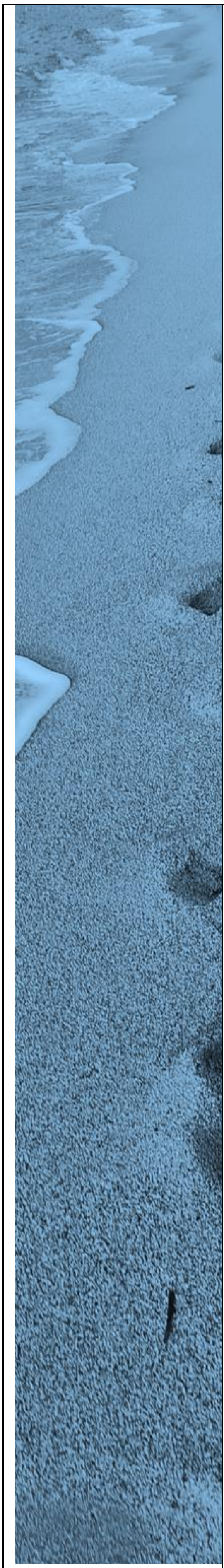

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Barcelona Convention

PAP/RAC

Report on lessons learned based on national reports for the CIs 15 and 16

June 2022

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Baseline sub-regional assessments for the Coast and Hydrography Cluster - CI 15 and support implementation of monitoring CI 16 in beneficiary country of the EcAp MED III project

Deliverable: **Report on lessons learned based on national reports for the CIs 15 and 16**

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CONTENTS

1 Introduction

The Ecosystem Approach (EcAp) represents the overarching guiding principle to policy developments and implementation under the auspices of the Barcelona Convention. EcAp refers to a specific roadmap: Contracting Parties have committed to implementing EcAp with the ultimate objective of achieving Good Environmental Status (GES) of the Mediterranean Sea and coast.

GES has been defined through eleven Ecological Objectives (EO) (often grouped in three clusters: (i) pollution, contaminants and eutrophication; (ii) marine biodiversity and fisheries; (iii) coast and hydrography) and twenty-eight corresponding operational objectives.

At their 19th ordinary meeting (CoP19), held in Athens (Greece) from February 9 to 12, 2016, the Contracting Parties to the Barcelona Convention adopted the IG decision. 22/7 on the Integrated Monitoring and Assessment Program (IMAP) of the Mediterranean Sea and Coasts and related assessment criteria. This decision includes a specific list of 27 Common Indicators (CI) for the 11 Environmental Objectives (Eos) which will make possible an integrated and quantitative analysis of the state of the marine and coastal environment to be achieved in order to achieve “Good Ecological Status”, encompassing both OE in three main clusters: pollution, including marine litter or litter, biodiversity, including non-native species; and the coastline and hydrography.

The 2017 Mediterranean Quality Status Report (QSR) issued in 2018 collates and synthesises data collected from different sources regarding these ecological objectives and indicators.

This report focuses on EO7 and the related CI15 and on EO8 and the related CI16 which are defined here below. Guidance for monitoring these indicators are provided in the document “Indicator guidance factsheets for EO7 and EO8 Coast and Hydrography Common Indicators 15, 16 and 25” (UNEP/MAP 2019).

EO7 is defined as “Alteration of hydrographical conditions“ and it addresses permanent alterations in the hydrographical regime of currents, waves and sediments due to new large-scale developments that have the potential to alter hydrographical conditions. The related, agreed common indicator is **CI15 “Location and extent of habitats impacted directly by hydrographic alterations' considers marine habitats which may be affected or disturbed by changes in hydrographic conditions (currents, waves, suspended sediment loads)”** (UNEP/MAP 2019).

CI15 is aimed to support planning of new structures considering possible mitigation in order to minimise the impact on coastal and marine ecosystems and its services, integrity and cultural / historic assets. Where possible, also to promote ecosystem health (UNEP/MAP 2019).

- Methodology used for CI15 measurement encompasses elaboration on (UNEP/MAP 2019):
- Mapping of area where human activities may cause permanent alterations of hydrographical conditions (using i.e. existing EIA, SEA and Maritime Spatial Planning -MSP); and
- Mapping of habitats of interest in this area of hydrographical changes; and
- Intersection of the spatial map of the areas of hydrographical changes with spatial maps of habitats to determine the areas of individual habitat types that are impacted by hydrographical changes.

The indicator should consider all relevant structures based on case by case approach, considering absolute surface of the structure and the depth where structure will be built). The hydrographic conditions to be considered are (UNEP/MAP 2019):

- At least, waves and currents changes (can be used to assess changes in bottom shear stress, turbulence and alike).
- For sandy sites or sites with natural sediment dynamic, changes in sediment transport processes and turbidity and induced changes in morphology of the coast.

- If the new structure involves water discharge, water extraction or changes in fresh water movements: assessment of salinity and/or temperature changes.

Challenges and uncertainties related to monitoring of the CI 15 have been noted several times already (UNEP(DEPI)/MED 2021). GIven the difficulties to implement CI 15 according to the Guidance Factsheet, few monitoring reports are expected to be submitted by the Contracting Parties (CPs), thus compromising the possibility to compose a picture on the status of hydrography at regional level. Therefore, it was decided to support the preparation of the baseline status with regard to CI 15 in the frame of the EcAp MED III project (UNEP(DEPI)/MED 2021). This was done by preparing a report structure including essential information related to CI 15. This would enable the collection of information on the baseline status for monitoring of CI 15 at least for the EcAp MED III eligible countries. All other CPs are invited to undertake the same approach (i.e. following the report structure) in the case they would not be able to provide monitoring results applying the Guidance Factsheet.

EO8 is defined as "The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved". **CI 16 is defined as the "Length of coastline subject to physical disturbance due to the influence of human-made structures".** The monitoring aim of the CI16 is twofold: (i) to quantify the rate and the spatial distribution of the Mediterranean coastline artificialisation and (ii) to provide a better understanding of the impact of those structures to the shoreline dynamics. It entails an inventory of the length and location of human made coastline (hard coastal defence structures, ports, marinas).

Indicator units are defined as follows:

- Km of artificial coastline and % of total length of coastline.
- Percentage (%) of natural coastline on the total coastline length.

The length of the artificial coastline should be calculated as the sum of segments on the reference coastline identified as the intersection of polylines representing human-made structures with reference coastline ignoring polylines representing human-made structures with no intersection with reference coastline. The minimum distance between coastal defence structures should be set to 10 m in order to classify such segments as natural, i.e. if the distance between two adjacent coastal defence structures is less than 10 m, all the segments including both coastal defence structures are classified as artificial. The identification procedure of human-made structures should be carried on based on typical situations added to the indicator guidance factsheet, including the minimum size (length, width of human-made structures) to be considered (UNEL/MAP 2019).

This report summarises the results of national reports on CI15 and CI16 prepared from seven beneficiary countries, namely Algeria, Egypt, Israel, Lebanon, Libya, Morocco and Tunisia through the activities undertaken under the EcAp Med III project, prepared by following the suggested report structure for CI 15.

2 Methodology

The report presents a summary of the national reports for CI 15 and CI16, respectively. The chapter on CI 15 (chapter 3) is organised in sections, according to the structure of the national reports:

- General characterization of the coastal area and marine environment
- Anthropogenic Activities Present in marine environment
- Hydrodynamic conditions
- Governance related to coastal infrastructures and planning of new installations in coastal or marine environment.

Chapter 4 summarises the results from the national reports on indicator CO 16.

Chapter 5 provides an overview at sub-regional level on the state of CI 15 and CI 16, as baseline for the preparation of the next Quality Status Report.

Chapter 6 indicates challenges and difficulties encountered by countries in monitoring and reporting for these Cis.

Chapter 7 proposes some reflections and consideration for the way forward.

3 Results from monitoring CI 15

The chapter is divided into four main sub-sections, reporting the characteristics of coastal areas, the anthropogenic activities along the coastline, the hydrographic conditions and the information relative to governance and future planned infrastructures. Each section reports the main findings arising from the different assessments performed by the single countries.

3.1 Characteristics of coastal area and the marine environment

The different countries are characterized by specific geomorphological diversity as well as biodiversity. This subsection illustrates the geomorphological conditions in each country and the alterations of existing habitats (biodiversity evaluation) as well as the physical processes occurring along the coastline (i.e., erosion or accretion processes). The characterization of the coast is illustrated at the country level.

3.1.1 Algeria

The Algerian coast extends for 1622 km on the west side of the Mediterranean Sea. The coastline is characterized by rocky coast (56.38%) and sandy beaches (27.25%) which alternate with bays and gulfs, separated by very steep regions. Overall, the coast is essentially rocky, shaped by very small continental shelves, which are relatively extended (90 km) on the west side, decrease (50 to 10 km)) in the central side and increase (50 km) again in the east side (Figure 1). Despite the fact that they are constantly threatened by natural hazards, such as coastal erosion and marine flooding, bays and gulfs are generally intensively urbanized, both with residential and touristic settlements. They also host important economic activities. Indeed, the high cliffs that border the coast are subject to marine and wind erosion.

Three morphological sectors can be identified along the Algerian coastline:

- Western sector: in the region of Arzew, the hard rocks of the Cretaceous and Jurassic era developed until Cape Carbon, while the region of Oran, to south, is made up of cliffs and beaches. Only the Tafna sector is constituted by volcanic rocks that form the cliffs of the coastline. The cliffs along the west coast occupy approximately 4% of the coastal length, while towards the east, large open beaches are present for hundreds of kilometres. These sandy beaches vary in width, from 10m to hundreds of metres, and some areas present coastal dunes of natural importance.
- Central sector: it is mainly constituted by rocky zones with cliffs formed in the Quaternary and quite sensible and friable to chemical erosion of seawater. The rocky coast is alternated by sandy beaches and shores with grey sediments due to the erosion of schistose rocks. The area to the west of Cherchell presents very high cliffs, reaching 300 m, and is the sector where the continental slope is very small. These cliffs have volcanic or sedimentary origin.
- Eastern sector: it stretches from the Gulf of Bejaia to the Gulf of Annaba, characterized by high cliffs of hard igneous and metamorphic rocks. The steep slopes are covered by soil and vegetation and end up directly in the sea. The rocky massifs are separated by low areas penetrated by wadis which open out to the sea. The beaches extend along the bottom of the bays and their width varies according to the location, from a few metres to tens of metres. The rivers are the main providers of sediments and sands along the coast.

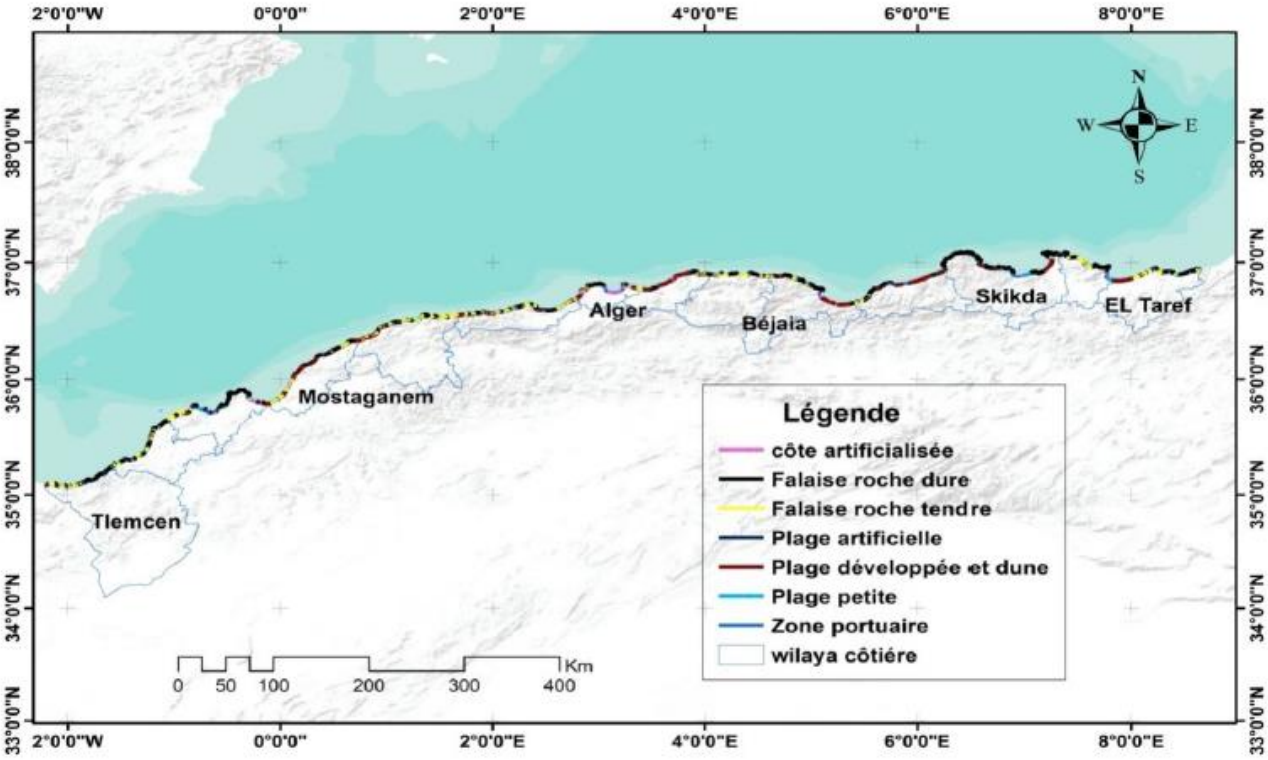
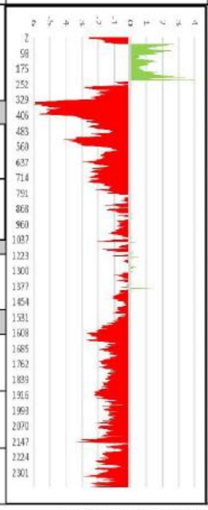
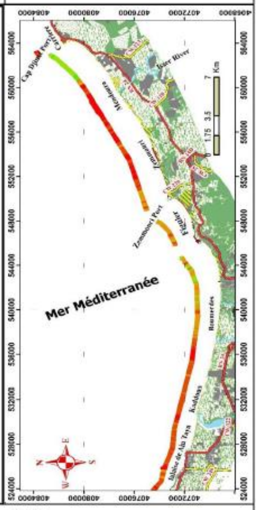


Figure 1. Algerian coastal typology.

In the last decades, the coastal erosion has become a consistent problem, with several touristic places experiencing significant declines, that led to jeopardizing tourist facilities, housing and economic development infrastructures. For example, the sandy beaches in the east of the wilaya of Algiers have experienced very strong erosion, shown by the negative sedimentary balance at the level of Déca beach and Surcouf beach, with -14,070 m2 and -14,120 m2, with a loss of 15.84% and 38.26% respectibely of the initial total areas.

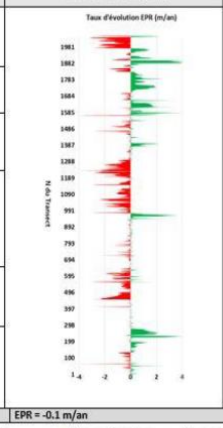
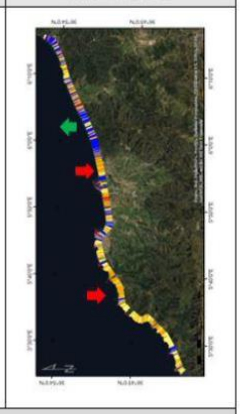
In addition to an increasing intensity of coastal erosion, urban development has rapidly expanded without considering the sensitivity of the coast. The coastline has hence become highly artificialized and different protective measures have been implemented to limit the erosion.

Coastal erosion has been estimated in an average annual retreat rate of -0.50m for all the coast types, with some areas reaching a retreat of 2.5 to 10.2 m. The net rate of change of the coastline has been estimated through three stages of data processing: i) georeferencing and correction of aerial photographs and satellite images for two-years' time period and assessment of differences; ii) estimation of coastal traits changes and estimation of the error; iii) data analysis for calculating coastal erosion/accretion rates. This methodology was carried out using automated calculation tools for rate change (DSAS), while changes in shoreline position have been calculated through the extreme point rate (EPR), net shoreline movement (NSM) and net rate of change from linear regression (LRR).
Figure 2 shows some assessments of the coastal evolution for part of the three main coastal sectors. However, in order to face coastal erosion, before undertaking costly protection measures, better management and monitoring of the coast should be prioritized.

Secteurs	Nombres de Transects	Plages	Evolution moyen (EPR, NSM)	L'évolution mesurée (m/an)	Localisation
Secteur Est	01 – 35 (35)	Plage Carrière	-1.7 m/an -61.39 m		
	Zone non mesurée (Port de Cap djinet)				
	56 – 514 (458)	Plage Mandoura	-1.18 m/an -44.05m		
	515 – 891 (376)	Plage Zemmouri	-1.71 m/an - 63.07 m		
	Zone non mesurée (Port de Zemmouri)				
Secteur Centre	907 – 1048 (141)	Plage Fighit	-0.64 m/an -23.89 m		
	Zone non mesurée (côte rocheuse)				
	1158 – 1682 (524)	Plage Boumerdes	-0.76 m/an -28.28 m		
Secteur Ouest	1683 – 2122 (439)	Plage Kadous	-1.49 m/an -55.53 m		
	2123 – 2375 (252)	Falaise	-1.63 m/an -60.23 m		
	2375	Evolution moyen Total (EPR) = - 1.3m/an			

Légende

Occupation du sol		EPR (m/an)	Evolution
Zone humide	Ouvrage de protection cotier	Erosion très élevée	Erosion
Dunes et plages	Patrimoine Historique	Erosion élevée	Accretion
Forêt	Terrain nu	Erosion modérée	stable
Végétations	Terre agricole	Stable	
Zone urbanisée	Zones portuaires	Accrétion modérée	
Cote rocheuse	Autre	Accrétion élevée	
	Rails	Accrétion très élevée	
	shoreline 2017		

	Nombres des transects N°	Le taux moyen d'évolution EPR m/an	Evolution mesurée (m/an)	Carte de l'aléa d'érosion
Le littoral de la wilaya de Jijel	2050 – 1901	-0.62		
	1900 – 1501	+0.6		
	1500 – 1301	+0.05		
	1300 – 601	-0.5		
	600 – 301	-0.4		
	300 – 01	+0.3		
	La moyenne totale de l'évolution		EPR = -0.1 m/an	
Légende	Taux d'évolition EPR (m/an): Extreme érosion; Severe érosion; Intense érosion; Erosion; Stable; Accrétion		Ligne de base; Trait de cote 2021; Trait de cote 2008	Erosion; Accrétion

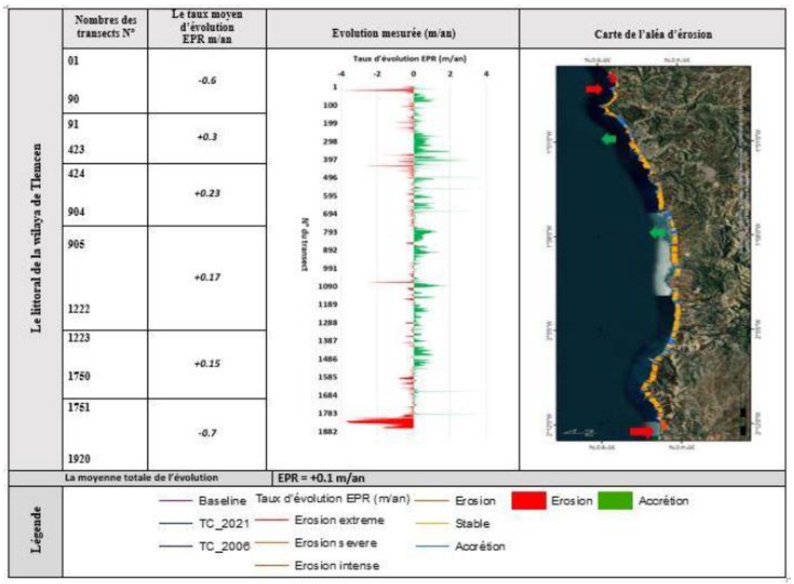


Figure 2. Coastal evolution for different sectors of Algerian coastline.

3.1.2 Egypt

The Mediterranean Egyptian coasts stretch over about 1,200 km, extending from Saloum in the West, to Rafah in the East.

In terms of elevation, the North-West Mediterranean coast ranges between +2 and +3 meters above sea level, with the exception of low-lying areas, such as natural and artificial lakes and beaches. The coast of the city of Alexandria ranges from +2.5 to +11 meters (on average +4 meters) above sea level. The Sinai coast ranges from + 3 to +5 meters above sea level.

Coasts along the Mediterranean Sea are relatively extended and comprise deltaic sediments, sand dunes, lakes and lagoons, salt marshes, mud flats, and rocky beaches (Figure 3). The coast has different geomorphologic aspects ranging from steep-slope-rocky cliffs to gentle sloping deltaic sediments. The landward limit may be several kilometres in sedimentary beaches and tens to hundreds of metres in rocky and cliffy beaches. The Nile Delta, which extends from Alexandria to Port Said, consists of deltaic sandy beaches of medium to very fine sand. It hosts the majority of the country's population and constitutes the breadbasket of the country.

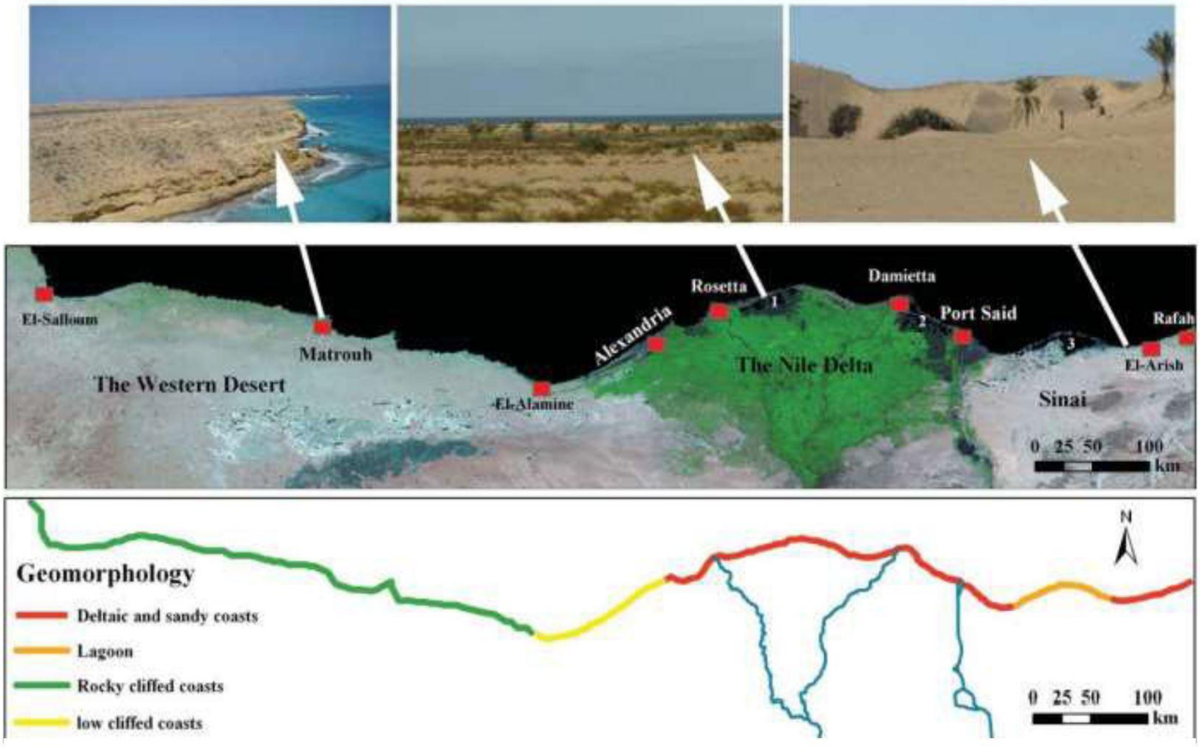


Figure 3. The geomorphology of the Mediterranean Sea coast of Egypt. Souce: Mahamed and Herer (2015).

The Egyptian Mediterranean coast is divided into three different geomorphologic regions the western region, which constitutes the coastal 550 km of the Western Desert (known as the North Coast); the middle region represents the Nile Delta coast with a length of 250 km; and the eastern region extends for 200 km in North Sinai.

The coastal geomorphology of the entire Mediterranean coast can be subdivided as follows:

- rocky cliffed coasts for the region extending from El-Alamine to El-Salloum along the North Coast (about 450 km);
- low cliffs for the region between Alexandria and El-Alamine (about 100 km);
- lagoons for the Bardawil Lagoon (85 km) in North Sinai; and
- deltaic and sandy coasts for the remaining coast 365 km, which represent the Nile Delta coast and the delta of Wadi El-Arish in North Sinai extending to Rafah.

The majority of the Egyptian Mediterranean coast includes stable coasts due to the rocky nature. The most dangerous and vulnerable locations to coastal erosion were observed either at the terminal parts of the Nile River branches (Rosetta, Damietta and the defunct Sebenetic branch along lake Burullus) or many touristic resorts along the coast particularly at the sandy beaches (Figure 4).

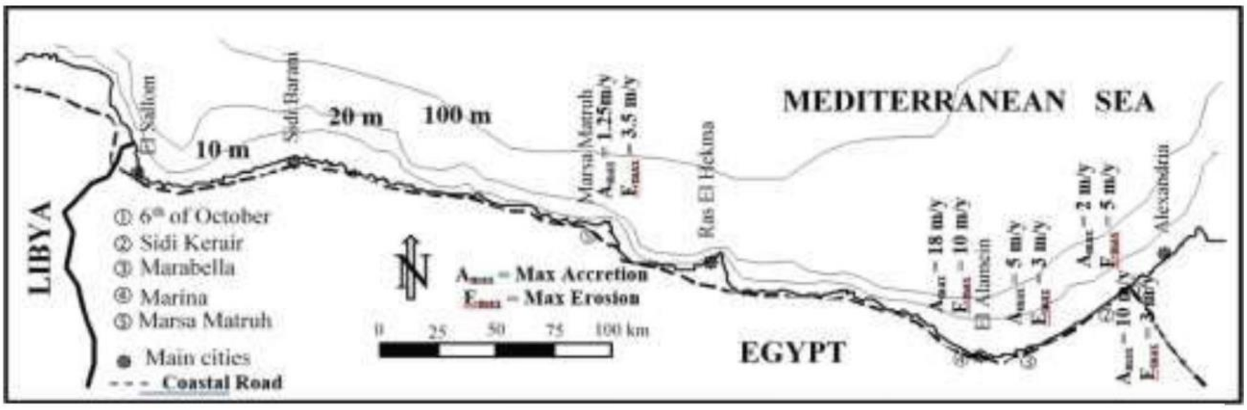


Figure 4. The north-western coast of Egypt from Alexandria to El Sallom shows the most affected areas by human activities and the maximum accretion and erosion rate in front of these areas from 2004 to 2015, modified from, Iskander and El Kut (2014). Source: Iskander (2021).

Analysis of satellite images has shown that the general alongshore erosion/accretion pattern is locally disrupted by the construction of protective engineering structures. For example, the erosion at the tip of the Damietta promontory is terminated due to the construction of the 6 km seawall built in the year 2000; erosion was originally -43 m/yr before construction of this wall. In the Rosetta area the shoreline retreat rate has decreased more than 70% from1984 to 2014. Nevertheless, it still suffers from significant erosion with a maximum rate of 37 m/year.

The shoreline response due to the construction of the submerged breakwater using the Digital Shoreline Analysis System (DSAS) showed shoreline accretion along most beaches of Miami, the western part of Asafra, and the eastern parts of Mandara and Montaza. In contrast, areas of shoreline erosion were present at the eastern part of Asafra beach and the western part of Mandara beach (Salama et al, 2021).

3.1.3 Israel

The Mediterranean coastline of Israel runs about 195 km from Zikim near the border with Gaza Strip in the south, to Rosh HaNikra near the Lebanese border in the north. With the exception of Haifa Bay, the Carmel headland and few small rocky promontories (e.g. Jaffa, Atlit, Akko), the coastline is a straight in general, open to the west and gradually changes its orientation from northeast (azimuth 32º) to approximately north (Bitan and Zviely, 2019). Most beaches in Israel are sandy and have a moderate slope (~ 1:30) and their width ranges from 10 to 50 meters. Relatively wide sandy beaches (50-100 m) are found mainly in south Israel and around the coastal rivers outlets (100-200 m) (Lichter et al., 2010), while beaches less than 30 m wide and sometimes only a few meters, are mainly located in the center of the country, along the coastal cliff. Compared to the large number of sandy beaches in Israel, the rocky coasts are limited and they are located mostly at the Carmel and Western Galilee coasts (northern Israel).

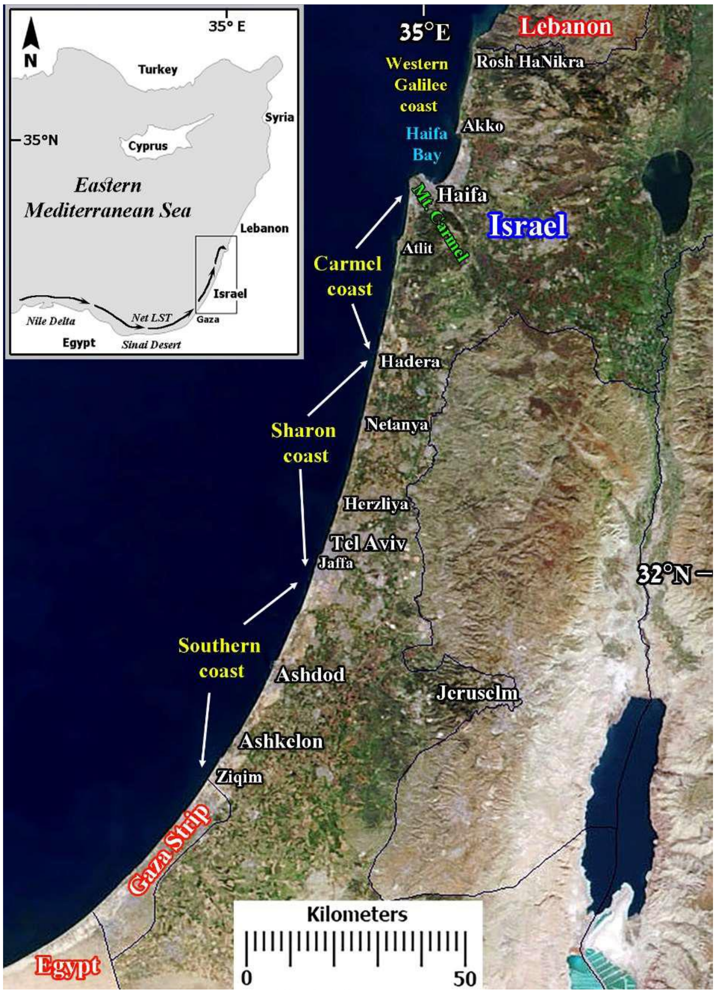


Figure 5. The Mediterranean coast of Israel (Background: Part of "Middle East" space image, Jacques Descloitres, MODIS Rapid Response Team, NASA/GSFC, 31 January 2013). Top left inset: The Nile littoral cell net LST direction.

The Mediterranean coast of Israel and is mostly comprised of a crystalline sand belt varying in width from several to hundreds of meters. The sand originates from the Nile delta and is transported along the continental shelf and coasts by alongshore currents in a general counter-clockwise movement along the eastern Mediterranean shorelines.

The total length of the Israeli coastline is 212.220 km. The length of the natural coastline is 172.147 km, which is 81.1% of the total coast; the length of the artificial coastline is 40.073 km, which is 18.9% of the total coast.

3.1.4 Lebanon

The Lebanese coast is the eastern part of the Mediterranean basin. It is characterized by a high geomorphological diversity and the state of the coast is unstable, fragile and subject to erosion processes. Over the years, a large urban expansion occurred along the coastline that led to an increasing anthropic pressure on the coast itself.

The total length of the Lebanese coastline is approximately 342 km, of which 125 km are natural coastline, corresponding to 36,59 % of the total Lebanese coast. The majority of natural coastline is located in the Southern part of the country, in which is also located one of the most important Coast Nature Reserve for the nesting of migratory birds and the endangered Loggerhead and green sea turtles. On the other hand, the artificial coastline represents 63,41 % with a length of about 217 km. The Lebanese coastline is highly artificialized and is mainly characterized by rocky coast for 30.8%, 22.8% are sandy beaches and 5.3% are pebble beaches. Figure 6 illustrates the coastal types and the percentage of artificial coast.

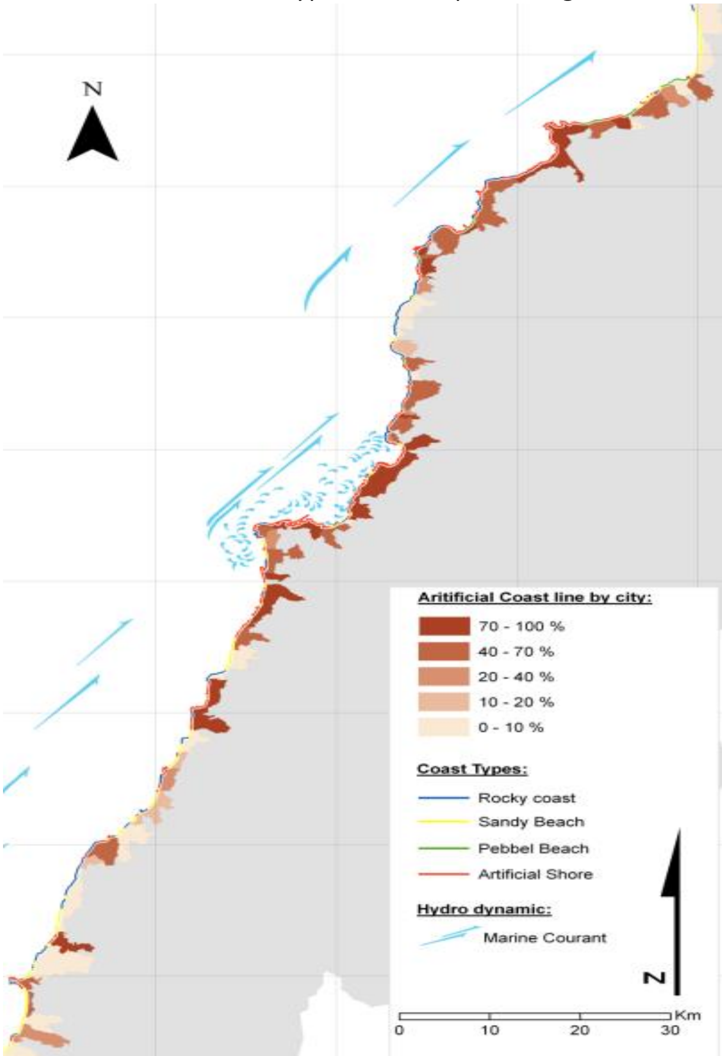


Figure 6. Coastal types in Lebanon and artificial coast.

Considering erosion and accretion processes, the Lebanese coast is subject to erosion phenomena and in lesser extent to accretion processes. Specifically, accretion has been assessed along the Beirut's coast, in which artificial shores and cliffs have been installed to protect the coast, while other parts of the country (e.g., Akkar and Tyre) characterized by sandy beaches erosion is more frequent. The withdrawal of the coastline is estimated at 1.4 meters/year and is driven by the marine currents occurring at high speed in Northern North-Eastern direction (Figure 7).

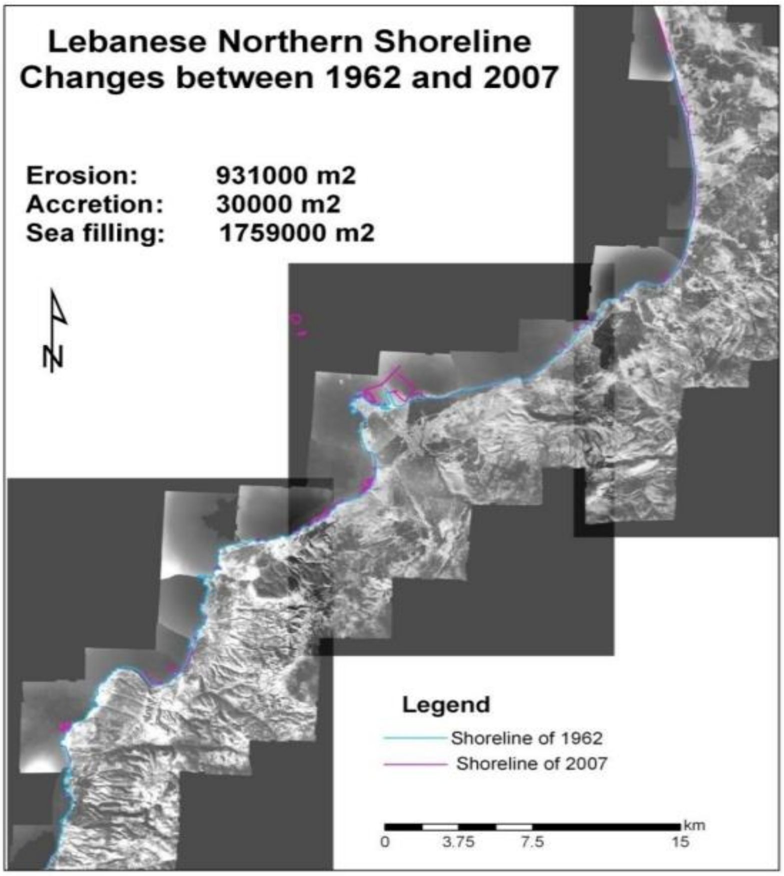


Figure 7. Erosion and sea filling in the Lebanese Northern coastline. Blue line represents the shoreline in 1962 and purple line represents the shoreline in 2007. Comparison between both shorelines shows erosion, accretion, and sea filling.

3.1.5 Libya

The total length of the Libyan coastline is 1976.41 km, of which 1891.39 km are naturals, representing the 95.60% of the total length, and 85.02 km are artificial coast, representing the 4.4% of the total length. The Libyan coast can be divided into three regions: the east coast, the middle coast and the west coast. The west coast presents the larger number of built structures, even though the Libyan coast is the most natural country among those considered in this report.

The Libyan coastline is mainly constituted by sandy beaches (64.7%), followed by medium to low elevated sandstone or limestone rocks (35.3%). Overall, the coast is divided into three main sectors with different morphology. The eastern part is mainly constituted of rocky coasts, sandy seabed's, shallow and deep waters, bays and submerged caves, while the central section is dominated by sandy beaches and salt marshes inland areas and small rocky areas. The western part is characterized by a wide continental shelf and the coastline is mainly rocky and with scattered sand areas and sand bars. Seven sectors of the coast can be distinguished:

- Ras Ajdir to Tripoli: this part of the coast lacks in gulfs and bays and it has a concave shape. The beaches are made of white sand, low with some areas having sand dunes.
- Tripoli to Misuratah: the coast is made up of medium-elevated rocks that form steep slopes, small sea heads and some narrow bays.

- Misuratah to El-Magroon: it is the longest coast, dominated by different size and topography of sandy beaches and sandy dunes. The sand dunes play a major role in shaping the coastline and are the result of wind and marine erosion processes.
- El-Magroon to Tolmitah: it is featured by the presence of coastal slopes and caves, formed by the marine erosion and the karstik rocks.
- Tolmitah to Ras Tin: this area is the most steep and elevated of the whole coastline, some limestone coastal formations reach more than 100m height. These slopes intercept with deep narrow wadis and some beaches vary from narrow sandy ones to gravelly or rocky in some parts, resulting from the sand precipitation in wadi mouths or from the strong wave action on limestone formations.
- Ras Tin to Elba foot: the arch shape of this sector is made up of intense sandy formations, low topography and extensive coastal lagoons and sebkhas.
- Elba foot to Bir Ramla: the coast is characterized by short wadis and steep, high edges ending in the sea through medium-small gulfs. Some parts are instead low-medium elevated rocky or gravel coast with limited sandy beaches.

Comparing satellite images between 1987 and 2006, the coastline presents erosion processes to be dominant over accretion or sediment deposition. Specifically, more than 70% of the total observed area shows erosion and only 30% of the total area shows sediment accretion. The coastal erosion is extensively affecting the different sectors and population set up along the coast, contributing to the collapse of the archaeological sites, of manufacturing facilities and buildings. The annual costs of lost land and infrastructure assets due to coastal erosion account for ~0.7% of national GDP, with an erosion rate of 28 cm/year.

3.1.6 Morocco

The Moroccan coast is fragmented and made up of both low coast profile with sand dunes and sandy coves, and rocky reliefs and abrupt cliffs. Specifically, five types of coasts have been identified in Morocco: rocky headlands (7,94%), rocky platforms (41,42%), fine sandy beaches (14,82%), medium to coarse sandy beaches (12,73%), and fine to medium sandy beaches (23,10%). Offshore the coastline, the seabed is mainly sandy and mussy with rocky substrates covered by coralligenous concretions.

Three main coastal sectors can be identified, presenting different geomorphology:

- East side (from Saïdia to Melilla): it is low coast, surrounded by dunes. Towards the west side, a basin closed by sandy dunes constitutes the Nador lagoon, which ends with an eruptive massif.
- The Riffian coast between Cap des Trois Fourches and Ceuta is made up of an alternation of sandy coves and rocky reliefs. The area is surrounded by some bays bordered by low beaches. Part of the coasts are rocky and steep that form some bays.
- The last segment extends from Ceuta to Cape Spartel and is made up of steep rocky cliffs.

Considering the processes of accretion and erosion of the Moroccan coastline, the main physical factors identified affecting the erosion of the coasts are: i) the high variability of the climate characterized by frequent periods of drought and periods of heavy rains; ii) the presence of highly erodible soils due to their weak structure, lack of depth and absence of organic matter; and iii) the uneven relief of steep slopes and very different landscape.

The erosion rate has been estimated at 0.14 m/yr on the Mediterranean side coast and at 0.12 m/yr on the Atlantic coast. The erosion is mainly due to the anthropic activities, such as ports, and to the hydrological cycle and the deposition rate of rivers into the estuaries which are obstructed by the construction of dams. The largest erosion rates are along the bay of Al Hocaeima and the port of Nador. The coastal infrastructures development are contributing to the erosion. In that area the coastline is moving inland and the beaches are shrinking, threatening their existence.

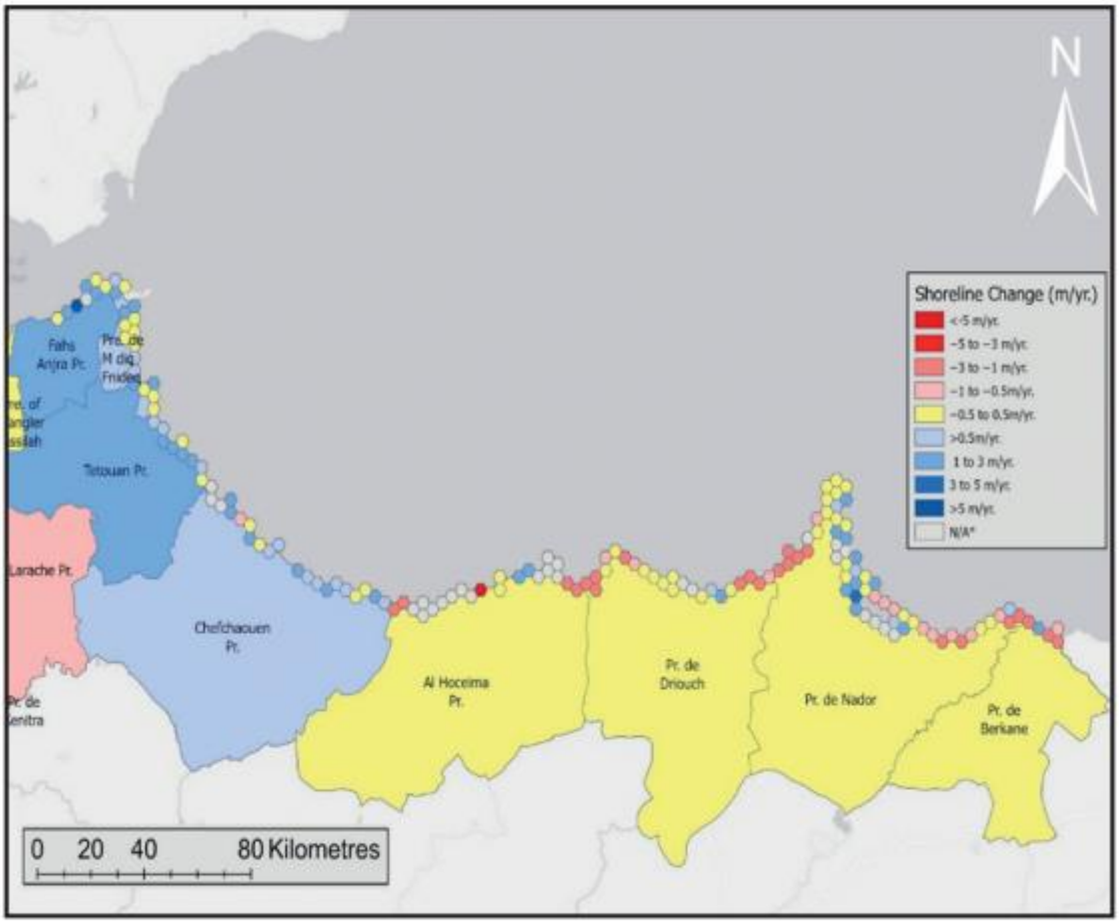


Figure 8. Erosion hotspots along the Mediterranean coast of Morocco (Heger. and Ashold, World Bank, 2021)

3.1.7 Tunisia

The Tunisian coastline is constituted by cliffs, rocks and sandy beaches (*Figure 9*) in different proportions.

The majority of Tunisian sandy beaches present processes of erosion, followed by stable beaches, while few beaches present accretion processes (*Figure 10*). Different factors have been identified as drivers of the erosion along the coast, primarily the building up of buildings (e.g., hotels) and infrastructures, and of structures to protect the coast from waves (e.g., breakwaters).

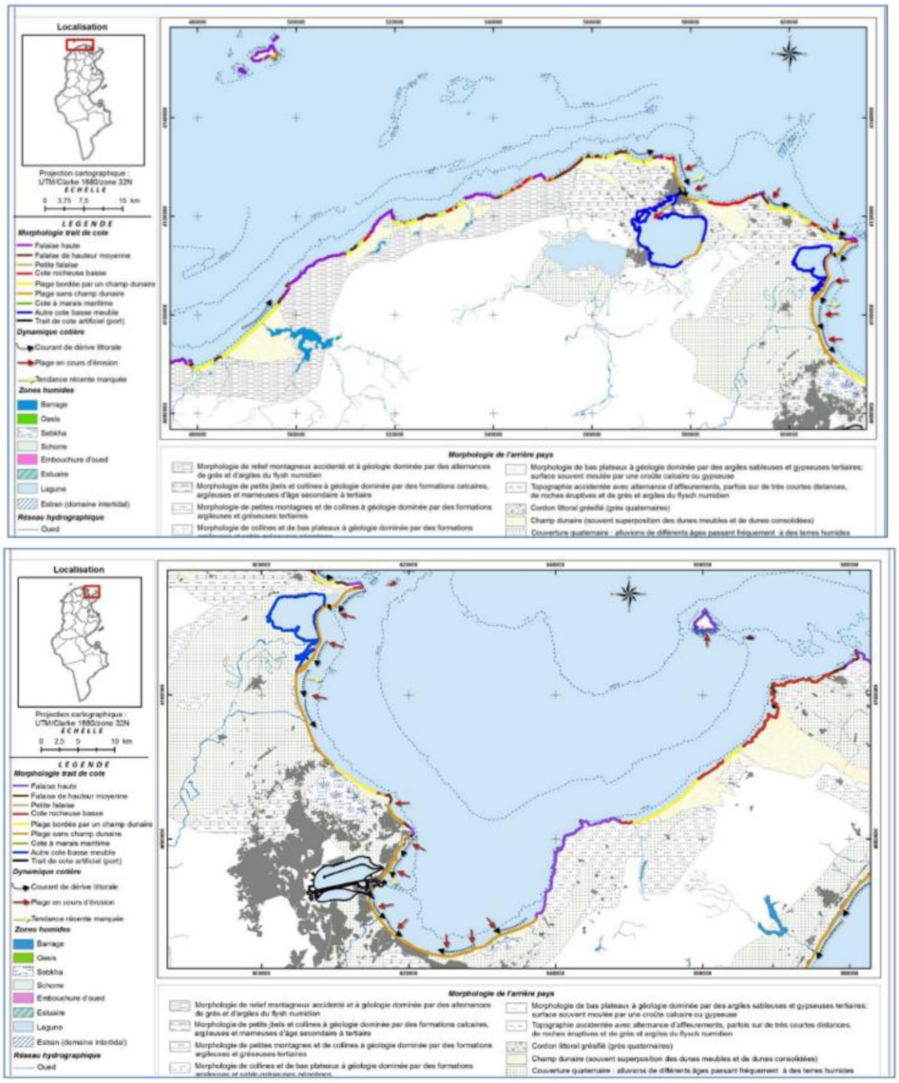


Figure 9. Examples of coastal morphology for the extreme north of Tunisia (above) and for the gulf of Tunis (below).

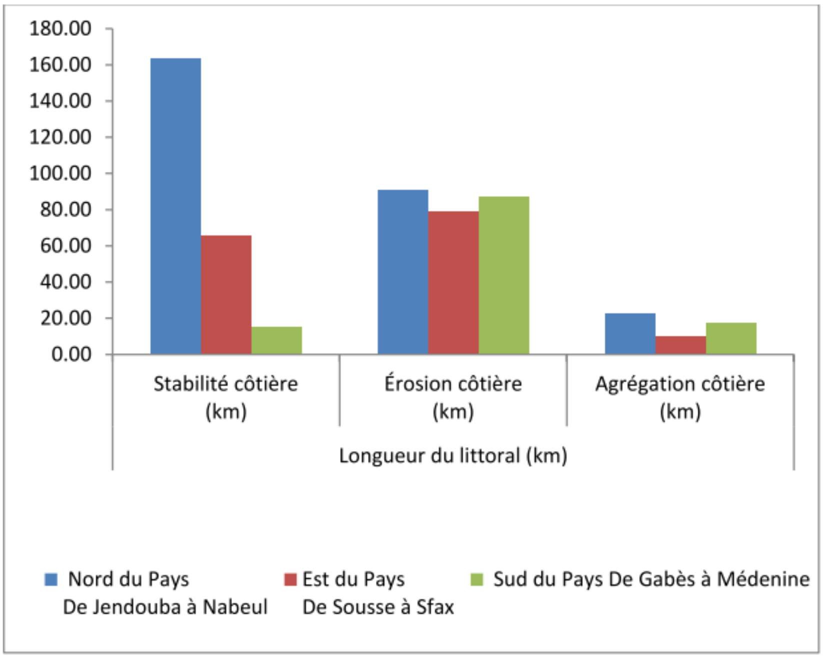


Figure 10. Km of Tunisian coast in erosion, accretion and stable.

3.2 Anthropogenic activities

The coastal areas of the countries assessed are highly urbanized and populated, which, inevitably, have affected the natural landscape and morphology. This sub-section analyses the anthropogenic activities present in the coastal-marine environment for the different countries.

3.2.1 Algeria

The coastal environment of Algeria is subject to anthropogenic pressures due to pollution, coastal erosion, degradation of coastal sites, urbanization determining detriment of agricultural land and suffocation of the sea shore.

The Mediterranean coast is the area with the highest **population density** in the country: more than 36% of the Algerian population (274 inhabitants/km²) is concentrated the coastal strip 50 to 100 km wide from east to west (about 45,000 km², 1.9% of the territory).

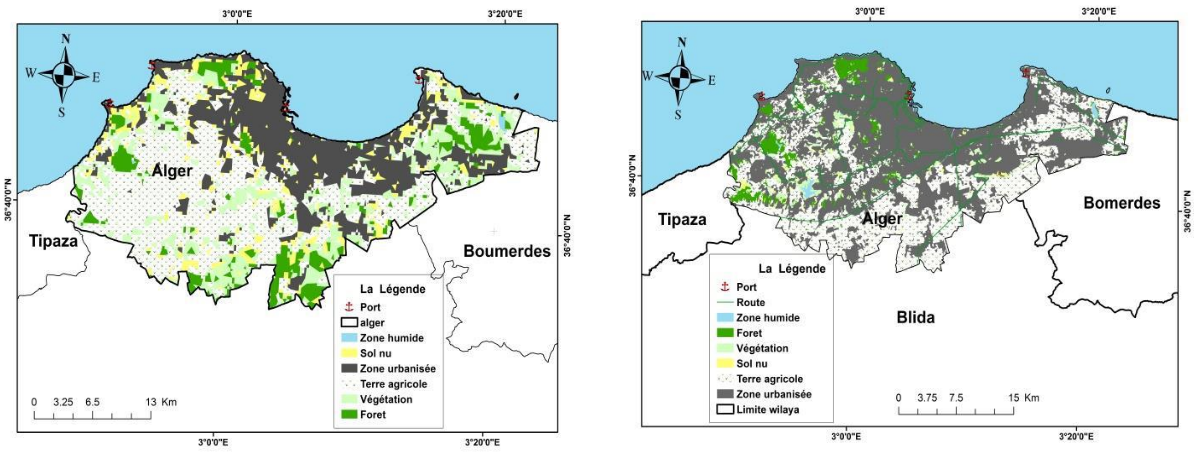


Figure 11. Evolution of urbanization in the district of Algiers between 2000 (right) and 2021 (left)

With a coastline of 1622 km, the Algerian coast hosts 11 **commercial ports**. Three oil ports (Arzew, Skikda and Bejaïa), three main polyfunctional ports (Algiers, Oran and Annaba), two average-size ones (DjenDjen and Mostaganem) and three small ports (Ghazaouet, Dellys and Ténès). In addition to these 11 major commercial ports, the Algerian coast is home to: 37 ports and fishing shelters, 11 mixed ports and a marina.

Several coastal environments in the country are struggling with eroding coastlines and increased anthropogenic pressure, including the pressure generated by the development of seaside infrastructure. Faced with the active erosion of the coasts, government authorities and individuals are increasingly resorting to the establishment of coastal protection works. Following the strong demand from the fishing sector to improve the conditions for landing fish products, the Ministry of Public Works has put in place some major new installations (thirty-four recorded projects) of structures in the coastal environment over the past 10 years.

In almost all the ports of Algeria, siltation constitute a permanent threat. Their structures are most often found in areas where the depth is relatively shallow; it is then essential to carry out dredging to allow ships to access the quays. For the 18 main national ports, the volume of silting and silting is estimated at 20 million m3. The frequency of dredging varies according to the size of the ports, their location and the maritime traffic they generate.

Dredging primarily concerns commercial ports, for which these operations are a necessity to maintain their activity, when their waters are too shallow and/or they are subject to sediment supply (maintenance dredging). In 2015, more than 1,200,000 m3 of sediments were dredged in the port of Annaba, 32,000 m3 at the port of Skikda, 60,000 m3 in the port of Oran. During the year 2016 200,000 m3 of sediment dredged at the port of Algiers. 70,000 m3 of sediments were taken from the port of Ténès in 2012. The sediments dredged from these ports are discharged into the sea.

In addition to dredging activities in commercial ports, around 16 other activities were launched for the various fishing and pleasure ports between 2010 and 2017 (Port of Sidi Frej, Azzefoune, Cap Djinet, Sidi Lakhedar, etc.). The dredged sediments are discharged into the sea or stored or recovered on land, for example in the context of beach replenishment.

More than 10 million m3 of **sand were extracted** in recent decades, with the consequences of beach erosion, soil and groundwater degradation (marine intrusion, infiltration of pollutants), reduction of fresh water resources, etc. Unfortunately, the extraction of sand persists, like for example at the level of dune cord located in the municipality of Bousfer, where the authorities have been asked to take the necessary measures to put an end to this act which threatens enormously the dune cord and which will have harmful consequences on the natural state of Oran coast.

3.2.2 Egypt

The effect of the human activities on the coastal area are very intense and include impacts on natural resources, coastal stability, environmental quality, and the cultural environment. The instability condition is the predominant feature of the Egyptian coastal zone due to natural and anthropogenic pressures.

The main activities in the coastal areas are related to fishing and marine aquaculture, maritime transport, cruising and pleasure boating, coastal tourism, energy production, extraction of marine aggregates, offshore oil and gas industry, and sub-marine telecommunication and electric cables.

The Mediterranean represent the grounds for the majority of **fishing activities** taking place in Egypt. In addition to the coastal belt along the Mediterranean Sea in the north of Egypt, there are a number of Egyptian brackish water lakes and lagoons situated along the Nile Delta: Manzala, Burullus, Edku and Mariout, and to the east of the Suez Canal, Port-Fouad and Bardawil.

Tourism is one of the more important sectors in Egypt contributing 11.3% of GDP and with 12.6% of the total labour force employed in the sector. Apart from the traditional destination cities such as Alexandria, Port Said, Matrouh and Al-Arish, the north coast extending from Alexandria to Matrouh has emerged as a main attraction for local tourism during the last two decades. This has been accompanied by extensive developments of resorts along the Mediterranean coast thus representing an increased pressure on the coastline and the ecosystem. The Government plans to further develop the north coast to absorb the future population growth in the country and to make it an attraction for foreign tourists and investors.

In recent years, Egypt has experienced a boom in fish production, where it has increased from 790,000 tonnes in 2001 to 1.8 million tonnes nowadays. This increase is mainly due to the expansion of **aquaculture**, which represented 74% of the total catch. Notably, the size of four of the northern lakes, namely Manzala, Burullus, Edku, and Mariout have drastically declined reaching up to 95.5% reduction in size in some cases, as is the case for lake Edku, mostly due to anthropogenic activities. Moreover, the northern lakes have been exposed to serious environmental degradation due to the disposal of industrial and agricultural waste, as well as municipal waste.

Maritime transport represents another import sector in Egypt. The strategic location of Egypt and with the Suez Canal connecting the Mediterranean Sea with the Red Sea linking East to West attracts a great deal of maritime traffic along the Egyptian Mediterranean coastal zone. Major ports in Egypt are located in Alexandria, New Damietta and Port Said. These ports also have oil and natural gas terminals. Smaller fishing ports are located at a number of designated fish landing facilities in addition to most major ports.

Oil shipping through the Suez Canal and along with the Egyptian oil terminals makes the Egyptian Mediterranean coast among the most important oil shipping routes in the Mediterranean basin. The importance of this facility has enhanced with the completion and inauguration of the new parallel canal in August 2015.

The main pressures to coastal stability are related to **urbanization**, construction of coastal structures, removal of sand dunes, but also infrastructures to control floodwater and sediments, as well as climate change. Such pressures are responsible for severe shoreline changes within the coastal zone. The dramatic erosion along the Northern coast and migration of the sand spit inland along the Rosetta Nile branch exemplify these unbalance conditions.

The North western coast of Egypt extends for 500 km west of Alexandria city, along the Mediterranean Sea. It can be divided into two parts according to the urbanization; the undeveloped areas (70% of the total coastline extend) and the developed area (30% of the total coastline extend). The dominant feature of Egypt's Northern Coastal Zone is the low-lying delta of the River Nile, with its large cities, industry, agriculture and tourism. The coastal areas of the Nile Delta have about 40% of Egypt's agricultural production, half of Egypt's industrial production, and large urban population centres. Egypt's population has reached about 100 million, with a growth rate of 2.0%/year, CAPMAS (2017). Of this number, more than 10 million people inhabit the northern coastal region. Population densities are extremely high (to 1000 or more/km2), especially in the Nile Delta and Valley.

Many **coastal protection structures** have been erected to stop or mitigate coastal problems. Although the western-Mediterranean coast of Egypt between Salloum and Alexandria, 550 km long, has maintained a considerable equilibrium throughout history, developers have built traditional protective structures in an effort to form sheltered recreational beaches without taking into consideration its geomorphologic characteristics, coastal processes and their harmful impact on the coastal environment and human safety. Recent Beach Protection Projects:

1- Protection of Ras al-Bar beaches and tongue area. The Ministry of Irrigation has carried out protection work in Ras al-Bar city to protect beaches and facilities from erosion, as the Beach Protection Authority has carried out the operation to protect the area west of Ras al-Bar. The Beach Protection Authority has also rehabilitated the sea wall west of Ras al-Bar, strengthened and rehabilitated surf barriers, protected and rebuilt the mouth of Jamsa Bank, and carried out protection work for the Gulf areas, east of Damietta port, west of San Ras al-Bar and east of the tower estate.
2- Beach protection in Alexandria. The Beach Protection Authority has implemented the project to protect the scaffolding area in front of the navy, in the Bay of Abi Qir, to protect the area from

flooding, especially in the season of the nucleus, through the work of concrete tiles above the stone tongue, a pavement of metal curtains, the extension of the width of the main scaffold, the restoration of the old scaffold, and the renovation of the current aquarium to the level (-3.00) meters.

3- Protecting the Nile Estuary of Rashid Branch. The Beach Protection Authority carried out the Nile Estuary Tekrik project for Rashid branch in Kafr Al-Sheikh and Al-Lake governorates, about 100 meters wide and about 2 km long. Drilling and reclining of sand deposited on the eastern side of the Nile, about 2 km from the Bougaz Rashid opening, was also carried out in the south to facilitate navigation. The operation to protect the low-lying coastal areas west of the mouth of the Rashid branch, in The New Rashid area of Lake Governorate, using geotextel mats, dalumite stones, daqshom and sand bumpers.
4- Protecting the beaches of Kafr Al-Sheikh In Kafr al-Sheikh province. Several protection projects, such as the coastal area protection project north of The Glyon Pond, have been implemented with the construction of 16 stone heads and the low-lying area protection project, from west of Al-Burles to the mouth of the Rashid branch, 29 km long.
5- Protecting the beaches of Daqahliya. The Beach Protection Authority has implemented the project to protect low-lying areas from the western entrance to Jamasa city to the west of the new city of Mansoura, 12 km long, and the area protection project east of the sea heads, which is carried out east of the mouth of The Bank of Kutcher and sand feeding.

For new natural based sea defence structures ongoing project "Enhancing Climate Change Adaptation in The North Coast and Nile Delta Regions in Egypt" funded by GCF is implementing a total of 69 km of soft coastal protection, in sections of the Nile Delta that currently experiences severe flooding, imminent risks of agricultural land loss and damages to coastal infrastructure. Soft coastal protection focuses on in constructing 69 km of artificial sand dune dikes along five vulnerable hotspots within the Nile delta that were identified during and engineering scoping assessment and technical visibility study.

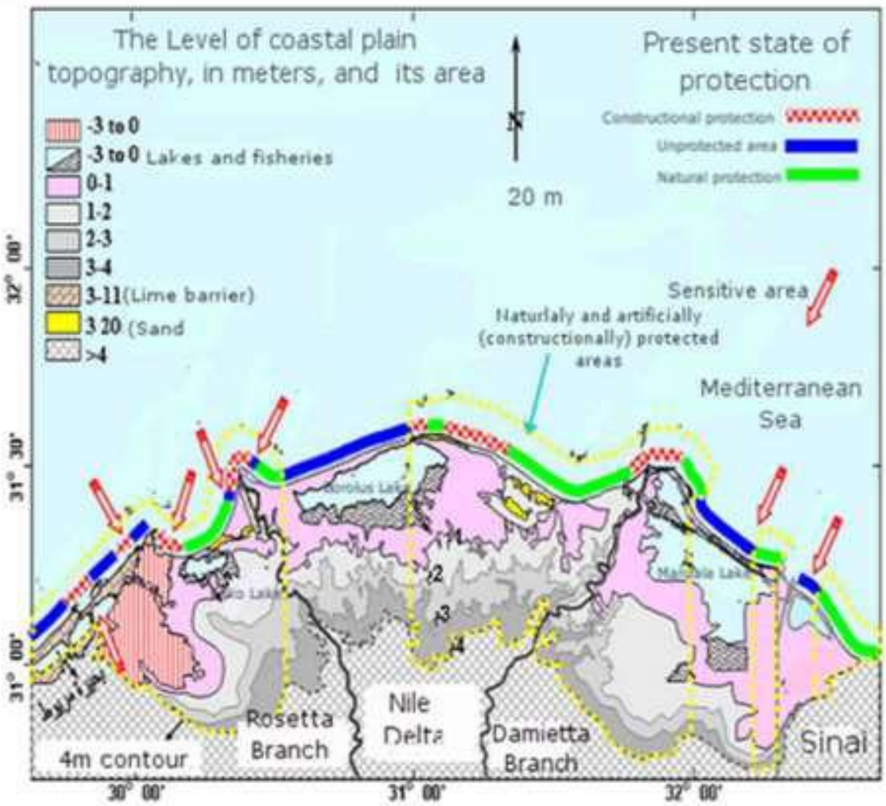


Figure 12. Current natural protection of the coastal area of the Nile Delta and Alexandria (accretional beaches, sand dunes, and long limestone ridges); constructional (protective sea walls and barriers)

protection areas for the Nile Delta and Alexandria coastal zone, as well as the more vulnerable areas requiring future measures of adaptation (areas indicated with the arrows). Sources: - Egyptian Authority for Coastal protection.2010

Dredging activities have been implemented mainly in Egyptian northern wetlands and their inlets for enhancing water circulation and thus quality. For example, this is done in Lake Burullus which is an important coastal wetland and RAMSAR site on the northern coast of Egypt. In the lake three processes led to dramatic environmental change and degradation: the unprecedented growth of aqua culture ponds (from close to 0 hectares in 1978 to over 40,000 hectares 12 years later in 1990), the expansion of urban area from nearly 2,000 hectares in 1973 to 8,500 hectares in 2011, and loss of open water from over 45,000 hectares in 1973 to about 25,000 hectares in 2011.

Dredging is crucial in other areas too, particularly in relation to navigation. Deep navigation channels have a great impact on adjacent beaches and crucial economic effects because of periodic dredging operations. The navigation channel of the Damietta harbor is considered a clear example of the sedimentation problem and deeply affects the North-eastern shoreline of the Nile Delta in Egypt. The Damietta harbor created an accretion area in the western side with an average rate of 2.13 m year-1. On the contrary, the shoreline in the eastern side of the harbor retreated by 92 m on average over the last 45 years. So, it is considered one of the main hazard areas along the North-eastern shoreline of the Nile Delta that needs a sustainable solution. Moreover, a detached breakwaters system is predicted to provide shore stabilization at the eastern side as the implemented one at Ras El-Bar beach. Predicted shoreline evolution of 2060 shows a significant retreat of 280.0 m on average.

3.2.3 Israel

The Israeli Mediterranean coastal environment has been exposed to multiple pressures due to rapid population growth and urbanization, coastal development and intensive agriculture and industrial activities.

The **discharges** by manmade activities released nutrients, heavy metals and toxic organic compounds to the costal water. Haifa Bay, in particular, suffered the highest pollution load along the Israeli coast. Since the 1970s and 1980s high levels of trace metal accumulation originating in effluents of chemical and petrochemical industries in the Haifa Bay area were found in the bay's fish and benthic invertebrates (e.g., Shefer et al., 2015). Despite efforts to reduce this pollution, the bay's sediments are still polluted with metals (including Hg), as well as concentrations of metals and nutrients in the vicinity of rivers, streams and outfalls (Herut and Rahav, 2017b; Shoham-Frider et al., 2020).

Physical disturbances due to **maritime constructions** (port enlargements, erosion protection, desalination plants, exploration and production of offshore energy resources, recurrent maintenance dredging and beach nourishment), and shipping are abundant and often result in disturbances, damage and destruction of natural habitats, sedimentation, chemical, acoustic and light pollution. Intensive, and sometime, uncontrolled fishing activities, threaten the sensitive coastal and marine ecosystems. Marine debris, especially plastic, mainly from onshore sources, endanger the coastal and marine organisms and inflict negative effects on coastal tourism (Pasternak et al., 2017).

In the years 1930-1964, the coastal sand was the main source of sand for construction. The **sand dredging** caused a disturbance in the natural sand balance and therefore there was an increase in the rate of retreat of the coastal cliff. Since 1964, sand mining from the beach has been banned.

Several dozen **marine infrastructures** are located along the Mediterranean coast of Israel. These structures can be classified into four groups according their projecting into the littoral zone:

- Groins and beach-parallel detached breakwaters, projected 100 to 200 m offshore, at water depth of 3 to 5 m.
- Marinas, harbors and power plants cooling basins, projected 400 to 600 m offshore, at water depth of 5 to 9 m.

- Haifa and Ashdod ports, projected about 2 km offshore from the natural coastline, at water depth of 21 m and 24 m respectively.
- Offshore coal pillars Jetties at Hadera and Ashkelon, projected 2 km offshore, at water depth
- of 28 m.

The morphological impact of the marine structures on their adjacent beaches and seabed were studied in detailed by using aerial photographs, coastal geodetic measurements, hydrographic surveys. bathymetric charts and some ecological surveys. The studies show that sand accretion has developed at the southern side (up-stream), while the northern side (down-stream) of marine structures along Israel's southern coast has eroded. Along Israel's central and northern coasts, however, this morphological phenomenon is less dominant - even inverted around some small coastal structures

Recently constructed marine infrastructures are:

- The Southport Terminal in Ashdod Port Ashdod Port is situated on the southern coast of Israel about 30 km south of Tel Aviv. It handles the largest cargo volume, and is the major gateway for cargo to and from the State of Israel. Between 2015 and 2020, another huge container terminal (Southport Terminal) to handle the largest container vessels (Class EEE) has been constructed, and the terminal and the additional main breakwater extension are set to become operational in 2022.
- The Bayport Terminal in Haifa Port Haifa Bay, in northern Israel, is the most significant morphological feature on the southeastern Mediterranean coast
- The construction of the latest container terminal (Bayport Terminal) has been ongoing since 2015, and it is due to become operational during 2021. This huge terminal, designed to handle Class EEE container vessels, is located relatively close to the Kiryat Haim beaches. To protect the Bayport Terminal, the main breakwater was extended by 882 m to a total length of 3,682 m, and its head located at a water depth of about 20 m.

Dredging and dumping activities. The Mediterranean coastal zone of Israel and the inner shelf, as mention above, is mainly composed of fine quartz sand. This non-renewable resource, which has been used for various purposes in the 20th century, has a high environmental value and is essential for the Israeli economy and its development. Over the past 20 years, there has been a dramatic increase in the use of marine sand that dredged along the Israeli coast. During this period, the seaports in Ashdod and Haifa were significantly expanded to include large container terminals that could serve large container ships (e.g. the new Panamax E class and Maersk Triple). For the construction, a huge amount of sand of about 25 million m3 dredged from the ports vicinity, was used to fill the new terminals.

Simultaneously with the port expansion, various projects that required several millions of cubic meters of marine sand, were carried out along the Israeli coast, for example: covering pipelines embedded in the seabed, sand bypass operations around the port of Ashdod, and sand beach nourishment activities that carried out on several eroded coasts.

Sand filling of marine structures. During the 20th century, two main ports and several marinas were built along the Israeli coast. In order to build these structures, large amounts of sand were dredged from the seabed surrounding these structures. According to estimates, the total amount of sand used to fill the piers and reclaim land for the ports and marinas was ~ 10 million m3, of which about 4.3 million was for the building of the port of Haifa and its expansion over the years.

Starting from the beginning of the 21st century, there has been a dramatic rise in the amount of dredging in the vicinities of the Haifa and Ashdod ports in order to build new container terminals. Most of the sand was used for the filling of the Carmel Terminal (2.3 million m3), the Eitan Terminal (Hayovel Port) (1.5 million m3), the Bay Port Terminal (~ 10.2 million m3) and the South Port Terminal (~ 9 million m3).

Dredging of sand and other sediment from the seabed in the vicinity of ports and marinas located along the Mediterranean coast of Israel, is also carried out in order to maintain the operational depths of these marine structures. These routine activities involve the dredging of large volumes of sand in order to maintain sailing channels, harbor entrances, maneuvering areas and the area of the terminals in the

Ashdod and Haifa ports, and to a lesser extent the entrances and other areas of the Trans-Israel Pipeline port (Ashkelon) and the Hadera Port, the main marinas (Ashkelon, Ashdod, Tel Aviv and Herzliya) and other smaller anchorages.

Most of the sand dredged in the ports' channels and anchorage areas was used to build new container terminals. The rest of the sand was dumped in deep water or near the beaches, according to the grain size and the polluting material it contained. It is worth mentioning that polluted sediment (including sand, silt, clay and sediment from the ports) was removed to maritime waste sites (i.e., Epsilon and Alpha) which are in deep water, far beyond Israel's continental shelf

3.2.4 Lebanon

More than 55% of the country's population lives in coastal areas and largely depend on coastal resources. Many activities take place on the coast, i.e., commercial ports, fishing ports, oil pipelines and power station, resorts, and industries, many of them built in a chaotic and unregulated way. Agriculture is also prominent in the coast with intensive use of fertilizers and pesticides that frequently are released on the marine environment.

The large and unregulated coastal development has affected the landscape and threatened the biodiversity, as well as factors as the solid waste (e.g., non-biodegradable plastic) discarded along the coast are damaging the marine fauna. Untreated domestic sewage and industrial runoffs are the main sources of chemical pollution and operational wastewater that are frequently released into the sea. These multiple pressures have caused a deterioration of water quality, ecological sites and natural resources, and have modified the local biodiversity. Indeed, native and marine flora and fauna are competing with an increasing number of invasive species originating from Indo-Pacific and Atlantic oceans.

Over the last decade, some major coastal infrastructures have been built along the coast, such as commercial basins, new ports, breakwaters. Dredging and dumping activities are also occurring to remove material from one side of the marine environment and relocating it in another site, with the aim of increasing the depth of water. These works have occurred to expand the access channel and the inner basins of Tripoli Commercial Port, to enlarge the river mouth and its channel, and in tanker offshore of oil terminals.

Besides dredging, sand and gravel extraction from beaches to embank the coast (e.g., ports, urban installations, built up of the Beirut International Airport) are impacting the Lebanese coastline and its dynamics. Sand extraction started in the 60's and evolved to reach up the maximum rate of 1500 m3 per day. These activities largely affected the sandy beaches, which were eroded and the sand started to be replaced with pebble dunes.

3.2.5 Libya

More than 90% of the population lives along the Mediterranean coast, between Tripoli, on the west-side, and Al-Bayda, on the east-side of the country. The inland regions, instead, suffer from low population rates due to the desert conditions and water shortages that make the environment less liveable. The population has grown from 1972 at an annual rate of 0.74%.

Many activities take place on the coast, which has commercial ports, oil exporting port terminals, multiple fishing ports/landing sites, a submarine natural gas pipeline crossing to southern Italy, electricity power stations. The main infrastructures are concentrated in the surrounding areas of the larger coastal cities of Tripoli, Benghazi and Misurata. Since 2011, a rapid demographic change and an increasing urbanization rate have greatly raised the demand of coastal resources for building houses and commercial development. This large development of the coastline has weakened the environmental monitoring and, sometimes, governmental regulations have been neglected.

Decades of weak environmental management have facilitated oil pollution from the **petrochemical industry** and the civil war has targeted oil storage facilities and pipelines, exacerbating the pollution problems. So far, it is still unknown the impact of war on pollution levels.

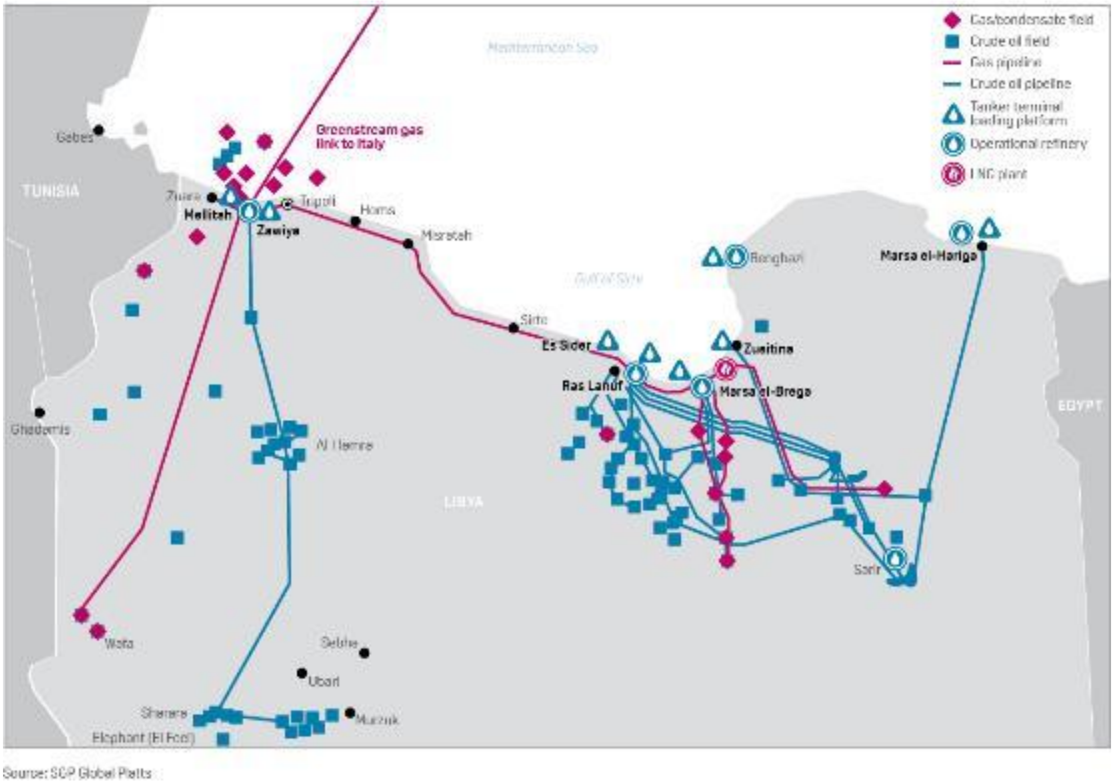


Figure 13. Libyan oil and Gas infrastructure. Source https://www.spglobal.com/platts/en/market-insights/blogs/oil/012920-map-libyas-oil-and-gas-infrastructure

Agricultural activities are restricted to certain areas of the coast, but the extensive use of chemical fertilizers and pesticides, and the extensive development of private housing have deteriorated the fertile lands, which have been converted into real estate areas, compromising the plant cover. Even before 2011, land degradation and desertification were major concerns, which pressures have increased over the coastal strip with the increased urbanization and population development. Despite Libya has signed up different multilateral environmental agreements, their implementation is inadequate due to a lack of proper and efficient policy instruments and strategies.

Furthermore, the majority of the country's population (86%), agricultural and industrial activities are concentrated in coastal areas, which are particularly vulnerable to sea level rise. Different studies show that an increase of one meter of sea level rise would flood 5.4% of Libya's total urban area and would salinize soils and renewable aquifers.

All these pressures have negative consequences on the marine environment, which is also threatened by the **untreated wastewaters**. Several cities discharge untreated wastewater directly into the sea because of the poor state of wastewater treatment plants. The unregulated discharge has increased between 2011 and 2019 as a result of several conflicts within the country and other African countries, which have led to the unregulated urban development. Most of the houses do not use the public wastewater system and depend on private septic tanks, frequently dug near the surface water table and hence contaminating the drinking water. Large pollution is also due to the solid waste disposal released into the sea, especially close to the large coastal cities, which contribute to the runoff of bleached materials and which consequences are on the marine living organisms.

In the last 10 years, **new coastal installations** took place in the Libyan coast, such as the reconstruction and completion of breakwaters at the port of Tripoli, the construction of Tripoli marina, of commercial and fishing ports, and a desalination plant in an oil refinery.

Dredging activities are mainly conducted to maintain the depth of water in commercial and oil sites along the Libyan coast. Such activities should be conducted after a proper EIA process and the granting permits of

the Ministry of Environment, but in most cases, these works are done without it.
Besides dredging, sand extraction from the beaches started in 2006 in the east of the country, mainly for building purposes. The activity, however, is largely contributing to the destruction of coastal dunes and to the abandonment of Local fauna of the area (e.g., marine turtles are not nesting in these areas). The activity, although illegal, is still widespread in several places along the eastern region, driven by the need of building sand for concrete making to use in an area dominated by rocky coast.

3.2.6 Morocco

The Mediterranean coast of Morocco, although relatively little developed as a whole, is the seat of many human uses and activities: coastal urbanization, port infrastructure, coastal fishing, sand extraction, seafood collection, coastal agriculture, activities leisure, etc.

Tourism has been developed as alternative to the decline of other traditional sectors (e.g. the textile industry). On the Mediterranean coast the targeted segment is beach tourism. New tourist infrastructures have been positioned at the two extremes of the Moroccan Mediterranean coast. At the eastern end the large tourist complex "Saidia Mediterranea" was constructed and on the western side, small hotel entities, such as marina-Smir, kabila, etc. were realized. Other activities are beginning develop recently, more oriented towards a cultural experience of the country.

Agriculture plays a minor role due to to the nature of substrate. Some developments take place in between cliffs, dune ridges or beaches or near the lagoon environments, in particular the lagoon of Nador. And with urbanization, the agricultural surface is today only 6% of the surface area of the coastal zone, against 12% at the scale of the country (IRIS 2010). In addition to limited extension of cultivable areas, low rainfall and the overexploitation of water resources have been a major factor in salinization and soil degradation.

Along the Mediterranean, in lagoon from Nador, Cap de l'Eau in the Saidia - Moulouya region, Cala Iris and, offshore, in M'diq **aquaculture** is practiced. The National Agency for the Development of Aquaculture (ANDA, 2012) indicated the bays of Jebha, Ras Kebdana, Cala Iris, too as suitable for aquaculture farming. At the end of 2015, national aquaculture production was estimated at 600 tonnes. Two species constitute almost all marine aquaculture production: these are oysters (65%) and sea bass (35%).

In Morocco, the **ports** provide 98% of the country external trade and therefore constitute a vital sector for its economy. According to the supervisory Ministry, port activity recorded in Morocco, at the end of December 2020, a growth of 5.1% with respect to the latest statistics from the National Ports Agency which report an overall volume of 92, 5 million tonnes. Along the Mediterranean coast 19 ports are located, characterized by the type of traffic indicated in the following table.

Table 1 Port activities on the Mediterranean coast of Morocco

Port (de l'Est vers l'Ouest)	**Nature de l'activité**
Port de Saidia	Plaisance / Marina
Port de Ras Kebdana	Plaisance / pêche
Port de Bou Areg	pêche / plaisance
Port de Nador ville	Port de Nador ville
Nador West Med	Pêche / commerce / passagers. complexe portuaire intégré, industriel, énergétique et commercial, à vocation de transit mondial,
Sidi Hssein	pêche
Port d'Al Hoceïma	pêche
Port Inouaren	Pêche
Port de Cala Iris	pêche
Port d'El Jebha	pêche
Port de Chemaâla	pêche
Port de M'diq	plaisance/pêche / Royal Yachting Club de Mdiq
Port de Kabila	Plaisance / Marina
Port de Smir	Plaisance / Marina
Port de Fnideq	pêche
Port de Dalia	pêche
Port de Tanger Med	commercial/passager/ croisière
Port de Ksar Sghir	Pêche/militaire
Port de Tanger Ville/ Tanja Marina Bay	plaisance/pêche/croisière

Urbanization is another relevant pressure for the Moroccan coast, determined by the high natality rate (7.8 children/family) combined with the immigration from rural areas. The rate of urbanization in Morocco increased from 55.1% in 2004 to 60.3% in 2014. Among the agglomerations of the Moroccan Mediterranean, only the city of Tangier is among the 7 most populated cities in the country with 947,952 inhabitants, in 3rd position.

The industrial establishments around the Renault factory, the development of the port of Tangier Med as well as the urbanization plans have undoubtedly contributed to this growth.
In relation with **new coastal infrastructures** the following should be noted:

- The Aquaculture Development Plan for the Eastern Mediterranean Zone identified a total area of 1,965 hectares and 89 production units for installation of aquaculture farms.
- The Moroccan Mediterranean has 19 port infrastructures, some of which are relatively recent (ten years or less): the Tangier Med I inaugurated in 2007; the Nador West MED port in the bay of Betoya which will be delivered at the end of 2022; the port of Fnideq commissioned in 2011, the Inouaren port built in 2014, the port of Dalia completed in 2016, the Port of Ksar Sghir built in 2011, the reconversion of the port area of Tangier city which was completed in April 2020.
- During the last decade, the Mediterranean coast of Morocco has been enriched with numerous infrastructures aimed at facilitating artisanal fishing activities and improving the living and working conditions of fishermen.
- Numerous infrastructures have been realized to support development of tourism activities.

The increasing need for construction materials to meet urbanization is increasing and consequently **sand extraction**: it was estimated at 21 million m3 in 2011 and more than 28 million m3 by 2016 (Hakkou et al. 2015, METL 2013). Currently, this sand comes from numerous quarries, some of which are marine and coastal (dunes, estuaries and marine frank). In 2011, coastal dunes provided the largest share of this material with nearly 15 million m3 of sand compared to 1.54 million m3 from port and estuarine dredging (METL 2013). Marine sources have been recently preferred to sand dunes

3.2.7 Tunisia

The coastal zone of Tunisia hosts the majority of population and the main cities of the country. The coast has always played a key role for the cultural and economic development of the country, indeed the main universities, schools, hospitals, telecommunication infrastructures, ports, textile industry, metallurgical industry are settled here. Overall, 70% of the economic activities and 90% of tourist accommodations and the majority of the irrigated agriculture are settled along the coast. All such activities have an impact on the natural environment, for instance air and water pollution (due to the energy production, road traffic, untreated or mismanagement of wastewater), loss of agricultural and natural areas, loss of flora and fauna, unregulated tourism development, disturbance of the coastal environment.

The largest **industrial areas** are located around the major urban and port agglomerations since they need large quantities of water for their processes and waste disposals. Thus, in large extent, the industry contributes to air pollution and has harmful effects on local flora and fauna. Quite often, these environmental risks are aggravated by an inadequate siting of industrial facilities (*Figure 14*).

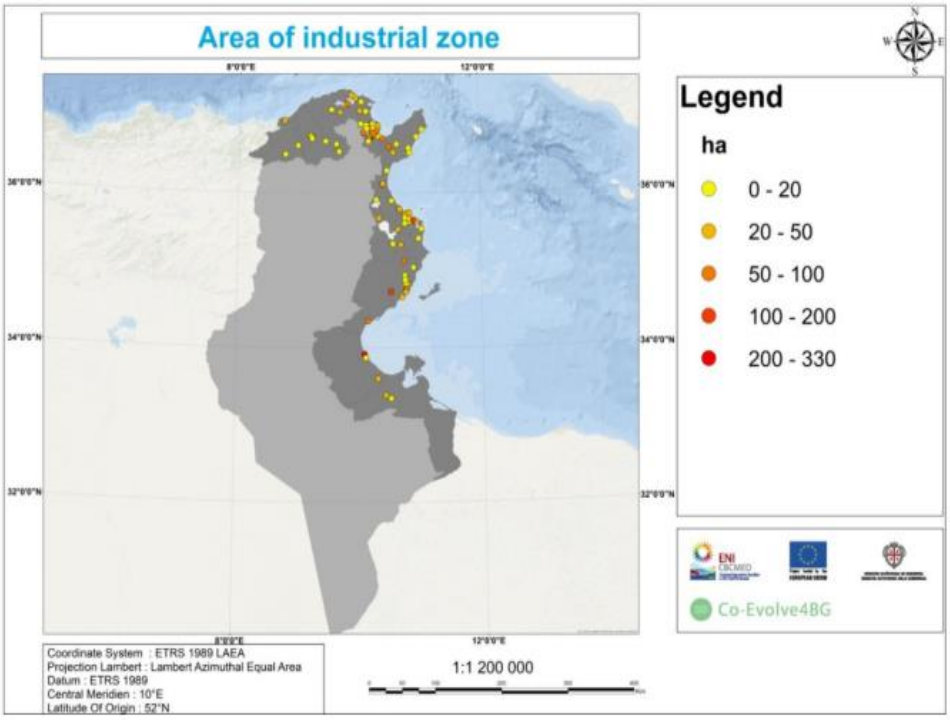


Figure 14. Industrial areas in Tunisia.

A further issue of concern in Tunisia is a worsening in **solid waste management** both in urban, rural and marine areas, which is manifested by the increasing presence of solid waste and dumps. Indeed, a wild accumulation of waste along the coast, roads, in the sea, sidewalks, in green spaces, urban parks, on embankment slopes are damaging and ruining the landscape. The waste treatment for household and municipal waste consists in burying them in controlled landfills.

Regarding the **effluent discharge**, some coastal hotspots receive excessive nutrient loads from sewage effluents, river flows, fish farms, fertilizers and industrial facilities. These threats accrue the oligotrophic conditions of the Mediterranean Sea and induce eutrophication processes, which negatively affect marine ecosystems.

Municipal wastewater is another important source of nutrients for water bodies and their water quality. The municipal wastewaters contribute as well to eutrophication phenomena in the Mediterranean Sea, affecting the natural environment from both an ecological and socio-economic perspective. Nutrient discharge from municipal effluents is a pressure indicator, which provides insight into the quality of municipal effluents discharged and the extent to which these nutrients discharged contribute to oligotrophic conditions of the Mediterranean Sea.

Data on heavy metals discharged by **industrial activities** into the sea are not available on a continuous basis, but in some areas have decreased, while in other have increased due to the settlement of new industries (e.g., Ariana Governorate).

In the last ten years, **new constructions** have been installed along the coastline, of which the most important ones are the touristic ports, the infrastructures to depollute the lake of Bizerte (i.e., a European funded project for the depollution of the lake by renewing the industrial units located around the lake), the construction of a fishing port, the built up of structures to protect the coast from erosion (e.g., dikes, breakwaters, sand refill). Inevitably, such measures have an impact on the coastal morphology.

Dredging is usually performed to increase the water depth to facilitate the maritime transport by removing part of the seabed material from one site to another. Three types of dredging are identified:
- maintenance dredging: is the removal of accumulated sediments from the bottom to maintain the depths to ensure the navigation of vessels;

- Deepening dredging: it is carried out to adapt the navigation path to the size of the vessels. This work generates large volumes of sediments and significant dredging resources.

- Development dredging and creation of new port areas: the creation of new port areas moves large volumes of various materials, such as clay, rocks, mud, gravel, sand.

Beyond dredging, **sand and gravel extraction** have largely impacted the coast and the sand beaches. The sand extraction from the beaches has been aggravated by the reduced contribution of sediments due to erosion, constructions of dams, ports, coastal developments.

3.3 Main hydrographic characteristics

3.3.1 Algeria

The distribution of the frequencies of annual and seasonal appearances of offshore winds during the period (1992-2016) show that winds coming from the northeast sector are more frequent with occurrence of 65% annually, 75% during the winter and 54% during the summer. Winds with speeds exceeding 15m/s are rare and occur mainly during the other three seasons (Autumn, Spring and Summer). Strong winds with maximum speeds > 20m/s are very rare (< 0.1%). The percentage of calm winds for all cumulative directions is higher during the summer (41.37%) than during the winter (21.68%).

The currents of the Atlantic waters which enter through the Strait of Gibraltar in the form of eddies are directed from west to east with a speed of around 7 knots. They reach the Algerian coast with a speed of 0.5 to 2.5 knots. These currents create a west-facing coastal counter-current with a speed of less than 0.5 knots.

Measurements made by the Hydrographic Service of the National Navy (SHMN) along the Algerian coast indicate that a tidal range of ± 0.34 m with a maximum level of +0.5 m and the lowest tide is at - 0.34 m. The Algerian coast is under the influence of a microtidal environment which makes it at very high risk in the face of sea level rise.

3.3.2 Egypt

The historical measured wave data from 1977 to 2010 were examined to investigate the effects of climate change on wave climate in front of the Nile Delta coast. Results showed that there was an increasing trend in the mean significant wave height during the period from 1985 to 2010 by a rate ranging from 2.6 to 2.9 cm/year. Increase in wave height coincides with a decrease in wave period ranging from 0.01 to 0.26 sec./year. Wave energy in front of the coastal structures within this area will increase by about 20% within high storms and decrease by about 1 % within the normal conditions in the next 50 years. Nevertheless, most of the Egyptian coastal structures are over designed and will not be affected by the increase in wave energy due to the climate change.

3.3.3 Israel

The Israeli climate is characterized by hot and dry summers with stable atmospheric conditions, cold and wet winters, and transitional seasons in spring and autumn (Reiter, 1975). During the summer, steady westerly and northwesterly winds dominate over the Levantine Basin, strengthened by the Aegean Etesian regime and superimposed by a well-developed coastal sea breeze. The winter wind is predominant westerlies. In contrast to summer, the winter atmospheric conditions are unstable and variable, with occasional cold and dry air outbreaks from the north local cyclogenesis. Also important are the depressions moving eastward across the Mediterranean Sea, which force strong southerly to south-westerly winds along the Israeli coast.

The Mediterranean wave climate of Israel can be divided into two seasons: summer (April to October) and winter (November to March). During the summer season, the wave climate is characterized by relatively calm sea with a wave height rarely exceeding 2 m (Hs < 2 m). In the winter season, however, the wave climate is characterized by alternating periods of calm seas and storm events of up to 5 m significant wave height (Hs).

Longshore currents are generated along the Israeli coast by radiation stresses of breaking waves in the littoral zone and shearing stresses of local winds acting across the shelf. Wave-induced currents are generated in the surf zone, generally limited to about 5 m water depth, and during extreme events may extending to about 10 m water depth. Since radiation stresses are generally at least an order of magnitude greater than shear stresses, the former predominate in the surf zone during storms. Beyond this region, however, to about 30 m water depth, shelf currents are generated by local winds).

Until the construction of the Low Dam at Aswan (1902) and especially after the construction of High Dam at Aswan (1964) the primary source of sand for the Nile littoral cell was the Nile River. The dam's construction, however, effectively blocked this flow, and forced the longshore currents to take sand from the Nile Delta coasts and its seabed, that eroding consecutively.

The sand from the Nile Delta is transported by longshore currents eastward to northern Sinai coast and continues north-eastward along the Gaza Strip and Israel's coasts, up to Haifa Bay which constitutes the northernmost final depositional sink of the Nile littoral cell. Sediment transport estimates along the Nile Delta and northern Sinai coasts, indicate a continuing decrease of sand transport rate, as the longshore currents move eastwards and then north-eastwards, up to the Gaza Strip and southern Israeli coasts.

The tidal regime along the Israeli Mediterranean coast exhibits a semi-diurnal and fortnight periodicity and ranges from 15 to 40 cm, which is not sufficient to create sediment transporting or beach eroding currents.

The Survey of Israel (SOI), which is the national body authorized for geodesic measurements, has been measuring sea level since 1958. An analysis of the data obtained by SOI indicates that since 1958 there has been an increase in sea level. During these past 63 years, the sea level has risen by an average increase of about 0.8 mm per year.

3.3.4 Libya

The bathymetry of the region is quite differentiated, primarily constituted by wide continental shelves, deep and shallow channels and wide abyssal plains. Data on Libyan waters is limited, the Admiralty standard nautical charts rare the main sources of information. Some studies tried to map the Libyan bathymetry to produce multi-layer geographic maps.

Considering the hydrodynamic conditions of the country, seawater temperature varies monthly, with the lowest average temperature of 16°C in winter time and the maximum 27.5°C in summer time. These values are expected to increase, favouring the presence of several alien marine species. The mean values of wave heights along the coast varies from a few centimetres to 4-6 metres in the winter season.

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.

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).

3.3.5 Lebanon

Multiple studies address the salinity and temperature of Lebanese coast, while few studies have focused on currents, waves and coastal drift. A study by Issa et al. (2016) modelled the surface currents in Eastern Levantine Mediterranean using surface drifters and satellite altimetry. On the other hand, Safadi (2016) developed a methodological approach for the evaluation of the natural affordances of old harbors along the Lebanese coast by modelling the wind speed and direction along the Levantine basin and the wave heights for harbor sites. To assess the wave power, the National Directorate for Meteorology, associated to the Ministry of Public Works and Transport, installed three buoys in the North, Center and South of Lebanon coast, even though only the buoy located in front of Beirut provided reliable data for 18 months (from December 2022 to May 2004). As well, for the measurement of sea level, mareographs were installed in cooperation with the European Commission's Joint Research Center (JRC), providing data since July 2016.

In situ monitoring of salinity and temperature is carried out by the Lebanese National Center for Marine Science, which has measured the physical, chemical and biological variables on 36 sites of the Lebanese coast since mid-80's. The monthly data are collected at 50m depth from the surface.

3.3.6 Morocco

The bathymetry of the Mediterranean coast of Morocco is known from a series of studies. According to Houssa and Abdellaoui (2002), these maps make it possible to highlight the main areas of steep slopes and those with very uneven relief. They show, among other things, that the coast of the Nador region continues seaward with very gentle slopes and very vast "plains", explaining the high concentration of trawlers in this area and that the region of Al Hoceima is characterized by a very steep continental shelf and a more rugged relief in the West than in the East.

The Mediterranean coast of Morocco is part of the Alboran Sea where the exchange of water masses between the Atlantic Ocean and the Mediterranean Sea takes place and where the renewal of water takes place which characterizes the Mediterranean circulation in its totality. The results of analyzes along the Mediterranean coast of Morocco (Ramdani and Berraho, 2008) on a number of stations show that the surface layer circulating off the Mediterranean coast, between Sebta and Cap des Trois Fourches, is constituted by modified Atlantic waters with a thickness of up to 150 meters; Mediterranean waters (WMDW) appear only from a depth of 150-170 meters.

Studies by Makaoui et al. in 2014 highlighted that the surface waters are colder in the West between Ceuta and Al-Hoceima in May, with an extension to Cap des Trois Fourches in September, and warmer on the of the Eastern Mediterranean area (east of Cap des Trois Fourches). At the bottom, the waters were colder, particularly offshore, in relation to the hydrographic characteristics of the continental shelf. These temperatures vary between 17°C and 19°C in May where they are relatively warmer on the surface than at the bottom (13°C - 18°C) while in September, with the same trend, they oscillate between 19°C C and 25°C on the surface and 13°C and 21°C at the bottom.

3.3.7 Tunisia

Under the supervision of the Ministry of National Defence, the Hydrographic and Oceanographic Center of the National Navy (CHOMN) is in charge of water level data in the main Tunisian ports and bathymetric data. A comprehensive bathymetric map has been compiled by APAL (Agence de Protection et d'Aménagement du Littoral) based on several databases, including nautical chart.

Distribution of surface water temperature and salinity for Tunisian waters are available from numerical model results (*Figure 15*). In winter, the salinity minimum follows the northern coasts of Tunisia and enters the Strait of Sicily. The lowest salinity values are located in the Gulf of Tunis, which reflects the inflow of fresh water from the Medjerda wadi which empties into the Gulf. In summer, the minimum salinity is stuck more significantly to the Tunisian coasts compared to winter. This is due to the surface winds which are directed more strongly towards the southwest in summer.

The water circulation along the northern Tunisian coasts should be considered as an integral part of the different hydrodynamic mechanisms affecting the region bounded by Tunisia, the Sardinia Channel and the Strait of Sicily. This region forms the junction between three major subsets of the Mediterranean: the Algerian-Provençal basin to the west, the Tyrrhenian Sea to the north and the eastern Mediterranean to the east (Ionian basin). Transfers of water masses from one of these three subsets to the other two are controlled through this common region. Water of Atlantic origin (MAW) is brought there by the Algerian Current through the Sardinia Channel.

The quantification of the phenomena associated with the tide (amplitude, phase) depends on the geomorphology and remains dependent on direct measurements collected using tide gauges. On the north coast, four-month time series obtained at Tabarka showed a maximum tidal range of 45 cm. Tidal currents are weak (v = 10 cm.s-1) and have no effect on sedimentary dynamics. For example, in the Gulf of Gabès the circulation induced by the tide presents a cyclic filling-emptying pattern of the Gulf. The simulations show that the tidal currents are important and affect the entire coastline of the Gulf of Gabes. These currents are periodic with relatively high intensities in shallow areas.

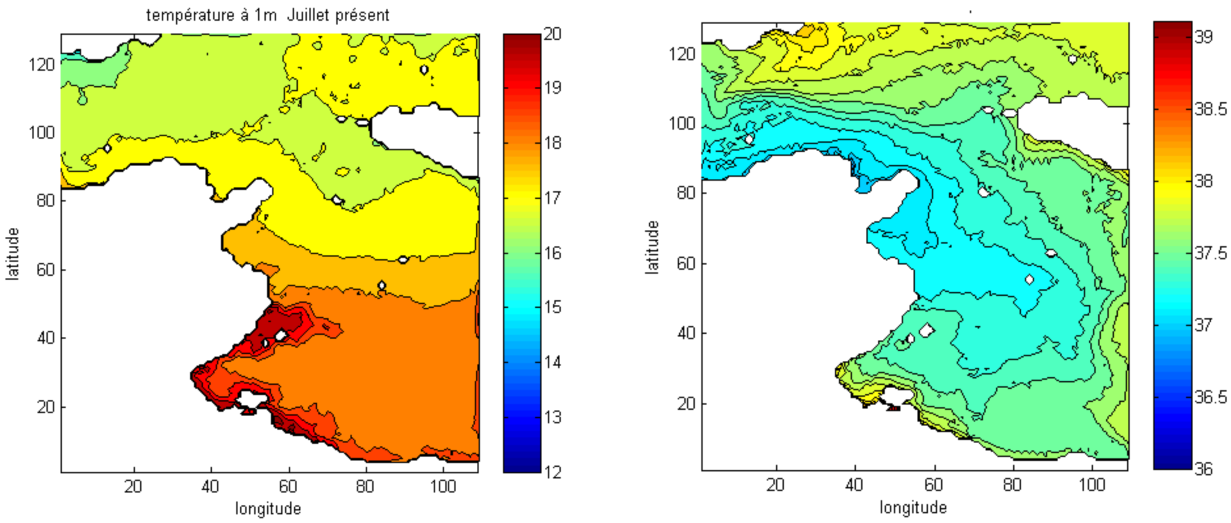


Figure 15. Average temperature of surface water in July (left) and average salinity of surface water in summer (right).

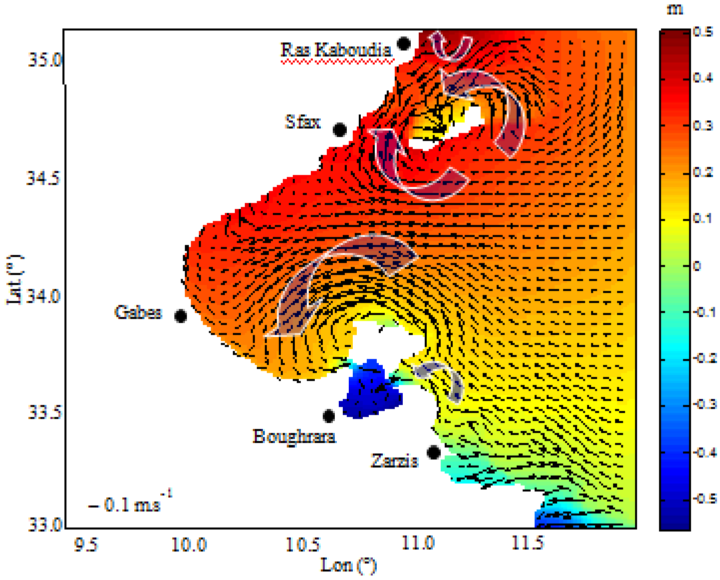


Figure 16. Simulated tidal currents and spatial distribution of water levels during the flood. The arrows indicate the directions of the currents and the colors designate the water levels.

3.4 Governance and planning

3.4.1 Algeria

Algerian ports only offer shallow drafts, as well as reduced and narrow storage spaces, which cannot meet the requirements of recent generation ships. The Algerian state has become aware that the transition to globalization necessarily requires efforts to upgrade and modernize its ports. As a result, it recognizes the need to invest in modernizing existing facilities by launching a **series of actions and projects including the construction of the mega port** in the center of El Hamdania, in Cherchell.

Environmental protection, impact assessment, regional planning, integrated management and sustainable development are being debated by public authorities in the country. One of the main measures taken in this context is the promulgation of legal texts, including Law 01-20 of December 12, 2001 relating to the planning and sustainable development of the territory, the law relating to the protection of the environment in the framework of sustainable development promulgated on July 19, 2003, the law relating to the protection and enhancement of the coast promulgated in February 2002, and law 04-20 of December 25, 2004 relating to the prevention of major risks and the management of disasters. Algeria participates in the international effort to protect the environment and the marine environment, in particular through the ratification of the United Nations Convention on the Law of the Sea in 1996 (Presidential Decree 96-53 of 22-01 -96).

In Algeria, there is an overlap of prerogatives between different ministries and local authorities in charge of planning. Several ministries can supervise or monitor different types of construction projects on the Algerian coast. Once the ministries have finalized their missions (based on their prerogatives and attribution by decree), all projects are managed at the local level under the chairmanship of the Wali. For each project, a wilaya commission is set up with local representatives from all ministries. In fact, no project is launched without the endorsement of representatives of the Ministry of the Environment (impact on the environment), of Fisheries (impact on fishing activity), of Energy (impact on hydrocarbon storage and transport facilities), transport (impact on the operation of transport networks), defence, etc.

Concerning environmental impact, before any realization (construction, repair, reinforcement, extension, dredging,) an **environmental impact study** is mandatory in accordance with national and international regulations. Such study assesses the impacts, direct and indirect, on the natural and human environment of the area concerned. It must also make it possible to identify preventive and compensatory measures in order to ensure better integration of the project into its environment, to be able to include it in a perspective of sustainable development, and thus ensure its success.

3.4.2 Egypt

National Institutions / organizations responsible for managing coastal and marine ecosystems along the Egyptian Mediterranean Sea according to the national committee for integrated coastal zone management (ICZM) include Ministries of Environment, Agriculture and Land Reclamation (General Agency For Fish Resource Development), Transportation, Tourism, Water Resources and Irrigation, Interior, Health, Planning, Petroleum, and Defense.

Several laws with mandates towards ICZM exist, assigning roles and responsibilities to different governmental entities which share the process of coastal management in Egypt including the Egyptian Constitution (2014), law 4/1994 for environmental protection and its amendments, law 102/1983 for nature protectorates, law 124/ 1983 for fisheries amended by new law this year, law 48/1983 for Protection of Water Bodies and its amendments, law 146 / 2021 for wetlands protection and fisheries development as well as relevant international and regional conventions signed by Egypt.

Various Egyptian agencies and institutions have regular monitoring programmes for coastal and marine different parameters including (water level, land level, ocean currents, ocean waves, salinity, temperature, shoreline position, bathymetry, others), thus integrated monitoring and assessment system with harmonized database is still required.

The following projects are planned:

Protecting the beaches of Matrouh. The first phase of the project to protect and develop the Bay of Marsa Matrouh city realized tongues to protect the southern region of the Gulf and the Corniche Marina Matrouh from the bay, and to maintain the appropriate depths of navigation, the nearby shipping corridor, and prevent the reassurance of sediments. The interventions were planned to protect tourism investments and promote on their development. The second phase of the project is under way and is expected to be completed within 2022.

Protecting Al-Abyad Beach. The Beach Protection Authority has also prepared a study to protect Al-Abyad Beach from the decline of the beach line, by establishing 5 stone protection heads within the sea (T-shaped wave barriers) and working a set of barriers with 20 head barriers east of the current barriers, and implementation is expected to take 3 years.

In Egypt **EIA studies** must be approved for any new project from EEAA, in addition to prior approval from high committee for licences according to Egyptian environmental law 4/1994 and its modifications.

EEAA is responsible preparing a database for all projects and their approval status which is available only between national authorities.

3.4.3 Israel

Ministries responsible for authorizing construction. The responsibility in State of Israel for any man-made construction in the coastal environment requires the approval of both the Ministry of the Interior and the Ministry of Environmental Protection. For specific issues, additional offices such as the Ministry of Transport for ports and marinas issues should also be involved.

The military (IDF – Israel Defense Forces) is sovereign to carry out activities in the coastal area according to military requirements. For example, the construction of the groin on the border with Gaza Strip and was not approved by a government ministry.

New/expected structures:

1) In April 2021, the Mediterranean Coastal Cliffs Preservation Government company LTD (MCCP) has started to construct six detached breakwaters, south of the existed detached breakwater in Central Netanya coast, in order to provide a significant protection for the coastal cliff collapse. As a second phase of this plan, six additional detached breakwaters will be erected to protect the cliff in Netanya South (Levin et al., 2011).

2) The total mooring places in marinas in Israel is about 2,800 places. There is a great demand for additional moorings. The Israel Administration of Shipping and Ports, in the Ministry of Transport, has initiated a plan to expand the number of marinas in Israel. The issue was brought up for discussion in the Coastal Environment Conservation Committee and at this point the green bodies prevented the construction of about five new marinas. Permission is granted for further planning for only one marina in northern Israel in Nahariya.

Authorization requests, impact studies and monitoring. Following the enactment of the State of Israel Coastal Law in 2004, it was determined that in order to implement the law, the Coastal Environment Conservation Committee will be established to approve or reject any activity in the coastal environment, defined for the coastal hinterland up to 300 meters from the shoreline. This determination required a definite "shoreline" definition. The legislature took into account the possibility that the sea level will rise and therefore the law stipulates that the shoreline for the purposes of the law is a + 0.75 m (above geodetic zero) line.

The committee members are appointed by the government ministries represented on the committee, as well as by representatives of the green bodies who also have representation on the committee. In addition, three representatives have been appointed as experts on the coastal environment. When a plan is submitted for discussion to the committee, among the various requirements there is a requirement for a survey of the environmental impact of the requested structure.

3.4.4 Libya

The main environmental legislation of Libya is the law 15/2003 on protection and enhancement of the environment, which gives the Ministry of Environment the sole responsibility of monitoring and regulating all the activities that may alter or change the terrestrial, marine and air environment. The law establishes that the EIA is performed prior to the decision-making of any major project that might affect the quality of the environment. Developers are required to perform and submit an EIA study to obtain the permits for the implementation of the project. So far, the majority of EIA studies have been carried out in the oil and gas industry, while other coastal sectors, such as port establishment, power stations, desalinization station construction did not require an EIA study or only in a limited form. The import of chemicals, industrial raw materials, pesticides and fertilizers is also regulated and authorized by the MOE.

The authorization to construct new installations in the coastal environment is under the authority of various ministries and municipal authorities, which have competing prerogatives and interests that make difficult to maintain high environmental conditions. For instance, the Ministry of Transports regulates and authorizes new constructions in the marine environment, including ports and marinas, while the Ministry of Oil is responsible for marine installations of oil and gas infrastructures. Over the years, several constructions have been conducted without coordination with the MOE, which is responsible for the EIA studies.

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. Only the oil and gas industry are carrying out the EIA studies, submitting them to the MOE, while the other authorities are performing the assessment by themselves.

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 progress. The expected development of structures along the coast concern primarily the expansion of the pipeline and the enlargement of the ports of Tripoli, Al-Khoms 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.

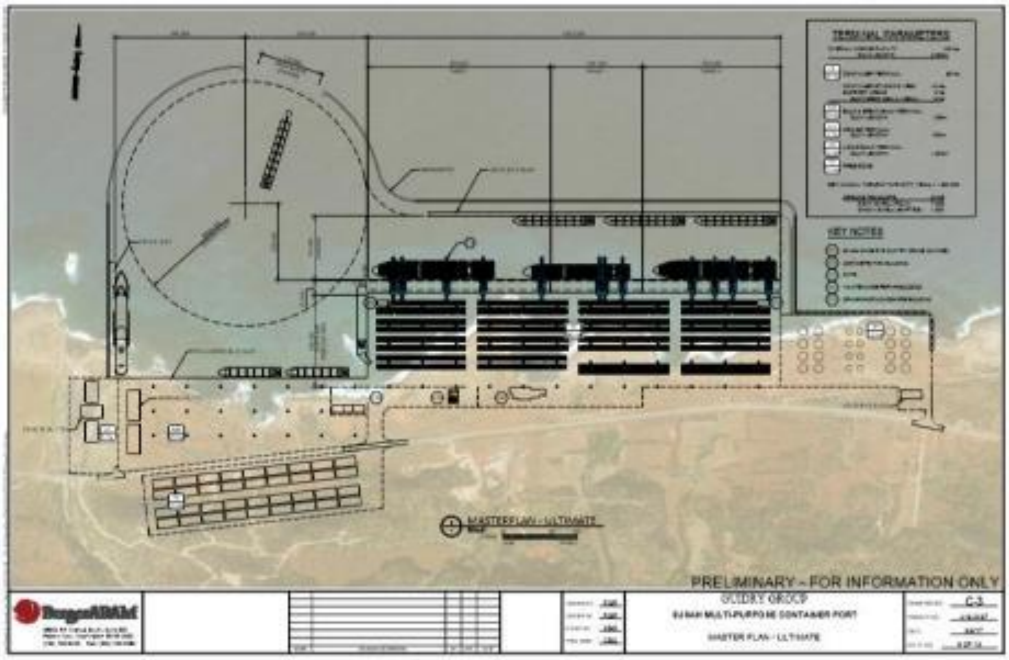


Figure 17. Plan for the new port of Susa. Source: https://libyaherald.com/2019/01/west-and-east-libya-unite-on-susah-port-project/

3.4.5 Lebanon

The Lebanese environmental regulation lacks in environmental standards for the coastal activities of dredging and sand extraction, the law (Decree number 3899/1993) prohibits the extraction of sand and gravel from the maritime public domains, even though there are some exceptions. Such activities are whenever allowed to clean up ports and harbours or materials used for natural defence purposes from water infiltration. These activities need to preserve the beauty of the beaches and to keep a distance of at least ten meters between the authorized site and any private property, roads, railways or public facilities. However, the environmental impact assessment (EIA) is required prior the decision-making and for each of these building up activities.

The authorization for new constructions along the coastline is a prerogative of multiple ministries and local authorities that overlap in their tasks, which, in turn, make more difficult to maintain and achieve a good environmental status of the Lebanese coast. For instance, the Ministry of Public Works and Transport (MoPWT) has instituted two decrees for the exploitation of the public maritime domain and for the regulation of the occupation of the maritime public domain, setting up the procedure pertaining the use of public maritime domain. However, the poor implementation of these decrees has led to the environmental and ecological deterioration of the coast. The permits for the public occupation of the coast do not require any coordination with the Ministry of Environment (MOE).

Legal documentation related to marine infrastructures and transportation (ports and ships) lack a proper environmental evaluation, which, over the years, has led to disregard environmental parameters and conditions during the construction of harbours. The EIA studies have been implemented by the law only in 2002 and this has determined that only a small number of harbours has carried out an EIA study. Regulations are also missing for the management and disposal of material in territorial water or underneath the seafloor of seas that do not produce chemical pollution and by-products (e.g., heavy metals, phenols, petroleum products, etc.). The MoPWT is entitled to license these activities, even though is missing a proper monitoring of the possible impacts on the marine environment.

The MOE has legislative functions, such as formulating strategies, policies, programs, relevant legislations and action plans for the management of coastal zones as well as promoting awareness and guidance at community level. Among the different tasks, the MOE also formulates environmental guidelines for the creation and exploitation of public beaches, for the protection of coastal zones, for the integrated management of hazardous and non-hazardous solid waste, domestic and industrial wastewater, regulates hunting and fishing activities, controls the use and disposal of chemicals, and conducts inspections on the sites.

3.4.6 Morocco

All human activities, in particular those relating to temporary or permanent use (occupation) on the coast, are regulated and require authorization. These are the activities planned in the Public Maritime Domain, which include:

- the sea shore up to the limit of the highest tides, as well as a zone of 6 meters measured from this limit.
- road steads, ports, harbors and their dependencies.
- lighthouses, lanterns, beacons and generally all works intended for the lighting and beaconing of the coasts and their dependencies.
- salt ponds in natural communication with the sea.
- artificial beaches.

A document entitled “Regulatory and legislative texts governing the temporary occupation of the maritime public domain. Management, protection and preservation of the DPM'' was developed by the supervisory ministry for the benefit of natural or legal persons wishing to create/exercise an activity in this area. There will be a royal letter addressed to the Prime Minister urging him to create a one-stop shop to facilitate the obtaining of these authorizations.

Morocco has a law relating to environmental impact studies (EIE entered into force in 2003. It imposes the preliminary study of the effects and the short, medium and long-term consequences of carrying out the economic and development on about fifty types of projects the. It is a document with legal value based on scientific data to provide a neutral opinion on the influence of any project on the environment. The objective of any impact study is to "remove, mitigate or compensate for the negative impacts and to improve the positive effects of the project on the environment.

Apart from almost daily construction due to urban development, the main **new or extended structures**, planned in the area are:

- Port Nador West Med, currently under construction on the bay of Betoya (province of Nador). The works were launched in 2016; they are very advanced and should be completed towards the end of 2022, with commissioning scheduled for 2024. Following a multi-criteria analysis of all the actions of the construction project, certain impacts of a cumulative nature are evident. However, taking into account the proposed mitigation measures, and their proper application, as well as the requirement for environmental monitoring and surveillance during the works and the operating phase, the new port construction project NADOR WEST MED, proves to be acceptable from an environmental point of view.

- Sykes Seafood involve the construction of two new coastal factories (Fnideq and Tangier) during of the next two years. The first structure, in Tangier, will produce 7,000 T/year of shrimp, while that of Fnideq, built on 25,000 square meters, will produce, cook and freeze wild and farmed shrimp.

3.4.7 Tunisia

Since the 1990s, Tunisian policy has been intensively concerned in waste management by implementing strategies and programs, in addition to environmental protection programs set up by the Ministry of Interior to support local authorities. Key indicators have been identified for characterizing the waste management process: Municipal Solid Waste, Hazardous Industrial Waste, Non-Hazardous Industrial Waste, Lubricating Oils, used tires, waste from healthcare activities, green and agricultural waste, packaging waste, and electrical and electronic equipment waste. The waste dumping activities have become important in recent years, even though some solid waste crisis arose in some areas of the country after the reopening of already saturated landfills.

The institution responsible for the environmental Impact Assessment (EIA) studies is ANPE (National Agency for the Environmental Protection). The overall objective of the EIA studies is to describe the different alternatives and variants envisaged for the different components of the project to implement and of the sites identified for the building up of the construction. It has to highlight the likely negative impacts that might arise and need to be analyzed during the environmental assessment. For the construction or interventions for coastal protection (e.g., dykes, groynes, breakwaters, etc.) and for the constructions for commercial purposes (e.g., ports, fishing ports, marinas, etc.), the EIA studies are evaluated by a national technical committee made up of the representatives of various ministries and public experts, which are administered by ANPE. The regulatory procedures for the preparation and approval of EIA studies for the construction of coastal defence structures and commercial, fishing and pleasure ports are regulated by the legislative Decree n. 2005-1991. The national technical committee has the responsibility of evaluating and deciding on the implementation of the projects under EIA and they have the possibility of intervening at the level of nature, size and shape of the structures to build up.
The units subject to a prior EIA study are classified into two categories, A and B. The category A units are subject to an opinion not exceeding 21 working days (e.g., household and similar waste management units with a capacity not exceeding 20 tonnes per day, units for producing and processing building materials, ceramics, glasses, etc.), while category B units are subject to an opinion not exceeding 3 working months (e.g., units of crude oil refineries and installations for gasification and liquefaction of at least 500 tonnes of coal or bituminous shale per day, hazardous waste management units, etc.). Finally, further units are subjected to specific assessments.

4 Results from monitoring CI16

Mediterranean coastal areas are particularly threatened by coastal development through buildings, infrastructures, tourist activities, coastal protection structure that modify and affect the coastline. These human-made infrastructures cause irreversible damages to the natural environment, biodiversity ad landscape, strongly influencing the configuration of the coastline. Therefore, the monitoring of the coastline to physical and human-made pressures is of paramount importance to preserve the habitat, biodiversity, to prevent coastal erosion phenomena and an overall deterioration of the natural environment.

According to the guidelines for the CI16 assessment, the length of artificial coastline is calculated as the sum of segments on reference coastline identified as the intersection of polylines representing human-made structures with refence coastline, ignoring polylines representing human-made structures with no intersection with reference coastline. The minimum distance between coastal defense structures is set to 10 m in order to classify such segments as natural, while, if this distance is less than 10 m, all the segments including both coastal defense structures are classified as artificial. The following tables sum up the length (km) and percentage of artificial, distinguishing in class of artificial structure, and natural coastline for each country.

The CI16 is described by two indicator units that classify the coastline according to:

i) km of artificial coastline and % of total length of coastline

ii) percentage of natural coastline on the total coastline length

These two indicator units are evaluated for each country in the table in the following sections.

AlgeriaTYPE	CLASS	LENGTH (KM)	PERCENTAGE (%)	TOTAL	REFERENCE YEAR	DATA SOURCES
Artificial coastline	Ports and marinas	238.60	-	319.60 (16.57%)	2017-2021	Satellite images
	Seawall/Revetments/Sea dike	41.38	-			
	Breakwaters	3.40	-			
	Groins	12.78	-			
	Jetties	10.48	-			
Natural coastline	-	1608.78	83.42%	1608.78 (83.42%)		

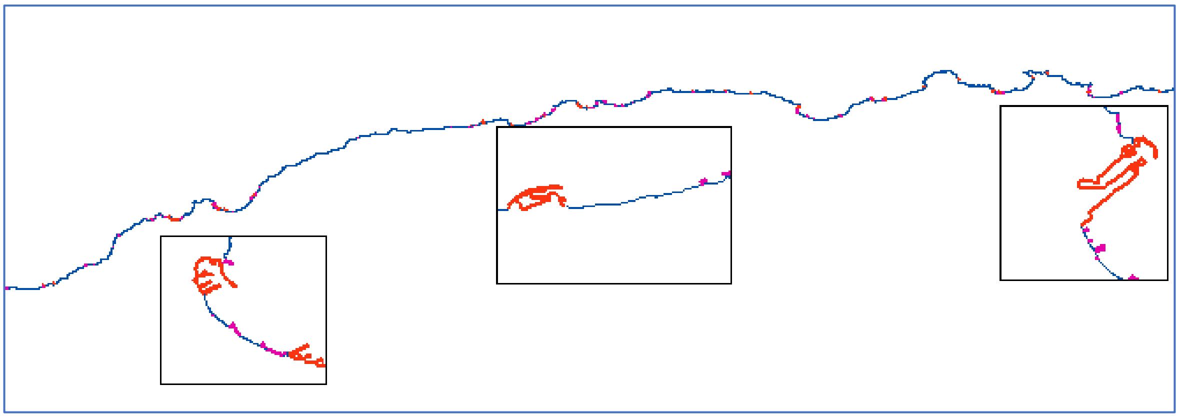


Figure 18. Trait of the Algerian coast reporting artificial and natural coastline.

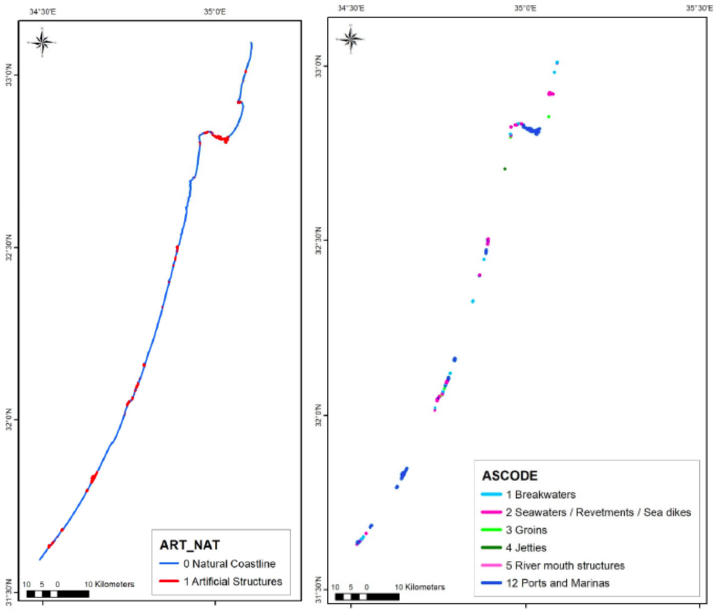
4.1 Egypt

TYPE	CLASS	LENGTH (KM)	PERCENTAGE (%)	TOTAL	REFERENCE YEAR	DATA SOURCES
Artificial coastline	Ports and marinas	-	6.5%	183 (16%)	2021	Sentinel-2 Earth Observation
	Seawall/Revetments/Sea dike	-	17%			
	Breakwaters	-	20.7%			
	Groins	-	53.7%			
	Jetties	-	2%			
Natural coastline	-	929.88	84%	930 (84%)		

4.2 Israel

TYPE	CLASS	LENGTH (KM)	PERCENTAGE (%)	TOTAL	REFERENCE YEAR	DATA SOURCES
Artificial coastline	Ports and marinas	32.258	78%	40.073 (18.90%)	2019	Orthophotos of the
	Seawall/Revetments/Sea dike	8.089	20.20%			
	Breakwaters	0.611	1.50%			

	Groins	0.089	0.20%			Survey of Israel
	Jetties	0.025	0.10%			
Natural coastline	-	172.147	81.10%	172.147 (81.10%)		

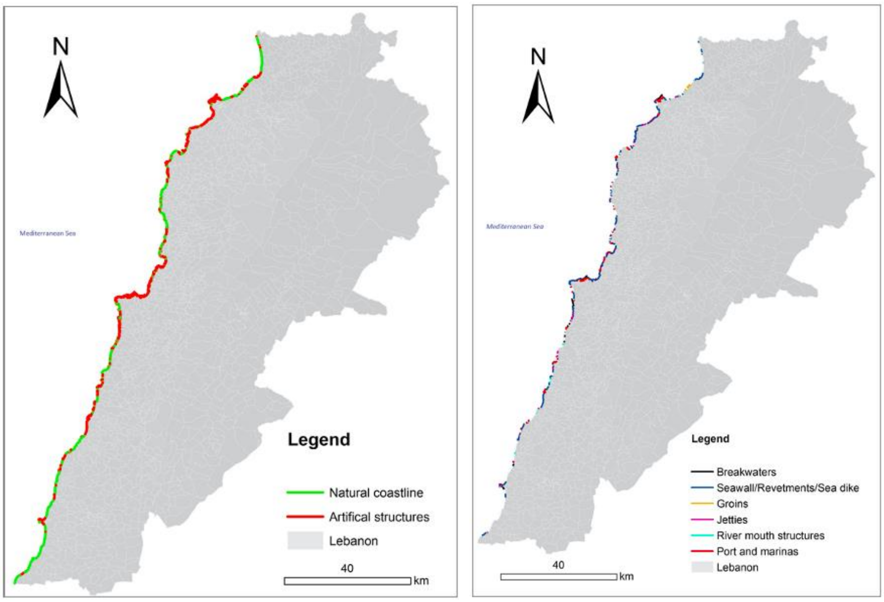


a) b)

Figure 19 a) Spatial distribution of the natural and artificial coastline of Israel. b) Spatial distribution and types of artificial structures on the Israeli coastline.

4.3 Lebanon

TYPE	CLASS	LENGTH (KM)	PERCENTAGE (%)	TOTAL	REFERENCE YEAR	DATA SOURCES
Artificial coastline	Port and marinas	65.6	19.2%	217.09 (63.41%)	2020	Geoeye-1 and WorldView-2 satellite images
	River mouth structures	3.03	0.89%			
	Jetties	15.77	4.62%			
	Groins	3.7	1.08%			
	Seawall/Revetments/Sea dike	110	32.06%			
	Breakwaters	18.99	5.56%			
Natural coastline	-	125	36.59%	125 (36.59%)		



(a) (b)

Figure 20. (a) Spatial presentation of natural and artificial coastline in Lebanon. (b) Spatial distribution and types of artificial coastline in Lebanon.

4.4 Libya

TYPE	CLASS	LENGTH (KM)	PERCENTAGE (%)	TOTAL	REFERENCE YEAR	DATA SOURCES
Artificial coastline	Port and marinas	114.2	56.97%	85.02 (4.40%)	2020	Spot6 satellite
	Seawall/Revetments/ Sea dike	20.6	10.27%			
	Jetties	18.1	9%			
	Breakwaters	47.47	23.68%			
Natural coastline	-	1891.39	95.60%	1891.39 (95.60%)		

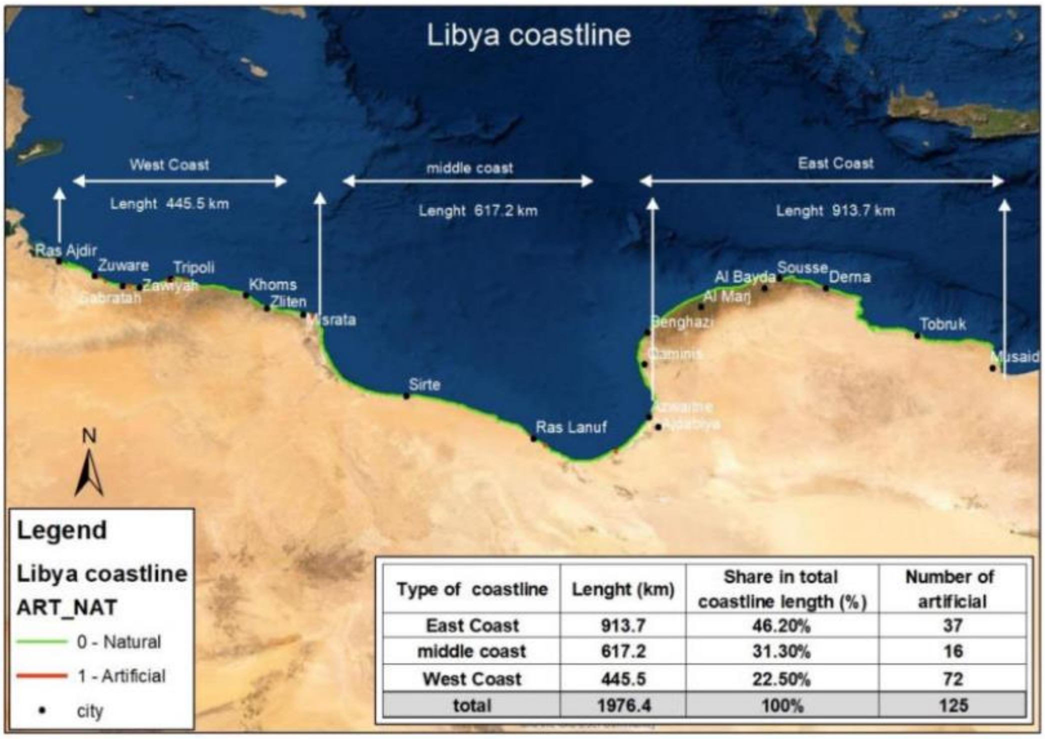


Figure 21. Spatial distribution of natural and artificial coastline of Libya.

4.5 Morocco

TYPE	CLASS	LENGTH (KM)	PERCENTAGE (%)	TOTAL	REFERENCE YEAR	DATA SOURCES
Artificial coastline	Port and marinas	-	53.8%	23.5%	2021	Satellite images
	River mouth structures	-	1.5%			
	Jetties	-	5.3%			
	Groins	-	1.9%			
	Seawall/Revetments/Sea dike	-	37.1%			
	Breakwaters	-	1.9%			
Natural coastline	-	-	76.5%	76.5%		

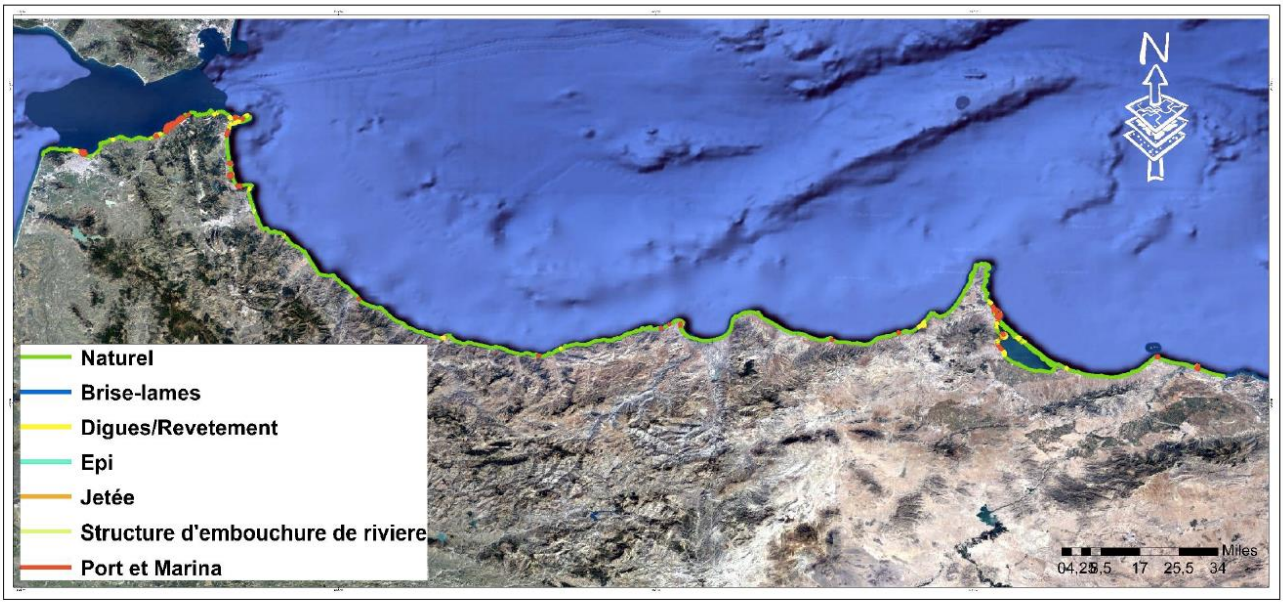


Figure 22. Spatial distribution of natural and artificial Mediterranean coastline.

4.6 Tunisia

TYPE	CLASS	LENGTH (KM)	PERCENTAGE (%)	TOTAL	REFERENCE YEAR	DATA SOURCES
Artificial coastline	Port and marinas	108	27%	396 (18%)	NA	Satellite images
	River mouth structures	25	6%			
	Jetties	18	5%			
	Groins	9	2%			
	Seawall/Revetments/Sea dike	231	59%			
	Breakwaters	5	1%			
Natural coastline	-	1866	82%	82%		

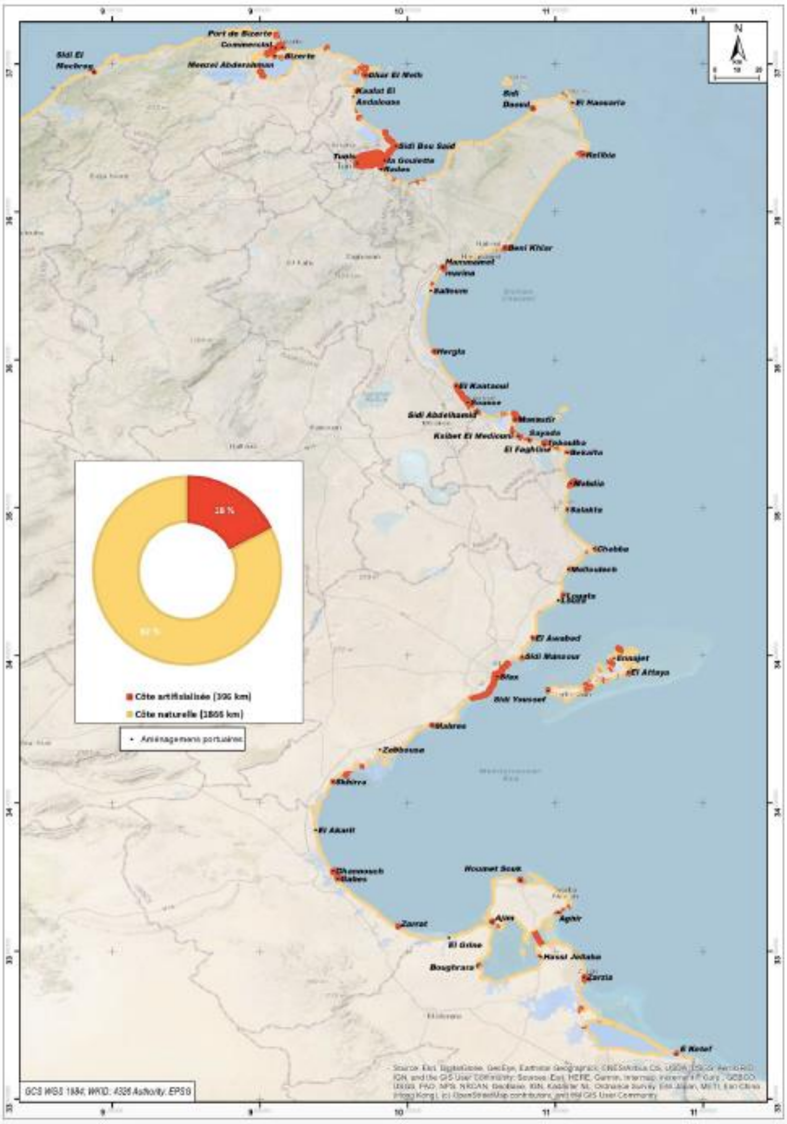


Figure 23. Spatial distribution of artificial and natural coastline of Tunisia.

5 Major findings related to the baseline situation at sub-regional level

Over the last two centuries, and even more intensively during the last decades, the Mediterranean coast has been significantly modified by human interventions. Along the Mediterranean southern shore, artificialization of coastline and commonly narrow coastal plains have also been massively engineered. Some examples are Tangiers and Tetouan coasts of Morocco, the north-eastern coast of the Nile delta (Anthony, 2014). These shoreline modifications have been associated with the construction of ports, marinas, leisure harbours and artificial beaches, and have resulted in the emergence of artificial shorelines. Rocky shores in the Mediterranean are also being subjected to increasing pressures from housing and tourism. Percentage of artificial coast in the countries of the sub-region ranges between 16% (Egypt) and 23% (Morocco) (*Table 2*), with the relevant exceptions of Lybia (4.4%) from one side and Lebanon (41.03%) on the other. As one may expect, countries with shorter shoreline show the higher percentage of artificialization (Lebanon, Israel).

From the analysis of CI15 and CI16 national reports, some discrepancies can be identified regarding the total coastal length for each country. Some CI16 reports indicate higher numbers for the total coastline length compared to CI15 data (Israel, Libya, Morocco and Tunisia), while, instead, lower values are reported for Egypt and Lebanon. This is due to different data sources consulted by the authors of the different reports.

In addition, information on the coastal length per coastal typology are missing for some countries (Egypt, Tunisia) (*Table 2*).

As a consequence of all interventions undertaken, large part of the coastal zone is now subject to geo-morphological instability. Erosion phenomena determined by anthropogenic pressures are observed throughout the sub-region, in presence of sandy shores (*Table 3*). Main causes are the construction of dams for agricultural and hydroelectric purposes and river channel modifications over the last two centuries that have affected the rivers, commonly generating drastic reductions in sediment inputs necessary for maintaining dynamic beach and dune systems. The most dramatic changes have been reported from the Nile delta, the fluvial sediment supply of which is considered to have been totally curtailed upstream of dams (Anthony, 2014). Artificialization of the coast represent another important pressure, determining coastal erosion. Erosion rates reported for the countries in the sub-region range between -0.14 m/y (Morocco) up to -1.4 m/y (Lebanon).

To contrast erosion, many protection structures have been constructed in the area. These interventions with traditional protective structures seem in general to lack a comprehensive view about geomorphology and coastal processes in general and therefore there is a risk to generate additional impacts on the coastal environment. The realization of nature-based sea defence structures is reported for Egypt, using soft, self-maintaining and reversible protection solutions.

Table 2. Types of coast and length (both in km and percentage) for the different countries. All the data reported have been taken from the CI15 national reports.

	COAST TYPOLOGY	LENGTH (KM)	PERCENTAGE (%)	TOTAL COASTAL LENGTH (KM)
ALGERIA	Artificial coast (including port areas)	319.60	16.57%	1928.38
	Rocky coast	1083.25	56.38%	
	Sandy beach	525.53	27.25%	
EGYPT	Artificial coast	-	-	1200
	Rocky coast	-	-	
	Sandy beach	-	-	
ISRAEL	Artificial coast	40.073	18.90%	195
	Rocky coast	45	-	
	Sandy beach	-	-	
LEBANON	Artificial coast	147	41.1%	357.8
	Rocky coast	110	30.8%	
	Sandy beach	81.90	22.8%	
	Pebble beach	18.9	5.30%	
LIBYA	Artificial coast	-	-	1770
	Rocky coast	626	35.3%	
	Sandy beach	1144	64.7%	
MOROCCO	Artificial coast	-	-	512
	Rocky coast	256.4	49.36%	
	Sandy beach	263.3	50.65%	

	COAST TYPOLOGY	LENGTH (KM)	PERCENTAGE (%)	TOTAL COASTAL LENGTH (KM)
TUNISIA	Artificial coast	-	-	1844
	Rocky coast	-	-	
	Sandy beach	-	-	
	Cliffs	-	-	
	Sand dunes	-	-	
	Coastal marsh	-	-	

Table 3 Coastal features in the countries of the sub-region.

	HYDROGRAPHIC CONDITIONS	BENTHIC HABITATS	COASTAL DYNAMICS
Algeria	Multiple studies monitor the hydrodynamic conditions of the coast. Sea level is increasing at a rate of 25mm/yr. Tides range of 34 cm.	NA	Coastal erosion is the main occurring process (both natural and human-induced) and different protective infrastructures have been implemented to limit the process.
Egypt	Salinity, temperature and currents are periodically monitored by different national institutions. Increasing trends in mean wave height ranging from 2.6 to 2.9 cm/yr. Sea level rise is becoming a concern, while there isn't yet precise measurement of it.	Rich in seagrasses meadows, brown, red and green algae, maerl beds. Shallow hard bottom and intertidal soft bottom are made up of polychaete assemblages, while deep sea waters are made up of different complex and heterogeneous habitats.	The majority of coastline is stable due to rocky nature. Erosion is observed in terminal parts of Nile River branches and in many sandy beaches closed to touristic resort areas.
Israel	Multiple studies and measurements assessed wave regimes (overall, in winter period wave height up to 5m, in summer period <2m), longshore currents, longshore sand transport (both wave-induced and wind-induced, and important in shaping coastal morphology), tides and sea level changes (tides range from 15 to 40cm, while SLR has risen by an average of 0.8mm/yr). Abrupt decline of salinity of surface water in summer months; warming trends (0.13°C/yr) of surface water temperature	Characterized by poverty of biological production, continuous abiotic changes (e.g., increasing water T) and biotic alternations (e.g., alien species), uniqueness of habitats and ecological processes, intense manmade effects with threats to marine and coastal ecosystems. Abrasion platforms: unique habitats, environmental conditions changing every 24-hours. Submerged kurkar ridges: high species richness and diversity. Shallow waters: beachrocks rich in species Soft substrate: lack of sessile species, low species diversity	Northern coast is under erosion processes, while the southern part is in accretion.
Lebanon	Multiple studies assessed salinity and temperature. Use of buoys and mareographs to assess	Shallow waters: coralligenous habitats, seagrass meadows, vermetid reefs	Erosion processes dominant over accretion.

	HYDROGRAPHIC CONDITIONS	BENTHIC HABITATS	COASTAL DYNAMICS
	respectively wave power and sea level	Deep waters: underwater canyons	Installation of artificial infrastructures to protect the coast.
Libya	Monthly seawater temperature variations between 16° and 27.5°C. Wave height: from cm to 4-6 m.	Salt marshes, seagrass meadows, vermetid reefs, deep-sea canyons.	Erosion processes (70% of the coast) are dominant over accretion (30% of the coast).
Morocco	The coastline is largely affected and shaped by the anthropogenic activities, which are modifying the morpho-dynamic processes.	The ecosystem features are differentiated according to the main natural structures of the coast (bays, lagoons, capes, river deltas, sandy beaches, etc.). They all have specific flora and fauna diversity.	Erosion processes occurring along both the Med and Atlantic coast, respectively at 0.14m/yr and 0.12m/yr.
Tunisia	High tides, high salinity	Seagrass meadow, multiple benthos species, lagoon ecosystems, coralligenous habitats, maerl bottoms, hard aggregations, salt tolerant species	Erosion processes are dominant over accretion and stable beaches. Installation of artificial infrastructures to protect the coast.

The coastal areas in the sub-region are subject to multiple pressures (*Table 4*), linked to both anthropogenic activities and climate change. Urban sprawling due to increase in coastal population and expansion of touristic areas is a common feature in some of the countries (Algeria, Egypt, Morocco, Tunisia). Waste and wastewater management still remain issues in the sub-region.

Artificialization of the coastline, and particularly maritime constructions, with realization of new ports and port enlargements, new marinas, structures for erosion protection, desalination plants, infrastructures for exploration and production of offshore energy resources, recurrent maintenance dredging and beach nourishment represent growing pressures on coastal environment of the sub-region in the last decades. These infrastructures have resulted in disturbance, damage and destruction of natural habitats (*Table 4*), in addition to impacts related to sedimentation, chemical, acoustic and light pollution.

Dredging and dumping are practiced in all the sub-region with increasing trend, due to the ever-increasing demand for material for coastal infrastructures and beach nourishment, as well as increasing dredging need in ports, demanding for ever deeper navigation channels to allow entrance to ever larger vessels.

All countries in the area (and in particular Algeria, Egypt. Israel. Morocco) have plans for new coastal infrastructures, mainly linked to enlargement of ports, new touristic settlements and establishment of aquaculture infrastructures.

Table 4. Main activities, infrastructures and related impacts on the coastal areas in the sub-region.

	Typology of activities on the coast	Typology of infrastructures	Impacts of benthic habitats/natural environment
Algeria	Agricultural activities Urban development Commercial activities Port activities Tourism Industry	Port infrastructures Waste disposal Digging infrastructures Tourism accommodation Digging infrastructures WWT plants	Deterioration of water quality Invasive species Beach erosion
Egypt	Sand extraction Urbanization Commercial activities Port activities Tourism Agricultural activities Fishing Industry	Port infrastructures Waste disposal Tourism accommodations WWT plants	Resource degradation Salt water intrusion Invasive species Water quality degradation Beach erosion
Israel	Agricultural activities Commercial activities Tourism Port activities Urban development Industry Fishing	Port infrastructures Waste disposal Digging infrastructures Tourism accommodations WWT plants	Deterioration of water quality – pollution Physical disturbances to marine environment Damage and destruction of natural habitats Invasive species Salt intrusion
Lebanon	Commercial activities Industry Tourism Fishing Oil and gas refinery Agricultural activities Dredging and dumping activities Sand and gravel extraction	Port infrastructures Energy grids – power stations WWT plants Urbanized water front Pipelines Waste disposal Digging infrastructures Tourism accommodations	Deterioration of water quality Invasive species Beach erosion
Libya	Commercial activities Industry Oil and gas refinery Fishing Agricultural activities Dredging and dumping activities Sand and gravel extraction	Port infrastructures Energy grids – power stations WWT plants Waste disposal Pipelines Digging infrastructures	Water pollution – water quality deterioration Land degradation and desertification Drinking water contamination Loss of coastal dunes Loss of nesting sites
Morocco	Tourism Agricultural activities Port activities Urbanization – coastal development Industry Commercial activities	Extraction infrastructures Port infrastructures Waste disposal Tourism accommodations	Water quality degradation Pollution Invasive species Coastal erosion
Tunisia	Commercial activities Industry Fishing Tourism Agricultural activities Dredging and pumping activities Sand and gravel extraction	Port infrastructures Tourism accommodations Energy grids – power stations WWT plants Digging infrastructures	Air and water pollution Loss of natural areas Loss of flora and fauna Eutrophication and oligotrophication phenomena Water quality deterioration Algae blooming

6 Difficulties and limitations in assessment

Information needed for reporting on CI 16 are available from all national reports prepared under this project (*Table 5*). This is not the case for CI 15 (*Table 5*).

Difficulties in assessing CI 15 are known. The Guidance Factsheet for this indicator recognize (i) lack of coherence in definitions, standard approaches in the development and application of indicators and in the assessment of impacts, together with lack of methodological standards; and (ii) lack of knowledge and understanding on the link between physical pressures and biological impacts and on the cumulative impacts.

Knowledge gaps, consisting in insufficient surveys and monitoring on all geographical levels are pointed out as a main challenge in some national reports (e.g. Egypt, Lybia), together with lack of sound assessment methodologies.

Particularly, lack of hydrographic data with detailed temporal and spatial scale (bathymetric data, seafloor topography, current velocity, wave exposure, turbidity, salinity, temperature, etc.) are recognized as one of the main challenges to implement this indicator, in particular to define the base-line conditions. High resolution bathymetric data, good datasets, in depth assessment of hydrological conditions through marine buoys for monitoring are recognized as essential features that need to be produced in order to be able to assess CI 15.

In fact, assessments that estimate the extent of hydrographic alterations and its intersection with marine habitats are currently rare in the Mediterranean, except for some local studies of Environmental Impact Assessment (EIA) /Strategic Environmental Assessment (SEA).

Lak of data is attributed to scarce monitoring activities performed by the competent authorities, but for some countries these are also due to the political instability that affects the well-functioning of ministries and slow down their activities. The fact that some existing data are not publicly available or takes long time to be published has also been pointed out (Morocco)

Furthermore, the analysis reported in the national reports are frequently based on outdated images and data, dating back to more than 10 years ago. While, according to the guidelines for the CI16 assessment, the monitoring of human-made structures should be updated at least every six years, and shoreline evolution of sandy coastline under anthropogenic pressure should be repeated annually.

In addition to that, difficulties in the use of numerical model to assess hydrographic alterations are mentioned in the national reports (Egypt). Difficulties are linked to their need for substantial data (bathymetry, offshore hydrodynamics data, field data) and to the fact they can be costly, time-consuming and their use requires experience and specific knowledge.

Difficulties in availability of accurate maps of benthic habitats in the zone of interest (broad habitat types and/or particularly sensitive habitats) are also mentions. Therefore, identifying the priority benthic habitats for consideration in EO7 together assessment of impacts, including cumulative impacts, is recognized as a cross-cutting issue of high priority for EO1 and EO7.

Table 5. sums up the features that should have been assessed through the national reports. Empty spaces indicate that the respective feature is not included in the national report.

CI15	Algeria	Egypt	Israel	Lebanon	Libya	Morocco	Tunisia
Location and extend of coastal or offshore infrastructures	X	X	X	X	X	X	X
Location and extend of hydrographical changes	X	X	X	X	X	X	X
Current velocity	X		X			X	
Temperature	X	X	X	X	X	X	
Salinity	X	X		X	X	X	
Sea surface height	X				X	X	
Turbidity							
Bathymetry	X	X	X		X	X	
Wave	X	X	X	X	X	X	X
Benthic habitat	X	X	X	X	X	X	X
CI16							
Location and extend of artificial structures	X	X	X	X	X	X	X
Artificial/Natural coastline	X	X	X	X	X	X	X

7 Recommendations for the future assessments

Given multiple challenges in assessing CI 15, related to (i) data collection and their public availability, (ii) coherence in definitions, standards and approaches, (iii) difficulties linked to the use of numerical models, (iv) uncertainty related to estimation of impacts on benthic communities (including spatial and temporal scale), additional effort towards operationalization and simplification of this CI can be recommended.

The questionnaire and the report structure provided under EcAp MED III project has demonstrated to be a practical tool to help countries reporting on the availability and on the nature of data needed to assess CI 15, information about recent and planned projects and assessment procedures and governance. Further use of simplified tools like questionnaire and templates with report structure can be recommended also for future assessments, in order to couple with difficulties in assessing this CI.

In order to achieve better harmonization and comparability of national reports, guidelines should better highlight the typology of information requested for national reports. In fact, in the reports prepared under the EcAp Med III project, countries have generally included synthetic information regarding each single element of the report structure but some of them have instead limited themselves to provided information about the availability of such data/knowledge.

The need for EIAs at country level to assess the impact on habitats due to hydrographic alteration should be strengthened in all countries. Common guidelines for EIA on this aspect should be prepared and agreed at regional level. Since EIAs are often undertaken by project designers/promoters, guidelines should ensure practical feasibility with time and effort generally available under such procedures. The need to undertake EIA at national level for all infrastructures and activities potentially generating impact on the coastal and marine ecosystems should also be agreed, in order minimize heterogeneity in approaches to and facilitate collection and availability of results from assessments at regional level.

Considering the present state of degradation of coastal areas in the sub-region of interest for this report, due to alteration in hydrographic conditions and the increasing trends of impacts on the coastline, the definition of GES for this indicator should target restoration of natural conditions.

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