 56,681 people, due to the change in the functional structure of the city after it became the first administrative headquarters in Libya, which doubled the role of the city and expanded its area as a result of the increase in population due to the migration factor to the city, in addition to the natural increase (Basheer Al-Subaie, 2009). Finally, in the 2012 National Population Survey (NPS), the city's population was 78488, an increase of 38.5%.

Population growth is one of the most important variables that clarify population development during the census periods. The table 12 shows the growth rates of the population of Sirte from 1954 to 2012, as we note that the growth rate during the first ten years (1954-1964) reached 3.1% and from (1964-1973) That is, during nine years, the growth rate reached 3.4%, while the period from (1973-1984) for the period of eleven years the growth rate increased to reach 10.7%, and this period is considered one of the highest rates of population growth. But during the period from (1984-1995), the growth rate was about 4.6%, and we notice here a decrease in the growth rate from the previous rate due to the dependence of the population increase on the natural increase of births and that the migration factor has become less after the population situation of the city of Sirte stabilised after the oil boom and the fall in oil prices during this period, which in turn was reflected in the development In the housing field and the decrease in housing allocations. As for the period of the year (1995-2006), the growth rate reached about 9.5%, and this period was characterized by an increase in the rate of population growth, due to the change in the functional composition of the city, as it became in that period the administrative headquarters of the government in Libya, which doubled The role of the city and the expansion of its area as a result of the increase in the population resulting from the migration factor to it in addition to the natural increase, as for the last period (2006-2012) the growth rate reached about 6.42%.

Table 12. The Population and Growth

Census Year	population	Growth rate %	population increase	Period/Years	Percentage of increase %
1954	4877	-	-	-	-
1964	6423	3.1	1546	10	**31.7**
1973	8408	3.4	1985	9	**30.9**
1984	18395	10.7	9987	11	**118.7**
1995	27700	4.6	9305	11	**50.6**
2006	56681	9.5	28981	11	**104.6**
2012	78488	6.42	21807	6	**38.5**

Source: 1- Basheer Al-Subaie, 2009.
2- Bureau of Statistics and Census (BSC), Libya, NPS. 2012.

28

4.2 Education

The educational buildings are distributed all over the city of Sirte to serve the population according to its density, and the percentage of education in the city has increased in recent years and this is due to the increase in the population and the development of educational institutions, as the number of educational schools in the Sirte region reached 114 schools, 91 of which are for basic education (primary and intermediate education) and 23 schools for secondary and technical education. In the school year (2010-2011), the number of students in basic education reached 24,413, and the number of teachers for basic education was 2372, which is an average of one teacher for 10.3 students, while in secondary education the number of students was 4634 and the number of teachers was 427, which is an average of one teacher for10.85 students (Table. 13).

Table 13. Number of students and teachers in primary and secondary schools.

Year	Number of Pupils and Students	teachers			The number per teacher	Reserve Teacher	Number of Schools	Number of Class	Class size
		Full-time	reserved	Total					
Basic education	24413	2118	254	2372	10.3	10.71	91	1151	21.2
Secondary stage	4634	374	53	427	10.85	12.41	23	214	21.7
Total	29047	2492	307	2799	-	-	114	1365	-

Source: General Information Authority (2015)

As for university education, the University of Sirte was established in 1989 as branch of the University of Garyounis, then in 1992 it became an independent university under the name of "Al-Tahaddi University" and in 2010 the name of the university was changed to Sirte University, since then, the University has been expanding to become one of the most important and prominent scientific institutions in Libya, as new faculties and departments have been created in it, and the number of scientific and student cadres has been steadily increasing. the university currently has (10) faculties, and there are departments of faculties in the cities of Zamzam and Abu Qurain.

In order to create a suitable climate for academic achievement and scientific research and to enrich research trends among postgraduate students, the University prepares its various correspondences to provide sources, references and documents that exceed 100,000 of these works, and in the same framework, the Language Centre has been established to teach English to graduate students and candidates for studies in English language.

In order to keep up with modern technologies in the field of communication and the use of computers, the Information and Communication Technology Centre has been developed and equipped, in addition to many research and consultancy centres to provide technical advice. The most important of these centers are the University's Research and Consulting Center and the Agricultural Research Center. (http://su.edu.ly/en/index.php/about-su/history)

29

The number of students reached 11,853 in the academic year (2014-2015), including 9,180 female students and 2,673 students, where the number of teaching staff members was 899, the number of teaching assistants was 327, and the number of technicians and employees reached 1504 (Tables. 14 and15).

Table. 14 Number of students at the University of Sirte (2014 -2015)

city	Libyan students			foreign Students			Total		
Sirte	Male	Female	Total	Male	Female	Total	Male	Female	Total
	2617	9100	11717	56	80	136	2673	9180	11853

Source: General Information Authority (2015)

Table 15. Number of Staff at the University of Sirte (2014 -2015)

City	Faculty Members			Teaching Assistants			Staff and Technicians		
Sirte	Male	Female	Total	Male	Female	Total	Male	Female	Total
	685	214	899	79	248	327	953	551	1504

Source: General Information Authority (2015)

4.3 Agriculture

The agricultural sector plays a role in development in its economic, social and environmental dimensions. The comprehensive agricultural development that began in 1972, when several valleys were cultivated in the central region. These dry valleys were pastures for animals and were developed to create rural agricultural housing complexes.

And to settle the population in these valleys. As we know that most of the inhabitants of the Sirte region and its surroundings are nomadic or semi-nomadic, and the nomadism is a basic characteristic of them.

The stability of these populations requires the development of the areas in which they live in order to limit migration to the city or other towns, and to create a rural, agricultural society capable of adapting to the natural environment. Indeed, Wadi Jarif, Tilal, Al Qubeiba, Harawa, Bin Jawad, Tamt, Azkair, Zamzam, Abu Nujim, Al Washaka, Marah, Bay Al Kabeer, Al Lud, Al Hanawah, Al Amerah, in addition to the coastal strip extending from the city of Sirte to Bin Jawad Including Al-Qardabiyah have been reclaimed and cultivated (Basheer Al-Subaie, 2009).

the most important insect affecting the barley crop in the 1995/96 agricultural season were wheat stem sawfly (Cephus spp.), only in the Sirte region, with an infection rate of 50%. The results also showed that there were no clear insect infestations appeared on the wheat crop during this season (Mustafa Al-Bouhsini and others 2003).

Despite the difficult natural conditions, the agricultural economy of Sirte region constitutes the lifeblood of the Libyan economy. Among the current negatives is the development of traditional agriculture through the expansion of small population centres and their spread around cities.

30

In 2005 the share of agricultural production in the region was small compared to agricultural projects whose area is estimated at 15,300 hectares, which is 18% of the irrigated areas in the region, and the region has good agricultural potential, especially in the north of the region, where there are 37,400 hectares of agricultural land, and the predominant agricultural production of Olive trees, palm trees, in addition to the cultivation of cereals, the most important of which is barley, as well as vegetables and fruits. The (Table.16) shows the total agricultural production in the in the Sirte region for the year 2005 (UPA, Libya, The third-generation scheme project. 2007).

Table. 16 The total production in the agricultural sector in the Sirte region (2005)

	Area (Hectares)		Quantity (ton)	Yield
Grain	Barley	10445	28724	2.75
	Wheat	959	3117	3.25
	Feed		1,693,000	
Trees	Olive		Palm	
	Yield / ton		Yield / ton	
	17,474,000		12142	

Source: (Ibid, Tab. 22).

Libya made huge investments in the agricultural sector, and a large part of this money was spent to reclaim lands, establish integrated agricultural settlements and establish modern farms, and these huge investments in the agricultural sector led to the reclamation and reconstruction of large areas of irrigated and rainfed lands (Rainfed Agriculture), which witnessed a significant decrease in Its area, and in the percentage of what it constitutes of the total agricultural land (Table. 17), its percentage decreased from 97.3% in 1974 to 15.8% in 2007, and this continuous decrease in rainfed lands is due to the conversion of some of these lands to irrigated agricultural, and most importantly, agricultural crops grown in rainfed lands are mainly barley, some areas of wheat and some legumes (Oweidat. F. 2008).

Table. 17 The area of Rainfall lands and Irrigated lands in Sirte region (1974 – 2007).

Irrigation type	**1974**		**1987**		**2001**		**2007**	
	Area (hectares)	**Percent %**	**Area (hectares)**	**Percent %**	**Area (hectares)**	**Percent %**	**Area (hectares)**	**Percent %**
Rainfall Agriculture	203982	97.3	70566.2	92.2	26817	72.3	10147	15.8
Irrigated agriculture	5565.7	2.7	5990.8	7.8	10289	27.7	54157	84.2
Total	209547.7	100	56557	100	37106	100	64304	100

Source: 1- Bureau of Statistics and Census Libya, Agricultural censuses and surveys 1974 & 1984
2- General Information Authority (GIA) Libya, Agricultural censuses 2001 & 2007

Local agriculture has an important role in the economic and productive movement,providing products that meet local needs as well as employment opportunities for family members, but it is necessary to develop the agricultural policy in the city in the long term, and some measures should be taken to meet the challenges and develop the local economy, the most important of which are:

- Planting of fruit trees to protect the soil from erosion and desertification.
- Using drip irrigation to rationalise water use.
- The Reduction of irrigated areas to reduce evaporation and water consumption.
- Using of treated wastewater fo irrigation.
- Protecting agricultural land from urban and industrial expansion.

4.3.1 The artificial River

The multi-phase of the artificial River project is listed in the 2008 Guinness Book of Records as the largest irrigation project in the world and is the largest water construction project ever undertaken. Libya is a desert country that survives on poor-quality groundwater and desalination plants, but in 1953 the search for oil led to the discovery of large quantities of fresh water. (https://www.cranebsu.com/en/project/view/id/82).
The project consists of a network of 4-metre diameter pipes stretching over 4,000 km to form underground water channels, and more than 1,300 wells, most of which are more than 500 metres deep, producing 6.1 million cubic metres of fresh water a day for the cities of Tripoli, Benghazi and Sirte and others.

Work on the project began in 1984 and was divided into five distinct phases (Fig. 12).:

- The first phase: Inaugurated in 1991, it supplies 2 million cubic metres of water per day from Tazarbo and Al Sarir to the cities of Benghazi and Sirte, with a pipeline length of 1,200 km. This phase is now operating at full capacity.
- The second phase: it officially inaugurated in 1989 and is now operating at full capacity. It transfers 2.5 million cubic metres of water per day to Tripoli and Al-Jafara, with a pipeline length of 2115 km.
- The third phase: completed in 2010, connects the Kufra and Tazarbo fields. It is 380 km long and transports 1.68 million cubic metres of water per day.
- The fourth stage: is divided into two parts. The first linking Al-Jaghboub to Tobruk has been completed and it transports 0.138 million cubic metres of water per day over a length of 500 km. The second part, which has not yet been completed, and is intended to connect Ghadames, Zawiya and Zuwara to the well fields located in southwest of Tripoli, over a length of 621 km, and to transport 0.25 million cubic metres of water per day to these cities.
- The fifth stage: has not yet been completed. It will be a small relative link between the first phase and the second phase, to transport 0.98 million cubic metres of water per day over a distance of 190 km (V. Gonnelli, C. Peruzzi. 2015).

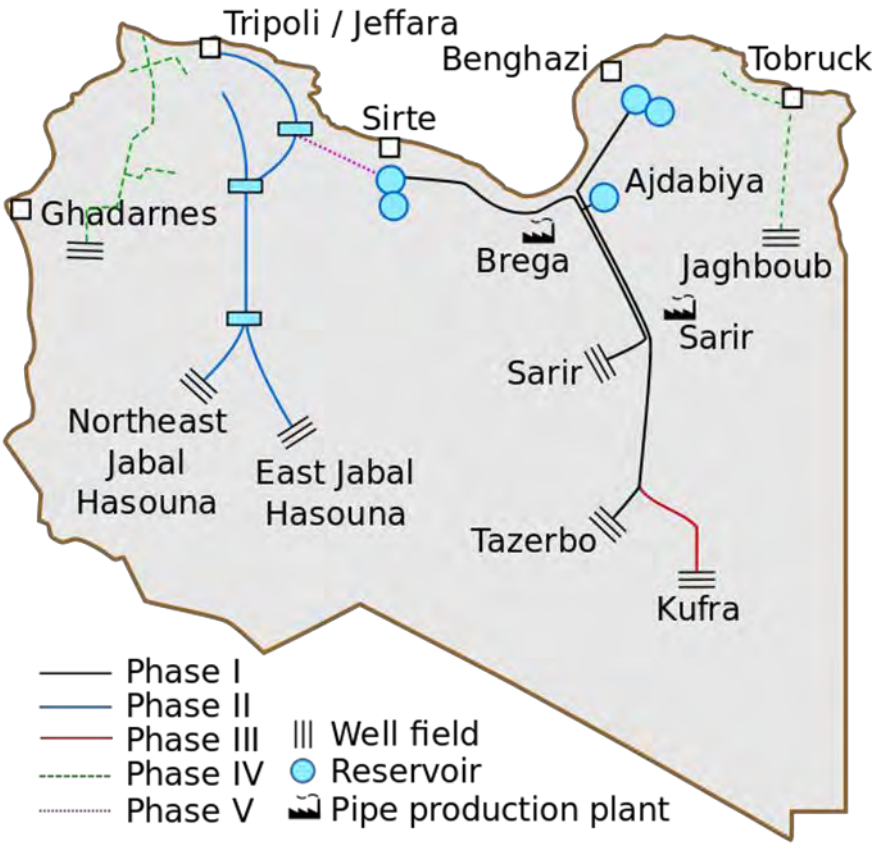


Figure 12. The 5 phases of the Great Man-Made River Project (GMRP).

The first phase of the project is the largest phase, transporting 2 million cubic metres per day from the Kufra and the Sirte Basins, which are huge basins, larger than most of the American Great Lakes. (CIA. 2011) The pipelines extend for a distance of 1,200 km from Sirte Basin to reach the Ajdabiya reservoir, which has a capacity of 4 million cubic metres, then it is distributed to Benghazi and Sirte through two pipelines, one heading north towards Benghazi and the other west towards Sirte to flow into the reservoir "Great Al-Qordhabiya" with a capacity of 15.4 million cubic metres and a diameter of 1182 metres, it is for agricultural purposes (Fig.13).

Figure 13. Subsurface water potential of basins in eastern Libya compared with the volume of the great lakes. (CIA. A research paper declassified in part. 1987)

and a reservoir (Small Al-Qordhabiya) with a capacity of 6.8 million cubic metres and a diameter

33

of about 850 metres, which is for domestic use. (Director of the Media Department of the Industrial River Water Investment Authority - personal interview) (Fig. 14).

Figure 14. Aerial view of the large Al-Qordhabiya reservoir. (Google Earth imagery)

Through experts' field visit to the artificial River Water Investment Authority and the meeting with the Director of the Media Department, who stated that the management and investment of the artificial River project in the Sirte region is divided between two government agencies:

Artificial River Authority: It is concerned with the supervision of the small Al-Qordhabiya reservoir, the maintainance of the supply lines, pumps and pipes, in addition to supplying drinking water to the city's reservoirs of the Sirte Water Company.

Water Utilization Authority for artificial River: It is concerned with the managment of the agency's large farm and agricultural projects (Table 18) and supervises the supply of irrigation water supply to small farms. The agency also supervises some other projects, namely:

- Al-Qordhabiya Nursery: It produces seedlings of fruit trees, fruits, vegetables and forest trees and is marketed to farmers.

- Cows project: It includes about 400 heads of cows that are invested in the manufacture of pasteurized milk.

- Al-Qordhabiya Dairy Factory: The factory's production decreased from 10,000 litres of milk and 3,000 litres of sour milk per day in 2014 to about 4,000 litres of milk and 1,000 litres of sour milk per day in 2020.

- Cheese Factory: It is a factory for the production of various types of cheese such as "mozzarella", pressed cheese and others, and it is currently not operating.

Table 18. large farm projects and agricultural projects.

No	Project	Location	Area (Hectares)

34

1	Small farms	Al-Sawawa & Abo-Zahia	5271
2	Al-Gbaiba	Al-Gbaiba	195
3	Jaref	Jaref	759
4	Sultan & Al-Amra	Al-Henewa & Al-Amra	1035
5	Besher	200 km east of Sirte	558
6	Al-Gharbi project	South of Etlal	494
7	Al-Gharbi project	North of Etlal	498
8	Al-Zeed	Etlal	170
9	Al-Naufalia	Al-Naufalia	1000
10	Al-Henewa	Al-Henewa	561
11	Al-Thalatheen	Al-Thalatheen	1173
12	Herawa	Herawa	486
13	Great farms	Al-Qordhabiya	7200
14	Ezkair & Tamet	Ezkair & Tamet	1000
15	Al-Qordhabiya plant nursery	Al-Qordhabiya	79

Source: UPA, Libya, The third-generation scheme project. 2007, Fig. 22.

4.4 Land use in the city of Sirte

4.4.1. Residential use

The number of housing units in 2002 amounted to about 6960 housing units, and the total area of residential areas in Sirte is 4045 hectares, which is 26.6% of the total area. The existing population density ranges from 80 persons per hectare in the area of low population density, to more than 200 persons per hectare in the central area, and the low population density is due to the large proportion of buildings with one and two floors and the presence of vacant land within the plan.

Most of the housing units are single family dwellings, as (8.7%) of these units are located in multi-storey buildings, which are the new buildings located in the south and north of the city.

The housing units are located in a group of residential neighbourhoods distributed over the city, as they are connected by service roads leading to the service areas of the neighbourhood or the neighbourhood in general. The percentage of occupancy in residential buildings in the city of Sirte reaches (100%), as there are no vacant housing units, and that the housing density in these neighbourhoods varies according to the location of the neighbourhoods from the city centre or urban centre. It reached 37 persons per hectare, as the population of Sirte, according to the 2006 census, reached 56,681 persons for the four localities, and the area of the exploited plan in 2006 amounted to approximately 1,327.28 hectares.

The total number of buildings intended for residential use is only 4419, while the number buildings used for both residential and commercial purposes is 445.

The area of residential land use reached 510 hectares in 2006, which represents 38.4% of the city's land use area compared to other uses.

4.4.2. Educational use

Educational services are important and necessary in any city, and the population depends on it to receive various sciences, and it reflects the civilized face of the city.

The area of land allocated for educational use in the city of Sirte was about 74.9 hectares, with a rate of (5.6%) in 2006, which is a high percentage compared to other uses and in previous years, as it was 61.8 hectares with a rate of (4.9%) of the total area of land use in 2002.

4.4.3. Hygienic use

Health services are a priority in terms of land use, as health facilities vary from a health centre to a hospital, and each facility has a specific area according to the density of the neighbourhood or the residential area in which it is located.

The area of land used for health purposes in 2002 was about 40.6 hectares, including the new hospital with a capacity of 200 beds, 5 basic health care centres, 2 complex clinics, and a specialized centre for communicable diseases and their control, i.e., 2.6% of the total use.

The number of health facilities in the city of Sirte amounted to 15 health facilities, which represent about 40.8 hectares, which is the total use of health facilities in the city of Sirte in 2006, at a rate of (3.07%) of the total uses.

4.4.4. Administrative and service use

The services are diverse and distributed throughout the city’s neighbourhoods, so the administrative use is of great importance in the concentration of official departments and offices, and it is directly proportional to the role that the city plays and the development and multiplicity of its functions.
In 2002, the area of land occupied by administrative and service buildings increased to 67.0 hectares, representing 4.4% of the total use, and we note here an increase in the area of land allocated for this purpose, which is the period during which the government and parliament moved to Sirte, and an integrated complex for the higher administration was built in the city of Sirte, on an area of 42 hectares, which doubled the area for administrative use in the city.
The area of land occupied by the administration increased to 97 hectares in 2006, representing a rate of 7.3%) from the total different uses. this a clear indication of the tremendous development of administrative services in the city of Sirte after the diversification of jobs and the increasing importance of the city, and it has become the headquarters of many ministries and service companies, and with-it other services have increased, and the shape of the city’s plan and its urban fabric have changed over the last twenty years as a direct result of the simultaneous increase in the administrative and political functions.

4.4.5. Industrial use

The industry is linked to the production processes, consumption and labour use of the city's residents, and is therefore one of the basic activities of the city, representing a permanent movement in the geographical space that is associated with it.

36

In 2002, the total area occupied by the industry was 2.8 hectares (1.2%), while in 2006 this area decreased to 2.5 hectares (0.18%) of the total area of the approved plan, this is due to the fact that the industrial zone has been completely transferred from inside the city to outside it, leaving only some transformative industries, such as bread making, water purification, and small mills.

4.4.6. Commercial use

In 2006, the total area used for commercial purposes was 29.2 hectares (2.19%) of the total area of 1327.28 hectares.

It should be noted that the area of land used for commercial purposes has increased, as it included markets for vegetables, animals, and various commercial stores.

4.4.7. Transport services

Transport plays an essential role in linking residential and urban areas and has a clear role in the development of all regions. Transport represents a high percentage of land use for what it occupies of the land, whether it is for streets, roads, warehouses, transport workshops and parking lots.

The length of the road network in the city of Sirte is about 161 km long, and the density of roads to the population is about 208 km per 1000 people, which is a high percentage, and this indicates that the streets and urban roads are eligible for urban growth, and the width of the roads ranges from 30 metres to 10 metres.

4.4.8. Recreational use

Each city has specific areas that are identified in the plan, divided into empty spaces, green spaces in the centre of the plan and around the city, and recreational areas. These areas are distributed throughout the planned the urban area, so that they include all residential neighbourhoods, and benefit all residents, and these areas include the beaches of the seas, forests, parks and various playgrounds.

In 2006, the total area used for recreational purposes was355.63 hectares, including green areas, parks, playgrounds, open space and private areas, which represents (26.2%) of the total area of 1327.28 hectares.

4.5 Environment

4.5.1. Desertification

The Sirte region is mostly located in arid area with the exception of the coastal strip around the city of Sirte which is dominated by the semi-arid climate, and is therefore characterized as a fragile ecosystem if it does not manage its resources well, as it is the most vulnerable environment to desertification, the characteristics and manifestations of which are soil erosion, sand dune encroachment, urban encroachment on agricultural land, decreasing the groundwater level and increasing its salinity and soil salinity (Oweidat. F. 2008).

Areas near marshes have high salinity in soil and water, and the groundwater level is close to the surface of the earth, as through the study conducted by the Agricultural Research Center (ARC) for the Al-Thalatheen region, west of Sirte, in 2001, it was found that the groundwater level ranges from 1 meter to 8 metres (Table 19), and analyses of water samples collected from some wells indicate that it is highly saline. The results of the analyses showed that the

37

Total Dissolved Salts amount to 132 g/litre and not less than 17.5 g/litre, as shown in (Table. 20).

Table. 19 groundwater level in Al-Thalatheen region

Sector - Board	Depth (m)	Sector - Board	Depth (m)
1-3	1.35	1-53	1.10
1-2	1.00	4-82	1.50
1-14	1.70	4-103	3.00
2-14	1.50	4-53	5.00
4-18	1.80	4-61	4.00
3-28	1.20	2-66	7.00
4-28	1.10	1-109	8.00

Agricultural Research Centre (ARC) Libya, Agricultural survey for the Al-Thalatheen region west of Sirte, Final report, 2001. P. 91.

Table 20. analysis of ground water samples from Al-Thalatheen region.

Sample source	Sector - Board	pH value	TDS (g/L)	Bicarbonate	Carbonate	chloride	Sulfate	Calcium	Magnesium	sodium	Potassium
				Milliequivalents per liter (mEq/L)							
Well	4-53	7.0	86.0	2.2	-	731	160	156	104	630	7.4
Well	2-66	7.4	17.5	2.0	-	137.5	70	32	35	125	1.3
Section	1-14	7.3	132.0	2.0	-	1200	170	184	133	1087	10.6
Section	4-82	7.6	86.5	1.8	-	720	150	176	96	609	7.8

Agricultural Research Center (ARC) Libya, Agricultural survey for the Al-Thalatheen region west of Sirte, Final report, 2001. P. 91.

4.5.2. Municipal Solid Waste

Municipal Solid Waste (MSW) management in the city of Sirte and its suburbs in terms of collection, transport and final disposal is done by the Public Services Company (PSC), which is a government company responsible for managing solid waste in the city in addition to several other tasks, including the control of harmful insects and rodents, the planting and

taking care of the ornamental plants in the streets and public squares, and cleaning beaches and public resorts.

According to reports from the Public Services Company, the daily average household waste collected from the city is 90 tonnes, which is disposed of in an open landfill 9 km from the city centre to the west and only 150 metres from the sea shore. The (Fig. 15) shows the location and size of the landfill.

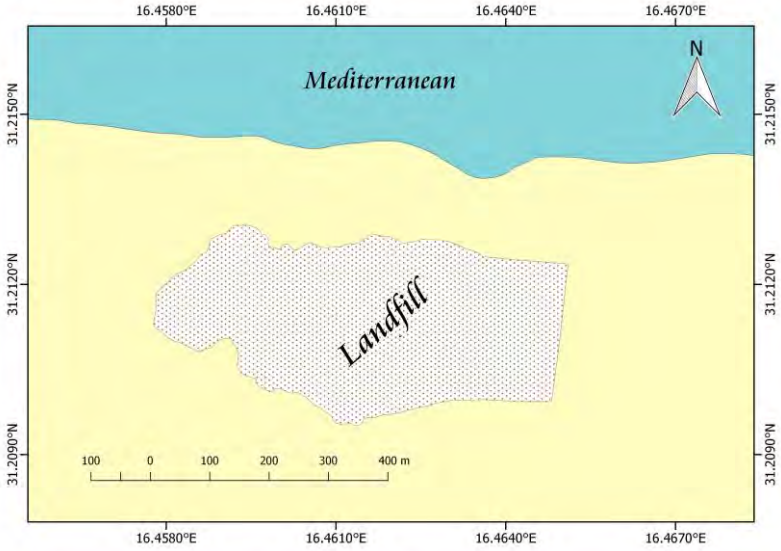


Figure 15. Public landfill for the city of Sirte.

With a population of 78,488 according to the 2012 National Population Survey, the city's per capita waste generation is 1.15 kg/day, which is close to the rates of North African countries (Table. 21).

Table 21. Current Waste Generation Per Capita in NA Countries

Country	Average Waste Generation Per Capita (kg/capita/day)
Egypt	1.37
Tunisia	0.81
Algeria	1.21
Morocco	1.46
Mauritania	0.50

Data source: Hoornweg, Daniel; Bhada-Tata, 2012. ANNEX J, p. 80-83.

There is no previous study on the components of solid waste in the city of Sirte, but estimates of the Environment General Authority indicate that about 60% of solid waste is organic materials, while the remaining proportions are distributed between paper, plastic, glass, etc, (Table. 22) shows the estimates of the percentages of MSW components in Sirte.

Table 22. estimation of the percentages of MSW components in Sirte

MSW Composition	Percent %
Organic	60

39

Paper	12
Plastic	14
Glass	2
Metal	4
Other	8

Source: EGA, Libya, (Unpublished reports)

4.5.3. Environmental awareness

It is believed that increased environmental awareness will reverse the misuse of the environment and its resources. Four decades after the international call for environmental education, earth's degradation is far from abating as it's pristineness is being continuously and irreversibly being eroded by no less than from anthropocentric activities. To protect the environment therefore, we must refocus the environment education to change people's view of the environment and their attitudes towards the use of its resources. Environmental education can become more effective in creating respect for the environment (Omoogun, Ajayi C. et al, 2016).

Through the study team's field visit to the Sirte Education Directorate and meeting with the director of the "school activity department" in the directorate, he stated that there is a focus by the activity department on environmental awareness programmes through awareness activities and competitions on various environmental issues in cooperation with the Environment General Authority, Sirte branch, the latest of which was organizing An environmental day for students of several schools together that includes a drawing, artistic and theatrical workshop on environmental pollution of the earth presented by the students, during which they embodied a dialogue between the planet and some living creatures such as the tree, dolphin, sea turtle and others (Fig. 16), and the Activity Department annually organizes some artistic and literary competitions on the environment in general.

Figure 16. Education activities in Sirte schools. (Photo.©. S.Diryaq. LibSTP)

The Libyan Sea Turtle Conservation Programme (LibSTP) has carried out several awareness-raising activities with schoolchildren in the city of Sirte through unconventional activities such as drawing a large sea turtle on the beach, collecting plastic littered on the beaches and putting it into a sea turtle shape. The aim was to teach the students about the importance of the sea turtle in the marine ecosystem and at the same time to make them aware of the problem of plastic waste and the dangers it poses to living organisms (Fig. 17).

Figure 17. Education activities on beach in Sirte. (Photo.©.A.Alhrary: LibSTP)

4.0 Cultural value

The location of the city of Sirte in the centre of northern Libya and the diversity of its social composition make it a culturally diverse city, as it combines the cultural heritage in eastern and western Libya in terms of geographical location and in terms of the tribal and social composition of the city, about 32 tribes inhabit the city of Sirte and its suburbs (Agostini, Enrico de. 1917). Each tribe has its own cultural heritage, customs and traditions, taking into account the presence of many complex overlaps between the customs and traditions of the various tribes.

Considering that most of the people who live in the city and its suburbs are Bedouins, most of the heritage is related to the Bedouin authenticity, and the environment in which the fathers and grandfathers lived in, so you find, for example, many residents still practicing sheep shearing or what is known among the people (al-Majez), in the month of May every year, Bedouin tents are set up, sheep breeders and families gather to shear the sheep in the traditional way, accompanied by singing and poetic chants.

weddings are not devoid of various styles of popular poetry for women and men alike, women sing a type of quadruple poetry called (Grindstones Songs) in addition to another type called (Al-Alem song) which men also sing along with (alkeshek), (al-tobela) and (dammat al-gasha), which are all types of poetry specific to men, usually, the words of songs have specific connotations about the state of those who sing about them, and sometimes they are a coded message to the beloved who listens to the men's songs with other women..

After the independence of Libya, the city of Sirte witnessed a remarkable development in its population, which reached 4,877 in 1954, that was accompanied by a development in the city's cultural activities, as the Sirte Scouts Regiment was established in November 1960, followed by the Khaleej Sirte Sports & Cultural Club in May 1963 from which the "Sirte national theater troupe" emerged, during that period, the troupe presented some theatrical performances and was particularly famous for its "monologue" art.

41

Many writers, poets and artists emerged from the city of Sirte from that era. In the field of writing and literature, the famous writer Omar Ramadan, and among the poets was Abdul Muttalib Al-Jamii, Amr Al-Janjan and Ali Al-Kilani. and on the stage of the Sirte theater, the theater artist Muhammad Al-Kour, who was famous in Libya, appeared as "Bennour".

Recently, the Sirte culture Office has played a prominent role in promoting culture in the city of Sirte and in Libya in general, so the cultural movement in the city has been active in the recent years by reviving the city's 3 cultural centres, establishing a library (Mustafa Al-Tarouq Cultural Library) and providing it with more than 2000 titles. The poetry forum was also established, and in 2017, a “cultural salon” was established in the city, which brought together those interested in culture to discuss many cultural aspects. Also, Sirte Cultural Radio and Amwaj Radio for Youth were opened in addition to the local Sirte radio station of the municipality of Sirte.

All these activities led to the Sirte Culture Office winning the award for the best cultural office in Libya for the year 2018.

4.7 Fishing

The Libyan government started to develop the fisheries sector by building several ice plants along the coast and increasing the demand for fisheries products. In 1986 a new port was established at Zuwara (northwestern coast of Libya), Moreover, the Libyan authorities have signed fishing agreements in the field of joint development with neighbouring countries, such as Tunisia and Spain (Metz, 1989; Khalaf Allah et al. 2015). In 1988, the Libyan government established the Public Authority for Maritime Resources (SMW) to develop the marine industry. The SMW is funded by the government to manage approximately 24 marine fisheries cooperatives (Khalaf Allah et al. 2015). During this period, the SMW initiative, supported by significant contributions from the Libyan authorities, led to the development of the sector in terms of trade, receiving, trading and distribution. The facilities have been greatly enhanced. Especially in the last few years that have followed the privatization of most of the marketing chains (FAO, 2005).

These fishing cooperatives were set up as fishing centres on the Libyan coast, with the aim of providing the necessary requirements for an artisanal fishing boat. Therefore, it was open to all fishermen holding a good boat and a valid fishing license issued by the fishing authorities, Moreover, a fishing agreement was signed between Libya and Egypt in 1995, which allows Egyptian fishermen to work in Libyan waters in the event that 20% of their total catch reaches Libya (European Commission Study, 2011).

In 2000, the Libyan government implemented a policy of decentraliation, = replacing SMW and delegating its functions to “municipal” local authorities (Reynolds et al. 1995; Osman and Karlberg, 2007; Khalaf Allah et al. 2015). As an indicator, it grew from almost 6,000 tonnes in 1988 to around 50,000 tonnes in 2000. In February 2005, Libya established the Exclusive Economic Zone (EFZ) extending 62 nautical miles from its territorial waters and covering 220,000 square kilometres (Milanes et al., 2008; European Commission Study, 2011).

In May 2009, Libya declared an exclusive economic zone (EEZ) of 335,120 km2 (European Commission, 2011). This has been very beneficial for artisanal fisheries.

The fisheries sector in Libya is based on the following main activities: Artisanal fishing (Batah fishing, Flouka, Mator and lampara), coastal cliffs, tuna fishing. Sponge fishing is not considered important (Reynolds at al., 1995; FAO, 2005; Khalfallah et al.).

Most fishing is done by artisanal boatsusing nets (trawls and gillnets) or hooks (longlines and handlines). During the survey in 2000, 1,866 literal fleets were counted in 135 landing sites (beaches, berths and ports), most of them concentrated on the western side of the country (Tripoli area). The table No.23 shows the distribution and percentage of fishing vessels in three regions on the coast, about (55%) of the artisanal fishing boats are located in the Tripoli section, while the other two areas share 23% in the Gulf of Sirte and 22% in the Green Mountain (Table. 23) (Lamboeuf et al. 2000& Filogh,2019).

Table 23. Boats in Tripoli, Sirte and Green Mountain

Boat type	Region		
	Tripoli	Sirte	Green Mountain
Batah	65	-	3
Flouka	662	211	262
Mator	187	192	149
Lampara	115	19	1
Total	1029 (55%)	422 (23%)	415 (22%)

4.8 Health

The government provides free health care to all citizens, through a series of public health facilities, providing health care services and regulating the growing private health sector. Libya spent 3.3% of its GDP and 7.5% of general government expenditure on health services in 2007. Although the health service is free for all citizens, but 20% of spending on health is external expenditures paid for private care, whether in the country or abroad (WHO 2010-2015).

Health services are all the means provided by the state to take care of the health of its citizens, whether in its public sector or within the private sector, including all hospitals, clinics, health centres, financial allocations and human resources such as doctors, nurses and all those working in this field. Health services are divided into primary care services and preventions. According to data from the World Bank, spending on health care is very high, with per capita spending on health care not exceeding 200 dollars per year in many countries. According to World Bank figures, the per capita expenditure on health care in Libya is 433 dollars per year. Spending on health is around 4% of the gross domestic product, and the state covers around 93% of the total spending on health according to official figures from the Ministry of Health,

43

and these figures are considered good compared to the level of health spending in the rest of the Arab countries (The Libyan Organization for Policies and Strategies, 2016).

According to the statistics, the number of public health centres has reached 29 health centres, including one hospital, one polyclinic, one village hospital, 11 health centres, 29 primary health care units and one dental centre, and (table. 24) shows the number Health centres.

The number of public clinics reached 6 clinics, as for private clinics, one clinic, and dental clinics, 3 clinics, and the number of pharmacies reached 52 pharmacies and 5 laboratories. The (Table. 25) shows the number of clinics, pharmacies, and medical analysis laboratories.

Table 24. Central and primary Health Care Centers in Sirte

Year	Central	Suburban	Combined Clinics	Health Centers	Teeth Centers	Health –Care Units Primary
2013	1	1	1	11	1	29

Table 25. Private and Government participatory Clinics in Sirte

year	No. private	No. Beds	No. Clinics	Teeth Clinics	Pharmacies	Labs
2013	**1**	**11**	**6**	**3**	**52**	**5**

5- Results:

5.1 Key Informants Interviews

Qualitative methods are often based on interviews with a relatively small number of individuals with particular characteristics (Patton MQ, 2002). The main advantages of the key informant technique lie in the quality of data that can be obtained in a relatively short period of time. Obtaining the same amount of information and insight from in-depth interviews with other members of a community can be prohibitively time-consuming and expensive. (Lincoln and Guba, 1985.).

In this study, 21 interviews were conducted with key informants from 8 sectors (Table. 26), including 18 men and 3 women, with a rate of 14.3%. Most of the interviews were conducted face-to-face, while some were conducted by phone between 20 October and 20 November 2020, some of the interviews were videotaped and some were audio-documented, while the rest of the interviews were documented in writing.

The data was coded according to events, behaviours, activities, meanings, etc., the qualitative analysis of the data was examined in order to identify the themes, patterns and relationships between local partners and the fishing sector in the Gulf of Sirte.

Table 26. the number of KIIs according to their institutions

Sector	No. KIIs
fishing Sector	6
Municipality	3
Culture and Media	2
Sirte University	3
Environment	2
Education	1
Water and Sanitation	2

44

(NGOs)	2
Total	21

5.2. women's role in the society

The views of the KIIs are unanimous on the limited role of women in promoting the economy, especially with regard to the fishing and tourism sectors, but their role is particularly prominent in the education sector, with 16 of the KIIs mentioned that they have a teacher at home, at a rate of 76.2%, and their role is also highlighted in the health sector and in civil society organisations.

In the city of Sirte, there are 3 women-led civil society organisations specialised in defending women's rights (Table.27), althought their role in the fishing sector was limited to "preparing baits and cleaning equipment," and they did not have any role in practicing fishing or even marketing fish production. Their role in leadership positions and in planning and decision-making positions is virtually absent, as the man controlled more than 95% of leadership positions in a society dominated by an inferior view towards the woman.

Table 27. the role of women in the sectors

Sector	Leadership position	Secondary position
Municipal and supervisory sectors		
Culture and Media		
Education		
Engineering and construction		
Fishing		
Tourism		
Health		
Civil society organizations, NGOs		

0 - 20%
20 - 40%
40 – 60%
60 – 80%
80 – 100%

5.3. The environmental state of the Gulf of Sirte

All KIIs agree on the biological importance of the coast of the Gulf of Sirte, and its importance is particularly evident in that it is one of the most important nesting areas for sea turtles and marine mammals. One of them recalled the delinquency of the fin whale with a length of 19 meters on a beach near the city of Sirte, and another mentioned that he often hears about the delinquency of whales, dolphins and sea turtles on the shores of Sirte, which means that the Gulf is rich in species that have become endangered and rare in the world, and the types of fish are diverse and abundant. In addition, the beaches close to the city of Sirte, especially the western shores, which are characterized by the presence of barriers and large tunnels that prevent access to the beaches except through labyrinth-like roads, are pure and virgin in some places.

45

On the other hand, there is great dissatisfaction with the proliferation of illegal fishing, especially in the absence of legislation in the country due to the frequent crises it is going through, as the use of explosives in hunting has become widespread and in large sizes causing explosions that can be heard at a distance, according to the head of the fishermen's union. KIIs from the marine fishing sector also focused on the proliferation of dredges in the Gulf waters, which caused a shortage of fish stocks than they were 10 years ago. as mentioned by an expert in the field of professional fishing, the other problem mentioned by those interviewed is the proliferation of some invasive species, especially the rabbitfish (Lagocephalus sceleratus), which causes significant economic damage to fishermen, in addition to some local species.

5.4. Survey methodology

Surveys are most commonly conducted using some form of questionnaire, which are also variously known as inventories, tests, batteries, checklists, scales, surveys, schedules, indexes, or indicators (Dörnyei, 2007). It is possible, if more time consuming and probably expensive, to conduct a survey using structured individual interviews, but questionnaires remain the single most common means of conducting surveys and are indeed probably one of, if not the, most commonly used research tools in the social sciences (Fife-Schaw, 2006).
In this study, researchers developed a questionnaire in line with the study population, which consists of three types of fishermen in the Sirte region, namely: professional fishermen, recreational fishermen, and diving fishermen. The questionnaire relied on a direct and personal distribution method to interact with the respondents in order to obtain more accurate and reliable information. The objectives of the research were explained to the respondents in order to encourage them to provide comprehensive and adequate information. The questionnaire were conducted for 33 days (from 19 October to 21 November 2020). The professional fishers questionnaire included 37 questions, the recreational fishers 40 questions, and the diving fishers 27 questions, each questionnaire took an average of 70 minutes to complete, in total 48 questionnaires were collected, including 23 for professional fishers, 17 for recreational fishers, 8 for diving fishers, some questions are common and some are specific to each type of fisher. Finally, the data were statistically analysed to reach objective results that meet the objectives of the study.

5.5. Age Categories

The normal distribution test (Kolmogorov-Smirnov) was performed on the age variable offishers (Table. 28) and the indicative value (Asymp Sig) was 0.200, a value that confirms that the data follow the normal distribution.

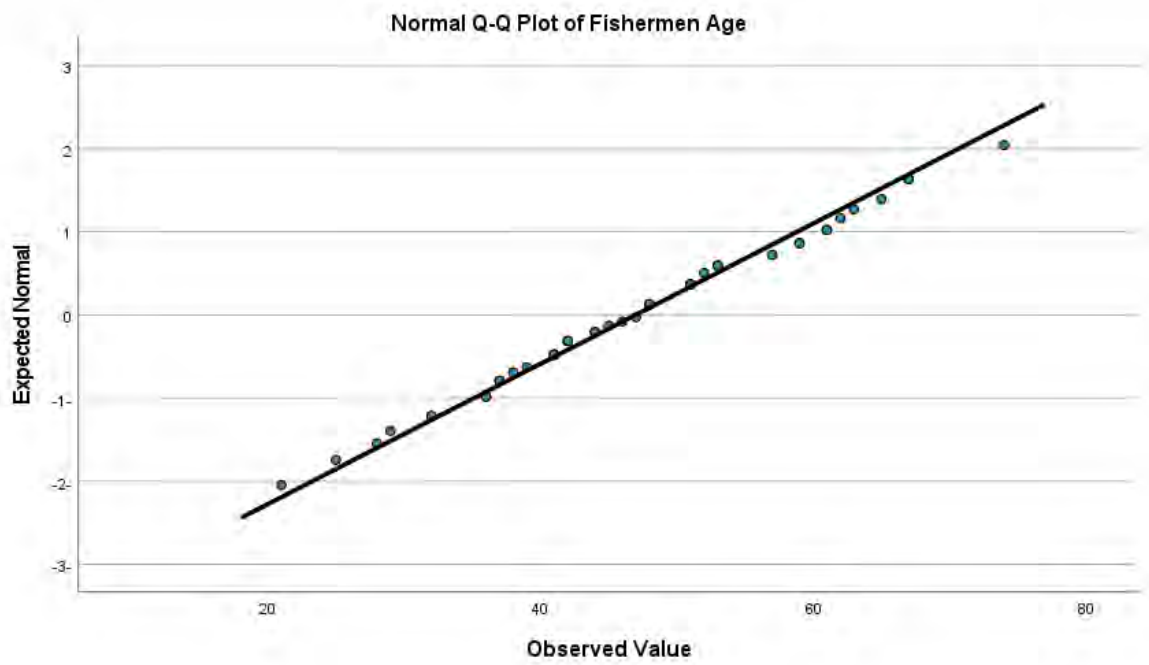


Table 28. the age variable of Fishers

One-Sample Kolmogorov-Smirnov Test		
		Fishers Age
N		48
Normal Parameters[a,b]	Mean	46.96

	Std. Deviation	11.850
Most Extreme Differences	Absolute	.069
	Positive	.069
	Negative	-.054-
Test Statistic		.069
Asymp. Sig. (2-tailed)[c]		.200[d]
a. Test distribution is Normal.		
b. Calculated from data.		
c. Lilliefors Significance Correction.		
d. This is a lower bound of the true significance.		

The hypothesis is also confirmed by (Fig. 18) and (Fig. 19) for the age distribution of the fishers who were included in the study sample.

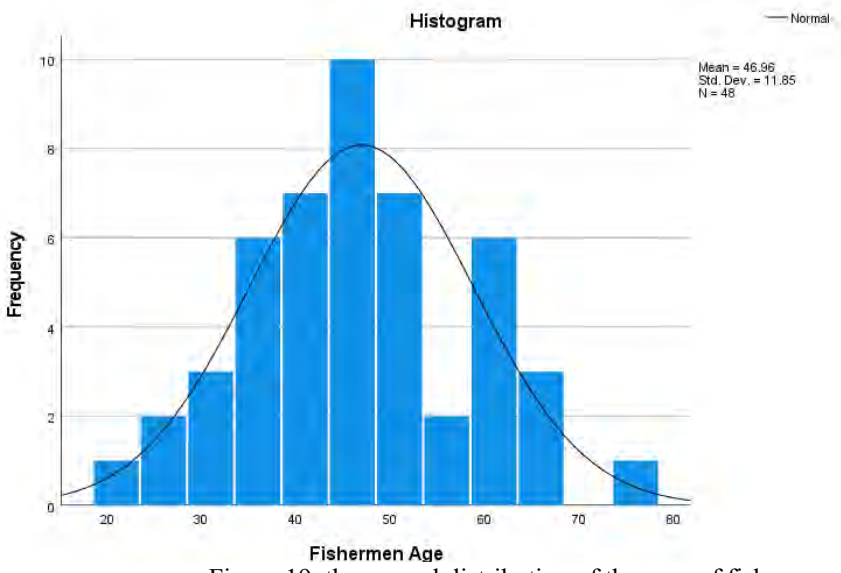


Figure 19. the normal distribution of the ages of fishers

Although the distribution is normal, the mean age of 46.96 with a standard deviation of 11.85 indicates a bias towards older ages. After distributing the ages of fishers among age groups, it is found that 39.6% are older than 50 years, and 33.3% between 40-50 years (Table. 29). There is a clear direct relationship between the number of fishers and their age (Fig. 20), and this is an indication that the marine fishing sector does not attract young people, perhaps because they are heading to more profitable sectors.

Table 29. fishers age groups

Fishers ages

48

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 30	4	8.3	8.3	8.3
	From 30 to 40	9	18.8	18.8	27.1
	From 40 to 50	16	33.3	33.3	60.4
	More than 50	19	39.6	39.6	100.0
	Total	48	100.0	100.0	

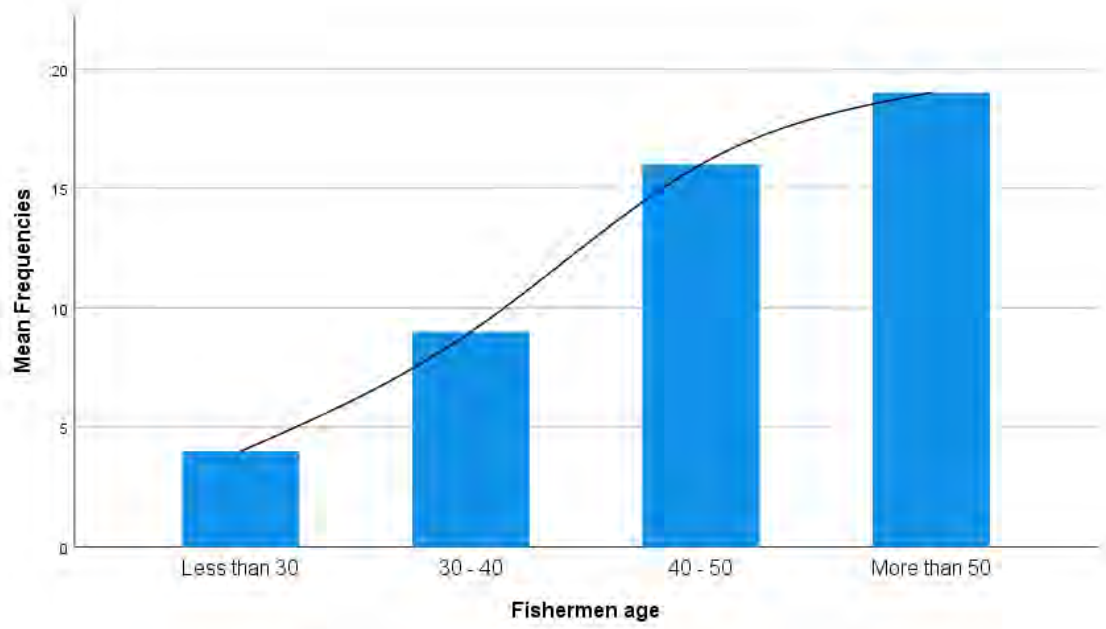


Figure 20. The direct relationship between the number of fishers and their age groups

5.6. Family members

The average number of family members was 6.7, as there was a clear effect of three dispersed values at the value of 16 (Fig. 21).
The (Table. 30) and (Fig. 22) show the distribution of the number of family members by categories.

49

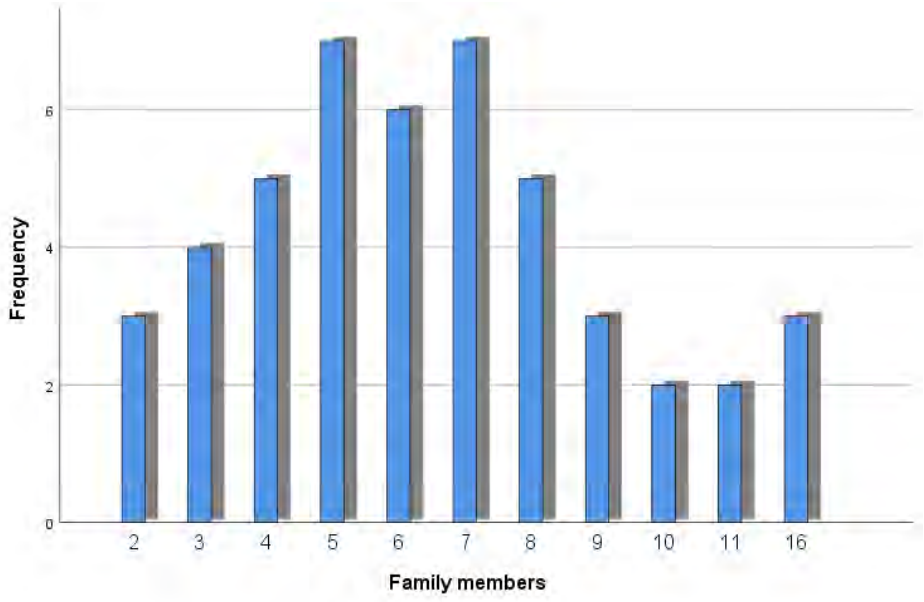


Figure 21 Distribution of the number of family members

Table 30. Distribution of the number of family members according to groups

		Frequency	Percent	Valid Percent	Cumulative Percent
F.	2 to 4	10	20.8	20.8	20.8
M.	5 to 6	13	27.1	27.1	47.9
	7 to 8	12	25.0	25.0	72.9
	9 to 10	5	10.4	10.4	83.3
	More than 10	7	14.6	14.6	97.9
	Missing	1	2.1	2.1	100.0
	Total	48	100.0	100.0	

50

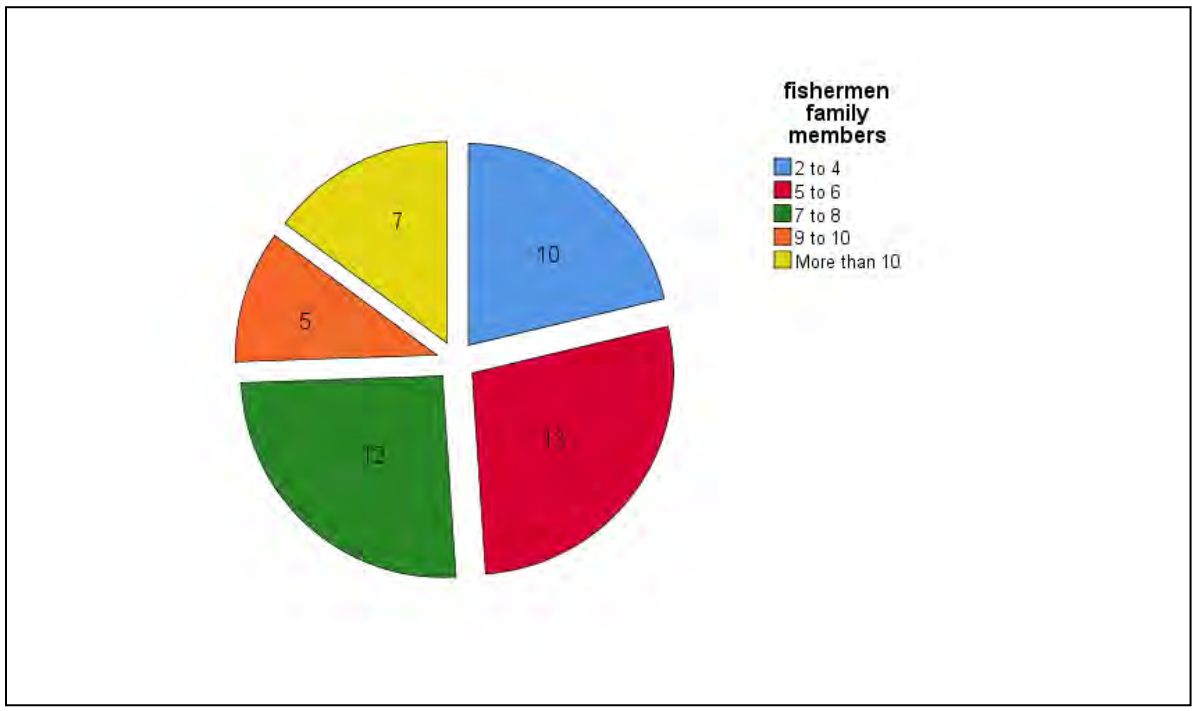


Figure 22. Number of family members by categories

5.7. Fishing Experience

With regard to the ages of fishermen, it is expected that fishing experience will be high. The analysis of the results showed that 47.9% have more than 20 years of experience (Table. 31), while only 18.8% have less than 10 years of experience. The direct filling of the questionnaire here may have a negative effect because the respondents try to show themselves more experience, but the researchers corrected this matter from the beginning and made it clear to the respondents that years of experience do not mean competence in order to obtain more accurate and reliable information.

Table 31. Fishing experience

Fishing experience					
		Frequency	Percent	Valid Percent	Cumulative Percent
Fishing start	1 to 5 years	6	12.5	12.5	12.5
	6 to 10 years	3	6.3	6.3	18.8
	11 to 15 years	8	16.7	16.7	35.4
	16 to 20 years	8	16.7	16.7	52.1
	More than 20 years	23	47.9	47.9	100.0
	Total	48	100.0	100.0	

5.8. Factors affecting the selection of the fishing area

The snalysis of the multiple-response question on the most important factors influencing the choice of the fishing area shows that the availability of fish is the most important factor, as it reached 47.5%, followed by the factor ‘the presence of certain types of fish’ by 20.0%, while

51

the factors ‘a small number of fishermen in the region’ and ‘ the lack of activities in the region ‘ were not of greatest important, and perhaps this is due to the fishers' fear of being alone in the fishing area, given the security crisis that the country is going through (Table. 32).

Table 32. Factors affecting the selection of the fishing area

Descriptive Statistics						
	Most important	2nd choice	3rd choice	4th choice	Least important	Not chose
Abundance of fish	19	5	6	3	4	3
Presence of particular species	8	11	7	7	0	7
Weather conditions	7	9	7	5	5	7
Accessibility / proximity of the fishing area	2	7	9	3	9	10
Experience	1	1	3	14	12	9
To go fishing where other fishers already fish	2	0	5	3	3	27
Few fishers go fishing in this area	0	4	2	4	5	25
Few other activities on this area (diving, surfing, sailing…)	0	3	1	1	0	35
Fishing area cleanliness	1	0	0	0	0	39
A non-stony sea	0	0	0	0	1	39

A comparison of the influencing factors was made using a (Multidimensional Scaling (ALSCAL)) scale (Table. 33), and by measuring the Stress value it was 0.0544 which means that the data has a good fit with the dimensional structure.

According to (Meyers. et al, 2013) :

- Stress values less than 0.05 are considered excellent,
- 0.05 to less than.10 are considered good,
- 0.10 to less than .20 are fair,
- Greater than .20 are considered a poor fit

The RSQ value of 0.98519 indicates an excellent fit with the data.

An acceptable fit is typically indicated by RSQ values of .60 or greater (Meyers. et al, 2013).

52

Stimulus Number	Stimulus Name	Dimension	
		1	2
1	Abundance of fish	2.1567	.4311
2	Weather conditions	1.4606	.2935
3	Presence of particular species	1.5164	-.9486
4	Experience	.1024	-.0488
5	Accessibility/proximity of the fishing area	.5123	.9439
6	To go fishing where other fishermen already fish	-.8782	.7193
7	Few fishers go fishing in this area	-.5721	-.8199
8	Few other activities on this area	-1.4054	-.3127
9	A non-stony area	-1.4402	-.1304
10	Fishing area cleanliness	-1.4524	-.1276

Table 33. coordinates of influencing factors

The (Fig. 23) represents the raw data that has been converted by the least square's algorithm, and the figure shows the division of the factors into four sections according to their similarity, it is clear that the factor (availability of fish) is similar to the factor (weather conditions). There is also a great similarity, clear and almost identical between the two factors (cleanliness of the fishing area) and (non-rocky fishing area), and it is somewhat similar to the two factors (lack of activities in the area) and (lack of fishermen) In the area), and in the lower right square there are two factors (the presence of certain species) and (experience), while the (going to an area the fishers go to) is unique in the upper left square.

It is clear that the horizontal dimension represents the most favourable factors on the right, while the less favourable factors remain on the left. The vertical dimension may represent the safety factor. The factors at the top have a relationship with safety, while the factors at the bottom lack the safety aspect.

The scatterplot for linear fit (Fig. 24) shows a good fit to the data, which is to be expected given the stress value, which was 0.0544.

53

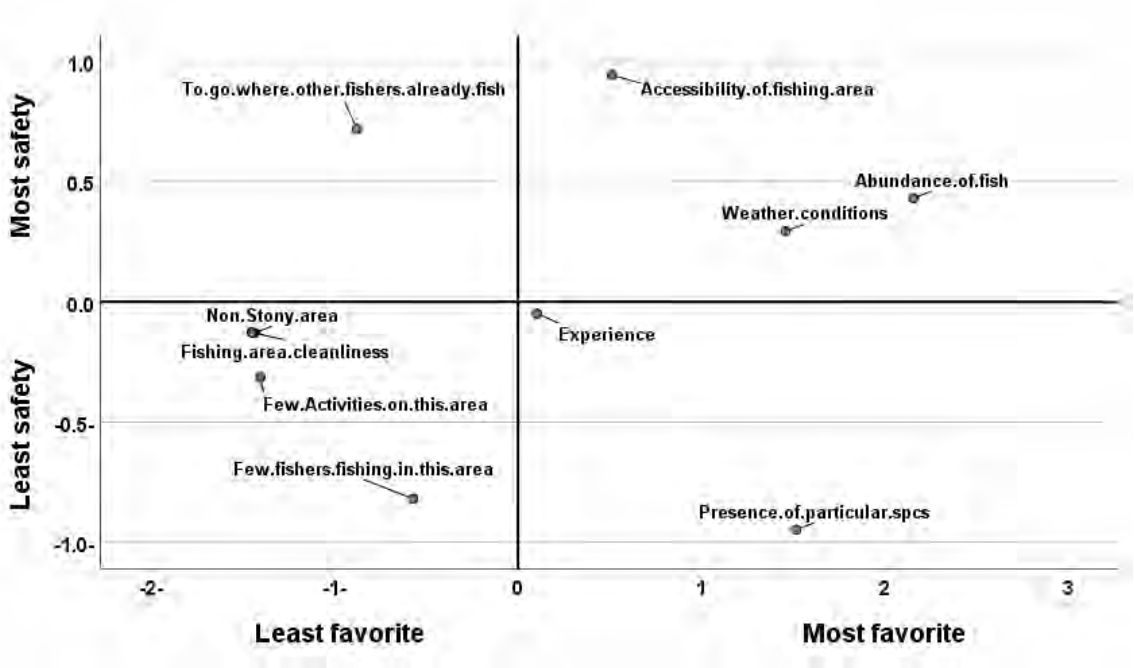


Figure 23. linear fit data

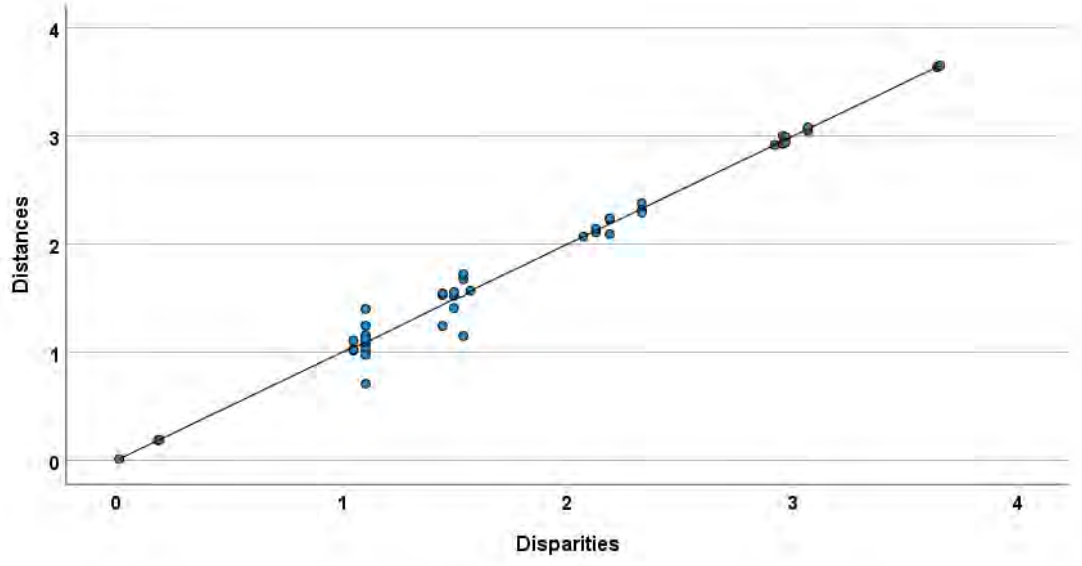


Figure 24. Factors affecting the selection of the fishing area

54

Comparing the responses of professional fishers and recreational fishers, there are no fundamental differences between them in terms of the factors influencing the choice of the fishing area, as can be seen from (Fig. 25), although the responses of recreational fisherms were more dispersed and this is evident from the stress value, which was 0.0364 for professional fishers, and 0.12518 for recreational fishers.

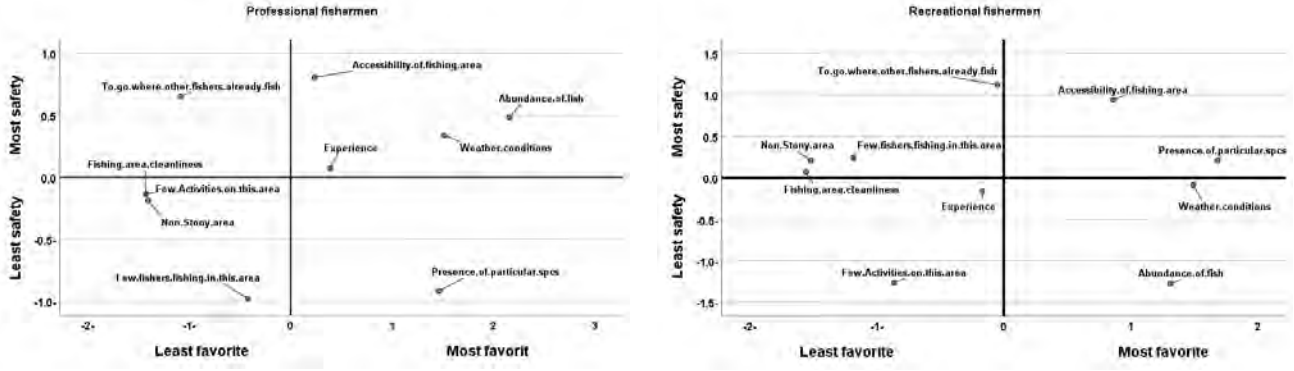


Figure 25 Factors affecting the selection of the fishing area according to the type of fishing

The factors influencing the choice of the fishing area for diving fishers are obviously different from those of professional and recreational fishers, although the sample of diving fishers was few (8 respondents) due to the small number of those who practice this hobby in the Sirte region, where their community is 12, but their responses were clearly different. The (Table. 34) shows the responses of fishermen in diving to the influencing factors

Table. 34 The factors affecting the selection of the fishing area for diving fishers

	Most important	2nd choice	3rd choice	4th choice	Least important	Not chose
underwater visibility	4	2	0	0	0	2
Weather conditions	1	2	2	1	0	2
Presence of spectacular species	2	0	2	0	1	3
Abundance and diversity of fish	1	1	1	2	2	1
Special underwater scenery (e.g. caves, cliffs)	0	1	0	3	1	3
Presence of a shipwreck	0	0	1	0	0	7
Accessibility / short distance to travel	0	1	1	1	1	4
Few divers on the site	0	0	0	0	1	7
Few other activities on the site	0	1	1	0	1	5
Explore and enjoy	0	0	0	1	0	7

The stress value was 0.12438, which indicates an acceptable fit to the data, while the RSQ value was high, reaching 0.93228, and (Fig. 26) shows the distribution of factors influencing the choice of the work area for diving fishers.

55

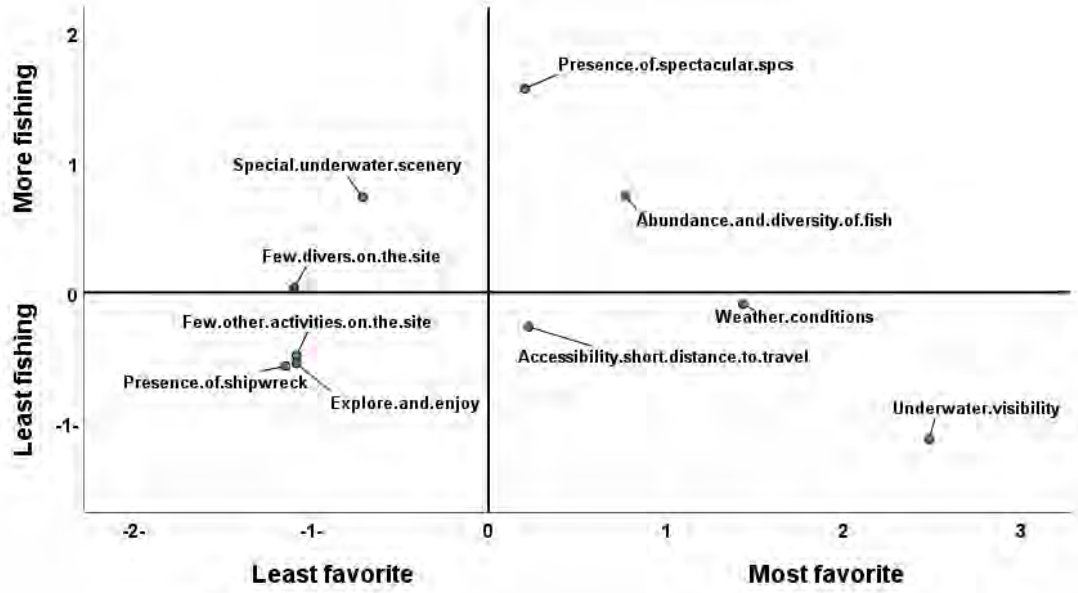


Figure. 26 Distribution of factors affecting the choice of work area for diving fishermen

The figure is divided into four sections, each bringing together factors with similar characteristics, while the clarity of the underwater vision is the most preferred factor on the far right, and the vertical axis takes practice fishing on the upper side and enjoyment and exploration on the lower side.

5.9. Main targeted species of fish:

Through 48 questionnaires, the total number of the main target species reached 25 species, of which 14 are the main species targeted by professional fishermen, 15 are by recreational fishers, while the main species targeted by diving fishermen were limited to 7 species, with overlaps between the three types of fishing as explained in (Fig.27).

56

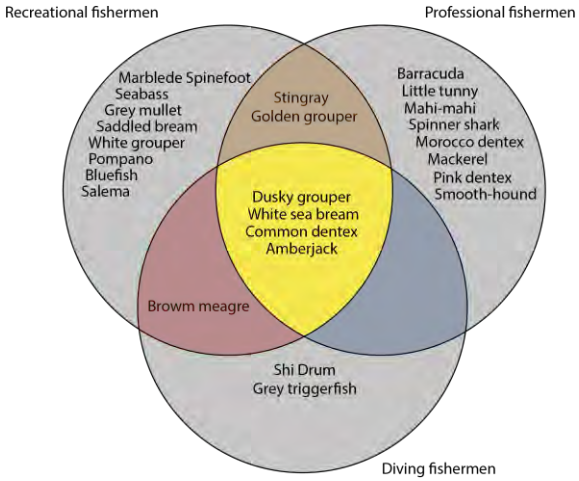


Figure 29 The main target species according to the fishing type

57

The main target species were the Dusky grouper (Epinephelus marginatus) 26 recurrences, followed by the White sea bream (Sephaus sargus) with 17 recurrences, and the (Seriola dumerili) Amberjack with 15 recurrences. The (Table. 35) shows the frequency and percentage of the main species.

Table. 35 The main species targeted by fishers in the Sirte region

Main species Frequencies			
Common name	Scientific name	Responses	
		N	Percent
Dusky grouper	*Epinephelus marginatus*	26	19%
White sea bream	*Diplodus sargus*	17	12%
Amberjack	*Seriola dumerili*	15	11%
Common dentex	*Dentex dentex*	12	9%
Seabass	*Dicentrarchus labrax*	10	7%
Little tunny	*Euthynnus alletteratus*	7	5%
Golden grouper	*Epinephelus costae*	6	4%
Morocco dentex	*Dentex maroccanus*	5	4%
Grey mullet	*Mugil cephalus*	5	4%
Barracuda	*Sphyraena sphyraena*	4	3%
Stingray	*Myliobatoidei*	4	3%
Mahi-mahi	*Coryphaena hippurus*	4	3%
Spinner shark	*Carcharhinus brevipinna*	3	2%
Bluefish	*Pomatomus saltator*	3	2%
Brown meagre	*Sciaena umbra*	3	2%
Pink dentex	*Dentex gibbosus*	2	1%
Mackerel	*Scomber scombrus*	2	1%
Grey triggerfish	*Balistes capriscus*	2	1%
Salema	*Sarpa salpa*	1	1%
Pompano	*Trachinotus ovatus*	1	1%
White grouper	*Epinephelus aeneus*	1	1%
Marblede Spinefoot	*Siganus rivulatus*	2	1%
Saddled bream	*Oblada melanura*	1	1%
Smooth-hound	*Mustelus mustelus*	1	1%
Shi Drum	*Umbrina cirrosa*	1	1%
Total		138	100.0%

58

5.10. Annual quantities for the main species:

5.10.1. Annual quantities for Professional fishermen

Taking into account the occurrence of the species, the average annual quantities of the main target species were calculated for each species (Table. 36). There is a deviation of some values, especially for the two species (Spiner shark) and (Barracuda), which led to an increase in the average annual weight for them, as can be seen from the data box graph (Fig. 28) and (Fig. 29) for the average annual weight in kilograms for the species.

Table 36 Average annual quantities of the main target species

Species	Annual weight (Avg.) (kg)	Low annual weight (kg)	High annual weight (kg)	Frequencies
Barracuda	10392.5	70	25000	4
Common dentex	1791.1	220	3300	10
Little tunny	5500	200	20000	7
Dusky grouper	2664.3	100	6000	9
Golden grouper	4962.5	1800	8000	5
Mahi-mahi	5000	2000	10000	4
Amberjack	1971.4	100	9000	9
Spinner shark	18333.3	1000	50000	3
Morocco dentex	2066.7	100	5000	5
Mackerel	600	200	1000	2
Stingray	1000	1000	1000	1
Pink dentex	999	999	999	2
White sea bream	1400	1400	1400	1
Smooth-hound	1500	1500	1500	1

59

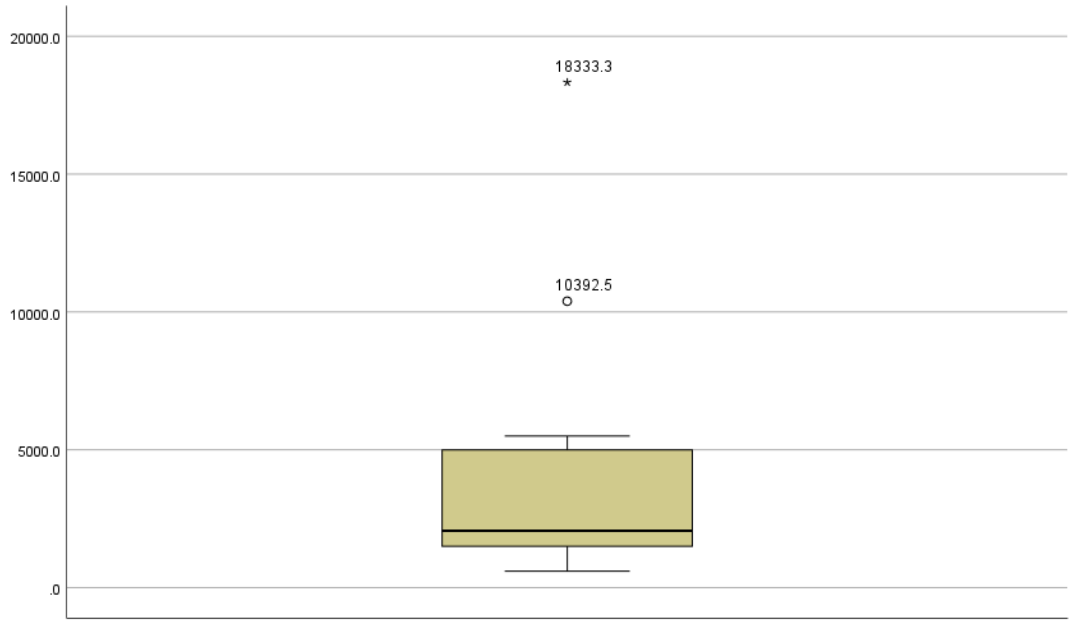
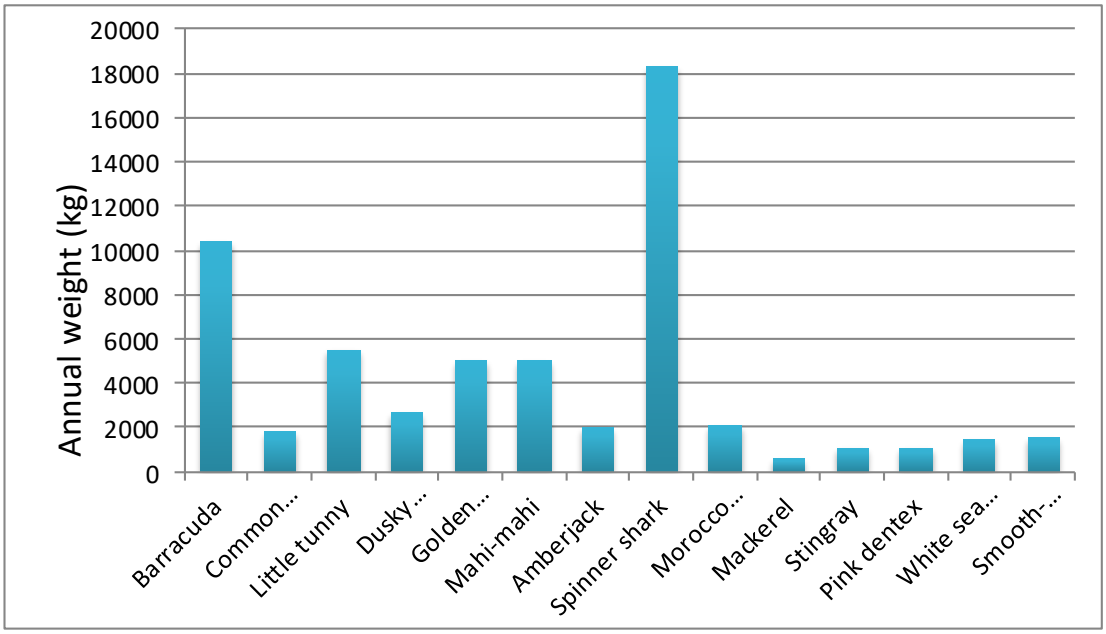


Figure 28 the data box diagram for the average annual weight of the main target species



60

5.10.2. . Annual amounts for recreational fishermen

Naturally, the annual quantity of main species caught by recreational fishers is much less than those caught by professional fishers.

The (Table. 37) Figure 29 Annual quantities of the main target species and (Fig. 30) show the average annual quantities of the main species targeted for recreational fishers

Table. 37 Average annual quantities of the main target species (recreational fishers)

Species	Annual weight (Avg.) (kg)	Low annual weight (kg)	High annual weight (kg)	Frequencies
Marblede Spinefoot	256.5	13	500	2
Dusky grouper	133.55	12	720	9
Seabass	155.55	10	500	10
White sea bream	140.1	12	720	11
Stingray	233.33	200	250	3
Grey mullet	350	100	600	5
Salema	600	600	600	1
Pompano	13	13	13	1
Common dentex	40	40	40	1
White grouper	50	50	50	1
Bluefish	46.67	25	80	3
Golden grouper	40	40	40	1
Amberjack	60	60	60	1
Saddled bream	90	90	90	1
Brown meagre	500	500	500	1

61

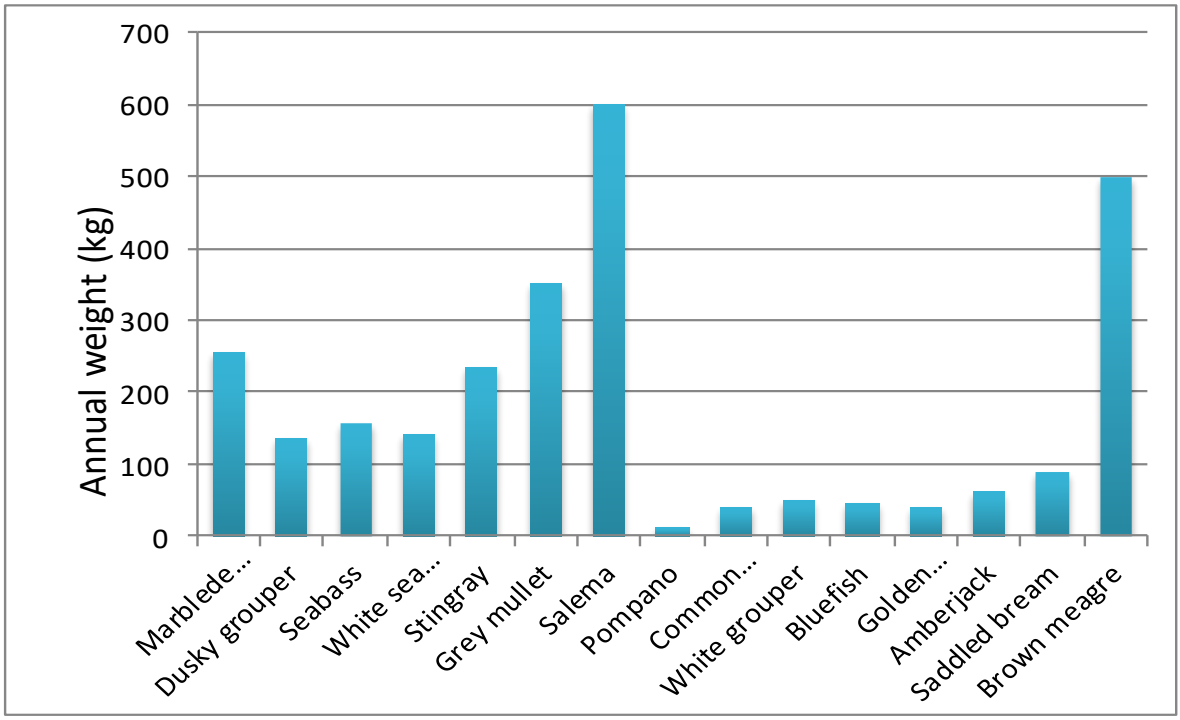


Figure. 30 The average annual weight of the main target species (recreational fishers)

5.10.3. Main types of diving fishers:

The data from dive fishers were less dispersed and less varied. There is agreement on (Dusky grouper) that it is the most important main species, it is the most frequent 100% of the number of cases, and it is also within the group of the most in terms of the annual amount with two other species: (Brown meager, White sea bream).

The (Table. 38) and (Figure. 31) show the main target species and their average annual quantities for diving fishers.

Table 38 Average quantities of the main species targeted by diving fishers

Species	Annual weight (Avg.) (kg)	Low annual weight (kg)	High annual weight (kg)	Frequencies
Dusky grouper	285.63	20	1040	8
Brown meagre	340	30	650	2
White sea bream	221	15	650	5
Common dentex	40	40	40	1
Amberjack	96	30	240	5
Shi drum	10	10	10	1
Grey triggerfish	60	50	70	2

62

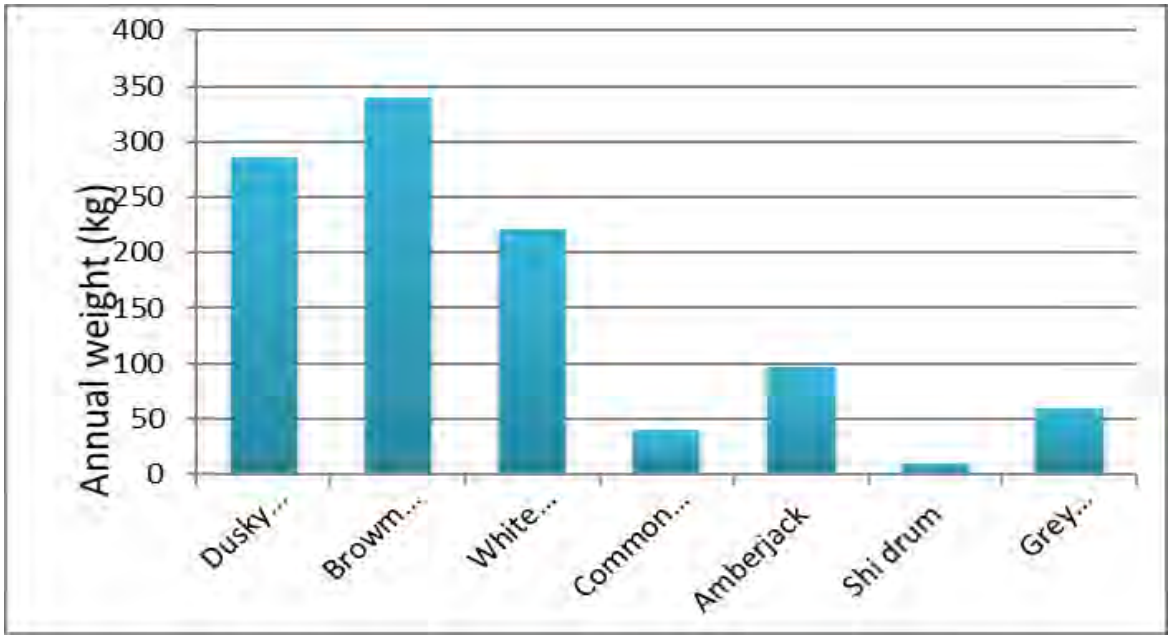


Figure 31 Average weight of the main species targeted by diving fishermen

5.11. Impact of the proposed marine Protected area on fishing activity

The fisher's expectations about the impact of the proposed protected area on their fishing activity tended to be positive (Fig. 32).

Among 48 fishers (the study sample), 32 of them expect that the impact of the proposed protected area will be "very positive", which is 66.7%. The (Table. 39) clarifies the fishermen's expectations about the impact of the proposed reserve on their fishing activity.

The five point Likert scale was used to analyze the data (Table 40). The mean was 1.56 with a standard deviation of 0.943, indicating that the fishers expect the proposed Marine Protected Area to have a "very positive" effect on their fishing activity.

Table 39 fisher's expectations about the impact of the proposed reserve on their fishing activity.

Impact of the proposed MPA on fishing activity					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very positive	32	66.7	66.7	66.7
	Rather positive	8	16.7	16.7	83.3
	No impact	6	12.5	12.5	95.8
	Rather negative	1	2.1	2.1	97.9
	Very negative	1	2.1	2.1	100.0
	Total	48	100.0	100.0	

63

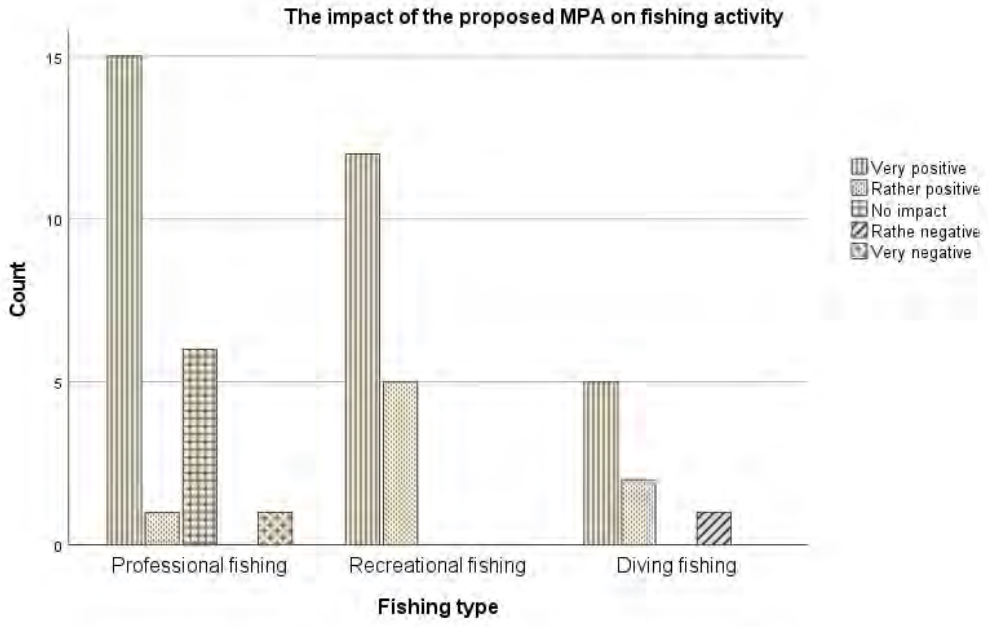


Table. 40 Five points Likert scale

Likert scale	Interval	Difference	Description
1	1.00-1.79	0.79	Fully agree
2	1.80-2.59	0.79	Rather agree
3	2.60-3.39	0.79	Neutral
4	3.40-4.19	0.79	Rather disagree
5	4.20-5.00	0.80	Fully disagree

Source: (Pimentel, J. L. 2010.)

Recreational fishers were more optimistic about the expected impact of the protected area on their fishing activity, with 70.6% expecting "very positive" impact, and the remaining 29.4% expecting "positive" impact, while professional fishers and dive fishers were more cautious about the potential effect (Table 41).

Table 41 Fisher's expectations about the effect of the proposed reserve on fishing activity by type of fishing

Impact of the proposed MPA on fishing activity with fishing type									
		Fishing type						Total	
		Professional fishing		Recreational fishing		Diving fishing			
		Count	% within Fishing type	Count	% within Fishing type	Count	% within Fishing type	Count	% within Fishing type
What is the impact of the proposed MPA on your fishing activity	Very positive	15	65.2%	12	70.6%	5	62.5%	32	66.7%
	Rather positive	1	4.3%	5	29.4%	2	25.0%	8	16.7%
	No impact	6	26.1%	0	0.0%	0	0.0%	6	12.5%
	Rather negative	0	0.0%	0	0.0%	1	12.5%	1	2.1%
	Very negative	1	4.3%	0	0.0%	0	0.0%	1	2.1%
Total		23	100.0%	17	100.0%	8	100.0%	48	100.0%

64

Figure 32 Fisher's expectations of the impact of the proposed reserve on fishing activity according to their numbers and type of fishing

5.12. The impact of the proposed Marine Protected area

The socioe-conomic impact of Marine Protected Areas (MPAs) and the stakeholders perceptions impacts are important to consider when designing, implementing, and managing MPAs. However, the currently available knowledge on these areas and especially of stakeholder perceptions is scarce and limited to restricted geographic areas (Pascual, et. al 2016.).

The current study aims to fill this gap in the Gulf of Sirte region by reviewing a set of literature related to the region, and a socio-economic survey methodology. 48 questionnaires were reviewed and analysed on 10 variables related to the environmental, social and economic impacts on the region. The reliability coefficient of the ten elements was measured.

The (Table. 42) gives us the short answer we were looking for at the begining of the analysis. As these items are not in standardised form, we refer to the column labelled Cronbach's Alpha where we note that the coefficient has a value of 0.748. For a 10-item scale (shown under N of Items), this would be considered to reflect good reliability (Meyers. et al, 2013).

Table 42 Cronbach alpha coefficient of reliability

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.748	.795	10

The overall mean of responses was 1.46, which means that, according to Likert scale, respondents believe that the impact of Marine Protected Area is "very positive".
The (Table. 43) shows the average responses to the variables on the impact of Marine Protected Areas, and (Table. 44) shows the frequency of responses to the elements.

Table 43 mean responses about the impacts of marine protected areas

65

Statements	N		Mean	Std. Deviation
	Valid	Missing		
The MPA helps to protect biodiversity	45	3	1.22	.420
The MPA enhances fish abundance inside the area	45	3	1.18	.442
The MPA enhances fish abundance outside the area	45	3	1.42	.690
The MPA helps to attract tourists	45	3	1.49	.695
The MPA benefits mainly professional fishing	45	3	1.53	.894
The MPA benefits mainly recreational fishing	45	3	1.42	.839
The MPA benefits mainly scuba-diving	45	3	1.36	.712
The zoning system of the MPA helps to reduce conflicts among different types of users	44	4	2.23	1.292
The MPA helps to reduce illegal fishing	45	3	1.29	.787
The MPA is good for the local economy	45	3	1.38	.684
General mean			1.46	

Statements source: Alban F., Roncin N. and Boncoeur J., 2008

Table 44 Frequencies of responses on the impacts of marine protected areas.

Statements	Fully agree	Rather agree	Neutral	Rather disagree	Fully disagree	Missing	Total
The MPA helps to protect biodiversity	35	10	0	0	0	3	48
The MPA enhances fish abundance inside the area	38	6	1	0	0	3	48
The MPA enhances fish abundance outside the area	30	12	2	1	0	3	48
The MPA helps to attract tourists	27	15	2	1	0	3	48
The MPA benefits mainly professional fishing	29	12	0	4	0	3	48
The MPA benefits mainly recreational fishing	32	10	1	1	1	3	48
The MPA benefits mainly diving	32	12	0	0	1	3	48
The zoning system of the MPA helps to reduce conflicts among different types of users	18	10	6	8	2	4	48
The MPA helps to reduce illegal fishing	37	6	0	1	1	3	48
The MPA is good for the local economy	33	7	5	0	0	3	48

Statements source: Alban F., Roncin N. and Boncoeur J., 2008

5.13 Hotspot areas in the Gulf of Sirte

Responses fo the establishment of a Protected Marine Area in the Gulf of Sirte were varied, but focued on three areas, listed below in order of priority:

A- Shash area

45.8% of the respondents focused on the area extending from the beach of Thalatheen to Khamseen west of Sirte and includes beaches (west of Thalatheen, Shash, Tamet, and

66

Khamseen), which has a total length of about 20 km, due to its abundance and diversity, for example characterised by the presence of sea turtles (Caretta caretta) that nest densely on these beaches, the presence of Posidonia Oceania, some species of cartilaginous, important species of molluscs such as Tonna galea, in addition to the presence of species of dolphins, and the beach in many parts of it is naturally protected due to the presence of barriers and tunnels that prevent access to the beach except through rugged and complex roads that look like a maze. This makes them semi-protected beaches except for those who have knowledge of those roads. Some respondents suggested that the proposed reserve extend to the beach of Al-bwirat to be a total length of 60 km due to its importance as a breeding area for cartilaginous fish and the presence of Posidonia Oceania and some other important species in that area.

Through group interviews with local community in the Thalatheen area, they suggested that Thalatheen Beach, which is the beach opposite the local community in the area (Fig. 33).

Figure 33 group interviews with local comunity in Thalatheen area

B- Lewaija area

It is located approximately 110 km east of the city of Sirte and is the preferred area for 27.1% of the professional fishers included in the field survey, and the importance of the region lies in the presence of marine cliffs, corridors and rocky slopes in some places, making it suitable for the formation of habitats for many important species, in addition to the presence of rocky areas on the beaches that form a small peninsula that fishermen and vacationers come to be a place of tourism and entertainment, but some professional fishermen who were interviewed

67

reported that illegal fishing activity abounds in that area, especially using explosives that led to the destruction of parts of the rocky reef in the area (Fig. 34).

Figure 34 Lewaija area

C- Ras Al-Ghara area

It is the least preferred area out of the three areas by 10.4%, and it is located to the west of the Red Valley Marina at a distance of about 5 km, away from the city of Sirte about 85 km to the east, and it is characterised by the presence of a twist in the coast which makes it a natural marina, and the area is characterized by the presence of separate marshes which is an important area for migratory birds (Figure. 35).

Figure 35 Ras Al-Ghara

68

6. Recommendations

During the field visits and interviews with basic information sources, local partners and stakeholders, it was found that there are several gaps within the community of the study area, which can be identified as follows:

6.1. community awareness Promotion

Awareness of the importance of protecting ecosystems is very important in order to achieve the sustainability of natural resources and to establish a partnership between the beneficiaries in their various sectors, for example between professional fishers and governmental and non-governmental organisations involved in biological diversity conservation, so that everyone benefits from the conservation of species and their habitats. In this context, the researchers made the the following recommendations:

- Develop effective methods to raise awareness of professional fishers and involve them in protecting ecosystems and reducing the risk of bycatch of some species.

- Work to increase awareness among local partners and decision-makers of the importance of biodiversity and its role in conserving resources and thus strengthening the local economies.

- Supporting and encouraging the school activity department to develop recreational methods, means and ressources to raiseawareness and knowledge among students about ecosystems and the importance of maintaning the natural balance and protecting species.

- Using local radio stations, which are particularly popular with housewives, to spread environmental awareness in the communities..

6.2. Empowering women in society and enhancing their role:

Through field research and interviews, it was found that one of the gaps in the community of the study area is the low rate of women's participation in economic development, and their role in planning and decision-making policies is almost non-existent, so the following is recommended:

- Supporting civil society institutions involved in empowering women in various fields and defending their rights.Create short and long-term programmes and plans to correct the traditional view of society towards women.Work to launch small and medium-scale projects that benefit only women, with the aim of encouraging them to highlight their status and competencies for decision makers.

6.3. Development of research and scientific centers

Scientific research has always been associated with the development of civilisations and nations. Societies that have been interested in scientific research are societies that have been able to advance the march of civilisation, herein lies the importance of scientific research, its support and encouragement, in this field the following is recommended:

- Supporting the research and consulting Centres at Sirte University and urging them to use advanced methodologies for scientific research.

- Working to provide research grants in various scientific fields to help researchers in governmental and non-governmental institutions conduct studies in the region.

69

- Developing local legislation in a way that contributes to and encourages conducting scientific research and benefiting from its results.

6.4. Local maritime decisions and laws

Approximately 78% of the professional fishermen interviewed believe that the failure to implement local laws on the regulation of fishing and the prevention of fishing with explosives has resulted in significant damage to the fish stocks of the region and had negative economic impacts on fishermen.

From this point of view, it is recommended to urge the authorities and decision-makers to activate the role of agencies concerned with implementing laws and legislations regulating marine fishing.

6.5. Supporting and improving livelihoods for fishers

Over the past decade, the Sirte region has experienced difficult security conditions, which had a significant on fishers. In addition to preventing them from fishing for months in a row, as is the case in this period, the lack of maintenance and improvement of ports has led to the closure of some of them and their lack of suitability for boat mooring, this matter raises several recommendations to support and improve the livelihood of professional fishermen:

- Adopting the sustainable livelihoods methodology to ensure the continuity of the resources and alternatives used by the targets and reduce the damages that may result from accidents, disasters and wars.

- Strengthening community partnership and involving fishers in decision-making on the management of Marine Protected Areas (MPAs) alongside local people.

- Protecting the fisher's rights and supporting them by providing objective methods to market their products, and compensating them for any damages that may befall them or their equipment in times of conflicts and wars.

- Encourage local authorities to ensure that ports are maintained in such a way to guarantee their contined suitability for berthing and handling.

Creating opportunities for activities that support fishermen in stabilizing their annual income through small projects related to the field of marine fishing.

6.6. Protecting ecosystems

Although the Gulf of Sirte region is rich in terristrial and marine species, the pressures resulting from human activities such as urban development, land use and some illegal practices such as the use of explosives in fishing will lead to the loss of some species in the long term, and also lead to the degradation and disruption of the environmental systems. In this regard the following is recommended:

- Work to declare a network of Marine Protected Areas (MPAs) in the Gulf of Sirte, especially since there are areas, as most professional fishermen mentioned during the interviews, "are rich in abundance and excellent diversity, but which need to be protected from illegal fishing".

70

- Work on the creattion of programmes and plans for the management of environmental, natural and cultural resources to ensure the conservation and sustainability of resources and to ensure a balance between resource conservation and community development.

- The establishment of research centres and a first aid centre for threatened marine organisms such as turtles and marine mammals.

- The use of natural resources in activating ecotourism to ensure the preservation of ecosystems and the well-being of the local population.

71

References

- *Abu-Medina, H. (2008).* Al-Mawani Al-Leebiya: derassa fi al-jugrafia al-eqtisadiyah *[Libyan Ports: Study in Economic Geography]. Misurata: 7th October University.*
- *Agostini, Enrico de. (1978). Le popolazioni della Tripolitania (K. Tillisi Trans.), Libya-Tunisia, Arabian Book House. (Original work published 1917).*
- *Agricultural Research Center. Agricultural survey for the Al-Thalatheen region west of Sirte, Final report, 2001.*
- *Alban F., Roncin N. and Boncoeur J., 2008. Methodological Guidebook For Socio-economic Field Surveys of MPA users. EMPAFISH Project. 39 pp.*
- *Al-Bouhsini, M; Al-Bakoosh, F; Al-Soul, E;& Al-Gheryani, I. (2003).* Hasser le aham alafat al-hashariya allaty toseeb mahsolay alqameh wa al-shaieir fi Libya *[Inventory of the most important insect pests affecting wheat and barley crops in Libya]. Arab Journal of Plant Protection, 21 (1), 35-38.*
- *Al-Dakhil, B.M. (2013).* Derasat attadharees wa al-bathemitry lelalamaq albahriya fi Khaleej Sirte *[Topography and pathology study for the Gulf of Sirte]. In Fourteenth Geographical Forum. Sirte: Sirte University Publications. pp. 148-166.*
- *Al-Fitouri, M. (2009).* Al-tarkeeb al-wadheefi lemadeenat Sirte wa alaqatoha bemojawarateha *[The functional composition of the city of Sirte and its relationship with its neighborhoods]. Tripoli: Publications of the General Organization for Culture.*
- *Al-Subaie, B. (2009).* Tatheer attagaiyer alwadheefi ala morphologiat madinat Sirte: Derasa fi gografia almodon *[The effect of functional change on the morphology of Sirte city]. Unpublished Master Thesis, University of Sirte.*
- *Argyriou, T. (2014). Description, paleoenvironmental and paleobiogeographical implications of Miocene fish faunas from Jabal Zaltan and Sahabi (Libya). A thesis submitted to the Faculty of Graduate Studies and Research (University of Alberta) in partial fulfillment of the requirements for the degree of Master of Science in Systematics and Evolution.*
- *Azafzaf, H., Etayeb, K. and Hamza, H. (2006) Report on the census of Lesser Crested Tern Sterna bengalensis in the Eastern coast of Libya. (1-7 August 2006). EGA, RAC/SPA-MAP-UNEP. pp 31*
- *Breakwell, G. M., Hammond, S., Fife-Schaw, C., & Smith, J. A. (Eds.). (2006). Research methods in psychology (3rd ed.). Sage Publications, Inc.*
- *Bureau of Statistics and Census. Agricultural censuses and surveys 1974 & 1984.*
- *Bureau of Statistics and Census. National Population Survey. (2012). from BSC website: https://www.bsc.ly/#b19.*
- *Central Intelligence Agency. (1987). Libya's Great Manmade River Project: Plan and Realities, A research paper declassified in part - sanitized copy approved for release*

72

12/14/2011. From website: https://www.cia.gov/library/readingroom/docs/CIA-RDP88T00706R000600520002-0.pdf

- *Crain BSU. Great Manmade River Project, Libya - Water Utilities - Water Supply and Irrigation. From https://www.cranebsu.com/en/project/view/id/82*
- *Delfino, M. (2008). New remains of Crocodylus checchiai Maccagno 1947 (Crocodylia, Crocodylidae) from the Late Miocene of As Sahabi, Libya. Garyounis Scientific Bulletin, 2008, pp. 111-118.*
- *Delfino, M., Iurino, D.A., Mercurio, B. et al. Old African fossils provide new evidence for the origin of the American crocodiles. Sci Rep 10, 11127 (2020).*
- *Dörnyei, Z. (2007). Research Methods in Applied Linguistics. Oxford: Oxford University Press.*
- *Filogh A.M., 2019. Libya Fishing Industry. Menba Su Ürünleri Dergisi, 5(1),16-26.*
- *FAO. © 2006-2009. National Aquaculture Sector Overview. Aperçu général du secteur national d'aquaculture - France. National Aquaculture Sector Overview Fact Sheets. Texte par Lacroix, D.*
- *FAO. 2008. Fisheries and Aquaculture Information and Statistics Service. Fishery and Aquaculture Statistics 2006. 57p.*
- *General Information Authority, Agricultural censuses 2001 & 2007. from GIA website: https://gia.gov.ly/ar/142/1062*
- *Gonnelli, V.; Peruzzi, C. (2015) Libya's water system and The Great Man-Made River.* Universita degli Studi di Firenze *[University of Florence].*
- *Hoornweg, Daniel; Bhada-Tata, Perinaz. (2012). What a Waste : A Global Review of Solid Waste Management. Urban development series; knowledge papers no. 15. World Bank, Washington, DC. © World Bank.*
- *Hufnagel E., 1972. Libyan Mammals. The oleander press, 85 pp*
- *Marshall, C; Rossman, Gretchen B. (1999). Designing Qualitative Research. SAGA Publication, Inc. (Fifth Edition. Published 2011). p. 207.*
- *Meyers, Lawrence S.; Gamst, Glenn C;& Guarino, A. J. (2013). Performing data analysis using IBM SPSS. First edition. Hoboken, New Jersey. Published simultaneously in Canada. Published by John Wiley & Sons, Inc.*
- *National Information & Documentation Authority. (2014).The Statistical book. Tripoli.*
- *Omoogun, Ajayi C; Egbonyi, Etuki E.; Onnoghen, Usang N. (2016). From Environmental Awareness to Environmental Responsibility: Towards a Stewardship Curriculum. Journal of Educational Issues, v2 n2 p60-72.*
- *Oweidat, F. (2008).* Al-Tasahor fi al-mantaqa al-momtadda ma bain wadi Ehrawa sharqan wa wadi Jaref gharban bi manteqat Sirte: Derassa fi ekhtilal al-tawazon al-beiey fi al-manateq al-jaafa wa shebeh al-jaafa *[Desertification in the area between Wadi Harawa in the*

east and Wadi Jarf to the west in the Sirte region: A study of ecological imbalance in arid and semi-arid regions]. Unpublished Master Thesis, University of Sirte.

- *Pascual, M. et. al, (20160. Socioeconomic impacts of marine protected areas in the Mediterranean and Black Seas. Ocean & Coastal Management 133:1-10.*
- *Patton MQ. (2002). Qualitative research & evaluation methods. 3rd. Thousand Oaks, Calif, Sage Publications.*
- *Pimentel, Jonald L. (2010). A note on the usage of Likert Scaling for research data analysis. USM R&D Journal, 18(2), 109-112.*
- *Pimentel, Jonald L. (2019). Some Biases in Likert Scaling Usage and its Correction. International Journal of Sciences: Basic and Applied Research (IJSBAR) 45(1):183-191.*
- *Saied A, Maffucci F, Hochscheid S, Dryag S and others (2012) Loggerhead turtles nesting in Libya: an important management unit for the Mediterranean stock. Mar Ecol Prog Ser 450:207-218.*
- *Salem, K. (2013).* Al-Boad attareekhi les seyada Al-Leebiya ala Khaleej Sirte wa tabiatoho alqanoniyah *[The historical dimension of the Libyan sovereignty over the Gulf of Sirte and its legal nature]. In* Fourteenth Geographical Forum*. Sirte: Sirte University Publications. Pp. 75-102.*
- *Shallouf, A. (2013).* AlSultan wa Sirte Tareekh madenatain fi madeena *[Al-Sultan and Sirte History of two cities in one city]. In* Sirte conference for peace and national cohesion*. Sirte: Sirte University Publications. pp. 14-28.*
- *Sirte University, Sirte. The history of university. (2014). From website: https://su.edu.ly/en/index.php/about-su/history*
- *Urban Planning Authority. (2007).* Meswadat mokhatat aleqleem alfariei altakhteeti Sirte *[Draft Schematic sub-region of Sirte]. Tripoli: University of Al-Fateh.*
- *Yvonna S. Lincoln and Egon G. Guba. (1985). Naturalistic inquiry. Sage Publications,. Beverly Hills, CA: Sage Publications, 1985, 416 pp.*
- V. Gonnelli, C. Peruzzi, Libya's water system and The Great Man-Made River, Universita degli Studi di Firenze, 2015.

74

Appendices

75

Appendix I. Questionnaire on Professional Fishing

Questionnaire on Professional Fishing

1. *Date: _____*
2. *Fishing area: _____*

INFORMATION ABOUT YOUR FISHING ACTIVITY

3. *Name and registration number of your vessel: _____*
4. *Registration port: _____*
5. *Where do you live? City: _____ / district: _____*
6. *Are you: Owner of your vessel _____ Co-owner ____Not the owner_____*
7. *How many boats do you own? _____ boats*
8. *Date of birth: _____*
9. *Date you started fishing: _____*
10. *Size of the household: _____ people*
11. *What are the main technical features of your vessel(s)?*

12. *According to your estimation, what is the present market-value of your boat and fishing gears? _____ LYD*

Boat number	Length (metres)	Tonnage (GT)	Engine power (kW)	Annual number of engine operating hours	Year of construction	Year of purchase	Usual crew size (including skipper)
1							
2							
3							

13. *Average distance between harbor and main fishing grounds (nautical miles) ----------*
14. *What are the 5 major factors influencing your choice of fishing site? Please rank these features from the most important (1) to the least important (5).*

	rank
ance of fish	
r conditions	
ce of particular species	
perience	
ibility / proximity of the fishing area	
ishing where other fishermen already fish	
hers go fishing in this area	

76

please specify	

15. Details of your fishing activity

	description	Gear 1	Gear 2	Gear 3
Main targeted species Name of species 1				
Name of species 2				
Name of species 3				
Annual number of trips				
Average trip duration (hours / trip)				

16. During this year, did you notice the presence of untargeted species accidentally stuck in nets or in the "Long line" (sea turtles, dolphins, whales, birds, strange and new species of fish):

Yes ☐ *No* ☐

17. If yes, what are the species and how often ?:

	sea turtles	dolphins	whales	birds	new species of fish
Number					

18. In your sharing system, what is the share of the entire crew? _____ %

19. Annual consumption of fuel and Oil?

	Quantity (litres/year)	Value (LYD /year)
Fuel		
Oil		

20. Is there any support from government agencies?

Yes ☐ *No* ☐

21. If yes, what kind of support? (equipment)

---

22. Annual fixed costs (euros per year)

	Description by gear	*Description by gear*			
			2	3	
Boat (maintenance and repairs, including engine and					

77

electronic equipment)					
g gears *maintenance and* *ement*					
ixed costs *,harbour dues, licence(insurance, costs management*					

23. . Variable costs in LYD per trip (i.e. costs that are approximately proportional to the number of trips)?

	l Description by gear *Trip)*	*l Description by gear*		
Ice, bait and food				
id lubricant				
Other variable costs .				

24. Is there a family member who helps you in the profession of fishing in any way?

Yes ☐ *No* ☐

25. If yes, what is the relationship and the nature of the assistance?

	h you as an assistant on the fishing trip	*Maintenance of equipment* *nets, preparing baits, etc.)*	*ing*
ter			
r			

26. What is the value of sales in each trip that are considered to cover the costs of spending .....dl / trip

CATCHES

-What are your total annual landings (all species)? _____Tons

78

27. What was the annual value of your landings? _____LYD /year

28. What percentage of your catches comes from the authorized fishing zone from Thalatheen to Kamseen area? _____%

29. Details of your annual catches.

		gs (tons)	ght inside the area from Thalatheen to Kamseen	e price (LYD / kg)	ear used
s 1					
s 2					
s 3					

30. Do you have other additional income?

☐ yes, an activity income ☐ yes, salary No ☐

31. If this is an activity income, please specify:

- from what activity : _____

32. the time dedicated to this activity : _____% of your working time.

what are the reasons for this activity ?

☐Impossible to fish (depletion of resources, weather, protected areas…)

☐ Other activities are more profitable (tourism, recreational fishing ...)

☐ For pleasure: you enjoy practicing other activities

☐ Other (please specify: _____)

33. For how many years have you been fishing in the area from Thalatheen to Khamseen?

34. On the whole, what is the impact of the future MPA on your fishing activity?

☐ Very positive ☐Rather positive ☐No impact ☐ Rather negative ☐Very negative

35. What do you think of the following statements ?

	gree		e	isagree	know
PA helps to protect biodiversity					
PA enhances fish abundance inside the area					
PA enhances fish abundance outside the					
PA helps to attract tourists					
PA benefits mainly professional fishing					
PA benefits mainly recreational fishing					
PA benefits mainly scuba-diving					

79

ning system of the MPA helps to reduce *ts among different types of users*					
PA helps to reduce illegal fishing					
PA is good for the local economy					

36. How are relations with other users?

	ooperation	*t*	*tact*
ional fishermen			
tional fishing			

37. Do you have any comments about our questionnaire and survey?

Thank you for your kind cooperation.

80

Appendix II . Questionnaire on Recreational Fishing

Questionnaire on Recreational Fishing

1. Date: _____
2. Name: _____
3. Which activity are you being interviewed about today?
Recreational fishing from a boat Angling from the shore
Spear fishing Shellfish gathering

YOUR EXPERIENCE OF RECREATIONAL FISHING

4. When do you fish?
all year round in summer in winter only during holidays other (specify)
5. How long have you been fishing?
less than one year 1 to 5 years 6 to 10 years 11 to 20 years more than 20 years
6. How many times do you fish per year? _____ Days
7. Among the following gears, please rank the gears you are using, from the most important (1) to the less (2, 3, …). Leave a blank when you are not using one of these gears.

Hook and line Nets Pots
Spear fishing Shellfish gathering Other (specify) : _____

8. Do you belong to a recreational fishing club or association? Yes No
9. What is your level of fishing expertise?
Beginner Medium Expert

10. What are the 5 major factors influencing your choice of fishing site? Please rank these features from the most important (1) to the least important (5).

	rank
ance of fish	
r conditions	
ce of particular species	
xperience	
ibility / proximity of the fishing area	
ishing where other fishermen already fish	
hers go fishing in this area	
please specify	

11. What are your total catches per year, and the detail for the three main species?

	Name	Catches kg / year
Species 1		
Species 2		
Species 3		

81

All Species		

12. What is your annual budget dedicated to recreational fishing?

	In LYD
Fishing gear (maintenance, replacement)	LYD
Licences, insurance, specialised magazines…	LYD
Boat: maintenance, fuel and lubricant, harbour costs…	LYD
Fees paid to fishing charters	LYD
Fishing tours (travelling and subsistence expenditures included)	LYD

If you are fishing from a boat:

13. Do you have own fishing boat? Yes No

14. If yes, what are the main technical features of your vessel?

Length: _____ metres

Power: _____ kW

Tonnage: _____

Date of purchase:

Year of construction

15. Usual number of persons fishing simultaneously from the same boat? _____ people

16. You use this boat:

only for recreational fishing

mainly for recreational fishing

mainly for non-fishing activities

17. What is the average cost of a fishing trip on your boat? _____LYD/trip

18. This fishing area is:

Your usual area One of your fishing areas among others Not your usual area

19. How many times do you fish in this particular area, per year? _____ days

20. What part of your annual catches come from this particular area? _____%

21. How long did it take you to travel to this fishing area?

By car / bicycle / foot (from your living place here to this fishing area or to the harbor if you are fishing from a boat)	____minutes	_____km
By boat (from harbor to fishing area	_____ minute	_____miles
Total transportation time from your home / holiday accommodation to your fishing area	_____minutes	_____km

22. Do you think this travelling time is:

A waste of time

A leisure time

No opinion

23. Why did you choose this fishing area?

Famous fishing area Proximity of a marine protected area Ttourism area Other (specify) --------

PERCEPTION OF THE MARINE PROTECTED AREAS AND FISHING STRATEGIES:

24. What are your catches in this fishing area?

82

	Name	Catches kg / year	% caught in Thalatheen to khamseen
Species 1			
Species 2			
Species 3			
All Species			

25. Is there a family member who helps you in the profession of fishing in any way?

Yes ☐ *No* ☐

	h you as an assistant on the fishing trip	*Maintenance of equipment nets, preparing baits, etc.)*	*ing*
ter			
r			

26. On the whole, what is the impact of the future MPA on your fishing activity?

☐ *Very positive* ☐*Rather positive* ☐*No impact* ☐ *Rather negative* ☐*Very negative*

27. What do you think of the following statements ?

	gree		*ee*	*isagree*	*know*
PA helps to protect biodiversity					
PA enhances fish abundance inside the area					
PA enhances fish abundance outside the					
PA helps to attract tourists					
PA benefits mainly professional fishing					
PA benefits mainly recreational fishing					
PA benefits mainly scuba-diving					
ning system of the MPA helps to reduce					

83

ts among different types of users					
PA helps to reduce illegal fishing					
PA is good for the local economy					

28. How are relations with other users?

	cooperation	*et*	*tact*
ional fishermen			
tional fishing			

29. Professional occupation:

- ☐ Farmer
- ☐ Craftsman or shop keeper
- ☐ Manager, senior civil servant, doctor, lawyer, professor…
- ☐ School teacher, other white collar worker
- ☐ Employee
- ☐ Blue collar worker
- ☐ Student
- ☐ Retired

30. What is your net monthly household income (all taxes paid)?

- ☐ Less than 600 LYD
- ☐ 601- 800 LYD
- ☐ 801-1000 LYD
- ☐ 1001- 1200 LYD
- ☐ 1201- 1400 LYD
- ☐ 1401- 1600 LYD
- ☐ More than 1600 LYD

31. Where do you live?

Region …… City:……

Thank you for your kind cooperation

84

Appendix III . Questionnaire for Diving Operators

Questionnaire for Diving Operators

1. What is your level?
   First dive Beginner Intermediate Expert
2. On the average, how many dives do you log per year? _____ dives/year
3. Do you normally dive:
   With a non-commercial diving club
   With a commercial diving club
   Independently
4. What is your annual diving budget?

Diving gears (purchase, maintenance)	LYD
License, insurance	LYD
Dive-trips, training courses, filling up tanks	LYD
Diving holidays (all included)	LYD
Total	LYD

5. What influences your choice of diving site?
   Please indicate the first (1), the second (2) and third (3) most important features that influence your choice of diving site.

	rank
clarity (underwater visibility)	
r conditions	
nce of fish	
ce of particular species	
xperience	
ibility / proximity of the fishing area	
ishing where other fishermen already fish	
hers go fishing in this area	
please specify	

6. What are your total catches per year, and the detail for the three main species?

	Name	Catches kg / year
Species 1		
Species 2		
Species 3		
All Species		

7. Do you think diving damages the marine environment in some areas?

85

□ Yes □No □ I don't know

8. If yes, why?

□Too many divers □Behaviour of some divers □ Others

9. . *On the whole, what is the impact of the future MPA on your fishing activity?*

□ *Very positive* □*Rather positive* □*No impact* □ *Rather negative* □*Very negative*

10. How are relations with other users?

	ooperation	*t*	*tact*
ional fishermen			
tional fishing			

11. What do you think of the following statements ?

	gree		*e*	*disag ree*	*know*
PA helps to protect biodiversity					
PA enhances fish abundance inside the area					
PA enhances fish abundance outside the					
PA helps to attract tourists					
PA benefits mainly professional fishing					
PA benefits mainly recreational fishing					
PA benefits mainly scuba-diving					
ning system of the MPA helps to reduce ts among different types of users					
PA helps to reduce illegal fishing					
PA is good for the local economy					

12. Professional occupation:

□Farmer

□ Craftsman or shop keeper

□ Manager, senior civil servant, doctor, lawyer, professor…

□School teacher, other white collar worker

□ Employee

86

□Blue collar worker
□ Student
□ Retired

13. What is your net monthly household income (all taxes paid)?
□ Less than 600 LYD
□601- 800 LYD
□801-1000 LYD
□1001- 1200 LYD
□1201- 1400 LYD
□1401- 1600 LYD
□ More than 1600 LYD

Thank you for your kind cooperation

87

Specially Protected Areas Regional Activity Centre (SPA/RAC)
Boulevard du Leader Yasser Arafat
B.P. 337 - 1080 Tunis Cedex - Tunisia
car-asp@spa-rac.org
www.spa-rac.org

Co-funded by the European Union