URBAN AND REGIONAL DEVELOPMENT

DIATI -Multiscale Hyperspectral GeoAI for Monitoring and Forecasting Environmental, Territorial, and Industrial Dynamics across the Land–Sea Continuum

Funded By	DIATI - Progetti ricerca Regione ed Enti Locali
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Context of the research activity	Development of GeoAI methodologies for the integration and multiscale analysis of hyperspectral data acquired from satellite, Uncrewed Aerial Vehicle, ground-based sensors, and underwater platforms. The research is aimed at monitoring and forecasting environmental, territorial, and industrial dynamics, with particular emphasis on the land–sea continuum, the quality of georeferenced data, and multitemporal analysis.
Objectives	This PhD project proposes the development of advanced methods for the acquisition, georeferencing, integration, and analysis of hyperspectral data collected from multiple observation platforms operating across satellite, aerial, terrestrial, and underwater domains. The research will exploit data from the PRISMA and IRIDE satellite systems, hyperspectral sensors deployed on uncrewed aerial vehicles, close-range ground-based instruments, and underwater platforms, with particular attention to the observation of Posidonia oceanica and marine vegetation. The project is grounded in the assumption that hyperspectral sensing, now increasingly accessible through lightweight and cost-effective platforms, can significantly enhance the quality and depth of information extracted for environmental, territorial, and industrial applications. Its scientific relevance lies in the possibility of linking synoptic observation at regional scale with high-resolution local surveying and in situ measurements, thereby enabling a truly multiscale interpretation of complex processes across natural and anthropogenic environments. A key research challenge concerns the integration of hyperspectral data within a rigorous geomatics perspective. The reliability and comparability of the information derived from heterogeneous sensors depend on accurate spatial positioning, robust geometric and radiometric consistency, and the harmonization of acquisitions performed at different scales and under different operational conditions. For this reason, the project will pay specific attention to the integration of positioning, navigation, and attitude sensors, with the aim of ensuring metric quality and methodological coherence throughout the entire acquisition and processing workflow. The research will further investigate the contribution of GeoAI, machine

	learning, and deep learning techniques to the interpretation of high-dimensional hyperspectral data. By combining spectral richness, spatial context, and temporal variability, the project aims to improve thematic segmentation and classification, material discrimination, anomaly detection, and the estimation of parameters relevant to environmental assessment and territorial analysis. This integrated approach is expected to support the monitoring of ecosystems, land cover, anthropogenic surfaces, and industrial areas, while also enabling a more accurate characterization of transformation processes and pressure factors. Particular importance will be assigned to the multitemporal dimension. Through the analysis of hyperspectral and multi-sensor time series, the project will address change detection, trend analysis, and the development of predictive models for forecasting environmental and territorial dynamics. In this sense, hyperspectral data will be investigated not only as a source of descriptive information, but also as a strategic asset for building advanced monitoring and decision-support capabilities. Overall, the project aims to contribute to the consolidation of a multiscale and interdisciplinary approach in which hyperspectral remote sensing, geomatics, and artificial intelligence converge to address emerging challenges in coastal and marine ecosystem protection, sustainable territorial management, and the monitoring of environmentally relevant industrial processes.

Skills and competencies for the development of the activity	Applicants are expected to have basic knowledge of, and a strong interest in, environmental and land engineering, climate change, geomatics, remote sensing, and Geospatial AI. Preferential qualifications include experience in geospatial data analysis, multispectral and hyperspectral imaging, machine learning and deep learning, GIS, multitemporal modelling, and the integration of positioning and georeferencing sensors.