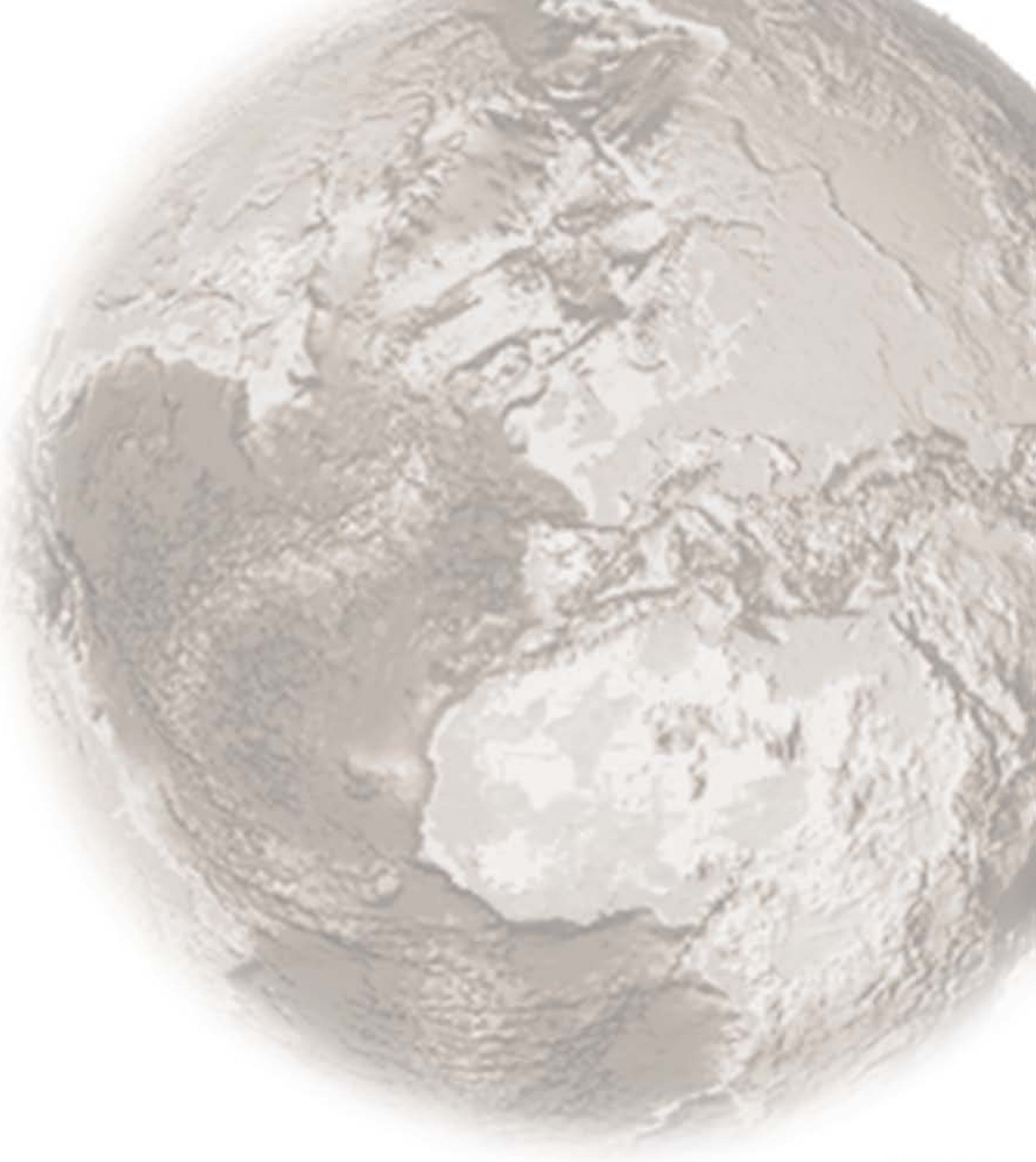
Rapporti Tecnici INGV



2008

Oil spill risk in the Adriatic Sea: an example of operational support capability in aid to the management of emergency

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OIL SPILL RISK IN THE ADRIATIC SEA: AN EXAMPLE OF OPERATIONAL SUPPORT CAPABILITY IN AID TO THE MANAGEMENT OF EMERGENCY

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Introduction

The Turkish cargo ship "Und Adriyatik" took fire in the early morning of the 6th of February 2008 (see figure 1) due to unknown reasons, only some 13 miles offshore the coasts of Rovinj, in Northern Croatia. The ship was sailing from Istanbul to Trieste. Such an accident was a real threat to the Adriatic Sea, as the ship tanks were full of engine fuel and many trucks were on board: the risk of explosion was high at any time.

At mid-morning of the same day, on behalf of the Slovenian Authorities the University of Port Rose (Slovenia) contacted the "Gruppo Nazionale di Oceanografia Operativa" of the "Istituto Nazionale di Geofisica e Vulcanologia" (GNOO-INGV) to get information on the hypothetical dispersion and fate of the oil in case of spillage from the ship.
From several years, GNOO-INGV is running a daily marine forecast system of the Mediterranean Sea (MFS) and of a nested higher resolution Adriatic Sea Forecasting Systeml (AFS) with an off-line coupled oil spill model (Medslik). INGV receives atmospheric forecast from the Ufficio Generale Spazio Aereo e Meteorologia (USAM) of the Italian Air Force and it is establishing an agreement with REMPEC (Regional Marine Pollution Emergency Response Centre for Mediterranean Sea) to help for management of oil spill emergencies.

Figure 1. Picture of the ship on fire. The picture was shot in the morning of the 6th of February and the fire was already spread all around.


LA STAMPA
QUOTIDIANO FONDATO NEL 1867
L'amarezza del Quirinale: «Anomale elezioni così anticipate». Prodi: non mi candiderò per dare l'esempio
"Vincere da soli, si può"
Sfida di Veltroni: Pd senza alleanze anche al Senato. Al voto il 13 e 14 aprile
GLI ANNI DI ROMANO
L'ARMA DI WALTER
Italia, lezione al Portogallo
Per il repubblicano McCain la nomination è vicina. Hillary preoccupata: sto finendo i soldi per la campagna
Supermartedì, il pari diventa un giallo
Carte clonate Torino trema
Adriatico, rischio catastrofe ecologica
IL FATTORE DOLLARI
IL LATO MOLLE DI SARKO
Buongiorno
Ci si abitua a tutto
22 Cronache
Una bomba ecologica sull'Adriatico
Nave turca brucia al largo della Croazia
Il carburante potrebbe riversarsi in mare
850
202
193
Gli esperti
«A rischio le coste di Ravenna»
A bordo 29 persone
Quattro sono rimaste ustionate e sono ricoverate a Venezia
Bollettino della Neve

Figure 2. The most important Italian newspapers highligted the news of the accident.

1. The Details of the Accident

One of the most important Italian mass media reported the news, as shown in figure number 2. According to the first information received the ship, a 194 meter long Turkish cargo, built in Germany in 2001, was carrying 22 sailors from the crew and nine passengers, two hundred trucks and nine tons of chemicals of various nature. Moreover the ship tanks were still filled with an amount of heavy fuel used as propellant for the engines, estimated in 800 tons, plus an extra eleven tons of light oil.

The accident that caused the fire to take place occurred at 4:00 a.m., February the 6^{th} 2008, in the ship's holds, and rapidly spread to the whole ship. The cause of fire is still unknown. The first information related to the exact location of the cargo ship received by INGV was referred to its position at 06:20 a.m. of the same day. The geographical coordinates of the ship were 44° 57' N and 013° 21' E and the simulations were started at this location.

The S.O.S. was launched by the captain at 4:04 a.m., and the first aid arrived from the sailing-by Greek ferry boat *"Icarus Palace"*, which rescued all the people from the ship and took them to the close port of Venice (Italy), where it was directed. From that moment on for the next 14 days the fire-fighting and rescue operations took place.

Croatian fire-fighting planes and one tugboat arrived soon at the scene, trying to extinguish the blaze. The planes were quickly withdrawn as they had no effect. As the fire started inside the ship, there was no way of extinguishing it from the outside. However, tugboats continued to pour water on the ship's hull, in an effort to lower its temperature and prevent its deformation. All the rescue operations have been coordinated by the Croatian Authorities and involved also the Italian Coast Guard.

On the 7^{th} of February a communication from the Italian Coast Guard reported that "Und Adriyatik" was being tugged north by four tugboats. On the 8^{th} of February the ship was still tugged by the tugboats and the operations of extinction of the blaze were still on going. Fortunately all the observations didn't show any evidence of oil spills.

These are the positions of the boat communicated to INGV by the Coast Guard everyday:

DAY	TIME	LATITUDE	LONGITUDE
February 06	06:20 a.m.	44° 57.6' N	013° 20.8' E
February 07	08:10 a.m.	44° 50.3' N	013° 39.8' E
February 08	08:00 a.m.	44° 45.5' N	013° 38.9' E
February 09	08:00 a.m.	44° 49.7' N	013° 44.2' E
February 10	08:00 a.m.	44° 50.3' N	013° 43.4' E
February 12	08:00 a.m	44° 49.6' N	013° 42.0' E

In figure 3 we can see a map showing the movements of the ship from the 6th to the 12th of February.

On the 9th of February lightening operations on the ship started in order to recover the normal buoyancy conditions of the ship, by removing the water and liquid chemicals used to extinguish the blaze, and causing the heeling of the ship (2 degrees approximately). Still there was no evidence of any spills at sea at this moment.

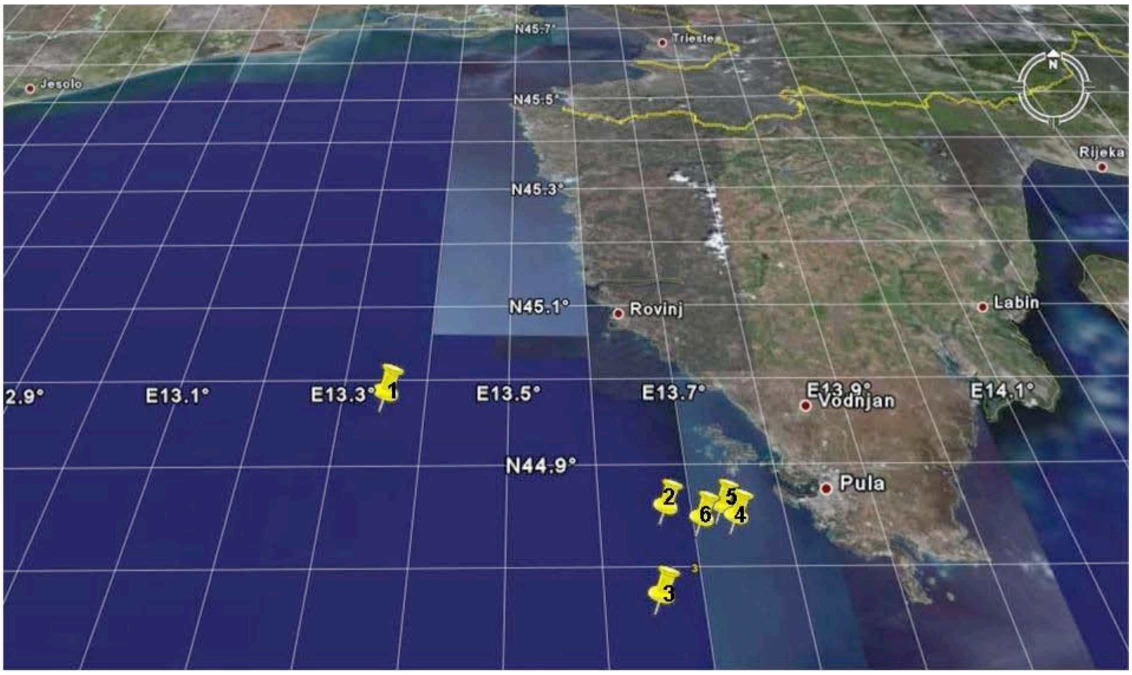

Figure 3. The ship's movements from the 6th to the 12th of February.

On the 10th of February the ship was still being tugged around by four tugboats (two from Italy and two from Croatia), moving at the speed of 1 knot, at about 2.5 nautical miles from the Croatian coasts. All the lightening operations were terminated successfully, being all the liquids pumped into the ballast holds and partially removed. The ship was still drifting around the site of the accident lead by the tugboats, waiting for the mooring authorizations from the Port Authorities of Trieste. The situation on board was quiet, and there seemed to be no more fire burning. The technical staff of the Dutch company in charge of inspecting the structural conditions of the ship was on board twice to check the accident.

On the 11th of February the boat was still heeling waiting for the authorizations to enter the Port of Trieste. In the meantime a crisis unit in charge of the accident management was active at the Coast Guard. The situation remained practically the same, with the ship being prevented from drifting by the tugboats, until the 20th of February, when an official communication from the *Comando Generale del Corpo delle Capitanerie di Porto* stated that the *Und Adriyatik* had been berthed to Trieste Harbour.
Figure 4 shows the official communication.

MINISTERO DEI TRASPORTI
(MINISTRY OF TRANSPORT)
COMANDO GENERALE DEL CORPO DELLE CAPITANERIE DI PORTO
(ITALIAN COAST GUARD)
CENTRALE OPERATIVA
(MARITIME RESCUE CO-ORDINATION CENTRE ROME)

GOOD MORNING
PLEASE BE INFORMED THAT AT 1150 LT M/V UND ADRIYATIK IS BERTHED TO TRIESTE HARBOUR.
BEST REGARDS.
ROMA, 20/02/2008

Figure 4. The official communication by the Italian Coast Guard of the berthing to Trieste Harbour of the *Und Adriyatik.*

2. The Marine forecasting system at GNOO-INGV

The Mediterranean Forecasting System (MFS-http://gnoo.bo.ingv.it/mfs), [Pinardi et al, 2003] and the Adriatic Forecasting System (AFS-http://gnoo.bo.ingv.it/afs), [Castellari et al., 2006] produce forecasts of marine currents and temperatures every day. The forecast systems have been developed over recent years within EU projects and projects funded by the Italian Ministry for the Environment, Land and Sea. MFS and AFS are part of the Mediterranean Operational Oceanography Network (MOON-http://www.oceanforecasting.eu).

A new forecast is produced every day by a complex system composed by an ocean general circulation model (OGCM) and an assimilation scheme to correct the model with all the in situ and satellite available observations. The ocean models are forced at the air-sea interface by atmospheric fields elaborated by the European Center for Medium-Range Weather Forecasts (ECMWF) and disseminated to INGV by the national meteorological office of the air force .

The forecast data can be visualized, compared and analysed over specific areas using UVT (User Visualisation Tool) which can also simulate the dispersion of particles in the sea advected by the forecasted currents.

The model MEDSLIK [Lardner et al. 2006], is integrated with MFS forecast currents and it is capable of reproducing the oil dispersion taking into account the weathering of the oil.
MEDSLIK is a user-friendly software package designed to predict the fate and transport of an oil spill in sub-regions of the Mediterranean Sea.. It is a Lagrangian Model: the oil slick is represented by a number of particles.
Particles of oil spill are transported by the water in which or on which they are located. There are two dominants mechanisms that drives the oil spill: the turbulent diffusion and the convection due to the background flow of the water currents and to the surface forces provided by the wind.
In addition to convective and diffusive displacements, the parcels in an oil spill suffer changes linked to various physical processes that affect the oil.

The lighter fractions of the oil disappear through evaporation and the remaining fractions begin to absorb water, or emulsify. These changes are reflected in changes of the properties of the oil, such as its density and viscosity and also in the volume of the surface slick. Finally, some of the oil is driven below the water surface by wave action (dispersion).
It may also happen that the horizontal displacement takes a particular parcel of oil onto the coast. The beaching of a parcel is not permanent however, and it is assumed that at subsequent time steps there is a probability that the parcel may wash back into the water. The rate of absorption as well as the probability of being washed off depends on the type of coastline and the model allows classification of coasts into categories such as sandy beach, small or large pebbles, rocky coast, exposed headland, and so on.
Medslik allows to display the temporal evolution of:

- percentage of oil remaining on the water surface;
- percentage of oil that has evaporated;
- percentage of oil that has been dispersed by wave action into the water body;
- percentage of oil that has become attached to the coast and the percentage of the oil that, although on the coast, is free to move back into the water body;
- oil viscosity (the maximum viscosity corresponds to the first oil to be released and the minimum to the last);
- oil density. (the maximum density corresponds to the first oil to be released and the minimum to the last);
- slick volume.

Figure 5-6-7-8 show the temporal evolution of the oil properties, according to the simulation shown in the bulletin in the next paragraph.

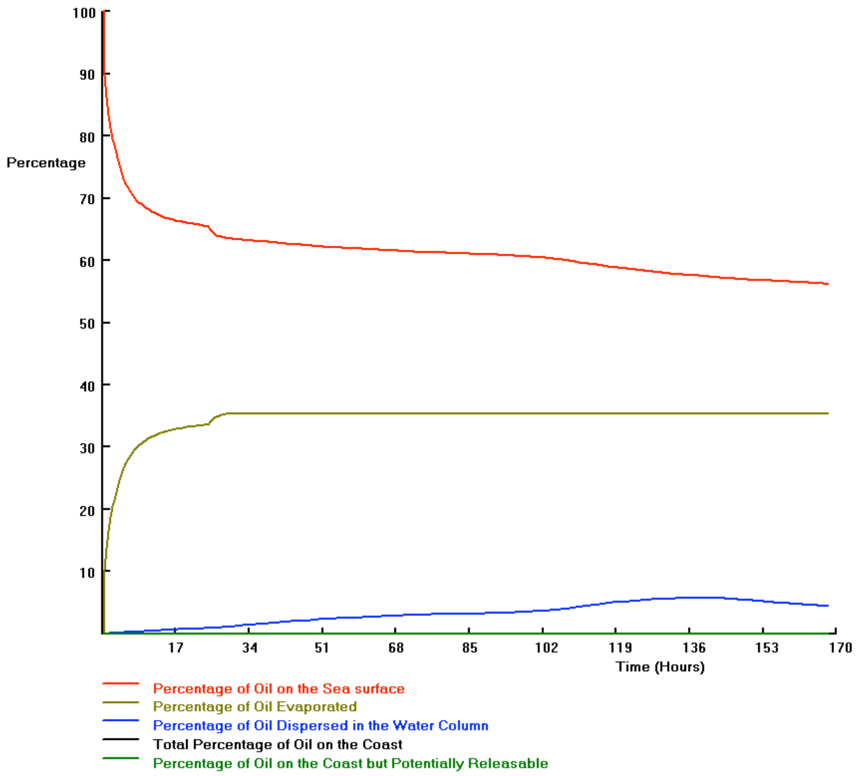

Figure 5. Temporal evolution of: 1) percentage of oil on the surface, 2) percentage of oil evaporated, 3) percentage of oil dispersed in the water column, 4) total percentage of oil on the coast, 5) percentage of oil on the coast but potentially releasable.

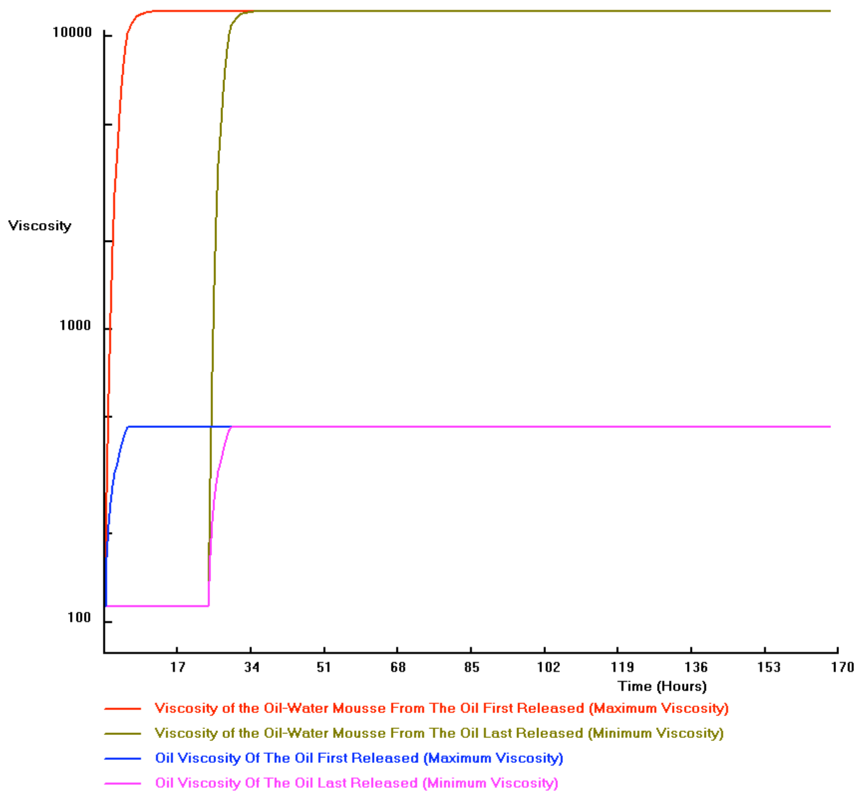

Figure 6. Temporal evolution of: 1) viscosity of the oil water mousse, 2) viscosity of the oil.

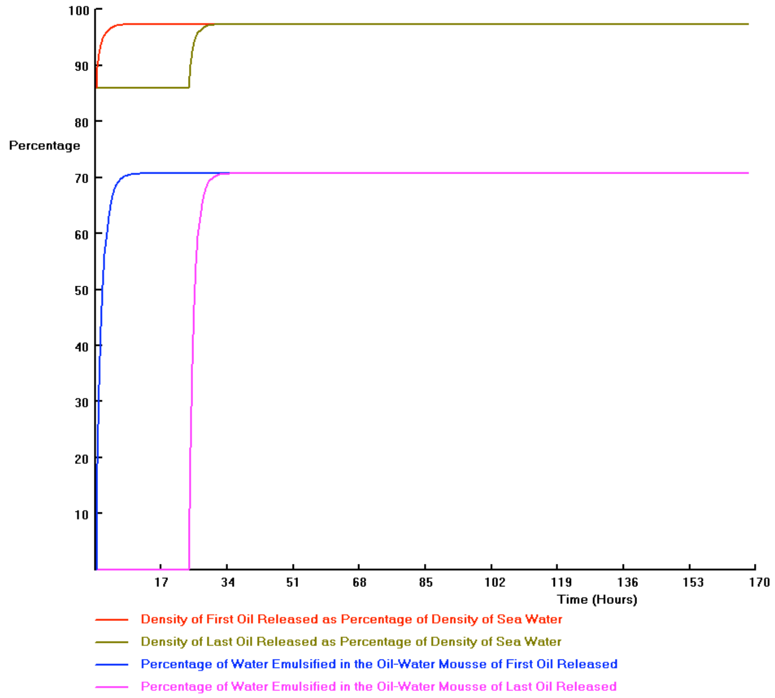

Figure 7. Temporal evolution of: 1) density, 2) percentage of water emulsified in the oil water mousse.

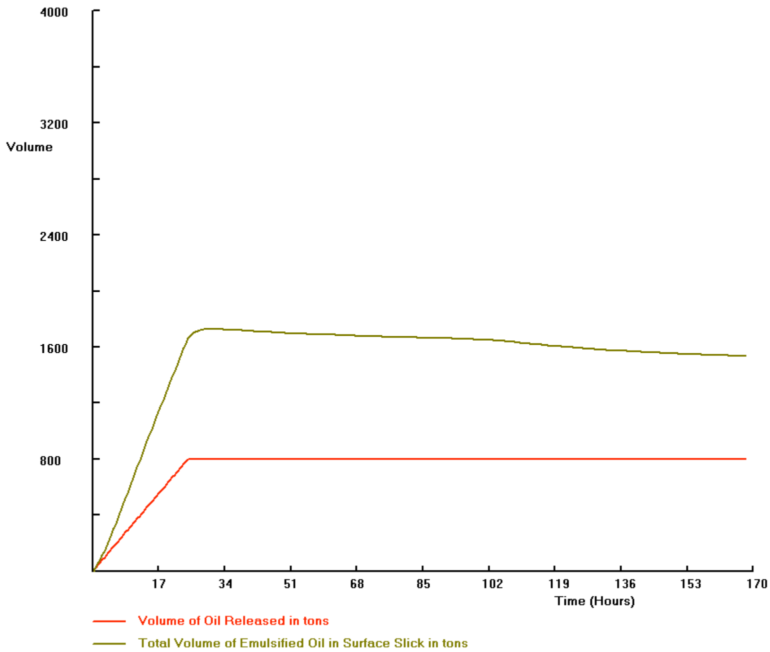

Figure 8. Temporal evolution of: 1) volume of oil released, 2) total volume of emulsified oil.

3. Emergency protocol followed

GNOO-INGV staff has been constantly in contact with the Operational unit of the Italian Coast Guard in order to get the most updated information about the ship position, the evolution of the fire and the local meteorological conditions. This information has been then used as input for the dedicated forecasts of the hypothetical dispersion and fate of oil spill from the ship.

The protocol used has been the following:

- collect the information from the Italian Coast Guard;
- analyse the marine currents for the area of interest and theri evolution using MFS and AFS;
- produce a dedicated visualisation of the wind stress and of the current at the surface by using UVT on the area of interest;
- simulate scenarios of oil spill occurrence with MEDSLIK;
- organise all the information and simulation in a dedicated bulletin to be disseminated to the Italian Coast Guard, USAM, Rempec, the Italian Civil protection and the media (TV, radio and newspapers).

Figure 9 shows the flow of information among all the involved institutions.

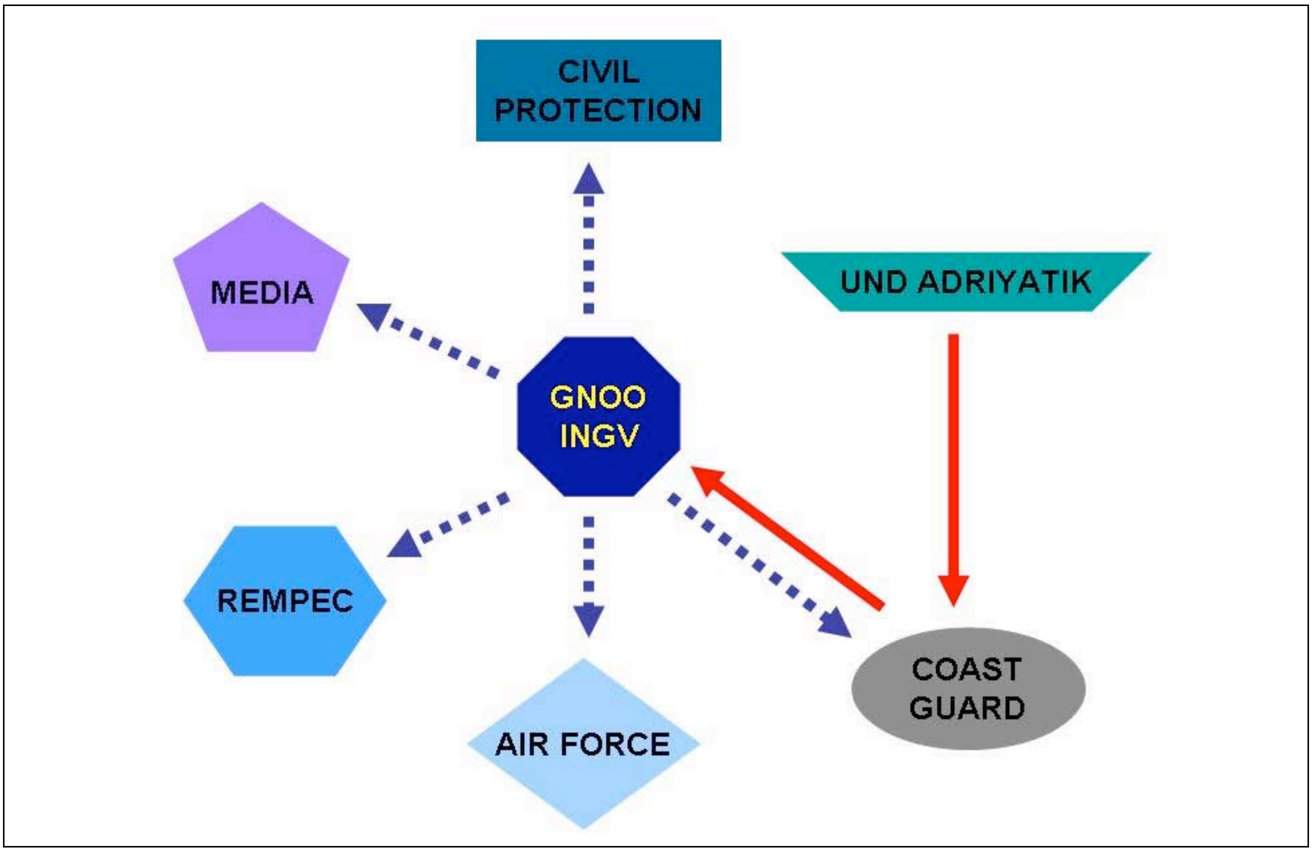

Figure 9. Flow of information among all the involved institutions.

Every day from the 6th to the 11th of February 2008 a new bulletin has been elaborated and disseminated by GNOO-INGV. An example of such a Bulletin and related pictures for the 8th of February 2008 follows.

GNOO Gruppo Nazionale di Oceanografia Operativa INGV

Bologna 08.02.2008

Executive Summary:

Following to the accident occurred to the Turkish ship "Und Adriyatik" in the early morning of the 06.02.2008:

- A fire developed on the ship at about 4:00 a.m.
- The ship has moved toward the Croatian coast
- The position at 08:10 of the 20080207 was 44° 50.3' N 13° 39.8' E
- The ship as been towed ca. at 13:00 of the 20080207
- The position at 08:30 of the 20080208 was 44° 45.5'N 013°38.9' E

GNOO-INGV SIMULATION RESULTS:

20080209: Wind stress, surface marine currents and oil slick position (Images 1-2-3)
20080210: Wind stress, surface marine currents and oil slick position (Images 4-5-6)
20080215: Wind stress, surface marine currents and oil slick position (Images 7-8-9)

Wins Stress (Images 1-4-7) and surface marine currents (Images 2-5-8) are the last forecast of the Adriatic Forecasting System (http://gnoo.bo.ingv.it/afs).

The simulation of the oil slick evolution (Images 3-6-9) are done with the advection due to the current fields coming from an ocean circulation model with approximately 6.5 km of horizontal resolution (Mediterranean Forecasting System, MFS http://www.bo.ingv.it/mfs), and considering the weathering of the oil. The spill has been simulated to be continuous for 24hr with a spill rate of 33.33 tons/hour starting from the 10:00 of the 20080208.

Accident Data:

- Target: Presumed oil spill
- Location of accident: approximately 13°21° and 44°57'N
- Time of the accident: 06.02.2008 at 4:00
- Name of the Ship: Und Adriyatik
- Route of the ship: from Istambul to Trieste
- Ship Cargo: 200 trucks, 9 tons of dangerous material, 800 tons of heavy oil in the tank, 11 tons of light oil

References:

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  Tel: 328 4172571; 051 3782643

GNOO-INGV Bulletin –Pag.1-

GNOO Gruppo Nazionale di Oceanografia Operativa INGV

MEAN WIND STRESS from 12:00 20080209 to 12:00 20080210

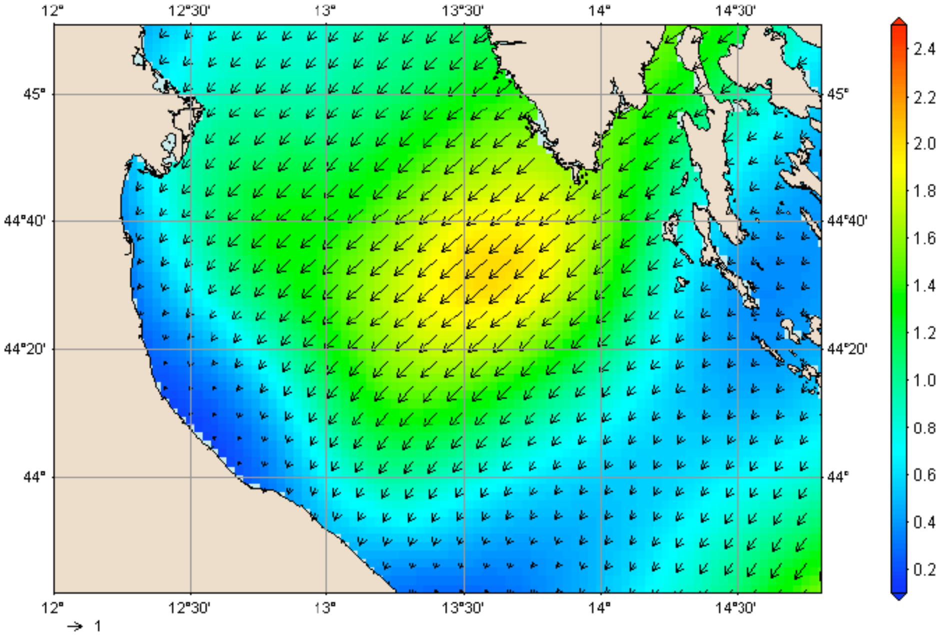

Figura 1: Wind Stress (dyne/cm2) mean field from 12:00 20080209 to 12:00 20080210.

MEAN OCEAN CURRENT AT SURFACE from 12:00 20080209 to 12:00 20080210

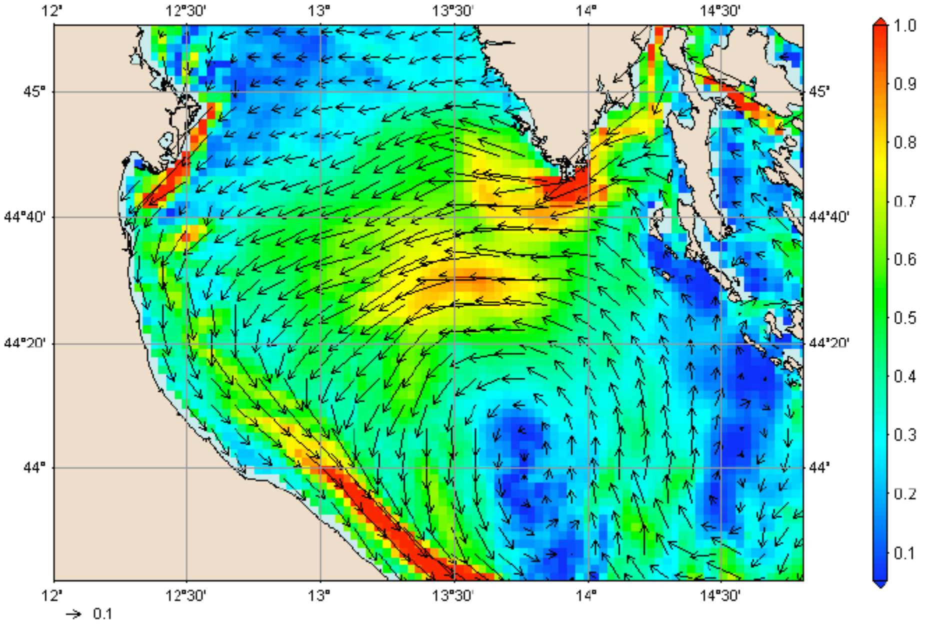

Figura 2: Current (knots) mean field at the surface from 12:00 20080209 to 12:00 20080210.

GNOO-INGV Bulletin -Pag.2-

OIL SLICK DRIFT at 20080209 (Saturday)

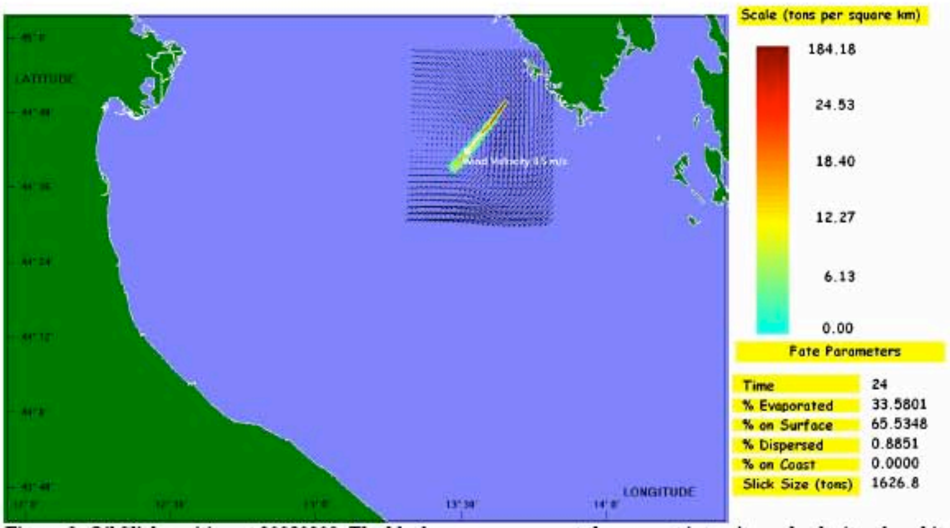

Figura 3: Oil Slick position at 20080209. The black arrows represent the current intensity and velocity, the white arrow represents the wind intensity and velocity.

MEAN WIND STRESS from 12:00 20080210 to 12:00 20080211

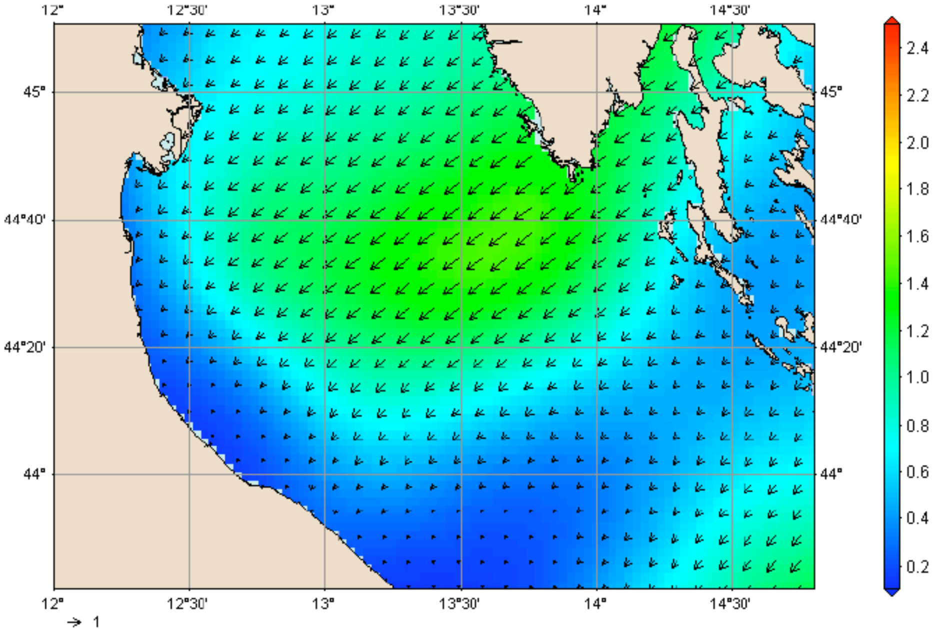

Figura 4: Wind Stress (dyne/cm2) mean field from 12:00 20080210 to 12:00 20080211.

MEAN OCEAN CURRENT AT SURFACE from 12:00 20080210 to 12:00 20080211

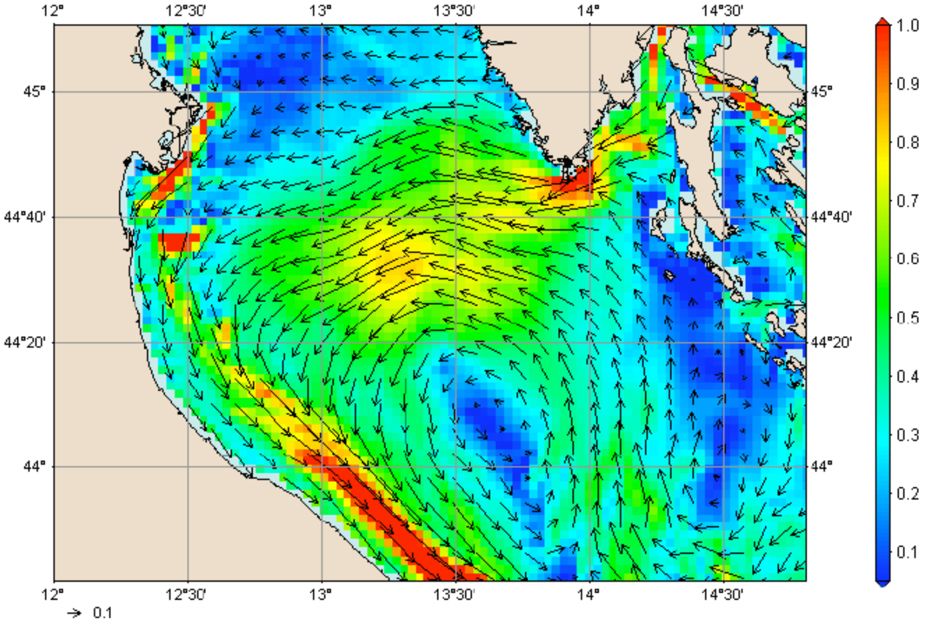

Figura 5: Current (knots) mean field at the surface from 12:00 20080210 to 12:00 20080211.

OIL SLICK DRIFT at 20080210 (Sunday)

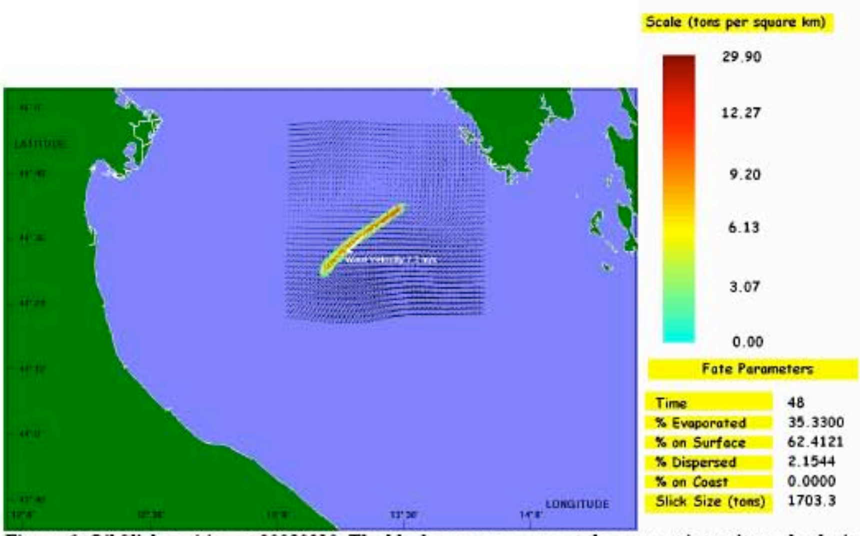

Figura 6: Oil Slick position at 20080210. The black arrows represent the current intensity and velocity, the white arrow represents the wind intensity and velocity.

MEAN WIND STRESS from 12:00 20080215 to 12:00 20080216

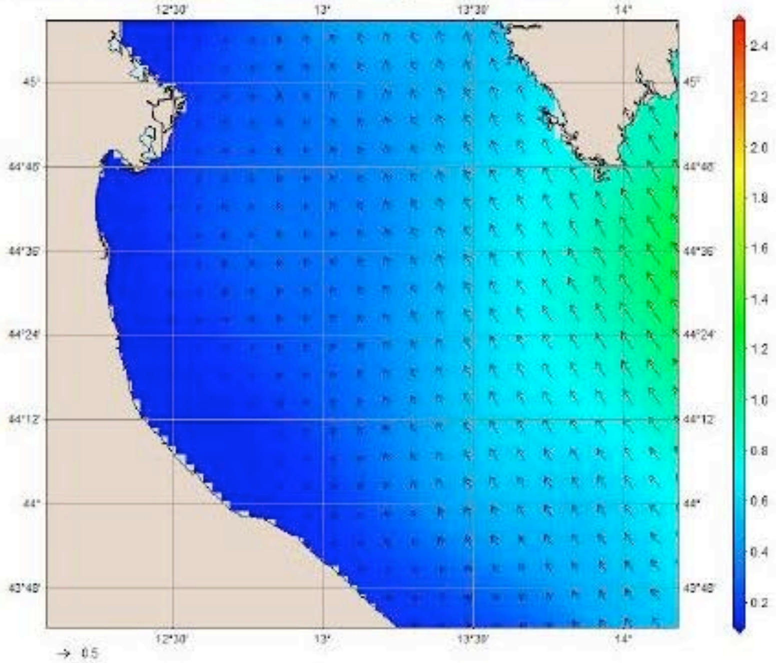

Figura 7: Wind Stress (dyne/cm2) mean field from 12:00 20080215 to 12:00 20080216.

MEAN OCEAN CURRENT AT SURFACE from 12:00 20080215 to 12:00 20080216

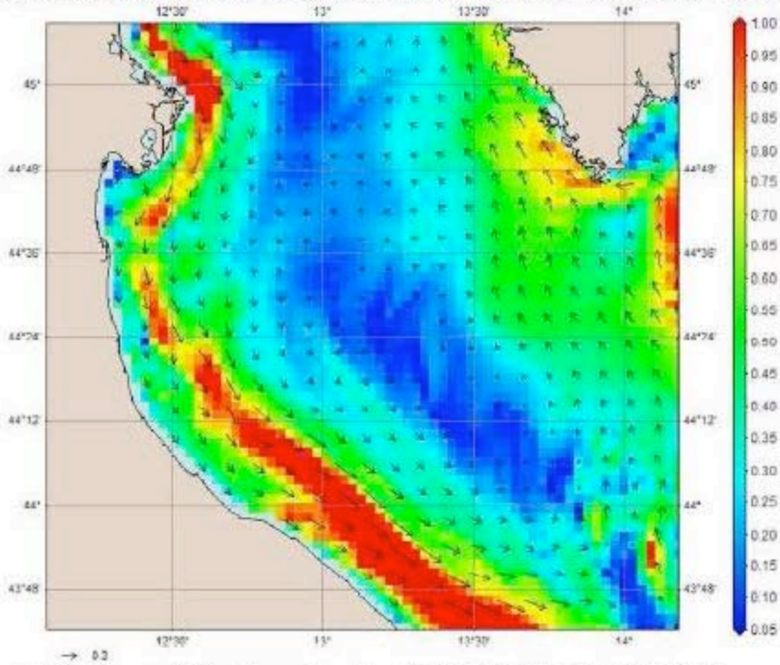

Figura 8: Current (knots) mean field at the surface from 12:00 20080215 to 12:00 20080216.

OIL SLICK DRIFT at 20080215 (Friday)

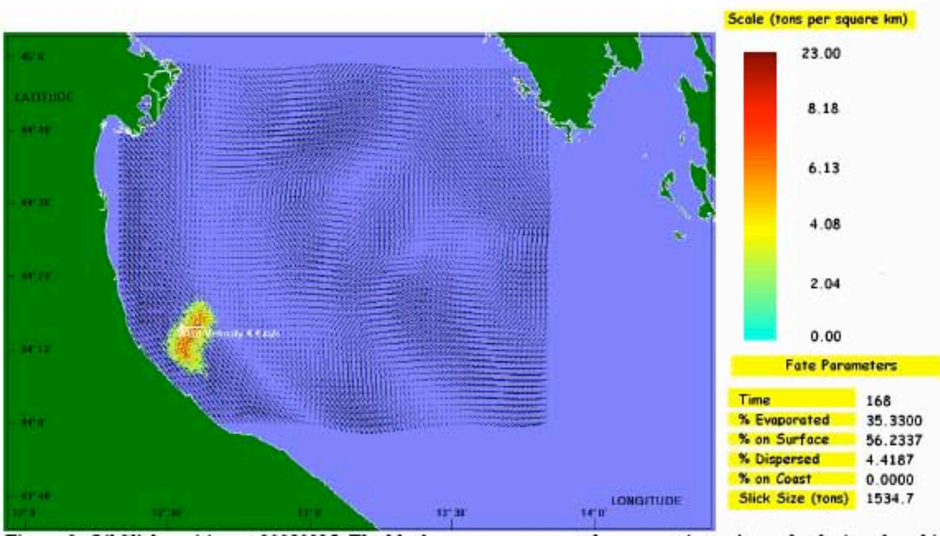

Figura 9: Oil Slick position at 20080215. The black arrows represent the current intensity and velocity, the white arrow represents the wind intensity and velocity.

4. Conclusions

The operational support capability shown by GNOO-INGV during the accident of Und Adriyatik has proven that the modelling and forecasting system running at INGV is ready to be used operationally in any case of emergencies at sea. Furthermore it is a useful tool for contingency planning during emergencies. During next crisis additional information could be included in the bulletins such as an estimation of the slick dimension, velocity of slick drifting and time that the slick may take to reach the coast. Satellite images are of extreme importance for the detection and monitoring of the oil spill, and MEDSLIK simulation can be automatically initialized from satellite images and therefore during an emergency satellite images can also be used to restart a simulation with MEDSLIK from the new detected slick position.

This experience has highlighted the necessity of strong coordination among different Italian institutions for a rapid and efficient exchange of information. It would be then mandatory in the future to consolidate the relationship and the agreements among all the institutional entities in order to assure an integrated operational service for oil spill emergencies at sea.

Acknowledgements

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Guardia Costiera Italiana
Gruppo di Oceanografia Operativa della sezione di Bologna dell'INGV

References

S.Castellari, N. Pinardi and A. Coluccelli, (2006). The ADRICOSM Pilot Project: a coastal and river basin prediction system for the Adriatic Sea. *Acta Adriatica* 47 (Suppl.), 5-18.

R. Lardner, G. Zodiatis, D. Hayes and N. Pinardi, (2006). Application of the MEDSLIK oil spill model to the Lebanese spill of July 2006. European Group of Experts on satellite monitoring of sea based oil pollution. *European Communities ISSN 1018-5593.*

N. Pinardi, I. Allen, E. Demirov, P. De Mey , G. Korres, A. Lascaratos, P.-Y. Le Traon, C. Maillard, G. Manzella, and C. Tziavos, (2003). The Mediterranean ocean forecasting system: first phase of implementation (1998–2001). *Annales Geophysicae*, 21: 3–20 c

Quotidiano *La Stampa*, Thursday the 7th 2008, page 1, page 22.

WIKIPEDIA: http://en.wikipedia.org/wiki/UND_Adriyatik