Report on the baseline situation for common indicator 15 “Location and extent of the habitats potentially impacted by hydrographic alterations” in Libya

Report

Prepared by:
Abdulmaula Hamza
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CONTRACTING AUTHORITY
PAP/RAC
Kraj sv. Ivana 11,21 000 Split, Republic of Croatia

CONTRACTOR/ AUTHOR
Abdulmaula Hamza, PhD. Biological Sciences

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List of acronyms

Agricultural Research Centre (ARC)

Biruni Remote Sensing Centre (BRSC)

Common Indication 15: Location and extent of the habitats potentially impacted by hydrographic alterations (CI 15)

Conference of Parties (COP)

Cyrenaica Coastal Survey project (CCS)

Environmental Impact Assessments (EIA)

Marine Strategy Framework Directive (MSFD)

Geographic Information System (GIS)

Global Public Goods and Challenges programme (GPGC)

Good Environmental Status (GES)

Gross domestic product (GDP)

Integrated Monitoring and Assessment Programme (IMAP)

International Union for Conservation of Nature (IUCN)

Land Cover Classification System (LCCS)

Libyan Remote Sensing Center (LRSC)

Mediterranean Ecosystem Approach Monitoring Programme (EcAp MED III)

Ministry of Environment (MOE)

1 Introduction

UNEP/MAP in the framework of the Global Public Goods and Challenges (GPGC) Programme Area 1, Component 4: International environment and Climate governance, is implementing an EC-funded project, the EcAp MED III project under the title of: "Support to Efficient Implementation of the Ecosystem Approach-based Integrated Monitoring and Assessment of the Mediterranean Sea and Coasts and to delivery of data-based 2023 Quality Status Report in synergy with the EU MSFD". Through assistance with the implementation of national IMAPs in the individual countries, the project outputs will support the release of a data-based 2023 Mediterranean Quality Status Report (2023 MED QSR). It will also help to promote harmonized assessment at the national level by developing national assessment factsheets. As a result, the EcAp MED III project is inextricably related to the implementation of COP 19 Decision IG.22/7 on IMAP, COP 20 Decision IG.23/6 on the 2023 MED QSR Roadmap and Implementation Plan, and COP 21 Decision IG.24/4 on the 2023 MED QSR Roadmap and Implementation Plan. Activity 1.3.1 of the EcAp MED III Project entails preparing a baseline report on the status of CI 15 monitoring. The outcomes of this research will help to publish a data-driven Mediterranean Quality Status report in 2023.

The Ecological Objective 7 (Alteration of hydrographical conditions) tackles long-term changes in the hydrographic regime of currents, waves, and sediments as a result of new large-scale developments with the ability to change hydrographical conditions. Marine habitats that may be influenced or disturbed by changes in hydrographic conditions are considered in common indication 15 "Location and extent of the habitats potentially impacted by hydrographic alterations" considers marine habitats which may be affected or disturbed by changes in hydrographic conditions (such as currents, waves, suspended sediment loads).

As a result, the accompanying study establishes a baseline for the monitoring of CI 15 in Libya. It does not monitor a specific site or installation, but rather gathers information on the current situation in terms of monitoring requirements. As a result, the process for preparing the report was based on the existing guidance factsheet for CI 15, which specifies assessment criteria.

2 Characteristics of the coastal area and marine environment

2.1 Types and proportion of the different types of the coast

Libya is situated in the centre of the northern border of Africa facing the Mediterranean lying between latitudes 33°N and approximately 18°N and longitudes 8°E and 25°E, with a coastline spanning 1770 kilometres from Tunisia in the West to Egypt in the East. The country has an area of 1.77 million square kilometres. Other bordering countries include Sudan in the East, Algeria in the West, Chad and Niger to the South and South West (Figure 1).

The Libyan Coastal Zone is characterized by high percentage of sandy beaches (1140 km) the remaining areas are scattered medium to low elevated sandstone or limestone rocky coastline (Figure 2). This coast can be divided geomorphologically into seven sectors:

Ras Ajdir to Tripoli (180 km):

This part (32.50N, 13.14E) is characterised by lacking of gulfs and bays, as it takes a general shape of a concave coastline, with very few bays at wadi mouths, Tripoli port rocky head and the sand bar that making Farwa Island to the west of the country. The beaches of this part are made of white sand, low but in some areas can reach 10m of sand dunes, which followed by several Sebkhas(1) (from Sabratah to Ras Ajdir), such as Samdine, Brega, Zourara saltpans, and Abukammash which also transboundary site with Tunisia.

Tripoli to Misuratah (220km):

This sector is featured with medium-elevated rocky formations, with coastal steep slopes, small sea heads and some narrow bays at wadi mouths, as in Wadi Kaam and Wadi Lebda (Leptis); the elevation is due to contact of foot hills of the western mountain (Nefusa mt) with the Sea (from Garabulli to Khoms), with continuous wave action on sandstone/limestone coast.

(1) Sebkha: A coastal, supratidal mudflat or sandflat in which evaporite-saline minerals accumulate as the result of semiarid to arid climate. It’s an Ecosystem between land and intertidal zone within restricted coastal plains just above normal high-tide level

Misuratah to El-Magroon (680km):

The lengthiest Libyan coast parts, with simple coastal structures, dominated by sandy coasts, with different sizes and topography, as the eastern and middle parts represented by flat sandy coasts, with few medium-elevated parts around halophytic vegetations, whilst the western part (near Misuratah) is having higher sand dune beaches (20m ASL). The sclerised sand dunes are abundant also at the middle and western parts of this sector, playing a major role in coastline shape and evolution, resulting from wind and marine erosion actions.

The most extended vast Sebkhas are found in this sector, such as Sebkhet Qaser Ahmed, Taourgha, Hisha, Ras Lanouf, Bisher, Brega, Ajdabiya and Karkura. These sites are mostly in same or even lower than sea level, some of them having a direct feeding from sea water and some receiving flush rain streams from wadis.

El-Magroon to Tolmitah (190km):

This sector is featured by presence of coastal slopes and caves in the east part, which made either by karstic or marine erosion in limestone medium elevated coastline. The remaining part is less elevated and specifically rich in coastal lagoons and sebkhas, that connected with the sea, and/or having freshwater input, making a brackish rich habitat.

Tolmitah to Ras Tin (250km):

The most steep and elevated Libyan coasts are found in this section, as some limestone coastal formations reach >100m (Ras Hilal and Lathroon), as the Al-Jabal Al-Akhdar Mountain contacting the sea, directly or with very narrow coastal plain. This area also is relatively having more coastal heads (e.g. Ras Buazza, Ras Karsa, Ras Hilal and Ras Amer). The high elevated slopes are intersected with deep narrow wadis, empties in narrow bays such as Wadi Khalij and Wad Jarma. The beaches of this part vary from narrow sandy beaches, to gravelly or rocky boulders in some parts, as a result of sand precipitation in wadi mouths or the result of strong wave action on limestone formations.

Ras Tin to Elba foot (90km):

This part appears as an arch in north-south direction, making the gulf of Bumba, with intense sandy formations, and low topography, and the extensive presence of coastal lagoons and sebkhas. This part having the highest number of small islands in Libya, as the island of Elolbah (Syn. Names Elba or Um Elmarakeb island) to the east, and Barda’a island to the northeast, and islands of Wetya, Misuratah and Um Elgarami at the middle of the gulf. Several wadis emteis in this Gulf as well, such as Wadi Tememi, Wadi Qusaibat and Wadi Elmaalaq.

Elba foot to Bir Ramla (160km):

The coastline here is east-west direction, with the highest proportion of curving coastline in the country, with short wadis with steep and high edges empties in the sea (E.g. Wadi Ungelanez) in small to medium sized gulfs. The Miocene limestone formations cover most of this sector, making coastal slops of more than 40m east to Tobruq. The remaining coasts vary from low-medium elevated rocky or gravel coasts, with limited small sandy beaches (in some areas less than 1000m, as in Ain Ghazala northern beaches)

Figure 1 Location of Libya in the Mediterranean Sea Basin.

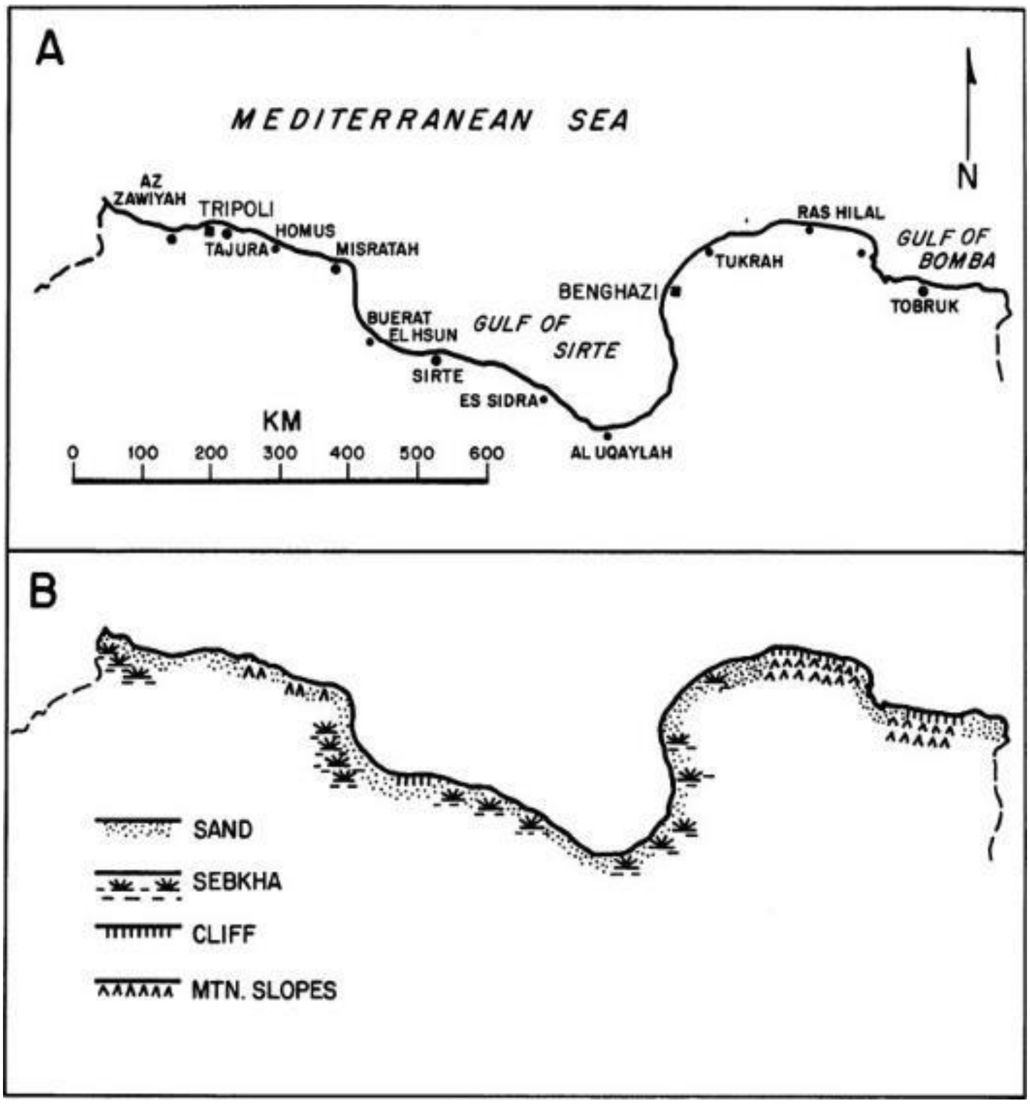

Figure 2. Coastal cities and formations (A) and generalized coast types of Libya (Schwartz M., 2010)

Table 1 Proportion (%) of the different types of coasts

Morpho sedimentary Type	Length (Km)	Percentage
Rocky coast (Cliffs/mountain slops)	626	35.3 %
Sandy beach (Sand/ Sebkha)	1144	64.7 %

2.2 Erosion and accretion

Many Libyans are vulnerable to even minor sea level rise because the vast majority of the country's population (86 %) lives in coastal cities. With merely 0.2 m of sea level rise, Benghazi, the country's second largest city, could be severely harmed. With a one-meter rise in sea level, an estimated 5.4 % of Libya's total urban area could be lost. Soils and renewable aquifers along the coast could be salinized as a result of flooding caused by sea level rise and storms. The cost of rising sea levels as a result of 2.6°C warming by 2100 is anticipated to be $1.7 billion. Because the majority of the population, agriculture, and industry are concentrated along the shore, soil salinization, fresh water contamination, and infrastructural degradation are common. (WHO, 2015; World Bank, 2016; World Bank, 2014).

Results from previous research in Libya (Ashour et al., 2014) showed variable levels of accretion and erosion on five watershed points on the Libyan coastline. Author compared satellite images taken between 1987 and 2006, and found that along the entire coastline, coastline erosion was observed to be dominant over accretion or sediment deposition. The total area of observed changes along the coastline was 243.65 Acres, of this 174.65 Acres constitutes eroded area (more than 70% of the total observed area), while 69 Acres of the area showed coastal sediment accretion (less than 30% of the total observed area). The coastal erosion is not only affecting the current urban population along the coast, but the archaeological sites as well, severe winter storms and incoming waves cause substantial erosion and collapse to archaeological features such as rock-cut processing and manufacturing facilities and buildings that are located close to the sea.

A study by the World Bank (Luijendijk *et al*., 2018) found that the Libyan coast erodes 28 cm per year on average annual change, the second in the Maghreb region after the Tunisian coasts. The same study found that the annual costs of lost land and infrastructure assets are equivalent to about 0.7% of GDP in Libya, driven mainly by erosion rates, degree of urbanization of the coast, and land prizes.

2.3 Data and studies on the coast, its length, spatial position, and its evolution/change

Few studies on the coast, its length, spatial position, and its evolution/change exist. A complete list of these studies is summarized in table 2.

Table 2 List of studies on the coast, its length, spatial position, and its evolution/change

Author(s) of the study	Work done/Main findings
Hazmi et al., 2021	Tunisia, Libya and Egypt show highest risk scores of vulnerability indices of respectively 71%, 9% and 70% to sea level rise. The highly urbanized areas in the Libyan coasts such as the coasts of the city of Tripoli experiment a very high social vulnerability rating between 4.7 and 4.8. The Libyan population growth rate is estimated to be 1.45%, with development that is dramatically urban ~ 80%66 The average population density in Tripoli is about 200 persons/km2.
The Cyrenaica Coastal Survey (CCS) 2021	A collaborative Cyrenaica Coastal Survey project (CCS) focuses on the documentation of endangered maritime cultural heritage along the coast of Cyrenaica in north-east Libya. During this first phase of the project, we concentrate on recording threats and damages to sites along the current shoreline (up to 1km inland) and on sites that are now located under water. The project is a collaboration between MarEA, the Department of Antiquities Cyrenaica, the University of Benghazi and the Omar Al-Mukhtar
Hamad (2020)	Libya Topography Project, “Libya Topo” for updating the previously compiled topographical map at scale, 1:250000.
Ghouma, K. (2015)	Converting paper geological maps to digital maps using GIS
Ghouma, K. (2015)	Delineation of the territorial waters of the Libyan coast using GIS
Ashour et al., 2014	Studied erosion and accretion at five coastal sites along the coastline,
Alsharif (2014)	the urban sprawl probability map of Tripoli was generated to estimate six scenarios of urban patterns for 2020 and 2025
Salih (2010)	studied urbanisation in Libya and its impact on changing the spatial distribution of the population
Ali, 1995	results indicate that the soils of this area are generally shallow, contain a high percent of clay and low amounts of organic matter. Consequently, these soils have a low infiltration rate and poor storage capacity, and runoff is the main agent of soil erosion

On national level, the land cover mapping is one of the main activities of the "Mapping of Natural Resources for Agricultural Use and Planning in Libya" (LIB/00/004) project. The project was funded by the Libya, and coordinated by UNDP and executed by FAO with collaboration from National Institutions was led by Food and Agriculture Organization of the United Nations (FAO), in collaboration with national institutions (Agricultural Research Centre, Biruni Remote Sensing

Centre, BRSC, and Libyan Centre for Remote Sensing and Space Sciences(LCRSSS) and the involvement of local staff, has led the mapping activities starting in 2002. Consolidated methodologies and standards on land cover mapping were adopted to generate a consistent and harmonized product. The land cover features have been classified using FAO’s Land Cover Classification System (LCCS), and produced several land-use maps for Libya. The Libyan full resolution land cover database consists of: 33,551 polygons covering the whole country; 108 single classes used for the interpretation; 755 mixed units deriving from the combination of the single classes; This dataset is the one of the key outputs of the project (Figure 3). Using this data set, a number of aggregated products at different scales:1:50,000; 1:100,000; 1:250,000; 1:500,000; have also been developed to meet the needs of the different users. Maps of land cover for the whole country were produced at a scale of 1:2,000,000. An experimental land cover change product for the urban conglomeration of Tripoli was also developed. Although most of the project products is concerned with the agricultural use, the project provided good database for several other aspects of mapping in Libya, and some of the maps of this report was taken from the project reports.

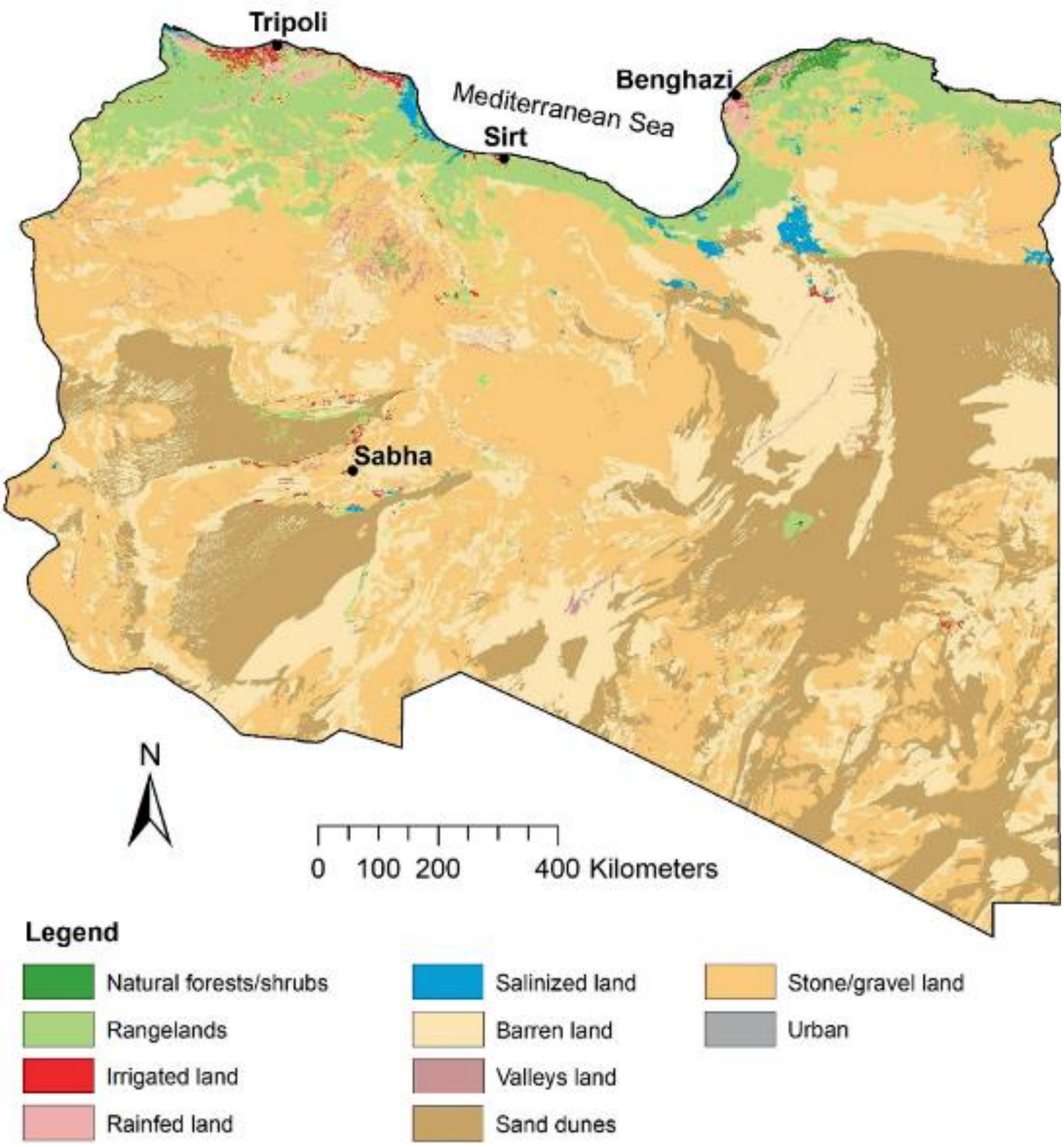

Figure 3 Example of Land use/Land cover maps for Libya produced by the (LIB/00/004) project.

3 Anthropogenic Activities Present in marine environment

3.1 Main human activities present in coastal and marine environment

Tripoli, on Libya's Mediterranean coast, has the highest population density in the country, with over 1000 people per square kilometre. This area is known as Jeffara Plain, and it is home to the majority of Libya's population (roughly 60%). The Benghazi region has the second highest population density, ranging from 250 to 999 people per kilometre, followed by the Sabha region, which has a much lower density, ranging from 4 to 24 people per kilometre (Attwairi, 2017). More than 90% of the population lives along the Mediterranean coast between Tripoli to the west and Al-Bayda to the east (Figure 4). The interior regions still suffer from a significant shortage of people due to desert and water shortages, and the urban population for Libya was 81 %. Urban population of Libya increased from 56.3 % in 1972 to 81 % in 2021 growing at an average annual rate of 0.75%, in comparison, the share was at around 76 percent in 2000 As of the same year, Libya registered the highest urbanization rate in Maghreb countries, followed by Algeria and Tunisia(World Bank; UN DESA).

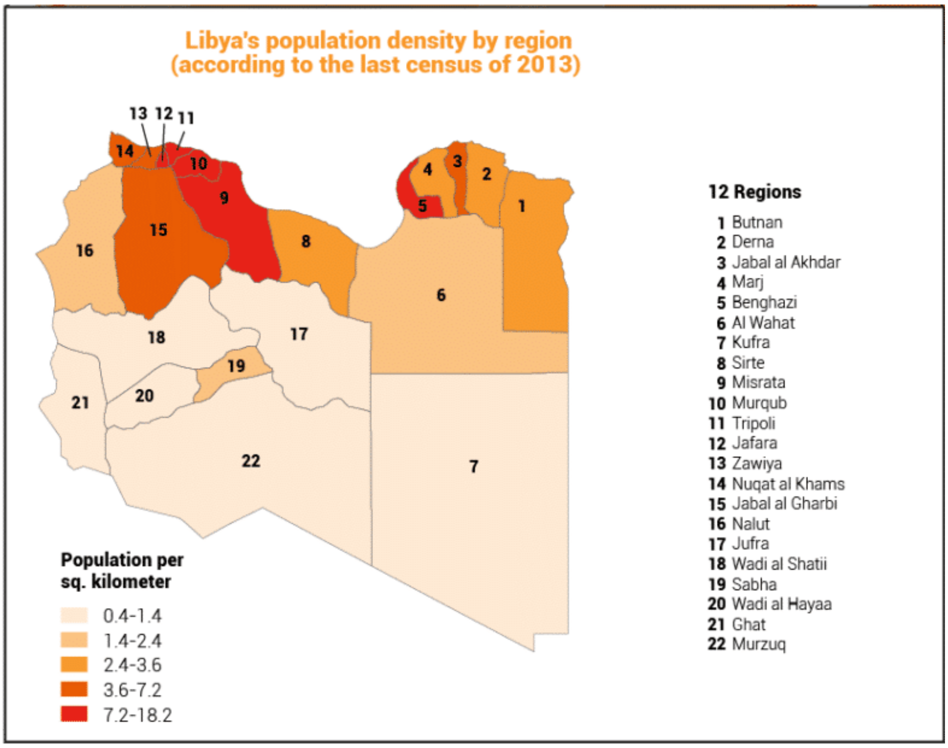

Figure 4 Population density and administrative divisions of Libya (modified from World Bank data and UN DESA)

Libya has five commercial ports, six oil exporting port terminals, 135 fishing ports/landing sites (of which 75 are active), one submarine natural gas pipeline (Green stream) crossing to southern Italy, fifteen electricity power stations along the coastal area, six of them running on heavy oil and nine stations on natural gas. Infrastructure development is concentrated at large coastal cities of Tripoli, Benghazi and Misurata, however it is illegal to build on the beach directly, a distance of 100 m is required for building permissions. The last 11 years since the 2011 uprising showed weakening of environmental monitoring of the coastal area and witnessed a rapid demographic change and associated urbanization have greatly increased the demand on coastal resources for building houses and commercial developments sometimes irrespective of the governmental regulations. Agriculture is restricted to certain areas along the coast, mainly at coastal plains of Tripoli and the Al-Jabal Al-Akhdar mountain to the east of the country with intensive use of chemical fertilizers and pesticides at irrigated crops. Today, because draught in agricultural areas, weakened implementation of legal measures, extensive development for private housing, most of the fertile land is converted to real estate areas and the amount of plant cover deteriorated rapidly (Figure 5).

Decades of weak environmental management had facilitated serious point-based spots of oil pollution and from related petrochemical industries, regardless of the good level of environmental management in the Libyan oil sector. Oil storage facilities and pipelines have been targeted during the civil war, exacerbating pre-existing pollution problems (Figure 6). The exact impacts of the war on increasing pollution levels are still unassessed.

Even before the 2011 uprising, land degradation and desertification were major concerns, with the pressures being greatest in the populated coastal strip. Libya had signed a large number of multilateral environmental agreements prior to 2011, but implementation was inadequate due to a lack of efficient policy instruments, and strategies.

2021

1976

Figure 5 Deterioration of plant land cover in Tripoli region between 1976 and 2021

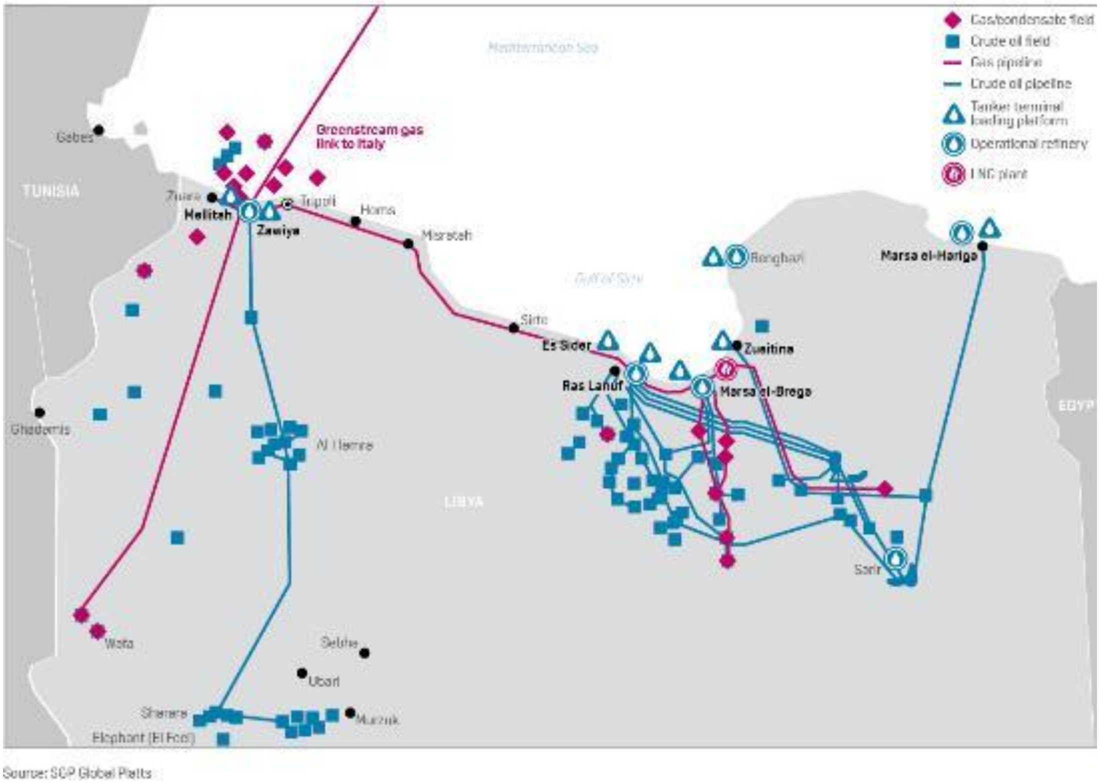

Figure 6 Libyan oil and Gas infrastructure. Source https://www.spglobal.com/platts/en/market-insights/blogs/oil/012920-map-libyas-oil-and-gas-infrastructure

Another alarming threat to the marine environment is untreated wastewater. Several large cities discharge untreated wastewater directly to the sea, due to the poor state of wastewater treatment plants, from the 36-wastewater treatment larger plants in Libyan major cities, only 9 of them are functioning, and the Non-functioning sewage stations in Tripoli has resulted in a spill of over 1,275,000 cubic meters of untreated water into the sea daily (Alsadey and Masour, 2020, Figure 7). It’s also noticeable the amounts of solid waste (plastic, glass, metal and organic waste) disposal in open areas including coastal spaces near large cities such as Tripoli eastern suburbs, and Benghazi southwest areas, which likely to cause runoff of bleached materials to the shallow sea water, as well as pose a threat of non-biodegradable plastic (i.e., plastic bags, other plastic debris, lost fishing gear), driven to the sea by winds or current actions, contributing to loss of megafauna such as fish, dolphins, turtles and seabirds. But there are no scientific studies to quantify the impact of such open disposed waste on the mentioned species.

As a result of the several conflicts within the country, between 2011 and 2019, rapid demographic changes and associated urbanization have greatly increased the demand on coastal resources, especially in Tripoli area, where human displacements from other provinces in the country concentrate, in addition to illegal foreign migrants from Africa and some Asian nationalities, who require housing and other means of life support, which mostly developed without proper permissions from governmental authorities. Most of these houses are not using the public wastewater system, and depends on private septic tanks, dug usually near surface water table, which can cause contamination of drinking water. The levels of electricity consumption are also increased sharply in the past 10 years, reaching 8125 megawatts, exceeding the 5200 megawatts produced in the country. The national power grid, was also targeted during the conflict years, leading to power deficiency across the country and black outs in some instances.

Figure 7 Satellite images of untreated wastewater outlets along Tripoli coastal area (Source: The Libyan Remote Sensing Centre)

3.2 New coastal installations in the last 5 to 10 years

Some major new installation of structures in the Libyan coastal environment took place in the last 10 years (some listed below are beyond 10 years limit). Based on Remote sensing images (Google Earth), a list on these new installations can be found below:

- Re-*Construction* completion and maintenance of 4700m long North-West Rubble Breakwater at the Port of Tripoli (Figure 8)
- Construction of the Tripoli marina 2008-2021 (Figure 9).
- Construction and breakdown of Tajura commercial port (Figure 10).
- Construction of Tajura Fishing port between 2002 and 2022 (Figure 11).
- Construction of Desalination Plant in Zawia Oil Refinary (Figure 12).
- Construction of Sousa Fishing port between 2003 and 2009 (Figure 13)

Figure 8 Re-Construction of North-West Rubble Breakwater at the Port of Tripoli.

Figure 9 Construction of Tripoli Marina, note the site in 2008 as a natural small bay, then between 2009- 2017 works completed, later in 2021, to the east of the marina dumping of coastal waters using building demolition materials, note the turbidity caused.

2010

2011

2021

Figure 10 Commercial port of Tajura from construction of breakwaters in 2010 then mostly ready in 2011, but later due to departure of construction company in 2011 the project was not completed, and the construction is breaking down in 2021.

2004

2022

Figure 11 Fishing port of Tajura after construction of breakwaters between 2002 and 2022

2004

2021

Figure 12 Zawia Oil refinery terminal between 2004 and 2021, notice the power station cooling outlet to the west of the terminal.

2003

2021

Figure 13. Fishing port of Sousa between 2003 and 2021

3.3 Dredging and dumping activities

Dredging is mainly conducted to maintain depth of water at commercial and oil exporting ports along the coast of Libya. Both activities should be conducted after granting a permit by the ministry of Environment, however, in many instances these works are done without proper Environment Impact Assessment (EIA) process or a permit.

For example, during the preparation of this report, the author was able to find several dredging tender announcements made by the national Oil Corporation for dredging oil terminal ports, as well as dredging works for other commercial ports. Currently both fishing ports of Tajura (Figure 10) and Sirte are in urgent need for dredging due to the accumulation of sediments and dead seagrasses, which made navigation through both ports near impossible for local fishermen.

Beside dredging, sand extraction from the beaches started in 2006 at some sandy beaches in the east of the country. The Kouf National Park (the oldest in Libya, since 1978) was impacted hardly by local developers who are extracting sand from the 20 Km beach for building purposes. This contributed to a mass destruction of coastal dunes in the area and abandonment of marine turtle nesting activity. The activity although illegal is still spread at several points along the eastern region coastal area, driven by the need of building sand for concrete making, in an area of predominately rocky coast.

On the other hand, not much dumping activities have been conducted in the last 10 years, as an activity to reclaim marine areas by direct dumping of coastal area. However, dumping of municipal solid waste, including medical and electronic waste, is the major method of waste disposal in the country, with some landfill sites close to the coast, such as Ganfuda landfill in Benghazi, which pose a threat of leakage of liquid waste to the sea directly, and to the underground water table.

3.4 Authorization requests and impact studies

The main Environmental legislation of Libya is the law no.15/2003 on protection and enhancement of the Environment, and its implementation regulatory acts. The law gives the ministry of Environment the sole responsibility on monitoring and regulating all activities that may alter or change the terrestrial, marina and air environment. The law requires environmental impact assessments (EIA) to be performed prior to decision-making of any major project that affects the quality of the environment, including all EIA stages. Developers are required to prepare and submit EIAs to obtain a permit to commence their planned project. Based on the ministry records, almost 90% of EIAs and permission requests come from Oil and Gas industry. Other sectors including port establishment, power stations and desalination station construction are made with limited or no EIAs. All imports of chemicals to Libya, including industrial raw materials, pesticides and fertilizers are required to obtain a permit from the ministry of Environment as well. This aspect is well organised and there is a national record for all materials, country of origin, chemical analysis and amounts in the ministry.

4 Main (natural) characteristics of the marine environment

4.1 General description of marine habitats / species

According to the topography of the continental shelf, the Libyan coast is divided into three main regions. Eastern, Central and Western sections. The coastal habitat in the eastern section constitute mostly of rocky coasts, including rocky shores, sandy seabed’s, shallow and deep-water with number of bays, and submerged caves and partially-submerged sea caves. The central section is dominated by sandy beaches followed inland by vast salt marshes and interspersed with small rocky areas. Finally, the western section is characterized by a wide continental shelf. Most of the coast is rocky, interspersed with some sandy areas and sand bars, such as Farwa island sandbar.

Along the Libyan coastal waters, several areas are covered with pristine seagrass meadows, vermetid reefs, and deep see canyons. Natural habitats including wide areas of pristine seagrass beds, composed of *Posidonia oceanica* and *Cymodosea nodosa*, especially along the Farwa lagoon in the west, and the Gulf of Sirte, and at several natural coves to the east of the country, such as Ain Al-Ghazala Bay and Bumbah bay (Pergent et al., 2002). These habitats are important breeding grounds for fish and other marine organisms, in addition to its role in fixing the sandy bottoms and control of sedimentation. It also proved to be feeding and wintering areas for endangered Seaturtles and cetaceans.

The Libyan coast has a high biodiversity with thousands of species, Algal diversity known so far is: 15 genera (29 species) of Chlorophyta, 19 genera (34 species) of Phaeophyta, 76 genera (112 species) of Rhodophyta and 2 genera (3 species) in the Cyanophyta (Nizamuddin, 1979). 46 marine algal species reported from the coasts of Tobruk and Ain Ghazala, eastern region (Godeh et al., 1992).

Sponges economic species *Spongia officinalis* and *Hippospngia communis* and other species like *Arcorina cerebum*, *Axinella* sp, *Petrosia* sp and *Calyx nicaensis* (Bazairi et al, 2010); A total of 343 Mollusca species (187 Gastropods, 119 Bivalvs, 27

Cephalopods, 5 Polyplacophora and 5 Scaphopods (Bek-Benghazi et al, 2020). In terms of Crustaceans 37 species in the western coasts Abushaala *et al* (2014), 24 species of the cephalopods (RAC/SPA, 2017).

Fish diversity :304 species are recorded 271 are native, 6 are endemic to the Mediterranean, 22 are nonindigenous and of Lessepsian origin, and 5 are a range of expanding taxa from Gibraltar (Elbarassi, 2019) in addition to 48 species of cartilaginous fishes (Shakman 2014).

The species of cetaceans that are existed in the Libyan waters including: Bottlenose dolphin (*Tursiops truncatus*), Common dolphin (*Delphinus delphus*), Striped dolphin (*Stenilla colarualba*), Risso’s dolphin (*Grampus griseus*), Cuvier’s beaked whale (*Ziphius cavirostris*), Sperm whale (*Physeter macrocephalus*), Fin whale (*Balaenoptera physalus*) (Bearzi, 2006).

The monk seal (*Monachus monachus*) a critically endangered species, historic colonies used to be in eastern region during the 1970s, and a female seal was caught in the area adjacent to Ain Al-Gazalah MPA (Alfaghi et al, 2013), later in 2020, an adult seal was seen on the sandy beaches of Zuwara, unusually at the western coasts near the Tunisian boarder. This implies more studies needed to quantify the presence of this species in Libya.

The seabirds species breed in Libya are: Lesser Crested Tern *Thalasseus bengalesnis* (Hamza et al, 2017) , Common Tern *Sterna hisundo* , Little Tern *Sterna albifrons,* Caspian Tern *Hydroprogne caspia* , Yellow-legged Gull *Larus cachinananus michahellis*, European Shag *Phalacrocorax aristotelis desmarestii* (Ettayeb and Essghaier, 2007) . Additionally, 20 species are overwintering in the country during the winter season (EGA/RACSPA waterbird census team, 2012)

Several invasive species have been recorded in the Libyan waters since they negatively impacted the diversity and the ecological balances in the region. The total number reached 73 species recorded in the Libyan waters; the highest percentage was for fishes (32.88%), followed by macrophytes (21.92%), molluscs (16.44%), crustaceans (13.70%), and parasites (9.59), (Shakman et al., 2019).

4.2 Cartographic data on bathymetry

Libya is located at the southern limit of central Mediterranean sub-region, this region is characterized by a complex bathymetry with wide continental shelves, deep and shallow channels and wide abyssal plains. In spite of such diverse bathymetric characters, data on Libyan waters is limited, the Admiralty standard nautical charts (Figure 14) are the main sources of information used by fishing and maritime traffic to navigate through the Libyan marine area. Less information available on the biological features of Libyan deep waters.

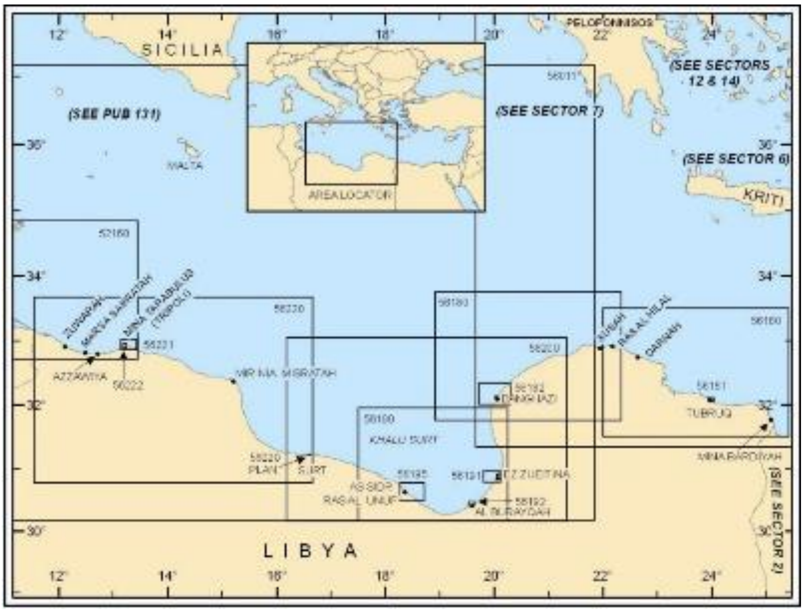

Figure 14. Admiralty standard nautical charts for Libya.

A recent study using quantum GIS (qGIS) and open geospatial data, within the Libya topo-project, by Hamad (2020) produced a multi-layer geographic maps for Libya, including some data on bathymetry for the coastal area. It is not clear whether the level of data accuracy of these maps was based on in-situ data or derived from older maps. An example of such maps is shown below in Figure (15).

Other research works on subregional level included parts of the Libyan marine area, such as the work by Drago et al., (2010) where parts of the northwest of Libya was included in their mapping of bathymetry (Figure 16).

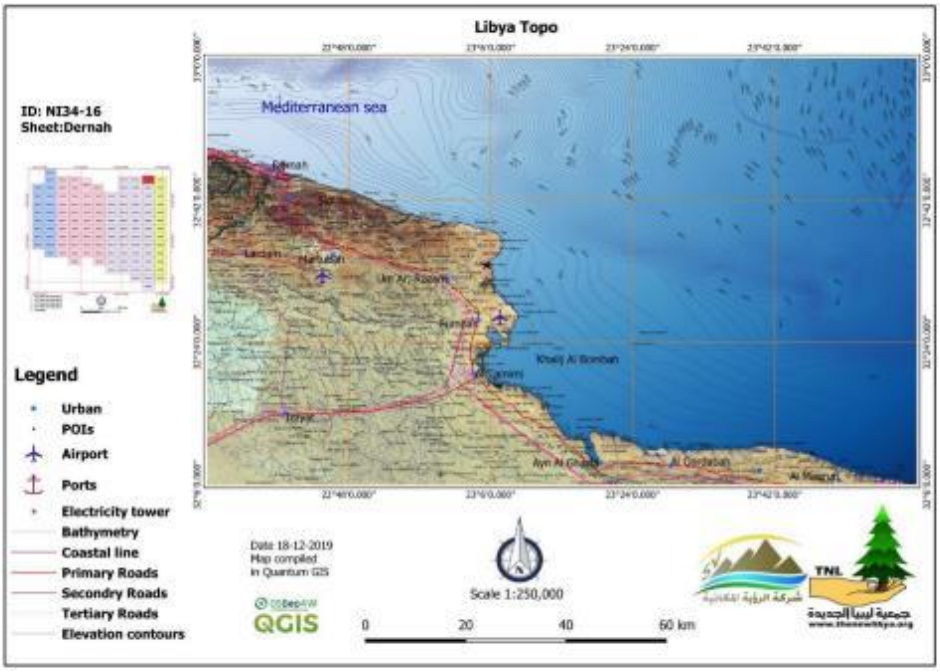

Figure 15. World Imagery based topographic map for Derna region, including bathymetry of the marine area.

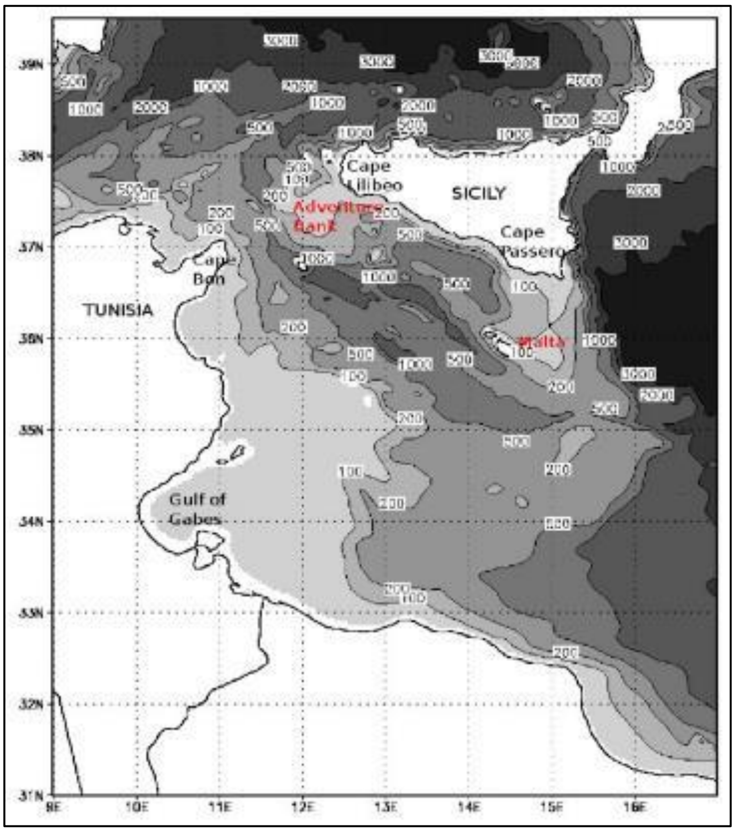

Figure 16. The bathymetry, in metres, of the Straits of Sicily shown in grey contours, from light (shallow) to dark (deep).

4.3 Data and studies in place regarding the hydrodynamic conditions

Seawater temperature in Libya varies monthly, the lowest recorded average temperature is 16C in February and March, whilst the highest is 27.5 in August (Figure 17). The atmospheric air temperature also affects the sea surface temperature, noticed from the correlation between the two parameters. Increased water temperature is one factor that provide favourable habitat for several invasive marine species in Libya.

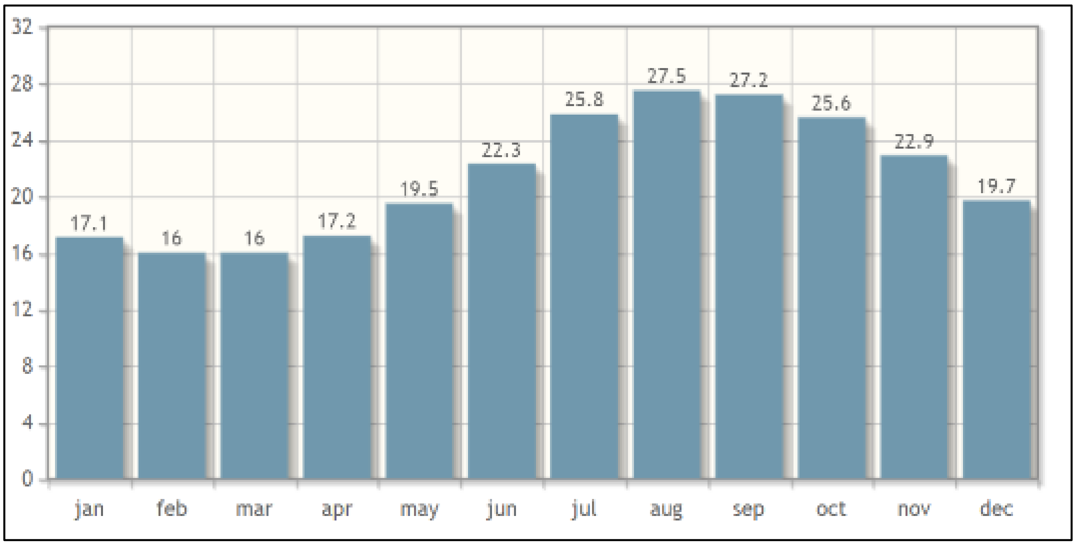

Figure 17 Average Sea-surface temperature in Tripoli, Libya (source: https://weather-stats.com/libya/sea_temperature).

Mean values of wave heights around the coastlines varies from few centimeters to 4-6 meters during the winter season, with an average of 3-4 m along the coast (Figure 18).

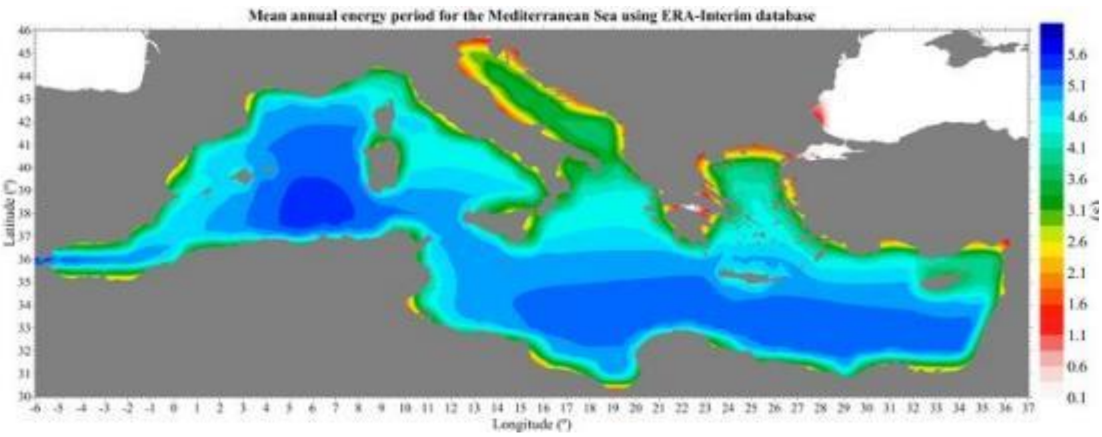

Figure 18 Mean annual wave climate in the Mediterranean Sea: (a) Significant wave height and mean wave direction, modified from

Inertial currents occur along the region between Sicily and Libya throughout the summer. Inertial events of around 10 days each occur in sequence, resulting in inertial oscillations with periods of 20 to 21 hours. On the Libyan continental shelf, their amplitude can reach 25 cms^{-1} and last for many days (Drago et al., 2010).

Due to the presence of large continental shelves and deep trenches, the variability of atmospheric disturbances, and the vertical density structure that couples with the wind stress producing barotropic and baroclinic responses of the current, the current pattern across the vertical section between Sicily and Libya is reported to be rather complex (Grancini and Michelato, 1987).

The research work by Placenti et al., (2003) showed the presence of three primary water masses with diverse chemical–physical properties was discovered in the Gulf of Sirte (Figure 19), during a water mass circulation analysis (Atlantic Water, Levantine Intermediate Water, and Deep Water. Near the Sicilian (≤ 37.6) and Libyan coasts (≤ 37.8) Atlantic Water reveals an invasive low-salinity water connected to the Atlantic Ionian Stream and the Atlantic Libyan Current, respectively. In the middle section of the Gulf of Syrte, the surface circulation shows meandering features and the existence of an anti-cyclonic vortex. There is no coastal surface current in this location, implying that coastal circulation has a seasonal nature. The intermediate water circulation in the Gulf is similarly characterized by an anti-cyclonic pattern.

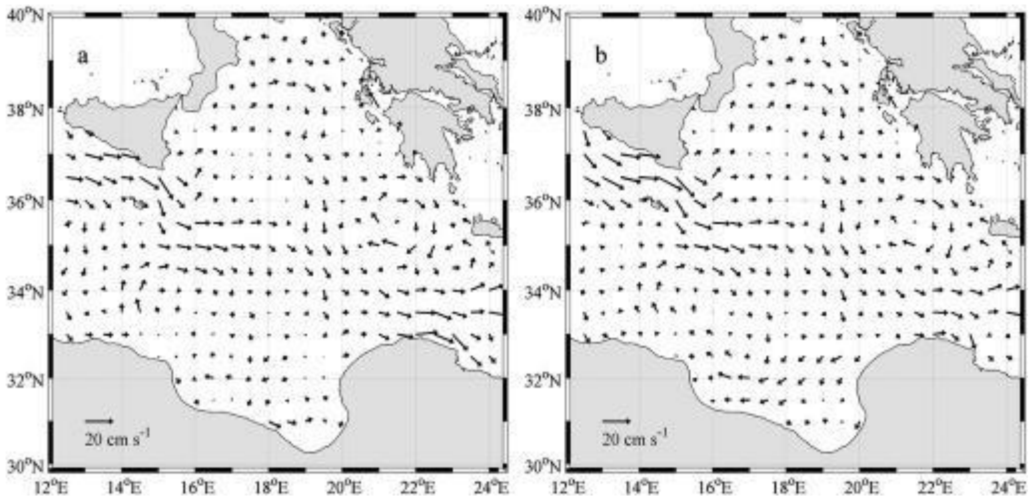

Figure 19 Unbiased estimates of the surface geostrophic circulation in the Ionian Sea during two extended seasons, (a) winter (Nov–Apr) and (b) summer (May–Oct), in spatial bins of 1° × 1° and for the period 14 Oct 1992–31 Dec 2010.

4.4 Available in situ measurements

No in-situ data or long-term measurements of temperature, wave lengths , wind speed or salinity along the Libyan coast is found. A national program to keep monitoring marine variable is needed in future. Data presented above are mainly taken from modelling studies made by foreign researchers and included in their data analysis Libyan waters.

5 Planned new installations in coastal environment

5.1 Ministries responsible for authorizing construction

In Libya, various ministries and municipal authorities have conflicting prerogatives, making it difficult to maintain a high environmental condition on the Libyan coast. For instance, Ministry of transportation through the national authority of ports and shipping has the main role authorizing construction in marine environment, including ports and marinas, while the ministry of Oil is responsible on marine installations of oil and gas industries, the ministry of defence has control on the navy bases ports, while the ministry of industry is running small ports for their steel works in Misurata. Several works conducted in the past or the present is conducted without any coordination with the Ministry of Environment (MoE), which responsible by law on the evaluation of the EIA studies which supposed to be submitted to the MoE. Only Oil and Gas industry usually submit such reports before the commence works, while other authorities seldom do that.

5.2 New/expected structures

Due to the current political unrest in Libya, not many projects that include installation or construction on the coastal area is expected, however some projects to expand the areas of several ports are in the pipeline. Among these building new port in Susa (Figure 19), expanding the ports of Tripoli (Figure 21), Al-Khoms (Figure 22) and Benghazi. At all of these projects plans to increase container handling and storage areas are planned, in Tripoli a marine bridge was also proposed to alleviate the traffic near Tripoli port.

As stated above all of these requires EIAs and permission from the ministry of environment, however it would be unlikely to be conducted soon if the current governance situation continued for the next few years.

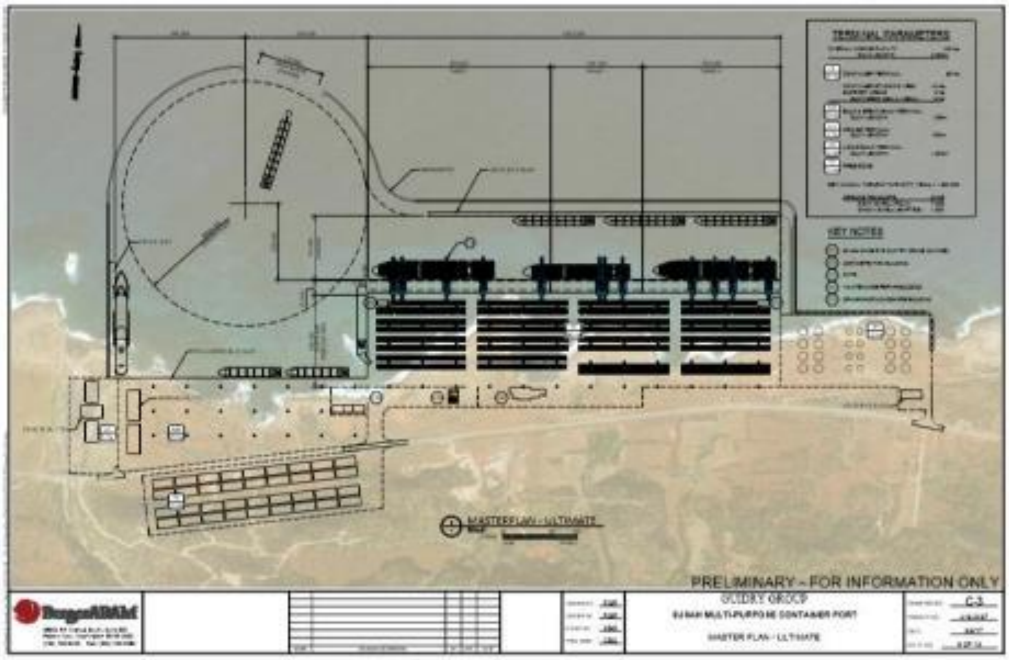

Figure 20. Plan for the new port of Susa (source https://libyaherald.com/2019/01/west-and-east-libya-unite-on-susah-port-project/)

Figure 21. Development of Tripoli Harbour, and construction of offshore bridge to ease traffic

Figure 22. Plan to develop Al-Khoms Commercial port

6 Conclusion

This report provides a baseline on the situation related to monitoring of CI 15 in Libya, according to the guidance factsheet. It summarizes achieved studies that can be related to the CI 15. Concerning data availability, high resolution bathymetric data were not available and need to be produced in future. Monthly temperature and salinity are limited to few points on the coastline and need also to be in-situ long-term monitored. There was also lack of good datasets on marine currents and waves, coastal drift for the entire Libyan coast and the presented data here depended largely on sub-regional research works conducted in European countries in central Mediterranean sub-basin. There is need for marine buoy deployments to investigate hydrographical conditions along the coastal area of Libya as it provides all input data needed for modelling.

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