NEWSLETTER 1
JULY 2020

SCIENCE

Project Title:
SpaCeborne SAR Interferometry as a Non-invasive tool to assess the vulnerability over Cultural hEritage sites
Acronym: SCIENCE

CULTURE HERITAGE

Culture heritage is a key element of history, the ancient monuments and archaeological sites enrich today's societies and help connect us to our cultural origins. Protection and conservation of our cultural assets for future generations in the face of various natural or anthropogenic hazards is a major concern nowadays. Heritage sites and monuments need to be protected and promoted, as they are vulnerable to ground motion.

RESEARCH GOAL

Reducing the impact of natural/man-made disasters on the human cultural heritage sites is a fundamental research goal. The ultimate objective is to predict vulnerability of the archaeological sites to ground deformation in time and space, and protecting them against damage. Chances to succeed are high because spaceborne SAR interferometry is an established technique providing very high deformation estimation accuracy. During the last few years, spaceborne Synthetic Aperture Radar (SAR) interferometry has proven to be a powerful remote sensing tool for detecting and measuring ground deformation and studying the deformation's impact on man-made structures. It provides centimetre to millimetre resolution and even single buildings/monuments can be mapped from space. It is therefore highly purposeful to develop and demonstrate the use of advanced SAR interferometric multitemporal techniques, a non-invasive method, to monitor the historical sites as well as to validate it by local field work.

PROJECT BACKGROUND

Public authorities (Ministry of Cultural Heritage, Institutions and local entities) are called to **continuously monitor archaeological sites**, examine their state of conservation and program and prioritize restoration activities when required. To accomplish this task, they need for **non-invasive and systematic instruments**.
The development and exploitation of techniques and methods based on the analysis of satellite earth observation data is a possible solution to their needs. This project aims to develop, demonstrate and validate, in terms of geotechnical local conditions and monuments' structural health, SAR interferometric techniques to monitor potential ground deformation affecting the archaeological sites and monuments of great importance.

Demonstrations will be performed on well-known test sites in China and in Greece, specifically the:

1. Great Wall in Zhangjiakou
2. Ming Dynasty City Walls in Nanjing
3. Acropolis complex of Athens
4. Heraklion walls (Crete Island)

THE BILATERAL CONSORTIUM

The bilateral consortium in the frame of this proposal composed by the following partners:

From Greece

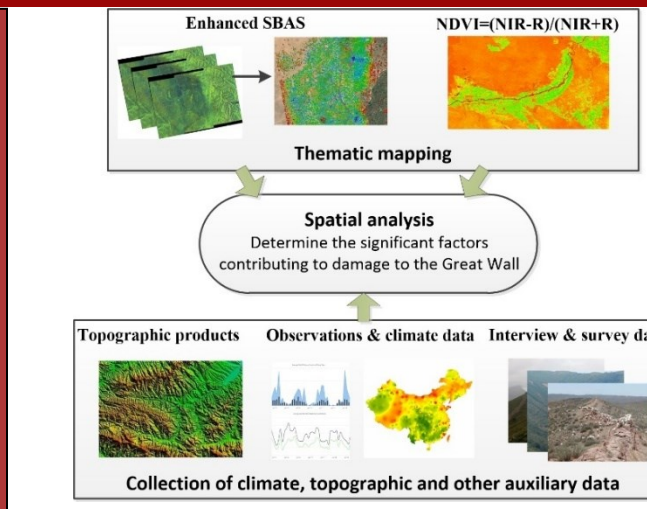
- Harokopio University of Athens
- Terra Spatium S.A.
- National Technical University of Athens
- Acropolis Restoration Service (YSMA)
- Ephorate of Antiquities of Heraklion (Crete Isl.)

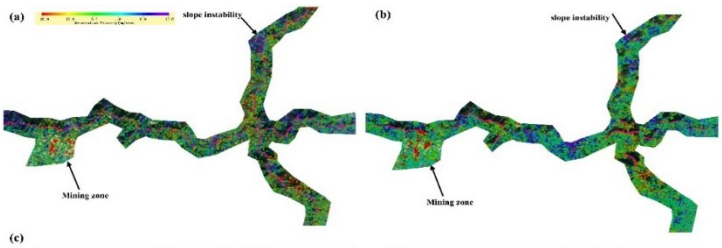
From China

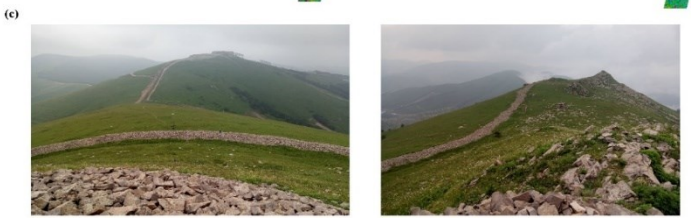
- Aerospace Information Research Institute, Chinese Academy of Sciences
- International Centre on Space Technologies for Natural and Cultural Heritage (HIST) under the auspices of UNESCO (HIST-UNESCO)

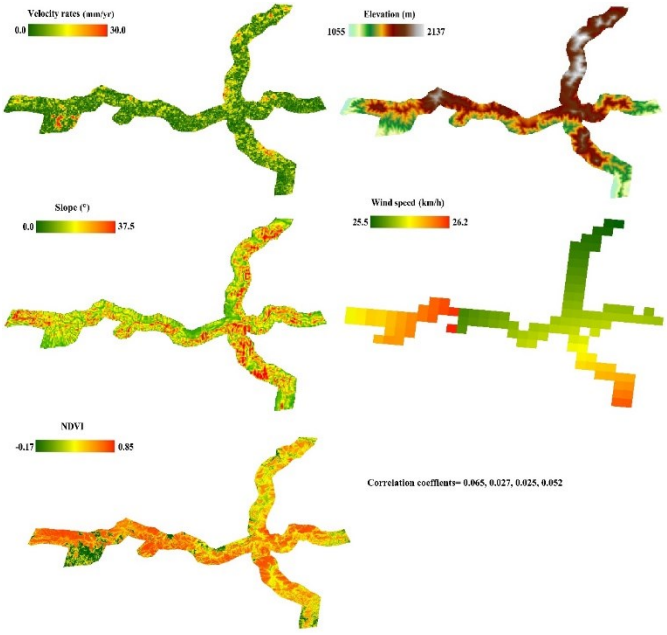
Preventive monitoring and preservation of the Great Wall

A systematic evaluation method that included surface deformation estimation and damage detection was proposed to ensure the safeguarding of the Great Wall corridor. Two representative sections of the Great Wall located in Qingtongxia County (in the west) and Zhangjiakou City (in the east) in China were selected for a preliminary comparative investigation to ascertain the coupling mechanism and spatiotemporal characteristics of the driving forces for the heritage damage. The surface deformation rates were estimated by synthetic aperture radar interferometry (InSAR), and the relationship between the deformation rates and the normalized difference vegetation index (NDVI) and meteorological and topographic data was assessed. The results showed the following: 1) the surface motions along the observed landscape corridor of the Great Wall were decreased in 2015-2018. 2) The correlation coefficients between the deformation rates and the elevation, slope, annual wind speed, and NDVI were 0.524, 0.115, 0.582, and 0.522, respectively, indicating the dominant influence of surface runoff and high winds on the degradation of the rammed-earth wall in the western arid regions. In contrast, 3) the correlation coefficients between the deformation rates and the aforementioned factors were 0.065, 0.027, 0.025, and 0.052, respectively, indicating negligible effects of natural processes on the degradation of the wall in the eastern section. This study not only provides new insights into preventive monitoring and risk assessment of the entire Great Wall but also highlights the potential of space technologies and a geographical perspective for the sustainable conservation of large-scale heritage sites.









HAROKOPIO UNIVERSITY
TERRA SPATIUM SA
National Technical University of Athens
Acropolis Restoration Service
HELLENIC REPUBLIC
Ministry of Culture and Sports
Ephorate of Antiquities of Heraklion

MEETING IN ACROPOLIS OF ATHENS

On 17th of June, all Greek consortium members met at Acropolis site to have their first in-situ visit. The context of the visit, was to inspect the Acropolis monument's in terms of structural integrity and its vulnerabilities. The in-situ visit was performed around Acropolis's walls, Parthenon and Erechtheion. In this event, all teams had the chance to exchange multidisciplinary knowledge on the structural integrity of the Acropolis's monuments, its vulnerable points, as well as the geotechnical conditions of the underlying layers.

The meeting concluded with a discussion about the available validation data and the next steps of the project.

MEETING IN HERACLION, CRETE

Team members took part on the in-situ visit conducted at the City Walls of Heraklion, the city walls of Venetian Candia, on 29th of June. The visit was perfectly organized by the Ephorate of Antiquities of Heraklion and its main context was to inspect structural integrity of the walls.

Several parts of the walls affected by differential settlements or earth pressures were identified and, in some parts, verified by preliminary inSAR data. In particular, the Sampionara, Vitturi and Martinengo Bastions were thoroughly examined, evaluating their structural and geotechnical conditions.

Project Coordinators - Principal Investigators

Chinese part
CHEN Fulong, Dr. & Professor
Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences
Greek part
Issaak Parcharidis, Professor
Department of Geography, Harokopio University

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