

PhD in INGEGNERIA AMBIENTALE E DELLE INFRASTRUTTURE / ENVIRONMENTAL AND INFRASTRUCTURE ENGINEERING - 40th cycle

Research Area n. 3 - Environmental and Hydraulic Engineering and Geomatics

THEMATIC Research Field: ENHANCING EARTH FOUNDATION MODELS WITH HYPERSPECTRAL SATELLITE IMAGERY FOR GEOSPATIAL GENERATIVE AI

Monthly net inco	ome of PhDscholarship (max 36 months)
€ 1750.0	
In case of a change of the welfare rates during the	three-year period, the amount could be modified.
Con	text of the research activity
Motivation and objectives of the research in this field	The primary motivation for this research lies in the significant advancements and potential applications of hyperspectral satellite imagery in conjunction with AI technologies, particularly foundation models (FMs), large language models (LLMs), and large vision models (LVMs). The integration of these technologies offers innovative solutions for analyzing and interpreting complex geospatial data, which is critical for various environmental and infrastructural applications. Hyperspectral satellite imagery, exemplified by the PRISMA mission, provides detailed spectral information that is essential for a wide range of applications, including environmental monitoring, urban planning, and disaster response. The wealth of data from hyperspectral sensors allows for more precise and comprehensive analysis of the Earth's surface, enhancing our ability to address environmental challenges. Foundation models like NASA-IBM's HLS Geospatial FM and the newly emerged SpectralGPT represent the forefront of AI-driven geospatial analysis. These models and other similar which are emerging utilize large datasets and advanced architectures, such as transformers, to perform diverse tasks with high efficiency and scalability. The potential to enhance these models with hyperspectral



	The potential to enhance these models with hyperspectral data, particularly from PRISMA, presents an opportunity to significantly improve their analytical capabilities and address specific environmental issues more effectively. The main objectives of the research are: to study the enhancement of Geospatial Foundation Models with Hyperspectral Data and to develop new methodologies based on AI for Hyperspectral Data Analysis.
Methods and techniques that will be developed and used to carry out the research	To enhance the capabilities of existing geospatial foundation models, this research will focus on integrating hyperspectral data, particularly from PRISMA and other datasets. This involves developing sophisticated techniques that enable these models, like NASA-IBM's HLS Geospatial FM, to effectively process and analyze high-dimensional spectral data. Advanced data processing and analysis form another critical aspect of the research. By developing algorithms for preprocessing, normalizing, and interpreting hyperspectral imagery, the research aims to handle the complexity of this data. To further refine the AI models, customized training protocols will be developed. These protocols will fine-tune existing foundation models using hyperspectral datasets, aiming to improve their performance for specific environmental and geospatial tasks. Comparative analysis of various hyperspectral datasets will possibly also be conducted to evaluate their impact on model performance and identify the most effective datasets for different applications. The PhD research includes 9 months abroad in centers relevant to the initiative.
Educational objectives	This project aims to provide doctoral candidates with comprehensive training in advanced AI models and hyperspectral satellite imagery, ensuring they gain proficiency in both AI and geospatial data analysis. By fostering expertise in cutting-edge technologies, the program prepares candidates to tackle complex, real- world problems through interdisciplinary learning across environmental, infrastructure, and geospatial sciences. Hands-on research opportunities are also a key

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	component; these practical experiences allow candidates to apply theoretical knowledge to real-world projects, enhancing their research capabilities and professional readiness. Engaging with global research communities through workshops, conferences, and internships will help build a global perspective and establish valuable professional connections. The project also emphasizes the development of strong publication and dissemination skills. Candidates will be trained to publish their research findings in scientific journals and present at conferences, meanwhile enhancing their academic communication skills and increasing the visibility and impact of their work. Aligning research activities with Sustainable Development Goals (SDGs) is the last important objective.
Job opportunities	Academic and Research Positions AI and Earth Observation Companies and Startups Space Agencies Environmental and Urban Planning Departments.
Composition of the research group	1 Full Professors 2 Associated Professors 1 Assistant Professors 1 PhD Students
Name of the research directors	Maria Antonia Brovelli

Contacts

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Additional support - Financial aid per PhD student per year (gross amount)		
Housing - Foreign Students		
Housing - Out-of-town residents (more than 80Km out of Milano)		

Scholarship Increase for a period abroad		
Amount monthly	875.0 €	
By number of months	9	

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Educational activities: financial aid per PhD student per year. The Ph.D. course supports the



educational activities of its Ph.D. students with an additional funding equal to 10% of the scholarship, starting from the first year.

Teaching assistantship: there are various forms of financial aid for activities of support to the teaching practice. The PhD is encouraged to take part in these activities, within the limits allowed by the regulations.

Computer availability: each Ph.D. student has his/her own computer for individual use.

Desk availability: each Ph.D. student has his/her own desk, cabinet and locker.