Scientific research for the study of coastal waters: methodologies and product improvement based on the new space missions

Coastal waters are characterised by small-scale processes and phenomena marked by high spatial and temporal variability of the ecosystem, with risks and unpredictable natural and anthropic events. Looking at the specificities of Mediterranean waters, whose natural characteristics are determined by a very variable climate, the need for information and data on the quality of the environment to better understand how ecosystems operate and how natural and anthropic processes interact is obvious.

Management of a coastal environment closely depends on the knowledge of its components, of the processes and of its dynamics in relation to the specific regional characteristics and to the request for information from local workers. EC legislation has a large number of directives and specific agreements that indicate an entire series of physical, chemical, biological, ecological, health and environmental, dynamic and morphological parameters that help define the quality of coastal and transitional waters. The solutions to such complex environmental problems force ecologists to carry out studies and evaluations on spatial and temporal scales that are difficult to conduct through traditional scientific approaches: satellite observation of waters is becoming more and more competitive in comparison with traditional investigations with multi-scale observations and analyses on broad temporal and spatial domains.

The use of remote sensing techniques is not limited to the observation and mapping of water quality parameters (chlorophyll concentration, yellow substance and suspended sediment) but attempts to obtain the quantitative measurement of the same. This aspect often represents the crucial step that considerably engages the scientific community, since it means obtaining a product with the best operationality and accuracy requisites, according to the requirements of the final users.

The continuous technological evolution of the Space Segment increases the application potentials of Earth observation: this stimulates the scientific community to develop geophysical parameter extraction methodologies, suitable for the new technologies, that are capable of improving product accuracy values and thus of furthering knowledge of the phenomena and processes that occur in the different environmental and ecological contexts. If we consider the complexity of coastal and internal waters, only hyperspectral data, through recognition of the spectral features of water reflectance, allow the identification and quantitative measurement of the optically active parameters, necessary to characterise its quality and to allow for useful environmental monitoring for managing these important ecosystems.

The new hyperspectral satellite sensors (PRISMA, EnMap), expected in 2013, will be capable of acquiring the data required by the scientific community for developing new applications for observation of the territory and supporting environmental risk management.

The goal of the CLAM-PHYM project (financed by ASI – the Italian Space Agency - under the authority of the CNR ISMAR, IIA and IREA institutes), is to verify the potentials of the PRISMA sensor for the improvement of

standard products and for the development of added value products for the management and monitoring of the aquatic environment through hyperspectral algorithms and their validation. The project proposes to tackle the complexity and optical variability of coastal and internal waters and their problems with a physically-based approach in order to improve EO product quality. Integration with activities in the field, such as the source of calibration data and data and EO product validation, is necessary.

In order to generalise the parameterisations of the algorithms, the study will be conducted in both freshwater and saltwater environments and special attention will be paid when considering the temporal and site-specific variability of the optical properties of the studied sites.

In the case of freshwaters, we plan to select lakes with different trophic states (e.g. oligo-mesotrophic conditions in Lake Garda and eutro-hypertrophic in Lake Trasimeno), which are in emergency conditions as far as the presence of cyanobacteria is concerned (sporadic blooms in Lake Garda, constant and massive concentrations in Lake Trasimeno) and with areas colonised by macrophytes subjected to various types of anthropic pressure (e.g. navigation and alteration of the coastal areas in Lake Garda, management of the hydrometric levels and of the organic loads in Lake Trasimeno).

On the coastline, the study will verify the applicability of the methodologies in sites with different degrees of "optical" complexity in relation to the morphological characteristics and the environmental problems found. One of the anticipated sites is the Venice Lagoon, where optically different waters coexist, influenced by weather and sea forces (wind, tide, wave motion), by the morphology and covering of the lagoon bed (areas a few tens of centimetres deep and 10 m deep canals, several types of substratum and prairies of marine phanerogams), by the presence of anthropic activities (civil, industrial, means of transport), by rivers and by the sea. The Gulf of Manfredonia area is relatively less complex as far as morphology is concerned. The intrinsic variables of the waters are linked to the presence of civil and industrial anthropic activities and to the amount of suspended sediment of fluvial origin (Ofanto River) due to re-suspension of the bed sediments caused by water column mixing due to wave motion.

Based on the specificities of the selected ecosystems, we will adopt ad hoc procedures for the generation of added value products such as bloom maps of potentially toxic algae (cyanobacteria) in waters with the highest degree of trophy; maps indicating the nature and extent of the submerged marine phanerogams in systems with low bathymetries, maps of suspended solids and their fractions in re-suspension areas (e.g. fluvial plumes, coastal areas).

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