URBAN AND REGIONAL DEVELOPMENT

CRT/DAD/DIST - GeoAI and Remote Sensing for Emergency Management (GEOREM)

Funded By	Dipartimento DIST FONDAZIONE CRT CASSA DI RISPARMIO DI TORINO [P.iva/CF:06655250014] Dipartimento DAD
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Context of the research activity	The PhD research activity is related to the identification, the analysis and the application of Geo-spatial Artificial Intelligence algorithms (GeoAI, with a focus on Deep Learning neural networks) applied to multi-temporal (but not only) remotely sensed multi-spectral data acquired mainly by satellite and Remotely Piloted Aircraft (RPAS) to support emergency management activities. The main goals are detecting/segmenting objects of interest and/or land cover classes, also detecting changes on multi-temporal images. The developed Geo-AI operational tools will therefore support both the climate and digital transitions.
	Extreme weather events, driven by global climate change, have become increasingly frequent and severe, posing significant risks to both urban and rural environments worldwide. Events such as floods, wildfires, hurricanes, and droughts contribute substantially to broader global challenges, including climate resilience, sustainable development, and environmental protection. In addition to hydrological hazards, geological events such as earthquakes can escalate into disasters when human infrastructure in affected areas, particularly in densely populated urban environments, is inadequately designed or maintained. In response to these challenges, this PhD research aims to explore and develop advanced Geomatics methodologies, primarily leveraging Geo-spatial Artificial Intelligence (GeoAI) and Geographic Information Systems (GIS), to automate as far as possible the mapping of disaster impacts and, indirectly, disaster risks. By utilizing multi-temporal and multi-spectral satellite imagery, particularly from the Copernicus programme - the Earth observation component of the European Union's Space Programme - and Remotely Piloted Aircraft Systems (RPAS), the research will focus on identifying key thematic layers, segmenting affected areas, and detecting changes in land cover, infrastructure, and terrain. These outputs are expected to support various phases of the emergency management cycle, especially disaster

Objectives	response and preparedness. The main goal of this PhD project is to identify, analyse, integrate and validate GeoAI-based tools capable of rapidly detecting and monitoring the impacts of extreme weather and geological events. These tools aim to address pressing global challenges related to climate change, disaster resilience, land degradation, and sustainable urban development. The focus will be on extracting actionable information from multi-temporal, multi-spectral, and, when available, multi-scale imagery to support near real-time decision-making in emergency management and planning through identification, segmentation, and change detection algorithms. Ultimately, the research will contribute to improved climate resilience and enhanced response efficiency on a global scale. The main objectives of this research are as follows: - To identify, test, and assess existing pre-trained GeoAI algorithms for the detection, segmentation, and classification of critical features in satellite and UAV imagery, such as infrastructure damage and disaster-related land cover (e.g., flooded or burned areas). The evaluation will emphasize the usability and performance of these models from the perspective of non-expert users, with particular attention to thematic accuracy and generalization capabilities. Special interest will be given to recently developed Earth Observation foundation models—large, pre-trained deep learning models trained on vast and diverse EO datasets. - To investigate the potential for fine-tuning pre-trained models using limited, domain-specific training data to improve their performance and generalization in new contexts. - To evaluate the integration of 3D information to enhance the quality and accuracy of extracted data, whenever appropriate multi-view satellite imagery or RPAS-derived photogrammetric datasets are available. - To explore the applicability of these models in additional domains, which may emerge over the course of the PhD, thanks to the interdisciplinary nature of the PhD program and synergies with ongoing research projects within the Geomatics research group. - To contribute to the dissemination of research outcomes through peer-reviewed publications, presentations at national and international conferences, and participation in relevant academic workshops.

Skills and competencies for the development of the activity	Ideal candidates should have expertise and skills in the following areas: - Knowledge of the fundamentals of remote sensing, including image classification, segmentation, and object detection. - Experience in processing satellite and UAV data, including the generation of 3D point clouds, digital surface models (DSMs), and orthophotos, as well as conducting multi-temporal analyses. - Experience with AI algorithms applied to geospatial data, particularly for object detection and image segmentation. - Experience working in a GIS environment for the integration and processing of geospatial data, and the development of geo-processing workflows. - Basic programming skills in Python.