THE ARGOMARINE PROJECT: A LOW COST PLATFORM TO INTEGRATE DATA AND THE EXPLORATORY USE OF NEW TOOLS IN MONITORING OIL SPILL

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1. The ARGOMARINE Project

The project ARGOMARINE[1] (Integration of Geo-positioning and Automatic Oil Spill Monitoring in a Marine Information System) has been launched in September 2009 with the support of the European Union Seventh Research Framework Programme. The project lasts 3 years and is developed by a consortium of eight research institutions in Europe: the Joint Research Center of the European Commission, the NATO Undersea Research Centre, the National Technical University of Athens (Greece), the National Research Council (Italy), the Nansen Environmental and Remote Sensing Center (Norway), the Environmental and Marine Research Center of the University of Algarve (Portugal), the National Maritime Park of Zakinthos (Greece), and the National Park of the Tuscany Archipelago (Italy), the coordinator.

One of the key aim of ARGOMARINE focuses on the development of a platform to integrate different maritime data (such as metoceanographic data, transport data, pollution data, etc). Major national organizations such as Navies and Coast Guards are aiming to integrate different types of information to define a maritime picture on a wide scale. This entails developing complex, expensive and classified "hubs" to collect, store, analyze and disseminate the maritime data. ARGOMARINE plans to develop a Marine Information System (MIS), a connected group of ICT subsystems performing data storage, mining and analysis, decision-support, as well as a web-GIS portal for the access and usage of the products and services released to System Managers and end-users. MIS will integrate remote sensing data, field experiment results, forecast models with tools for data storage and retrieval, data manipulation, analysis and presentation; all these features will be accessible through a common interface. Operationally, the following sub-systems have been confirmed for the MIS platform: SAR (Synthetic Aperture Radar) image processing, hyperspectral-thermal image analysis, mathematical simulation for forecast models, dynamic risk maps management, Autonomous Underwater Vehicle (AUV) management and data analysis, marine traffic monitoring through Automatic Identification System (AIS), Environmental Decision Support (EDS), and data mining/warehousing through operational and historical databases. Data integration of all data from these different systems is an innovative approach to maritime surveillance.

ARGOMARINE tries to respond to the different specific need of "minor" (smaller) maritime actors, such as national marine parks. These actors need, in general, the knowledge of different maritime data for a small area but with a very high level of detail. For this reason, they aim at "low cost" hubs but with well defined capabilities.

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[1] According to the Greek mythology, **Argos Panoptes** is the hundred-eyed giant put by Hera to keep guard over the heifer/nymph Io.

2. The Marine Information System

The core of ARGOMARINE is the Marine Information System (MIS), which collects, converts, stores and processes data from a large set of different data sources, including remote sensing data, in situ data and mathematical model results (fig. 1). The communication network is managed by the Integrated Communication System (ICS).

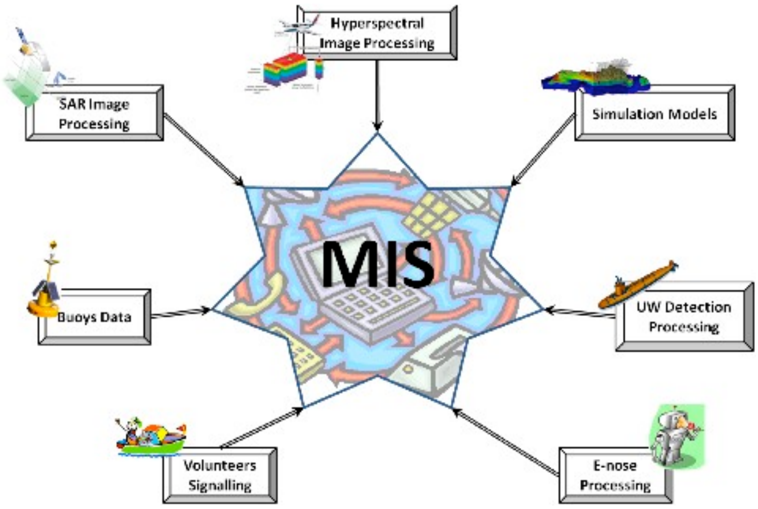

Fig.1 The ARGOMARINE MIS (Marine Information System): an integrating system for all sensor platforms.

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 possesses tools for data storage and retrieval, data manipulation and analysis, as well as for graphical presentation. The interface is divided in two parts: The HI (Human Interface) used by the operator and the DEI (Data External Interface), for interfacing the MIS with other networks/structures such as GMES services and systems. The DEI is developed using a web-based GIS portal. The main functions of the MIS are: analysis of signals coming from external data sources, data storage in data warehouse, GIS connection, data mining algorithms, management of a control console with interactive panels and implementation of decision Support System routines. MIS is being designed for a robust fault tolerance: some entry-level servers, distributed on the territory will enable a decentralization of the data storage and the calculation. The MIS decisional and storage architecture will be structured into layers: a first layer allow the handling of global information, a second pre-computation layer sorts which information has to be written in the data warehouse and finally a third "data warehouse" layer extracts information by data mining techniques. This architecture will integrate robustness and reliable calculation and, in order to support catastrophic events, it will reallocate computational tasks from one computer to another as a consequence of the workload, or the drawbacks.

The ICS is a communication structure with the objective of transferring data between passive and active actors present in the geographic area to be monitored. It will be structured as a network where the nodes can be associated to the functions: informative Intranet flow, informative flow towards other nets and capability of simple elaborations of the collected data. This last function permits to use the net of the integrated informative system at its best as a nervous digital system able to adapt quickly to new situations and to send alarms in case of anomalies.

From a logical point of view, the pre-computational nodes are placed between the informative nodes and the bridge nodes. Pre-computational nodes will get raw-data flow from the informative nodes. They can be located in fixed or mobile positions, the last by a suitable data routing. The mobile nodes can be set up by portable devices like mobile phones, palm tops etc. or computers installed on jeeps, boats etc.

3. Technologies to monitor oil spills

3.1 Remote sensing data

As mentioned above, ARGOMARINE plans to integrate different types of data. Some of them have reached a good level of maturity. Synthetic Aperture Radar (SAR) images from some of the available satellites (ENVISAT-ASAR and Radarsat-2) are already used operationally to monitor oil spills (Ferraro *et al.* 2007). In addition to them, ARGOMARINE wants to test also the capability of the more recent satellites such as Cosmo-SkyMed, TerraSAR-X, which allow for a higher image resolution.

Hyperspectral Compact Airborne Spectrographic Imager (CASI) and Thermal Airborne Broadband Imager (TABI) will be mounted on helicopters and tested by ARGOMARINE. These systems offer a highly detailed view over a specific area, complementing satellite imagery during surveillance and are crucial during accidents. The CASI hyperspectral sensor acquires digital spectral data in the visible and near infrared wavelengths. The method is based on the simultaneous use of spatial and spectral information by extended mathematical morphology operations. It also uses signal processing tools to correct aircraft position and movement errors. With this method CASI has proved to be capable of defining the shape of slicks with high contrast and spatial resolution, moreover it is also able to penetrate to depths of 20-30 m in clean water to see the submerged oil (Salem and Kafatos 2001). The TABI sensors acquire infrared images with refractive optics, uncooled and with a thermally stabilized microbolometer, showing a resolution of 0.1ºC. The resulting temperature differences will lead to potential oil spill formations and will permit to infer the thickness of the oil slick, (Maya *et al.* 2008).

3.2 Exploratory use of e-nose

Chemical (electronic nose) sensors are rather selective for hydrocarbons and oils (Sobanski *et al*. 2006). In ARGOMARINE a new type of sensor will be developed to rapidly detect volatile chemicals (VOCs) associated with oil and fuels in the sea water. The sensors are all pure semiconductive polymers deposited electrochemically on interdigitated gold on silicon transducers and the system is run by proprietary electronics. The electronic nose sensors will be mounted experimentally in a fixed buoy for testing trails and afterwards they will be installed in an autonomous underwater glider.

3.2 Potential use of Underwater Autonomous Vehicle (UAV)

In ARGOMARINE, the potential use of Underwater Autonomous Vehicle (UAV) will be explored. The glider will be of the Folaga type which combines gliding capabilities with active propulsion (Alvarez *et al.* 2009). The system will be useful in two different types of missions: surveillance (patrolling) and accident assessment.

CONCLUSIONS

The ARGOMARINE concept for oil spill surveillance, early warning and management contains some innovative ideas. First, there are “actors”, like Marine National Parks, which need to develop their own maritime surveillance system. They cannot afford complex and expensive systems but are ready to “buy” tailored systems for their needs. Secondly, the potential use of e-nose to detect oil at sea is tentatively assessed in this project. Last but not least, ARGOMARINE explores the potential of Underwater Autonomous Vehicles, an additional important tool in the field of maritime surveillance.

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