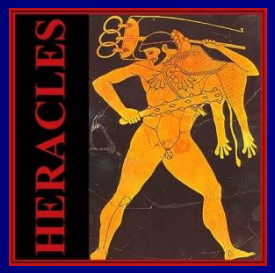
International Conference, Jan. 23, 2018
Danube University Krems (Austria)

SAFEGUARDING CULTURAL HERITAGE FROM NATURAL AND MAN-MADE DISASTERS



HERACLES

HEritage Resilience Against CLimate Events on Site

Integrated monitoring from wide-area surveillance to in-situ sensing and characterization for increasing CH resilience to CC and supporting decisions: the HERACLES approach.

SEC DRS11-2015: Disaster Resilience & Climate Change topic 3: Mitigating the impacts of climate change and natural hazards on cultural heritage sites, structures and artefacts

The integrity of monuments, historical centers and archaeological landscapes is nowadays increasingly threatened by **the climatic change, the extreme meteorological phenomena and the natural hazards**.

The Cultural Heritage monuments are exceptionally vulnerable to these threats while any loss or deterioration of these outstanding assets would negatively impact local and national communities, due to their cultural importance as a source of information on the past and a symbol of identity, as well as for their socio-economic value

the CONSORTIUM (CNR coordination)

- **The Project received funding from the *European Union's Horizon 2020 research and innovation programme* under Grant Agreement No 700395**
- **Funding:** *6.564.313,75 Euro*
- *Starting date: May 1°, 2016*

Advisory Board & SSH/Ethical Board
(CUEBC, UNESCO Chairs, MIBACT, Hellenic Ministry of Culture, ISCR, national, regional and local Decision & Policy makers, restorers, local civil protection, social experts etc…)

the SITES

Archaeological site

Living area

Greece, Heraklion : ***Minoan Palace of Knossos***, *centre of the first civilization of the Mediterranean basin, namely the Minoan civilization and is in the tentative UNESCO list.*

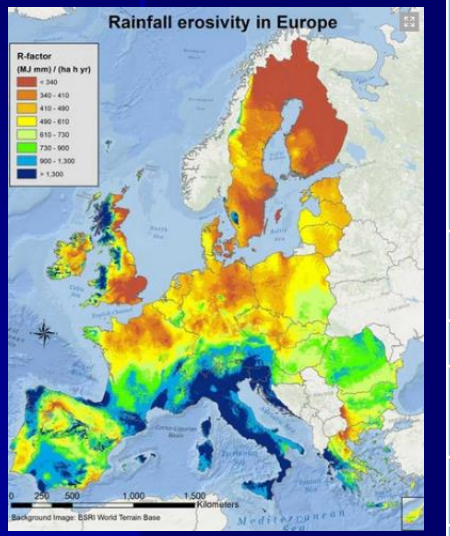
*The **Sea Fortress of "Koules"** symbolises all monuments facing the risk of hazards from climatic change, such as **significant impact from the sea** , (sea level rising, increasing intensity of extreme weather phenomena combined with the air and land associated hazards, increased salinity accelerating corrosion and deterioration of materials and structures, etc)*

Living town

Italy, Gubbio *wants to represent **all the historical monumental towns in Italy and in Europe**, that were conceived and built in the past following criteria when the climate conditions were very different from nowadays and that suffers at present the effects of climate changes, that would endanger their safeguard, particularly the **hydrogeological risk (heavy rains , flood, landslides)**.*

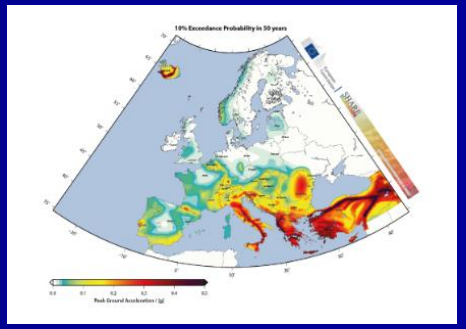
Hazards list in the HERACLES CH sites

Rainfall erosivity



Climate parameters	Climate change risk
Atmospheric moisture change	Flooding (sea, river) Intense rainfall Changes in water table levels Changes in soil chemistry Ground water changes Changes in humidity cycles Increase in time of wetness Sea salt chlorides
Temperature	Diurnal, seasonal, extreme events (heat waves, snow loading) Changes in freeze-thaw and ice storms, and increase in wet frost
Sea level rises	Coastal flooding Sea water incursion
Wind	Wind-driven rain Wind-transported salt Wind-driven sand Winds, gusts and changes in direction
Desertification	Drought Heat waves Fall in water table
Climate and pollution acting together	pH precipitation Changes in deposition of pollutants
Climate and biological effects	Spread of existing and new species of insects Increase in mould growth Changes in lichen colonies on buildings Decline of original materials

Seismic risk



Threats to heritage monuments/assets deriving from CC effects and natural hazards:

- ✓ floods, storms, earthquakes, among others….
- ✓ effects of temperature and athmospheric moisture
- ✓ environmental pollution
- ✓ others….

- ❖ structural instability
- ❖ materials degradation
- ❖ weathering, erosion
- ❖ others…

➢ Governmental budget constraints limit mitigation strategies

Need for effective management tool for cost-effective maintenance and restoration: HERACLES

NEEDS FOR CH RISK MANAGEMENT IN GREECE/HERAKLION AND ITALY/GUBBIO:

Based first on the end-users requirements and on our investigations and surveys on site, one of the key elements necessary for the effective implementation and exploitation of a platform is represented by the:

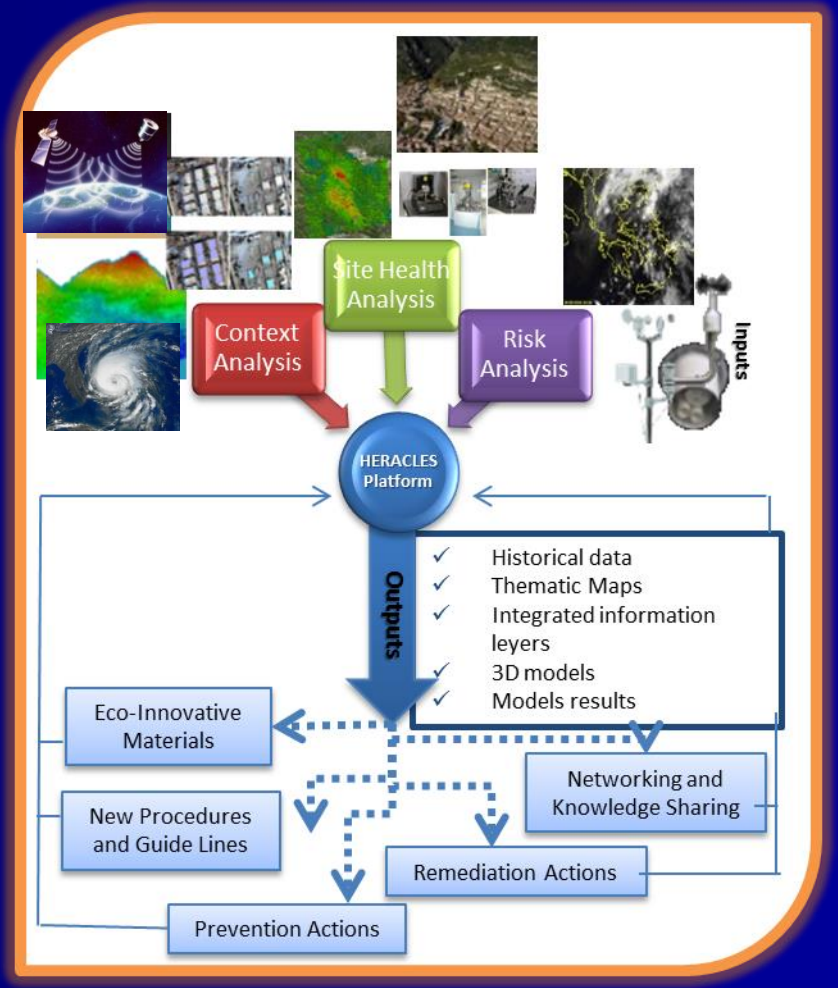
- **Integrated Monitoring technologies** from the wide area surveillance till the single CH asset/monument including the surrounding territory.

HERACLES ICT platform concept

There is the NEED OF NEW TOOLS for IMPROVING THE CURRENT CH MAINTENANCE:

HERACLES PLATFORM DEVELOPMENT

HERACLES platform Multirisks → multisource data



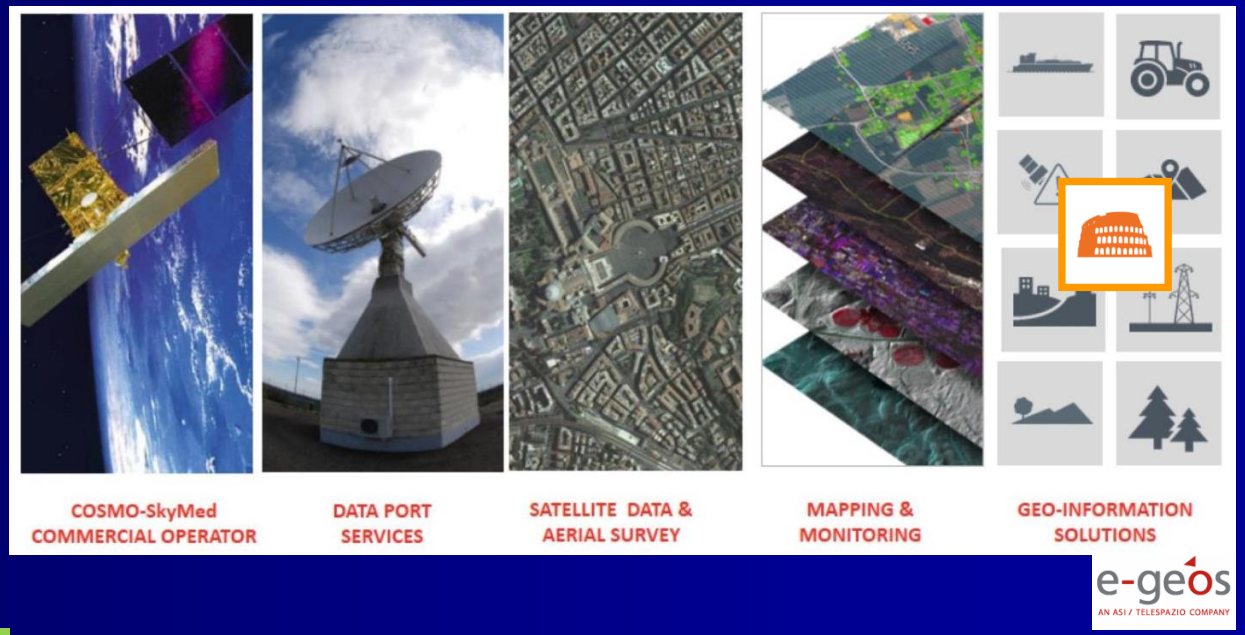
Flexible, general applicability

THE HERACLES TARGETS

- ✓ **Context and Site Analysis / Risk Assessment**
- ✓ **Related answers** in terms of :
  - **New materials and solutions for restoration and conservation**
  - **Monitoring/mitigation & preservation actions for best practices and guidelines**
  - **Safeguard & valorization of cultural heritage, promoting the social and economical values of the Communities**

..... some examples .....

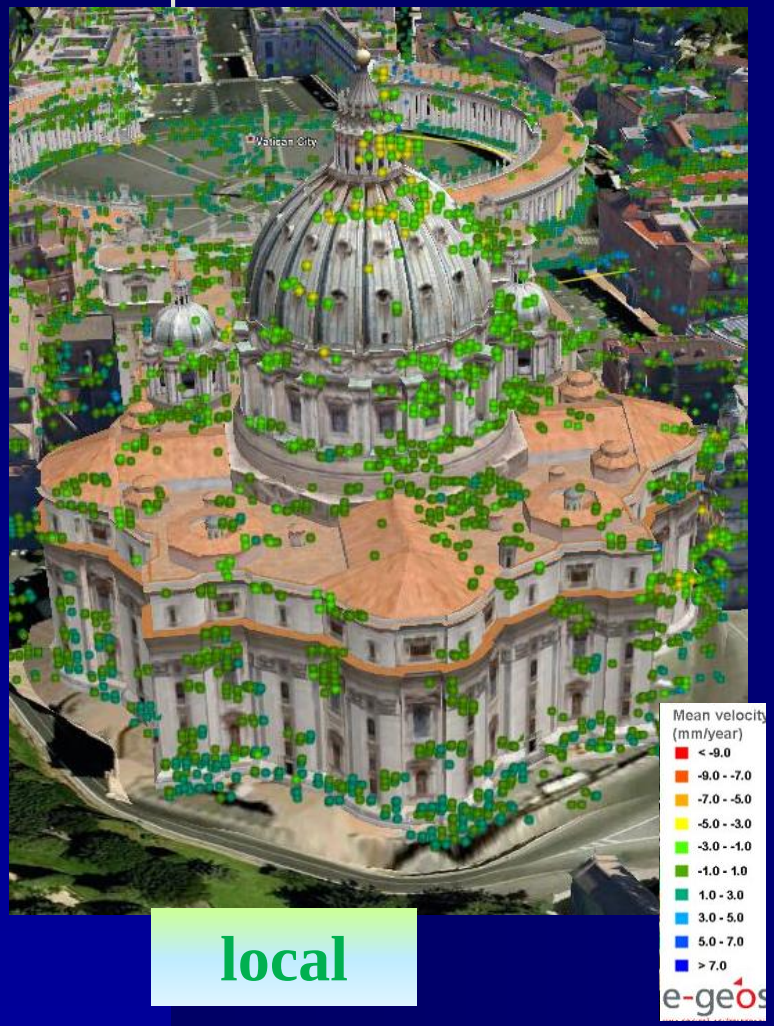
Realization of geo-information layers: specific informations for specific domains



other in-situ sensing and monitoring systems

Useful information for mitigation and preventive maintenance/conservation

..... some examples ..... monitoring of a structure



local

Interferometric analysis

Interferometric service based on PSP-IFSAR technique, using the data from the **COSMO-SkyMed satellite constellation (**X–band SAR allows the detection of movements of building structure parts**)**.

Historical and updated data will be analysed for studying the evolution of the site and highlighten potential problems in terms of structure deformation.

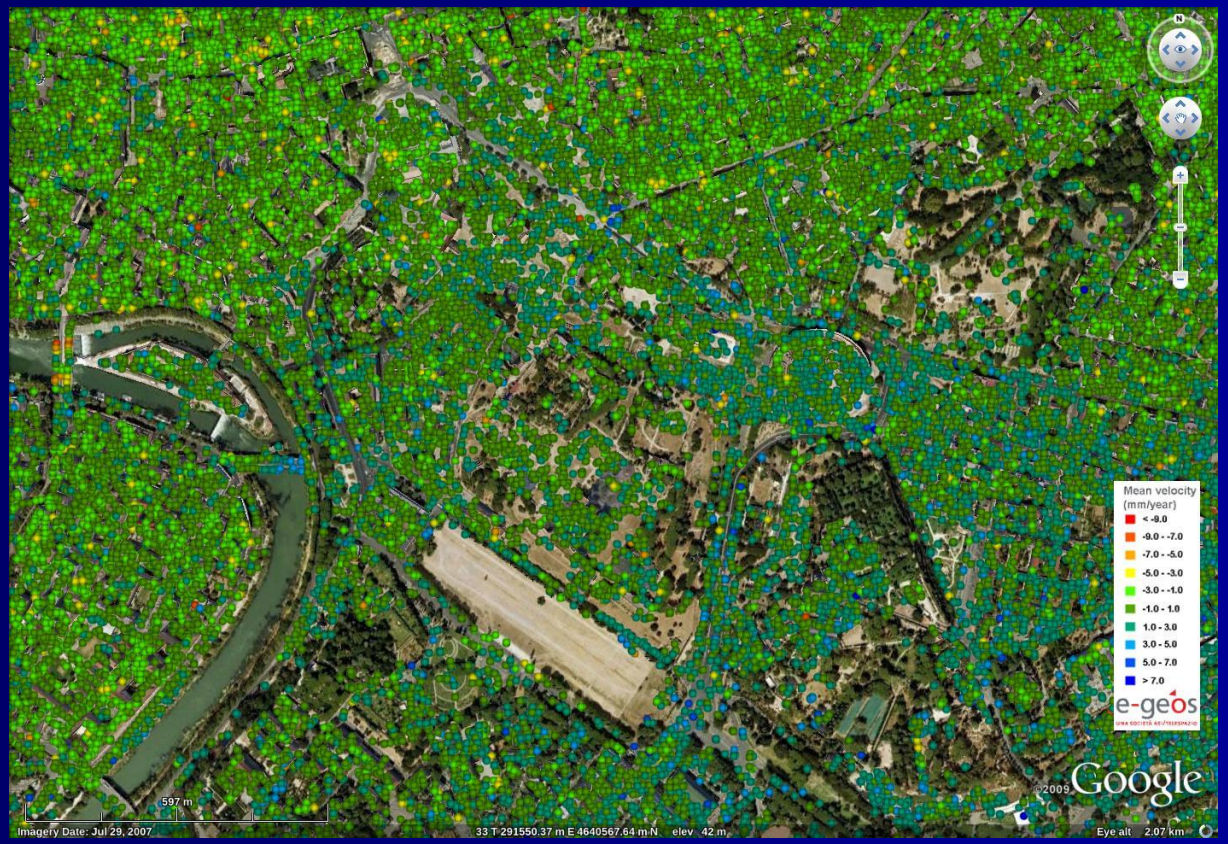
To recover the maximum info for a site, ascending and descending passes are analised to observe the structures from different point of views.
Monthly updates will guarantee an effective monitoring of the area.

Here, an example showing the detail level that the PSP-IFSAR technique, X-band SAR, can provide for a building like San Pietro, Rome (**deformation evaluation**).

..... some examples ..... monitoring of structures in an area

Main archeological area of Rome
CSK PSP-IFSAR analysis (Jan. 2010 – May 2012)

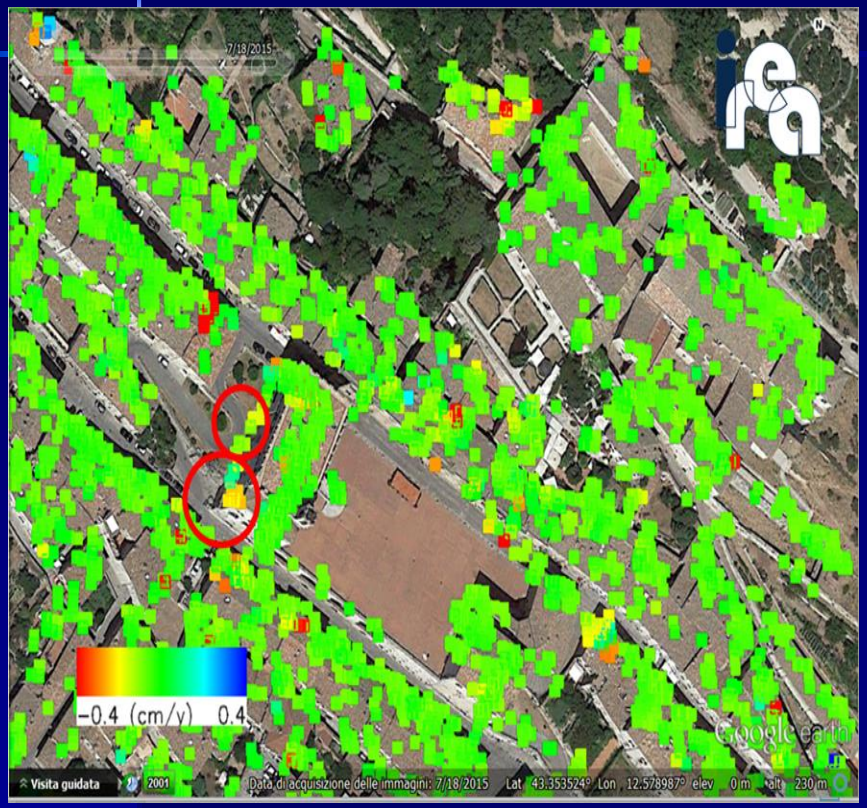
Map of displacements in time

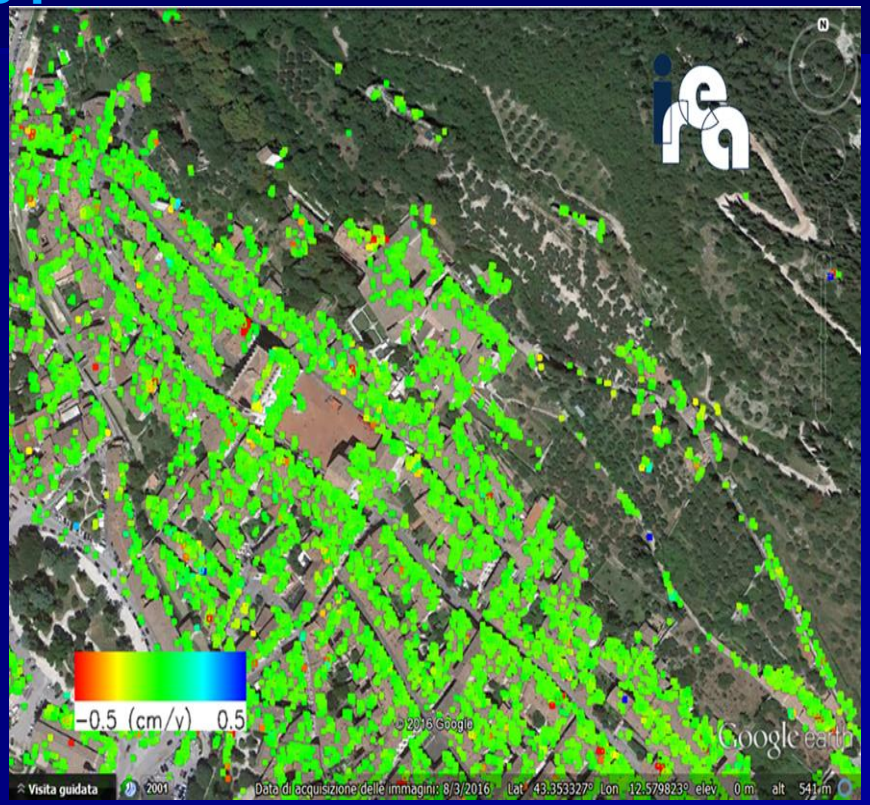


satellite technologies – experimental

Processing of COSMO-SKYMED acquisitions on Gubbio

Consoli Palace — **descending passes** — **Town Walls**

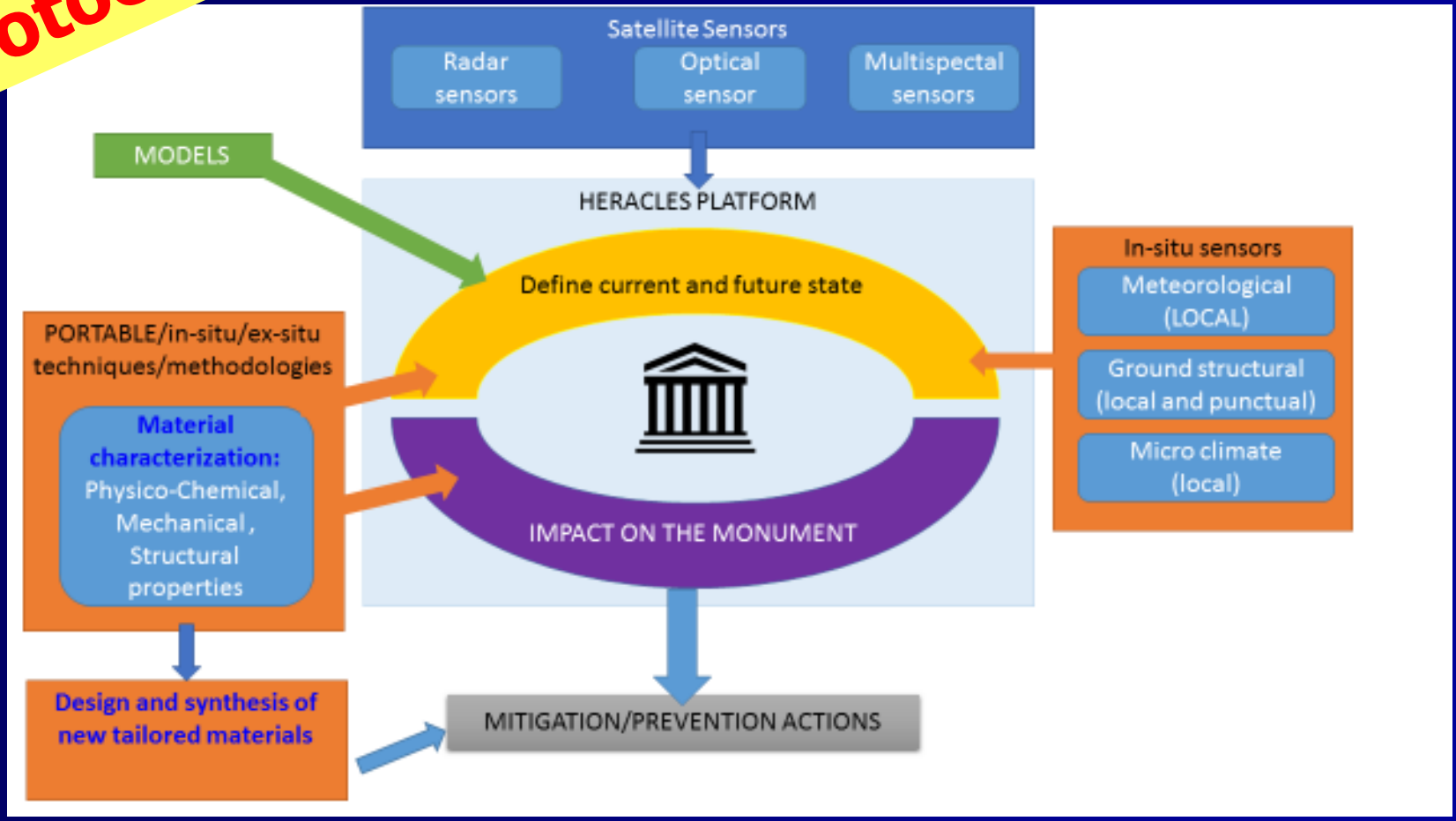




- **Spatial resolution: 3m**
- **6 years**
- **19/02/2011-15/02/2017**
- **72 acqusitions**

..... but HERACLES is also much more than this.....

Protocol



….. but HERACLES is also much more than this……

- ✓ **Definition of methodological procedures/protocols for assessing the CH asset structural behaviour, the materials characteristics and their degradation processes**
- ✓ **Meteorological, environmental and oceanografic monitoring**
- ✓ **Design of new materials and solutions for restoration and conservation (binders and plasters in particular)**
- ✓ **Activities on going to improve the societal awareness and the sense of belonging of the local communities, promoting the social (Identity) and economical (tourism among others) values related to CH**

The HERACLES test beds Countries, Italy and Greece hold 69 UNESCO world heritage sites (tangibles)

A vulnerable European heritage at risk to preserve !

Thanks for your kind attention !