COASTAL WATER ASSESSMENT AND MONITORING BY HYPERSPECTRAL REMOTE SENSING TECHNIQUES: SELECTED APPLICATIONS IN THE ADRIATIC SEA

F. Braga [1]*, L. Alberotanza [1], R. M. Cavalli [2], S. Pignatti [3] and F. Santini [2]
[1] CNR Ismar, 30122, Venezia, Italy - f.braga@ismar.cnr.it
[2] Institute of Atmospheric Pollution (CNR IIA - LARA), 00133, Roma, Italy
[3] Institute of Methodologies for Environmental Analysis, CNR IMAA, 85050, Tito Scalo, Italy

Abstract
Observation of coastal areas may address to different aspects of the environment such as parameters and processes of water quality, hydrodynamics, geomorphology, meteorology and ecology. Satellite and airborne remote sensing can provide an important contribute for assessing and monitoring the status of water quality. Selected case studies, which describe data acquisition and processing, outline improvements in the advanced methodologies and provide examples of gaps and barriers to produce useful applications in coastal areas, are presented.
Keywords: Coastal Waters, Remote Sensing, Adriatic Sea

Introduction
Coastal areas are characterized by small-scale processes, high spatial and temporal variability of the main physical and biogeochemical properties of the water, hazards and unpredictable events. These areas are very sensitive to the impact of human activities and land use in watersheds, along the coast and further inland, of fluvial discharges, and of marine processes.
Local and national authorities require innovative methods and technologies for managing coastal risks and monitoring water quality, in order to satisfy operational, spatial and qualitative requirements with a good cost-benefit ratio. In the recent decades, a helpful contribution has been obtained by the Remote Sensing data, which can significantly enhance the information available from traditional data sources providing synoptic views of large portions of Earth with a relatively high revisiting frequency and therefore early detection of anomalies and degradation of the ecological status.
Remote sensing of the bio-optical parameters can be an important way for monitoring the coastal environment. Whereas the optical properties of open ocean (Case 1 water) are primarily a function of phytoplankton concentration, coastal waters (Case 2 water) represent a more complex optical environment [1]. The optical properties in these areas are due to a mix of phytoplankton, suspended sediments, and CDOM that can vary independently from each other. Besides the water colour can be influenced by bottom reflectance and we must take account of the natural variability in the types of bottom (e.g., sand, mud, rocky, algae or seagrasses covered).
Water quality parameters may be derived from hyperspectral data [2] [3] [4].

Methodology and results
In the last years, we have investigated the capability of multi and hyperspectral remote sensing data to meet the information needs of end users in the coastal zone and we present some case studies which describe data acquisition and processing, outline improvements in the advanced methodologies and provide examples of gaps and barriers to producing useful applications.
During satellite and airborne overpasses on the Adriatic Sea (Lagoon of Venice , 2001-05; Sacca di Goro Lagoon, 2005-06; Montenegro, 2007-09, see Fig. 1), we acquired an extensive in situ data set: the field campaigns retrieved inherent optical properties, apparent optical properties, substrate reflectance spectra, and water quality parameters with advanced instruments. The efforts aim at making a first step in the construction of a feasible and timely methodology for quantitative assessment of water quality parameters detectable from hyperspectral data. The adopted analysis techniques of satellite and airborne imagery were: the empirical algorithm for CDOM/chl-a retrieval; the classification techniques for algae and submerged vegetation identification with spectral libraries; the complex physically based model that considers analytical formulations of radiative transfer equations and the application of numerical simulations (Hydrolight software).
In particular, for the Venice Lagoon the authors have been involved in the tuning of a physical model for the highly turbid Venice lagoon waters and developed an inversion technique appropriate for hyperspectral data processing to retrieve water constituent concentrations from remotely data.

Conclusions
Within the hyperspectral VIS-NIR spectral range, several parameters are detectable from space: presence/absence of algal blooms, concentration of phytoplankton with some information on content of different pigments, suspended matter and yellow substances concentrations, diffuse attenuation coefficient, water colour, water transparency and, over shallow waters, bathymetry, submerged vegetations and substrate types.

The selected applications of hyperspectral observation techniques in the Adriatic sea, financed and conducted in the framework of international projects (i.e. NERC, ESA, ASI, Italian Environmental Ministry), provide examples of the remote sensing efficiency in the field of integrated coastal environmental management.

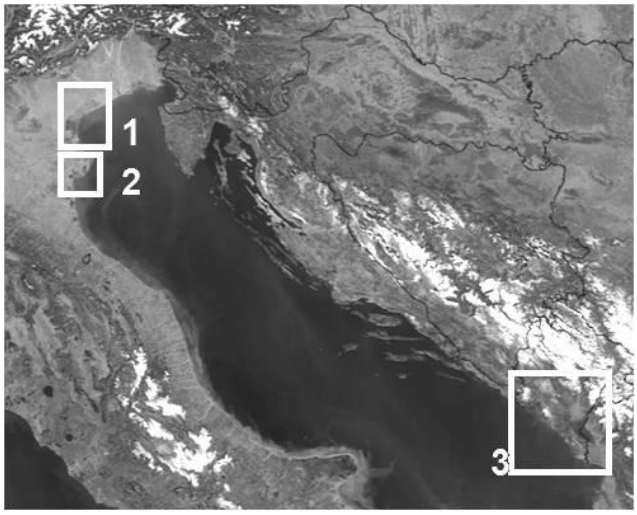

Fig. 1. Location of case studies: Lagoon of Venice (1), Sacca di Goro Lagoon (2), Montenegro coastal area (3).

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