EcAp Med II project

Israel's National Integrated Monitoring and Assessment Programme (IMAP) for Coast and Hydrography indicators

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1. Physical characteristics of the Israeli Mediterranean coast

1.1 Geography and sedimentology

The Israeli shoreline along the Mediterranean Sea extends 187 kilometres from Rosh Hanikra in the north to the Gaza Strip in the south-east. The coastal plain is composed primarily of Nile-derived quartz sand, carried northward in the Nile Littoral Cell, and partly windblown on land. Occasional clay and gravel deposits originated in the mountains to the east are confined to the eastern end of the plain. A sandy sediment strip stretches along Israel's continental shelf to a depth of approximately 35 m, and beyond it are fine-grained sediments. The orientation of the Israeli coastline, combined with strong coastal current flowing northwards and local climatic conditions, result in a net sediment transport towards the north.

The coastal plain consists of two distinct parts: The eastern part is made of Early and Middle Pleistocene deposits, while the western part contains Upper Pleistocene and Holocene deposits. The western part is characterized by several elongated, shore-parallel aeolianite ridges distributed on- and off-shore. Such ridges are absent in the eastern part of the coastal plain. On the other hand, unconsolidated sands form a considerable volume of the deposits in the eastern part but hardly exist in the western part.

The impact of anthropomorphic activity on the coastal zone is clearly noticeable, in particular, adjacent to coastal structures which caused changes in the waterline position: accretion on one side of the structure and erosion on its other side. But beyond these changes, which are local, recent archaeological findings indicate that the coastal sand balance of Israel suffers from a significant deficit. It is estimated that during the 20th century, some 20 million m^3 of sand were removed from the coastal zone by mining and entrapment of sand behind coastal structures. It is also estimated that this quantity is equivalent to the natural influx of sand to the Israeli coast during some 50 years.

1.2 Bathymetry

The Mediterranean bathymetry opposite Israel is relatively simple, with depth contours aligned approximately parallel to the north-south coastline. The continental shelf extends from the shoreline to a depth of approximately 100 m, where the pronounced continental slope begins. The Israeli shelf is relatively narrow: from 20 Km at Ashkelon in the south to about 10 Km near Atlit in the north. Therefore, the deep sea is rather close to shore.

Concerning the south-eastern Levantine Sea, Israel has contributed to the EMODNET database a very detailed bathymetry survey up to 1,600 m depth, undertaken by the Geological Survey of Israel (GSI), together with the Israel Oceanographic and Limnological Research (IOLR) and the Survey of Israel, as part of the National Bathymetric Survey project, initiated in 2001. The horizontal resolution of the measurements is 2-5 m up to a depth of 100 m, and 10-25 m on the continental slope up to a depth of 700 m.

In the immediate vicinity of the shoreline, more detailed bathymetry maps exist in the context of particular coastal development projects and construction of marine structures. These are changing as soon as dredging or sand deposition works are undertaken, a breakwater is prolonged, etc., as is the case for Haifa Port in recent years. Similar detailed bathymetry maps exist for Ashkelon region in the vicinity of Rutenberg Power station settling basin (CAMERI report P.N.781/13), Ashdod Port development projects (CAMERI report P.N.795/14 = differential maps; CAMERI report P.N.762/12 = Sand Mining EIA for Haifa Port development; CAMERI report P.N.706/09 = DHV), Tel Aviv – Herzliya region new protection scheme (CAMERI report P.N.790/14), Netanya cliff protection project (CAMERI report P.N.760/12) and in the vicinity of Hadera Power station settling basin (CAMERI report P.N.747/11), Haifa Port development projects (CAMERI report P.N.799/14 = Channel monitoring; CAMERI report P.N.782/13 = Channel hind cast model; and CAMERI report P.N.761/12 = Sand Mining EIA).

Geological research into the retreat of the coastal cliff and other hazards has resulted in the Geological Survey of Israel (GSI) carrying out a complete mapping of the coastal zone by LIDAR (laser beam LIght and raDAR) technology, producing a basic 50 cm grid.

1.3 Climate

The climate in the coastal plain is characterized by mild, rainy winters, and dry, hot summers. Precipitation amounts decrease from west to east, and from north to south, ranging from 600-850 mm in the north to about 400 mm or less in the south. The weather is characterized by (sometimes very strong) precipitations with calm conditions between them.

The source of long term wind measurements is the Israel Meteorological Service (IMS). In the IMS website http://www.ims.gov.il/IMSEng/Tazpiot, last-day hourly wind speed (and direction) is available online at the coastal stations (Hadera, Tel Aviv west, Ashkelon).

Approximately 90% of annual winds, 86% of winter winds, and 93% of summer winds, are light (wind speed below 6 m/s); and about 9% of annual winds, 12% of winter winds and 7% of summer winds are fresh (wind speed between 6 and 10 m/s). In general, only 1.2% of annual winds, 2.7% of winter winds and 0.26% of summer winds, are strong and exceed 10 m/s.

The direction of winds with speed above 6 m/s is NW (1.64% occurrence). The dominant direction in general is SSE, and that of strong winds (above 10 m/s), able to generate wave storms and strong currents, is SW (0.30% occurrence). The strongest winds are in reasonable agreement with wave storm events in deep water.

An analysis of extreme events indicates wind speed of 22.7 m/s, with return period of 10 years, 24 m/s for 20 years, 25.5 for 50 years, and 27 m/s with return period of 100 years. These values cannot be employed for applications that need higher resolution than the 10 min averages.

An assessment of climatic change in the Eastern Mediterranean predicts increasing temperatures, particularly in the northern part (Turkey, Greece) with 1-3°C by 2030, 3-5°C by 2050 and 3.5-7°C by the end of the century. In addition, it predicts heat waves and extreme high summer temperature peaks. Another predicted trend is of decreasing rain - 10-50% less rain is expected the north during this century, with even drier springs and summers.

1.4 Waves

More than 20 years of wave measurements at Haifa and Ashdod have been continuously recorded by Datawell directional waverider buoys operated by CAMERI. The recordings are done on behalf of the Israel Port Company, IPC. The buoys are deployed offshore Haifa and Ashdod ports, at locations where sea depth is 24 m. These can be obtained for the three-last-days at the ISRAMAR website http://isramar.ocean.org.il/isramar2009/#. Other wave measurements are continuously conducted at Hadera and Ashkelon (IOLR) and Ashdod (CAMERI).

The dominant wave direction for Ashdod is WNW. Approximately 51% of the annual waves come from this direction. An analysis of extreme wave events at Ashdod during 19 hydrographic years (1992-2011) shows that according to the Weibull distribution with a 3.5 m threshold: (a) at the buoy location, the extreme wave height with 50 years return period is about 7.2 m, the one with 100 years return period is about 7.6 m, and the one with 200 years return period is about 8.0 m; and (b) in deep waters, the extreme wave height with 50 years return period is about 8.1 m, the one with 100 years return period is about 8.7 m, and the one with 200 years return period is about 9.2 m.

The dominant wave direction for Haifa is W to WNW. Approximately 70% of the annual waves come from these directions. The directional distribution of waves in deep water is similar to that at Ashdod. However, waves are generally higher at Haifa. An analysis of extreme wave events at Haifa during the considered 19 hydrographic years shows that, according to the Weibull distribution with a 3.5 m threshold, the extreme wave height in deep waters with 50 years return period is about 8.3 m, with 100 years return period is about 8.8 m, with 200 years return period is about 9.3 m.

1.5 Coastal currents

In the coastal zone, wind is responsible for the creation of waves and currents. In the surf zone close to the shore, waves arriving obliquely to the shore are the cause of the longshore current.

A background current due to the water mass circulation in the Mediterranean is always present. In the Eastern Mediterranean, the background current circulates counterclockwise and parallel to the coastline (south to north along Israel's coast), with a mean velocity of about 15 to 25 cm/s. Its activity is observed mainly way offshore, in the region where the water depth is 20 m or more. The values of tidal currents within the study area are, in general, quite low, reaching about 5 cm/s.

Stronger currents in the coastal area are generated mainly by waves and wind. Wave induced currents occur within the breaker zone, flowing mainly parallel to the coastline (longshore currents induced by waves approaching obliquely to the bathymetry contour lines), but sometimes also narrow currents flowing offshore may occur (rip currents). The maximum theoretical values of the longshore current may reach 1.5 to 2.0 m/s during storms. However, outside the surf zone, the longshore current is estimated to diminish rapidly to a few centimeters per second at about 15 m water depth.

A program for measuring the current regime in the Israeli continental shelf was initiated by IOLR in 1987. Historical and up-to-date records are offered for more than 20 offshore stations located at different places south of Haifa, opposite Hadera, Netanya, Ashdod and Ashkelon, and for depths ranging from 30 m to more than 500 m, as displayed at the ISRAMAR Internet website: http://isramar.ocean.org.il/CurrentsBuoy/default.asp. Another source of measurements is the survey performed by OCEANA Marine Research Ltd. on behalf of the Israel Ports Company (IPC), in whose framework current meters were deployed.

There is a very pronounced majority of records corresponding to the current from south to north along the shore. About 58% of the near-surface currents and 57% of near-bottom currents correspond to the N-NE sectors. Also, about 20% of the near-surface and 13% of near-bottom currents flow in the opposite (southern) direction, i.e. sectors SSW-SW. Obviously, local differences occur due to geographical and topographical features.

1.6 Sea temperature and salinity

Mediterranean waters are warmer and saltier than the inflowing ocean water. Evaporation increases the salinity of surface waters. When warm saline surface water cools after the summer season, it may become denser than deeper waters, which are perhaps slightly less saline but still keep warm. This unstable buoyancy gradient gives rise to the (vertical) termohaline circulation.

Gridded monthly temperature and salinity values are available (upon registration) from the Internet site: http://gher-diva.phys.ulg.ac.be/web-vis/clim.html. The grid has a horizontal resolution of 16 points per longitude (and latitude) arc-degree, and 33 depth levels, from sea surface to -5,500 m at the deepest point, starting at 0, 10, 20, 30, 50, 75, 100, 125, 150, 200, 250 and 300 m, then each 100 m to 1,500 m, and then each 250 m to the seafloor. The grid also covers the south-eastern Levantine Sea and can be visualized online for a user defined vertical section or on a horizontal map. Seasonal temperature and salinity data files can be extracted directly from the Mediterranean Oceanic Database, MODB, at the website http://modb.oce.ulg.ac.be/backup/modb/welcome.html. Temperature and salinity depth profiles by year can also be found there, from measurements done at different surveys, at diverse times and locations.

In Israel, the Mediterranean's surface temperature in summer is approximately 29°C, decreasing rapidly to about 16°C at 200 m depth, and thereafter gradually to the steady 14°C at 800 m depth and more. The winter distribution starts at about 17°C at the surface and coincides with the winter distribution already at 200 m depth. This shows a 12°C cyclic seasonal difference in sea surface temperature.

The Datawell directional waveriders operated by CAMERI at Haifa and Ashdod have temperature gauges mounted on the bottom of the buoys, providing seawater temperatures about 40- 50 cm below sea surface. Thus, sea surface temperatures were measured during approximately two decades at both Haifa and Ashdod (Waverider buoys are placed at locations where sea depth is approximately 24 m). In addition, Conductivity-Temperature-Depth (CTD) instruments are in continuous operation at Hadera and Ashkelon, operated by

IOLR. Last four and a half day measurements are published online at the ISRAMAR Internet website http://isramar.ocean.org.il/isramar2009/#.

1.7 Land use in the coastal zone

The increasing development of the Israeli coastal zone by various sectors, such as housing, tourism, industry, infrastructure, and agriculture, generated an anthropogenic pressure on the coastal zone and the marine environment. However, besides the areas of important coastal cities, large portions of the Mediterranean coast of Israel are still in a relatively good environmental status and many sites host marine biodiversity hotspots providing habitats for many species, including endangered ones, such as birds and marine turtles that have nesting sites along this coast. Most of these habitats are vulnerable to a wide range of threats.

Israel's main maritime activity concerns maritime transport. Israel has four large ports (two of them still under construction) and seven marinas along its coast. In addition, four large power plant and five desalination plants are located along the coast.

Israel has established several Marine Protected Areas (MPAs) to safeguard ecosystems, species, and their habitats. However, while the country effort for creating terrestrial protected areas is considered satisfactory, further effort is required to achieve Aichi Targets regarding MPAs in Israel. In this context, a new master plan for marine protected areas was formulated and being implemented. It aims at improving the representativeness of the network by covering more habitat types, including underwater limestone ridges, underground canyons, and mountain ridges that extend to the sea.

2. Institutional and regulatory aspects

2.1 Introduction

Since the 1980's, Israel is continuously developing its regulatory and institutional framework for managing the coastal zone. However, despite many significant advancements, Israel has not yet developed a holistic or integrated maritime policy, and no national dedicated maritime governance structure exists at the Government level to support the development of a national integrated maritime policy. Currently, maritime policy is conducted on sector by sector basis, although in some cases (some ministries, some policy areas), a high level of coordination already exists. Legislation provides for some cross-cutting measures (e.g., environmental impact assessment for most major projects), but is generally designed in a sectoral manner. Most traditional maritime activities are based on explicit and well-defined sectoral strategies supported by dedicated sectoral administrations and generally complete legislative frameworks.

Israel is one of the Contracting Parties of the Mediterranean Action Plan (MAP), the first-ever plan adopted as a Regional Seas Program under the umbrella of UNEP. The original aim of MAP was to help Mediterranean countries assess and control marine pollution. In 1976, the MAP Parties adopted the Barcelona Convention, aimed at protecting the Mediterranean Sea against pollution. Over the years, MAP's mandate has widened to include integrated coastal zone planning and management.

Article 4.3(e) of the Barcelona Convention requests the contracting parties to promote the integrated management of the coastal zones, taking into account the protection of areas of ecological and landscape interest and the rational use of natural resources. In 2008, a Protocol was developed to provide a common framework for the contracting parties to promote and implement integrated coastal zone management (ICZM). The protocol was ratified by Israel in April 2014.

Within the existing regulatory framework, several legislative and planning items have a significant bearing on monitoring of the marine environment in Israeli waters. **Items of particular relevance to coast and hydrography indicators are presented hereinafter**.

2.2 Legislative framework

The following Israeli laws and regulations related to collecting, compiling, and sharing marine/coastal data are presented in a chronological order.

Planning and Building Law (5725-1965)

According to Article 156b in the licencing chapter of the Planning and Building Law, “no person shall do anything within the area of the coastal environment, which requires a permit under this chapter, except in accordance with the provisions of the Second Schedule”. A permit is required to undertake any mining, digging, quarrying and landfilling activities, which change the form, the stability, or the safety of the land, except digging and extraction works within maritime boundaries of marinas. A detailed monitoring program is a prerequisite for issuing a permit for many requested activities in the coastal environment. The content of the permit request is defined by the Permits Committee and the Marine Environment Division, and should include, inter alia, instructions for mitigating negative impact on the marine environment

Until 2004, the Planning and Building Law conferred exclusive rights to the Territorial Waters Committee (which was established in 1965 by the Act for Marine Planning in Territorial Waters) to prepare, approve or postpone any plans connected with the coast and the Israeli territorial waters. A marine spatial plan was prepared by this committee in 2000 as a non-statutory guidance document. In 2004, this committee was replaced by The Committee for the Protection of the Coastal Environment (see section 2.5).

The Planning and Building Law includes regulations that require the preparation of an **Environmental Impact Assessment** (EIA) as an integral part of the planning process for specified subjects and projects, and for projects proposed in environmentally sensitive areas. According to the regulations (2003, replacing the 1982 regulations), in the coastal and marine environment, EIA is required for sea ports, marinas, and land reclamations, or for any other marine infrastructure proposed in the marine environment (e.g., long wave breakers, marine aquaculture, gas drilling), which the planning committee has decided that it may have a significant impact of the environment. EIAs for marine infrastructure are required, inter alia, to assess the hydrographic and ecological impacts of the proposed project. Therefore, they can be used as an important source for baseline and predicted data. However, the regulations are very general and do not specify content of the assessment. This is determined case by case by the Ministry of Environmental Protection.

Regulations related to the Prevention of Sea Pollution (Law. 5748-1988)

The Law for the Prevention of Sea Pollution from Land-Based Sources prohibits the dumping and discharge of "waste or wastewater to the sea from a land-based source, either directly or indirectly, except under a permit and in accordance with its conditions". The Law provides for the appointment of inspectors to carry out enforcement activities. The inspectors are entitled to take samples and have them analysed by a laboratory.

The Prevention of Sea Pollution (Dumping of Waste) Regulations of 1984 (5744- 1984) defines the Materials prohibited for dumping and the provisions for granting dumping permits. It includes detailed considerations regarding monitoring and reporting to the relevant authorities by the permit holders.

There are other regulations in Israel that relate to marine pollution, but they have no explicit provisions in relation to monitoring.

Law for National Parks, Nature Reserves, National Sites and Memorial Sites (Law 5758-1998)

This Law established the Nature and National Parks Protection Authority (NPPA) with prerogatives to declare, establish, maintain, operate, and enhance terrestrial and marine nature reserves and national parks. Concerning the monitoring of species and habitats, this law entrusted NPPA with the function of coordinating the documentation and recording of information within the fields of nature protection and natural assets.

Environmental quality standards for the Mediterranean Sea in Israel (proposed in 2002)

The proposed Israeli marine environmental quality standards (EQS) for the Mediterranean Sea define, in a measurable and quantifiable way, the acceptable qualities of a wide range of biological, physical, and chemical indices. These may serve as official benchmarks for monitoring the coastal waters.

Protection of the Coastal Environment Law (Law 5764-2004)

The Protection of the Coastal Environment Law incorporates the ICZM approach. Its aims are to: “(a) protect the coastal environment, its natural and heritage assets, to restore and conserve them as a resource of unique value, and to prevent and reduce as far as possible any damage to them; (b) preserve the coastal environment and coastal sand for the public's benefit and enjoyment and for future generations; and (c) establish principles and limitations for the sustainable management, development and use of the coastal environment.”

The law defines two coastal units: the coastal environment and the shore area (which is included within the coastal environment). According to this Law, the sea and the shore are considered one integral unit that extends from two miles inside Israel's territorial waters to 300 metres inland. This entire area is considered a public resource, which is to be preserved and protected from damage. Within the coastal environment, the law determines that the coastal strip, which is the area directly adjacent to the waterline, should be protected from construction. The coastal strip is defined as the “shore area”, which extends from the coastline 100 meters inland and from the coastline seawards to a depth of 30 meters or to a distance of one nautical mile (whichever is furthest from the coastline).

In this context, the law provides for the following measures:

- prohibits damage to the coastal environment;
- assures an open public right of way along the entire length of the shore;
- gives the Minister of Environmental Protection authority to: (a) impose a fee for the protection of the coastal environment on owners or holders of coastal facilities considered to cause damage to the coastal environment, which will be paid to the Maintenance of Cleanliness Fund; (b) to issue an order to prevent or remove environmental damage so as to restore the coastal environment to its former state; and (c) to appoint inspectors to supervise the implementation of the law's provisions;
- imposes severe penalties for coastal damage;
- establishes a Protection of the Coastal Environment Committee, which is responsible for decisions on coastal development plans, taking into account such considerations as preventing damage to the coastal environment, preserving the coast for public benefit, assuring public access to the coast, and conserving nature, landscape and heritage values.

The Law requires that if a person is allowed by permit, licence or approval given by a competent authority to damage the coastal environment, he will have to take steps, as determined by the permit, licence, approval, or plan, to restore the coastal environment and to return it, to the greatest extent possible, to its former state.

2.3 Local and national outline plans

Since the early 1980’s, Israel has prepared and approved many local and national outline plans (NOP), which relate to coastal zone management. Some of them address monitoring issues directly and explicitly. The list of key plans for the coastal environment is presented in hierarchical and chronological order in Table 1. Most of the plans are for coastal infrastructure.

National Outline Plan for the Mediterranean Coast (NOP 13), approved in the early 1980’s, aims to prevent development which does not require coastal location, and to resolve conflicts of interest among land uses which need coastal location. The plan relates only to the terrestrial part of the coast, but certainly influences the use and development in the nearby waters.

According to this plan, the allocation of land uses in the coastline is based on two guiding principles: (a) preference to recreational activities on the coastal strip, and (b) assessment of land suitability for different land uses, based on environmental carrying capacity. The plan allocates land along the coastal strip to be managed, preserved, developed, and used for the following uses: swimming, recreation and sport, tourist facilities, protection of antiquities, nature reserves, national parks, forests, coastal reserves, ports and other essential uses which require a coastal location. The plan includes a clause prohibiting development within 100-meter (area to be measured inland from the coastline), and requires environmental assessments as a prerequisite for all coastal plans [analysis of local conditions, including the impact of existing land uses, analysis of the proposed land uses, environmental impact assessment (EIA), detailed coastal surveys (including of coastal currents), and analysis of existing and proposed access routes and infrastructure systems]. The plan also allocates sites for several ports and fourteen marinas.

Table 1. Key local and national outline and detailed plans for the coastal environment

	Level	Name and no.	Year of approval
1	Local	Detailed local plan no. HR/2002/a/1 for wave breakers at Herzlia Marina	1988
2		Detailed local plans no. HR/2002/a/2 and HR/2003/a for Herzlia Marina	1990, 1995
3		Detailed local plan no. 168/02/11 for Ashkelon Marina	1991
4	National	National outline plan no. 13 for the Mediterranean Coast	1983
5		National outline plan no. 13/b/2 for ports and marinas, Ashdod Port	2000
6		National outline plan no. 13/b/1/a for Haifa Port, Carmel project, phase 1	2003
7		National outline plan no. 13/b/1/a/1 for Haifa Port, Carmel project: conditions for marine sand mining for the construction of the terminal	2006
8		National outline plan no. 13/b/1/b for the marine entrance to Haifa Port	2006
9		National outline plan no. 13/3 for Haifa and Tirat Hacarmel beaches	2007
10		National outline plan no. 13/4 for Tel Aviv district beaches and coastal waters	2008
11		National outline plan no. 13/b/2/1 for ports and marinas, the expansion of Ashdod Port	2011
12		National outline plan no. 13/b/1/c for laying down and deepening of the marine entrance tunnel to Haifa Port	2012
13		National outline plan no. 13/b/2/1/a for the Mediterranean beaches, ports and marinas: the development of a new container terminal and extension of the wave breaker at Ashdod Port	2013
14		Detailed National outline plan no. 13/b/1/1 for marine structures in Haifa Bay: the development of container terminals in the Bay Port and Carmel B Port	2014
15		National outline plan no. 13/b/1/a for sand sources and dredging works for the construction of the Bay Port and the Oil Port in Haifa	2014
16		Detailed Coastal Cliff Protection plan no. 13/9/a	2015
17		National outline plan no. 13/6 for Netanya beaches	In preparation

It should be noted, that NOP 13 incorporates the ICZM approach and includes environmental assessment in its terms of approval. However, it does not include any reference to coastal monitoring. An explicit monitoring requirement, in addition to environmental assessment, was incorporated in later plans for marine manmade structures as terms for approval of a detailed plan. These terms include, inter alia:

- approval of an **environmental impact assessment** by a planning institution;
- inclusion of instructions that will ensure the implementation of corrective measures concerning negative impacts;
- inclusion of a **marine sand management mechanism**;
- submission of a **monitoring plan** prepared in accordance with detailed instructions from the Marine Environment Protection Division at the Ministry of Environmental Protection.

The information gathered through the EIAs and the monitoring programmes prepared in accordance with these terms is of primary relevance for various IMAP indicators, including EO7 and EO8. However, it should be noted that until a few years ago, not all marine infrastructure were subject to EIA and monitoring programs.

The main documents that can be used as good reference are: (a) the EIA and the Environmental Management Plan (EMP) prepared for NOP no. 13/b/2/1/a (for the development of a new container terminal and extension of the wave breaker at Ashdod Port); (b) the EIA prepared for NOP no. 13/b/1/a (for the development of a new container terminal in Haifa Port); and (c) an EMP prepared for NOP no. 13/b/1/a (for sand sources and dredging works for the construction of the Bay Port and the Oil Port in Haifa).

2.4 Non-statutory plans

The Coastal Area Management Programme (CAMP) for Israel

The programme started in 1996 and was mainly focused on analysing the pressures on the coastal environment. Consequently, a number of policies and relevant tools were proposed. The majority of its recommendations concerned the territorial waters and the (former) Territorial Waters Committee. The programme’s main recommendations were:

- to prepare a master plan for the territorial waters (the **Territorial Waters Policy** Document was published 1999, and is founded on the principles of ICZM);
- the power of the Territorial Waters Committee should be extended and broadened to include the 100m area in which construction is prohibited;
- all marine and coastal plans should be subject to EIA requirements;
- the Territorial Waters Committee should be entrusted with further inspection capabilities;
- an updated and reliable database on territorial water management should be established;
- conflicts of land-use should be resolved by the use of the consensus building approach;
- change the legislation and implement the Law for the Protection of the Coastal Environment.

Israel's National Action Plan (NAP) to address pollution from land based activities (2005, 2015)

In accordance with the Strategic Action Plan (SAP) related to the Barcelona Convention's Land Based Sources Protocol, Israel elaborated in 2005 its first NAP. The NAP was updated in 2015 and recommends to pursue the Mediterranean water monitoring carried out by IOLR under the supervision of the Marine and Coastal Division of the Ministry of Environmental

Protection. It also recommends to extend the monitored region to include Israel's economic waters, along with the addition of further sampled parameters and higher sampling frequency. This expansion is critical in order to comply with the requirement of the Barcelona Convention and its protocols, and also with the European Marine Strategic Framework Directive (MSFD) and Mediterranean Water Framework Directive (MWFD).

The Israel Marine Plan (2016)

Israel Marine Plan was prepared by a group of researchers and planners at the Israel Institute of Technology (Technion). It aims "to develop marine knowledge, to improve public awareness of what exists in the marine environment, and to shape the way it is depicted spatially". It provides guidelines for maritime spatial planning aimed at reducing conflicts and creating synergies between sea uses and stakeholders. Monitoring the marine environment to inform decision makers is at the heart of the plan.

Integrated Maritime Policy (IMP) for Israel

In 2013, an inter-ministerial committee, headed by the Ministry of Interior, was established in order to promote Israel's future marine national policy, encompassing all the country’s maritime areas (Mediterranean and Red Sea) and sectors. The first phase of the project, completed in 2015, included a comprehensive study of the baseline situation and relevant policies. Currently, the committee is working on defining an integrated maritime national vision and objectives.

2.5 National monitoring programmes

Following are the main national monitoring initiatives for the Israeli Mediterranean, which are relevant to coast and hydrography indicators. It should be noted that Israel does not have a national monitoring program related to land use dynamics.

Mediterranean Monitoring Program

In order to create a scientific basis for policies related to marine protection, including enforcement of marine pollution prevention laws and of relevant international conventions, IOLR developed (under the guidance of Israel Ministry of Environmental Protection - IMEP) a monitoring programme for the marine environment, which is implemented in the Mediterranean Sea from 1978. It is Israel’s main monitoring programme, covering representative sites along the Mediterranean coast. The programme involves sampling and testing of various parameters, including:

- heavy metals in coastal waters (carried out since 1978);
- introduction of nutrients and particulate metals into coastal waters through coastal rivers (since 1990);
- atmospheric fluxes of nutrients and heavy metals into coastal waters (since 1996);
- nutrient levels and algal populations in the shallow area of the coastal waters (since 2000);
- benthic communities along the coastline (since 2005);

- biological effects of pollution on the sea ('biomarkers') (since 2005);
- mapping of the coastal waters area based on satellite data (SISCAL) (since 2005);
- estimation of the overall pollution load introduced into the coastal waters derived from a database on point sources of pollution (since 2002);

As a contracting party of the Barcelona Convention, Israel shares data generated by this monitoring programme with MEDPOL.

The information gathered through this programme is of primary relevance for various IMAP indicators, including those of EO7 and EO8. The data can be used for both establishing baseline conditions and for identifying continuous alterations.

Real time “smart” water quality monitoring near marine infrastructures

A real-time water quality monitoring system near marine infrastructures was developed by IOLR, with financial support from the Ministry of Science and Technology. The project aimed at developing an operational system (prototype) for real time monitoring of water quality at marine infrastructure sites, that will provide tools for long term analysis of marine water quality and for alarming conditions (e.g. algae blooms, oil spills, etc.).

The monitoring was conducted by National Institute of Oceanography (NIO) during a period of three years (2011-2013). State of the art image processing techniques, multispectral sensors, molecular-biological indicators and advanced water analysis techniques were utilized for developing a “smart” decision making software that was based on geo-information. The sites monitored under this project can serve as good candidate reference under the IMAP for many indicators, including those of EO7.

Israeli Maritime Strategic Assessment 2015

The Strategic Environmental Assessment (SEA) project was launched in 2014 by The Ministry of National Infrastructure, Energy and Water Resources. It aims at providing a knowledge base for decision making in granting petroleum exploration and production rights in the Mediterranean waters *offshore* Israel. Its final report included maps of habitats, identification of sensitive areas, and an assessment of ecosystem services. It also presented the knowledge gaps and ways to bridge them.

The habitat maps and the identified sensitive areas presented in the final report of the Project have limited relevance for assessing the extent of habitats impacted by hydrographic alterations, as defined by indicator 8.1.4 of EO7. The main reasons for that are: (a) the project refers only to rather deep offshore waters; (b) there are knowledge gaps in certain areas; and (c) the potential impacts of petroleum exploration and production activities differ from those of hydrographic alterations.

2.6 Site-specific monitoring programmes

The instructions of some coastal infrastructure plans (as listed in Table 1) contain requirements for continuous, dynamic, and adaptive monitoring and management. According to these requirements, monitoring programs should be site-specific and make provision for the analysis of both physical and biological parameters. The guidelines derived from these requirements include, inter alia, the following demands:

- monitoring will be performed according to a monitoring plan, which will determine, inter alia: boundaries, sampling locations, parameters, methods, frequency, timing, and duration of measurements, relevant benchmark values, report procedures, and any other relevant information that will be required;
- the Ministry of Environmental Protection will determine the guidelines for the monitoring plan and approve the plan;
- in certain projects, the monitoring findings will be reported to the Territorial Waters Committee, the Ministry of Environmental Protection, the Ministry of Health, and the relevant local municipalities; and
- the monitoring findings will be used to determine the need, scope, nature and timing of the measures to mitigate negative effects.

2.7 National Institutions

In Israel, the monitoring of the Mediterranean marine environment is carried out within the framework of a National Monitoring Programme coordinated by the Ministry of Environmental Protection and conducted mainly by the National Institute of Oceanography (NIO), which is part of the Israel Oceanographic and Limnological Research (IOLR).

Israel Ministry of Environmental Protection (IMEP)

IMEP was established in 1989 by the Government's decision No. 5 of 25 December 1988. The ministry works on three levels: national, regional, and local. The main mission of IMEP is to protect the environmental quality through environmental laws and regulations, in terms of control and law enforcement. It bears the responsibility to protect the environment by the development of a comprehensive national policy, as well as strategies, laws and regulations. The protection of the coastal and marine environment is mainly conducted by the Marine Environment Protection division of IMEP, which, among other things, is responsible for the coordination of sea monitoring programs, including monitoring of species and habitats performed by Israel Nature and Parks Authority (as further discussed below).

When issuing permits for waste dumping, the IMEP may include provisions for monitoring with obligation of reporting. Currently, about 80 local monitoring programmes are being undertaken by private companies to fulfil the requirements set in the dumping permits they obtained from the IMEP.

The Committee for the Protection of the Coastal Environment

The committee was established in 2004, under the Protection of the Coastal Environment Law, as the successor of the Territorial Waters Committee. This professional committee consists of representatives of nine Ministries and other organizations, and is mandated to review every plan falling within the coastal environment according to criteria defined by the Law for Protection of the Coastal Environment (2004), including plans concerning marine and coastal infrastructure. However, the following activities are not within the competences of the committee: shipping, fishing, drilling, military, and extraction of oil and natural gas.

Israel Oceanographic and Limnological Research (IOLR)

IOLR is a national research institution. It was established in 1967 as a non-profit governmental body with the mission of generating knowledge for sustainable use and protection of Israel's marine, coastal, and freshwater resources. It conducts scientific research in the fields of oceanography, limnology, mariculture and marine biotechnology, through three research centres:

- The National Institute of Oceanography;
- The Yigal Allon Kinneret Limnological;
- The National Center for Mariculture.

The National Institute of Oceanography (NIO) is located in Haifa, on the shore of the Mediterranean. It conducts a multi-faceted research program in oceanography and marine biotechnology, and provides information and advice to government agencies and public and private sectors with regard to the utilization and conservation of Israel's marine and coastal resources.

The Israel Marine Data Center (ISRAMAR) was established in 2001 at the IOLR as the national repository for oceanographic data. ISRAMAR acquires archives and distributes three types of data and information on Israel's marine environment: historical, near real time, and forecast. ISRAMAR is a member of the International Oceanographic Data and Information Exchange (IODE) network.

IOLR is the main actor regarding the monitoring of the marine environment in the Mediterranean waters of Israel, and it has an official approval from the Ministry of Environmental protection for performing compliance marine monitoring programs.

Israel Nature and Parks Authority (NPA)

NPA is a government organization that manages nature reserves and national parks in Israel, the Golan Heights and parts of the West Bank. The organization was founded in 1998, merging two organizations that had managed the nature reserves and national parks separately since 1964. In addition to managing protected areas, NPA promotes the planning of establishment of protected areas, including in the marine environment. NPA is also responsible for monitoring species and habitats throughout the country.

Survey of Israel (SOI)

The Survey of Israel is the government agency for mapping, geodesy, cadastre and geo-informatics. As the national mapping agency, the Survey is responsible for defining mapping products required, with a special attention to construction, infrastructure, security and emergency services, environmental protection, tourism, and research and development.

SOI is responsible for the National GIS databank, including a uniform set of codes to ensure compatibility. The National GIS includes a topographic data bank, derived from aerial photographs at the scale of 1:40,000 and periodically revised.

With regards to the coastal environment, SOI is responsible for the production and update of a reference coastline and the ITSI Structure - Israeli Topographic Spatial Infrastructure, which contains information on land use and land cover.

3. Databases and Information Systems

In Israel, hydrographic and land use data on the coastal and marine environments is collected and analysed by many institutions. However, the accessibility and availability of these data bases varies. Some of them are open-access, some are available only to researchers and decision makers, and some have to be purchased. The relevant data sources are presented in tables 2-4 in the next section.

With regards to the availability and accessibility of all three types of databases, a few things should be noted:

- Some of the data sources, such as most EIAs and monitoring programmes, are written in Hebrew.
- The categories of land use and land cover, as determined by SOI and the Planning Authority at Ministry of Finance, are dynamic and may vary over time.
- Funds will be required for acquisition of data that has to be collected differently, or further processed, or translated to English, for the purposes of this monitoring plan. At this stage, the Ministry of Environmental Protection cannot determine the scope of the human and financial resources needed for these purposes.
- High-resolution raw databases and purchased databases cannot be publicly distributed. Nevertheless, the products of processed data (with lower spatial resolution that still fits the requirements of this monitoring program), could be distributed, subject to authorization from the respective governmental and/or non-governmental sources. Consequently, the access policy for each parameter will have to be determined in the future, case by case.
- The access policy may vary over time.

4. Monitoring plan for coast and hydrography indictors (EO7, EO8)

The monitoring plan relates to the three following indicators:

- EO7 – Hydrography, Common indicator 15: Location and extent of the habitats impacted directly by hydrographic alterations (a cross-cutting issue for EO1 and EO7). It should be noted, that the reference year for reporting is 2017.
- EO8 - Coastal ecosystems and landscapes, Common indicator 16: Length of coastline subject to physical disturbance due to the influence of manmade structures. It should be noted, that the reference year for reporting is 2018.
- EO8 - Coastal ecosystems and landscapes, Candidate Indicator 25: Land Use Change. It should be noted, that the reference year for reporting is 2018.

The goals, rational, and calculation methodology for these indicators are presented in Annexes 1-3.

The detailed Israeli monitoring plan with regards to each indicator is presented in Tables 2-4 below. The Tables contain indication of data availability (asterisk indicators).

Table 2. EO7 – Hydrography, common indicator 15: location and extent of the habitats impacted directly by hydrographic alterations

Parameter	Units	Data type (modeled/ measured)	Spatial resolution / scale	Reporting threshold	Location/ Spatial considerations	Temporal resolution (frequency, duration)	Acquisition/ production method	Submission format	Available/ needed data source
Bathymetry	Location, area and extent of alteration: absolute surface in m^2, range of depths; coast evolution (coast line position, morphology monitoring)	Measured, modeled	Available - Horizontal resolution: 2-5m up to 100m depth, 10-25m on the continental slope to 700m depth; In the immediate vicinity of the shoreline; more detailed bathymetry maps exist in the context of particular coastal development projects and construction of marine structures.	Every new structure	Specific locations where new permanent manmade structures are planned, starting from 2017	Before construction - part of the EIA. During and after construction - defined case by case	A model will be operated as part of the EIA; Data gathered through existing monitoring plans needs integration	Maps of potentially altered habitats due to changes of the hydrographic conditions; The exact format of habitats/GIS data will be defined in link with EO1 indicator	Baseline and prediction: Recent survey (2014) - Israel Oceanographic and limnological Research Institute (IOLR) + Geological Survey of Israel (GSI)*; recent EIAs for manmade structures**; CAMERI-Coastal and Marine Engineering Research Institute*** Alteration: Monitoring programmes for new ports, marinas, breakwaters, desalination and power plants **
Wind		measured			In the vicinity of planned permanent manmade structures, starting from 2017	Before construction (as part of the EIA). During and after construction – is defined case by case	In case of no sufficient data, the use of assessment methods needing less data (empirical formulae, expert judgment, comparison with similar sites) should be considered, as well as acquisition/ monitoring of missing data, promoting regional cooperation		Baseline: general – Israel Meteorological Service (IMS)*; In Ashkelon and Hadera coal terminals – IOLR**. Recent EIAs for manmade structures**; 15-year wind time-series*; Alteration: Monitoring programs for new ports, marinas, breakwaters, desalination and power plants**
Bottom nature				structures that require EIA			link between EO1 and EO7 needs to be determined on a case-by-case basis		Habitat maps from Israeli Maritime Strategic Assessment*; Habitat maps provided by EO1 (detailed and updated to 2017)
Sea level (tide gauge, storm surge)		measured							Baseline & annual measures- GSI*, IOLR***
Hydrodynamics: wave height and exposure,	Waves and currents characterization in terms of direction,	Measured + modeled	Existing - Annual & seasonal height – Cm; Annual			Before construction; During	Integration of the data gathered through existing monitoring	Statistics, maps	Baseline and prediction: In Ashdod and Haifa - Coastal and Marine Engineering Research

Table 2. EO7 – Hydrography, common indicator 15: location and extent of the habitats impacted directly by hydrographic alterations

Parameter	Units	Data type (modeled/ measured)	Spatial resolution / scale	Reporting threshold	Location/ Spatial considerations	Temporal resolution (frequency, duration)	Acquisition/ production method	Submission format	Available/ needed data source
currents velocities and directions, turbulence, bed shear stress	intensity, occurrence and period. Seasonal variability should be taken into account (mean/max/min values, quantile)		directional distribution – cm & %; wave and current fields for representative waves (Height - m, Tp. – s, Dir. - ^{0}, Vs. – m/s)			and after construction – no site-specific monitoring	plans		Institute (CAMERI)***; In Hadera coal terminal – IOLR**; recent EIAs for large manmade structures**; 16-year wave time-series**
Sediment transport and/or turbidity data – sediment concentrations, turbidity, bed evolution	Quantitative assessment of sediment transport rate and turbidity, actual evolution tendencies (stability, erosion, accretion of the coast) and rate of change (ex: coast retreat of x meter/year); km^2 of impacted habitat, proportion (%) of the total area/habitat impacted	Modeled	Sediment transport fields – (total sediment load, m3/s/m) for rep. wave		For sandy sites or sites with natural sediment dynamic; Specific locations where manmade structures are planned; western boundary limited by the 30 m water depths	Before construction; During and after construction – is defined case by case	Integration of the data gathered through existing monitoring plans		Baseline and prediction: Recent EIAs for large manmade structures**; CAMERI***; relevant scientific literature*
Salinity	Total dissolved salts and electrical conductivity	Measured + modeled	‰		If the new structure involves brine discharge,	Before construction; after - annually	Integration of the data gathered through existing monitoring plans –		IOLR - Monitoring programmes for desalination plants (incl. impacts on habitats)**
temperature	^{0}C	Measured + modeled			If the new structure involves cooling water discharge	Before construction; after construction - annually	Integration of the data gathered through existing monitoring plans –		IOLR -Monitoring programmes for desalination/ power plants**; for Haifa bay – EMP for NOP /13/B/1/2 (maybe for 2018)**

* Available

** Available, but financial resources are needed for data processing and/or analysis, and/or integration

*** Has to be acquired

Table 3. EO8 – Coastal ecosystems and landscapes

Common indicator 16: Length of coastline subject to physical disturbance due to the influence of manmade structures

Parameter	Units	Data type (modeled/ measured)	Spatial resolution / scale	Minimum mapping unit	Location/ Spatial considerations	Temporal resolution (frequency, duration)	Acquisition/ production method	Submission format	Available/ needed data source
Length of manmade structures attached to the coastline (Breakwaters, seawalls bulkheads, groins, jetties, pilings, ports and marinas) / natural (incl. eroded) length	m	measured	5m / 1:2,000; Available 0.5m, 2m		All the coastline; fixed reference coastline – e.g. the highest tide line; 10 m buffer around coastal structures	Every 6 yrs; Reference year - 2012	Analysis of very high-resolution satellite imagery or orthorectified aerial photographs; Images from max 3 yrs period centered on the reference year	GIS – SHP files; WS84; Colors: green - natural coastline, red - artificial; Categories: Breakwaters (1), seawalls bulkheads (2), groins (3), jetties (4), pilings (5), ports and marinas (6), land reclamation (7)	Survey of Israel (SOI)**; Ministry of Environmental Protection**
% of artificial/ natural length of the total coastline length	%	measured	5m / 1:2,000; Available 0.5m, 2m		All the coastline; fixed reference coastline – e.g. the highest tide line; 10 m buffer around coastal structures	Every 6 yrs; Reference year - 2012	Analysis of very high-resolution satellite imagery or orthorectified aerial photographs; Images from max 3 yrs period centered on the reference year	GIS – SHP files; WS84; Colors: green - natural coastline, red - artificial; Categories: Breakwaters (1), seawalls bulkheads (2), groins (3), jetties (4), pilings (5), ports and marinas (6), land reclamation (7)	Survey of Israel (SOI)**; Ministry of Environmental Protection**

* Available

** Available, but financial resources are needed for data analysis and/or integration

*** Has to be acquired

Table 3. EO8 – Coastal ecosystems and landscapes, candidate indicator 25: Land Use Change

Parameter	Units	Data type (modeled/ measured)	Spatial resolution / scale	Minimum mapping unit	Location/ Spatial considerations	Temporal resolution (frequency, duration)	Acquisition/ production method	Submission format	Available/ needed data source
Area of built-up land in coastal zone (300m) as a proportion of the total area in the same unit (300m)	% of artificial areas (incl. associated non-sealed and vegetated areas)	measured	1:100,000	$1km^2$ Min. width of linear element: 100 m	Coastal zone: within 300m from shoreline	Every 5-6 yrs	For land cover: very high-resolution satellite imagery; aerial photographs; A transformation of land use classes is required For land use: in progress and recently approved detailed planning schemes	Raster GeoTIFF gv-SIG desktop (transform CRS from WGS-84 to ETRS); Statistics	Survey of Israel (SOI) - The ITSI Structure - Israeli Topographic Spatial Infrastructure**; Ministry of Finance (Planning Authority)**
Area of built-up land in setback zone(100m) as a proportion of the area of built-up land in the wider coastal unit (300 m)	-“-	measured	-“-	-“-	within 100m from shoreline (Narrower coastal strips within the wider ones)	-“-	-“-	-“-	-“-
Land take as % initial urban area on the coastal zone	% of increase of urban areas	measured	-“-	-“-	Coastal zone: within 300m from shoreline	-“-	-“-	-“-	-“-
Area of agriculture in coastal zone as a proportion of the total area in the same unit	%	measured					-“-	-“-	-“-
Change of agricultural areas	% of change of agriculture (incl. aquaculture)	measured	-“-	-“-	-“-	-“-	-“-	-“-	-“-
Area of forest and semi-natural areas in coastal zone as a proportion of the total area in the same unit	%	measured	-“-	-“-	-“-	-“-	-“-	-“-	-“-
Change of forest and semi-natural areas	% of change of forest and semi-natural areas	measured	-“-	-“-	-“-	-“-		-“-	-“-
Area of wetlands in coastal zone as a proportion of the total area in the same unit	-“-	measured	-“-	-“-	-“-	-“-	-“-	-“-	-“-
Change of wetlands	% of change of wetlands	measured	-“-	-“-	-“-	-“-	-“-	-“-	-“-
Area of water bodies in coastal zone as a proportion of the total area in the same unit	%	measured	-“-	-“-	-“-	-“-	-“-	-“-	-“-
Change of water bodies areas	% of change of water bodies (incl. reservoirs)	measured	-“-	-“-	-“-	-“-	-“-	-“-	-“-

*   Available

** Available, but financial resources are needed for data analysis and/or integration

*** Has to be acquired

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Annex 1: EO7 – Hydrography

Common indicator 15: Location and extent of the habitats impacted directly by hydrographic alterations

Definition	The EO7 Common Indicator reflects location and extent of the habitats impacted directly by the alterations and/or the circulation changes induced by them: footprints of impacting structures. It concerns area/habitat and the proportion of the total area/habitat where alterations of hydrographical conditions are expected to occur (estimations by modelling or semi-quantitative estimation).
Goal(s)	Assess and minimise the physical impacts of permanent new structures on ecosystems Permanent structure: > 10 years
How to achieve this goal	• When planning new structures – applying mitigations measures to minimize impacts • During construction - limiting physical impacts • After construction - monitoring of hydrographical alterations
Rational - Justification for indicator selection	
Ecological Objective 7 ("Alteration of hydrographical conditions“) 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. An agreed common indicator - <u>'Location and extent of habitats impacted directly by hydrographic alterations'</u> considers marine habitats which may be affected or disturbed by changes in hydrographic conditions (currents, waves, suspended sediment loads). There is a clear link between EO7 and other ecological objectives, especially EO1 (Biodiversity). Such link needs to be determined on a case-by-case basis. For example, the definition of functional habitats under EO1 could help identify the priority benthic habitats for consideration in EO7 (see Annex 1, for a first general identification of these habitats). Ultimately, the assessment of impacts, including cumulative impacts, is a cross-cutting issue for EO1 and EO7.	
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Policy Context	
Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean calls to Contracting Parties of the Barcelona Convection for continuous monitoring of ecological processes, population dynamics, landscapes, as well as the impacts of human activities (Article 7 b). In addition, it calls to Parties to evaluate and take into consideration the possible direct or indirect, immediate or long-term impacts, including the cumulative impact of the projects and activities, on protected areas, species and their habitats (Article 17). Another Protocol of the Barcelona Convention, the **Protocol on the Integrated Coastal Zone Management in the Mediterranean**, in its Article 9, calls for Parties to minimize negative impacts on coastal ecosystems, landscapes and geomorphology, coming from infrastructure, energy facilities, ports and maritime works and structures; or where appropriate to compensate these impacts by non-financial measures. In addition, the Article 9 demands maritime activities to be conducted “in such a manner as to ensure the preservation of coastal ecosystems in conformity with the rules, standards and procedures of the relevant international conventions“. Out of other international legislation that can be relevant for the EO7 Ecological Objective, it is essential to	

mention **Marine Strategy Framework Directive – MSFD 2008/56/EC** since EcAp's EO7 is basically transposed MSFD's Descriptor 7. However, it should be kept in mind that this Directive is eligible only at the EU level.

Policy documents

Protocol on the ICZM in the Mediterranean - http://www.pap-thecoastcentre.org/pdfs/Protocol_publikacija_May09.pdf

Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean - http://www.rac-spa.org/sites/default/files/protocole_aspdb/protocol_eng.pdf

MSFD Directive - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN

Other EU-related documents can be found at: http://ec.europa.eu/environment/eia/eia-support.htm

Indicator analysis methods

Methodology for indicator calculation

Methodology* used for indicator measurement encompasses elaboration on:

1) 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
2) modelling potential changes in the spatial extent of habitats affected by permanent alterations, using field data and validated model data.

Models should be calibrated and continuously supported and validated with "in situ" monitoring datasets.

A methodological approach of how to reflect the objectives of the Hydrography Common Indicator, in the main steps undertaken in an EIA (and SEA) procedure can be seen in Fig. 1.

Further details on the methodological approach can be found in ***Anex 1: Guidance for EO7 implementation****.*

* Methodology strongly depends on the site of interest and its natural hydrographical conditions; on the dimension, the location and the functions of the future structure, and on the data and means available

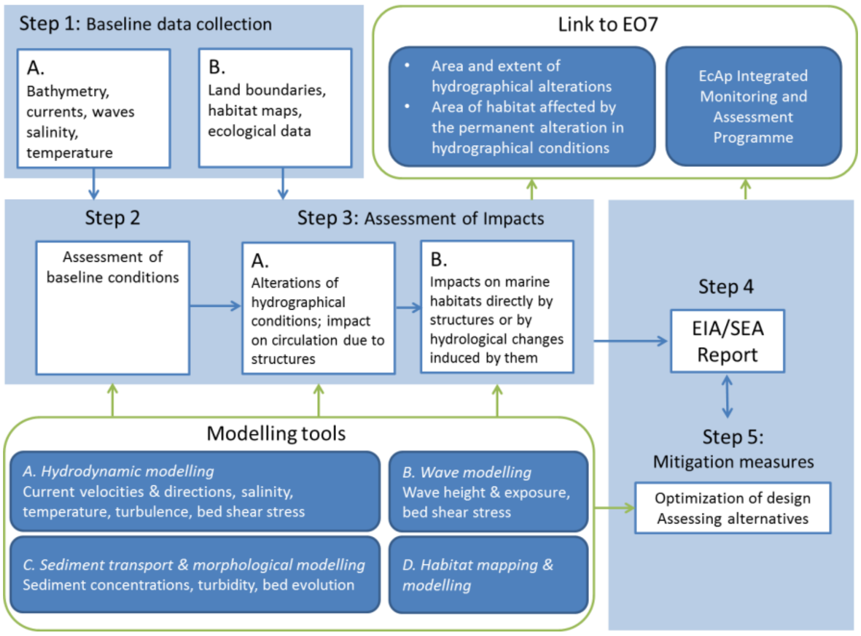

Figure 1. Methodological approach to integrating EIA/SEA process with EO7 implementation

The methodology to assess the indicator can be divided into three main steps:

1) **baseline hydrographical conditions characterisation** - monitoring and modelling of actual conditions without structure);
2) **assessment of hydrographical alterations induced by new structure** - comparing baseline conditions and with structure conditions, using modelling tools);
3) **assessment of habitats impacted directly by hydrographic alterations** - by crossing hydrographical alterations and habitat maps.

New structures to be considered:

Use a case by case approach, depending on the nature of the coast, the function of the structure and the depth reached by the structure where appropriate threshold values are taken into account (such as absolute surface in m², and range of depths where structure will be built (to avoid habitat segmentation). As an additional criterion all permanent structures, for which an EIA and/or a planning/building permit is required, should be considered.

Hydrographical conditions to be considered:

- **waves and currents changes** (can be used to assess changes in bottom shear stress, turbulence…);
- **sediment transport processes and turbidity** - for sandy sites or sites with natural sediment dynamic, changes in and induced changes in morphology of the coast;
- **assessment of salinity and/or temperature changes** - if the new structure involves water discharge, water extraction or changes in fresh water movements.

Base-line hydrodynamic conditions are defined by:

- actual bathymetric data (with fine resolution to the coast or closed to the structure, less fine resolution off-shore) and knowledge of bottom nature (taken from habitat map EO1);
- water level variations (tide, storm surge);
- waves and currents characterisation in terms of direction, intensity, occurrence and period for waves (from long duration waves and currents data analysis and hydrodynamic modelling). Seasonal variability should be taken into account (mean/max/min values, quantile);
- for sandy sites or sites with sediment transit: quantitative assessment of sediment transport rate and turbidity, actual evolution tendencies (stability, erosion, accretion of the coast) and rate of change (ex: coast retreat of x meter/year);
- temperature and salinity actual conditions if the new structure will involve water discharge, water extraction or changes in fresh water movements;
- new structure location and dimensions (footprint, height, shape, …).

The knowledge of these base-line conditions, with the new structure location and dimensions (footprint, height, shape …), will allow assessing the hydrographical conditions induced by the presence of the structure.

Comparison of hydrographical conditions with and without the structure will allow assessing the significant changes, i.e., the alterations induced by the structure.

The last step will consist in crossing hydrographical alterations and habitats maps. *The link to EO1 is so essential, as map of benthic habitats in the zone of interest (broad habitat types and/or particular sensitive habitats) is required*.

EO7 parameters:

- area (km^2) of hydrographical changes induced by structure;
- area of habitats impacted by these changes;
- proportion of impacted habitats in the area of interest.

Methodology for monitoring, temporal and spatial scope

Spatial scope guidance and selection of monitoring stations

The monitoring will focus on habitats of interest around new permanent constructions (lasting more than 10 years) in coastal waters.

The study area should depend on the footprint of the new construction considered and on the local (or regional) geographical and marine conditions. It should be large enough to:

- show all the hydrographic alterations induced by the construction, even for long term;
- follow all the habitats of interest that could be potentially impacted.

The spatial scale (in cross-shore and long-shore directions) should be about 10 to 50 times the characteristic length of the structure. Depending on the first results obtained for this area, the area should be enlarged or zoomed in around the structure.

It should be highlighted if monitoring was performed in sensitive areas, such as marine protected areas, spawning, breeding and feeding areas and migration routes of fish, seabirds and marine mammals, since they are priority.

Temporal Scope guidance

To correctly assess changes in time on habitats induced by constructions, the monitoring timescales

should include the following: • **before construction**, initial state assessment (baseline conditions): monitoring should provide the initial distribution (area, location, eventually density…) of the habitats of interest located in and around the future impacted area and the initial hydrodynamics conditions surrounding the future construction. • **during construction**: monitoring should ensure that impacts due to works are limited in space and in time. • **after construction, short term changes (0 to 5 years after)**: at least yearly up to 5 years. During this period, strong changes should happen on hydrographical, morphological and habitats conditions. The monitoring frequency should be high enough* to assess these changes. It should be annual (at the same period of year) and provide, each year, the distribution of the habitats of interest around the construction and the changes in hydrodynamic conditions (assessed by comparing present and initial conditions). • **after construction (5 to 10 years after)**: at least binnemium to 10 years. Same as before with a lower* monitoring frequency as the changes should be lower. • **long term changes (10 to 15 years after)** - same as before with a lower* monitoring frequency as the changes should be lower. * The monitoring frequencies should depend on the habitats considered (link to EO1→ adequate frequency/habitat) and on the intensity of changes in hydrographical, morphological or habitats conditions occurring on the site (case by case).
Data analysis and assessment outputs
Expected assessments outputs All the outputs that came out of the monitoring (i.e., trend analysis, distribution maps, etc.) should be listed, along with source(s) where they can be found. The outputs to be reported are (map and GIS data): • area and location where the future structure will be built; • area and location where alterations in hydrographical conditions are expected to occur and those areas where alterations are actually occurring; • area and location of the habitats of interest potentially impacted by these alterations; • area and location of these habitats of interest previously identified for the whole analysis unit (to assess the proportion of total habitats that are altered). NOTE: *The exact format of habitats/GIS data will be defined in link with EO1 indicator*.
Available data sources - Global Global marine data source at the scale of the Mediterranean Sea: EMODnet Central Portal (http://www.emodnet.eu/) Mediterranean Marine Data (http://www.mediterranean-marinedata.eu/) Copernicus, Marine environment monitoring service (http://marine.copernicus.eu/) **Available data sources - Local** See Table 2.
List of Guidance documents and protocols available Guidance document on how to reflect changes in hydrographical conditions in relevant assessments, by Spiteri, C. (2015); Draft Integrated Monitoring and Assessment Guidance; Advice document on hydrographical conditions (Descriptor 7) in the context of MSFD, published by OSPAR Commission (2012); Scientific and technical review of the MSFD Commission Decision 2010/477/EU in relation to Descriptor 7 carried out by the EC JRC.
Data Confidence and uncertainties Data used or produced for the monitoring should be in agreement with Shared Environmental Information System (SEIS) principles. More on SEIS principles can be found in "Draft Integrated Monitoring and Assessment Guidance".

Annex 2: EO8 - Coastal ecosystems and landscapes

Common indicator 16: Length of coastline subject to physical disturbance due to the influence of manmade structures

Definition	Negative impacts of human activities on coastal areas are minimized through appropriate management measures.
Gaol(s)	1) To quantify the rate and the spatial distribution of the Mediterranean coastline artificialisations; 2) to provide a better understanding of the impact of those structures to the shoreline dynamics.
How to achieve this goal	Additional criteria should be taken into account for definition of targets, measures and interpretation of results regarding this indicator: due to strong socio-economic, historic and cultural dimensions in addition to specific geomorphological and geographical conditions.

Rationale - Justification for indicator selection

Mediterranean coastal areas are particularity threatened by coastal development that modifies the coastline through the construction of buildings and infrastructure. The land, intertidal zone and near-shore estuarine and marine waters are increasingly altered by the loss and fragmentation of natural habitats, and by the proliferation of a variety of built structures, such as ports, marinas, breakwaters, seawalls, jetties and pilings. These coastal manmade infrastructures cause irreversible damage to landscapes, losses in habitat and biodiversity, and strong influence on the configuration of the shoreline. Indeed, physical disturbance due to the development of artificial structures in the coastal fringe can disrupt the sediment transport, reduce the ability of the shoreline to respond to natural forcing factors, and fragment the coastal space. The modification of emerged beach and elimination of dune system contribute to coastal erosion phenomena by lessening the beach resilience to sea storms. Coastal defence infrastructures have been implemented to solve the problem, together with beach nourishment, but preserving the natural shoreline system with adequate sediment transport from river has proved to be the best solution.

Scientific References

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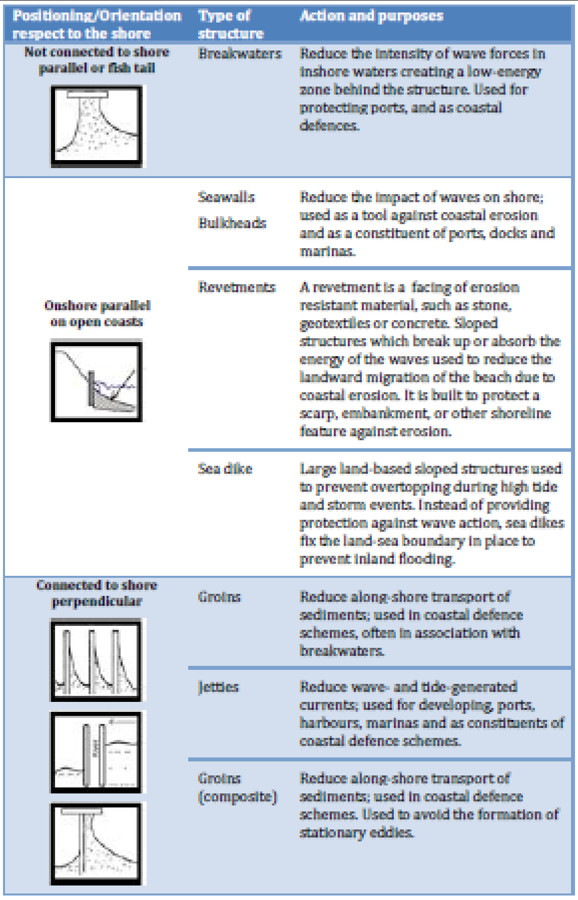
UNEP/MAP/PAP (2001). White paper: coastal zone management in the Mediterranean. (Split).

UNEP/MAP (2013). Approaches for definition of Good Environmental Status (GES) and setting targets for the Ecological Objective EO7 “Hydrography” and EO8 “Coastal ecosystems and landscape” in the framework of the Ecosystem Approach.

Policy Context
ICZM Protocol (Article 8, point 3): The Parties shall also endeavour to ensure that their national legal instruments include criteria for sustainable use of the coastal zone. Such criteria, taking into account specific local conditions, shall include, inter alia, the following: • identifying and delimiting, outside protected areas, open areas in which urban development and other activities are restricted or, where necessary, prohibited; • limiting the linear extension of urban development and the creation of new transport infrastructure along the coast; • ensuring that environmental concerns are integrated into the rules for the management and use of the public maritime domain; • providing for freedom of access by the public to the sea and along the shore; • restricting or, where necessary, prohibiting the movement and parking of land vehicles, as well as the movement and anchoring of marine vessels, in fragile natural areas on land or at sea, including beaches and dunes.
Policy documents Protocol on the ICZM in the Mediterranean http://www.pap-thecoastcentre.org/pdfs/Protocol_publikacija_May09.pdf
Indicator analysis methods
Methodology for indicator calculation: The monitoring of this Common Indicator entails an inventory of: • the length and location of manmade coastline (**hard coastal defence structures, ports, marinas** (see Fig. 2). Soft techniques (e.g., beach nourishment) are not included; • **land claim**, i.e., the surface area reclaimed from the 1980's onward (ha). **Coastline to be considered:** The fixed reference official coastline. The optimal resolution should be 5 m or 1: 2,000 spatial scale. **Identification procedure of manmade structures:** The procedure should be based on typical situations (Fig 2), including the minimum size (length, width of manmade structures) to be taken into account. Monitoring should focus, in particular, on the location, the spatial extent and the types of coastal structures, taking into account the minimum coastal length that can be classified as artificial or natural. As monitoring should be done every 6 years, the reference year should be in the time interval 2000-2012 in order to eliminate the bias due to old or past manmade infrastructures.



Positioning/Orientation respect to the shore	Type of structure	Action and purposes
Not connected to shore parallel or fish tail	Breakwaters	Reduce the intensity of wave forces in inshore waters creating a low-energy zone behind the structure. Used for protecting ports, and as coastal defences.
Onshore parallel on open coasts	Seawalls Bulkheads	Reduce the impact of waves on shore; used as a tool against coastal erosion and as a constituent of ports, docks and marinas.
	Revetments	A revetment is a facing of erosion resistant material, such as stone, geotextiles or concrete. Sloped structures which break up or absorb the energy of the waves used to reduce the landward migration of the beach due to coastal erosion. It is built to protect a scarp, embankment, or other shoreline feature against erosion.
	Sea dike	Large land-based sloped structures used to prevent overtopping during high tide and storm events. Instead of providing protection against wave action, sea dikes fix the land-sea boundary in place to prevent inland flooding.
Connected to shore perpendicular	Groins	Reduce along-shore transport of sediments; used in coastal defence schemes, often in association with breakwaters.
	Jetties	Reduce wave- and tide-generated currents; used for developing ports, harbours, marinas and as constituents of coastal defence schemes.
	Groins (composite)	Reduce along-shore transport of sediments; used in coastal defence schemes. Used to avoid the formation of stationary eddies.

Figure 2. Hard coastal defence structures, modified from the EUROSION Shoreline Management Guide, EU, 2004. Taken from IMAP guidelines, page 134, Table 1

EO7 parameters:

- length (Km) of artificial coastline and of total length of coastline;
- percentage (%) of natural coastline of the total coastline length.

The length of artificial coastline should be calculated as the **sum of segments on reference coastline identified as the intersection of polylines representing manmade structures with reference coastline**. Poylines representing manmade structures with no intersection with reference coastline will be ignored.

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 segment including both coastal defence structures is classified as artificial.

*Further details on the methodological approach can be found in **Anex 2: Step-by-step approach for indicator 8.1.4**.*

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Space and airborne earth observation systems are the most suitable tool to conduct the monitoring strategy of the EO8 common indicator, i.e., very high resolution (VHR) satellite imagery, aerial photographs, laser scanners etc. Beyond earth observation data, identification techniques and procedures used through GIS tools also have to be described

As for the monitoring protocols, the monitoring and assessment methodological guidance on EO8: coastal ecosystems and landscapes is essential (especially the 4.1 chapter).

Spatial scope guidance and selection of monitoring stations

The exact territorial extent of the monitoring should be presented - (see in IMAP guidelines: “The spatial coverage where manmade structures can be found only involves a coastal fringe of 200 meters

in amplitude“). The optimum spatial scale for a proper identification of manmade structures should be 5 m by satellite imagery or aerial photographs, according to common procedures for GIS digitalization.
Temporal Scope guidance While monitoring manmade structures, data should be updated at least **every 6 years**. Shoreline survey of **sandy coastline** under manmade pressure should be repeated **annually** (at the same time of the year)” – from the IMAP guidelines
Data analysis and assessment outputs
Statistical analysis and basis for aggregation The total length of coastline estimated as being subjected to physical disturbance due to the influence of manmade structures should be summed. In addition, the share of this coastline in total country's coastline should be determined. If an official coastline is available, i.e., an institutional body provides a GIS polyline, then such coastline can be used to “project” the identified manmade structures in order to classify parts of the coastline as being subjected to physical disturbance due to the influence of manmade structures. Geographic scale of maps and cartography used to identify manmade structures could be different, but not too much, form the ones used for the official coastline. In case if such official coastline is not available or its geographic scale is too coarse with respect to one needed to properly identify manmade structures, then coastline will be defined by the same maps/cartography used for manmade structures identification.
Expected assessments outputs: • the total length of coastline influenced by manmade structures, the share of this coastline in total country’s coastal length, etc. should be provided on **a map showing the coastline subject to physical disturbance due to manmade structures (artificial segments) in red line and the rest (natural segments) in green line;** • the assessment output should be reported as a common shape file format with GRS as WGS84; • Shape file with other GRS will also be accepted if provided with a complete prj file that allows GRS transformations by standard GIS tools.
Available data sources - Global CORINE land cover, national spatial plans, World Imagery Basemap feature (in ArcGIS 10.1), Landsat satellite imagery, Google earth, aerial photographs surveys. **Available data sources - Local** See Table 3.
List of Guidance documents and protocols available Monitoring and assessment methodological guidance on EO8: coastal ecosystems and landscapes (within IMAP guidelines) EUROSION Shoreline Management Guide (European Commission and Directorate General Environment, 2004, Annex 2)

Annex 3: EO8 - Coastal ecosystems and landscapes

Candidate Indicator 25: Land Use Change

<table>
<tr><td>Definition</td><td>Land use change is the change of purpose to which land is profited by humans (e.g., protected areas, forestry for timber products, plantations, row-crop, agriculture, pastures, or human settlements).</td></tr>
<tr><td>Gaol(s)</td><td>1) No further construction within the setback zone;
2) Change of coastal land use structure, dominance of urban land use reversed;
3) Keep, and increase, where needed, landscape diversity.</td></tr>
<tr><td>How to achieve this goal</td><td>Focus on:
where pressures are higher (by amount of change and by pace of the process);
spatial trends (along the coast and landwards).
These targets should be taken as general guidelines that need to be considered in light with the local knowledge. Given the relevance of the socio-economic, historic and cultural dimension, in addition to specific geographical conditions, local experts will provide the needed input in support to this indicator.</td></tr>
<tr><td colspan="2">Rationale - Justification for indicator selection</td></tr>
<tr><td colspan="2">Identifying and understanding the processes of land use change is especially relevant for critical and vulnerable areas, such as coastal zones, where several competitive uses are pressing. In this context, urbanization, or land take, is the most dramatic change given the (almost) irreversibility of the process. The main associated impacts are as follows (Figure):
habitat loss with the associated impact on related ecosystem functions like C sequestration, regulation of water cycle, or biomass production.
fragmentation - the division of natural habitats into smaller parcels contributes to the isolation of number of species and also compromises its viability.
Therefore, the accumulated impacts of urbanization highly compromise ecosystem integrity. Since impacts are dependent on the scale and pace of changes, it is important to consider these aspects when monitoring land use changes.
Beyond the process of urbanisation, there are other changes that are less irreversible but also have important consequences:
Conversion from forest to agricultural use. This results in habitat loss, habitat fragmentation and. Consequently, loss of biodiversity. There is also a decrease on the degree of soil coverage by vegetation which in turn determines the risk of erosion. Also, this type of change results in a net loss of soil carbon.
Conversion from agriculture to semi-natural. The impact strongly depends on the conditions at the time of abandonment. If conditions are favorable, land abandonment can lead to a recovery of natural vegetation. However, in case of unfavorable conditions, like low vegetation coverage, steep slope agricultural abandonment could lead to further land degradation.
Conversion from agricultural land to forest (forestation). This change involves tree plantation and it has a positive impact on land stability by increasing the vegetation cover of the soil and the increase of C sequestration. In terms of biodiversity, it strongly depends on the species used for plantation. Native species definitely increase diversity and connectivity.</td></tr>
</table>

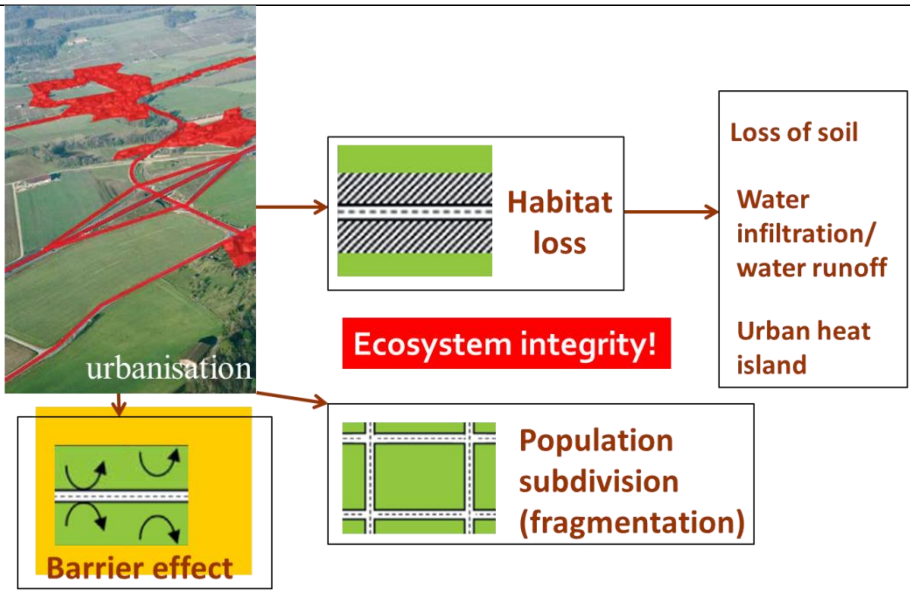


Figure 3. Overview of major impacts on land take

Scientific References

References are grouped by the topic addressed. Within each section references are sorted by relevance (the first ones are more relevant to the current indicator).

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- Gibbs, H. K., Helkowski, J. H., Holloway, T., Howard, E. A., Kucharik, C. J., Monfreda, C., Patz, J. A., Prentice, I. C., Ramankutty, N., Snyder, P. K., Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., Chapin, F. S., Coe, M. T. and Daily, G. C. (2005). Global Consequences of Land Use. Science, 309(5734), p.570-574.
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Methodology to compute land use change indicator:

Breton, F., Ivanov, E., Morisseau, F., Nowell, M. (2014). D4.2 Report, accompanying database and supporting materials on LEAC Methodology and how to apply it in CASES. PEGASO 06/Deliverable. URL: http://www.pegasoproject.eu/images/stories/WP4/D4.2%20LEAC_UAB_140401.pdf

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V. Perdigao i S. Christensen. (2000), The LACOAST atlas: Land cover changes in European coastal zones, Joint Research Centre, Milan.

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Weber, J.-L. (2007), Implementation of land and ecosystem accounts at the European Environment Agency, Ecological Economics, 61(4), p.695-707.

EC - DG.ENV (2013). Mapping and assessment of ecosystems and their services an analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020: discussion paper - final, April 2013. Publications Office, Luxembourg. URL: http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2

013.pdf

Policy Context

ICZM protocol (articles 6 & 8):

The protocol identifies the need of balanced use of coastal zones in several articles. For example, the Article 5 sets the objectives of integrated coastal management:

- to facilitate, through the rational planning of activities, the sustainable development of coastal zones by ensuring that the environment and landscapes are taken into account in harmony with economic, social and cultural development;
- to preserve coastal zones for the benefit of current and future generations;
- to ensure the sustainable use of natural resources, particularly with regard to water use;
- to ensure preservation of the integrity of coastal ecosystems, landscapes and geomorphology.

In Article 6, where general principles of ICZM are discussed, it is highlighted that the formulation of land use strategies, plans and programmes covering urban development and socioeconomic activities, as well as other relevant sectoral policies, shall be required (f). In addition, the Article 6 calls for the allocation of uses throughout the entire coastal zone to be balanced, and unnecessary concentration and urban sprawl to be avoided(h).

Article 8 calls the Contracting Parties to ensure that their national legal instruments include criteria for sustainable use of the coastal zone. Some of such criteria ask for "identifying and delimiting, outside protected areas, open areas in which urban development and other activities are restricted or, where necessary, prohibited" (a). The Article also asks for limiting the linear extension of urban development and the creation of new transport infrastructure along the coast(b).

In addition, the EU's Habitats Directive (92/43/EEC), Birds Directive (2009/147/EC), as well as Convention of Biological Diversity, can also be relevant for policy context regarding land use change.

Policy documents

ICZM Protocol (available in different languages at

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A22009A0204(01))

Convention on Biological Diversity (www.cbd.int)

Habitats Directive (92/43/EEC)

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31992L0043

Birds Directive (2009/147/EC)

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0147

Indicator analysis methods

Parameters:

Different parameters can be considered for evaluation of this indicator, as summed in Table 4. The combined analysis of these parameters entails an inventory of the urbanization pressures on coastal ecosystems. In practice, the parameters can identify: (i) where pressures are higher (by amount of change and by pace of the process); (ii) spatial trends (along the coast and landwards); and (iii) areas for priority action. These processes and the drivers behind them should be locally inturpeted.

Table 4. Description of the parameters calculated for the indicator Land Use Change

Parameter	Units	Data required	Reporting units	Meaning
Area of built-up land in coastal zone as a proportion of the total area in the same unit	% of artificial areas	Artificial surfaces at a single time shot	Coastal zone as defined by the country. Also, coastal strips (<300m, 300m-1km)	State of urban areas at a particular time. This is used as a baseline, i.e. initial condition for the analysis of changes.
Area of built-up land in coastal units as a proportion of the area of built-up land in the wider coastal unit	% of artificial areas	Artificial surfaces at a single time shot	Narrower coastal strips within the wider ones (or even within the whole coastal unit).	This parameter shows to what extent the process of urbanisation has been more intense on the coast than on the inland. It also reflects the relevance of economic activities on the coast as a driver of urban development, and also impacts of such activities (e.g., pressures on biodiversity).

Land take as % of initial urban area on the coastal zone	% of increase of urban areas	Artificial surfaces at t_0 and t_1	Coastal zone as defined by the country. Also, coastal strips (<300m, 300m-1km, 1-10 km)	Intensity of the process of urbanisation in a given period of time.
Change of forest and semi-natural areas	% of change of forest and semi-natural areas	Forest and semi-natural land at t_0 and t_1	Coastal zone as defined by the country. Also coastal strips (<300m*, 300m-1km*)*	This parameter would reflect to what extent management is leading to an increase, maintenance or decrease of forest and semi-natural areas. This represents the land cover closer to "natural land" excluding wetlands (specific indicator). .
Change of wetlands	% of change of wetlands	Wetlands at t_0 and t_1	Coastal zone as defined by the country. Also, coastal strips (<300m, 300m-1km*)*	This parameter will indicate how effective is protection of wetlands in terms of coverage. The indicator could reflect and increase, maintenance or a decrease of wetlands.

Indicator units

The first monitoring will focus on the base line. The indicator units are indicated below:

- km^2 of built-up area in coastal zone;
- % of built-up area in coastal zone;
- % of other land use classes in coastal zone;
- % of built up area within coastal strips of different width (see Table 4) compared to wider coastal units;
- % of other land use classes within coastal strips of different width (see Table 4) compared to wider coastal units.

For second monitoring, the following units will also be relevant:

- % of increase of built-up area, or land take;
- % of change of other land use classes.

Methodology for indicator calculation

Data compilation - Land cover classes needed for the indicator are listed in the Table 5. If more detailed classification is available, then it could be provided making the clear unique link with Table 5.

Table 5. Land cover classes for the Land Use Change indicator

LU/LC class	Definition
Artificial surfaces (also referred as built-up areas)	Surfaces with dominant human influence but without agricultural land use. These areas include all artificial structures and their associated non-sealed and vegetated surfaces. Artificial structures are defined as buildings, roads, all constructions of infrastructure and other artificially sealed or paved areas. Associated non-sealed and vegetated surfaces are areas functionally related to human activities, except agriculture. Also, the areas where the natural surface is replaced by extraction and / or deposition or designed landscapes (such as urban parks or leisure parks) are mapped in this class. The land use is dominated by permanently populated areas and / or traffic, exploration, non-agricultural production, sports, recreation and leisure.
Agricultural	It includes: arable land, permanent crops, pastures and heterogeneous agricultural areas (complex cultivation patterns, land principally occupied by agriculture, with significant areas of natural vegetation).
Forest and semi-natural land	It includes: forests, scrub and/or herbaceous vegetation associations, open spaces with little or no vegetation
Wetlands	Inland marshes, peatbogs, salt marshes, salinas, intertidal flats
Water bodies	Water courses (inc. rivers), water bodies, coastal lagoons, estuaries, sea and ocean.

Data processing

Data processing includes the following steps (Figure):

(i) Pre-processing

Land use data could be available in two formats: vector data (polygons) or raster data (grid). For practical reasons, and to simplify the computing process, the first step is to ensure that all the data is in a grid of 1 km x 1km. Most of the GIS software provides different options to convert vector data into a grid. Here the 'Maximum area' criterion is suggested as one of the most standard methods.

(II) Combining data

Once the data is available in 1 km x 1 km grid, the different layers are combined automatically by any GIS software and create an associated table with all the information available for each cell in the grid. The layers to be combined are listed as follows:

- baseline land cover data (y0);
- land cover change data (y0-y1);
- delimitation of coastal zone;
- administrative unit where the coastal zone belongs (NUTS3 or equivalent)

Therefore, the minimum information available on the resulting table is as follows:

- Grid ID. Unique identifier for each cell in the grid of 1 km x 1 km.
- Coastal zone. Yes/No. Boolean parameter that indicates if the cell is within the coastal zone, as defined by the country.
- Administrative unit. Code that identifies the administrative unit where the cell is located (NUTS3 of equivalent).
- Land cover class at t_0. Code for the land cover class of the cell.

(iii) Extracting statistics

As a result of the previous step, a table should be available with the unique code of each cell of the 1 km x 1 km grid and all related parameters. Therefore, the extraction of the statistics for the calculation of the indicator could be done in a spreadsheet and does not require any GIS processing (see Data analysis and assessment outputs section for the details).

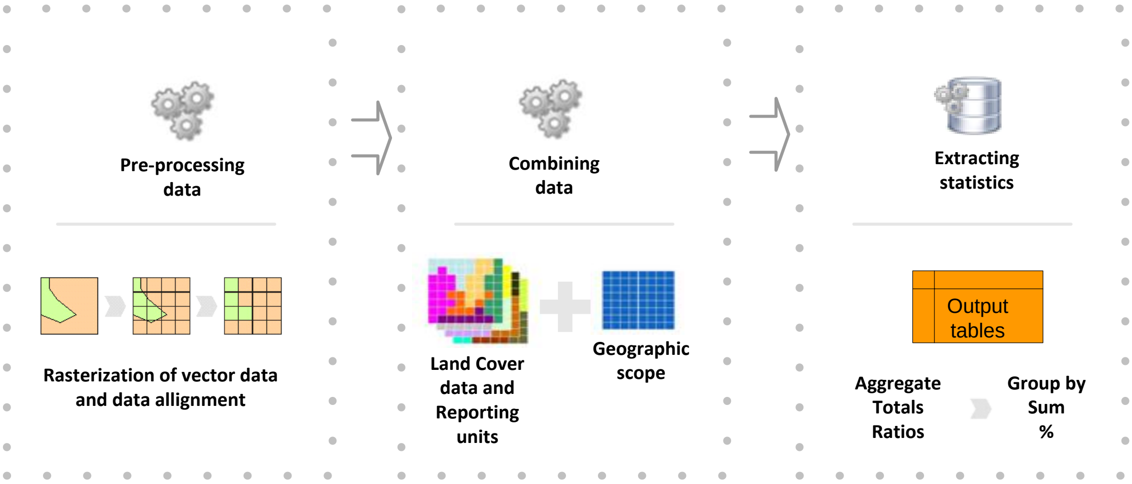

Figure 4. Data processing for the Land Use Change indicator

Further details on the methodological approach can be found in ***Anex 3: How to implement the EO8 Land Use Change indicator? Illustrated User Guide***

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

The most elaborated guidelines are available from the Corine Land Cover programme (currently integrated in the Copernicus Programme).

http://www.eea.europa.eu/publications/technical_report_2007_17

Spatial scope guidance and selection of monitoring stations

The Mediterranean ICZM Protocol defines the landward limit of coastal zone as the "limit of the competent coastal units, as defined by the Parties" (Article 3). In other words, the landward limit will be country-specific, e.g., dependant on definition given by certain Contracting party when ratifying the Protocol.

The resolution of the source data is a "compromise between precision and efforts needed in processing the satellite images". The following indications could be considered as minimum requirements:

- minimum mapping unit of 25 ha and 100 m of linear elements;
- minimum change detection 5 ha.

Temporal Scope guidance

The temporal scale should be 5 years, in order to be effective on the counteracting negative effects and taking early actions on problematic areas.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

The statistics can be computed as follows:

- Percentage of built-up area in coastal zone:
    1) Filter the data by the grids belonging to the coastal zone.
    2) Calculate total area by counting the total number of cells. This is the area in km^2.
    3) Filter, within the coastal zone, by land use "artificial areas" (see Table for the definition of land use classes).
    4) Calculate area of "artificial areas" by counting the number of cells. This is the area in km^2.
    5) Divide 4 by 2 in order to obtain the percentage of artificial area on the coastal zone.
- Percentage of other land use classes on the coastal zone. As complementary to "Percentage of built-up area in coastal zone", the same procedure could be applied to each land use class as defined in Table :
    1) Area of built-up land in coastal units as a proportion of the area of built-up land in the wider reference region.
    2) Filter the data by the grids belonging to the entire administrative unit where the coastal zone belongs (NUTS3 or equivalent).
    3) Filter by land use "artificial areas" (see Table for the definition of land use classes).
    4) Calculate area of "artificial areas" by counting the number of cells. This is the area in km^2.
    5) Sum 4 from "Percentage of built-up area in coastal zone" with 3 (obtained in previous step).
    6) Divide 4 from "Percentage of built-up area in coastal zone" by 4 (previous step). This value is the percentage of built-up area within the administrative unit that is located on the coastal zone.
- Land take as % of initial urban area on the coastal zone. This parameter will start to be computed on the second monitoring since the first monitoring focus only on the baseline (state at t_0):
    1) Filter the data by the grids belonging to the coastal zone.
    2) Calculate total area by counting the total number of cells. This is the area in km^2.
    3) Filter, within the coastal zone, by land use "artificial areas" (see Table for the definition of land use classes) for t_0.
    4) Filter, within the coastal zone, by land use "artificial areas" (see Table for the definition of land use classes) for t_1.
    5) Calculate 4-3 and divide by 3. This provides the percentage of land take compared to the initial built-up area.
- Change of forest and semi-natural land. This parameter will start to be computed on the second monitoring since the first monitoring focus only on the baseline (state at t_0):
    1) Filter the data by the grids belonging to the coastal zone.
    2) Calculate total area by counting the total number of cells. This is the area in km^2.
    3) Filter, within the coastal zone, by land use "Forest and semi-natural land" (see Table for the definition of land use classes) for t_0.
    4) Filter, within the coastal zone, by land use "Forest and semi-natural land" (see Table for the definition of land use classes) for t_1.

5) Calculate 4-3 and divide by 3. This provides the percentage of change of forest and semi-natural areas for the given period.

- Change of wetlands. This parameter will start to be computed on the second monitoring since the first monitoring focus only on the baseline (state at t_0):
  1) Filter the data by the grids belonging to the coastal zone.
  2) Calculate total area by counting the total number of cells. This is the area in km^2.
  3) Filter, within the coastal zone, by land use "Wetlands" (see Table for the definition of land use classes) for t_0.
  4) Filter, within the coastal zone, by land use "Wetlands" (see Table for the definition of land use classes) for t_1.
  5) Calculate 4-3 and divide by 3. This provides the percentage of change of wetlands for the given period.

The above-mentioned analysis can be complemented with the following ones that provide additional insight on the land use indicator.

- Optional analytical units:
  1) Setback zone (if defined in the country). Given the relevance of this part of the coastal area, as referred on the ICZM protocol, the indicators on % of built-up and land take can be analysed for this specific zone.
  2) Elevation breakdown within the coastal area. Distance to the coast and elevation are elements that configure different habitat distribution and patterns. With available local knowledge 3 to 5 elevations classes could be considered to be analysed independently within the coastal area in order to better link the pressure of land take to specific habitats. An example follows: < 50 m asl, 50 – 300 m, >300 m.
- Additional parameters: What has been lost by urbanisation?
  1) Filter the data by the grids belonging to the coastal zone.
  2) Calculate total area by counting the total number of cells. This is the area in km^2.
  3) Develop a pivot table with land cover classes at t_0, on rows, and land cover classes at t_1 on columns. Cells in this matrix will contain the area that has changed from certain land cover class at $t_0$to a new class in t_1.
  4) Select the column for "Built-up areas".
  5) Values on the rows indicate the different land cover classes at t_0 that have been converted into built-up area.
  6) Values from 5 can be divided by the corresponding area of the same class at t_0. This will provide the percentage of certain land cover class that has been converted into built-up.

Expected assessments outputs

The outputs are detailed below:

- Digital map with the land cover classes for the coastal area. Land cover classes should follow the classification provided in Table 5. If more detailed classification is available, then it could be provided making the clear link with Table 5. The following specifications will ensure the interoperability of the maps provided by different institutions/countries:
  1) Format: raster GeoTIFF (Geographic Tagged Image File Format) 1 km x 1km.
  2) Metadata:
     I. title of the map;
        a. geographic reference;
        b. bounding box.
     II. coordinate reference system;
     III. temporal reference (year);
     IV. responsible organisation.
- Spreadsheet with the calculated indicators as described in the methodology.
- Starting with the second monitoring, additional maps will be provided indicating areas of land take (new urbanisation). The specifications for these maps are the same as indicated above.

Available data sources - Global

The data sources listed below are transnational data bases (the first one only European, the rest global). Existing national data (official) is also suitable for this indicator.

Corine land Cover (only European coverage) http://land.copernicus.eu/pan-european/corine-land-cover GlobCover. Global land cover dataset at 300m resolution from the MERIS sensor on the ENVISAT satellite. http://due.esrin.esa.int/page_globcover.php Climate Change Initiative Land Cover map. Global land cover dataset at 300m resolution, for 1998-2002, 2003-2007, 2008-2012. http://maps.elie.ucl.ac.be/CCI/viewer/index.php GLC-SHARE: Global Land Cover data combined from 'best available' national land cover maps. 1km resolution. http://www.fao.org/geonetwork/srv/en/main.home?uuid=ba4526fd-cdbf-4028-a1bd-5a559c4bff38 **Available data sources - Local** See Table 4.
List of Guidance documents and protocols available Pilot project in the Adriatic on testing the candidate common indicator 'Land use change' in the Mediterranean, by: Anna Marín. Raquel Ubach. and Jaume Fons-Esteve. Coordinated by: Marko Prem, PAP/RAC. URL: http://www.pap-thecoastcentre.org/pdfs/Pilot%20Adriatic_Final_Sep2015.pdf
Data confidence and uncertainties The definition of the analytical units of the coastal zone could be revised in view of more detailed data on habitats distribution, or input from national experts. In any case, it is important to take into account the implications of the different delineations on the interpretation of the results. The use of remote sensing and the selected resolution is the main constrain when analysing the outcomes: • Not all changes are observed, since there is minimum change detection. Therefore, the patterns observed indicate that changes are underestimated. In any case, the proposed approach is still relevant since it provides an idea of the magnitude of the processes of urbanization. • Given the resolution and processing, linear elements are not well captured; therefore linear elements perpendicular to the coast, for example, are not detected. • The information currently available does not allow identifying built-up on the territorial waters. Since these limitations arise from the definition of the resolution, there is space for improvement if it is needed. However, there is always a trade-off between resolution and efforts required to obtain the information. In addition, countries may obtain data from different sources (different resolution, different level of precision), which may make comparability of data difficult.