# STABLE Summer School

Remote Sensing Methods and Structural Stability of Historical Buildings
Rethymno, Crete, Greece 14-18 September 2020

## Abstracts

### The role of Engineering Geology and Geotechnics for the preservation of Cultural Heritage in a changing environment

Dr. Charalampos Saroglou (Teaching & Research Assoc National Technical University of Athens, Greece

The lecture will present the current state-of-the art and theoretical background on the potential risks related with ground movements impacting cultural heritage sites and historical cities. Emphasis will be given to the impact of climate change on Cultural Heritage. Specific guidelines regarding the assessment, analysis and mitigation of selected risks (such as ground movements, flooding, water level change, etc) will be presented. The methodologies available for the analyses of ground instabilities and the associated risks will be demonstrated through specific case studies. Through these case studies it will be possible to highlight the importance of appropriate geological and geotechnical investigation in order to mitigate the potential risks on Cultural heritage sites and historical cities.

### Satellite ADInSAR monitoring for heritage preservation: The example of the Vittoriano Monument in Rome downtown (Italy)

Prof. Francesca Bozzano and Prof. Gabriele Scarascia Mugnozza, Sapienza University of Rome, Italy

"Vittoriano" monument, dedicated to king Vittorio Emanuele II, is one of the most famous cultural heritage landmarks in Rome (Italy), even because it hosts the Tomb of the unknown soldier, monument to the Italian fallen in wars. It was designed by the architect Giuseppe Sacconi at the end of 19th century and since the beginning of its construction, it has been affected by cracks and deformations. In the last years, such phenomena have become more evident, especially on the western side of the building. With the aim of understanding the causes of the deformation process and making a diagnosis of the soil-structure interaction of the Monument, a specific project has been undertaken between CERI Sapienza and the Lazio Museum Network. Satellite ADInSAR was performed to infer the recent deformational history of the main parts of the monument, by using medium and high-resolution SAR images acquired in double orbital geometry (ascending and descending) and covering the last two decades. Through the support of selected geological and lithotechnical data it was possible to interpret the deformational

dynamics of the Vittoriano. The overall investigations allowed to better define the volume and the structures that have been involved in the deformation mechanisms, which is currently driving the overall process, in order to address effective mitigation measures. They are capable of backward analysing the deformational process reconstructing the evolution of a phenomenon and above all capable of easily investigating large areas.

### Photogrammetry and Machine Learning for Cultural Heritage

Panagiotis Agrafiotis, National Technical University of Athens, Greece

Current technologies for Cultural Heritage documentation are strongly based on image-based techniques and especially close range photogrammetry. Through these methods, complete and easy to use 3D data are generated, enabling experts to approach the studied objects in an exhaustive and efficient way. Moreover, exploiting the recent advances in Machine and Deep Learning, the 2D and 3D data are enriched with semantic information of materials and pathologies, reinforcing and advancing their potential exploitation and understanding. This presentation will present the state-of-the-art on the above techniques, involving interesting overwater and underwater case-studies.

### Challenges in Civil Protection planning regarding historic city centers and monuments

Nikos Votsoglou, Prefecture of Crete, Greece

Historic city centers and historic buildings incorporate certain characteristics- narrow streets, unpredicted seismic behavior of buildings, lack of escape routes – that rise a complex problem towards planning an emergency plan. To overcome these difficulties, Civil Protection (CP) officials need to use modern technology tools, spanning from GIS, remote sensing and drone technology, to human psychology behavior patterns in natural disasters, as well as sufficient field knowledge of the area under planning . Population exercises (Small or big scale) are also a necessary procedure towards training the citizens of historic centers against natural disasters. Outside civil protection frameworks, efforts to renovate and seismically reinforce historic buildings in order to behave within certain limits in case of an earthquake, simplify the whole CP planning procedure, since less historic buildings are expected to suffer damages

**Greening urban mobility in tourism destinations**

Prof. T. Tsoutsos, Technical University of Crete, Greece

Historical cities are facing significant challenges related to mobility, in terms of congestion, air and noise pollution, fuel consumption, road accidents, accessibility and quality of life. Road transport vehicles are mostly using fossil fuels, which emit significant quantities of Greenhouse Gases (GHGs) and it is worth mentioning that nearly two-thirds of these emissions originate from light-duty vehicles. Urban transportation has become one of the crucial factors for achieving the goals of the 2015 Paris Agreement on climate change commitments.

**Fragility analysis of a masonry structure**

Giorgos Xekalakis, Petros Christou, Paris Fokaides, Phoebe - Zoe Morsink - Georgali Frederick University, Cyprus

Masonry buildings are part of our history and cultural heritage. These buildings are normally found in the history centres of cities in Europe and simultaneously they are of great interest for every engineer because of their antiquity and durability through time. In the present study, using the computational and design programs but also the special knowledge of architects and civil engineers, we simulate such a type of construction and study its behavior after the application (excitation) of a pre-existing earthquake (Athens 1999). The earthquake will be applied as an accelerogram adapted to the site conditions of the Strovolos case study. Fragility curves are useful tools for showing the probability of structural damage due to earthquakes as a function of ground motion. Applying the fragility curves analysis and using appropriate measures to define the damage states, we are able to examine probabilistically the size of damage, creation of cracks or collapse, in relationship with the intensity of the earthquake. Finite elements have been used for the model simulation and Incremental Dynamic Analysis in order to estimate more thoroughly the structural performance under seismic loads.

**Change detection and classification techniques through ERDAS IMAGINE**

Mr. Christos Kontopoulos* – Geosystem Hellas

Basic algorithmic approaches for change detection and classification will be deployed. High resolution imagery of a built up area will be analyzed for the change detection task while 4-band (RGBNIR) images will be tested on clustering and classification techniques. Automated workflows through spatial modeling will examined on the aforementioned approaches.

**Urban areas monitoring using LiDAR data**

Mr. Christos Kontopoulos* – Geosystem Hellas

Overview of a complete workflow for DTM and DSM extraction from raw LiDAR sample data capturing built-up area. Building footprints will be extracted through classification techniques. The final 3D models should be presented in a 3D GIS environment

**CH monitoring with digital technologies: laser scanning and aerial/ground photogrammetry for change detection**

Dr. Gianluca Cantoro, Foundation for Research and Technology, Greece

Cultural Heritage is often exposed to natural or human driven events that may change a monument's appearance or even threaten its existence. It is not always possible to put in place good practices for the safeguarding and protection of general cultural artifacts. It is nevertheless possible to document the current state of a specific item and monitor its changes at a given time, having a chance to quantify damages and localize them precisely on the surface. The presentation will focus on methods to map and highlight changes on CH assets across time and will underline, with case studies and examples, how this approach may help future protection and restoration practices.