HERACLES NEWSLETTER

Nº2 - December 2016

HERACLES

This project has received funding from the European Union's Framework Programme for Research and Innovation HORIZON 2020 under Grant Agreement 700395

Funding 6.564.313.75 Euro
Starting date 1st May 2016

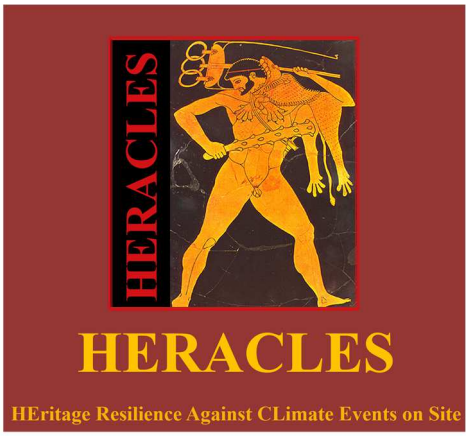
CASE STUDIES

CRETE, GREECE:

1. *Minoan Knossos Palace*
2. *Venetian coastal fortress of Koules*

GUBBIO, ITALY

3. Medieval Wall and High Town



HERACLES OBJECTIVES

The concept underpinning HERACLES project is to propose a holistic multidisciplinary and multi-sectorial approach with the aim to provide an operative system and eco-solutions to innovate and to promote a strategy and vision of the future of the CH resilience. The overall objective of HERACLES is the set-up of an interoperative operational chain (remote and local monitoring, simulating and forecasting, characterizing, maintaining, restoring, etc.), with the purpose to increase the resilience of a CH assets supported by a decision support system and innovative eco-solutions.

This system is conceived to be operationally available for decision makers at different levels as well as to the different actors involved in the mitigation of the Climate Change effects on CH vulnerable assets for promoting concerted actions. As a consequence, integrated innovative solutions and conservation techniques in the cutting-edge of the present state of art will be delivered by the present project.

Therefore, HERACLES requires research and expertise on different fields such as: user needs assessing, forecasting and modeling of the climate events, sensing and ICT systems, designing and development of eco-innovative materials, defining new standard operative procedures, organization of training and education.

HERACLES team has been built to cover all these specific competences according the very deep experiences and skills of individual partners. According to the described concepts, the general objectives of HERACLES project are summarized as follows:

Objective 1: Development and validation of a scalable and flexible innovative ICT platform able to collect and integrate heterogeneous data for a situational awareness and decision support.

Objective 2: Design and implementation of new environmentally sustainable solutions and materials for the long-term maintenance and restoration of CH, under the climatic change impact, taking also into account the economical sustainability and the cultural and social integrity. Outcomes of the HERACLES platform and new solution/materials identified will be strictly correlated in a iterative process where new designed and adopted solutions for the interventions represent information to be ingested in the ICT platform in order to identify proper maintenance, remediation and restoration actions.

Objective 3: Elaboration and integration of forecast climate models and experimental data into the platform as start-point of the local CH-specific analysis where implementing the solutions developed during Objective 2.

Objective 4: Set-up specific guidelines for long-term prevention and maintenance actions, able to account specifically the CH site

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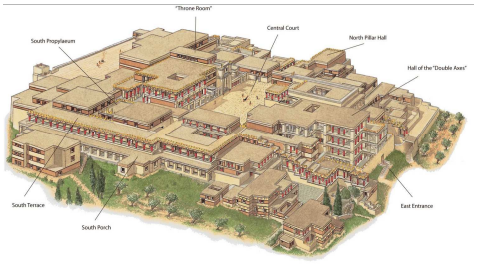


Image via The Heritage Podcast

features and the risks affecting it, and for the operational procedures for risk management.

Objective 5: Strategies and tools to promote HERACLES results to a widespread arena of recipient communities.

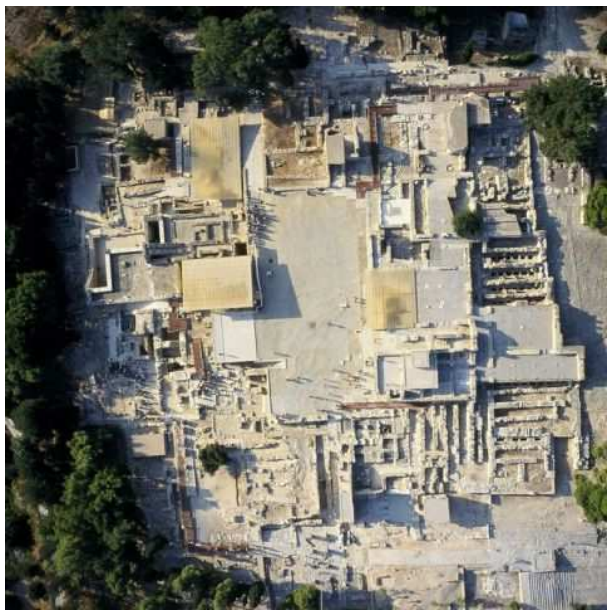
Objective 6: Demonstration of the effectiveness of HERACLES at three challenging tests beds: two are in Crete, Greece, the Knossos Palace and the coastal Venetian fortification with a focus on the Sea Fortness of "Koules" (both on the UNESCO Tentative List); the third one is the historical town of Gubbio in Italy (on the Tentative List of immaterial UNESCO Heritage. In addition to their historical value, these sites are affected by different kinds of hazards due to climate change effects, that can be generalized to several other areas in Europe and worldwide.

http://www.heracles-project.eu/objectives-2

THE PALACE OF KNOSSOS

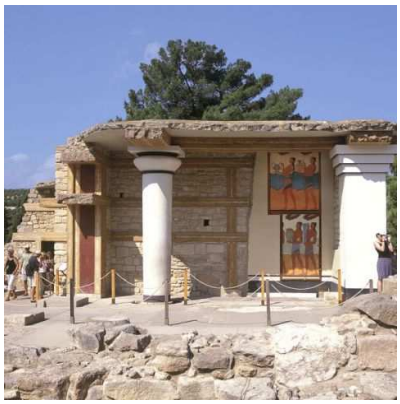
The Palace of Knossos bears unique testimony to the Minoan civilization, which was arguably considered as the first centrally organized civilization to flourish in Europe and amongst the first civilizations worldwide. It is also unique because of its continuous habitation from the Neolithic to the Mycenaean Age, while the city of Knossos continued to be an important city-state down to the Hellenistic era, the period of the Roman Empire and the early Byzantine period.

The Palace of Knossos, the largest of the Cretan palaces, (it covers an area of 22000 sqm) and the city that arose around it are built on the top and slopes of the low hill of Kefala, where the River Kairatos meets the small Vlychia stream. Security, fertile land, water and proximity to the sea were the main reasons not only for the choice of the site as a place of habitation from earliest prehistoric times, but also for its subsequent prosperity and growth.



The first palace was built circa 1900 BC, following the leveling and landscaping of the hill. It was destroyed around 1700 BC and the new palace was erected in its place. The new palace was constructed according to a specific architectural plan, similar to that of the other palaces, befitting its character and function as the centre of political, economic and religious authority. The main feature remained the Central Court, with monumental buildings rising around it, oriented N-S. There were entrances on every side, the most official being the Southwest and the North Entrance. The West Wing contained shrines, official halls and extensive storage areas, while the East Wing housed the royal apartments. There were also workshops, storerooms and other areas serving a variety of functions to north and south. They feature typical architectural elements of the period, such as polythyra (sets of rooms with multiple pier-and-door partitions on two or three sides) and lustral basins (small, rectangular, semi-underground rooms accessed by a small, L-shaped set of stairs). Poros-stone ashlars were used in the masonry. The floors were paved with slabs of green schist pointed with red plaster. The columns, beams and doorframes were made of wood. Gypsum slabs covered the walls (in the form of marble revetment) and floors, giving the spaces an air of luxury. Gypsum was also used for the bases of columns and jambs, seats, stairs, etc. The decoration of the rooms was supplemented by colourful plaster and frescoes.

The Palace of Knossos was the only palace to remain in use after the destruction of 1450 BC, when the Mycenaeans settled Crete. Following the final destruction of 1380 BC, large parts of the Palace were reoccupied and remodeled, mainly as private houses.

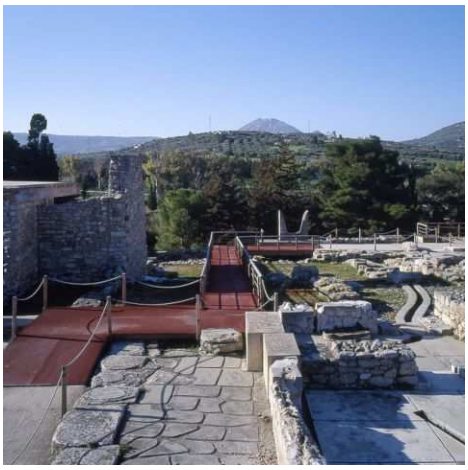


The first excavations at Knossos were carried out in 1878 by a merchant and antiquarian from Heraklion, Minos Kalokairinos, who discovered part of the West Wing of the Palace.

Systematic excavations began in March 1900 under Arthur Evans, then Curator of the Ashmolean Museum in Oxford. Two years later, the excavation of the Palace was almost complete. The fragile building materials proved extremely sensitive to weathering. During the first phase of their restoration efforts, in 1905, Evans and his colleagues restricted themselves to protecting the ruins. After 1925, however, Evans attempted a radical reconstruction of the monument, with large-scale use of reinforced concrete. Upper storeys and architectural elements were reconstructed. The timber frames and wooden Minoan columns were made of concrete, painted. The frescoes were restored and copies placed in different parts of the Palace.

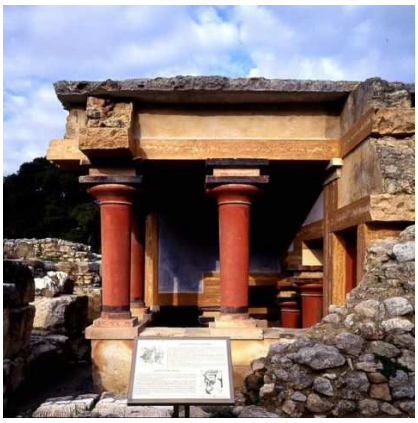
Today, Evans's reconstruction of the Palace forms an integral part of the monument and its history.

After the Second World War, extensive restoration work was carried out on the Palace by the Directors of the Heraklion Archaeological Museum N. Platon and S. Alexiou. This work was limited to the conservation of the ancient masonry, the restoration of the floors and the protection of certain areas with roofing.



During the nineties the Ministry of Culture, recognizing the problems that the monument was facing, took measures for its preservation and restoration. Under the authority of the Ephorate of Antiquities a great part of the concrete slabs of Evans' restoration of the Palace was conserved, and paths for the visitors were developed, which reduced the wear of the monument and gave the visitors a more complete view of it.

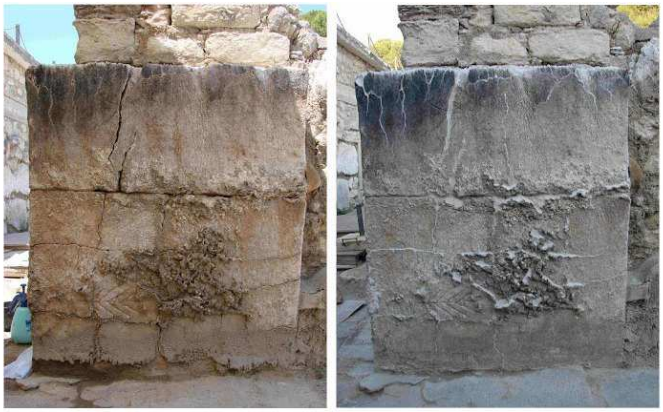
In 2000 – 2008 a conservation project of the Palace was included in the 3rd C.S.F (Community Structural Funds). For its protection and restoration a NSRF (National Strategic Reference Framework) Project begun in 2010 and finished 2015, concerning the restoration and conservation of the monument. Indeed, a complete programme of conservation and promotion of the site was launched: conservation of masonry, gypsum stones and limestones, ancient coatings and plaster, copies of frescoes, columns and wood imitations, conservation of the Minoan pithoi, and replacement of Evans's lightly-arched roofs.



Gypsum

Gypsum is one of the main building materials on the archaeological site of Knossos and was used extensively for walls, floors, column and pillar bases, door jamb sockets, stairs, etc, originating from the local quarry at the nearby hill of Gypsades.

Mineral gypsum shows a great diversity in crystal morphology and occurs in varieties with quite different macroscopic characteristics. In the Palace of Knossos the dominant types of mineral gypsum belong to the medium to coarse crystal varieties, namely "Selenite". The identification and characterization of gypsum varieties can be intricate due to surface alterations caused by natural weathering processes or forced dehydration. The result of the aforementioned decay processes is the loss of original material mainly due to dissolution as well as the degradation of the aesthetic values that eventually leads to misinterpretation.



Within the concept of the HERACLES project, the contribution of the Crystal Engineering, Growth & Design Laboratory of the Department of Chemistry, University of Crete, focuses on two distinct but interdependent problems. The qualitative and quantitative study of the dissolution rate of mineral gypsum (a chemical process), in correlation with the environmental parameters of the area of Knossos and Heraklion, in general. In parallel, a second focus point will be on the design and evaluation of materials and multifunctional chemical compounds that will aid the restoration of the original ancient material in terms of restoring – consolidating the structural integrity of the stone constituents (i.e. crystal aggregates).

Determination of the degradation state of the Palace of Knossos

Generally, the Palace of Knossos had suffered extensive damage due to mechanical and biological factors, combined with the local microclimate and the structure of the walls. The direct exposure to sunlight, rain, wind and atmospheric pollution, the relative humidity and temperature, which ranges beyond recommended limits, and the extensive use of reinforced concrete for its restoration are the main reasons for its damage.

Indeed, the deterioration of the palace is due to the physicochemical properties of the materials, suffering the parallel effects of environmental and man-made factors.

Water (in all types, such as rain, humidity, frost) is a main factor for decay of all the materials of Knossos palace. Fluctuations in temperature precipitate the formation and deposition of salt crusts on the surfaces of the monument. The presence of soluble salts is in partly due to the prevailing sea wind that comes from the north. During periods of humidity microbial growth develops on stone and masonry surfaces.

Restoration works that took place after the palace's discovery by A. Evans hindered its maintenance for many years. The cement additions to the architectural structures created mechanical stress and were another source of soluble salts.

The identification and analysis of major risks regarding structures and artworks' preservation (e.g. the excessive deformation in reinforced concrete elements), the contribution to identification and analysis of materials degradation state (e.g. degradation status and corrosion of reinforced concrete elements) and proposals of restoration strategies for structures and materials will be useful for the monument.

Finally, the large number of visitors, combined with the free access previously given (until '90's), increased the deterioration of the palace's vulnerable materials.

Proposed methodologies for analysis, diagnostics and conservation

IESL-FORTH has a solid experience on laser methodologies for analysis, diagnostics and conservation (cleaning) on CH monuments and objects, with emphasis to portable instrumentation and in-situ application methodologies. In this respect the contribution of the photonics for Cultural Heritage group IESL-FORTH to the works of HERACLES project focused on the Knossos archaeological site is expected to lie along the following lines:

a) In-situ diagnosis, monitoring and interventions. **Portable instrumentation** based on optical and laser spectroscopic analysis (LIBS, Raman, multispectral imaging etc.) will provide **fast, reliable and in-situ analysis and monitoring** of the weathering state and its progress on areas of interest. Among the issues that will be studied are the nature and expansion/propagation of efflorescence salts on the ancient and restored masonry as well as on the restored roofs of the archaeological site of Knossos and the preservation state of the Minoan pithoi and Evans's fresco replicas etc. Furthermore, selected untreated and recently restored surfaces will be monitored in order to visualize their response to the environmental conditions and thus assess their resistance to climate changes and evaluate the

effectiveness of the treatments and /or the criticality and necessity of new restoration interventions, etc.

b) In parallel (ex-situ) analyses based on laser spectroscopy will be carried out in the laboratory in order to characterize the structural, chemical and physical properties of the materials (ancient, new, as well as alteration forms). Moreover, novel imaging techniques as for example non-linear microscopy and 4-D surface /volume topography will be employed to non-destructively characterize, delineate and map materials aiming at gathering complementary high-resolution information for their composition and morphology.

Installation of meteorological stations in the archaeological site of Knossos

Monitoring the local climatology in the vicinity of the Knossos Palace, will help the HERACLES research program, participants to access the major adverse-effects-factors that are related with the current and future change in climatic conditions. For the needs of HERACLES, it was decided to install a meteorological station to measure wind speed and direction, temperature, humidity, solar radiation and UV index. The meteorological station will be installed at the maintenance area north of the Palace, by the Coastal Research Laboratory (CRL), Institute of Applied and Computational mathematics (IACM) of FORTH.

General Remarks: The Meteorological Station will be installed on 3 meters metal mast, which should be protected from lightning strike and be able to withstand wind speeds in the range of over 8 Beaufort. The sitting position was chosen, in order to minimize the intervention at the historic environment of Knossos.

Met. Station Sitting position: The weather station will be located within the premises of the maintenance area, North of the archaeological site and outside visit area. In coperation with the Ephorate of Antiquities of Heraklion the maintenance area was chosen as the final location. The installation position is by the main gate of the maintenance area.

Lightning Protection: The mast will be equipped on its highest point with a Franklin type lightning rod. This will be grounded with a copper rod and the connection will be made with a 50mm^2 copper wire.

Position	Long. (dec. deg)	Lat. (dec. deg)	Bearing
Knossos Maintenance area	25.163284	35.29871	B (4°)

Bioclimatology in the city of Heraklion

The following tables depict a long-term analysis of the seasonal, statistical climatic characteristics for the city of Heraklion, focusing on temperature, wind speed and rainfall on monthly basis.

Table 1: *Statistical characteristics of average daily air temperature throughout the year for Heraklion, during the period 1955-2013.*

	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
MEAN	12.1	12.1	13.4	16.1	19.6	23.5	25.7	25.7	23.2	20.0	16.7	13.8
MAX	22.7	24.4	26.9	29.6	30.2	33.0	35.7	35.1	31.2	30.7	26.6	23.4
MIN	3.5	3.2	2.7	8.8	13.0	17.2	20.4	21.3	16.0	13.0	9.1	4.4
ST. DEV.	2.3	2.6	2.7	2.8	2.6	2.2	1.7	1.5	1.8	2.5	2.6	2.5

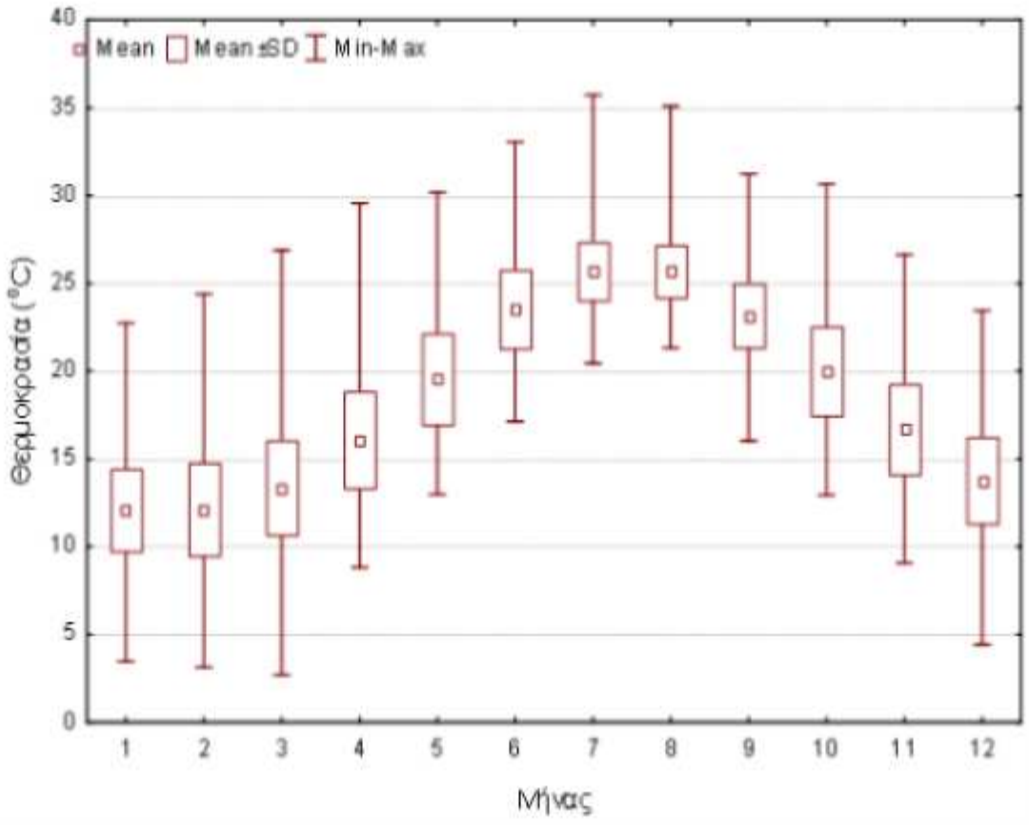


Figure 2.: *Statistical characteristics of average daily air temperature for Heraklion, during the period 1955-2013.*

Table 2: *Statistical characteristics of average daily wind speed (knots for Heraklion, during the period 1955-2013.*

	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
MEAN	9.5	10.0	9.2	8.2	6.6	7.2	9.2	9.2	7.9	7.9	8.4	9.4
MAX	36.5	38.9	41.6	29.3	32.0	22.0	24.6	23.6	22.6	33.8	31.4	31.3
MIN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ST. DEV.	5.5	5.7	5.5	4.9	4.1	4.1	4.3	4.1	4.1	4.7	5.3	5.4

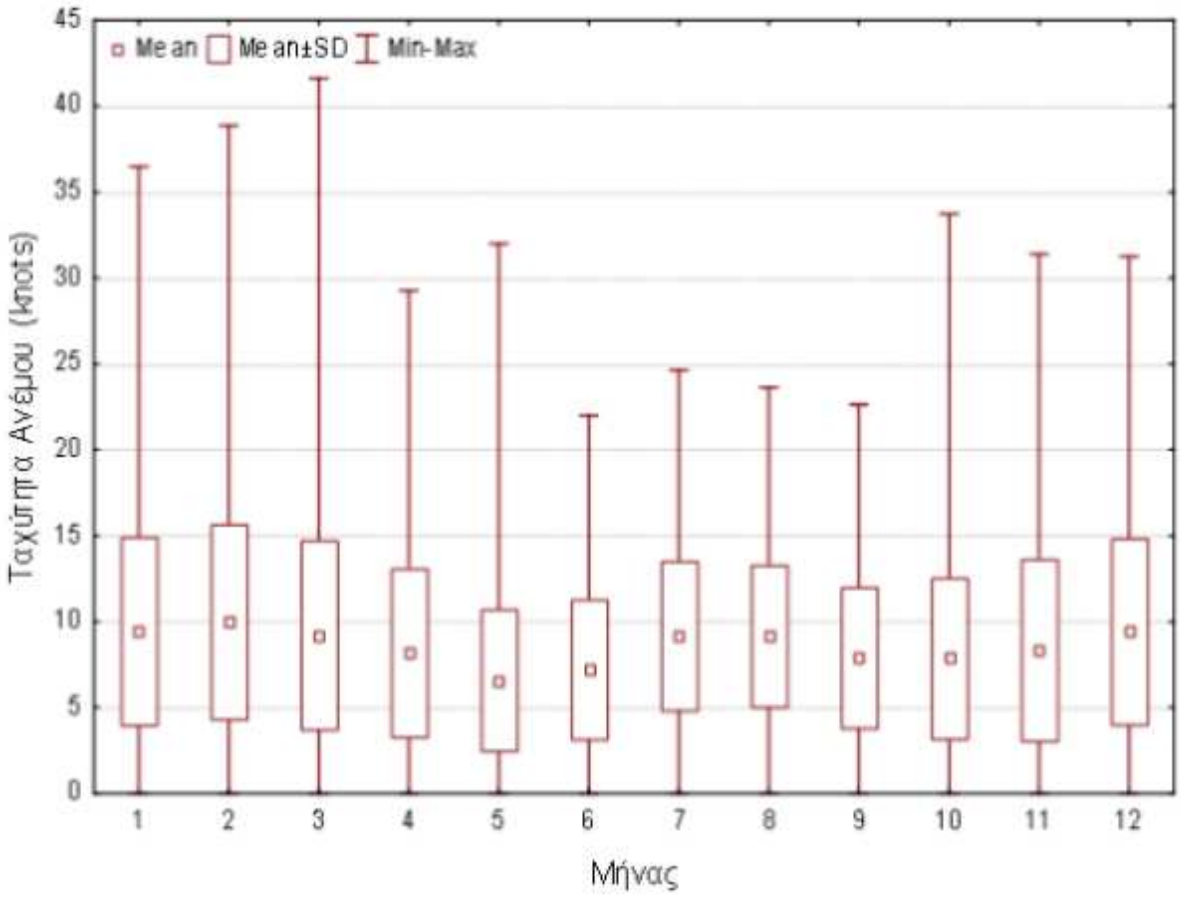


Figure 3.: *Statistical characteristics of average daily wind speed (knots for Heraklion, during the period 1955-2013).*

Table 3: *Statistical characteristics of average monthly rainfall (mm), for Heraklion, during the period 1955-1997.*

	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
MEAN MONTHLY RAINFALL	90.1	67.6	58.2	28.5	14.2	3.5	1.0	0.6	17.7	64.9	59.0	77.9
TOTAL RAINFALL DAYS	16.0	13.6	12.0	7.7	4.4	1.3	0.3	0.4	2.4	7.8	10.6	15.1

Linear regression of the long term data shows a statistically significant positive trend but only from 1976 until the end of the period considered (b = 0.02 °C/year, $p < 0.05$); the temperature increases by 0.54°Cthe last 27 years (1976-2014). Regarding the wind speed, a statistically significant upward trend, is presented for Heraklion for the entire period (b = 0.050 kt/year, $p < 0.05$). More specifically, during the 48 years of the considered period, the wind speed display an increase of 2.4 kt.

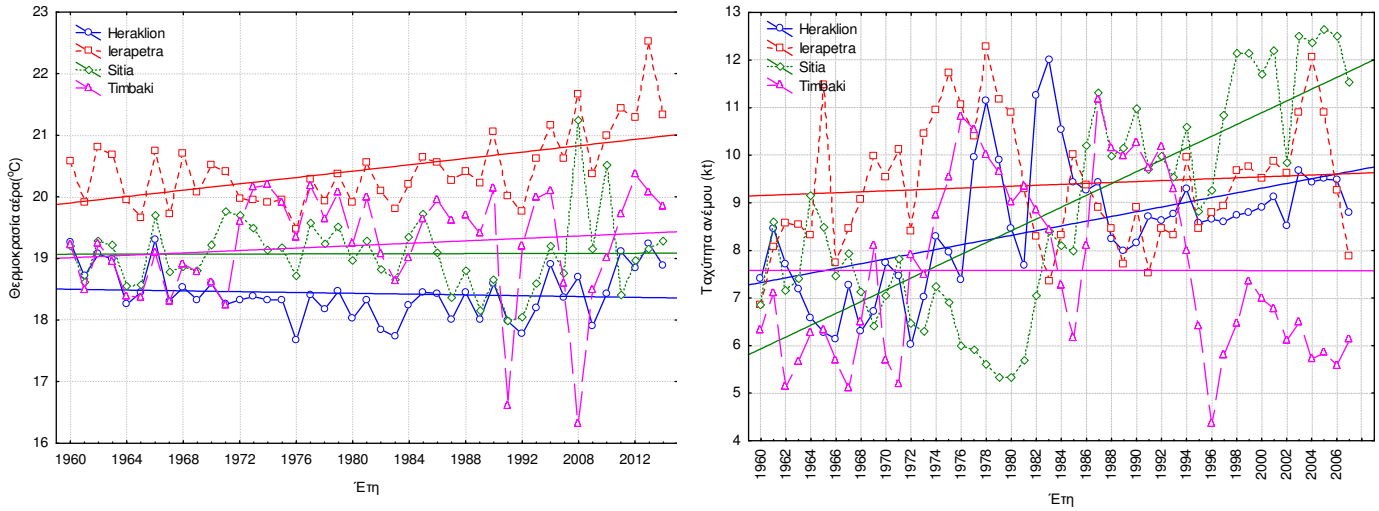


Figure 4.: *Time series of air temperature (left) and wind speed (right) along with their respective linear trends for stations in Eastern Crete, for the period 1960-2014.*

1st INTERIM MEETING OF HERACLES

7 - 9TH OF NOVEMBER 2016, HERAKLION, CRETE, GR

The 1st Interim Meeting of HERACLES took place on 7th -9th of November 2016 in Heraklion, Crete, Greece. Following their kick-off meeting (May 2016) in Gubbio, the 55 delegates from the 16 partners of HERACLES renewed their assembly in the Greek island of Crete, where two (of three) test beds of the project are located. During this meeting the HERACLES partners had the opportunity to become acquainted with the Cretan monuments, as well as to discuss the progress of the research activities that took place within the first six months of HERACLES.

Welcome greetings from Dr. V. Sythiakaki, director of the Ephorate of Antiquities of Heraklion, on behalf of the General Secretary of Culture of the Greek Ministry of Culture & Sports (M. Andreadaki-Vlazaki).

The meeting opened officially on the evening of Monday of November 7th 2016 at the Municipal Cultural Center of Heraklion. Welcome messages were addressed by G. Garancini, Vice Mayor of Tourism of Heraklion, S. Anastasiadis Director of IESL-FORTH, K. Demadis, Professor at the University of Crete (on behalf of the Rector of UoC), and V. Sythiakaki Director of the Ephorate of Antiquities of Heraklion. Also, a greeting from M. Andreadaki-Vlazaki, General Secretary of Culture of the Greek Ministry of Culture & Sports was read. Subsequently, the Coordinator of the project (G. Padeletti) gave an open- talk on the aims and the activities of HERACLES project. The talk was attended by a wide audience from the local Ephorates of Antiquities and Museums in Crete, as well as researchers from FORTH and professors and scholars from the University of Crete. The event was concluded by a reception accompanied by a violin duet of the Municipality of Heraklion.

On Tuesday 8th of November 2016 the meeting continued taking place at the Venetian Sea-side fortress of Heraklion "Koule", during which, the Director of the Ephorate of Antiquities of Heraklion (V. Sythiakaki) together with the senior Archaeologists of the monument (E. Kanaki, G. Tsimpoukis) and the dedicated conservators (K. Patedakis, A. Psaroudaki) informed the participants on the history of the monument, its construction materials and the recent restoration works, while open issues for research were highlighted with emphasis to the direct exposure of the monument to the environment (i.e. north-west winds) and the climate change.

After this tour, the Work Package Leaders presented in detail the workflow of the project so far, and discussed details of their work. The 2nd day of the meeting was concluded with the Steering Committee discussing on on-going issues and future plans related to dissemination, training actions and communication with EU and other H2020 projects of similar research focus. The day was concluded with a dinner offered by the 3 hosts (FORTH, UoC and Ephorate) during which the participants had the chance to bond together and enjoy traditional local dishes and wine.

The last day of the meeting started with a tour of the archaeological site of Knossos during which the senior Archaeologist in the Knossos Scientific Committee (E. Kavoulaki), together with the director of the Ephorate of Antiquities of Heraklion (V. Sythiakaki) and the dedicated conservator of the Ephorate (E. Politaki) presented the Minoan Palace, as well as the other monuments that constitute the Minoan citadel. Emphasis was given to previous as well as open restoration challenges which are to be investigated through the HERACLES project. The meeting was concluded at FORTH with presentations of the remaining Work Packages and a recap on the remarks, priorities, working meetings and future directions discussed during these 3 days. Our next appointment is in France, in May of 2017.

HERACLES 1st Interim Meeting Group Photo at Knossos

E-MRS 2016 FALL MEETING

HERACLES PRESENTATION, WARSAW UNIVERSITY OF TECHNOLOGY, 19TH - 26TH SEPTEMBER 2016, POLAND

The Fall Meeting provides the opportunity to exchange ideas, expand one's knowledge and make new contacts. The conference took place at the Central Campus of the Warsaw University of Technology, from 19th to 22nd September. The event attracted more than 1250 scientists from all over the globe who presented more than 1800 papers spread over 26 parallel symposia. Moreover, a scientific exhibition hall with more than 15 booths attracted the presence of a corresponding number of companies presenting their recent technological advances in all fields of materials science and applications.

The main objectives and strategies of the HERACLES project were presented by Luisa Torsi, E-MRS President,to a large targeted audience during the plenary session (attended by almost 1500 scientists).

Plenary session

Heracles booth

http://www.european-mrs.com/meetings/2016-fall/2016-fall-symposia-program

PRESENTATION OF THE HERACLES CONSORTIUM

The Consortium is constituted by 16 entities from 7 countries.

The Consiglio Nazionale delle Ricerche (CNR), Italy, has a duty to promote research activities for the scientific, technological, economic and social development of Italy. Institutes involved are: the Institute of Nanostructured Materials, ISMN (chemistry, materials science and nano-technologies applied to CH), the Institute for Electromagnetic Sensing of the Environment, IREA (remote sensing, diagnostics and monitoring environmental risks) and the Institute of Research on Population and Social Policies, IRPPS, (demography & migration, welfare, social policies, higher education and dissemination of knowledge and information technology). https://www.cnr.it

e-GEOS, Italy, an ASI/Telespazio, is a leading international player in the geo-spatial business. e-GEOS offers a complete range of products and services in the Earth Observation and in the geo-spatial application domains, based on both optical and radar satellites as well as on aerial surveys.As the European hub for VHR (Very High Resolution) data, e-GEOS grants unique access to the COSMO-SkyMed and distributes also GeoEye-1, IKONOS, Radarsat, QuickBird and WorldView and IRS satellites. http://www.e-geos.it/

Leonardo, Italy, is a global high-tech company and a key player in the Aerospace, Defence and Security sectors.Experts in international information management, sensors and systems integration. In leveraging collective strengths, and capitalizing on the synergies across major business areas, Leonardo exploits world-class systems, ICT and smart services to deliver robust, high-integrity mission-critical solutions across different sectors and domains. http://www.leonardocompany.com

Thales, France, is a world leader for critical information systems, with activities in aerospace (with all major aircraft manufacturers as customers), defence, and security (including ground transportation solutions). It provides its customers with all the key functions in the critical information loop, from detection and processing to transmission and distribution. Thales develops its strategic capabilities in component, software and system engineering and architectures through its R&T organisation. https://www.thalesgroup.com

Fraunhofer, Germany, is a leading organisation of institutes of applied research in Germany, undertaking contract research on behalf of industry, the service sector and the government. Fraunhofer IOSB core expertise comprises information and knowledge management, software architectures and object-oriented systems, signal and image processing, optronics and image exploitation, system technologies, modelling and optimisation. http://www.iosb.fraunhofer.de

ARIA Technologies SA, France, is a consulting and software development company, fully dedicated to the study of the atmospheric environment. ARIA is a leading supplier of computerized modelling systems for the purpose of managing air quality resources and offers a wide range of tools at all spatial scales, from building scale to continental scale. The technical solutions offered by ARIA are in daily operation in several countries worldwide, for studies and for the management of air quality resources. http://www.aria.fr/

SISTEMA GmbH, Austria, offers products and services based on Remote Sensing analysis techniques for environmental monitoring and soil management. R&D activities in direct contact with Universities, Research Centers, Customers and End-users mainly focus on meteo-climatic data processing, climate data services, solar radiation mapping, multi-spectral and multi-temporal analysis, geo-spatial data infrastructures implementation for time series access and visualization and standardization of processes. http://www.sistema.at

CVR, Italy, is a SME for the design, development and production of glues, plasters, plasterboards, mortars, gypsum and cement based materials for innovative and sustainable constructions. Smart products for the construction, the renovation and the historical preservation of buildings represent

a key business of CVR. Through cooperation with academic institutions, CVR became market leader for hi-tech production systems and sustainable, smart and energy efficient materials for building and urban improvement. http://www.cvr.it/

Uninova, Portugal, is an institute devoted to the development and application of new technologies.CEMOP has expertise is thin-film technologies and development of advanced materials. CENIMAT is devoted to R&D+ Innovation in advanced materials science & engineering, nanomaterials and nanotechnologies, including semiconductors, biotechnology, polymers, thin film coatings, dielectrics, metals, ceramics and composite materials, covering all the scientific & technological aspects of processing and characterization. http://www.uninova.pt/

TIEMS, Belgium, is a Global Forum for Education, Training, Certification and Policy in Emergency and Disaster Management, dedicated to developing and bringing the benefits of modern emergency management tools, techniques and good industry practices to society for a safer world. This is accomplished through the exchange of information, methodology innovations and new technologies, to improve society's ability to avoid, mitigate, respond to, and recover from natural and man-made disasters. http://tiems.info/

European Materials Research Society (E-MRS), France,has as mission to promote advocacy and outreach of advanced materials science and technology towards industry and policy makers, to provide reports on education and research prospective on advanced materials to assist or help national, European authorities and industries, encouraging discussions among researchers and key players of science and technology, to establish strong links with other scientific societies worldwide. http://www.european-mrs.com/

The Foundation for Research and Technology Hellas (FORTH), Greece, is one of the largest research centres of Greece. The Institute of Electronic Structure and Laser (IESL) is the main laser research centre in Greece, including atto-science, micro/nano-electronics, polymer science, materials science and astrophysics.IESL pioneered in the use of advanced laser technology in diagnostics and conservation, laser cleaning and analysis of works of art and monuments.The Institute of Applied and Computational Mathematics (IACM) specializes in research on numerical simulation and monitoring of environmental, engineering and physiological processes. http://forth.gr/

The Department of Chemistry at the University of Crete, Greece, was founded as a research-driven entity with a vibrant and strong research environment that has succeeded in attracting the highest quality researchers and is having ever-increasing success at bringing in a diverse range of funding.the department has devoted much effort to establishing collaborative relationships with other institutions both at the national and international level, maximizing its international profile, exchanging knowledge, disseminating its findings, and building a growing network of productive research relationships. http://eilotas.chemistry.uoc.gr/uocchem/

The Ephorate of Antiquities of Heraklion (EphAH), Greece, is responsible for the Antiquities from the Prehistoric to the Ottoman Period in the District of Heraklion in Crete.The responsibilities of EphAH span from Archaeological research and studies to architectural preservation and surface conservation interventions on the monuments that belong to its supervision.EphAH is responsible for the two unique monuments of different archaeological eras to be studied in HERACLES: a) The Palace of Knossos (located to the South-East of the city) and b) The Venetian Sea-Fortress of "Koules" (Rocca a Mare) in Heraklion port (located to the North of the city). http://www.culture.gr

Gubbio, Italy, is the capital of a municipality, among the largest in Italy (the seventh "commune" in Italy). The town is located in the middle of a wide territory located approximately 200 km North from Romeand 200 km South East from Florence. The historic city centre has many medieval buildings and major monuments: an urban space miraculously intact in its plant with churches, convents, palaces, public and private buildings, ancient walls, squares, streets, fountains, shop-houses, orchards and gardens. Gubbio is responsible for one of the sites to be analysed in the HERACLES project. http://www.comune.gubbio.pg.it/

TheUniversity of Perugia and the researchers affiliated to the Department of Civil and Environmental Engineering, and to the CIRIAF Interuniversity Research Center on Pollution and Environment "M. Felli" of the Department of Engineering have renowned expertise in carrying out continuous structural health monitoring and rapid post-earthquake and post-disaster assessment of historic constructions using techniques such as vibration measurements, automated operational modal and statistical process control analysis. http://www.unipg.it