GROWTH AND INNOVATION IN OCEAN ECONOMY

GAPS AND PRIORITIES IN SEA BASIN OBSERVATION AND DATA

D4.3.5 MedSea Checkpoint Challenge 4 (Oil Platform Leak): Description of Targeted Products, the methodology and the expert evaluation of fitness for purpose

Total number of pages: 34

Workpackage:	**4**	**Challenge 3: Oil Platform Leak**	
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Glossary

CMEMS	Copernicus Marine Environment Monitoring Service
MFS	Mediterranean Forecasting System
OPL	Oil Platform Leak
SST	Sea Surface Temperature

Executive Summary

This document illustrates the EMODnet Oil Platform Leaks (OPL) Bulletin, which is the **Targeted Product** of Challenge 3. The EMODnet OPL Bulletin simulates the fate and transport of oil leaks from platforms. The oil movement from the platform is simulated for a week after the release and the bulletin can be updated at the customer's request. Possible impacts on the coasts are also considered. The EMODnet OPL Bulletin is issued every time a request arrives and is released within 24 hours of the alert using a pre-defined template. The customer (the EC and other users allowed by the EC) supplies the specific data through an online input data form.

General scope of the Targeted Products

The scope of the challenge 3 OPL is to provide rapid information on the movement of oil and its coastal impact after a DGMARE request. The EMODNet OPL Bulletin was implemented to fulfil this scope.

The EMODNet OPL Bulletin contains the oil spill forecast maps for a specific oil spill leak scenario. The bulletin must be released within 24 hours, with the simulation results and confidence limits and the following data layers:

1) maps of the surface, subsurface and on-coast oil concentration,
2) winds and currents maps, and
3) seabed habitats and type of coast impacted.

Within 72 hours, a new bulletin should be issued with an updated oil spill forecast using the updated meteo-oceanographic forcing fields. This new bulletin should also include a comparison between the simulated oil slick and the oil slick observed by satellite, if this information is available from EMSA within 72 hours of the leak.

Targeted Products catalogue for this Challenge

Name of Targeted Product	Short description	Format
MEDSEA_CH3_Product_1	OPL Bulletin produced after the DG MARE request received by email on 28 July 2014	pdf
MEDSEA_CH3_Product_2	OPL Bulletin produced after the DG MARE request received by email on 10 May 2016	pdf

Description of Characteristics and Data sources used by Targeted products

The data inputs needed for the production of the EMODnet-OPL Bulletin are described in full in deliverable D4.1 (last version 27/06/2014). The production of the Bulletin relies on the availability of high-resolution meteo-oceanographic forecasts and analyses for the Mediterranean Sea (including winds, currents, Stokes drift and SST) provided through the CMEMS portal and other national and experimental forecasting systems.

The **input characteristics** are as follows:

- horizontal velocity of the water column (currents),
- sea surface water temperature,
- wind velocity components,
- wave direction, and
- wave height and period statistis.

Additional data sets are required to evaluate the impacts of oil spills on human activities, the environment and coastal habitats (seabed habitats and geology). These **input characteristics** are:

- bathymetry and elevation,
- coastal geomorphology,

- seabed substrate,
- marine and coastal infrastructures,
- mariculture,
- Marine Protection Areas (MPAs),
- transport routes, and
- use of coastal areas.

Most of these characteristics were identified in EMODnet portals.
The OPL Bulletin also relies on specific **input data** on oil platform leaks:

- oil platform position (lat, lon),
- date and time of the leak,
- type of oil (API or oil type name),
- rate of spillage or total amount of oil spilled,
- slick satellite observations provided by EMSA (optional, if available), and
- simulation length.

These specific input data are supplied by the customer, the EC, through a request by e-mail to emodnet-opl-Bull@ingv.it, or using the input data form at http://www.emodnet-mediterranean.eu/bulletin_form/.
The following table summarizes the **characteristics** and **data sources** that were actually used to generate the CH3 Targeted Products.

MEDSEA_CH3_Product_1

Nb	Characteristic name (P02)	Environmental Matrix	Data source (URL)
1	**Bathymetry and elevation**	Seabed-riverbed	http://www.gebco.net/
2	**Wind speed and direction**	Air	**European Centre for Medium-Range Weather Forecasts** http://www.ecmwf.int/
3	**Wind speed and direction**	Air	**Cyprus Oceanography Center** SKIRON meteorological model http://www.oceanography.ucy.ac.cy
4	**Wind speed and direction**	Air	**Hellenic Centre for Marine Research** POSEIDON meteorological model http://www.hcmr.gr
5	**Horizontal velocity of the water column (currents)**	Marine water	**CMEMS Mediterranean Sea Physics Analysis and Forecast** http://marine.copernicus.eu/web/69-interactive-catalogue.php?option=com_csw&view=details&product_id=MEDSEA_ANALYSIS_FORECAST_PHYS_006_001_a
6	**Sea-surface water temperature**	Marine water	**CMEMS Mediterranean Sea Physics Analysis and Forecast** http://marine.copernicus.eu/web/69-interactive-catalogue.php?option=com_csw&view=details&product_id=MEDSEA_ANALYSIS_FORECAST_PHYS_006_001_a

7	**Wave height and period statistics** – average zero crossing period of waves	Marine Water	**Cyprus Oceanography Center** **Data provider website** CYCOFOS WAM4 wave model Mediterranean http://www.oceanography.ucy.ac.cy
8	**Wave height and period statistics** – P01 significant height of waves	Marine Water	**Cyprus Oceanography Center** **Data provider website** CYCOFOS WAM4 wave model Mediterranean http://www.oceanography.ucy.ac.cy
9	**Wave direction**	Marine Water	**Cyprus Oceanography Center** **Data provider website** CYCOFOS WAM4 wave model Mediterranean

MEDSEA_CH3_Product_2

N	Characteristic name (P02)	Environmental Matrix	Data source (URL)
1	**Bathymetry and elevation**	Seabed-riverbed	http://www.gebco.net/
2	**Wind speed and direction**	Air	**European Centre for Medium-Range Weather Forecasts** http://www.ecmwf.int/
3	**Wind speed and direction**	Air	**Cyprus Oceanography Center** SKIRON meteorological model http://www.oceanography.ucy.ac.cy
4	**Horizontal velocity of the water column (currents)**	Marine water	**CMEMS Mediterranean Sea Physics Analysis and Forecast** http://marine.copernicus.eu/web/69-interactive-catalogue.php?option=com_csw&view=details&product_id=MEDSEA_ANALYSIS_FORECAST_PHYS_006_001_a
5	**Sea-surface water temperature**	Marine water	**CMEMS Mediterranean Sea Physics Analysis and Forecast** http://marine.copernicus.eu/web/69-interactive-catalogue.php?option=com_csw&view=details&product_id=MEDSEA_ANALYSIS_FORECAST_PHYS_006_001_a
6	**Wave height and period statistics** – P01 average zero crossing period of waves	Marine Water	**Cyprus Oceanography Center** **Data provider website** CYCOFOS WAM4 wave model Mediterranean http://www.oceanography.ucy.ac.cy

7	**Wave height and period** statistics – P01 significant height of waves	Marine Water	**Cyprus Oceanography Center** **Data provider website** CYCOFOS WAM4 wave model Mediterranean http://www.oceanography.ucy.ac.cy
8	Wave direction	Marine Water	**Cyprus Oceanography Center** **Data provider website** CYCOFOS WAM4 wave model Mediterranean
9	Bathymetry and elevation	Seabed - riverbed	http://portal.emodnet-bathymetry.eu/
10	Seabed substrate	Biota-biology	coralligenous habitat maerl habitat Posidonia Oceanica http://www.emodnet-seabedhabitats.eu/
11	Administrative units (MPAs)	Marine Water	http://www.emodnet-mediterranean.eu/medsea-challenge-2-product-1/
12	Biological zones	Biota-biology	http://www.emodnet-mediterranean.eu/medsea-challenge-2-product-1/

Description of method used to produce the Targeted Products

MEDSEA_CH3_Product_1

The first Bulletin was issued within 24 hours from the receipt of the Input Data Form. A new Bulletin was issued with an updated oil spill forecast within 72 hours, using the updated forecast provided by the CMEMS service and the MEDESS4MS multi-model system.

The OPL Bulletin request was received on 28 July 2014, with the following statement:
"The drillship 'Magna Belgica' in the wider area of 'Caliph prospect' off the coast of Libya encountered a technical failure. A fire and crude oil leak began immediately. The spill was contained for the duration of 5 hours with total of 50 tons crude oil loss at sea surface.
After initial repairs the vessel set sail for inspection in Naples. Reaching the strait of Messina around 06:15 CET this morning, the drillship experienced engine and rudder failure leading to a collision with a cargo ship. The drillship was heavily damaged and lost a total load of 2000 tons of diesel fuel oil by 10:20 CET."

Table 1 summarizes the initial assumptions that were made to predict the fate and transport of the two oil leaks communicated by the customer.

Spill n.1: Caliph Prospect. The position of the oil spill should coincide with the drillship's position at LAT = 33° 13.58' N, LON= 15° 54.30' E, in the proximity of the 'Caliph prospect' off the coast of Libya. The overall amount of crude oil released is set to 500 tons. The oil is released as a continuous oil spill over a 5-hour period from the beginning of the simulation. The bulletin request identified the oil in the Caliph prospect accident as crude oil, which has the following API values:

- light crude oil API > 31.1,
- medium crude oil 22.3<API<31.1,
- heavy crude oil API<22.3,
- extra heavy crude oil API<10.

INGV considered an intermediate API value of 26, while UCY considered an API value of 33.

Spill n.2: Messina Strait. The position of the oil spill should coincide with the ship's position at LAT = 38° 14.84' N, LON = 15° 37.94' E. The overall amount of crude oil released is set to 2000 tons. The oil is released as a continuous oil spill over a 4-hour period from the beginning of the simulation. The bulletin request identified the oil in the Caliph prospect accident as diesel fuel oil. INGV considered an intermediate API value of 40, while UCY considered a value of 33, equal to the first spill.

	SPILL n. 1: Caliph prospect	SPILL n.2: Messina Strait
Oil drillship position	LAT = 33° 13.58' N LON= 15° 54.30' E	LAT = 38° 14.84' N LON = 15° 37.94' E
Start date and time (UTC) of the leak	27 July 2014 at 05:05:45	28 July between 06:15:00 and 10:20:00
Type of oil	Crude oil API 26 (**SCENARIO 1**) API 33 (**SCENARIO 2-3-4**)	Diesel fuel oil API 40 (**SCENARIO 1**) API 33 (**SCENARIO 2-3-4**)
Duration of spillage	5 hours	Oil spill from 6:15 to 10:20 (4 hours)
Rate of spillage	10 tons/hour	
Total amount of oil spilled	50 tons	2000 tons

Table 1 Initial assumptions made to predict the fate and transport of the two oil spills, Caliph Prospect and Messina Straight, following the customer request on 28 July 2014.

In response to the customer's request, the four scenarios summarized in Table 2 were run, each considering different

- oil spill models,
- wind,
- currents and SST, and
- waves.

The scenarios are from different models and have different space-time resolutions and forecast temporal horizons (number of days predicted). Currents, sea surface temperature, waves and wind forecasts were updated every day.

SCENARIO	1	2	3	4
Production Centre	INGV	OC-UCY	OC-UCY	OC-UCY
Oil spill model	MEDSLIK II	MEDSLIK	MEDSLIK	MEDSLIK
WIND	ECMWF	SKIRON	ECMWF	POSEIDON
temporal resolution	6	1	24	1
spatial resolution	25	5	25	5
days of forecast	5	10	10	5
update frequency	1	1	1	1
CURRENTS and SST	CMEMS	CMEMS	CMEMS	CMEMS
temporal resolution	1	24	24	1
spatial resolution	6.5	6.5	6.5	6.5
days of forecast	5	10	10	5
update frequency	1	1	1	1
WAVES		CYCOFOS		CYCOFOS
temporal resolution		3		1
spatial resolution		5		5
days of forecast		5		5
update frequency		1		1

Table 2 Prediction systems implemented to produce the OPL Bulletin results.

The outputs from two oil drift and transformation models were used to produce the **EMODnet OPL Bulletin**.

1. **MEDSLIK** (OC-UCY) predicts the expected state of the oil in 3D scale for a given period after a spill, including the amount of evaporation, the degree of emulsification, the viscosity change, the amount that will have been vertically dispersed as fine droplets, the likely position of the spill, the time to reach that position and the coastal adhesion. MEDSLIK handles the release from the surface and from the bottom.
2. **MEDSLIK-II** (INGV) is another oil prediction model that considers the transport, dispersion and transformation processes from a surface release. MEDSLIK-II is an evolution of MEDSLIK and shares same of its basic processes. The model was validated using surface drift data, satellite data and in-situ data from different Mediterranean regions. The model has been also used to provide timely information on oil spill evolution forecasting during several emergency cases in the Mediterranean Sea, and is used by REMPEC (Barcelona Convention) and by the Operations Centre of the Italian Coast Guard.

Two bulletins were produced for the two spills considering **SCENARIO N.1** (see Table 2):

1. EMODNET_OPL_Bulletin_SPILLn1_SCENARIOn1.pdf
2. EMODNET_OPL_Bulletin_SPILLn2_SCENARIOn1.pdf

The first scenario relies on the MEDSLIK-II oil spill model to calculate the advection, turbulent diffusion and transformation processes of the oil. The model produces an hourly forecast of the oil concentration distribution (the bulletins present the oil concentration at 24-hour intervals). These two bulletins use the forecast produced by the CMEMS Mediterranean Forecasting System (MFS) ocean model with an hourly temporal resolution and 6.5-km spatial resolution, together with the wind data from the European Centre for Medium Range Weather Forecasting Centre (ECMWF) with a 6-hour temporal resolution, 25-km spatial resolution and 10-day temporal horizon. The CMEMS-MFS hourly forecast data have a temporal horizon of 5 days. The MEDSLIK-II oil spill model has the advantage of hourly current data, which significantly increases the accuracy of the oil spill simulations. However, the oil spill forecast is limited to 5 days (120 hours) because of the limitation of the temporal horizon of the CMEMS-MFS hourly input data.

Figure 1 shows the results from **SCENARIO n.1** applied to **SPILL n.1** at Caliph Prospect. Surface currents were north-eastward and reached a velocity of 0.2 m/s in the proximity of the drillship position (a); the wind was south-westerly and reached a velocity of 1.6 m/s. After 48 hours (c), the surface currents were meanly north-westward (0.1 m/s); the wind was north-easterly and its intensity was about 1.8 m/s. The oil spread south-westward. After 96 hours (e), the surface currents were divergent around the oil slick and weak (~0.03 m/s); the wind was north-easterly with an intensity of about 4 m/s. The oil continued to spread northward.

Figure 2 shows the results from **SCENARIO n.1** applied to **SPILL n.2** in the Messina Strait. After 92 hours, almost all of the released, non-evaporated oil arrived at both coasts of the Strait of Messina. Figure 3 illustrates the average percentage of oil in the area in four categories:

1. evaporated,
2. at the sea surface.
3. dispersed in the water column, and
4. on the coasts.

Due to the light oil (API=40), 50% of the oil evaporated in the first 6-7 hours and attached to the coasts after 40 hours. Re-detachment of the oil from the coasts was evident from 42 to 75 hours.

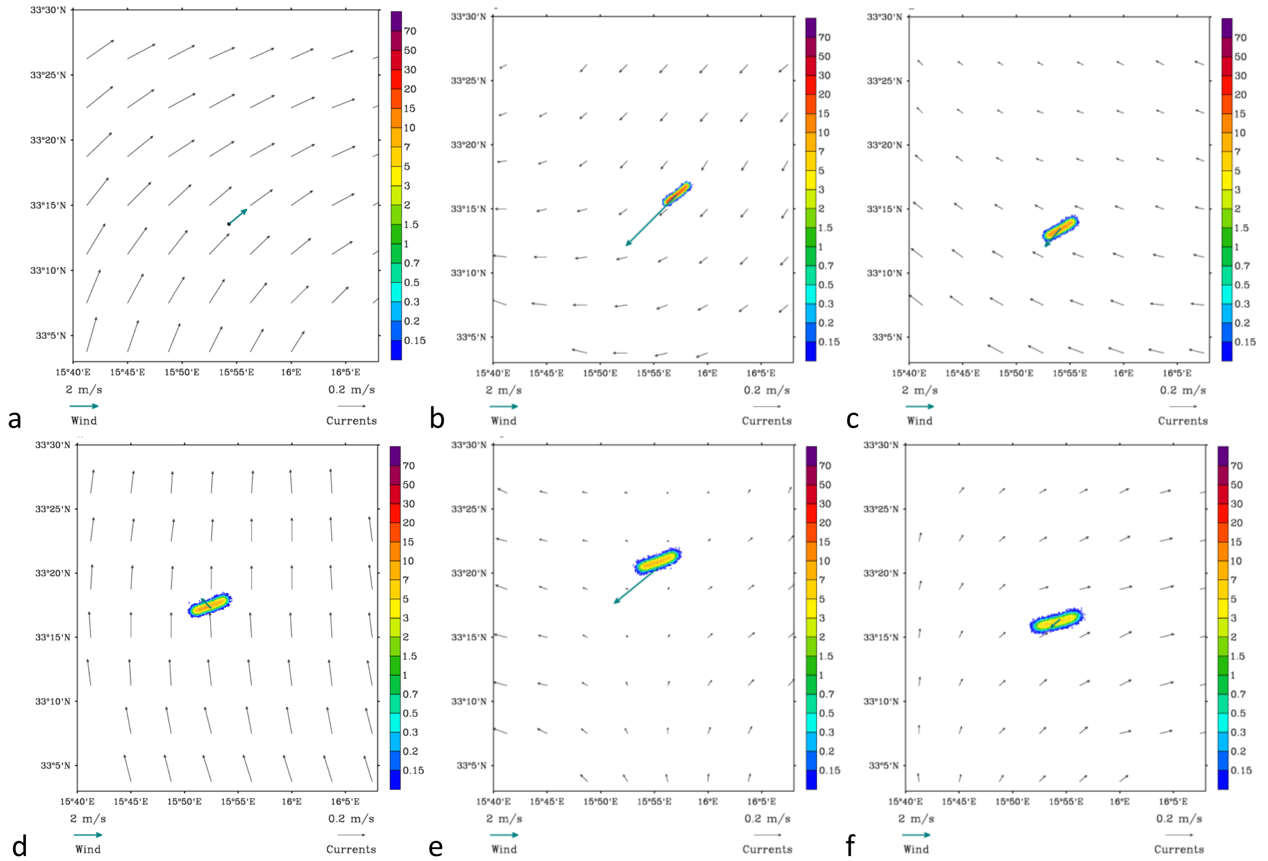


Figure 1. Results from the **SCENARIO N.1** applied to **SPILL n.1** at Caliph Prospect: surface currents (black arrows), wind (green arrow) and oil concentration [ton/km2]. a) The black dot represents the release point at 05:00 CET on 27/07/2014; b) position of the oil slick at 05:00 on 28/07/2014; c) position of the oil slick at 05:00 on 29/07/2014; d) position of the oil slick at 05:00 on 30/07/2014; e) position of the oil slick at 05:00 on 31/07/2014; f) position of the oil slick at 05:00 on 01/08/2014.

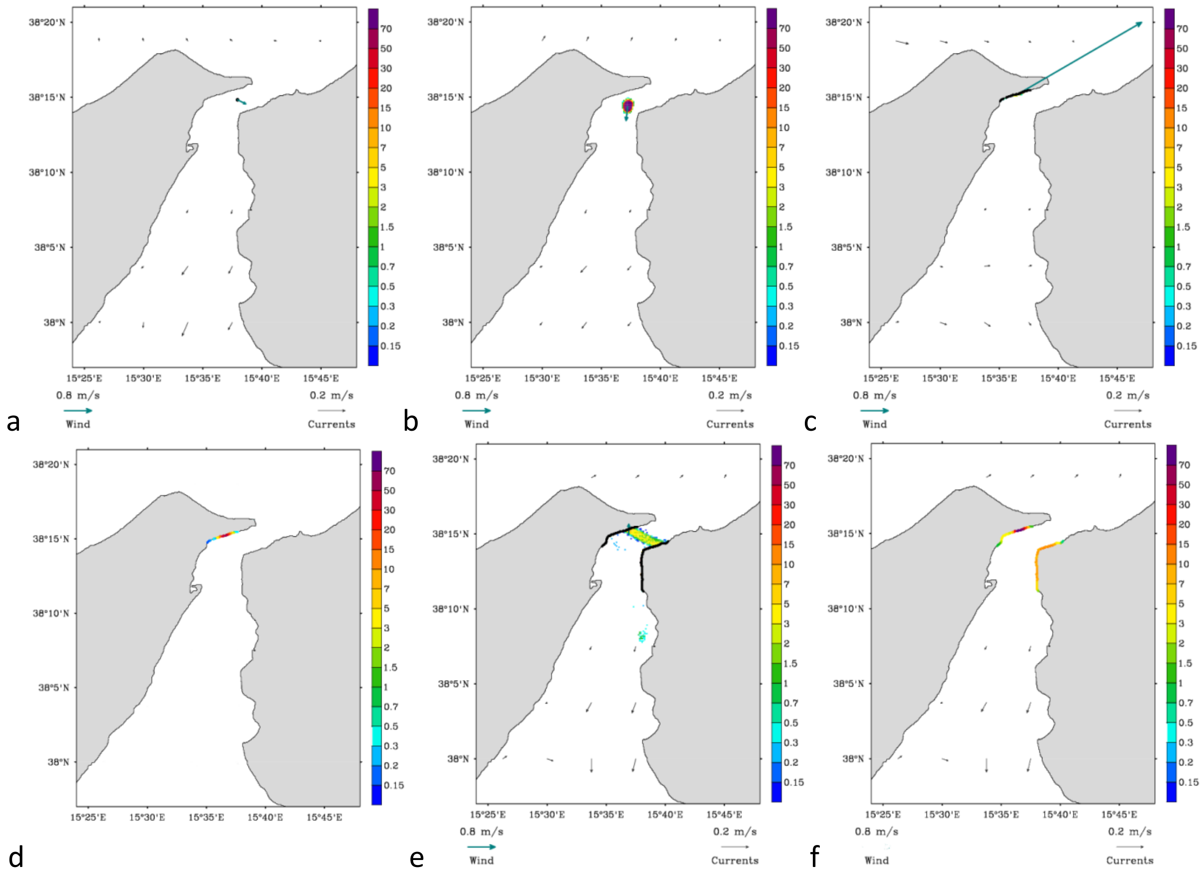


Figure 2. Results from **SCENARIO N.1** applied to **SPILL n.2** in the Messina Strait: surface currents (black arrows), wind (green arrow) and oil concentration [ton/km2]. a) The black dot represents the position of the ship at 06:00 CET on 28/07/2014; b) position of the oil slick at 06:00 on 29/07/2014; c) position of the oil slick at 06:00 on 30/07/2014; d) position of the oil slick at 06:00 on 31/07/2014; e) position of the oil slick at 06:00 on 01/08/2014; f) position of the oil slick at 06:00 on 02/08/2014.

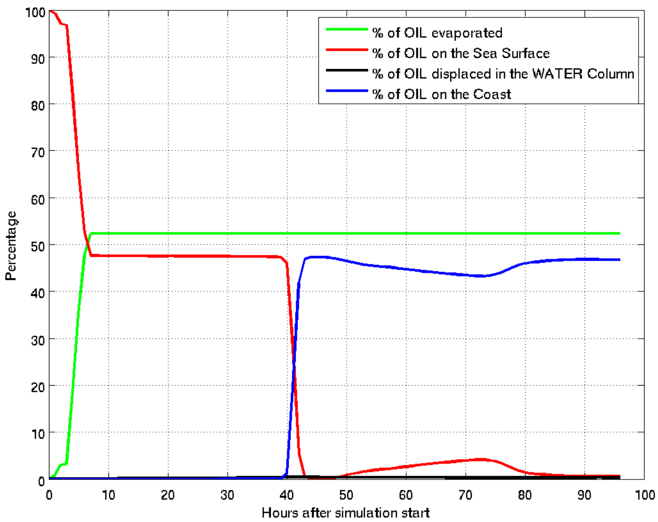


Figure 3. Percentage of oil in four categories: on the surface, dispersed in the water column, evaporated and on the coasts, as a function of the model simulation.

One bulletin was produced in parallel by OC-UCY, containing predictions of the two spills under three different scenarios (see Table 2, scenarios n.2, n.3 and n.4): EMODNET_OPL_SPILLn1n2_SCENARIOn2n3n4.pdf. The MEDSLIK oil spill model was used to calculate the advection, turbulent diffusion and transformations processes of the oil. The three scenarios differ in terms of the currents, SST, waves and wind data used to run the oil spill model.

Scenario n.2 (Table 2) was produced using the SKIRON wind data, which has a temporal resolution of 1 hour, spatial resolution of 5 km and a temporal horizon of 5 days (see Table 2). The added value of the first scenario is the use of hourly winds, which significantly increases the accuracy of the oil spill simulations. However, the temporal horizon of the SKIRON hourly forecast data limits the oil spill forecast to 5 days.

Scenario n.3 (Table 2) differs from the first scenario in terms of the wind forcing used. The ECMWF wind forecast was used, which made it possible to provide a 10-day bulletin because both the ECMWF wind data and CMEMS MFS daily current data are available for the next 10 days. In this case, wave fields were not used as input.

Scenario n.4 (Table 2) differs from the first and second scenario in terms of the currents used. CMEMS-MFS hourly current data and POSEIDON wind data were used, both of which are available for 5 days.

A 5-day forecast for SPILL n.1, SCENARIO n.2 at Caliph Prospect showed that about 42% of the oil evaporated in the first 8 hours and the rest remained floating on the surface. There was no further significant evaporation but the surface oil dispersed slowly. About 1.5% had dispersed into the water column after 5 days. None reached the coast. The calculation for SCENARIO n.3 showed similar trends for the amount of oil that was dispersed, evaporated and reached the coast. Figure 4 shows the forecast movement of SPILL n.1 for the three scenarios considered. The oil spill movement was significantly different, but no oil reached the coast in all three cases.

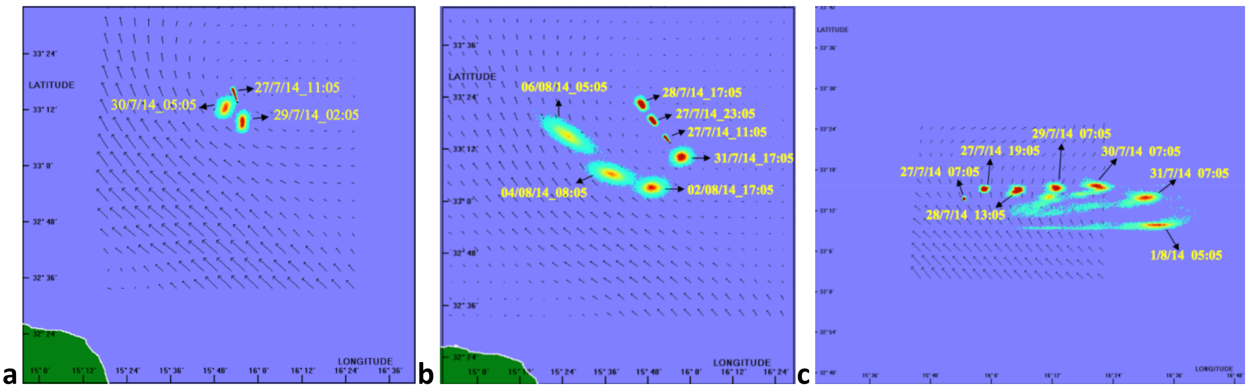


Figure 4. Movement of the spill for **SPILL n.1** at Caliph Prospect considering the three scenarios outlined in **Table 2**: a) **SCENARIO n.2**; b) **SCENARIO n.3**; c) **SCENARIO n.4**.

Figure 5 presents the results of SCENARIOS 2, 3 and 4 in case of SPILL n.2. After 6 hours, almost 25% of the oil had evaporated but the rest of the slick hit the Sicilian coast. Only 2% was left on the water. The calculation using the ECMWF wind forecast (SCENARIO n.3) showed rather different behaviour. A similar amount of oil (75%) hit the coast before evaporating, but the oil was more widely spread than when using the SKIRON wind forecast (SCENARIO n.2). Instead of remaining in one continuous agglomeration along the Sicilian coast, it spread out and some reached the mainland.

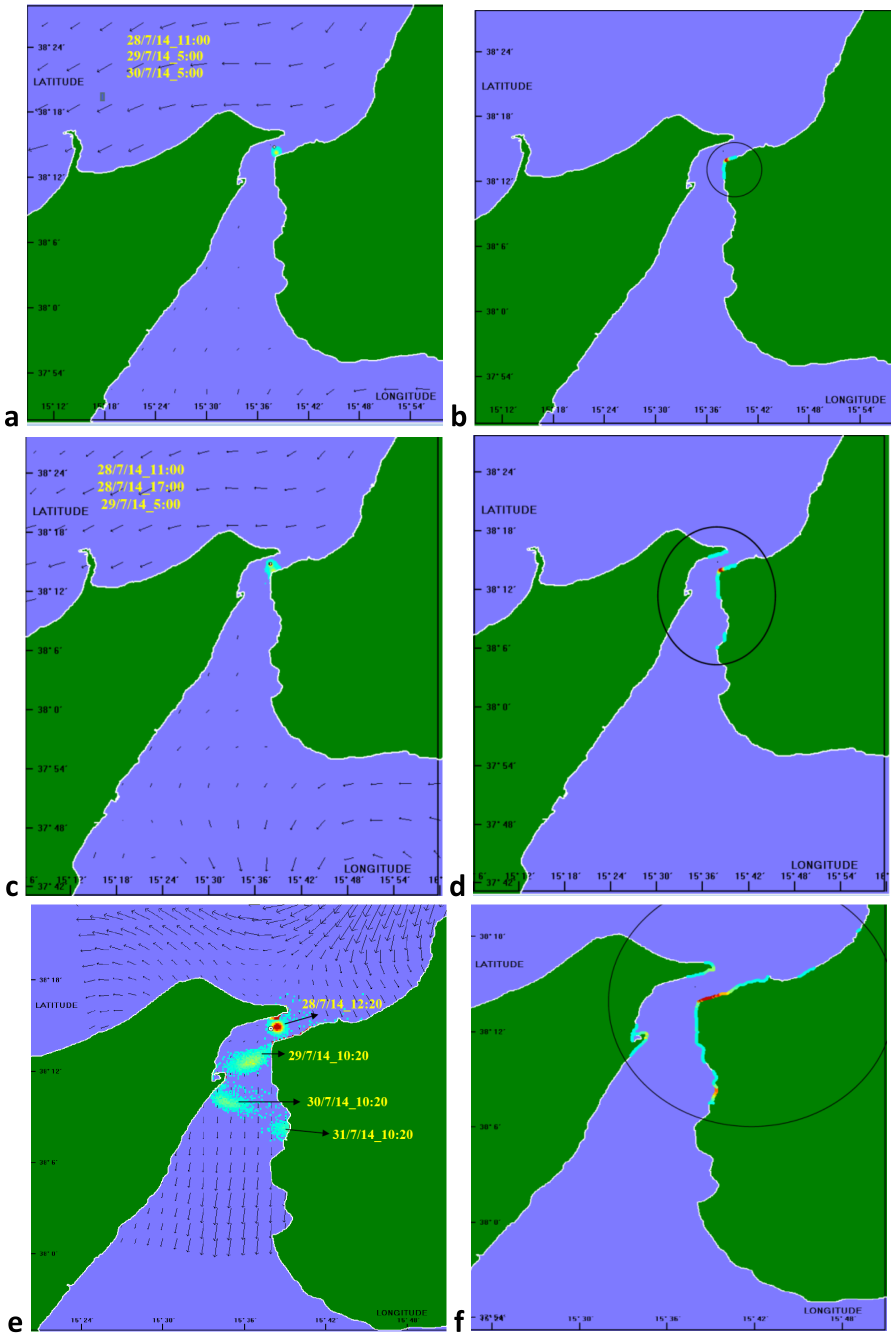


Figure 5. Results for **SPILL n.2** in the Messina Strait: **a) SCENARIO n.2,** superimposition of slick forecasts at 11:00 on 28/7/2014, 5:00 on 29/7/2014 and 5:00 on 30/7/2014; **b)** SCENARIO n.2, oil on coast after 2 days; **c) SCENARIO n.3** superimposition of slick forecast at 11:00 on 28/7/2014, 5:00 29/7/2014 and 5:00 on 30/7/2014; **d)** SCENARIO n.3, oil on coast after 9 days; **e) SCENARIO n.4** superimposition of slick forecast at 11:00 on 28/7/2014, 5:00 on 29/7/2014 and 5:00 on 30/7/2014; **f)** SCENARIO n.4, oil on coast after 5 days.

MEDSEA_CH3_Product_2

On 10 May 2016 at 11.23, DGMARE issued the following announcement (Figure 6):
"In August 2013 an incident occurred during a tanker loading operation at a buoy off the coast of the Sidi Kerir terminal of the Sumed pipeline (LAT: 31,130824N; LON: 29,75227E) with an estimated rate of 5000 m3 Brent crude oil spilled during a period of 24 hours starting 8:15 CET on 13/08/2013. The accident went largely unattended in the aftermath of the 2013 Egyptian Coup d'état during a period of unrest and instability."

The bulletin was produced within 24 hours after the DGMARE request. The bulletin simulated the transport and transformation of the oil in the days following the incident and the likely impact on the environment, considering the availability of forcing data sets for wind and current fields to run MEDSLIK and MEDSLIK-II simulations. Daily updates (each morning before 11:00 CET) were also provided to inform interested stakeholders.

Figure 6: Release point of the oil spill (LAT: 31,130824; LON: 29,75227).

Table 3 summarizes the input data used to run the oil spill models.

INITIAL ASSUMPTIONS	
OIL TYPE	Brent crude oil (API=38)
LEAK POSITION	LAT:31,130824 LON: 29,75227
TIME OF THE LEAK	8:15 CET on 13/08/2013
DURATION OF SPILLAGE	24 hours
RATE OF SPILLAGE	177 Ton/hr
TOTAL AMOUT OF OIL SPILLED	5000m3

Table 3 Oil spill model set up parameters

The production of the OPL Bulletin relies on the availability of meteo-oceanographic analyses for the Mediterranean Sea provided through the CMEMS (Copernicus Marine Environment Monitoring Service) portal and other national forecasting systems. The necessary input characteristics are:

- horizontal velocity of the water column (currents),
- sea surface water temperature,
- wind velocity components, and
- wave direction (not compulsory).

Two SCENARIOS were simulated, one at INGV and one at OC-UCY. Table 4 summarizes the forcing datasets used for the OPL Bulletin in the two systems.

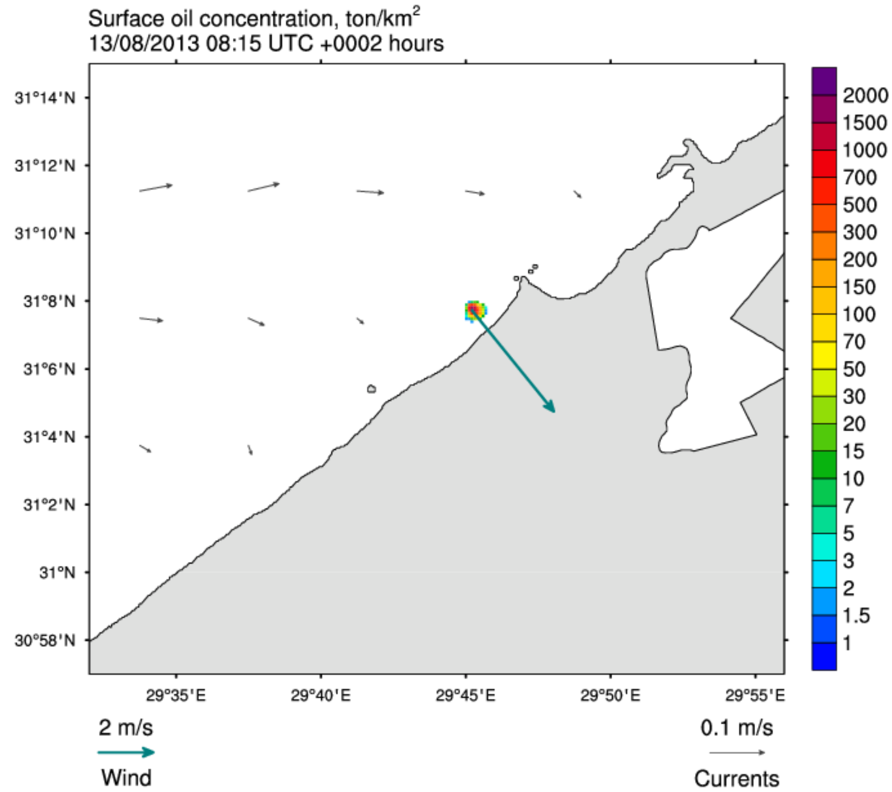
Ocean current and temperature data were downloaded from the available CMEMS MED-MFC data archive containing daily averages of the model analyses. Hourly data are not available for previous years because CMEMS only maintains a 30-day rolling archive for hourly data. Atmospheric analyses from ECMWF (SCENARIO 1) were available for the test period. SCENARIO 2 considered 1-hourly SKIRON wind fields and 3-hourly CYCOFOS 3 wave simulations.

SCENARIO	**1**	**2**
Production Centre	**INGV**	**OC-UCY**
Oil spill model	**MEDSLIK II**	**MEDSLIK**
WIND	**ECMWF**	**SKIRON**
temporal resolution	6 hours	1 hour
spatial resolution	25 km	5 km
update frequency	daily	daily
CURRENTS and SST	**CMEMS**	**CMEMS**
temporal resolution	daily means	daily means
spatial resolution	6.5 km	6.5 km
update frequency	daily	daily
WAVES	-	**CYCOFOS**
temporal resolution	-	3 hours
spatial resolution	-	5 km
update frequency	-	daily

Table 4 Prediction systems implemented to produce the OPL Bulletin results.

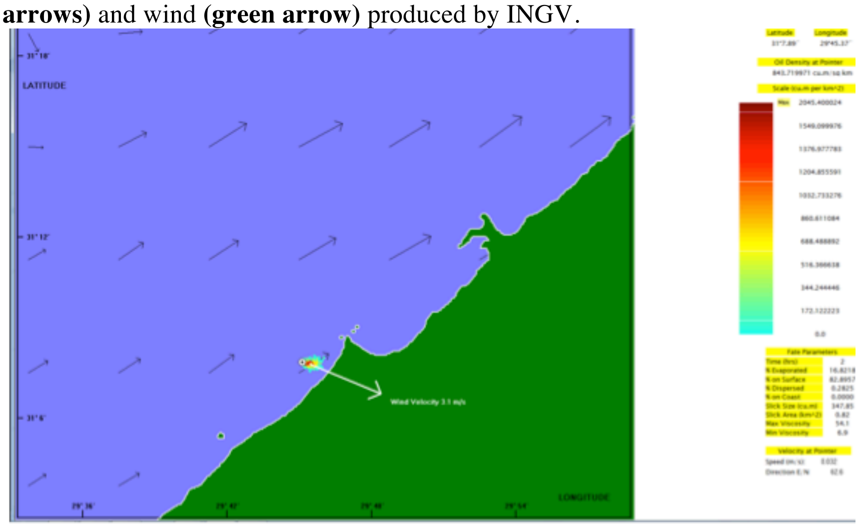
Oil spill after 2 hours
13/08/2013 10:15 CET

SCENARIO 1
Sea surface currents are eastward and turn slightly south approaching the coastline. Wind is north-westerly and reaches a velocity of about 6 m/s.
The oil spill 2 hours after the reported incident did not impact the coastal zone.



SCENARIO 1 – Position of the oil slick at 10:15 on 13/08/2013 (oil concentration is given in units of ton/km^2) and the corresponding daily surface currents **(black arrows)** and wind **(green arrow)** produced by INGV.

SCENARIO 2
In the Sidi Kerir terminal, the sea surface currents are north-easterly, while the wind is north-westerly with an intensity as low as 3.1 m/s.
The oil spill 2 hours after the reported incident was at 82.9% on the sea surface with no impact on the coastal zone.

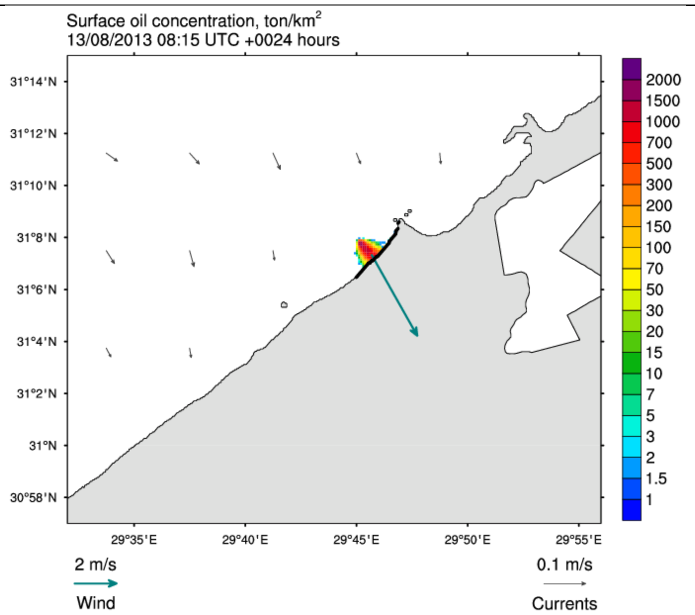


SCENARIO 2 – Position of the oil slick at 10:15 on 13/08/2013 (oil concentration is given in units of cu.m) and the corresponding daily surface currents **(black arrows)** and wind **(white arrow)** produced by OC-UCY.

Oil spill after 24 hours 14/08/2013 08:15 CET

SCENARIO 1

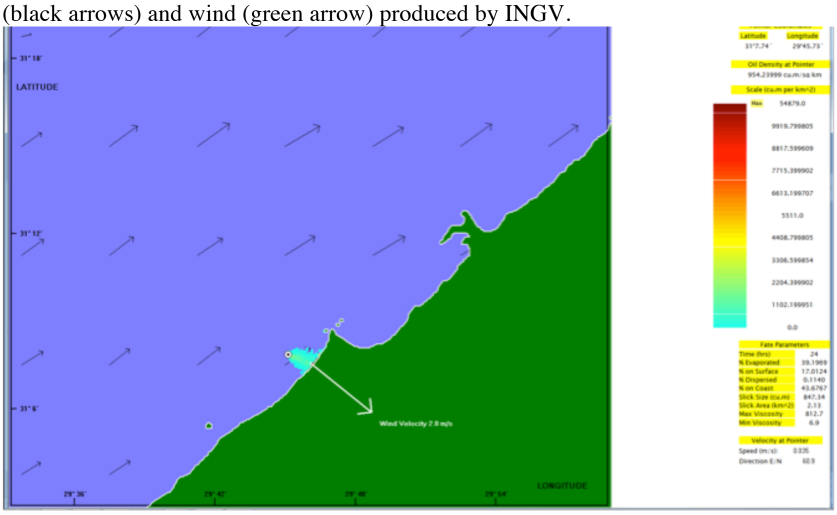
Sea surface currents are south-eastward and turn southward approaching the coastline. Wind is north-westerly and reaches a velocity of about 6 m/s.
The oil spill impacts the coastal zone after 6 hours of simulation (15:15 CET) and there is progressive beaching of the oil.



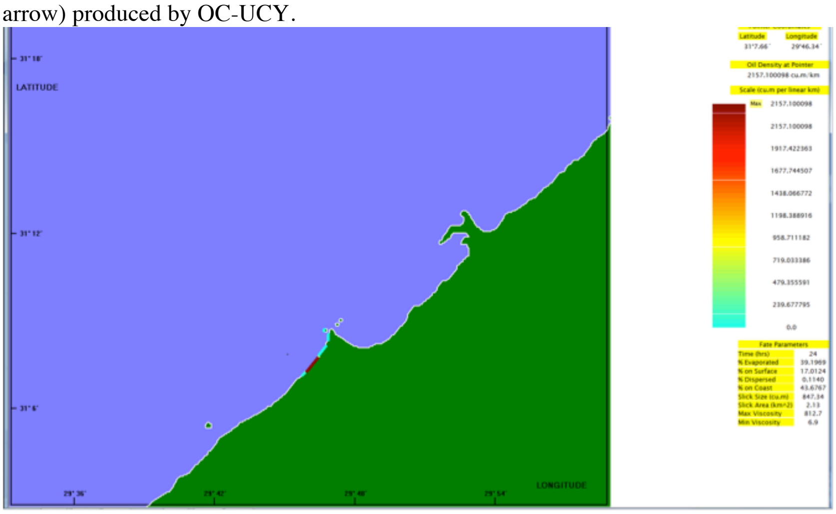
SCENARIO 1 Position of the oil slick at surface and on the coasts at 08:15 on 14/08/2013 (oil concentration is given in units of ton/km2) and the corresponding daily surface currents (black arrows) and wind (green arrow) produced by INGV.

SCENARIO 2

The oil starts to reach the coastal zone of Sidi Kerir terminal 3 hours after the reported time of the incident. After 24 hours, the oil on the coast (permanent and potentially releasable) constitutes 43.68% of the total released amount, while 39.20% evaporates



SCENARIO 2 Position of the oil slick at 08:15 on 14/08/2013 (oil concentration is given in units of cu.m) and the corresponding daily surface currents (black arrows) and wind (white arrow) produced by OC-UCY.

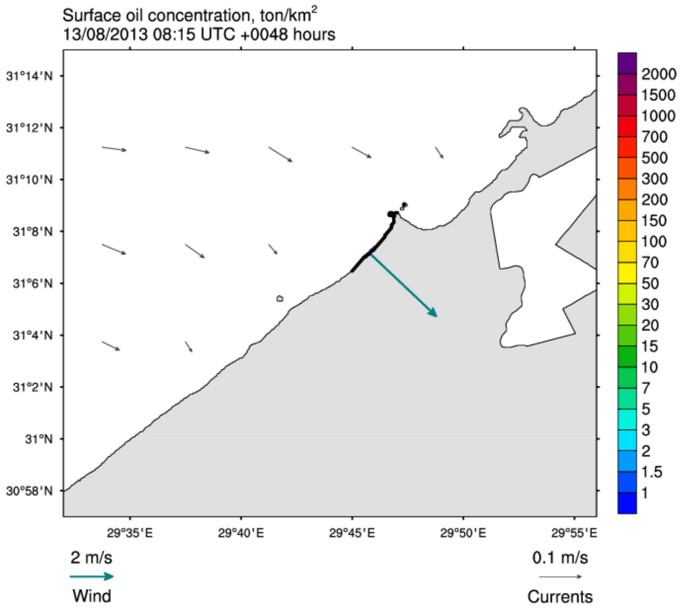


SCENARIO 2 – oil on the coasts after 24 hours in cu.m.

Oil spill after 48 hours 15/08/2013 08:15 CET

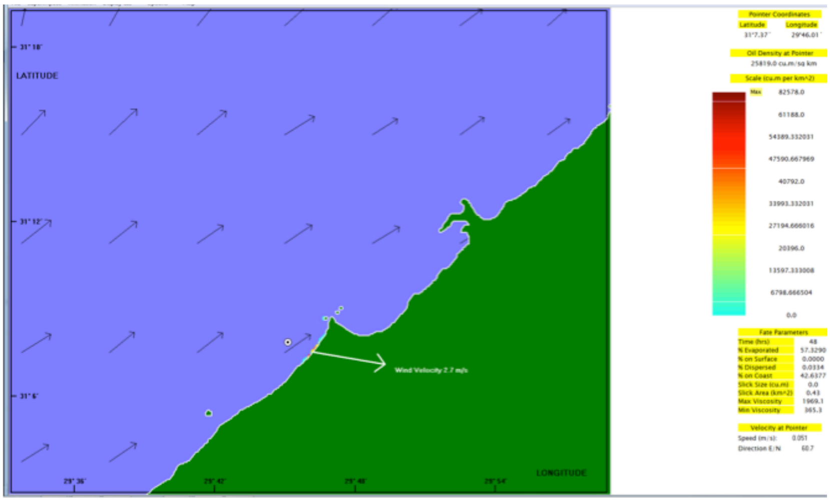
SCENARIO 1

Surface currents are eastward, turning south-eastward, and the wind is north-westerly at about 6 m/s. The oil accumulates in the coastal zone.



SCENARIO 1

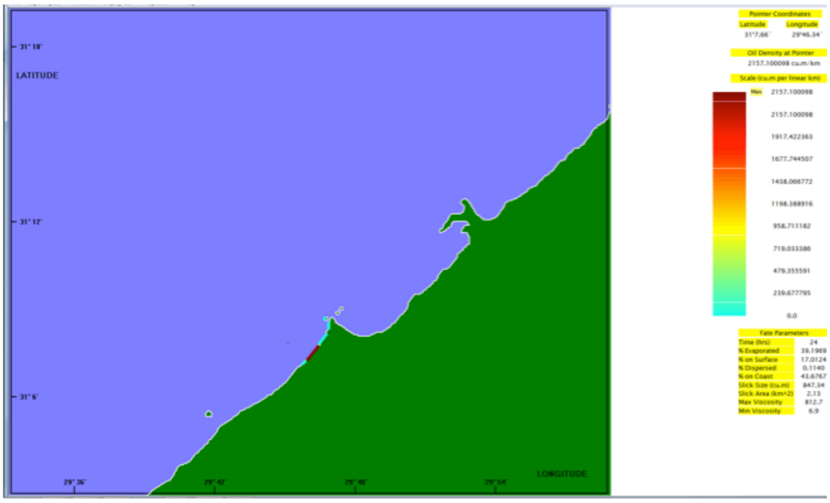
SCENARIO 1 Oil on the surface and the coasts in tons/km after 48 hours.



SCENARIO 2 Position of the oil slick at 08:15 on 15/08/2013; oil concentration is given in units of cu.m.

SCENARIO 2

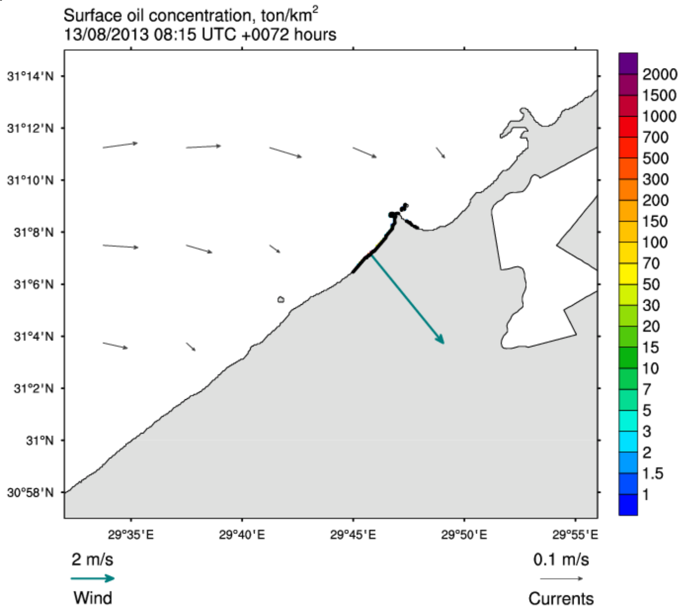
In the Sidi Kerir terminal, the sea surface currents are still north-easterly, while the wind is west with a low intensity of 2.7 m/s. The oil accumulates in the coastal zone (42.64% of the total amount is permanent and potentially releasable), while 57.33% evaporates during the 48 hours of the simulation.



SCENARIO 2 Oil on the coast after 48 hours in cu.m

Oil spill after 72 hours 16/08/2013 08:15 CET

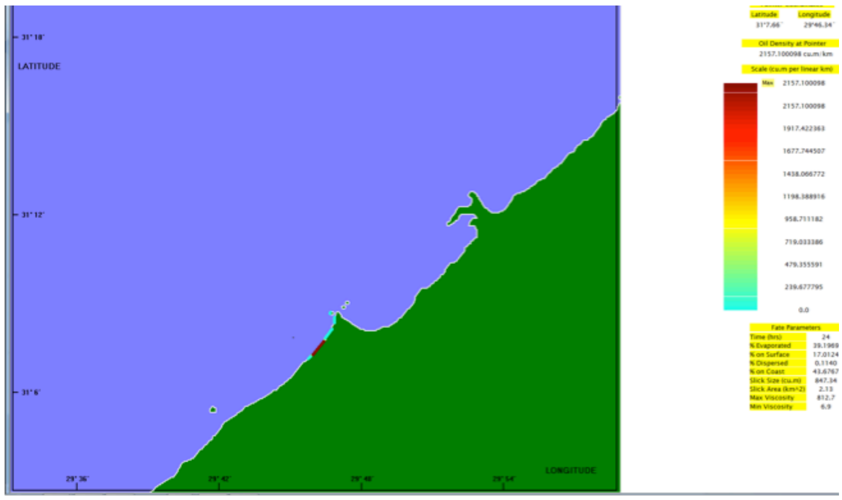
SCENARIO 1
Surface currents are eastward, turning south-eastward and the wind is north-westerly at about 6 m/s. The oil accumulates in the coastal zone.



SCENARIO 1 Oil on the surface and the coast in tons/km after 72 hours.

SCENARIO 2
In the Sidi Kerir terminal, the sea surface currents continue to be north-easterly. The wind is north-westerly with an intensity as low as 3.2 m/s.
The oil accumulates in the coastal zone (36.14% is permanent and potentially releasable), while 63.86% evaporates during the 72 hours of the simulation.

SCENARIO 2 Position of the oil slick at 08:15 of 16/08/2013, oil concentration is given in units of cu.m.



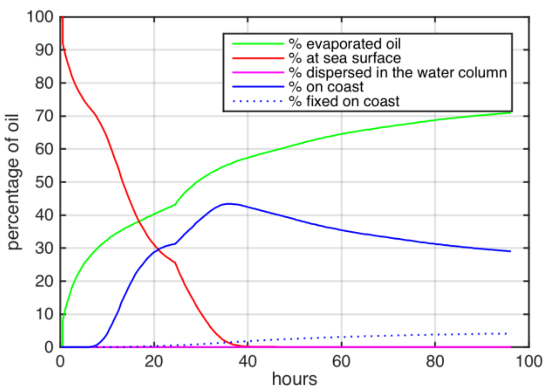
SCENARIO 2 Oil on the coast in cu.m after 72 hours.

Figure 7 illustrates the average percentage of oil in the area in four categories: evaporated, at the sea surface, dispersed in the water column and on the coasts for **SCENARIOS 1** and 2.

The results of both SCENARIOS show that after 30-40 hours almost all the released, non-evaporated oil (Figure 7 red line) arrived on the coast, mainly due to the persistent north-westerly winds and currents. The high percentage of free oil on the coast (potentially capable of returning to the sea) shown by both SCENARIOS indicates the possibility of prolonged and extended coastal impacts for up to 72 hours.

In **SCENARIO 1,** about 30% of the oil evaporated in the first 8 hours and more than 50% evaporated within 30 hours. In **SCENARIO 2,** 40% of the oil evaporated in the first 8 hours, increasing to 60% after 72 hours.

Figure 11 presents the estimated impact of the oil on the coast in **SCENARIO 2**. The length of the coastal strip impacted by the oil leak is 3.55 km after 40 hours.



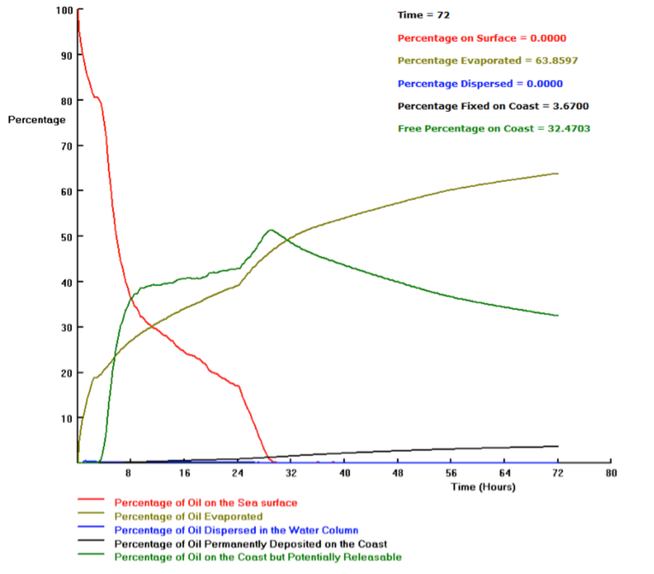


Figure 7: Percentage of oil in four categories: on the surface, dispersed in the water column, evaporated and on the coasts, as a function of simulation time: (left) SCENARIO 1, (right) SCENARIO 2.

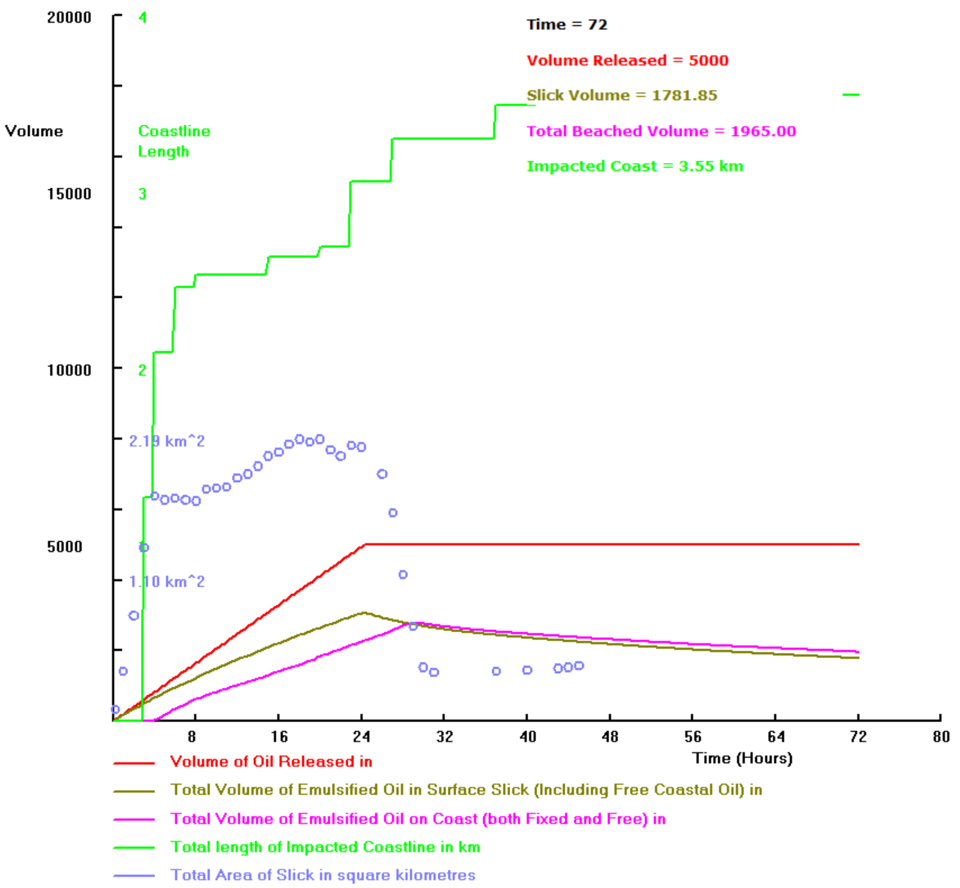


Figure 8. SCENARIO 2 estimates of the oil impact on the coast

Potential Impact on environmental and human activities

The assessment of potential impacts on the coastal environment and human activities requires additional data sets with the following key characteristics:

- bathymetry and elevation,
- coastal geomorphology,
- seabed substrate,
- marine and coastal infrastructures,
- mariculture,
- MPAs,
- transport routes,
- use of coastal areas.

The availability of this information was first analysed using the EMODNET thematic portals.

Bathymetry/elevation and coastal geomorphology

Information was retrieved from the EMODnet Bathymetry portal http://portal.emodnet-bathymetry.eu/, by selecting the incident area and the interesting layers. The result is shown in Figure 12. The initial oil leak occurred on the continental shelf very close to the coast, which is largely influenced by the Nile river delta. The bathymetry of the incident area is shallower than 50 metres.

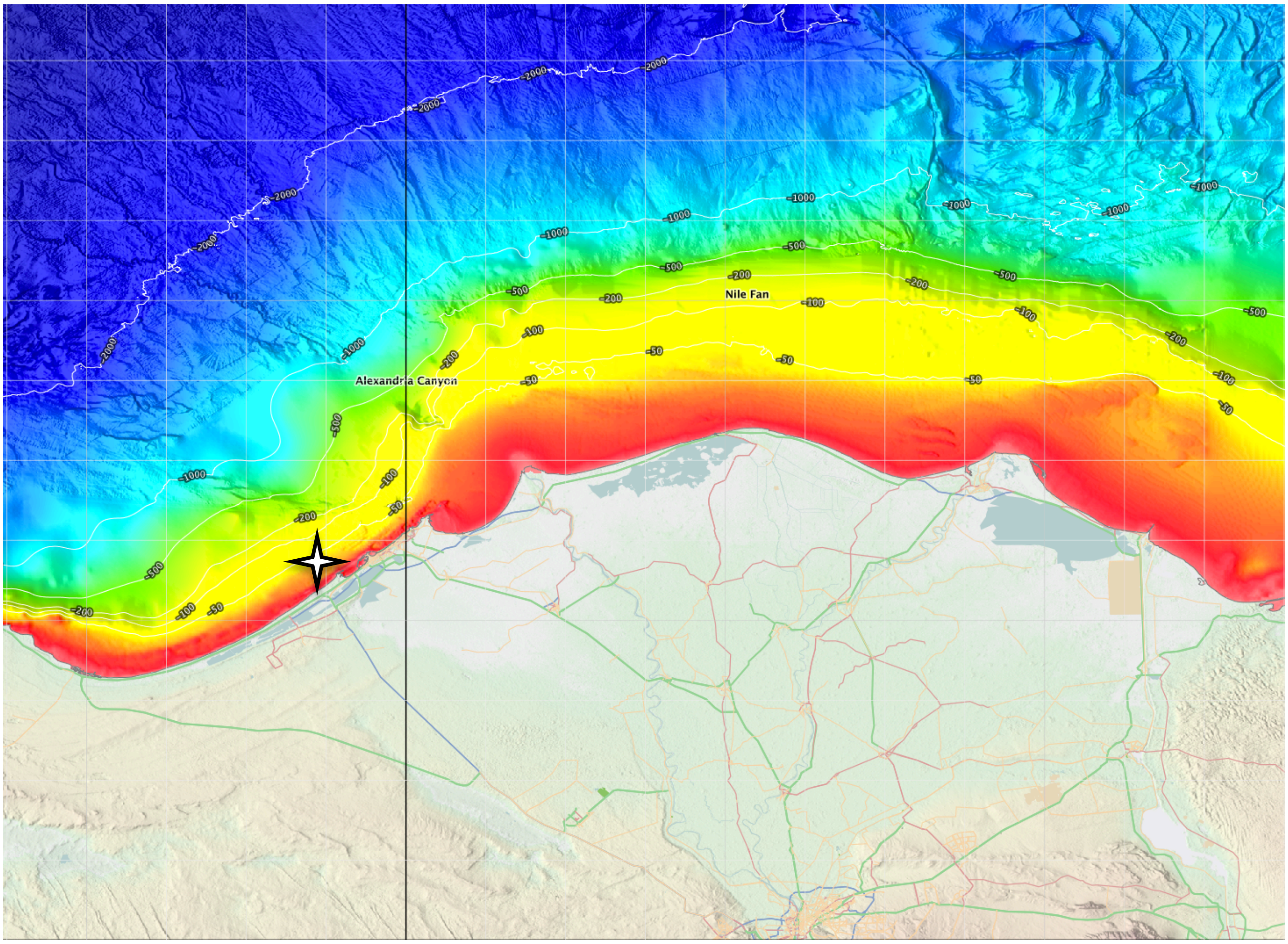


Figure 9. Map of the Incident area containing layer information on bathymetry, coastline depth contours, land geography and topography, coastal areas with high-resolution bathymetry, mean depth full coverage.

SeaBed Habitats

Information was retrieved from EMODnet Seabed Habitat regarding modelled maps of specific habitats from the MEDISEH EU Project.

- Figure 10 shows that the probability of coralligenous habitats in the impacted area is very low (<10%), as it is a river influenced area.
- Figure 11 shows high to very high (50-90%) probabilities of maërl habitats in the impacted area, as it is a river-influenced area.
- Figure 12 shows high to very high (>50%) probabilities of finding Posidonia Oceanica in the near-shore area, with the exception of Alexandria harbour.

The high probability of Posidonia Oceanica in the affected near-shore area indicates that the effects on the seabed habitat and the ecosystem could be disastrous.

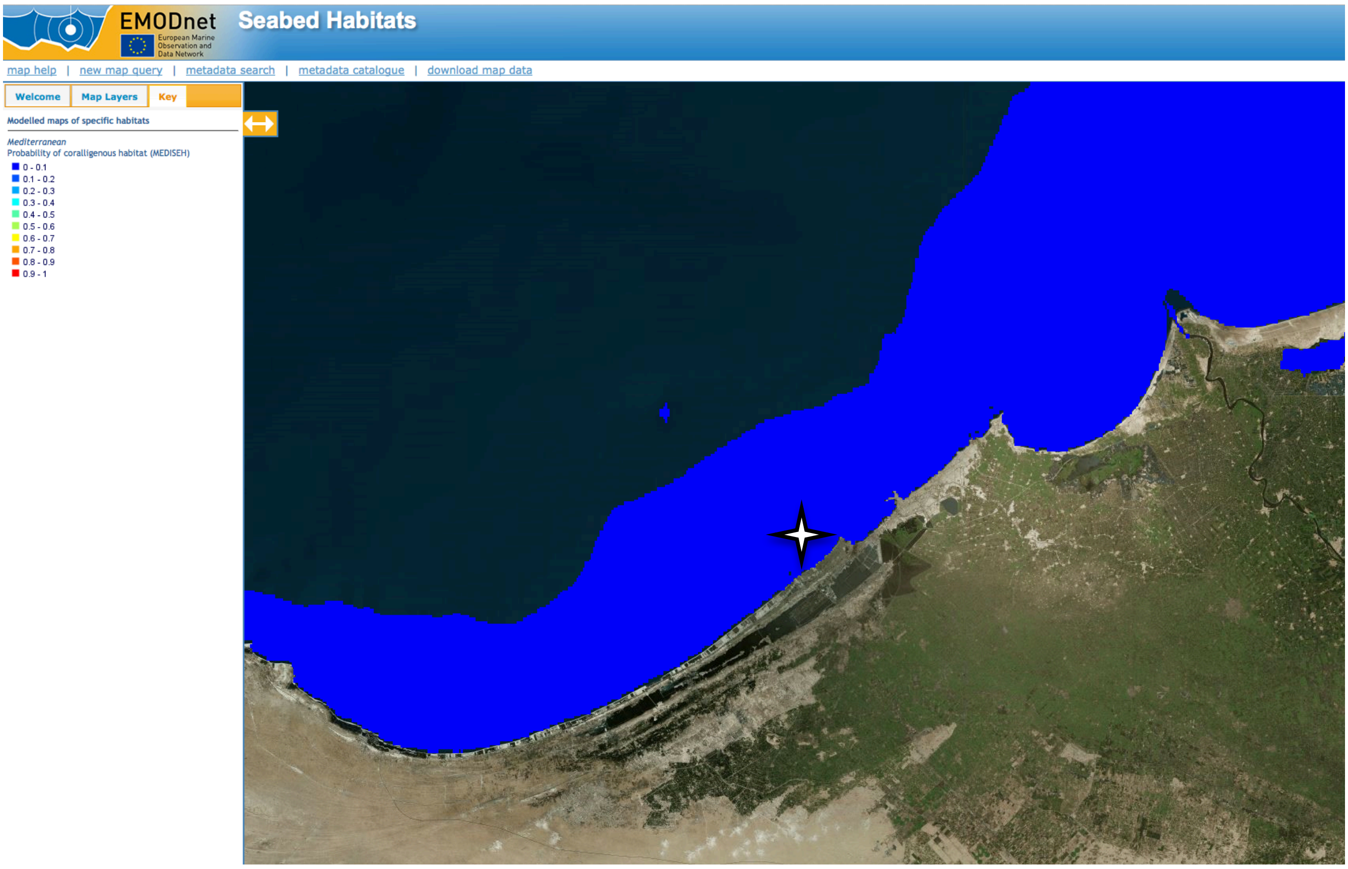


Figure 10. Modelled map of the probability of Coralligenous habitat (from the MEDISEH Project) retrieved from the EMODnet Seabed Habitat web portal:

http://www.emodnet-seabedhabitats.eu/default.aspx?page=1974

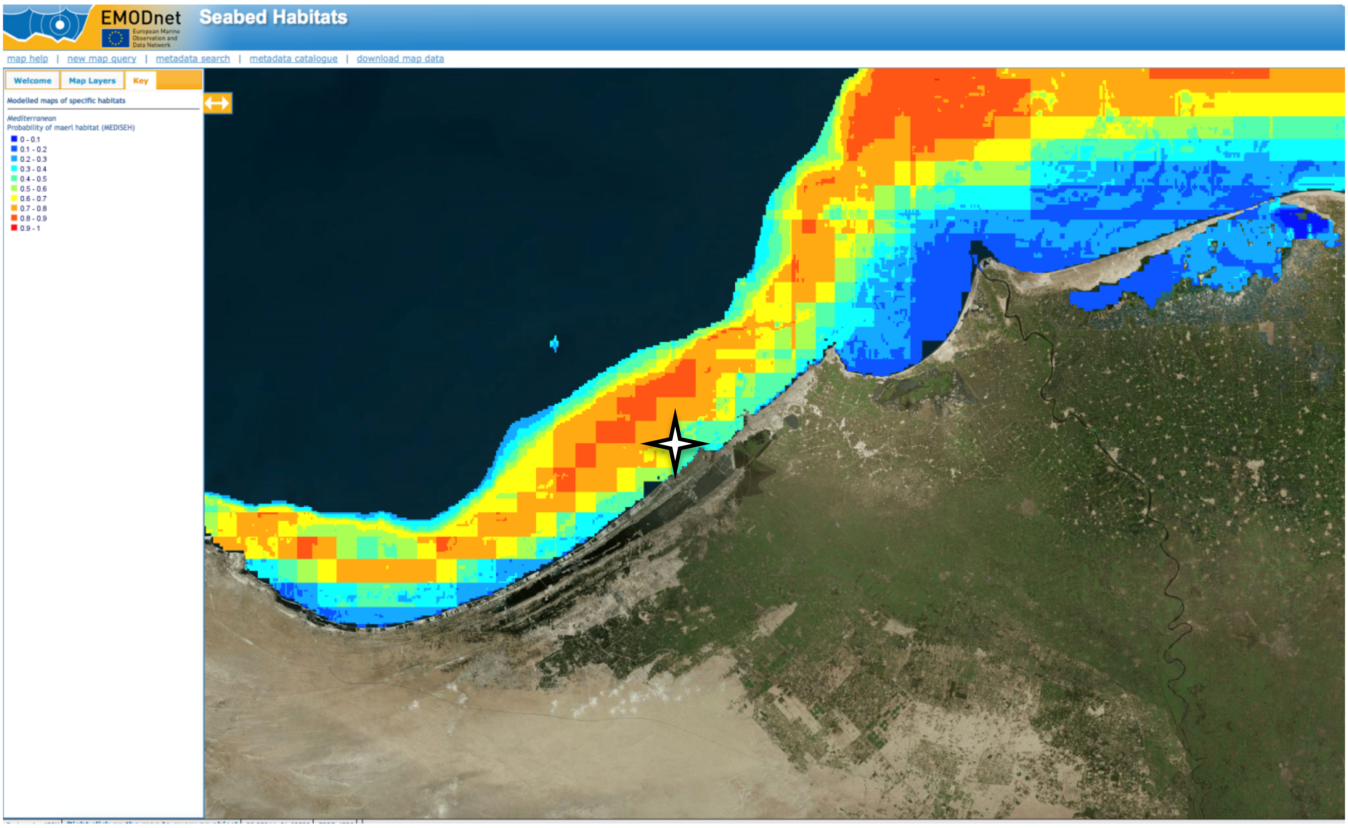


Figure 11. Modelled map of the probability of maërl habitat (from the MEDISEH Project) retrieved from the EMODnet Seabed Habitat web portal:

http://www.emodnet-seabedhabitats.eu/default.aspx?page=1974

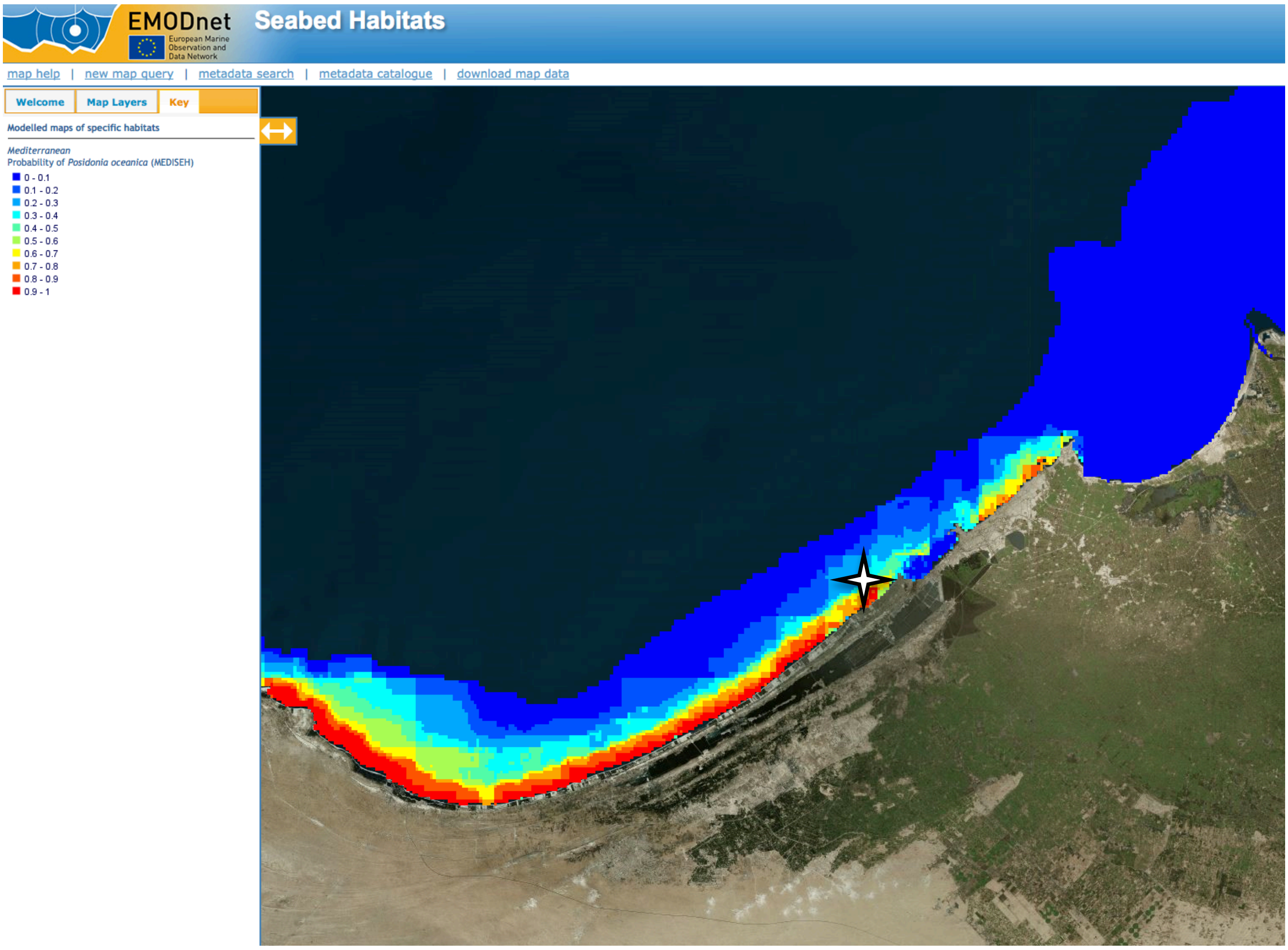


Figure 12. Modelled map of the probability of Posidonia Oceanica (from the MEDISEH Project) retrieved from the EMODnet Seabed Habitat web portal:

http://www.emodnet-seabedhabitats.eu/default.aspx?page=1974

Marine Protected Areas and Biological zones

Information about Mediterranean conservation areas and biological zones was retrieved by the MedSea Checkpoint Challenge 2 targeted product (MEDSEA_CH2_Product_2). The produced shape file contains layers with the Mediterranean protection initiatives (management and conservation areas), MPA extension areas, their protection levels and biological depth zones. http://www.emodnet-mediterranean.eu/medsea-challenge-2-product-1/

Circalittoral and infralittoral biological zones would be highly damaged, as shown in Figure 16.

Two MPAs are located close to the accident zone:

1. an international MPA close to El-Alamain, south-west of the impacted area;
2. a national MPA enclosing a wetland area close to Baltim, north-east of the impacted area.

Considering the seasonal prevailing circulation in the impacted coastal area, the second MPA could be affected by the damage to the coastal ecosystem.

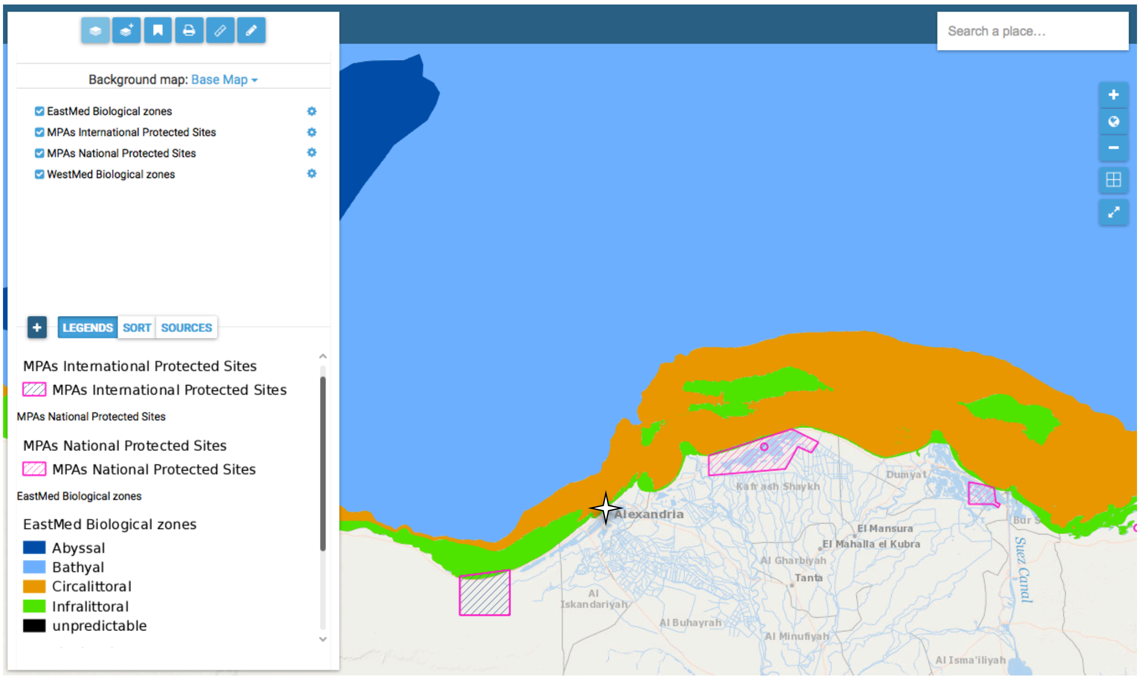


Figure 13. MEDSEA_CH2_Product_2 developed by MedSea Checkpoint Challenge 2: Med conservation areas and biological zones. Shape file with the layers containing the Med protection initiatives (management and conservation areas), the MPA extension areas, their different protection levels and depth zones. http://www.emodnet-mediterranean.eu/medsea-challenge-2-product-1/

Transport route and use of coastal areas

We considered retrieving information from the Human Activities web portal (http://www.emodnet-humanactivities.eu/view-data.php). However, there were gaps in the information along the African coast, with no MPAs or harbours displayed on the graphic interface. The initial leak area is close to the entrance of Alexandria Harbour, which is the main port in Egypt. Alexandria is also considered the second most important city in Egypt and its coastal strip is densely populated. The economic impact of the incident on touristic and maritime transport activities must be estimated.

Expert evaluation of Targeted Product quality and gaps in the input data sets

The objective is to provide an expert evaluation of the "fitness for purpose and use" for each Targeted Product. The coordinator asked the challenges teams to answer to the following points:

1. Assign an overall product quality score with respect to scope (fitness for purpose) and explain why according to the scale in Table A.
2. Explain what is (are) the most important characteristic(s) for the Targeted Product quality (if all characteristics are important please say so);
3. Explain what is (are) the quality element(s) (see Annex 1) of the most important characteristic(s) that affects the Targeted Product quality;
4. Explain the limitations on the quality of Targeted products due to the input data set used;
5. Explain which characteristics "fails the most" to meet the scope of the Targeted Product;
6. Provide an expert judgement to describe for each Targeted Product the most important **gaps in the input data sets**.

SCORE	MEANING
1	EXCELLENT → it meets completely the scope of the Targeted Product
2	VERY GOOD → it meets more than 70% of the scope of the Targeted Product
3	GOOD → it meets less than 50% of the scope of the Targeted Product
4	SUFFICIENT → it does not really meet the scope but it is a starting point
5	INADEQUATE → it does not really fulfil the scope, not usable

Table A Targeted Products quality scores and their meaning.

MEDSEA_CH3_Product_1

1) The overall product quality score is **good (3)** for estimating the consequences of a spill in a previously unknown location, with only the barest details of the incident itself and within 24 hours. The implementation of different scenarios for the two spills illustrates the uncertainties related to this kind of application, which derive from the combination of ocean, wind, wave and oil spill model uncertainties. However, the results of the different scenarios were presented side-by-side to facilitate the comparison of results, together with a clear presentation of the scenarios characteristics. Moreover, the OPL Bulletin did not provide any information about the impact of the incident on the coastal environment (e.g., beaches, protected sites) and human activities (e.g., tourist areas, MPAs, harbours). The availability of these characteristics and their integration within the OPL Bulletin structure were difficult tasks to address.
2) All characteristics needed to produce the OPL Bulletin are important:
    - specific input data on oil leaks (leak position, date and time of the leak, type of oil, rate of spillage or total amount of oil spilled, slick satellite observations provided by EMSA) were provided to implement the most realistic experimental set up or scenario;
    - hourly oceanographic forecasts for the Mediterranean Sea (currents and SST) were available through the CMEMS portal;
    - wave data from CYCOFOS were available;

- ECMWF wind data were available, together with the higher-resolution SKYRON and POSEIDON systems.

Advances in operational oceanography and the establishment of CMEMS ensure full coverage of meteo-oceanographic data (wind, currents and waves) over the Mediterranean Sea, thus the availability of data is not a limitation for the OPL Bulletin. However, the importance of very high temporal and spatial resolutions for the accurate representation of oil transport is emphasized in the literature.

Additional data sets are required to evaluate the impacts of oil spills on human activities, the environment and coastal habitats (coastal geomorphology, seabed substrate, marine and coastal infrastructures, mariculture, MPAs, transport routes, use of coastal areas). Most of these characteristics were identified in the EMODnet and MEDESS4MS portals, but were not integrated in the first OPL Bulletin.

3) The **meteo-oceanographic forecasts and analyses** available through the CMEMS portal provide full coverage of the Mediterranean Sea. However, the product quality would be improved by increasing the **spatial and temporal resolution** together with a longer temporal horizon (**time extent**). The very-high-resolution operational forecasting systems (national and experimental forecasting systems) nested within the CMEMS Mediterranean Forecasting System could provide higher resolution predictions; however, the **availability** of these data is still limited and linked to projects such as MEDESS4MS. Readiness and responsiveness are crucial because the 24-hr response time requires input datasets to be inserted automatically into the oil spill models.

   The availability (readiness and responsiveness) and **completeness** are the quality elements that most affect the assessment of the impact on human activities, the environment and coastal habitats, in particular: coastal geomorphology, seabed substrate, mariculture, MPAs, Fisheries Restricted Areas, seabed habitats, coralligenous, eco/bio significant areas, special areas for cetaceans, marine and coastal infrastructures (major ports, ocean energy facilities, wind farms, oil offshore installations), transport routes (commercial shipping, recreational shipping, not yet available) and the use of coastal areas (tourism).
4) The lack of assessment of the impact on the coastal environment limits the quality of the product. Satellite observations of the leak are crucial both to validate the oil spill model results and to update the prediction results after the initial alert.
5) None of the considered input characteristics fails to meet the scope of the targeted product.
6) MEDSEA_CH3_Product_1 is missing the coastal impact component, because most of the necessary input data sets were not available or were incomplete (spatial coverage) at the time of the first OPL Bulletin request. The availability of satellite observations of the leak is crucial, as stated before. The availability of all regional (limited area models) high-resolution models in a web portal would allow the use of the highest-resolution data (the MEDESS4MS Decision Support System uses them all, but does not disseminate them) to increase the accuracy of the oil spill prediction, especially in coastal areas.

MEDSEA_CH3_Product_2

1) The overall quality score is **very good (2)** for estimating the consequences of a spill in a previously unknown location, with only the barest details of the incident itself and within 24 hours. The implementation of different scenarios illustrates the uncertainties related to this kind of application. The results of the different scenarios have been presented side-by-

side, together with a clear specification of the scenario characteristics. The bulletin also provided information about the possible impact of the incident on the coastal environment and human activities.

2) All characteristics needed to produce the OPL Bulletin are important.
3) The high-resolution **meteo-oceanographic forecasts and analyses** available through the CMEMS portal and other national and experimental forecasting systems provide full coverage of the Mediterranean Sea. However, the OPL Bulletin quality would be improved by increasing the **spatial and temporal resolution** of the data analyses. The **completeness** is the quality element that most affects the characteristics needed to assess the impact on the coastal environment.
4) CMEMS is the only service that provides historical oceanographic data to produce the oil spill simulations for the specific exercise requested by the customer, a hindcast of a past event. However, the input data time resolution is daily instead of hourly, which impacts on the oil spill transport, as shown in the literature. Hourly data are maintained in the CMEMS catalogue for the past 30 days in a rolling archive. Thus, the quality of the simulation is limited by the lack of time resolution in the CMEMS historical data, but we could not validate the results with observations or quantify the prediction accuracy.
5) Ocean analyses that provide currents and temperature are the characteristics that fail the most to meet the scope of the Targeted Product. Data from CMEMS are only available at an hourly resolution for the past 30 days; otherwise, they are available as daily averages, thus reduces the product accuracy.
6) MEDSEA_CH3_Product_2 was produced using CMEMS daily analyses as the oceanographic input data (currents), limiting the accuracy of the oil slick trajectory simulation. These are the only data in existence; in fact, the CMEMS hourly analyses are archived only for the past 30 days and older data are deleted. This represents a gap for hindcast simulations of oil spills, which might be crucial for risk assessment. The quality of the impact assessment on the coastal environment is connected to the non-homogeneous spatial coverage of the information (coastal geomorphology, seabed substrate, marine and coastal infrastructures, mariculture, MPAs, transport routes, use of coastal areas). The Southern Mediterranean area is not fully covered.

TP	CH3
1	3
2	2

Table B Summary of the quality scores associated with each Targeted Product according to the experts' evaluations and the evaluation scheme presented in Table A.

Annex 1

From the MedSea Literature Survey we have extracted the following definitions:

Characteristic

In this document, a "characteristic" is a distinguishing feature which refers :

1. either to a variable derived from the observation, the measurement or the numerical model output of a phenomenon or of an object property in the environment
2. or to the geographical representation of an object on a map (i.e. a layer such as a protected area, a coastline or wrecks) by a set of vectors (polygon, curve, point) or a raster (a spatial data model that defines space as an array of equally sized cells such as a grid or an image).

Environmental matrices

This concept is introduced to avoid ambiguities when using a characteristic name such as "temperature". The environment matrix is the environment to which a characteristic is related and we define them to be:

1. Air,
2. Marine Waters,
3. Fresh Waters,
4. Biota/Biology,
5. Seabed,
6. Human activities.

Quality principles

- ✓ ***Spatial extent***
  Box or geographic region bounding the datasets
- ✓ ***Spatial resolution*** :
  Size of the smallest object that can be resolved on the ground. In a raster dataset, the resolution is limited by the cell size.
- ✓ ***Spatial Accuracy***
  Requested closeness of coordinate values to values accepted as or being true e.g. on the base of instrumentation used
- ✓ ***Time extent***
  Time interval represented by the dataset or by the collection.
- ✓ ***Time resolution***
  Size of the smallest interval of time that can be resolved.
- ✓ ***Time Accuracy***
  Requested closeness of temporal values to values accepted as or being true.
- ✓ ***Usability***
  The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.
- ✓ ***Completeness***
  Degree of absence of data in a dataset
- ✓ ***Logical Consistency***
  Degree of adherence to format required
- ✓ ***Thematic Accuracy***

Requested closeness of characteristic values to values accepted as or being true (the so called attribute of a data entity e.g. "wave height"). It includes the correctness of the classification of features or of their associations...