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**ARGOMARINE: Integration of Gepositioning and Automatic Oil Spill Monitoring in a Marine Information System**

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**General information on National Park of the Tuscan Archipelago**

The National Park of the Tuscany Archipelago includes seven islands unique for climate, flora, fauna, history and legend. They are characterized by diversified natural environments, created by a rather complex geological history. The National Park was established by the law 394/91, by the decree D.P.R. of 22 July 1996 and by the D.M. (Ministry Act) "Environment", 19 December 1997. The Park's area comprises circa 18.000 hectares of land, with interesting geological and naturalistic sites, and 60.000 hectares at sea. The Tyrrhenian is populated by numerous species rare to come across today in other places, hence it is comprised in the area of the International Sanctuary for the protection of sea mammals called "Pelagos".

The National Park's duty is to preserve the heritage of species and eco systems of these seven islands, in a joined effort between conservation and protection and the value achieved by man.

***Notice on the authors***

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QuickTime™ and a decompressor are needed to see this picture.

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**Introduction: the Scenario**

Short Sea Shipping is a central part of the logistics chain of transport in Europe, delivering nearly 40% of the total tonne-kilometres per year, only superseded by road transport with 44% (Ferraro, 2006). Between 1995 and 2004 the transport in this sector increased by 32% in EU-25 countries, and while increase in sea transport can be desirable from an economic point of view, it places a growing burden on the marine and coastal zone environment due to the risk of pollution.

Some ocean areas are particularly exposed. For example, in the Mediterranean Sea the oil transport is intense, since it gives maritime way to Europe, for the oil produced in Middle East, in the Northern Africa and in Caspian basins. According to Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC, 2002), 360-370 million tons of oil and refined products is transported annually through Mediterranean Sea, representing 20-25% of the world total. Maritime traffic in the Mediterranean is characterized by the existence of a large number of ports in the region (more than 300), and by a significant volume of traffic that transits the Mediterranean, without ships entering any of these ports. The East Mediterranean Sea is a high-risk area for pollution as the Black, Red and Mediterranean Seas are interconnected.

Due to very high marine traffic density, Mediterranean Sea is often quoted as one of the places in world with the highest risk of oil pollution. Transportation of large quantities of crude oil and refined products, narrow and congested straits through which ships enter and exit the Mediterranean, large number of ports, large number of islands especially in

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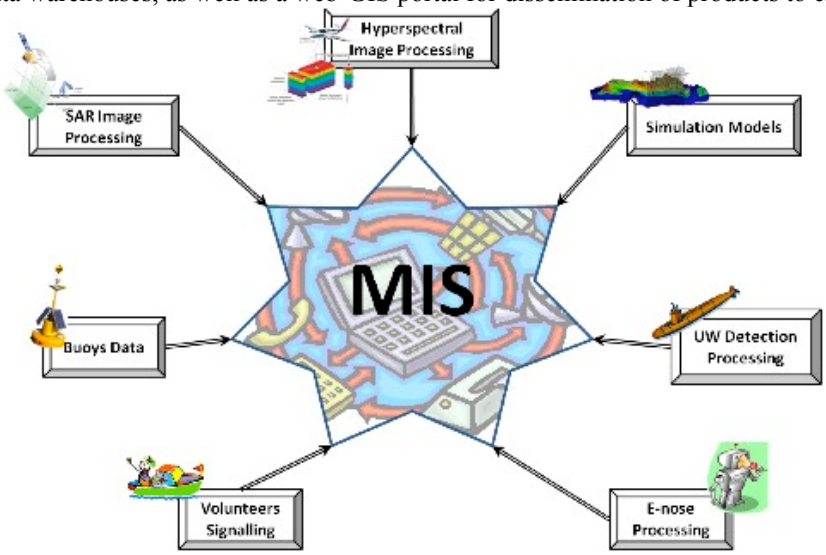
certain areas with high traffic density are increasing the risk of oil pollution in the region. Thus, decision-makers in this region have a strong need for an efficient pollution monitoring and forecasting system, which supports them in planning and conducting preventive and emergency interventions. Such system must provide timely and reliable access to all available observations and forecasts for the area of interest, and seamlessly integrate these as well as software for analysis, decision-support and dissemination.

Recent events such as the Prestige and Erika tanker accidents have shown that there is also a strong need for improved pollution monitoring and forecasting in other European Seas. In the average, about 60 maritime accidents occur per year, 15 of them involving ships provoking oil/chemical spills. The increase in transport of oil and other dangerous chemicals in Northern European and Arctic Ocean areas, such as the Barents Sea, further extend the demand for marine pollution services to support early warning and planning of mitigation actions to reduce the environmental impact.

**ARGOMARINE: Overall and Specific Objectives**

The overall objective of the ARGOMARINE[3] project is develop and test a Marine Information System (MIS) capable of providing precise and punctual pollution control in coastal zone areas with vulnerable or protected habitats, and/or are exposed to risk of accidental or intentional contamination due to their vicinity to industrial or highly densely populated settlements, or crossed by a heavy ship traffic. The ARGOMARINE project will develop a *Marine Information System* (MIS) to meet the needs for improved marine pollution monitoring and forecasting in support of emergency handling.

The MIS (see picture below) will consist of a network of systems for data storage, data mining and analysis, decision-support and data warehouses, as well as a web-GIS portal for dissemination of products to end-users.




*The ARGOMARINE MIS (Marine Information System): an integrating system for all sensor platforms*.

An Integrated Communication System (ICS) will also be developed to ensure reliable and efficient data transmission from different types of sensors to the MIS, providing accurate geo-positioning of every data item.

The MIS will be developed in line with recommendations from INSPIRE and GMES initiatives, adhering to de facto W3C, ISO and OGC standards for ensuring interoperability between the different subsystem. The MIS will have an open and extensible architecture allowing new components to be "plugged in" as needed, e.g. when new sensors or algorithms become available.

A preventive area, and environmental post-accident monitoring, will be realized using Underwater Monitoring Technologies based on both new gliding technology, and Autonomous Underwater Vehicles (AUVs).

The specific objectives of the project are:

1. Develop and combine marine observing technologies (satellite, airborne, vessel-mounted sensors along with stand-alone sensors on autonomous buoys, AUV) for more reliable detection and monitoring of hydrocarbon/oil spills in marine environment, in support of preventive and emergency interventions;
2. Develop and test a pre-operational high resolution mathematical modelling system to forecast hydrodynamic conditions and prediction of oil slick spreading during emergency situations as part of an early warning system;
3. To design and test an infrastructure that must make the necessary environmental and situational information available to local managers and decision makers within a short response time.
4. Implement a geo-positioning/tracking system for ship traffic monitoring based on the integration of AIS with ARGOMARINE technology, so acting as an intelligent transponder through either satellite platforms or ground-based stations;

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3 According to the Greek mythology, **Argus Panoptes** is the hundred-eyed giant put by Zeus to keep guard over his beloved heifer/nymph Io

5. Design and implement an integrated data transmission network ensuring high speed/high volume communication with ships, sensor-equipped platforms, including vessels, aeroplanes, helicopters, satellites, autonomous floating buoys, and AUVs;
6. Build and test a MIS (Marine Information System) comprised of distributed, interoperable systems for data transmission, data mining and analysis, decision-support and data dissemination to end-users, designed with a component based architecture that can form the foundation of other environmental applications like anti-fire forestry protection and wetland habitat monitoring;
7. Test the sensor platforms and validate the developed algorithms and systems in carefully designed test scenarios where the capabilities of the devised solutions will be assessed, and feedback used to improve their reliability and accuracy;
8. Disseminate regularly towards key end-users such as EMSA (European Maritime Safety Agency), National Parks and other institutions managing protected areas, and organise a dedicated workshop on marine pollution to reach a wider audience in the marine community;
9. Prepare recommendations and plans for post-project exploitation of ARGOMARINE products and services.
The Project will last three years (Sept. 1st, 2009 – August 31st, 2012).

**Scope of the Project**

The scope of the proposed ARGOMARINE Project is to develop and test an integrated system for monitoring of the marine traffic and pollution events due to carriers/commercial ships as well as recreational boats through environmental-sensitive sea areas. The integrated system will be used to monitor ship traffic and marine operations in areas with intense ship traffic and high risk of pollution as well as, for effective interventions in case of maritime accidents. This monitoring will be implemented by means of electronic, geopositioning, and tools for transmitting ship navigation data through a high speed communication network. Environmental data from different sensors (SAR, hyperspectral sensor, thermal sensors, electronic noses, acoustic sensors) on satellites, aircraft, vessels, in situ anchored buoys and AUVs will be collected in test areas, and sent by telemetric links to a central server where all the data are integrated by use of web mapping technology. Accident modelling and post-accident intervention simulation tools for impact prediction will be implemented and tested through field experiments.

The envisaged goal is connected to the necessity of precise and punctual pollution control in areas and shores which are, for instance, of particular naturalistic value, and/or are exposed to risk of accidental or even intentional contamination due to their vicinity to industrial or highly densely populated settlements, or crossed by a heavy ship traffic. Other areas which can benefit by the results of a distributed sea monitoring could be those exposed to environmental risk in particular periods during the year due to an abrupt increase of the human population (i.e. tourist localities and shores).

Ship traffic through Mediterranean basin daily consists of 2,000 ferries, 1,500 freight ships and 2,000 commercial crafts, 300 of them are tankers (20% of the world amount of oil sea traffic), carrying more than 350M oil tons per year (8M barrel per day).

To monitor marine pollution, data from both satellite and airborne remote sensors and in situ sensors on vessels and buoys will be used to derive information about water quality and spread of hydrocarbons/oil slicks over large areas. Vessel and airborne support will be provided by Italian Coast Guard and Foresters Corps.

Other data will come from electronic nose technology, which is being shown as effective to monitor oil/hydrocarbons leakage in marine water. The final sensor device will be scale-reduced and hosted on an autonomous buoy. An electronic control will supervise the performance and the activation of the sensor device.

At the same time, tracking of sea ship traffic will be accomplished by ARGOMARINE technology. The system will act as an intelligent transponder through either satellite platforms or ground-based stations. External data such as weather station data, weather operational models and large scale hydrodynamic and wave models will be gathered from the external providers. Local implementations of high resolution mathematical models will be developed for the study sites. The modelling system will include a 3D hydrodynamic model a wave model and an oil spill model. The modelling system will be run in pre-operational mode, downscaling the solutions of existing global/Mediterranean operational models.

All the data and the information obtained will be merged and elaborated in a *Marine Information System (MIS)*, i.e. an information system where remote sensing data, field experiment results and estimates from simulation models can be integrated, and tools for data storage and retrieval, data manipulation and analysis, as well as for presentation, are available through a common interface.

Thus, ARGOMARINE project will make profit of:

(1) Satellite, airborne and vessel-mounted sensor platforms for:

- Capturing images of the area of interest regardless of cloud cover and weather conditions.
- Capturing images of very high spatial and spectral resolution
- Combining remotely sensed information and improving oil spill detection methods and techniques.

(2) Underwater Monitoring Technologies for:

- Passive acoustic monitoring for detection and preventive action to detect possible unauthorized access
- Autonomous Vehicles for detection and confirmation of accidents and oil spill detection

(3) Mathematical modelling for:

- Predicting the sea hydrodynamics and simulating the fate of oil slicks after spill events

(4) Integrated communication and high-performance data processing for:

- Producing near real time information about ship traffic situation and marine pollution events
- Realizing a fault tolerant integrated communication system between sensors, database, and MIS
- Integration of real time simultaneous data transmission of different kinds of information (different formats, geo-positioning, etc)
- Realisation of a web-based GIS, accessible by professionals, Authorities and scientists.

The simultaneous achievement of these results will constitute a substantial step beyond the present state-of-the-art in marine pollution monitoring and forecasting, providing new and innovative solutions for integrated communication between sensor networks and data centrals, data mining and analysis, decision-support and data warehouses, as well as web-GIS portals. The envisaged ARGOMARINE system will perform like an on-line, early-warning network, able to alert local authorities and environmental control agencies as well as specialized operators

**ARGOMARINE: the partneship**

The ARGOMARINE Consortium is detailed in the table below:

| Participant no. | Participant organisation name | Country |
|---|---|---|
| 1 (Coordinator) | National Park of the Tuscany Archipelago, Portoferraio-Isle of Elba | Italy |
| 2 | National Technical University of Athens, Athens | Greece |
| 3 | National Research Council – Institute of Information Science and Technologies, Pisa | Italy |
| 4 | Nansen Environmental and Remote Sensing Center, Bergen | Norway |
| 5 | Centro de Investigação Marinha e Ambiental – Universidade do Algarve, Faro | Portugal |
| 6 | Sciensive Technologies Limited, Normanton | UK |
| 7 | National Maritime Park of Zakinthos, Isle of Zakinthos | Greece |
| 8 | Joint Research Center – Institute for the Protection and Security of the Citizen, Ispra, Italy | EU |
| 9 | NATO Undersea Research Centre, La Spezia, Italy | NATO |

Partners will contribute with their international excellence and experience, advanced analytical facilities and established collaboration with Institutions devoted to study and management of environmental resources. A **European consortium of multi-disciplinary expertise** where the partners combine their **expertise** in Information Management and communication, innovative computer science, remote sensing and sensors The interdisciplinary and complementary structure of the partnership guarantees the solution of the scientific and technological tasks of the project.

***Oil Spill Detection in ENVISAR ASAR Imagery 7 June 2008, Tuscan Archipelago:***

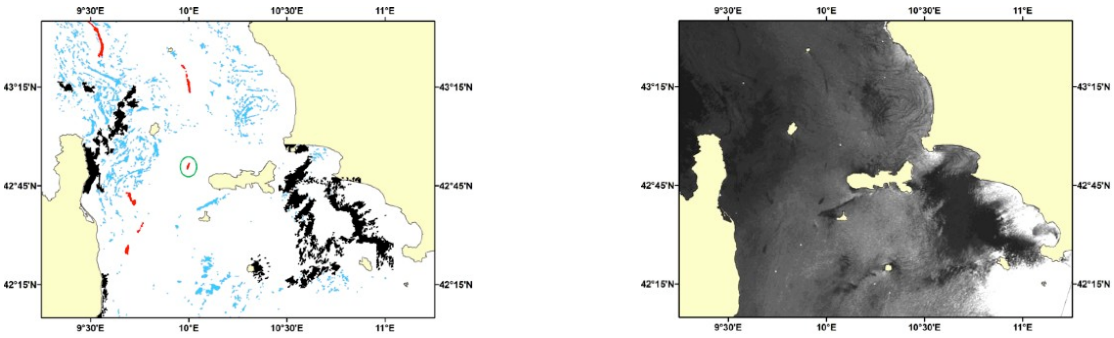


***Fig.2***

Data Analysis Copyright © 2010 NERSC (Nansen Environmental and Remote Sensing Center, Bergen, Norway). In red: potential oil spills; in blue: currents and waves; in black: low wind speed

ENVISAT ASAR Data Copyright © 2008 European Space Agency.


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Project will last three years (Sept. 1st, 2009 – August 31st, 2012). The research leading to these results has received funding from the European Community's Seventh Framework Programme under **Grant Agreement SCP8-GA-2009-234096-ARGOMARINE**


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