Title: Urban geology and geohazards: an integrated analysis for a resilient urban planning

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Research program

Expansion of urban centres resulted, especially in the last decades, in a strong land demand and a problematic urban planning. Flood- and landslide-prone areas as well as soft grounds characterize peri-urban areas where urbanization occurs often disregarding building codes. Human pressure modifies the geological, geomorphological and hydrological features of original terrains, acting on the topography, stratigraphy, geotechnical properties of the subsurface, constructing networks of superficial and underground structures, modifying or even obliterating water streams, and pumping groundwater. "Mega-cities" represent the most important expression of Anthropocene geosystems, thus coping with the related engineering-geological, geohazard and technological problems requires the development of new approaches and techniques. Italian regulations for urban planning include aspects related to surface and subsurface geology, geomorphology, hydrogeology and the related geohazard implications, for a safer and more sustainable urban development. However, such knowledge has not yet been poured in specific integrated planning tools, with the partial exception, at least in Italy, of the Emergency and Civil Protection Plans.

The project aims at characterizing, modeling and verifying the spatial-temporal occurrence of possible geohazards, which interact with the geological settings of some urban areas, to preserve value making smart and resilient cities. To account for the geohazards and their interactions in the urban context, a multi-approach study rationale has to be adopted, which involves a comprehensive urban geology and geohazards knowledge, monitoring and modeling of ground (i.e. landslides) and underground instabilities (i.e. sinkholes), and potential domino effects. The sensitivity to climatic features and scenarios, implementation of tools and smart solutions for risk mitigation and management through multi-hazard and multi-risk analysis will be considered. The project will take advantage of the massive amount of data available in the urban area of Napoli, which have already allowed to reach interesting results in the past (Bellucci Sessa et al., 2006), to conduct detailed studies on geohazards, advancing the knowledge through state-of-the-art methods.

Among the different techniques which will be used to assess the hazards induced by the phenomena described above, a particular focus will be paid to the Differential Interferometry SAR (DInSAR) technique. This will allow us to identify possible "hot spots" of instability and to validate the results deriving from geological survey activities. Furthermore, it will be implemented a GIS-semiautomatic procedure using remote sensing and conventional data to detect deformations induced on structures and infrastructures and caused by ground and underground instabilities.

Taking advantage of the URGENT project research network, the results achieved at Napoli will be compared with those progressively reached in other large Italian cities (Milan, Bologna, Florence, Rome). These cities share common pressing challenges such as soil pollution, ground instabilities, flooding and groundwater vulnerability, and seismic hazard. In addition, the

possibility of studying important foreign cities and Mega-cities (e.g. Istanbul, Barcelona, Bucharest, Cuenca), affected by similar hazards, will be evaluated on the basis of the international agreements already active at DiSTAR.

Proposal for a PhD position

Starting from the above mentioned scientific premise, a PhD position is proposed for which collaborations already active with the Partners involved in the URGENT project will be exploited; collaborations will also be activated with leading European research centers actively engaged on multi-risk analyses (e.g.: University of Lausanne, ITC-University of Twente), considering such collaborations fundamental for the scientific growth of the PhD student, as well as for the achievement of shared and validated scientific results within the international scientific community. It is believed, therefore, that the research can be organized, during the three PhD years, as follows:

- first year: training institutionally provided for all PhD students and specific to deal with the research topic; collection and analysis of the specific literature; acquisition of skills related to methods of processing and interpretation of DInSAR satellite data; selection of study areas; collection of data and existing geo-thematic map layers (e.g.: Hydro-geomorphologic Setting Plans, Municipal Development Plans, Emergency and Civil Protection Plans, ISPRA and local authorities's archives, scientific publications, etc.);
- second year: integration of available knowledge with ad *hoc* surveys in the study areas; implementation of a GIS platform, including the cartographic development of the main types of geological hazard, also considering the vulnerability of the urban setting; development of a multi-hazard analysis procedure;
- third year: verification and validation of the multi-hazard analysis procedure; drafting of the thesis.

The research period envisages a period of about 5 months to be carried out in a research facility abroad, to allow the PhD student to learn different analytical methods and to compare himself with other scholars, also to have the possibility to further develop his career.