H2020-TWINN-2015. Grant Agreement no 691936	
Project full title:	Remote Sensing Science Center for Cultural Heritage
Project acronym:	ATHENA
Work Package	WP4
Deliverable	D4.7 Material from 4th workshop

	**H2020-TWINN-2015** **Grant Agreement no 691936** This project is funded under the **EUROPEAN COMMISSION** in the Framework Programme for Research and Innovation (2014-2020).
Call:	Work programme **H2020** under **"Spreading Excellence and Widening Participation", call: H2020-TWINN-2015: Twinning** (Coordination and Support Action).
Project full title:	**Remote Sensing Science Center for Cultural Heritage**
Project acronym:	**ATHENA**
Work Package (WP):	**WP4**
Deliverable (D):	**D4.7 Material from 4th workshop - ATHENA: Remote Sensing and archaeology: future and expectations**
Due date of deliverable:	**November 2018 (Month 36 of the project)** / **Version: 1**
Author(s):	**Diofantos G. Hadjimitsis, Evagoras Evagorou, Christodoulos Mettas, Athos Agapiou, Vasiliki Lysandrou, Andreas Christofe, Marios Tzouvaras, Christiana Papoutsa, Argyro Nisantzi, Kyriacos Themistocleous**
Contributor(s):	**Gunter Schreier, Thomas Krauss, Nicola Masini**
Start date of project:	**1/12/2015** / Duration: **36 months**

Dissemination Level		
PU	Public	√
CO	Confidential, only for members of the consortium (including the Agency Services)	

Document Sign-off				
Nature	**Name**	**Role**	**Partner**	**Date**
DRAFT	Diofantos G. Hadjimitsis, Evagoras Evagorou, Christodoulos Mettas, Athos Agapiou, Vasiliki Lysandrou, Andreas Christofe, Marios Tzouvaras, Christiana Papoutsa, Argyro Nisantzi, Kyriacos Themistocleous	Work Package Leader	CUT	19/11/2018
REVIEWED	Gunter Schreier Thomas Krauss	Partner 2	DLR	27/11/2018
APPROVED	Diofantos G. Hadjimitsis	WP Leader / Partner 2	CUT, DLR	28/11/2018

Work Package: 4 – Training and knowledge transfer Deliverable: D4.7 – Material from 4th t workshop				
Sections to be protected	**Description**	**Owner**	**Access Rights**	
			Period	**Type***
none				

Table of Contents

Summary

The specific deliverable summarizes the material related to the fourth workshop of the ATHENA project entitled as “ATHENA: Remote Sensing and archaeology: future and expectations”. The deliverable includes the overall agenda, the list of participants as well as the presentations carried out during the event. The minutes and the main outcomes of the workshop are also included in this report.

1. Introduction

The 4th Workshop of ATHENA project has been successfully accomplished during the 7th International Euro-Mediterranean Conference EuroMed 2018, conducted in October 29th – November 3rd, 2018. Since EuroMED is considered an important digital cultural heritage bi-annual conference, it was a very good opportunity for ATHENA project to have its last workshop in such a significant event. The event was hosted in the Filoxenia Conference Centre (Figure 1), in Nicosia, the capital of Cyprus. A screenshot of the EUROMED 2018 website can be seen in Figure 2.

Figure 1:Filoxenia conference center

Figure 2: EuroMED 2018 international conference

It should also be noted that the ATHENA project was among the main supporter of this event as shown in Figure 3 (see dashed rectangle). The Workshop was led by partner 2 (DLR) and supported by Partner 1 (CUT-Project's coordinator) in cooperation with the other advanced partner, namely the National Research Centre of Italy (CNR - Partner 3).

Figure 3: Some of the main supporters of the EUROMED 2018 international conference

Since the main topics of the conference were highly related to the ones of the workshop, the partners of the ATHENA project decided to host the workshop during the conference. This would have increased the number of the scientists interested on the subject areas but also the project would have been benefited thought further dissemination to the international scientific community and to local stakeholders.

The workshop was a half-day event, advertised through the EuroMED's (www.euromed2018.eu) and ATHENA's websites (see Figure 4 and Figure 5) . The final discussions were very interesting since they highlighted some comments for future work, taking into consideration recent trends such the potential exploitation of the Copernicus mission.

Figure 4: Dissemination of the workshop through Twitter

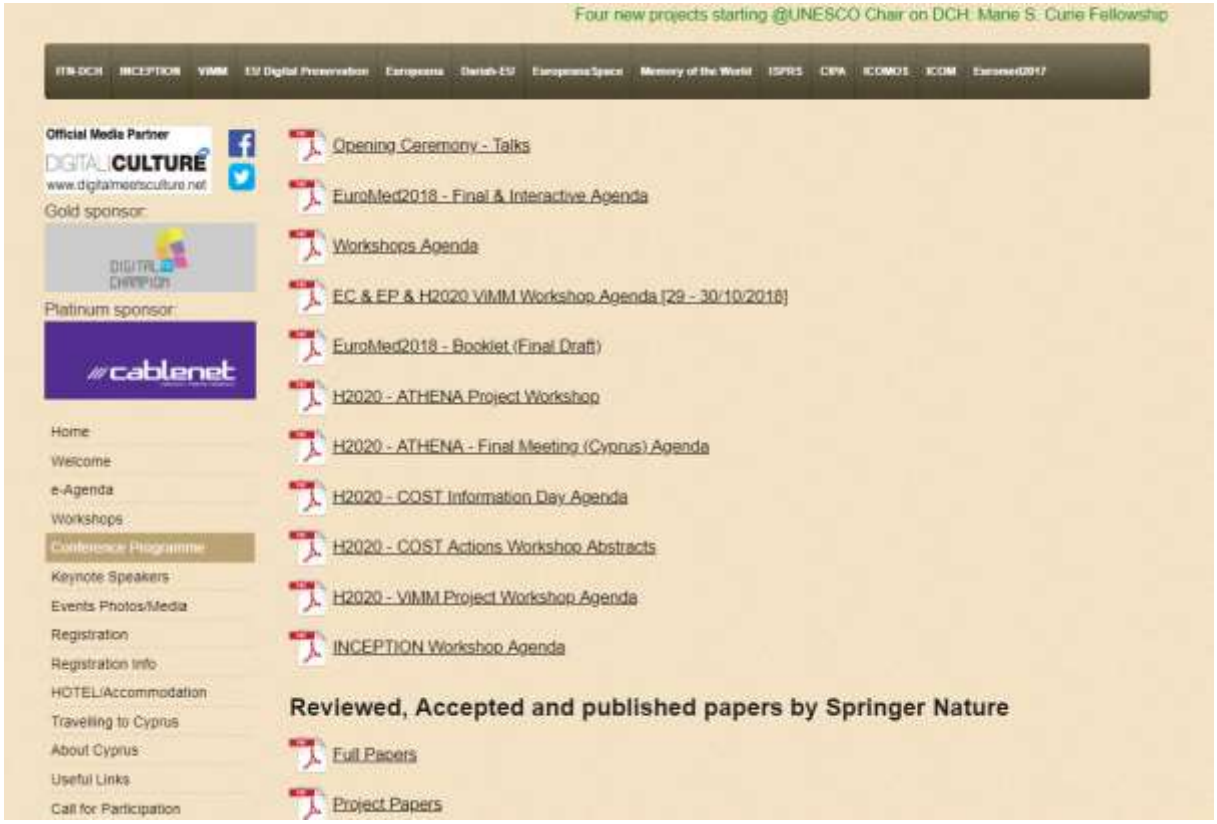

Figure 5: Dissemination of the workshop through EuroMED's website

2. Agenda of the workshop

The following two-paged figure (Figure 6) is the agenda of the workshop distributed to the stakeholders through social media, emails and the internet. It was consisted of some basic information about the ATHENA project and the program that would have taken place, which was broken into 8 parts.

ATHENA

Remote Sensing Science Center for Cultural Heritage

ATHENA: Remote Sensing and archaeology:
future and expectations

Date: October 30, 2018

Venue: Filoxenia Conference Centre

Hosted by: 7th International Euro-Mediterranean Conference EuroMed 2018

Project Coordination Team

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936. Work programme **H2020** under **"Spreading Excellence and Widening Participation", call: H2020-TWINN-2015: Twinning** (Coordination and Support Action)

About ATHENA project

The "ATHENA" project aims to promote Remote Sensing for Cultural Heritage through the development of an enhanced knowledge base and innovative methods. This will be achieved by twinning the existing Remote Sensing and Geo-environment Research Laboratory at the Cyprus University of Technology (CUT) with internationally-leading counterparts from other Member States of the EU, such as the Institute of Archaeological and Architectural Heritage of the National Research Council of Italy (IBAM- CNR) and the German Aerospace Centre (DLR). The goals of the project are aligned with the Smart Specialization Strategy of Cyprus. The close collaboration between CUT and other experts in the field of Remote Sensing for Cultural Heritage in the EU will form a synergic network that will permit the transfer of knowledge and training of the existing personnel of CUT. As a result, the ATHENA project will have both direct and indirect social, scientific, and economic outcomes. In addition, the implementation of the project will facilitate future collaborations with experts of the Archaeology and Cultural Heritage sector in an EU level, increase the Centers' research capabilities, as well as enhance the research and academic profile of all participants. It is noteworthy to underline the importance of the geographical position of the Center in the region of eastern Mediterranean, a region inhabited thousands of years before and therefore abound in archaeological residues.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691936. Work programme H2020 under "Spreading Excellence and Widening Participation", call: H2020-TWINN-2015: Twinning (Coordination and Support Action).

Programme:

Introduction to the topic and ATHENA by Cyprus University of Technology

Presentation on ATHENA results by German Aerospace Centre

Presentation on ATHENA results by National Research Council of Italy

Presentation of ATHENA Video

Overview of Earth Observation data sources

On-going work of Horizon 2020 and cultural heritage

Cultural Heritage as potential new Copernicus Service

Discussion

Cyprus University of Technology DLR HORIZON 2020

Figure 6: Agenda of the 4th workshop

3. List of participants

During the 4th ATHENA Workshop, 26 individuals participated from various European and international institutions, representing both the academia, industry and research centers. The signed list of participants can be seen in the following pages (see figure below). It is important to highlight the fact that the ICOMOS Cyprus section and the Department of Antiquities of Cyprus were present to this event.

DEPARTMENT OF ANTIQUITIES CYPRUS

Table 1: List of participants

ATHENA

Cyprus University of Technology

DLR

H2020-TWINN-2015 - Remote Sensing Science Center for Cultural Heritage - A T H E N A
Topic: 4th ATHENA workshop (WS4)
Date: Tuesday, 30 of October, 2018
Venue: Filoxenia Conference Centre, Nicosia, Cyprus

List of participants

A/A	NAME	INSTITUTION	CONTACT DETAILS	SIGNATURE
1	VASILIKI KYRIANDROU	CUT	vasiliki.kyriandrou@cut.ac.cy	
2	ATHOI AGAPIOU	CUT	athoi.agapiou@cut.ac.cy	
3	CHRYSANTHOS PISSARIDIS	ICOMOS	p.issaridis@yahoo.com	
4	NICOLETTA PAPAGEORGIOU	CUT	nicolettapapageorgiou@edu.cut.ac.cy	
5	Sarri Dimitra	Εθνολογία Αρχαίων Κορινθίων	dimitra.sari@gmail.com	

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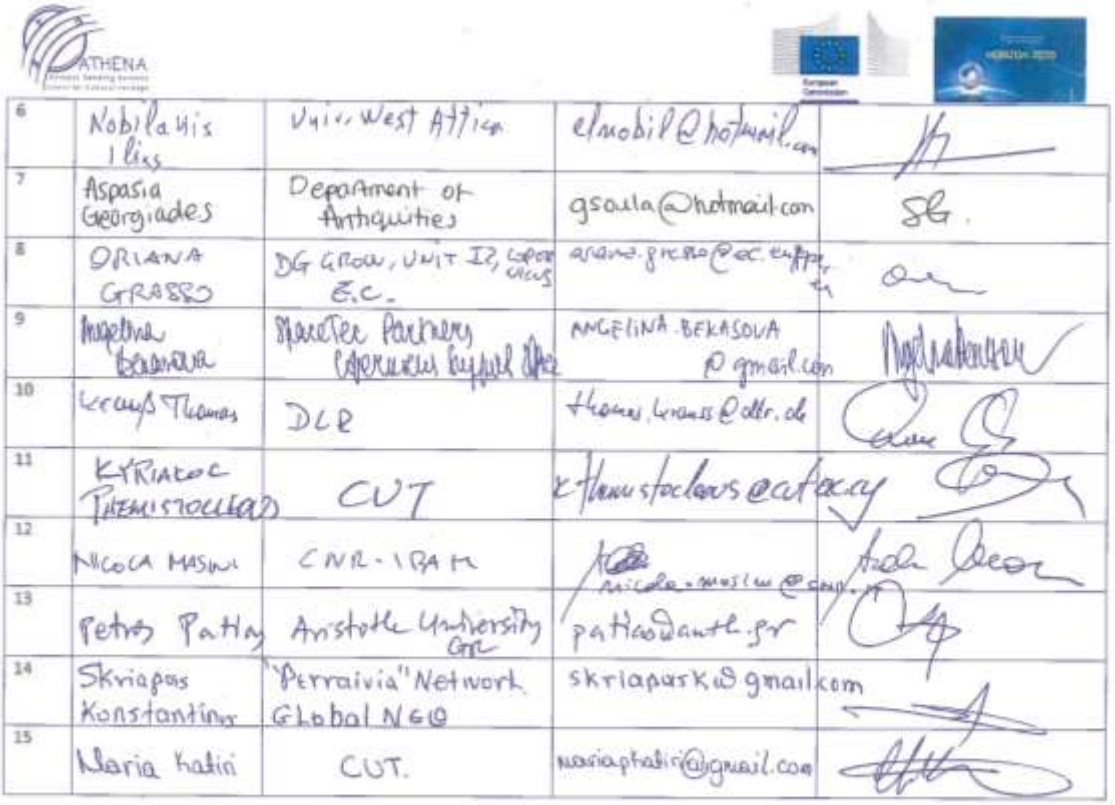
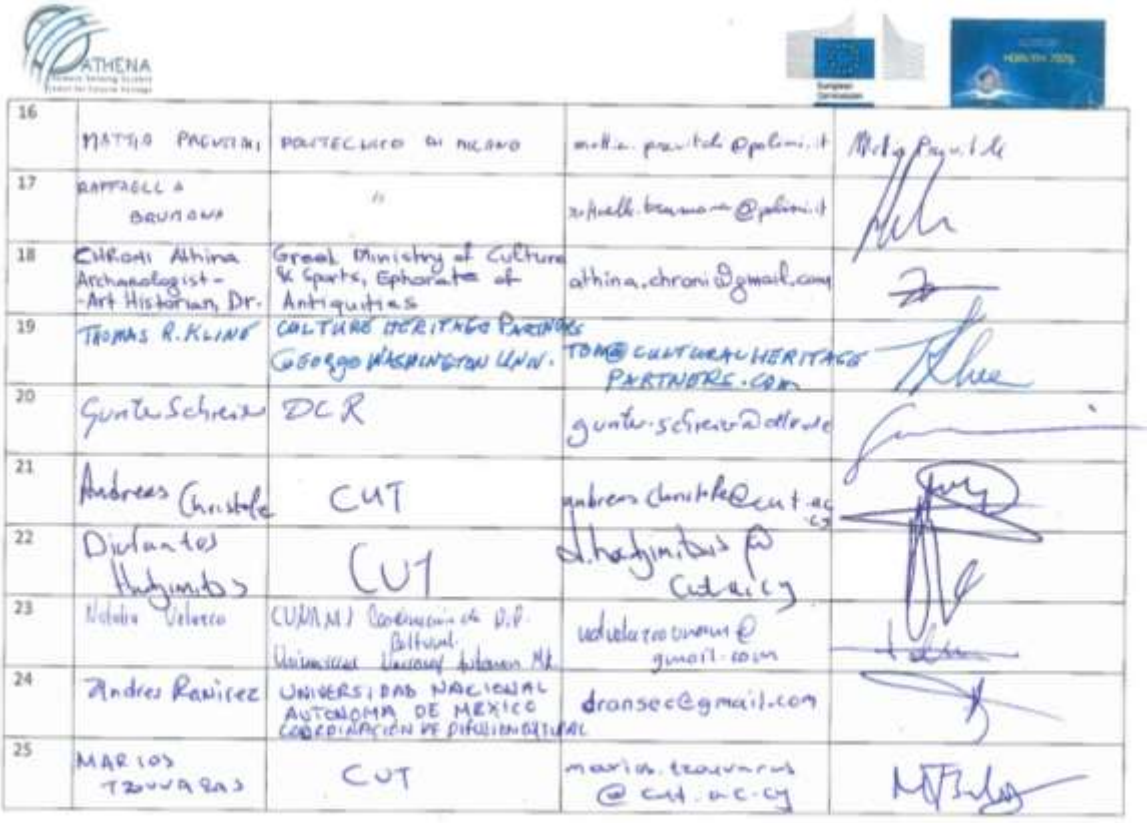


6	Nobila His Iliss	Univ. West Attica	elnobil@hotmail.com	
7	Aspasia Georgiades	Department of Antiquities	gsaula@hotmail.com	SG.
8	ORIANA GRASSO	DG GROW, UNIT I2, Cooperation EC.	oriana.grasso@ec.europa.eu	
9	Angelina Bekasova	Another Partners Cooperation Cultural Sites	ANGELINA.BEKASOVA @ gmail.com	
10	Georgs Thomas	DLR	Thomas.Georgs@dlr.de	
11	KYRIAKOS PAPADOPOULOS	CUT	k.papadopoulos@cut.ac.cy	
12	NICOLA MASINI	CNR-IBAM	nicola.masini@cnr.it	
13	Petros Patias	Aristotle University GR	patias@auth.gr	
14	Skriapas Konstantinos	"Perraivia" Network Global NGO	skriapark@gmail.com	
15	Maria Hatiri	CUT.	mariaphatiri@gmail.com	

2



16	MATTEO PACITTI	POLITECNICO DI MILANO	matteo.pacitti@polimi.it	
17	RAFFAELLA BRUMANA	"	raffaella.brumana@polimi.it	
18	Chroni Athina Archaeologist - Art Historian, Dr.	Greek Ministry of Culture & Sports, Ephorate of Antiquities	athina.chroni@gmail.com	
19	THOMAS R. KLINE	CULTURAL HERITAGE PARTNERS Georgetown Washington Univ.	TOM@CULTURALHERITAGEPARTNERS.COM	
20	Gunter Schreier	DLR	gunter.schreier@dlr.de	
21	Andreas Christofe	CUT	andreas.christofe@cut.ac.cy	
22	Diofantos Hadjimitsis	CUT	d.hadjimitsis@cut.ac.cy	
23	Nicoletta Veloccia	CUARM) Coordinación de D.P. Cultural Universidad Autónoma de Nuevo León	nicoletta.veloccia@gmail.com	
24	Andres Ramirez	UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO COORDINACION DE DIFUSION CULTURAL	dransec@gmail.com	
25	MARIOS TZOUVARAS	CUT	marios.tzouvaras@cut.ac.cy	

3

26	Christina Papoutsa	CUT	Christiana.papoutsa@cut.ac.cy	
27				
28				
29				
30				
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32				
33				
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4

4. Presentations during the workshop

The presentations contacted during the 4th ATHENA workshop can be found in ANNEX 1. The titles of the presentations are:

A. Introduction to the topic and ATHENA by Cyprus University of Technology

B. Presentation on ATHENA results by German Aerospace Centre

C. Presentation on ATHENA results by National Research Council of Italy

D. Presentation of ATHENA Video (see D5.5)

E. Overview of Earth Observation data sources

F. Cultural Heritage as potential new Copernicus Service

5. Minutes of the workshop

This section gives emphasis on the main issues and results came through the discussion with the participants of the ATHENA's 4th workshop. The minutes were compiled by Gunter Schreier, DLR, as part of the ATHENA project

5.1 Place and time of the workshop

The 4th ATHENA workshop took place on October 30th, 2018 at the Filoxenia Conference Centre, Nikosia, Cyprus, during the 7th International Euro-Mediterranean Conference EuroMed 2018, conducted there during October 29th – November 3rd, 2018.

As this was the last workshop of ATHENA within the EC funded project lifetime, it reviewed the achievements of ATHENA partners and gave an outlook on how the topic of Earth observation and cultural heritage is possibly maintained and further developed in related projects and European policy initiatives.

The workshop was titled: "ATHENA: Remote Sensing and archaeology: future and expectations".

It was attended by about 25 participants, mostly registered to the EUROMED workshop.

5.2 Programme and speakers of the workshop

The following table (Table 2) shows the agenda and the presenters of the workshop, while the following table consists of the workshop's minutes.

Table 2: Agenda and Presenters of the 4th workshop

Title	Presenter
Introduction to the topic and ATHENA by Cyprus University of Technology	Diofantos G. Hadjimitsis
Presentation on ATHENA results by German Aerospace Center	Thomas Krauss
Presentation of ATHENA Video	Gunter Schreier
Presentation on ATHENA results by National Research Council of Italy	Nicola Masini
Overview of Earth Observation data sources	Gunter Schreier
On-going work of Horizon 2020 and cultural heritage	Kyriacos Themistocleous
Cultural Heritage as potential new Copernicus Service	Oriana Grasso

At the beginning of the agenda, the ATHENA project coordinator, Prof. Hadjimitsis, gave an overview on the ATHENA project, addressing its achievements and the policy aspects. He also referred to the sustainability of the project which can come through other institutional possibilities (i.e. EXCELSIOR Center of Excellence).

Thomas Krauss, ATHENA deputy project coordinator at DLR, reported the work conducted by DLR during the project, including the training and workshop activities and on-site work performed by DLR colleagues in Cyprus. These included work and training performed with VHR SAR (TerraSAR-X), optical and hyperspectral sensors. The presentation included also a brief overview of other related works of DLR in this domain. Amongst the deliverables of DLR, is also a Video about ATHENA, generated by the DLR department of Science Communication and Visualisation (DFD-WIS). DLR captured the video schemes and material mostly in Cyprus and it was noted that it will also be available in YouTube.

Nicola Masini, CNR, reported the CNR's work in ATHENA project, including workshops, trainings and practical demonstration work. A major site and training visit was organized in Pompeij.

Kyriacos Themistocleous presented the work performed by CUT on archaeological sites in Cyprus based on Satellite and aerial imagery, Field surveying using sensors and wireless networks, GNSS control network, 3D modelling and simulation.

Gunter Schreier, DLR, reported the variety of space-based Earth observation missions and how someone can access the data and use it for monitoring archaeological and world heritage sites. Focus was also given on opportunities through the Copernicus European Programme and its fleet of Sentinel-satellites mentioning the access to – mostly higher resolution – contribution mission data.

Oriana Grasso, from the EC Copernicus office, added in her talk that the Copernicus programme is just contemplating to extend its core service portfolio. Amongst other possible EO applications, the subject of the "preservation of cultural heritage" sites is being discussed to becoming a substantial add-on of the existing core services. She described the further political and programmatic agenda on this topic.

The workshop closed through some discussion with various questions from the audience. The general conclusive statement was that ATHENA can gain more than the fulfilling of its objectives, if

more projects and sustainable mechanisms for using Earth observation data in preserving cultural heritage and supporting archaeologic research, will be implemented.

6. Main outcome of the workshop

The project foresees to support the current cultural heritage needs through the systematic exploitation of earth observation technologies. Also, ATHENA strengthens the remote sensing capacity in cultural heritage at CUT, through the networking.

A core element within ATHENA was knowledge transfer, achieved primarily through intense training activities (including virtual training courses, workshops and summer schools) with an ultimate scope to: enhance the scientific profile of the research staff; to accelerate the development of research capabilities of the ERC as well as to promote earth observation knowledge and best practices intended for Cultural Heritage.

Furthermore, the scientific strengthening and networking achieved in Cyprus through the ATHENA project, could be of great benefit for Cyprus bearing a plethora of archaeological sites and monuments urgently calling for monitoring and safeguarding. The complete database developed through the project showing all the existing institutions which deal with earth observation in cultural heritage, is a very good tool for future use.

Copernicus can support projects similar to ATHENA on monitoring Natural subsidence, shifting ground, earthquakes, Pollution attacking artefacts, Buried archaeological sites, Destruction of sites/looting, Urban sprawl, Climate change, Land use changes.

7. Photos from the Workshop

Figure 7: EuroMED 2018

Figure 8: Professor Diofantos Hadjimitsis (CUT) presentation at the 4th workshop of ATHENA project

Figure 9: Dr. Thomas Krauss (DLR) presentation at the 4th workshop of ATHENA project

Figure 10: Dr. Nicola Masini (CNR) presentation at the 4th workshop of ATHENA project

Figure 11: Dr. Gunter Schreier (DLR) presentation at the 4th workshop of ATHENA project

Figure 12: Dr. Kyriacos Themistocleous (CUT) presentation at the 4th workshop of ATHENA project

Figure 13: Dr. Oriana Grasso (Copernicus Service) presentation at the 4th workshop of ATHENA project

Figure 14: 4th workshop of ATHENA project

ANNEX 1

PRESENTATIONS OF THE WORKSHOP

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

Workshop

ATHENA: Remote Sensing and archaeology:
future and expectations

Introduction of ATHENA Twinning Project

Cyprus University of Technology

ATHENA
Remote Sensing Science
Center for Cultural Heritage

Prof. Hadjimitsis D.G., Coordinator

Cyprus University of Technology

DLR

Outline

- Introduction
- About the project
- About CUT
- Training activities and knowledge transfer
- Examples from common research activities
- Future and expectations
- Conclusion

Outline

- Introduction
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- About CUT
- Training activities and knowledge transfer
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Introduction

Despite serious efforts deployed at national and European level, the Union sees significant internal disparities in terms of research and innovation performance. Indeed, there is still a significant evidence pointing to the fact that the pathway to economic growth and competitiveness is largely connected to research and innovation. **To this direction a stronger participation in Horizon 2020 coupled with greater commitment by the low-performing Member States and Associated Countries can be instrumental. The 'Spreading Excellence and Widening Participation' framework aims to support these low-performing countries, including Cyprus, to improve their research and innovation profile, filling this gap.**

Fig. The Members and Associated Countries eligible for Widening support in blue and yellow colour respectively (Cyprus in circle).

Twinning call

Specific challenge: The specific challenge is to address networking gaps and deficiencies between the research institutions of the low performing Member States and regions and internationally-leading counterparts at EU level.

Twinning aims:

- ✓ Enhance the capacity of the linked institutions;
- ✓ Help raise staff's research profile as well as the one of the institutions involved.

Outline

- Introduction
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ATHENA project

The ATHENA project is devoted to the **development**, **introduction** and **systematic use** of **advanced remote sensing science and technologies** in the **field of archaeology and CH.**

ATHENA takes advantage the **current capabilities of Cyprus University of Technology (CUT),** both in terms of capacity as well of equipment, performing advance research and support to the CH sector.

The project **aims to be in close collaboration with both national as well international research institutes and stakeholders**, providing integrated remote sensing services and solutions in the area of the Eastern Mediterranean.

ATHENA
Remote Sensing Science
Center for Cultural Heritage

The new perspectives on archaeological and cultural heritage in the region will position the CUT as a centre of knowledge and a standard lab in the field of Remote Sensing Archaeology.

The consortium

Cyprus University of Technology

DLR

Workshop: Remote Sensing and archaeology: future and expectations

Supporters

Department of Antiquities

Association of Cypriot Archaeologists

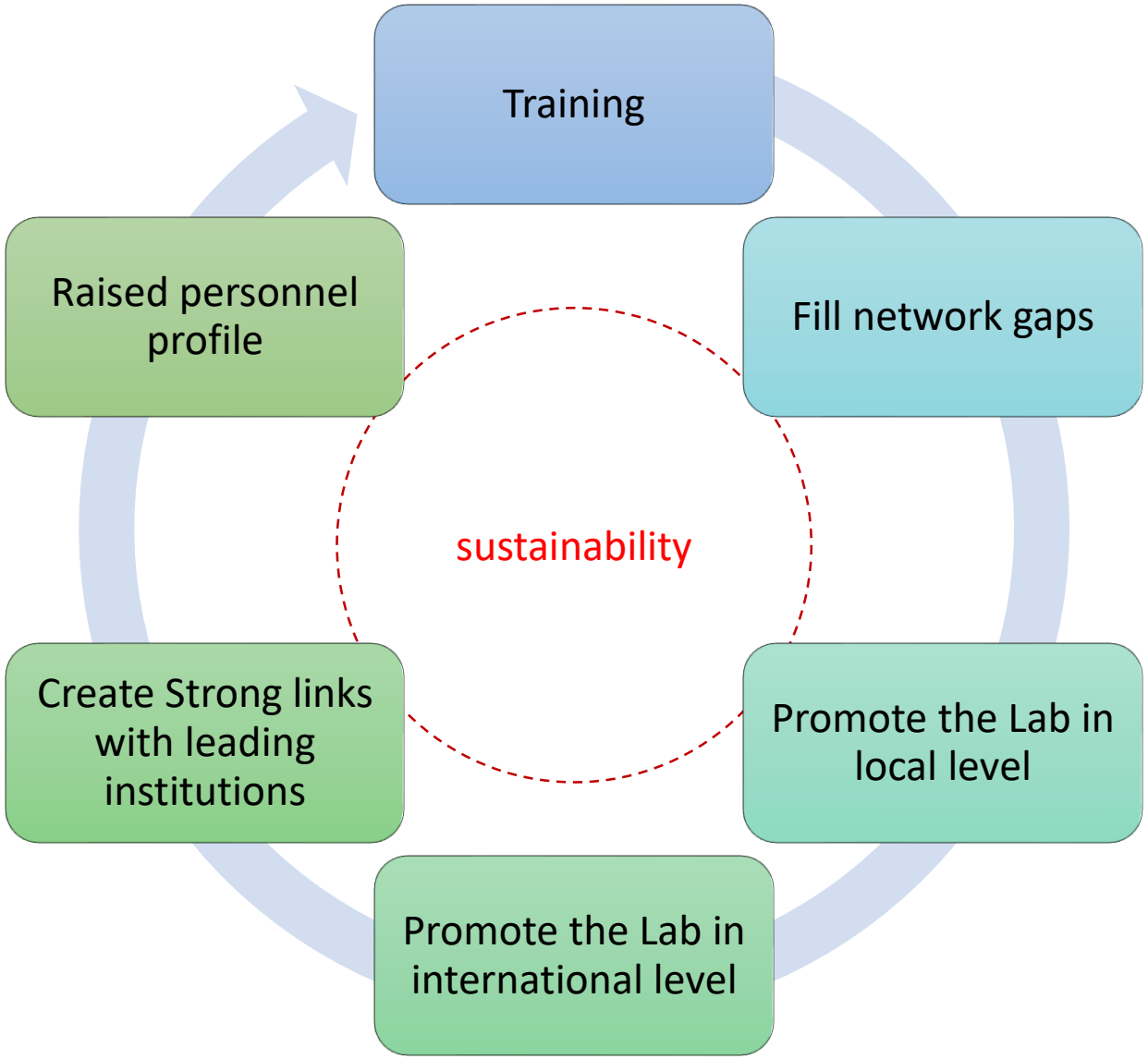
Cyprus Remote Sensing Society

Department of Electronic Communications

United Nations Education Scientific and Cultural Organization

The International Centre on Space Technologies for Natural and Cultural Heritage (HIST) under the auspices of UNESCO

Added value of the Twinning Call



Work Packages

WP1: Project Management (M1-M36)

WP2: International RS research applied on CH, innovation agenda and best practices assessment (M1-M9)

WP3: Evaluation of gap and capacity development (M3-M12)

WP4: Training and knowledge transfer (M1-M36)

WP5: Promotion of the centre locally and internationally (M30-M36)

WP6: Dissemination and exploitation (M1-M36)

Why Remote Sensing…for Archaeology?

The **European space policy** aims to tackle some of the most pressing challenges today, such as climate change, monitoring built and natural environment, providing precise and systematic information around the world, helping to stimulate technological innovation, and providing socio-economic benefits to citizens. Space technology, data and services have become indispensable in the lives of citizens. We rely on them when using mobile phones and car navigation systems, using e-maps and information geo-systems. Satellites also provide **immediate information** when disasters, such as earthquakes, forest fires or floods strike, enabling better coordination between emergency and rescue teams. The economic and social benefits from the exploitation of the space technologies have been highlighted in several reports.

Furthermore, the earth observation industry sector has the capacity to **mobilise research**, **innovation** and **development** and to **boost the local economies not only in Cyprus but in the entire Middle East region**. This is also because satellite earth observation is the basis of "Geo-services", which are estimated to account for a global revenue of €150-270 billion per year. **With the first European Earth Observation Copernicus satellites active since 2014, information arriving from them is already available for research purposes in a full, open and free (FOF) manner**. Such a vast amount of data requires processing and, more importantly, "fine-tuning" towards the needs of the local users and their specific context in all branches of environmental monitoring and emergency response management.

Monitoring archaeological sites

Detection of archaeological proxies

Risk assessment

Archived information

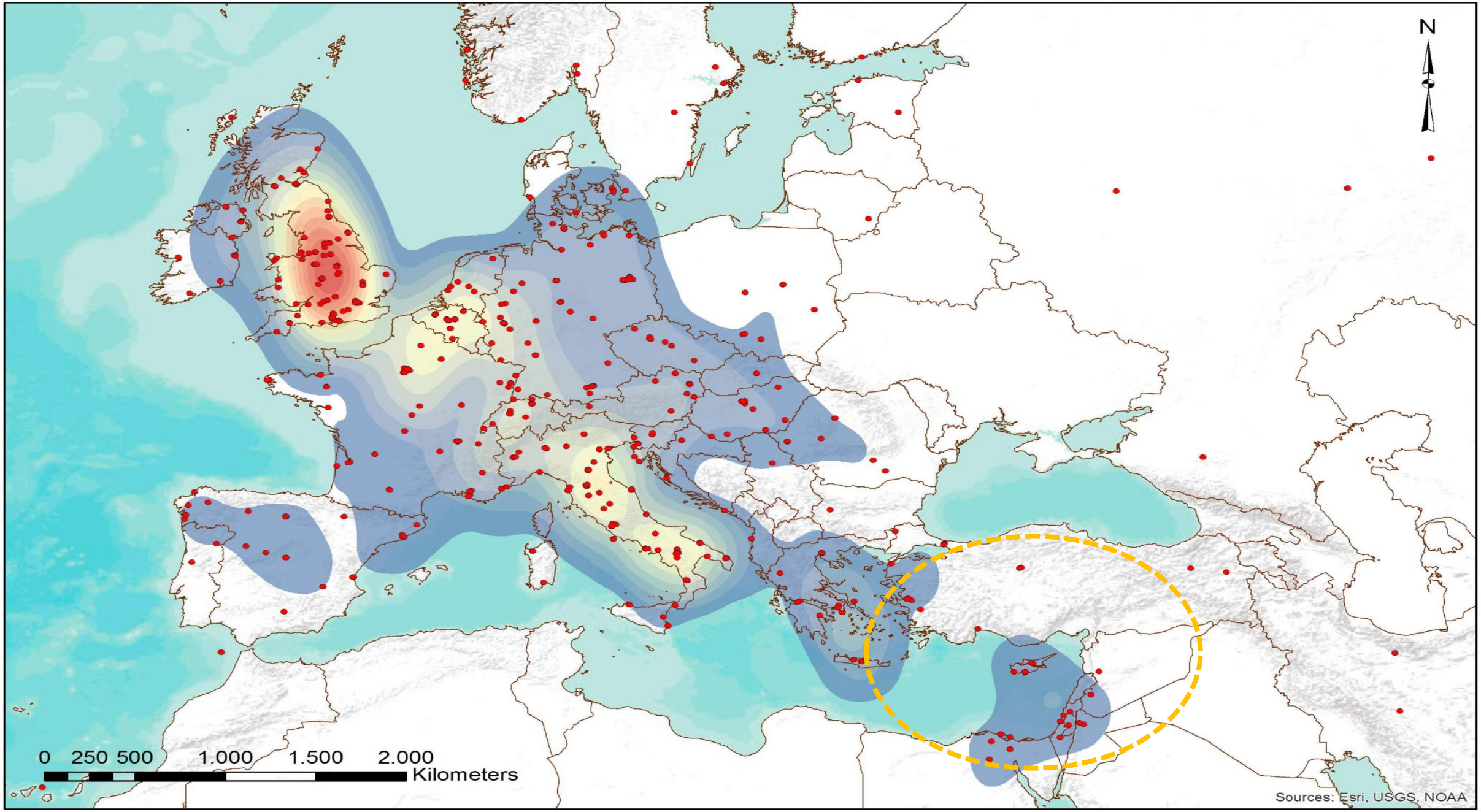
Micro-movements

Looting

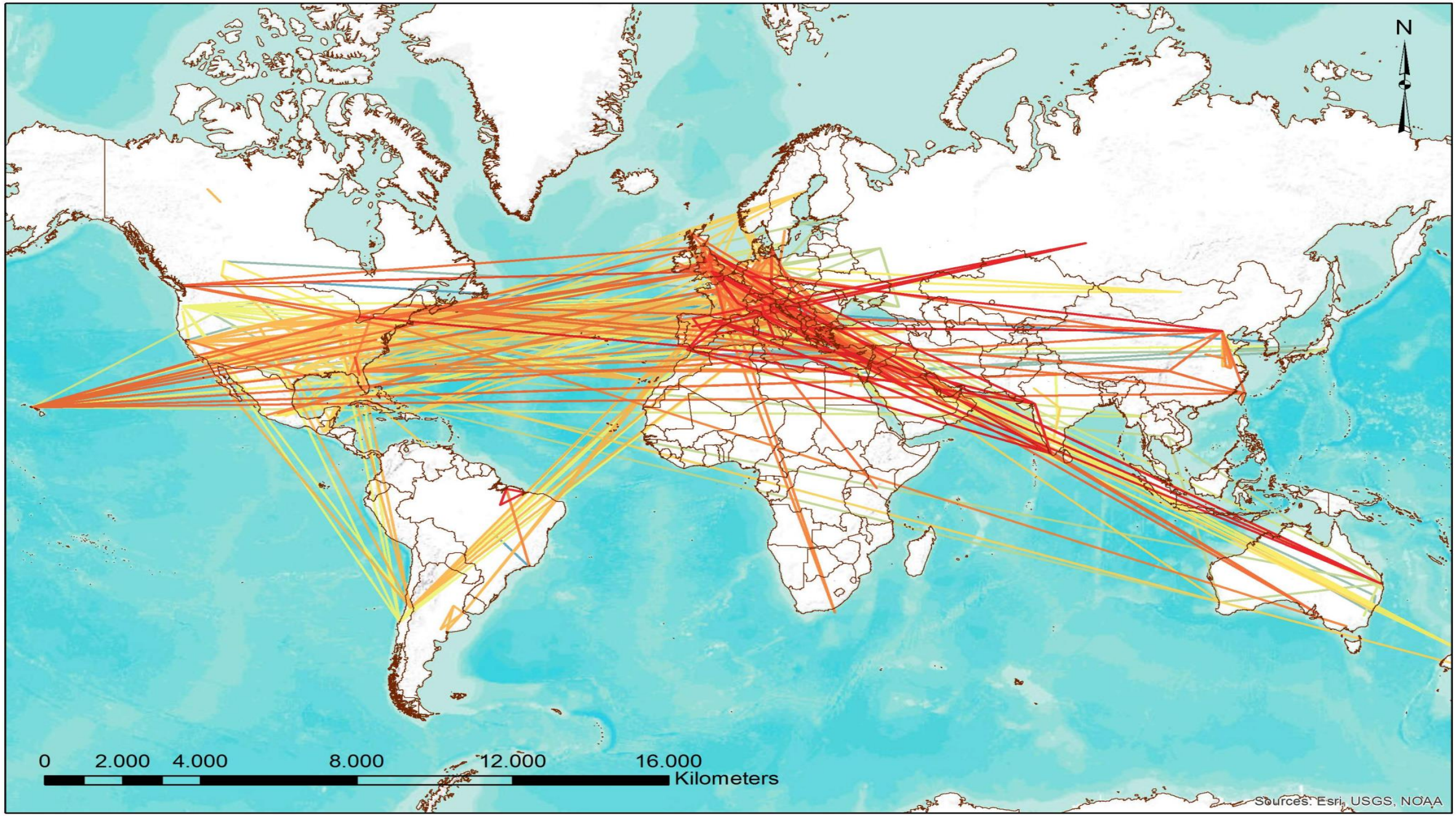
….

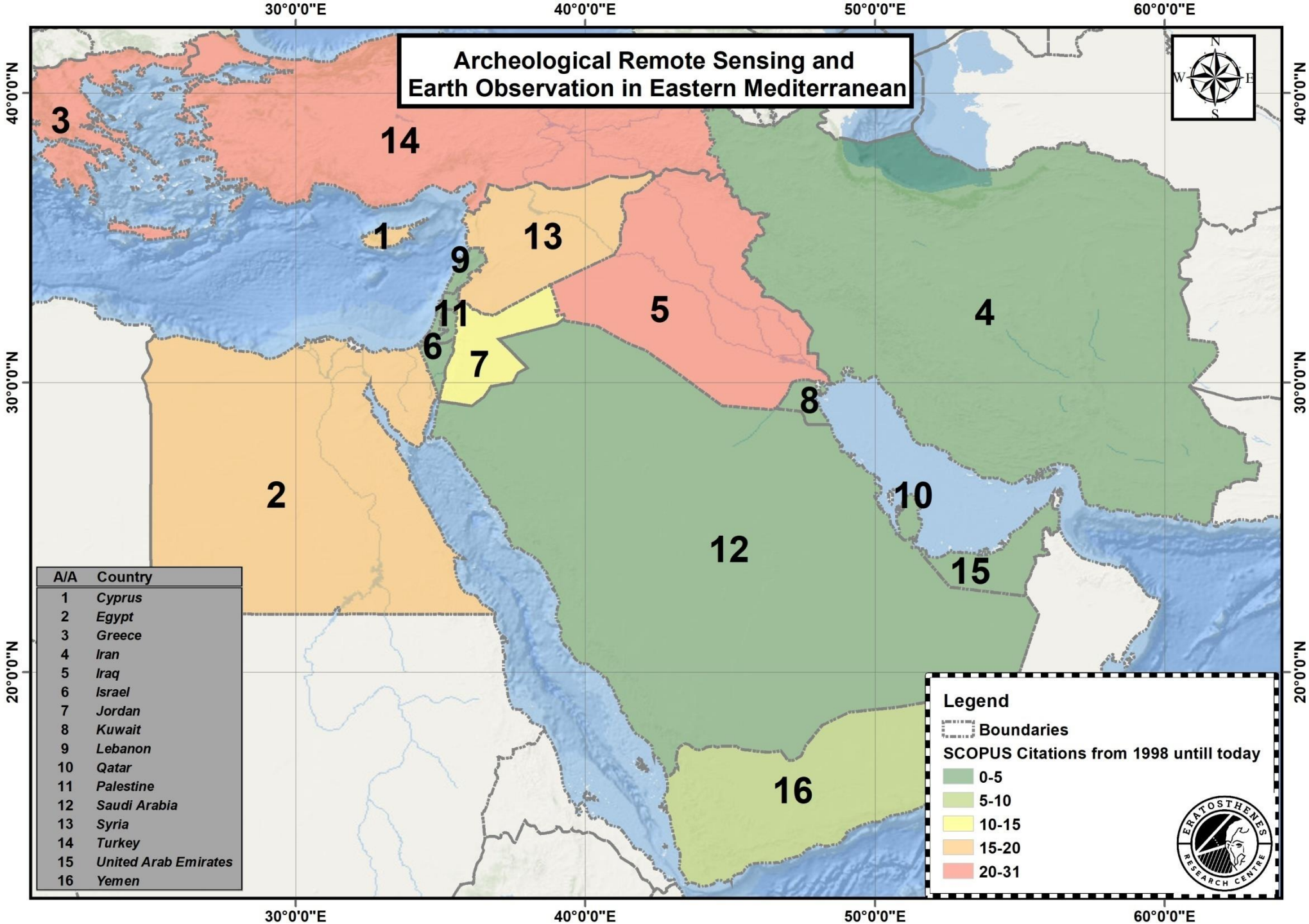
Copernicus
Europe's eyes on Earth

“Remote Sensing Archaeology”, Citation based research from 1999-2015



“Remote Sensing Archaeology”, Citation based research from 1999-2015




Archeological Remote Sensing and
Earth Observation in Eastern Mediterranean
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A/A Country
1 Cyprus
2 Egypt
3 Greece
4 Iran
5 Iraq
6 Israel
7 Jordan
8 Kuwait
9 Lebanon
10 Qatar
11 Palestine
12 Saudi Arabia
13 Syria
14 Turkey
15 United Arab Emirates
16 Yemen
Legend
Boundaries
SCOPUS Citations from 1998 untill today
0-5
5-10
10-15
15-20
20-31
ERATOSTHENES
RESEARCH CENTRE

H2020-TWINN-2015: Remote Sensing Science Center for Cultural Heritage - ATHENA

ATHENA database

Display all the information on a webgis platform

Outline

- Introduction
- About the project
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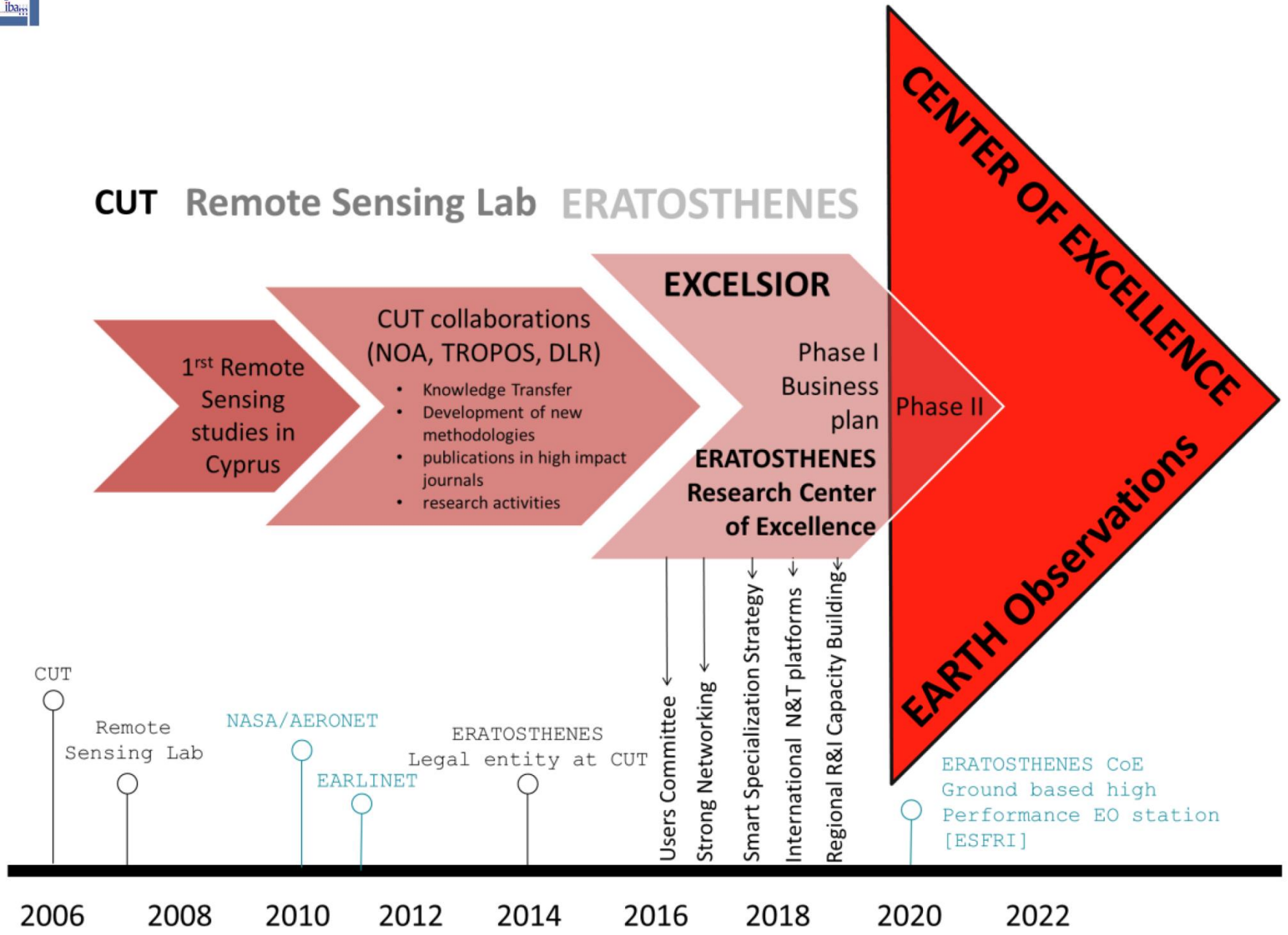
- Future and expectations
- Conclusion

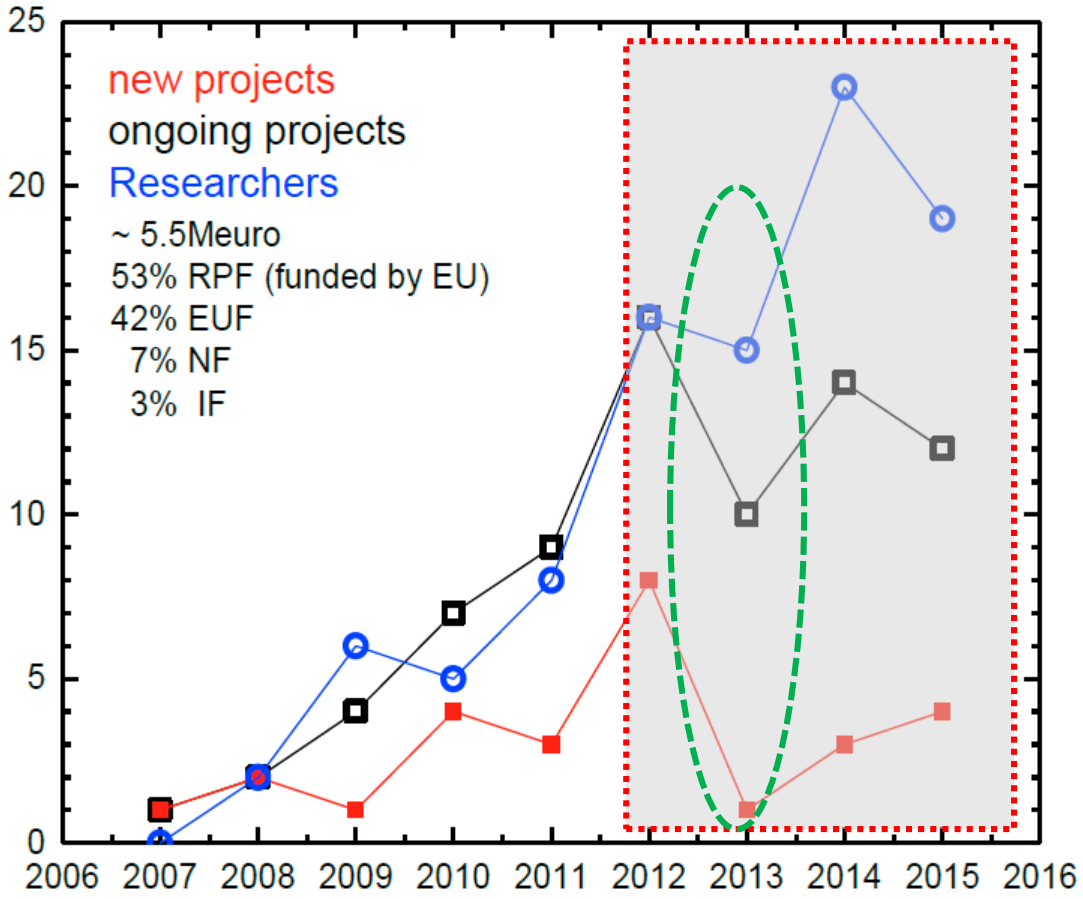
Cyprus University of Technology

The end of the ATHENA project comes in a unique moment for the hosting University (CUT) as a whole since is has been recently (2018) ranked as the second-best university of the '**New Europe**' by the Times Higher Education while it was ranked first among other public and private Universities of the country in terms of research and academia (CUT was ranked within the 300-350 best universities in the world based on the list 2018-2019 of "Times Higher Education World University Rankings").

10 years of activities



ERATOSTHENES RESEARCH CENTRE – REMOTE SENSING AND GEOENVIROMENT LAB



Economic crisis hit Cyprus

No national budgets for funding!

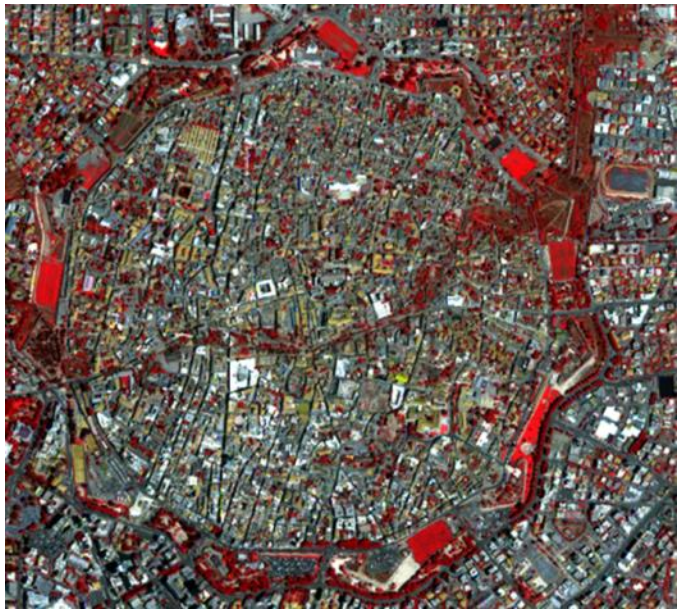
ERATOSTHENES RESEARCH CENTRE – REMOTE SENSING AND GEOENVIROMENT LAB

Funding

- ✓ Participation to more than 55 projects from since 2007
- ✓ Total budget more than 55 million euros. 5,5 million where allocated to CUT
- ✓ Coordination of more than 20 funded research projects

Research

- ✓ 30 active researchers coming form different backgrounds such as engineers; physics; earth scientist; chemists etc working in 6 different thematic research areas of the Lab
- ✓ Provide 120 job positions since 2007
- ✓ Academics from various departments
- ✓ More than 85 dissertations/ final year projects



The **Lab is active in various networks and events**

RSCy2018
Sixth International Conference on Remote Sensing and Geo-information of Environment
March 26-29, 2018 - Paphos, Cyprus

REMOTE SENSING AND GEOENVIROMENT LAB - funds

Funding sources

1. Cyprus Research Promotion Foundation
2. European Union
3. Industry

Outline

- Introduction
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Training activities and knowledge transfer

3rd Virtual Training

Topic: Archaeological looting: Ancient problems and New approaches based on Remote Sensing

Trainer: CNR

1st September 2017

Cyprus University of Technology, Limassol - Cyprus

2nd Workshop

Topic: Remote sensing for Cultural Heritage beyond Europe

Trainer: CNR/DLR

20th April 2017

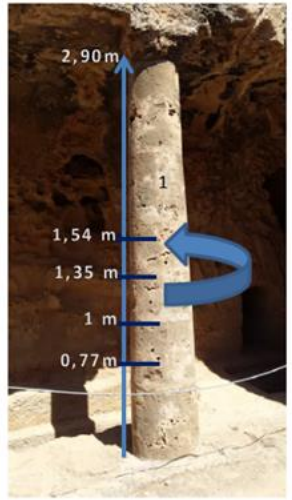
RSCy2017, Paphos - Cyprus

Training activities and knowledge transfer

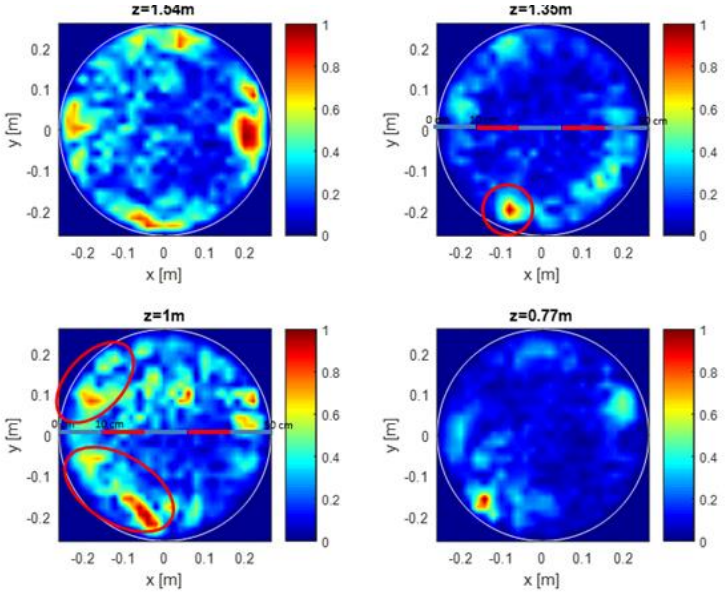
2nd Short term visit on site (OS2)

The second short term visit on site within the ATHENA project activities for testing, evaluation and discussion in Cultural Heritage sites has been carried out during March 2017.

CNR & CUT staff researchers visited the UNESCO archaeological site "Tombs of the Kings" in Paphos. Portable GPR's have been used to map the preservation status of specific elements of tomb no. 4.



2,90m altezza colonna



Training activities and knowledge transfer

ATHENA @ the Departments of Civil Engineering and Geomatics summer school June 2017

ATHENA presented at Sheffield University.

Training activities and knowledge transfer

ATHENA supported RSCy 2017 - 2018

The ATHENA team participated in the Special Issue

"Advances in Remote Sensing for Archaeological Heritage"

ATHENA supported EGU Special Session

Training activities and knowledge transfer

ATHENA…
back to school!

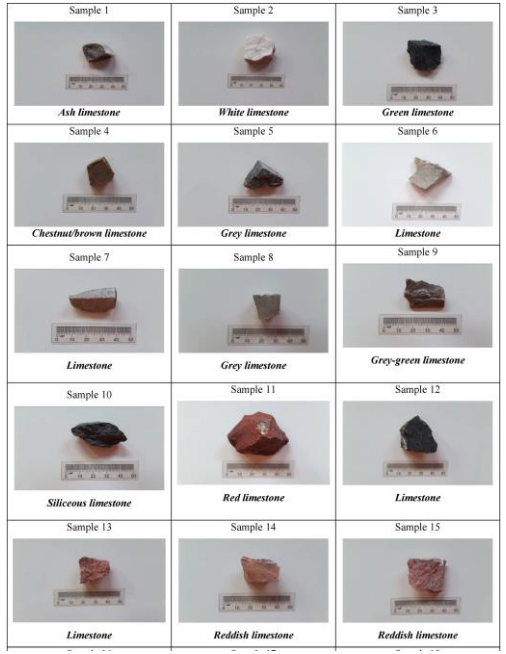
Researcher's Night 2016-2017-2018

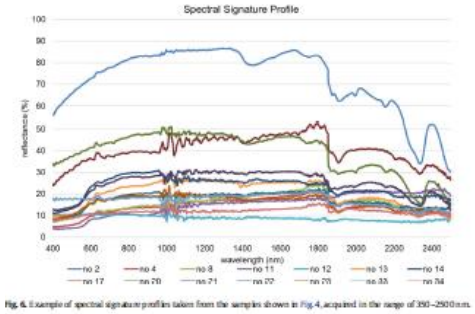
Outline

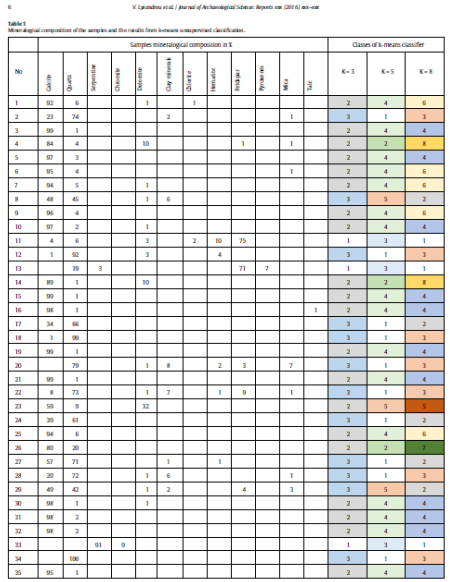
- Introduction
- About the project
- About CUT
- Training activities and knowledge transfer
- Examples from common research activities
- Future and expectations
- Conclusion

1. Examples of Research activities…

Identification of materials used in mosaics in Cyprus using non-destructive techniques (>90% success)







mosaics → samples → spectral signatures → Discrimination analysis

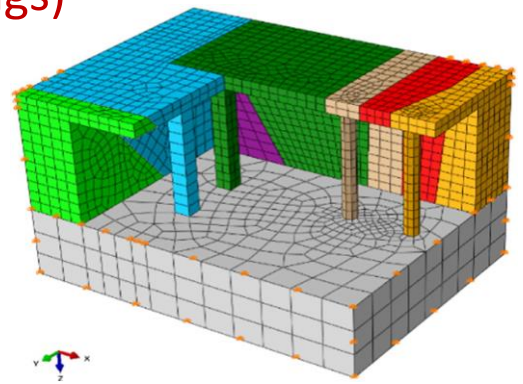
Lysandrou V., Cerra D., Agapiou A., Charalambous E., Hadjimitsis D. G. (2016), “Towards a spectral library of Roman to Early Christian Cypriot floor mosaics”, *Journal of Archaeological Science: Reports*

2. Examples of Research activities…

Damage condition with historical seismic activity in underground sepulchral monuments of Cyprus (Tomb 4, Tombs of the Kings)

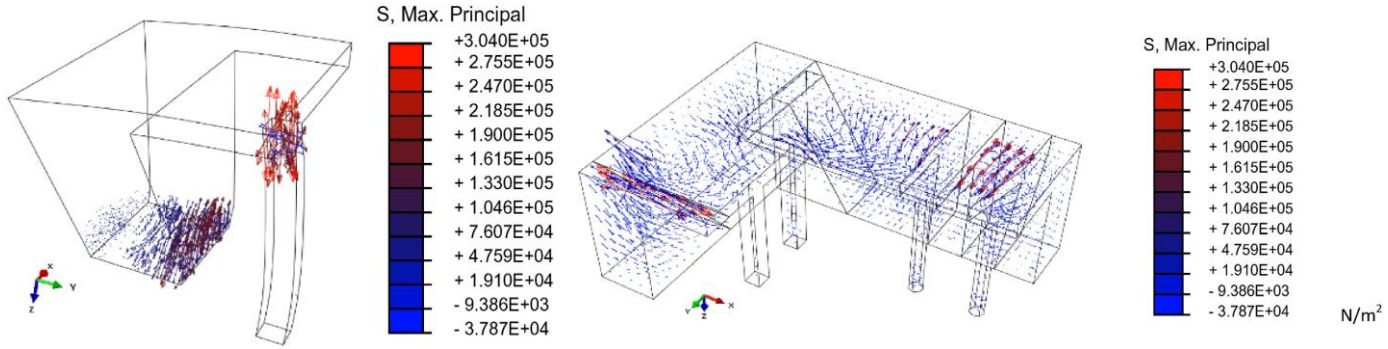
Kyriakides N., Lysandrou V., Agapiou A., Illampas R., Charalambous E. (2016), "Correlating damage condition with historical seismic activity in underground sepulchral monuments of Cyprus", *Journal of Archaeological Science: Reports*

3D modeling



3D FE model developed for examining the seismic behavior of the T4 tomb. Interacting stone blocks separated by cracks are shown in different colors

Tensor diagram showing the computed distribution of the maximum principal stresses when the peak ground acceleration is imposed



…It is clear from the results that during the selected earthquake, the displacement at the top of the rocking block will reach a value close to the overturning limit but a severe force is required to actually cause overturning. It should be noted though that during such an excitation, the rocking of the blocks and their disintegration through cracking would lead to the creation of small loose rock masses that might fall due to gravity.

3. Examples of Research activities…

Mapping and monitoring looted areas

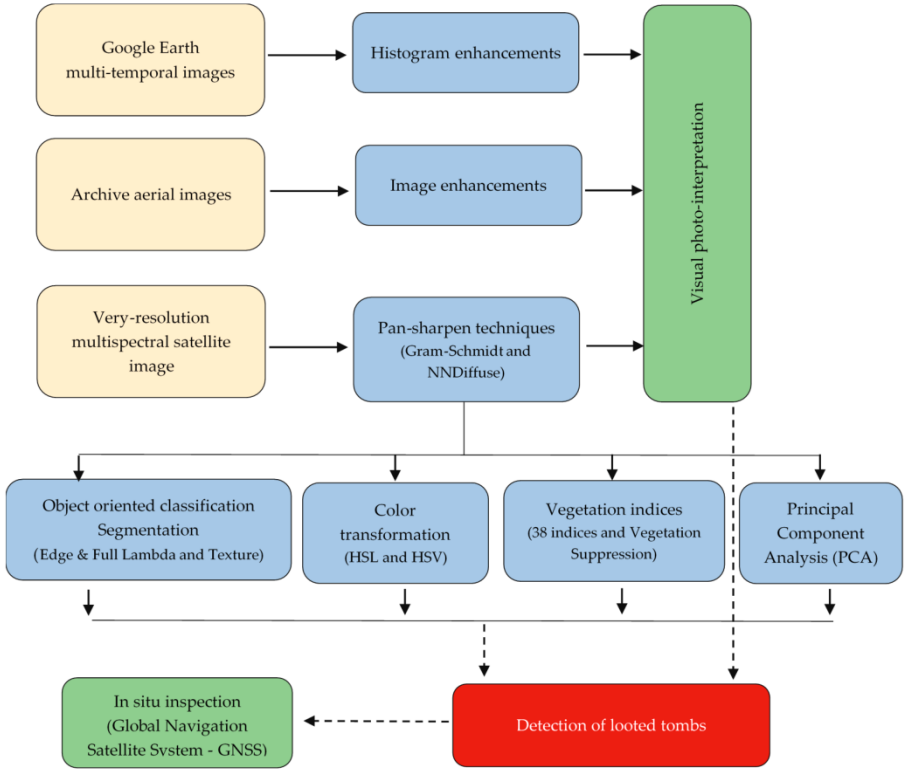
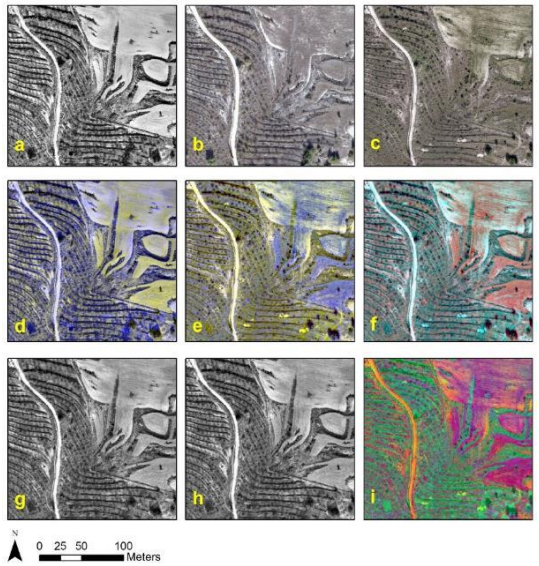
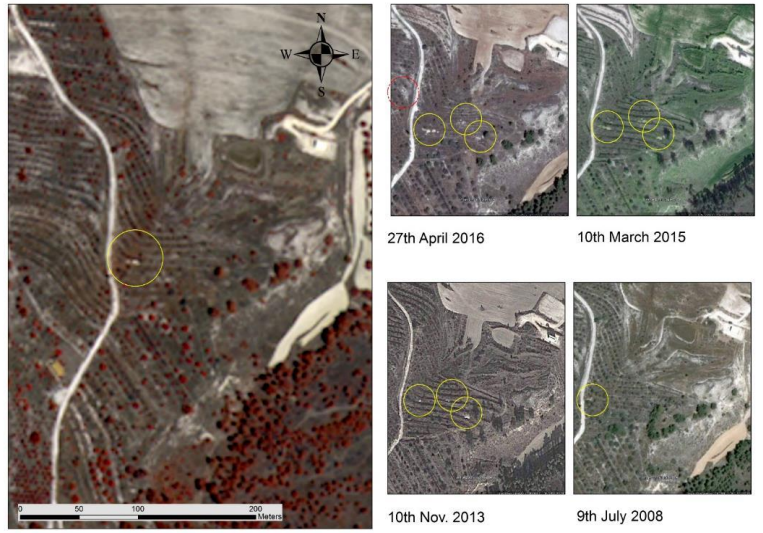


Figure 1. Overall methodology and resources used for the current study.

……existing literature is mainly focused on the exploitation of remote sensing technologies for extended looted areas, where hundreds of looted signs are visible from space and air. On the contrary, this paper aims to present small-scale looting attempts which seem to have been made in recent years in Cyprus. In addition, no scheduled flight or satellite overpass was performed to monitor the site under investigation. Therefore, the use of existing datasets captured by various sources and sensors was the only means of mapping the looting imprints.

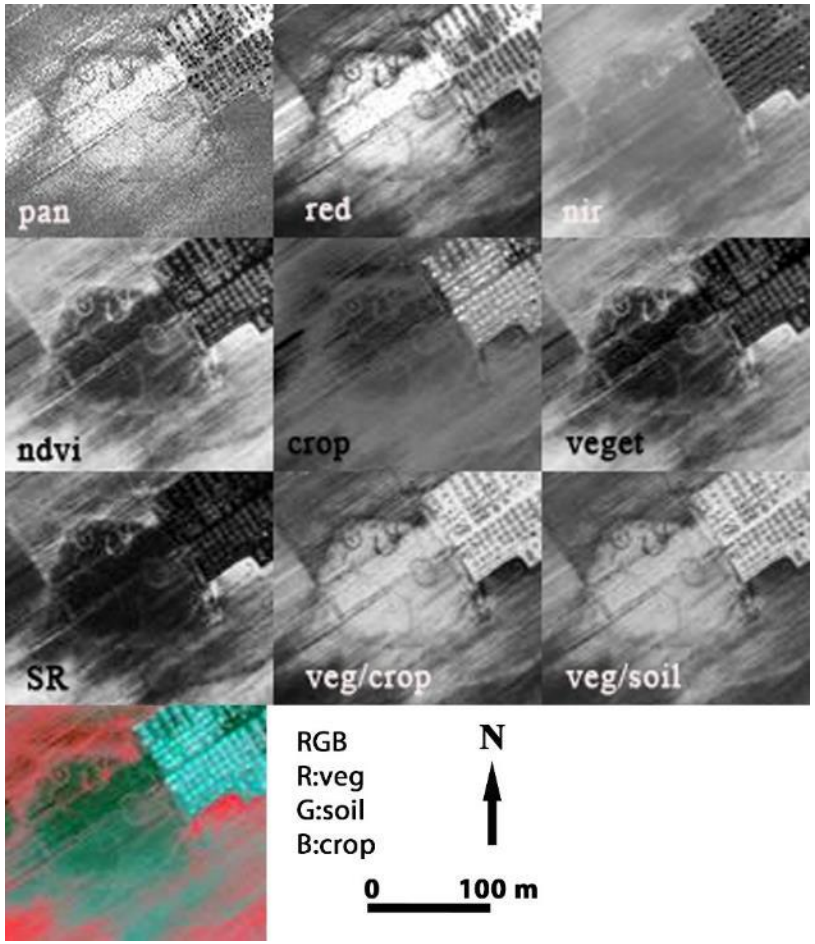




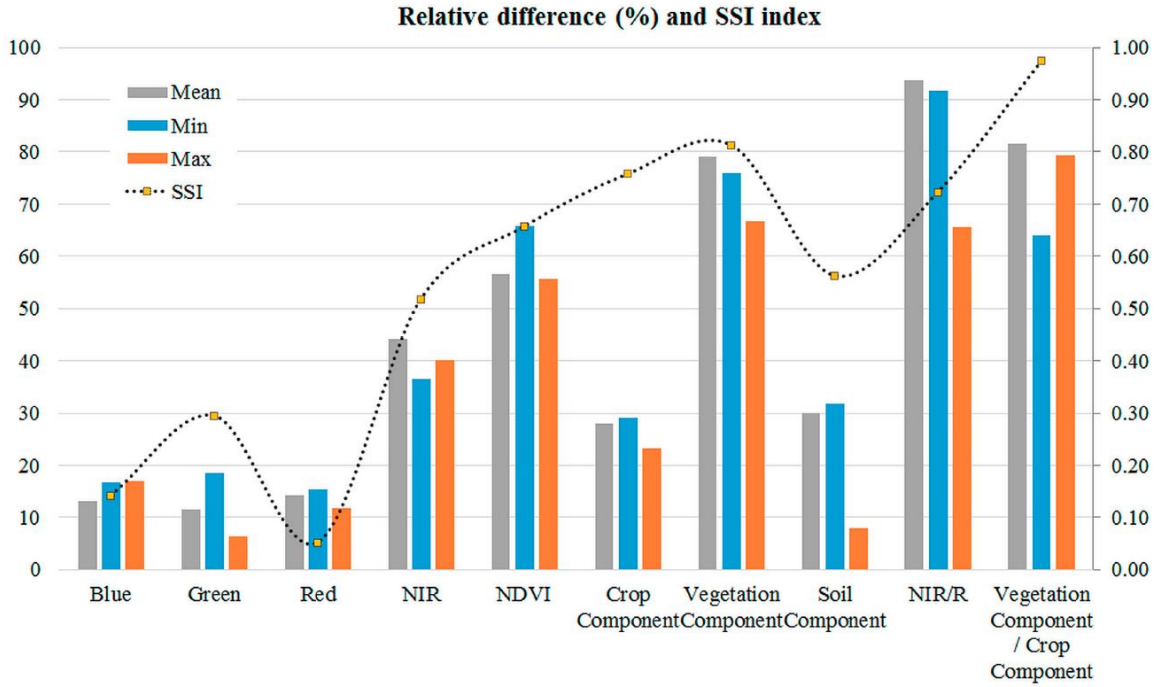
Agapiou, A.; Lysandrou, V.; Hadjimitsis, D.G. Optical Remote Sensing Potentials for Looting Detection. Geosciences 2017, 7, 98.

4. Examples of Research activities…

Detection of underground buried remains

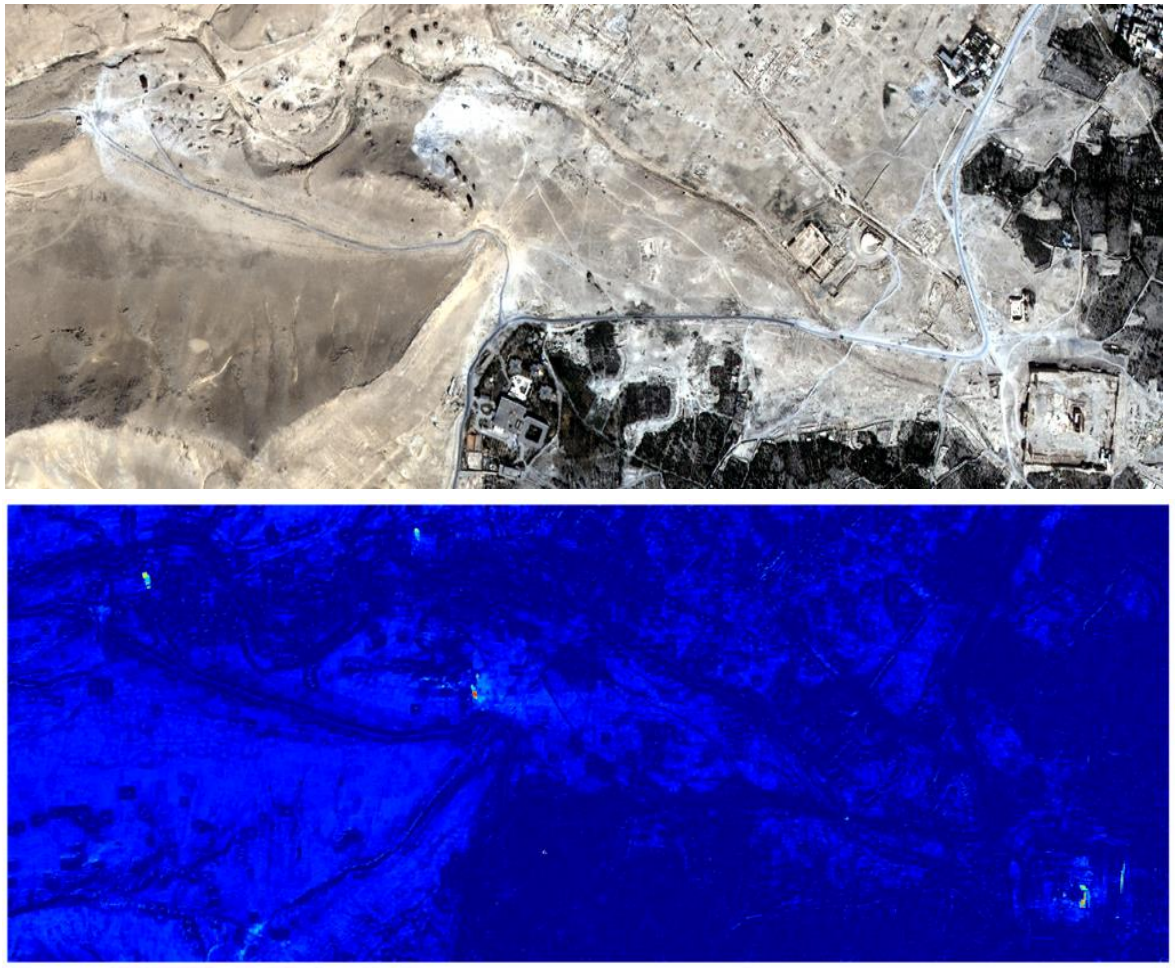


Agapiou A., Lysandrou V., Lasaponara R., Masini N., Hadjimitsis D. G., 2016, Study of the variations of archaeological marks at Neolithic site of Lucera, Italy using multispectral high resolution datasets, Remote Sensing, 8(9), 723; doi:10.3390/rs8090723.



5. Examples of Research activities…

Monitoring CH sites in in-accessible areas

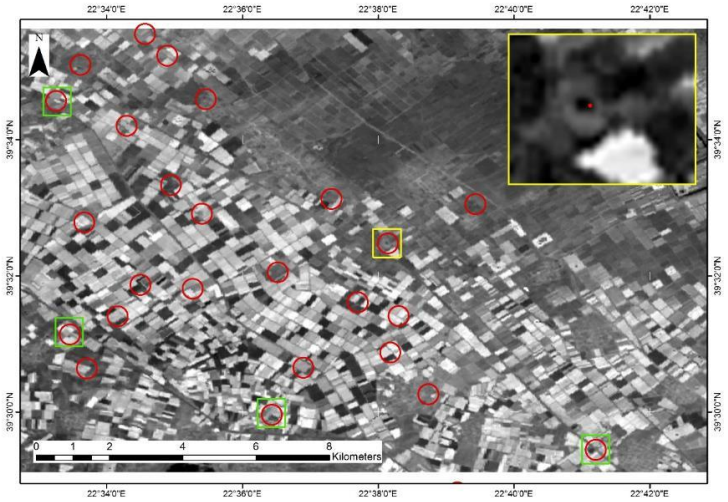


The intentional damage to local Cultural Heritage sites carried out in recent months by the Islamic State have received wide coverage from the media worldwide. Earth Observation data provide important information to assess this damage in such non-accessible areas, and automated image processing techniques will be needed to speed up the analysis if a fast response is desired. This paper shows the first results of applying fast and robust change detection techniques to sensitive areas, based on the extraction of textural information and robust differences of brightness values related to pre- and post-disaster satellite images. A map highlighting potentially damaged buildings is derived, which could help experts at timely assessing the damages to the Cultural Heritage sites of interest. Encouraging results are obtained for two archaeological sites in Syria and Iraq.

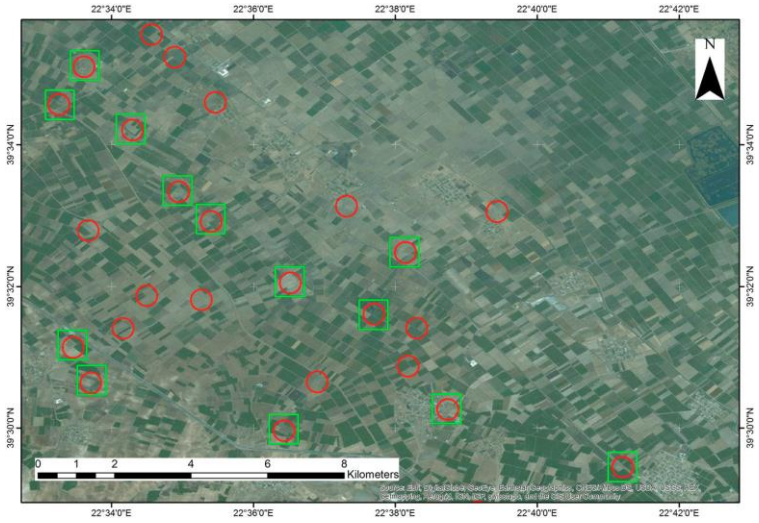
Cerra, D., Plank, S., Lysandrou, V., Tian, J., 2016, Cultural Heritage Sites in Danger—Towards Automatic Damage Detection from Space. Preprints 2016, 2016090055 (doi: 10.20944/preprints201609.0055.v1).

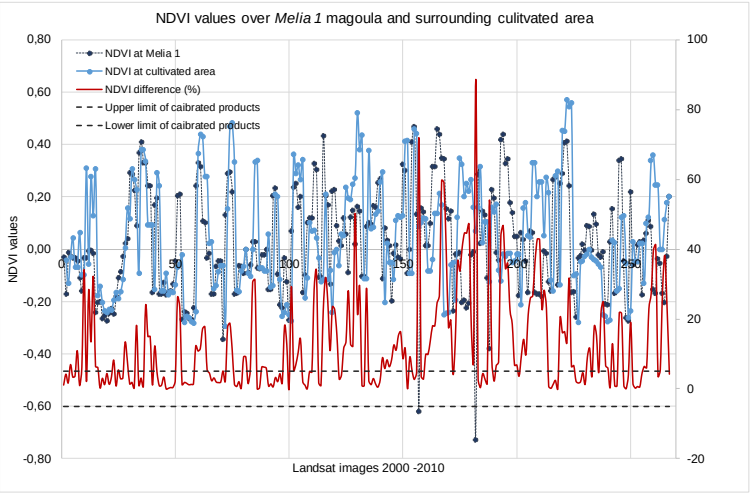
6. Examples of Research activities…

Use of big data..



This study aims to demonstrate results and considerations regarding the use of remote sensing big data for archaeological and Cultural Heritage management large scale applications. For this purpose, the Earth Engine© developed by Google© was exploited. Earth Engine© provides a robust and expandable cloud platform where several freely distributed remote sensing big data, such as Landsat, can be accessed, analysed and visualized.

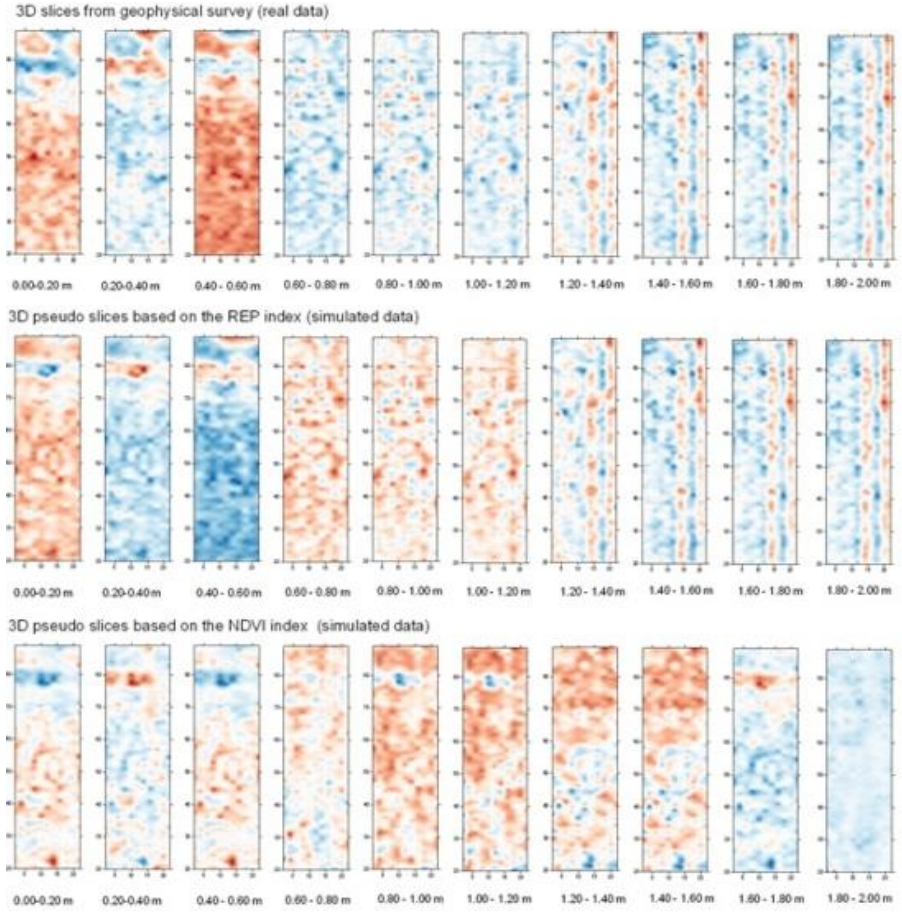


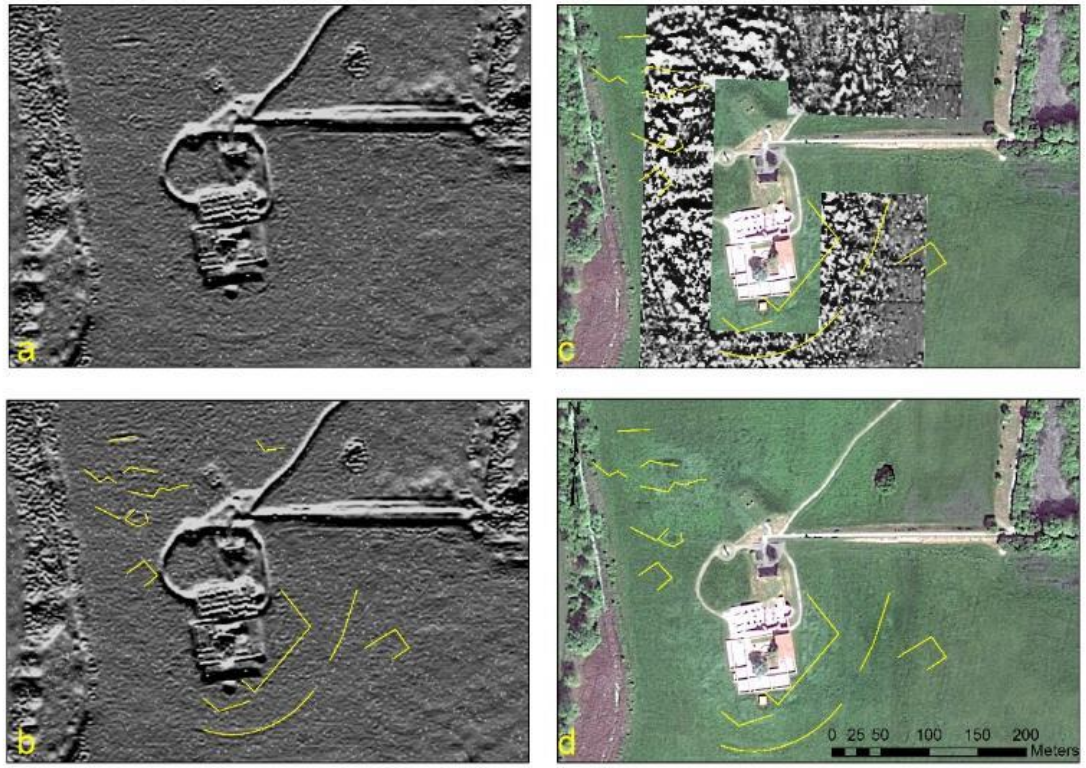


Agapiou A., 2016, Remote Sensing Heritage in a petabyte-scale: Satellite Data and Heritage Earth Engine© applications, International Journal of Digital Earth, 10.1080/17538947.2016.1250829.

7. Examples of Research activities…

Research on fusion of RS data..





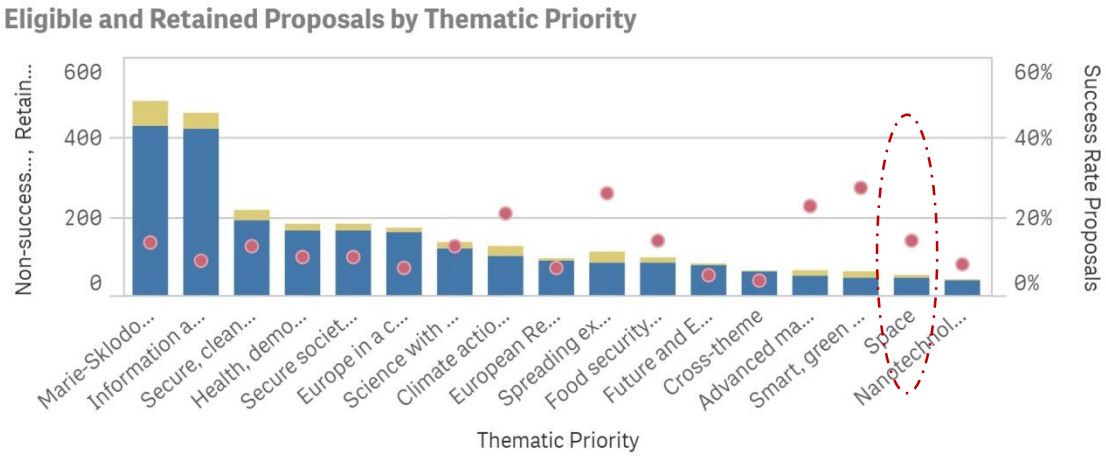
Agapiou A., Sarris A., Papadopoulos N., Hadjimitsis D. G., Pseudo penetration of optical remote sensing images: Application for the detection buried archaeological remains in the area of Vészto-Mágor Tell, Hungary, Remote Sensing, (under review).

Outline

- Introduction
- About the project
- About CUT
- Training activities and knowledge transfer
- Examples from common research activities
- Future and expectations
- Conclusion

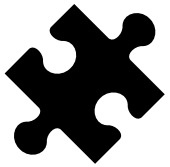
Future and expectations

Despite its success of securing more than 6 million euro for the Lab in the last years (and involvement of more than 60 million euros in total funded projects) **there is an obvious gap in securing competitive funds in the specific scientific pillar related to the core of the Centre: Space and ICT technologies**. This is due to the high competition of the research arena in a European level, but also due to the research capacity of the Centre. This is what we expect **to change**, by **building a high-research ecosystem** within the Centre, **attracting core scientific projects**, and **work together with high-performance institutions** and **researchers**.



Thematic **proposals** submitted by **Cyprus** under the H2020 calls (total 2702 eligible proposals with a budget of more than 1.1 billion euros, 1.64% of the total H2020 proposals submitted, requesting the 0.45% of the total EU contribution) (source H2020 dashboard, accessed on Oct. 2018)

Future and expectations



MCS RISE project

Remote Sensing Archaeology

Teaming Phase 2

15th November
15+15 million euros

ERA Chair

15th November
2.5 million euros

Outline

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Conclusions

Main outcomes of the on-going Horizon 2020 ATHENA Twinning project:

i. The project foresees to support the current cultural heritage needs **through the systematic exploitation of earth observation technologies.**

ii. Through the networking, the ATHENA twinning project **strengthens the remote sensing capacity in cultural heritage at CUT.**

iii. A core element within ATHENA is knowledge transfer, achieved primarily through intense training activities (including virtual training courses, workshops and summer schools) with an ultimate scope to: **enhance the scientific profile of the research staff**; **to accelerate the development of research capabilities of the ERC** as well as to promote earth observation knowledge and best practices intended for Cultural Heritage.

iv. The scientific strengthening and networking achieved in Cyprus through the ATHENA project, **could be of great benefit for Cyprus bearing a plethora of archaeological sites and monuments urgently calling for monitoring and safeguarding.**

v. Through Athena, a complete database has been developed showing all the existing institutions which deal with earth observation in cultural heritage.

Great thanks to:

- Our partners: **CNR, DLR**
- My team: Athos, Vassiliki, Andreas, Kyriacos, Branca, Christiana, Argyro, Evagoras, Marios…
- EC: for funding this project
- Our Project officers
- Our supporters..




2015-2018

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

Workshop

ATHENA: Remote Sensing and archaeology:
future and expectations

Introduction of ATHENA Twinning Project

Cyprus University of Technology

ATHENA
Remote Sensing Science
Center for Cultural Heritage

Prof. Hadjimitsis D.G., Coordinator

Cyprus University of Technology

DLR

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

ATHENA

Remote Sensing Science Center for Cultural Heritage Monuments and Sites

DLR results

EuroMed2018 – ATHENA-Workshop, 30/10/2018

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Website: www.athena2020.eu
Email: info@athena2020.eu
Tel. +357 25002542

Overview

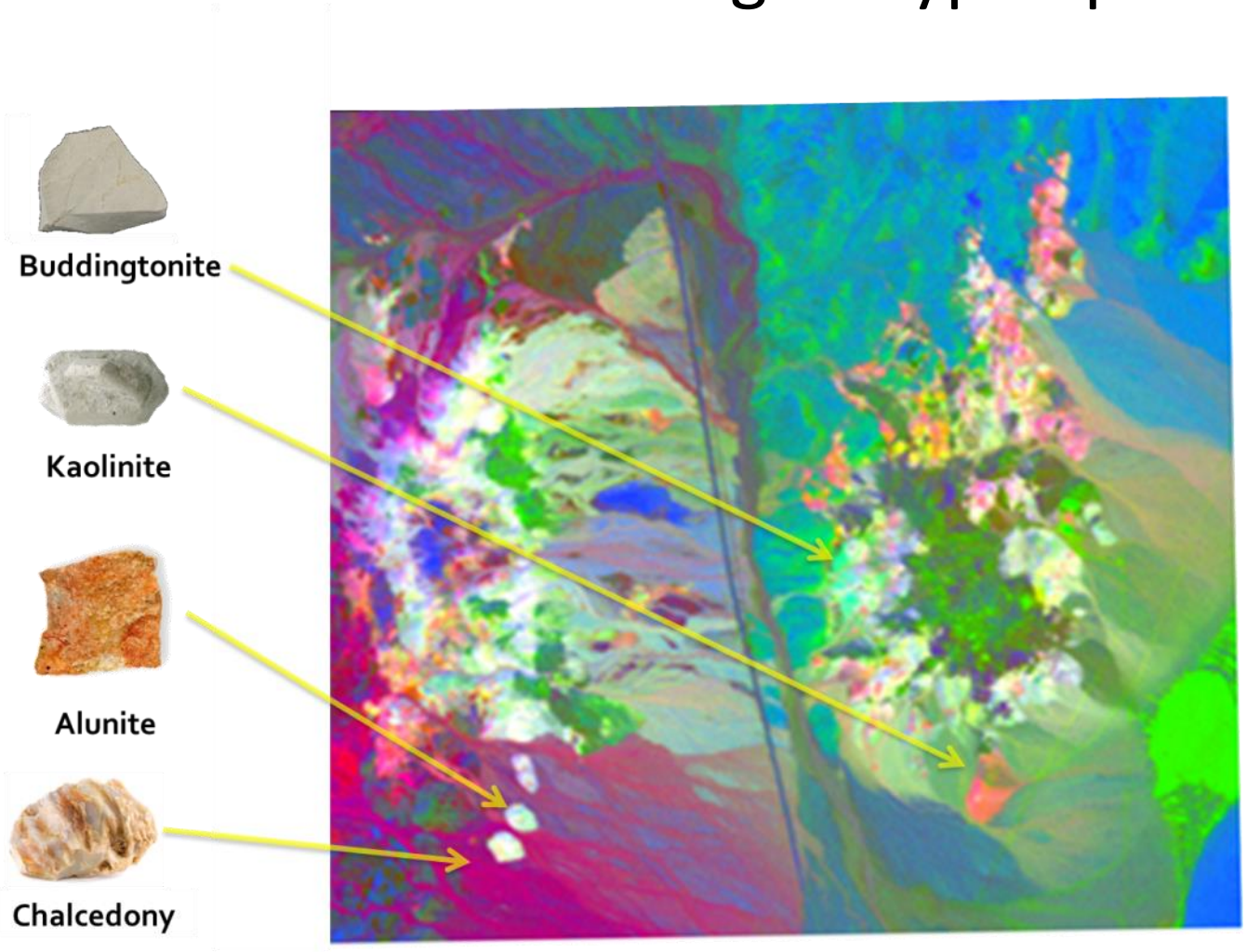
- Training and Knowledge Transfer
  - 02/2016 Virtual training „Hyperspectral“
  - 04/2016 Workshop at CUT „Copernicus contribution to CH”
  - 05/2016 Summer School at CUT „Synthetic Aperture Radar“
  - 10/2016 Workshop at CUT „Multitemporal remote sensing“
  - 03/2018 Workshop at CUT „Geo Information Systems“
  - 10/2018 Webinar „Remote Sensing for Cultural Heritage“
- Site exchange CUT to DLR:
  - Visit 03/2018 at DLR „Technologies“, also State office for preservation of ancient monuments and Technical University, Munich
  - Visit 11/2018 at DLR: „Sensor-systems“
- Scientific Outreach:
  - Cerra, D., Plank, S., Lysandrou, V., Tian, J., 2016, Cultural Heritage Sites in Danger—Towards Automatic Damage Detection from Space. Preprints 2016, 2016090055

Virtual Training „Hyperspectral processing“

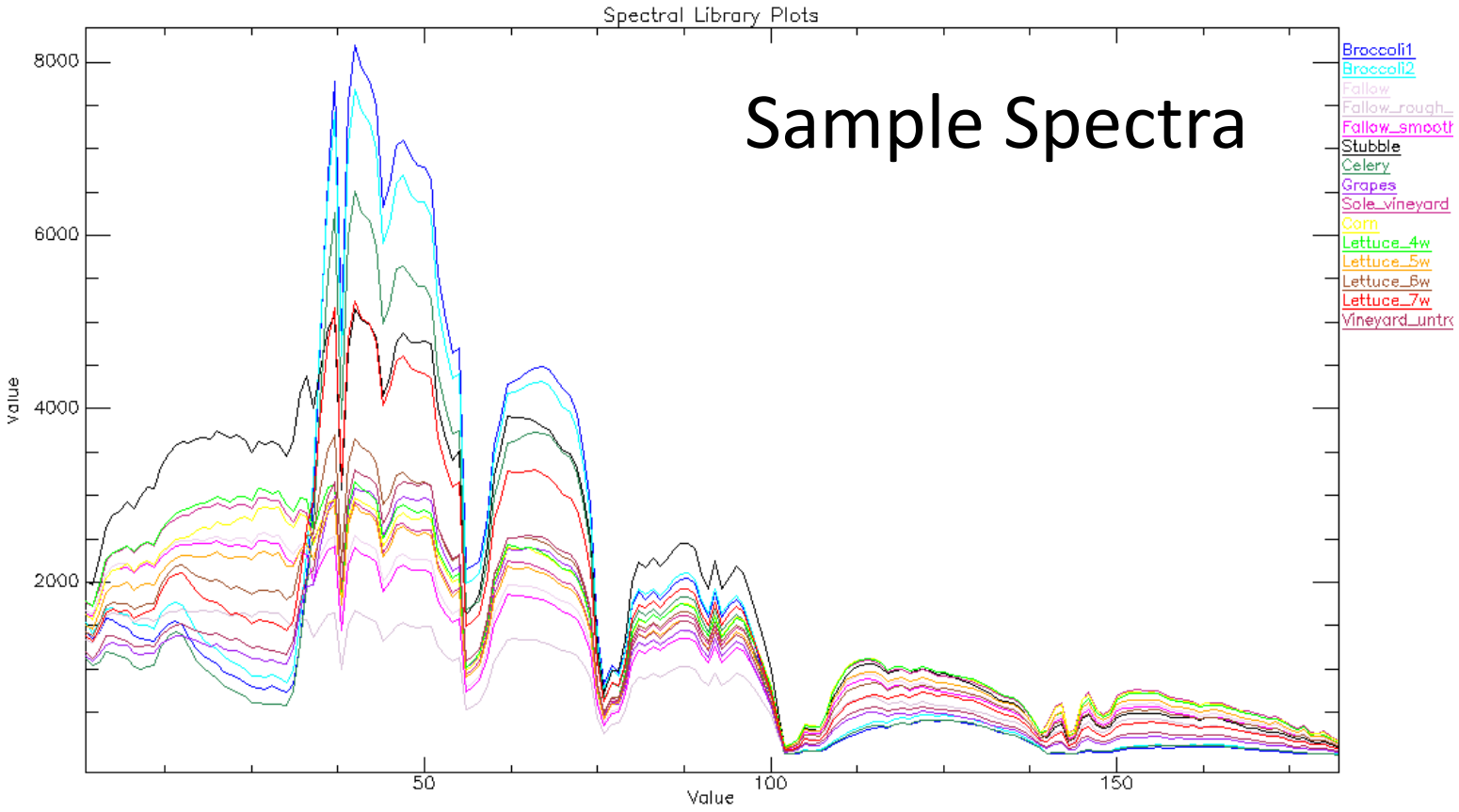
02/2016 virtually from DLR at CUT

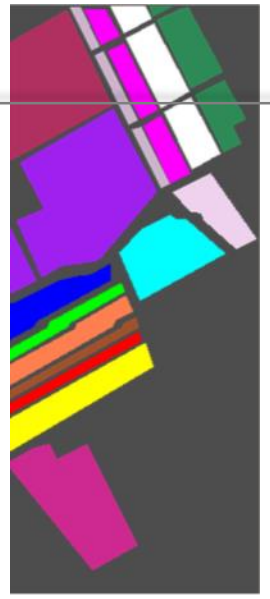
Daniele Cerra, DLR

Virtual Trainings - Hyperspectral



Virtual Trainings - Hyperspectral

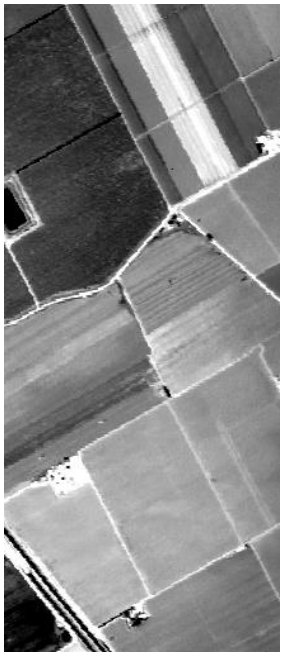




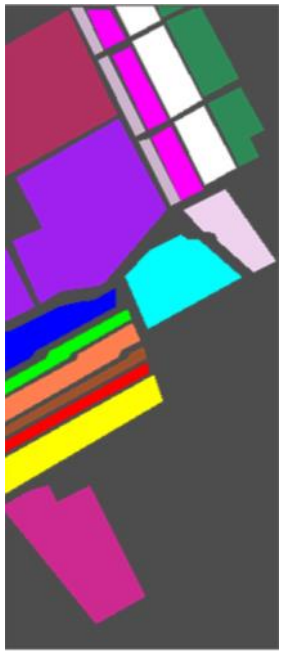
Broccoli_green_weeds_1
Broccoli_green_weeds_2
Fallow
Fallow_rough_plow
Fallow_smooth
Stubble
Celery
Grapes_untrained
Sole_vineyard_develop
Corn_senesced_weeds
Lettuce_romain_4_weeks
Lettuce_romain_5_weeks
Lettuce_romain_6_weeks
Lettuce_romain_7_weeks
Vineyard_untrained

The mutual information between any two bands in the Salinas dataset and the ground truth are based on these joint distributions…

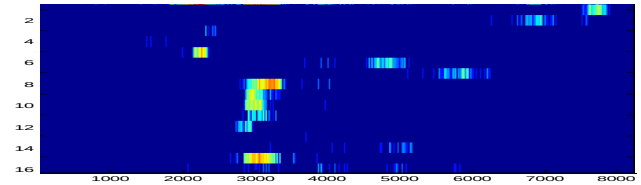
Banda 1



Banda 42

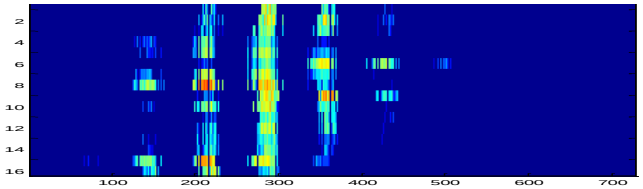


Ground Truth



Mutual info band 42 / ground truth

Mutual info band ? / ground truth

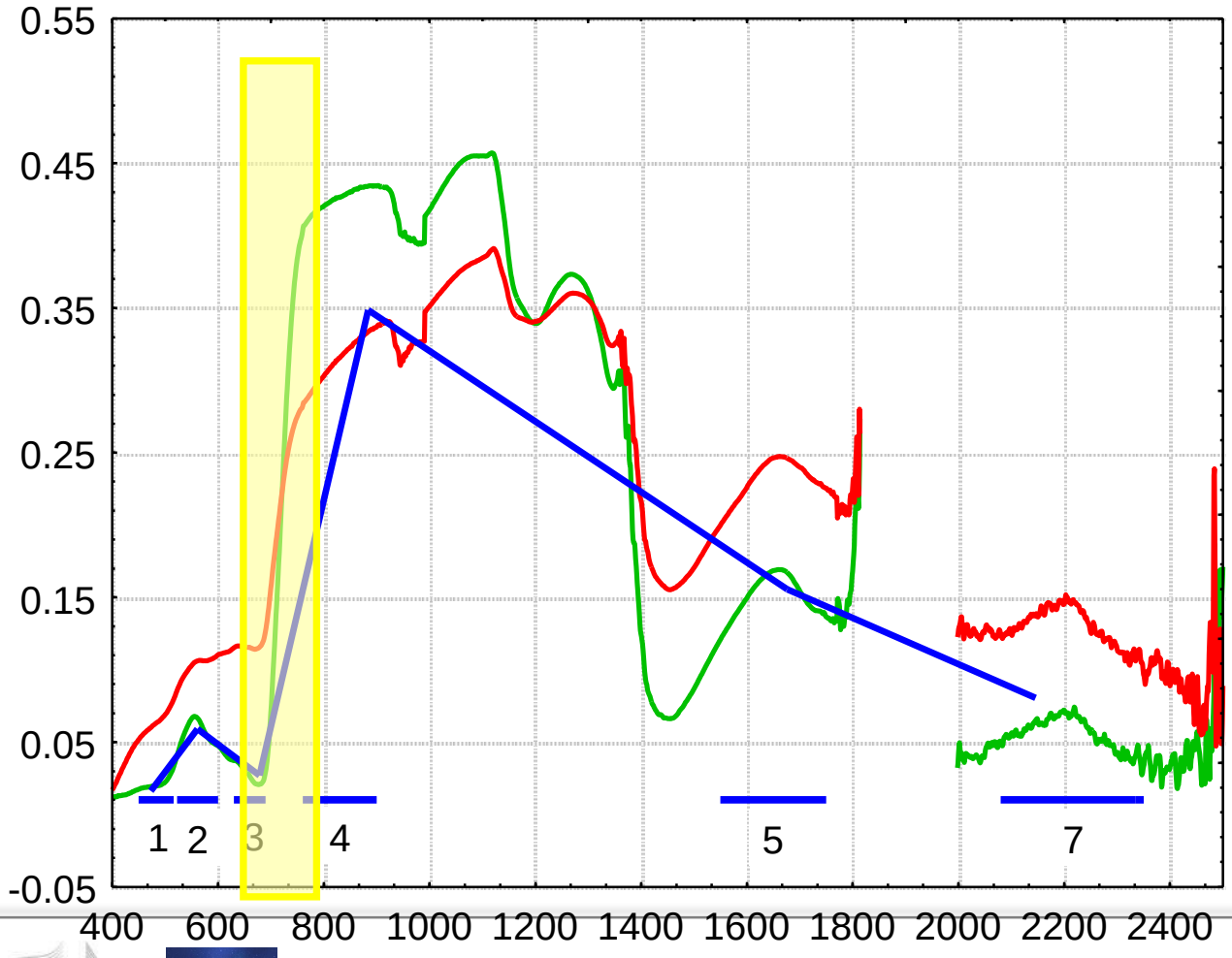


Mutual info band 1 / ground truth

Mutual info band ? / ground truth

Vegetation's Spectral Signature: beyond NDVI

Clorophyll | Cell Structure | Water Content

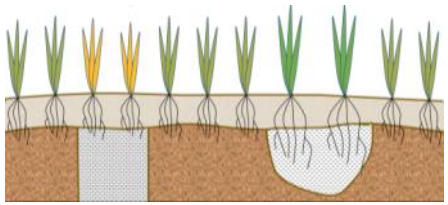


Landsat bands

Healthy Vegetation

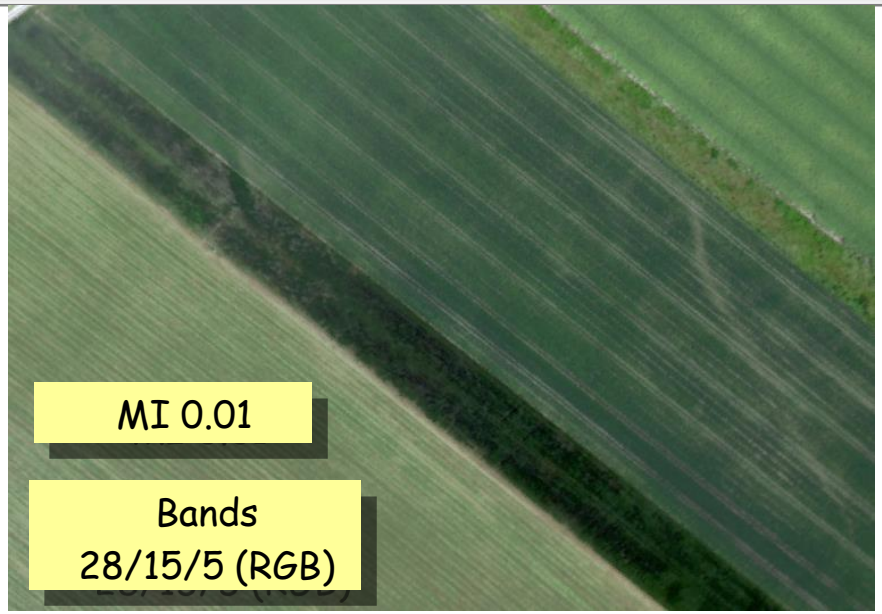
Unhealthy Vegetation

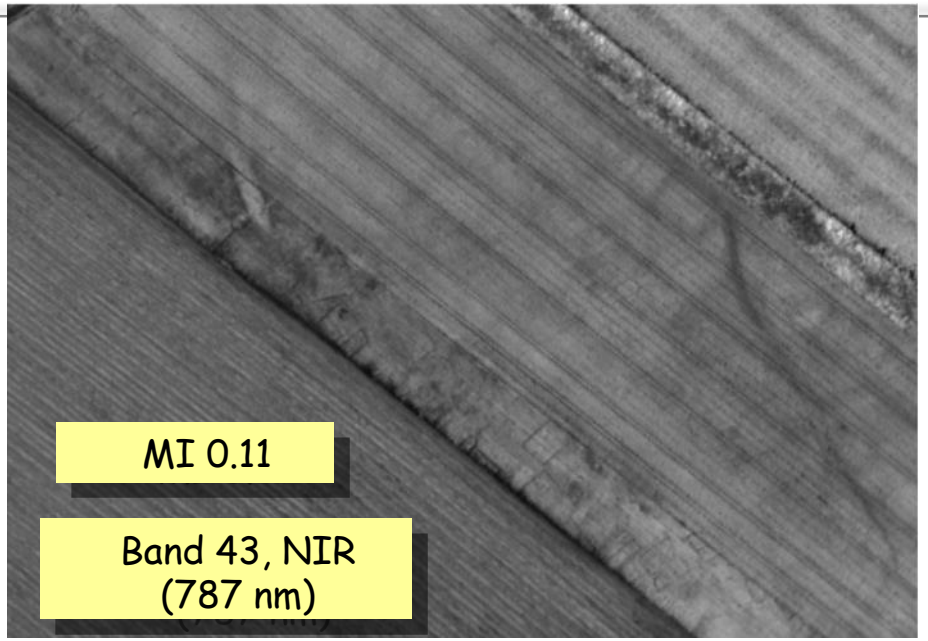
About Vegetation Health: Crop Marks

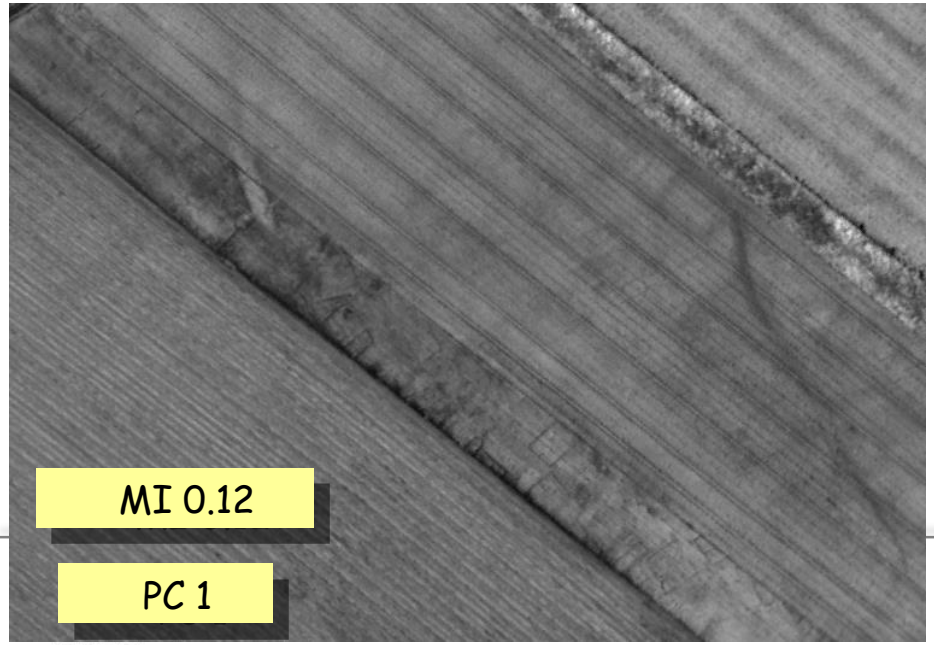


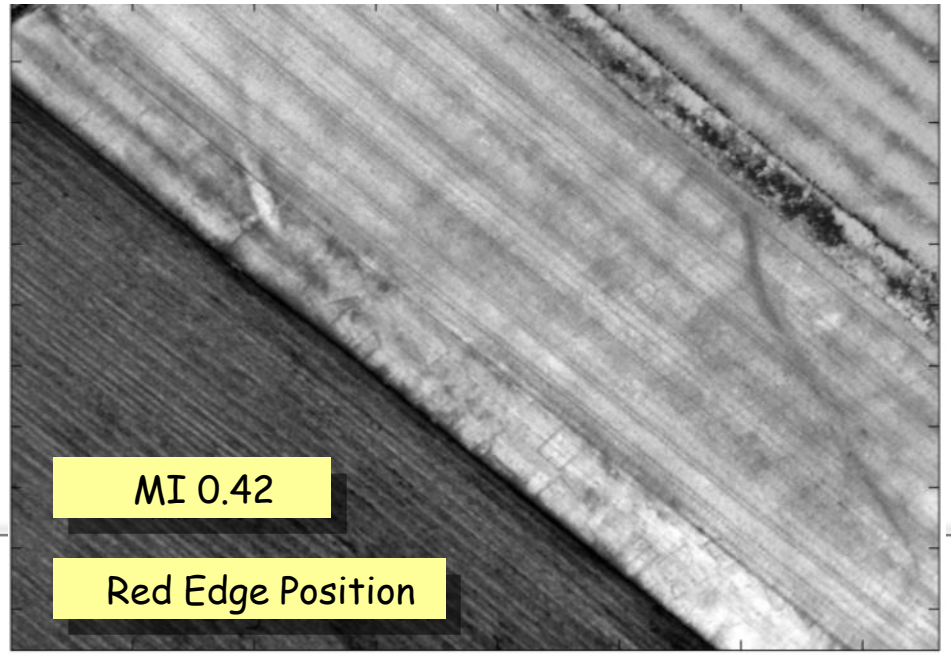
Local vegetation health altered by buried objects (negatively) or dug sites (positively)

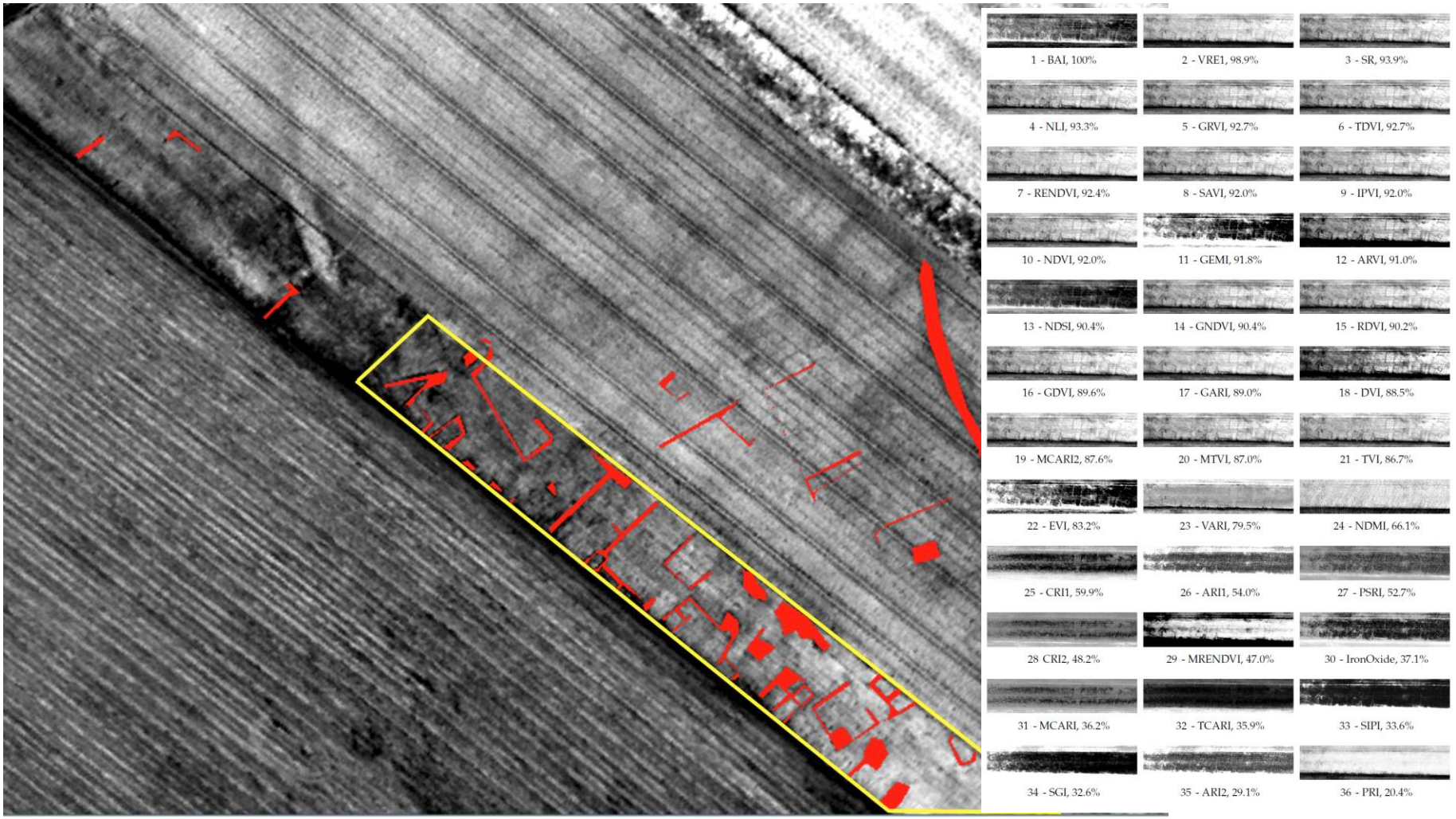
Evident crop marks in Grezac, France
RGB True Color Composite
(source: wikipedia)


MI 0.01
Bands
28/15/5 (RGB)


MI 0.11
Band 43, NIR
(787 nm)


MI 0.12
PC 1


MI 0.42
Red Edge Position



Submitted paper under review from the ATHENA members after this webinar

Workshop „Copernicus contribution to Cultural Heritage”

04/2016 (aside RSCY 2016), Paphos

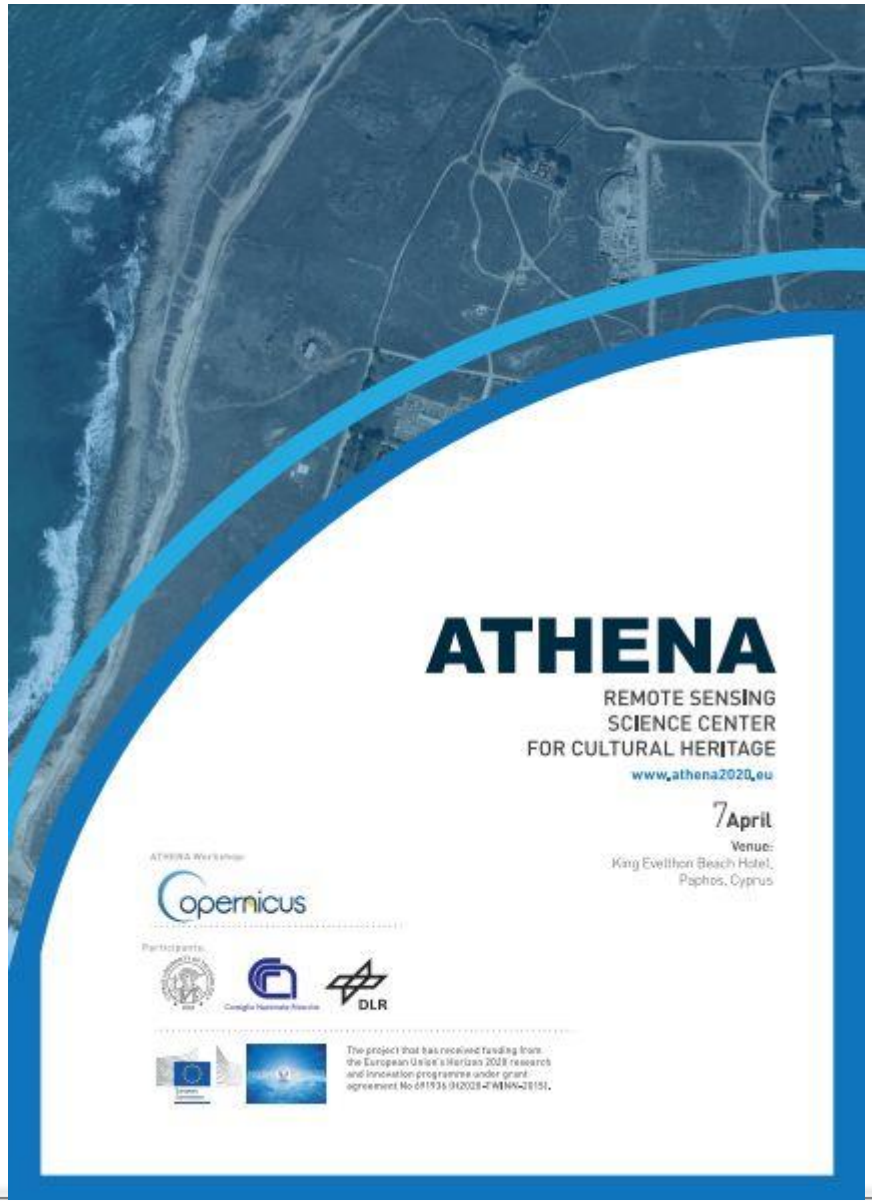
DLR, CNR and various other speakers,
incl. European Commission and ESA

ATHENA

Copernicus Workshop

7 April 2016

Paphos Cyprus




LAND
ATMOSPHERE
DISASTERS
RAPID MAPPING
World Heritage
CLIMATE CHAN
'IL SECURITY
opernicus
The European Earth Observation Programme


European Commission
Copernicus Programme Potential for Cultural Heritage
Peter Breger, DHoU Copernicus, DG GROW.I2
24 April 2017, Brussels
Space
Copernicus EU
Copernicus EU
Copernicus EU
www.copernicus.eu
copernicus
Europe's eyes on Earth

Summer Schools – Interferometry/Radar

23-25 May 2016; Limassol

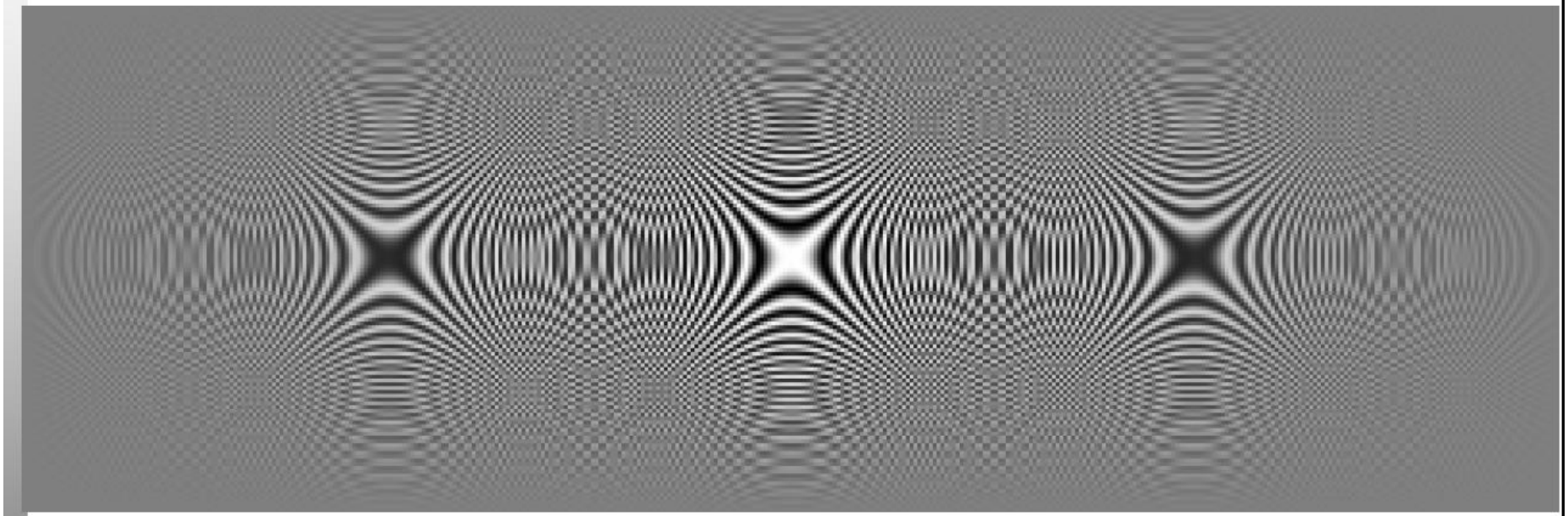
Ramon Brcic, Michael Eineder, DLR

Also visit at the UNESCO WHS Site Nea Paphos

DLR

Athena Summer School – SAR

Cyprus University of Technology, Lemesos May 2016

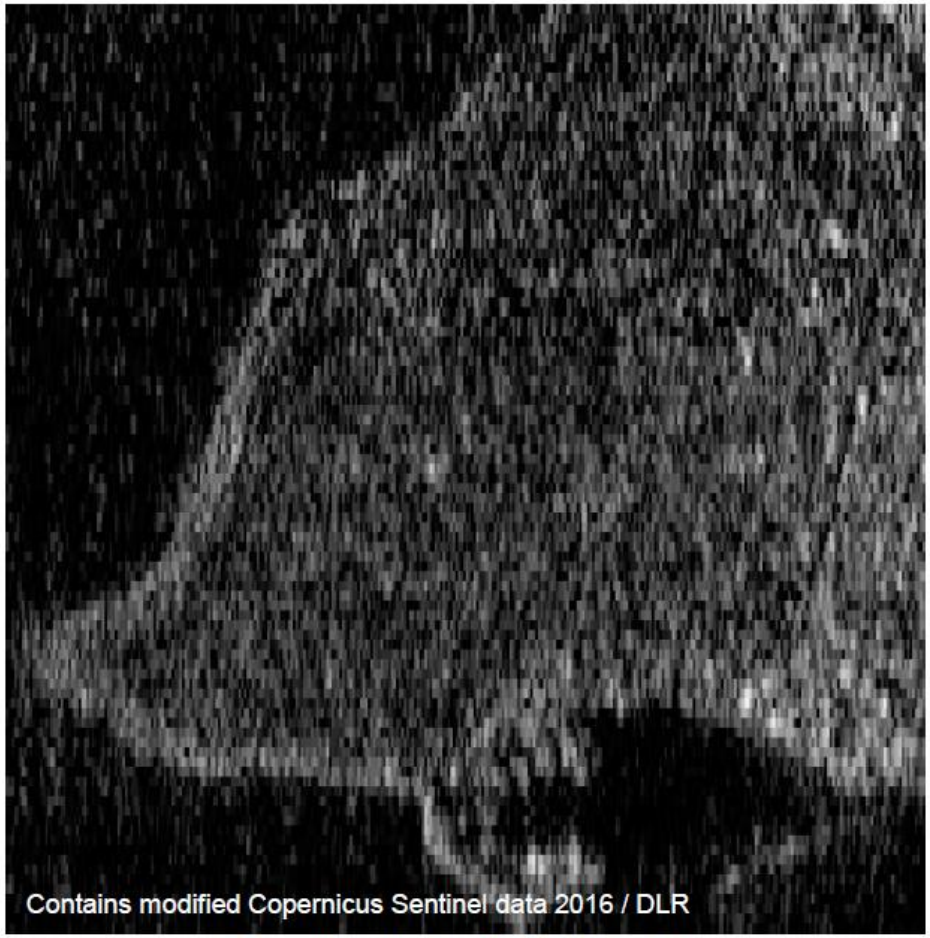


Part 1: Synthetic Aperture Radar (SAR) Principles

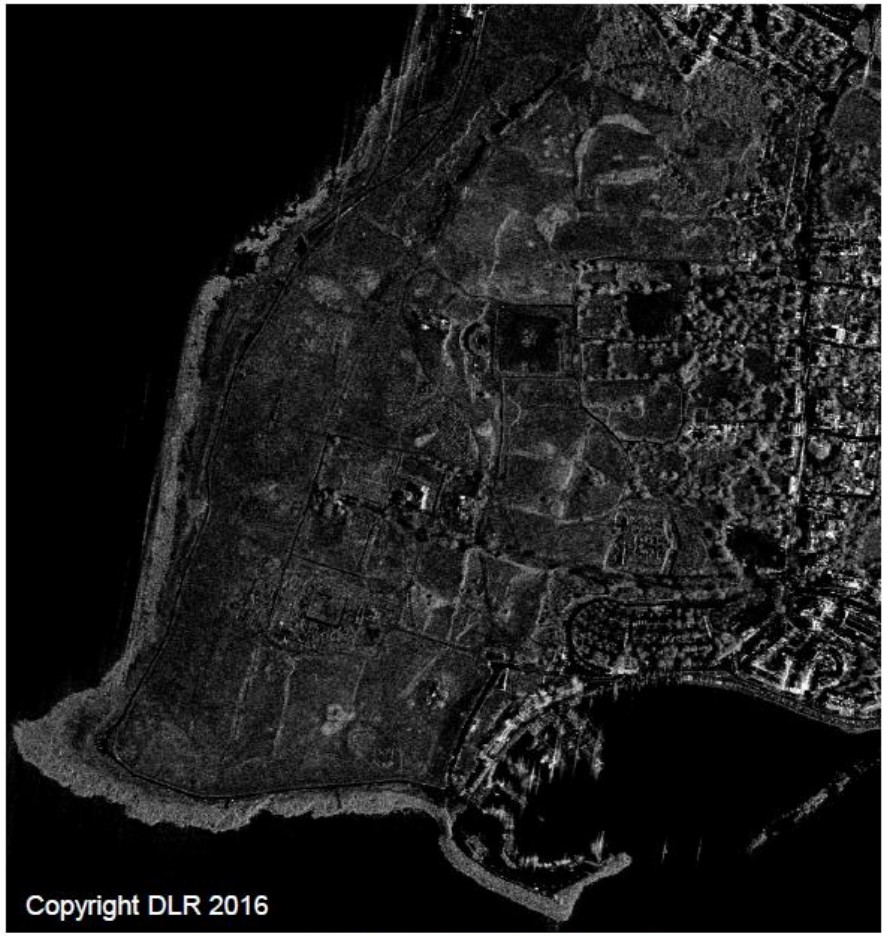
Prof. Dr. Michael Eineder (DLR/TUM)

Resolution

Paphos - Cyprus



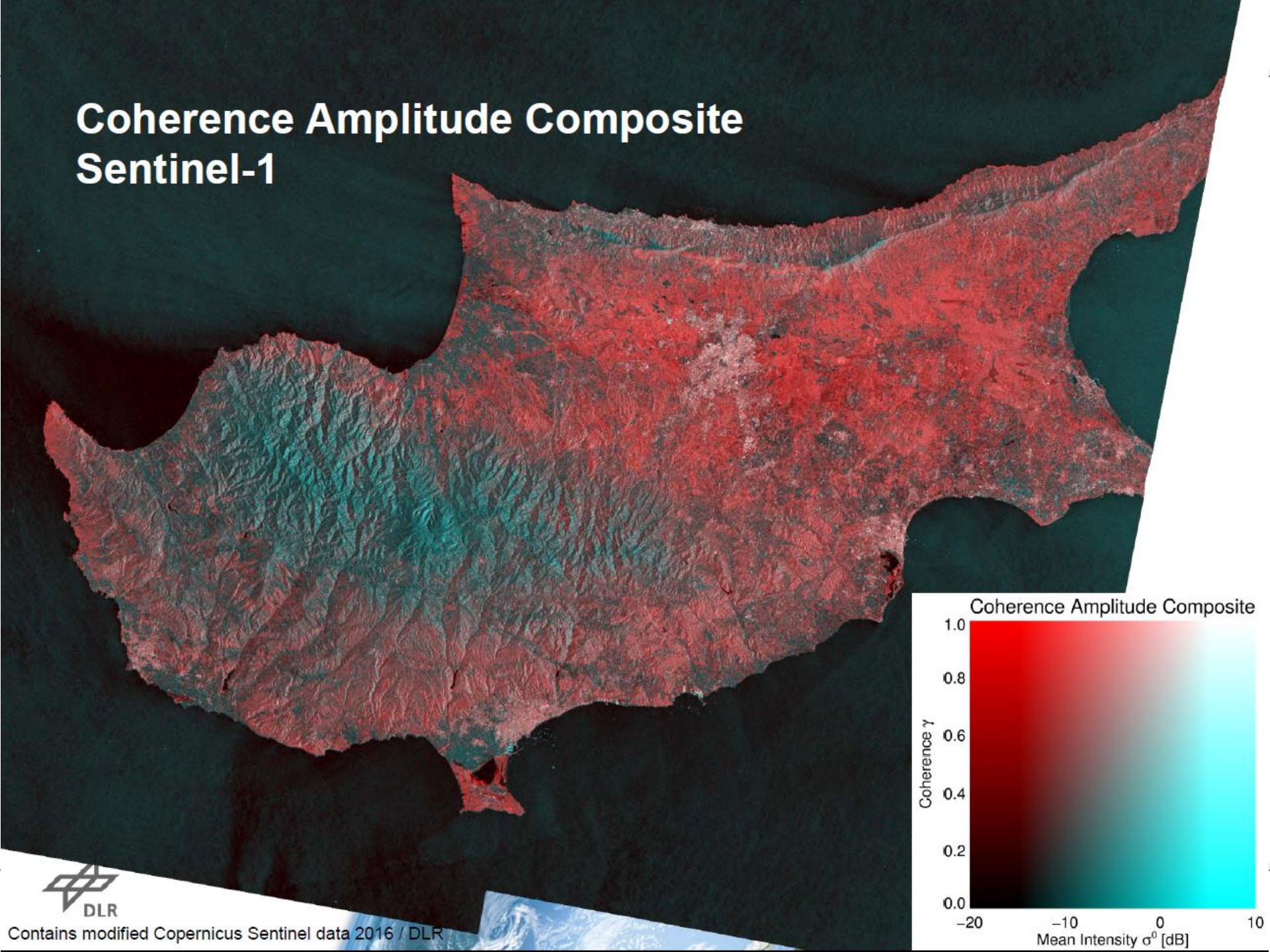
Sentinel-1, IWS Mode
5x20 m ground resolution



TerraSAR-X, ST Mode
1x1 m ground resolution (multi-looked)

DLR

Coherence Amplitude Composite
Sentinel-1



DLR

Workshop „Multitemporal Remote Sensing Analysis“

10/2016 at CUT

Ursula Gessner, DLR

Virtual Trainings – Time Series
Agenda

Thursday, October 6	
12:30-13:30 Lunch	
13:30-14:30	- Time series in earth observation: o Suitable sensors and missions o Types of EO time series o Data access
14:30-15:30	- Theoretical background on time series processing: o Time series components and characteristics o Preprocessing of EO time series (handling of outliers, quality information, smoothing methods etc.) o Data fusion for EO time series
15:30-16:30	- Methods for EO time series analysis I: o Variability, seasonality, trend, correlation analyses etc. o Phenological analyses

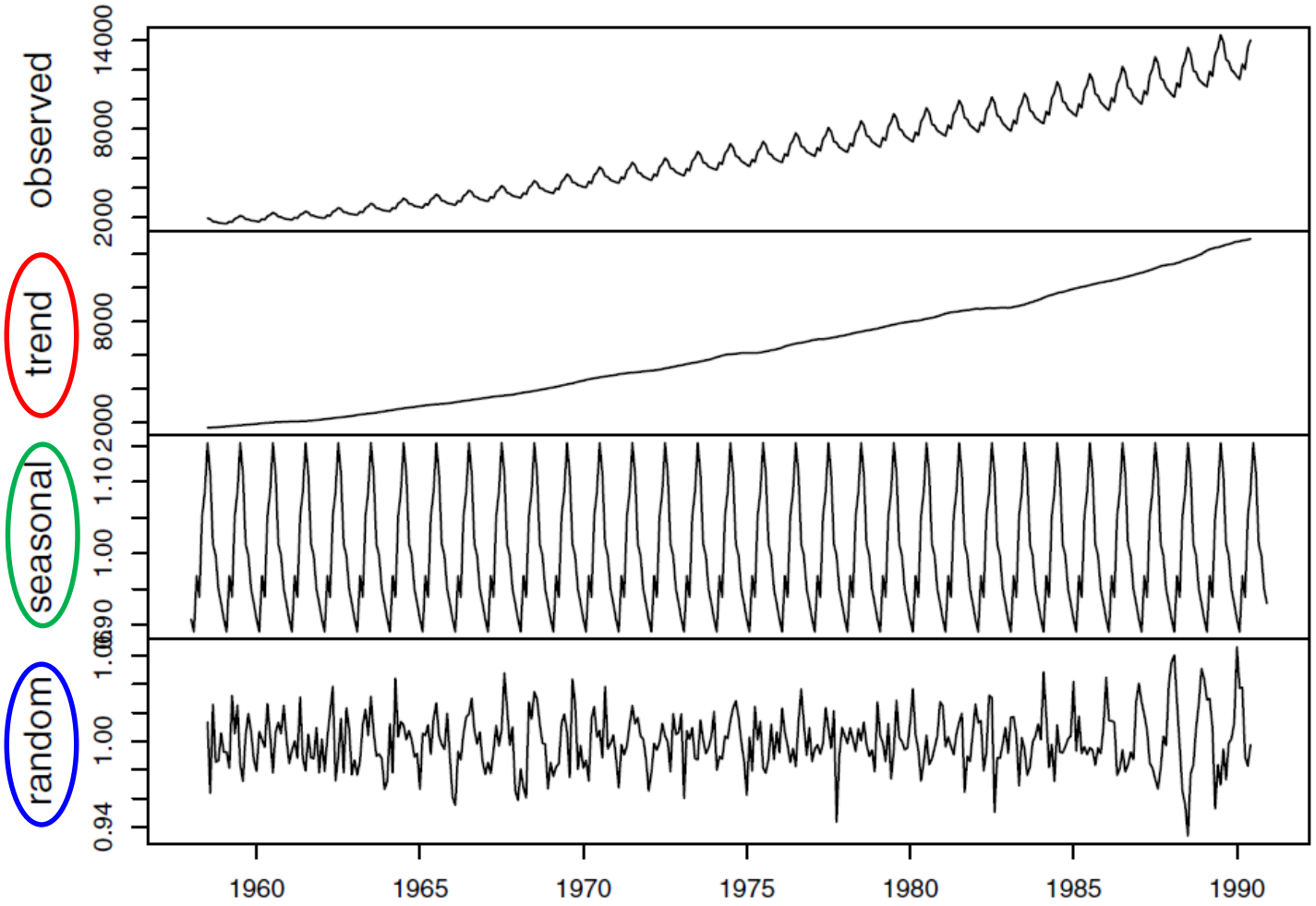
Friday, October 7	
9:30-10:30	- Methods for EO time series analysis II: Complex developments (abrupt changes, multi-directional changes, etc.)
10:30-12:30	- Examples for EO applications based on time series (examples from DLR research and activities)
12:30-13:30 Lunch	
13:30-14:30	- Use Cases: o Land surface phenology: theoretical background and practical exercise with optical data o Inundation/flood dynamics: theoretical background and practical exercise with SAR data
14:30-16:30	- Discussion of presented aspects - Identification of interesting aspects for joint studies - Ideas for joint journal paper /conference presentation

Time Series Components & Decomposition

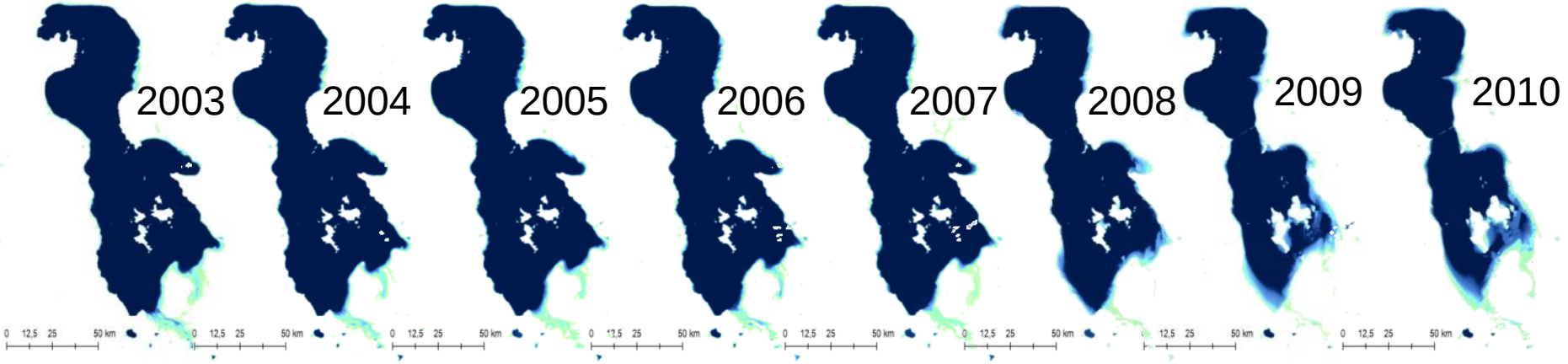
trend component:
gradual changes

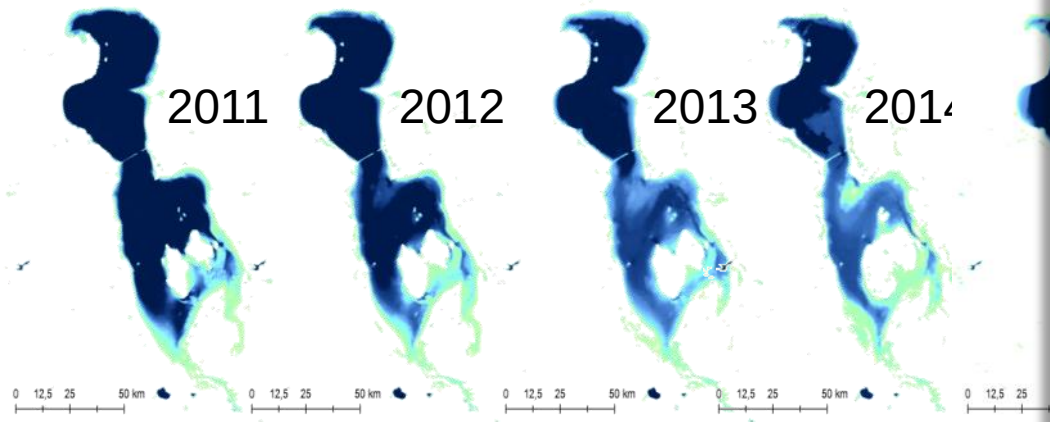
seasonal component:
seasons or crop cycles

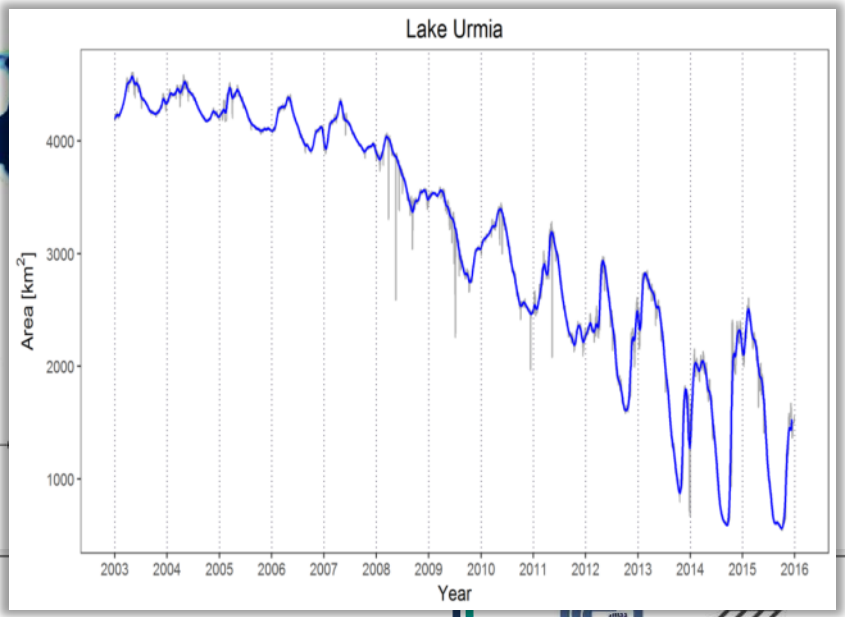
‚random' or **remainder** component:
contains outliers and structural breaks

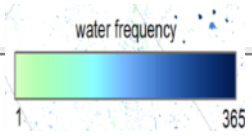


Global WaterPack – Lake Urmia (Iran) lost 90% of the permanent water surface







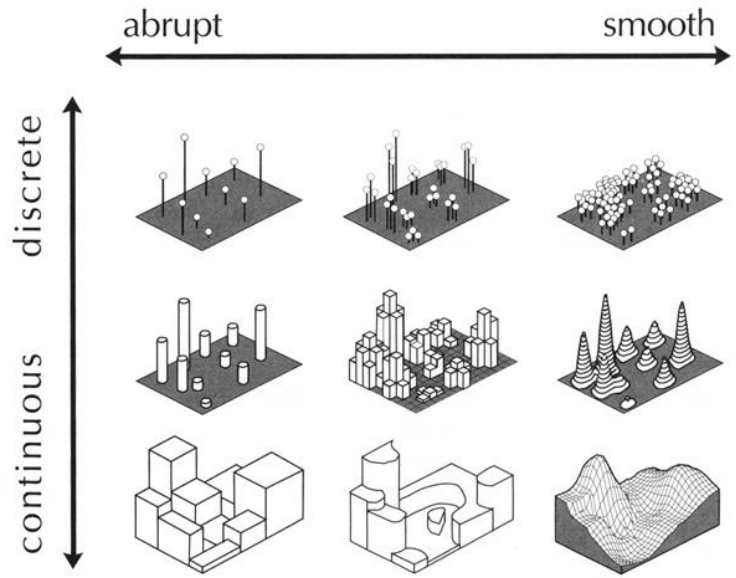


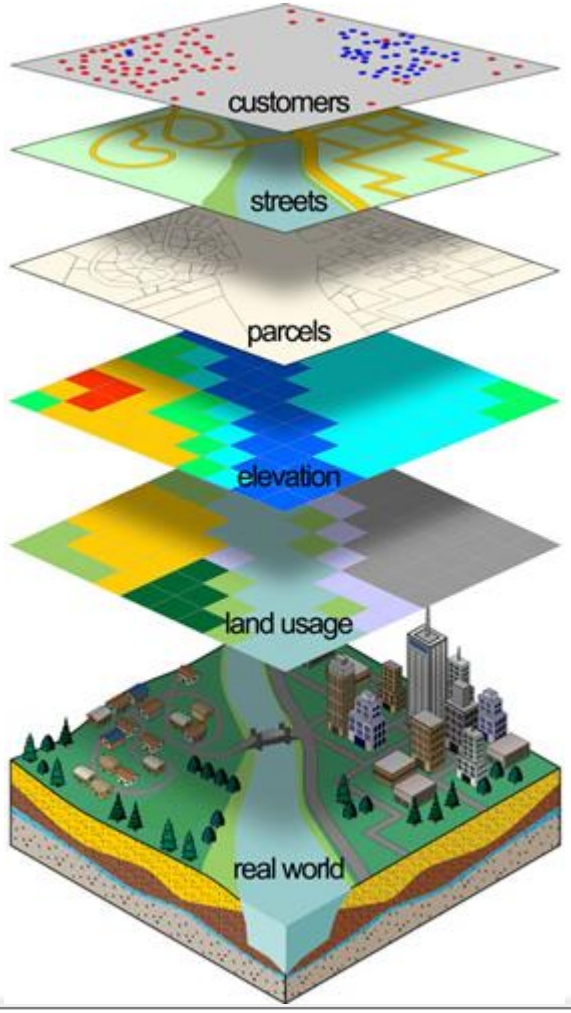
(Dr. I. Klein)

Workshop „Geographic Information Systems“

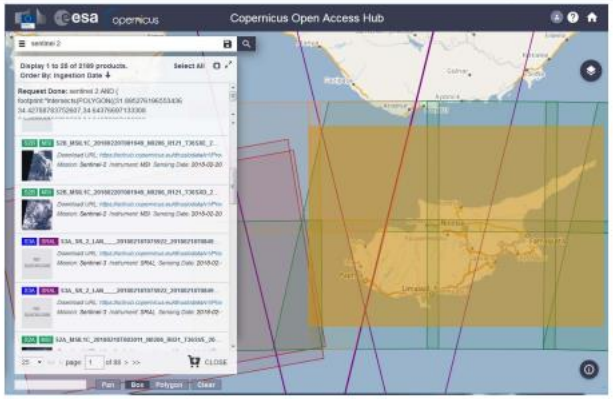
03/2018 at CUT

Verena Jaspersen, DLR

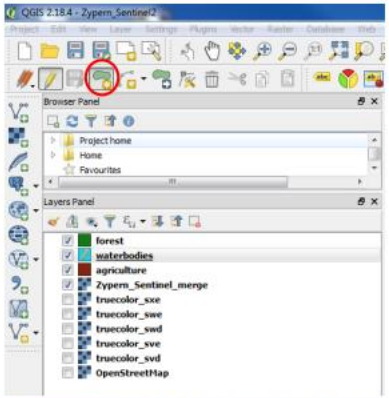




	Basic Usage of QGIS	Command, software
1.	**Get Data: https://scihub.copernicus.eu**	Open hub, sign up/login,
2.	Search for data for Cyprus and download if needed (Data is rather big, so download takes some time	



	Working With QGIS: Load Different Data To Map	
1.	**Open QGIS 2.18.15 and start a new Project**	Project > Project Properties > check enable *'on the fly'* CRS information coordinate reference system: WGS 84 / UTM zone 36N (EPSG:32636)
2.	Add **WMS Layer** from https://geoservice.dlr.de:	Layer > Add Layer > Add WMS/WMTS Layer

13.	**New field:** you can add many different attributes (name, area…)	
14.	Start editing the polygons	Right click at the shp., toggle editing,
15.		Add feature
16.		Clip the polygon
17.	When you finished the polygon: right click, the attributes appear (make sure that the id of each polygon of the same land cover/ land use category is the same)	insert attributes
18.	Stop editing	Right click at the layer > save layer edits. current edits, cancel for selected layer(s)
19.	**Merge shapefiles**	Vector > Data Management Tools

Seite 5

GIS Hands on - Paphos March 2018 - Verena Jaspersen

Webinar 10/2018

Webinars

2 hours web-event

(Targeted audience graduate and post graduate students, researchers, private sector)

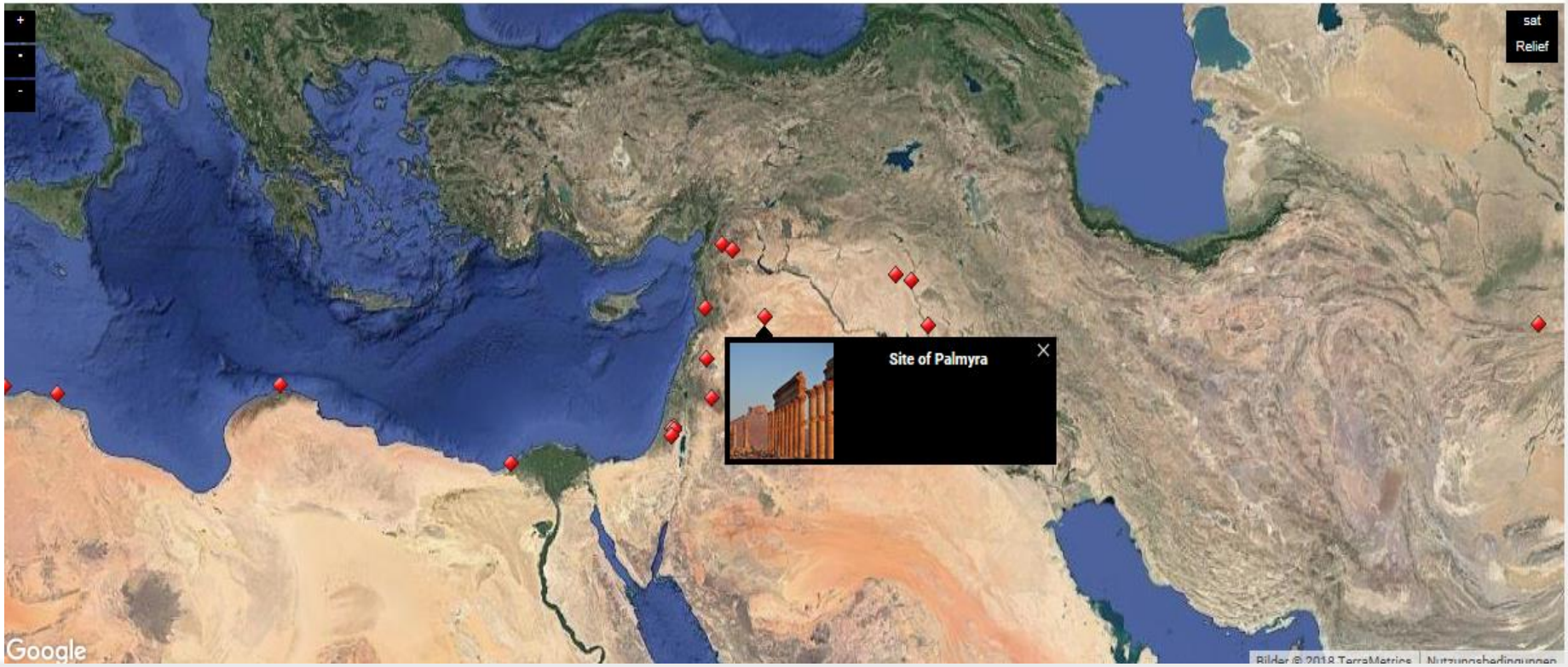
14:00 -14:15(CET)	**Introduction to the ATHENA project (D.Hadjimitsis- CUT)**
14:15–15:00(CET)	**Webinar 1 , DLR contribution to ATHENA** Geo Information Systems (GIS) (V.Jaspersen –DLR) Analysis of hyperspectral images (D.Cerra- DLR) Multi-Temporal Remote Sensing Analyses (U.Gessner –DLR)
15:00-15:45(CET)	**Webinar 2, CNR contribution to ATHENA** Archaeological looting (N.Massini & R.Lasaponara- CNR) Integration of RS data for Cultural Heritage management (R.Lasaponara- CNR) Geophysics (F.Soldovieri and I.Catapano)
15:45-16:00(CET)	**Discussion -Questions**
End of Webinars	

Webinar 10/2018

United Nations
Educational, Scientific and
Cultural Organization

List of World Heritage in Danger

The 54 properties which the World Heritage Committee has decided to include on the List of World Heritage in danger in accordance with Article 11 (4) of the *Convention*.



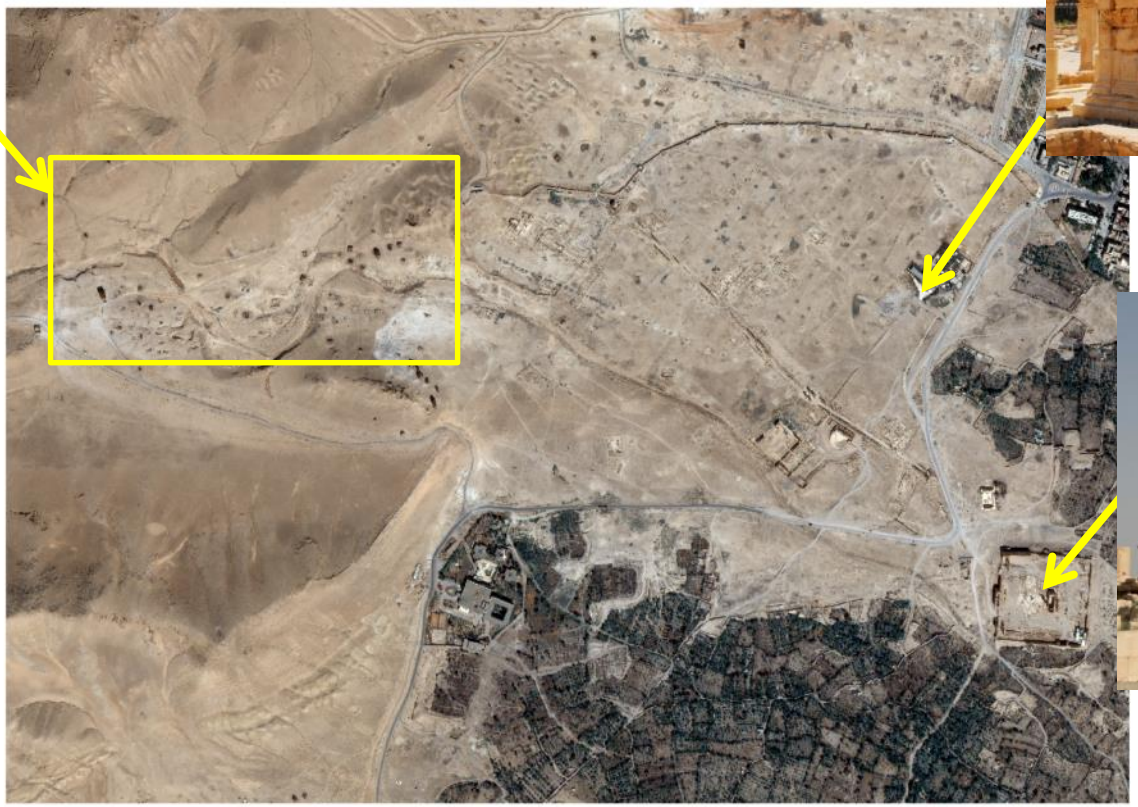
Palmyra – Baalshamin Temple: destroyed by IS (24.08.2015)

Source: http://www.asor-syrianheritage.org/special-report-update-on-the-situation-in-palmyra/

Palmyra, Syria

Image: WorldView-2, Date: 27 August 2015

Tower Tombs of Elahbel

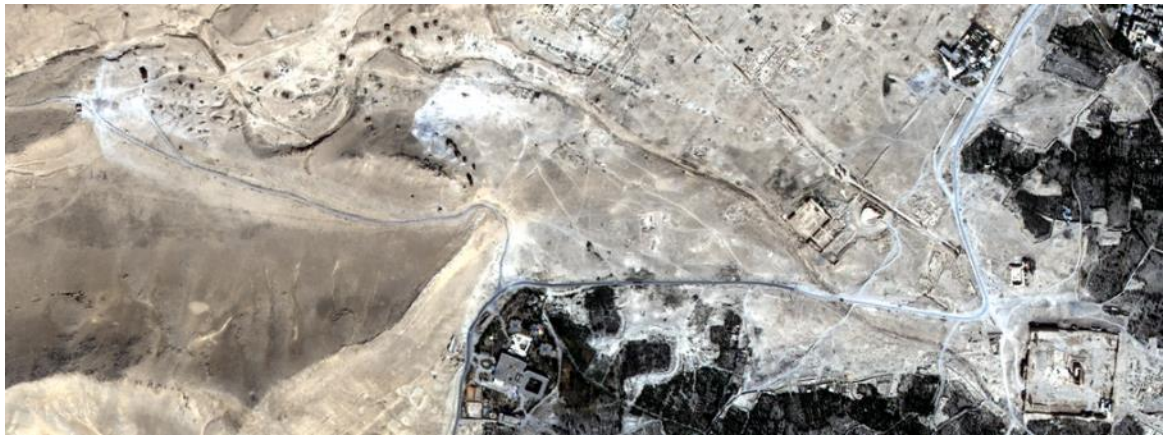


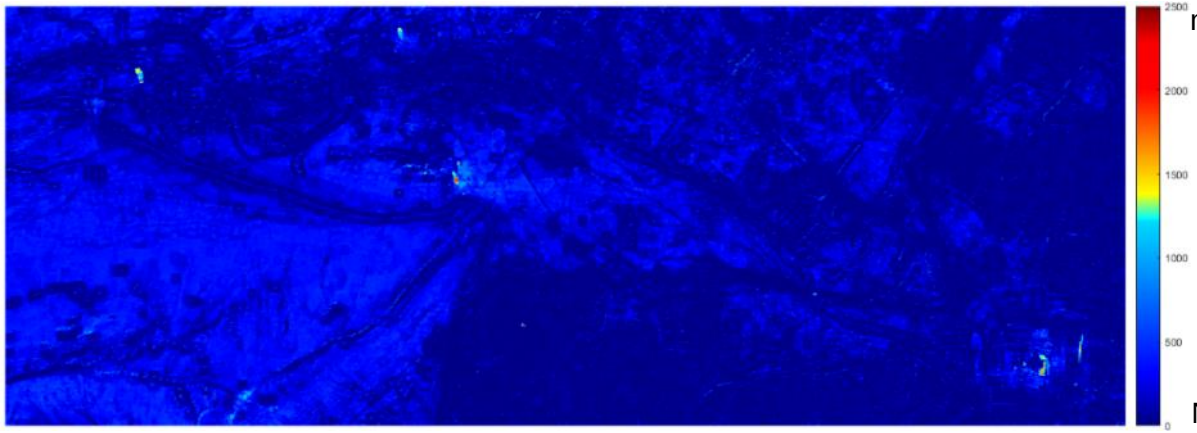
Baalshamin Temple

Temple of Bel

Palmyra – Temple of Bel: destroyed by IS (30.08.2015)

Palmyra: Large Area Change Detection





maximum change

No change

- fast and robust change detection techniques to sensitive areas,
- related to pre- and post-crisis satellite images.
- A map highlighting potentially damaged buildings, which could help experts at timely assessing the damages to the Cultural Heritage sites of interest.

Cerra, D., Plank, S., Lysandrou, V., Tian, J., 2016, Cultural Heritage Sites in Danger—Towards Automatic Damage Detection from Space. Preprints 2016, 2016090055

Palmyra – Baalshamin Temple: Digitally reconstructed

eine Produktion der Filmproduktion Stein in Kooperation mit ZDF/Terra-X und der Stiftung Preußischer

Palmyra – The Temple of Bel - Digitally reconstructed

eine Produktion der Filmproduktion Stein in Kooperation mit ZDF/Terra-X und der Stiftung Preußischer Kulturbesitz.
Generated by Film Production Stein/ZDF Terra-X/SPK

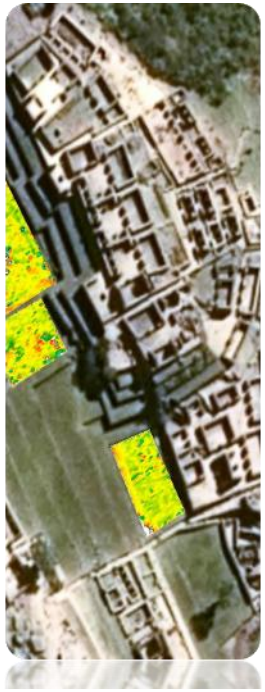
Conclusions

- DLR contributions to ATHENA
  - Virtual training “Hyperspectral”
  - Workshop at CUT “Copernicus contribution to CH”
  - Summer School at CUT “Synthetic Aperture Radar”
  - Workshop at CUT “Multitemporal remote sensing”
  - Workshop at CUT “Geo Information Systems”
  - Webinar “Remote Sensing for Cultural Heritage”
  - Site exchange CUT at DLR “Technologies”
  - Site exchange CUT DLR: “Sensor-systems”
  - Scientific analysis of damages in Palmyra “Cultural Heritage Sites in Danger — Towards Automatic Damage Detection from Space”
  - Scientific analysis of hyperspectral crop marks in “Carnuntum”

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

ATHENA results by National Research Council of Italy

Nicola Masini
CNR/IBAM, Potenza, Italy



This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

CNR-IBAM

Institute of Archaeological and Architectural Heritage

CNR-IMAA

Institute of Methodologies for Environmental Analysis

CNR location

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

2014 **Start year of CNR (ibam/imaa) activies in the field of RS and CH**

260 **Publications** 85 paper ISI

14 **International Projects** 2 H2020 (among which Athena)

2 **Scientific Mission** ITACA-Peru (2008-on going)

CINA-Silk Road (2012-2016))

24 **Field surveys** Italy, Turkey, China, Peru, Bolivia, Colombia, Argentina, Tunisia

21 **CH sites** Among others: Pompeii, Hierapolis, Machu Picchu, Luoyang, Cartagena de Indias, Tiwanaku…

2 **patents** CINA-Silk Roard (2012-2016))

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Cyprus University of Technology

DLR

Hierapolis

Luoyang

Silk Road

Cipro

Siria

Progetto Athena
Horizon 2020

Colombia

Missione Itaca
Sud America

Peru

Bolivia

Argentina

Cartagena

Lambayeque

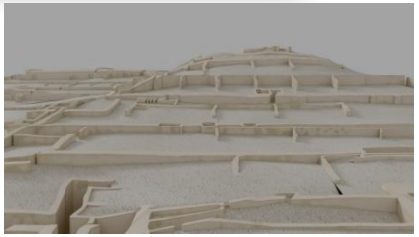
Pachacamac

Macchu Picchu

Nasca

Tiwanaku

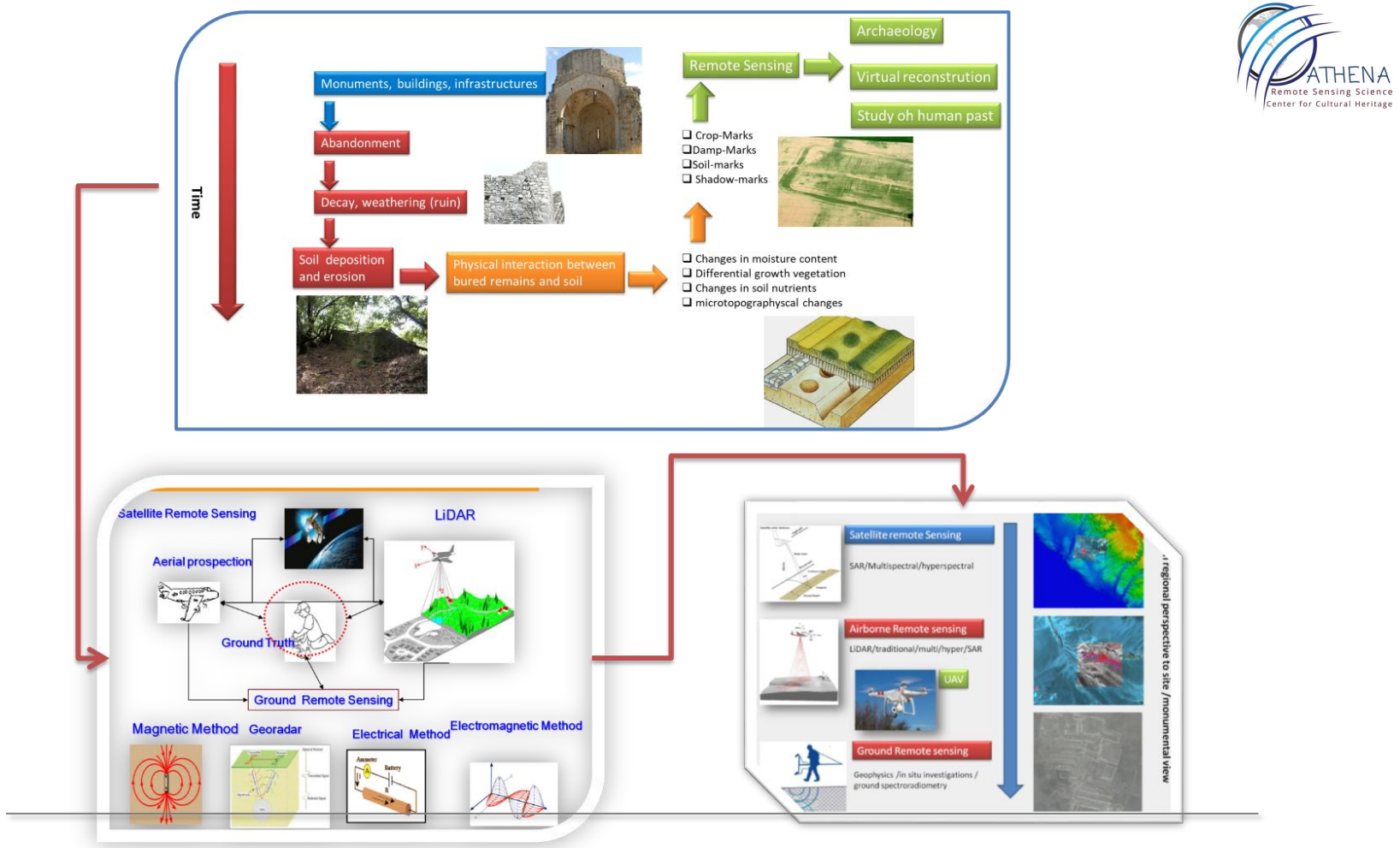
Iguazu



ATHENA
Remote Sensing Science Center for Cultural Heritage

International reseach activity in the field of Remote Sensing and Cultural heritage

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions



EARTH Observation based approach to Archaeology of CNR

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

Work package No	Work Package Title	Lead Participant No	Lead Participant Short Name	Person-Months	Start Month	End month
1	Project management	1	CUT	8	1	36
2	International RS research applied on CH, innovation agenda and best practices assessment	2	CNR	14	1	9
3	Evaluation of gap and capacity development	3	DLR	11	4	12
4	Training and knowledge transfer	3	DLR	67	2	36
5	Promotion of the centre locally and internationally	1	CUT	13	30	36
6	Dissemination and exploitation	1	CUT	12	1	36
				125		

CNR Role and tasks in Athena Project

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

Scope

The scope WP2 is to provide a full understanding of the current as well as forthcoming research and innovation agenda within as well beyond Europe in the field of RS Archaeology.
Part of this WP will be to define the options and alternatives of the Centre of Excellence to be created, based on international established best practices.

Objectives

- Define the nature and scale of demand for RS archaeological research and innovation;
- Profile international best practice in the delivery of RS archaeology, architectural cultural heritage and innovation;
- Define the scientific context for the proposed Centre of Excellence, considering international, European and national strategies and programmes of relevance to the proposed Centre of Excellence, and their long-term objectives

WP2 International RS research applied on CH, innovation agenda and best

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

WP2 Activity

detail study of the current exploitation of RS technologies and approaches on an international level as well best practices applied worldwide for archaeological research, protection and preservation of CH.

Special attention has been be given to some current RS applications in the area of eastern Mediterranean, Middle East, Asia and Southern and Central America.

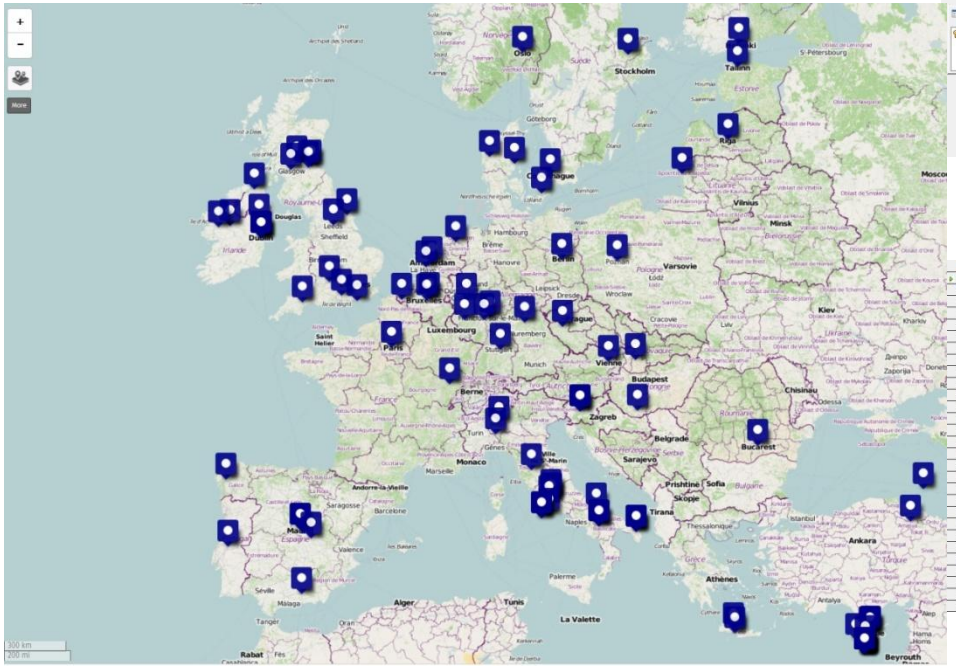
Analysis of the scientific interest of RS & CH

N. of publications in the last 15 years
Mapping of scientific literature
Geoportal of institutions and projects

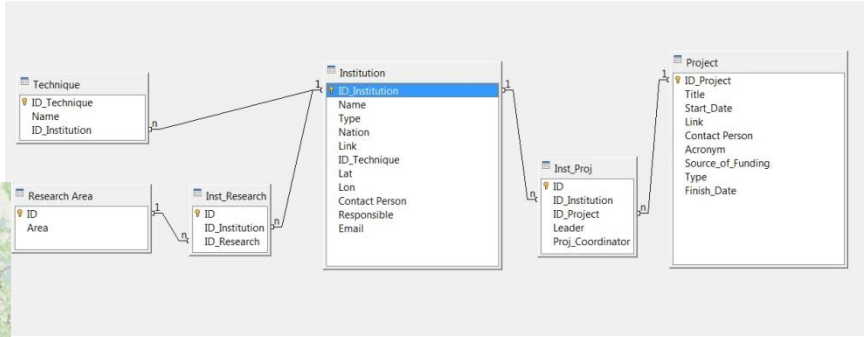
New opportunities and emerging RS approaches

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

Remote Sensing for Cultural Heritage: database and Geoportal of Institutions and Projects



Web GIS



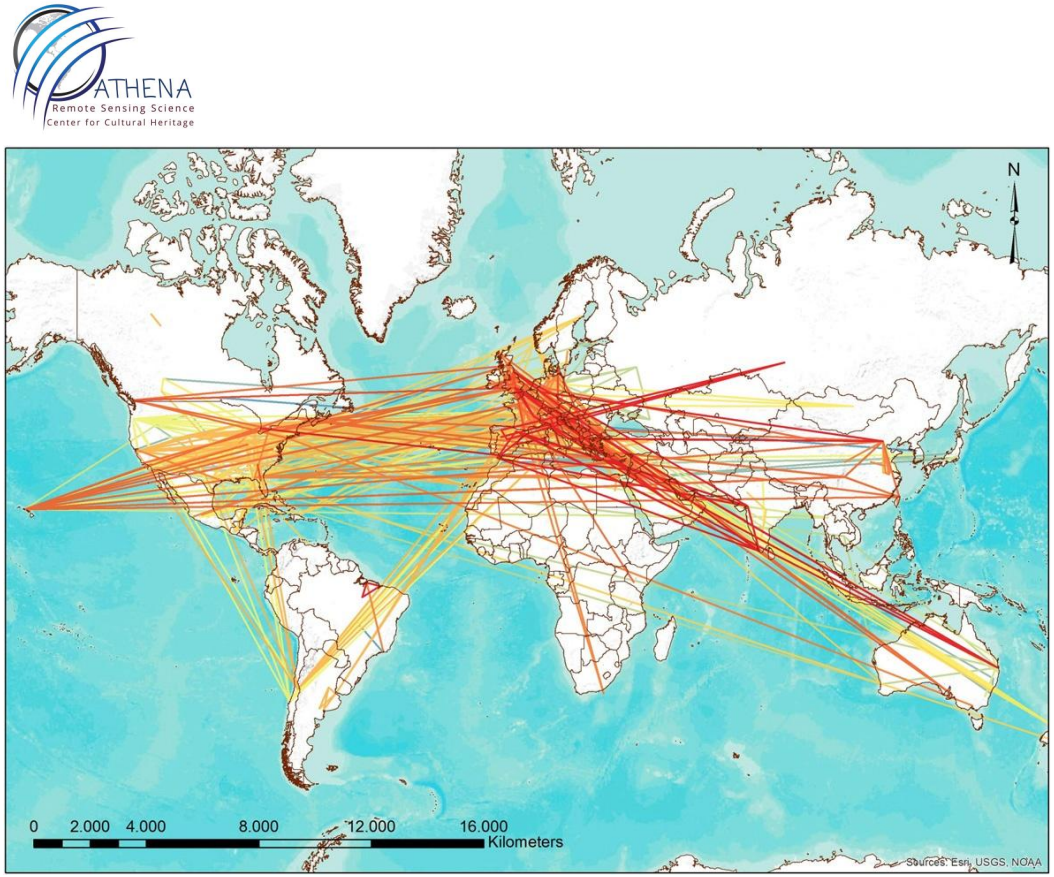
Database structure and relationships

ID_Institution	Name	Type	Nation	Link	ID_Technique	Lat	Lon	Contact Person	Responsible	Email
1	Cyprus University of Technology		Cyprus	http://www.cut.ac.cy/		34,68	33,04	Andreas Anayiotos		
2	IBAM CNR GISeARCHLab		Italy	http://www.ibam.cnr.it/		40,6	15,72	Nicola Masini	Daniele Malfitana	
3	German Aerospace Center		Germany	http://www.dlr.de/		50,85	7,11	Pascale Ehrenfreund		
4	Tuscia University		Italy	http://www3.unitus.it/		42,41	36,83	Alessandro Ruggieri		
5	University of Stirling		United Kin	https://www.stir.ac.uk/		56,15	-3,92	James Naughtie		
6	German Archaeological Institute DAI	Public Authority	Germany	http://www.dainst.org/		52,46	13,3	Margarethe van Ess	Friederike Fless	mve@orient.dainst.de
7	Agenzia Spaziale Italiana		Italy	http://www.asi.it/		41,86	12,62	Roberto Battiston		
8	Alma Sistemi sas		Italy	http://alma-sistemi.com/		41,94	12,66	Alessio Di Iorio		
9	University of Copenhagen		Denmark	http://www.ku.dk/english/		55,68	12,57	Ralf Hemmingsen		
10	Natural Environment Research Council NERC		United Kin	http://www.nerc.ac.uk/		51,57	-1,79	Tim Wheeler		
11	Istituto Superiore per la Protezione e la Ricerca Ambie		Italy	http://www.isprambiente.gov		41,82	12,47	Bernardo De Bernardini		
12	Università degli Studi di Milano Bicocca		Italy	http://www.unimib.it/go/101/		45,51	9,21	Cristina Messa		
13	Instituto Geológico y Minero de España IGME		Spain	http://www.igme.es/default.a		40,44	-3,7	Jorge Civis Llovera		
14	Institute for Mediterranean Studies/Foundation for Re		Greece	http://www.forth.gr/index_mc		35,37	24,47	Christos Hadziiossif		
15	Kykkos Museum		Cyprus	http://kykkos-museum.org.cy/		35,13	33,3			
16	Paphos Municipality		Cyprus	http://pafos.org.cy/		34,77	32,42	Phedon Phedonos		
17	English Heritage		United Kin	http://www.english-heritage.c		50,79	0,01	Timothy Laurence		
18	Holstebro Museum		Denmark	http://www.holstebro-museu		56,35	8,62	Jens Kjær Larsen		
19	State Office for Cultural Heritage Management Baden		Germany	http://www.denkmalpflege-b		48,74	9,3			
20	Scientific Research Centre of the Slovenian Academy c		Slovenia	http://www.sazu.si/en/o-sazu		46,05	14,5	Tadej Bajd		
21	Leiden University		Netherland	http://www.universiteitleiden.		52,16	4,48	Carel Stolker		
22	Landscape & Geophysical Services LGS		Ireland	http://www.lgs.ie/index.shtml		53,73	-9	Kevin Barton		
23	Aerial Archaeology Research Group AARG		Austria	http://www.univie.ac.at/aarg/		0	0			
24	University of Siena		Italy	http://www.unisi.it/		43,32	11,33	Angelo Riccaboni		
25	University of Glasgow		United Kin	http://www.gla.ac.uk/		55,87	-4,29	Kenneth Calman		
26	University of Exeter		United Kin	http://www.exeter.ac.uk/		50,74	-3,54	Floella Benjamin		
27	Janus Pannonius Museum JPM (former Directorate of E		Hungary	http://www.jpm.hu/		46,08	18,22	János Hargitai		
28	Dutch Expertise Centre for Archaeological Remote Sen		Netherland	http://www.decarn.nl/		53,14	6,41			
29	Discovery Programme Centre for Archaeology and Inn		Ireland	http://www.discoveryprogram		53,34	-6,25	Finbar McCormick		

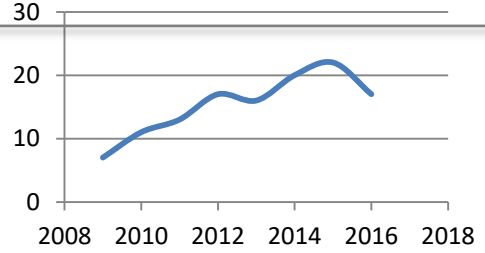
Institution Table

WP2 International RS research applied on CH, innovation agenda and best practices assessment

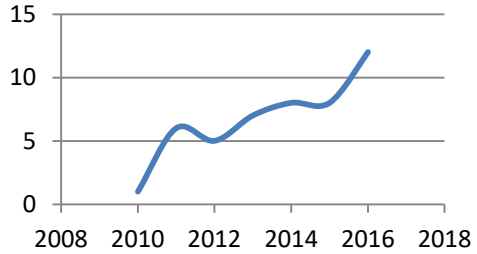
This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions



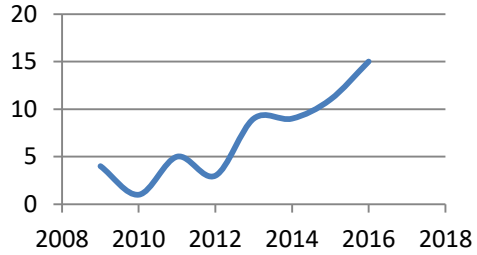
Visualization of institutions exchange and transfer of knowledge in global level (Agapiou & Lysandrou)



LiDAR & Archaeology



SAR & Archaeology



UAV & Archaeology

Emerging remote sensing technologies for Cultural heritage: n. of publications from 2009 to 2016

WP2 International RS research applied on CH, innovation agenda and best practices assessment

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ATHENA strategy (Months 0-18)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Meetings (M)	1											2						
Summer Schools (SS)						1												2
Workshops (WS)				1												2		
Virtual training (VT)		1								2								
Short term staff exchanges (SE)									1					2				
Experts visits (EV)		1																
Short term on site (OS)						1												2

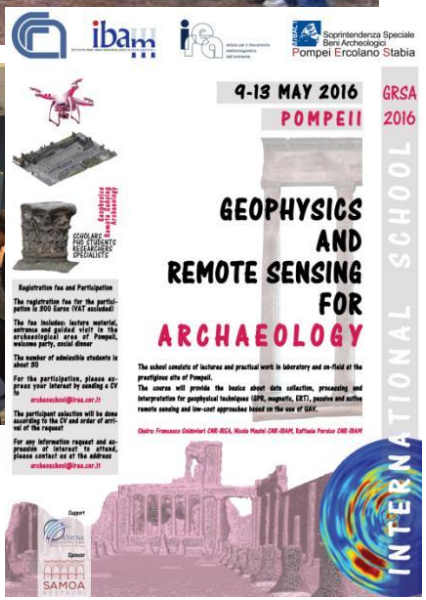
ATHENA strategy (Months 18-36)	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Meetings (M)						3												4
Summer Schools (SS)												3						
Workshops (WS)										3								4
Virtual training (VT)			3											4				
Short term staff exchanges (SE)								3										
Experts visits (EV)													2					
Short term on site (OS)									3			4						

Information related to the strategy					
Training type	**No of activities**	**Training topic**	**M**	**Participant**	**Hosting institution**
Meetings (M)	M1	Kick-off meeting	1	All partners	CUT
	M2	Annual meeting	12	All partners	CUT
	M3	2nd year's meeting	24	All partners	CUT
	M4	Final meeting	36	All partners	CUT
Summer Schools (SS)	SS1	Geophysics	6	CNR-CUT	CUT
	SS2	Special issues of Optical RS	18	DLR-CUT	CUT
	SS3	Interferometry / Radar	30	DLR-CUT	CUT
Workshops (WS)	WS1	Copernicus contribution to CH	4	DLR-CUT	CUT
	WS2	RS archaeology applications beyond Europe	16	CNR-CUT	CUT
	WS3	Information systems in RS	28	DLR-CUT	CUT
	WS4	RS to archaeology: future and expectations (in parallel with M4)	36	All partners	CUT
Virtual training (VT)	VT1	Multi-temporal RS analysis	2	DLR-CUT	CUT
	VT2	Hyperspectral processing	10	DLR-CUT	CUT
	VT3	Satellite monitoring for archaeological looting	21	CNR-CUT	CUT
	VT4	Integration of RS data for protection and preservation of CH (depicting deformation of monuments and sites through persistent scattered interferometry)	32	CNR-CUT	CUT
Short term staff exchanges (SE)	SE1	Active and passive RS data & Archaeology	9	CNR-CUT	CNR
	SE2	DLR technologies	14	DLR-CUT	DLR
	SE3	DLR sensors	26	DLR-CUT	DLR
Experts visits (EV)	EV1	GAP evaluation (See WP3)	2	All partners	CUT
	EV2	Promotion of ATHENA centre (see WP5)	31	All partners	CUT
Short term on site (OS)	OS1	Visits to CH sites for testing/evaluation/discussion (in parallel with SS1)	6	CNR-CUT	CUT
	OS2	Visits to CH sites for testing/evaluation/discussion (in parallel with SS2)	18	DLR-CUT	CUT
	OS3	Fusion and interpretation of active and passive RS data for CH applications	27	CNR-CUT	CUT
	OS4	Visits to CH sites for testing/evaluation/discussion (in parallel with SS3)	30	DLR-CUT	CUT

CNR Role and tasks in Athena Project

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

Archaeogeophysical School in Pompeii
9-13 May 2016



In cooperation with CNR-IREA

Chairs: F. Soldovieri, N. Masini, R. Persico

WP4 Training and Knowledge Transfer

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

Archaeogeophysical School in Pompeii

Monday, 9 May 2016		
9.30-10.30	*Opening Ceremony and introduction to the course*	Chairs, Institute directors and Superintendent
10:30-12:00	*Remote sensing for Archaeology and cultural heritage management*	R. Lasaponara
12:00-13:00	*Ground-truth spectroradiometric data for archaeological applications*	A. Agapiou
13:00.14:30	*Welcome party : lunch*	
14:30-16.00	*Magnetic and ERT for preventive archaeology*	E. Rizzo
16:00-17:30	*Ground Penetrating Radar*	R. Persico

Tuesday, 10 May 2016		
9:30-10:30	*Infrared and high frequency technologies for diagnosis*	I. Catapano
10:30-12:00	*Acoustic and seismic techniques*	G. Leucci
12:00-13:00	*Monitoring Strategies for conservation of Cultural Heritage*	B. De Nigris, F. Soldovieri
13:00-14:00	*Lunch break*	
14:00-15:00	*Administrative and financial issues related to registration (invoices, VAT, etc..)*	G. Sole, F. Di Matteo
15:00-16:00	*Remote sensing and geophysics for archaeology and cultural heritage: the interpretation issue*	N. Masini
16:00-18:00	Visit of the archaeological area of Pompeii and test sites	

Wednesday, 11 May 2016		
9:30-13:00	*Field surveys on monuments Part 1*	All the lecturers and tutors divided in two-three groups
13:00-14:00	*Lunch break*	
14:00-18:00	*Field surveys on monuments Part 2*	All the lecturers and tutors divided in two-three groups

Thursday, 12 May 2016		
9:30-11:30	*Tutorial of data processing for the technologies deployed at field survey*	The lecturers involved in the data processing
11:30-13:00	*Processing of data collected during the field survey*	All lecturers and tutors
13:00-14:00	*Lunch break*	
14:00-18:00	*Processing of data collected during the field survey*	All lecturers and tutors
21:00	*SOCIAL DINNER at Restaurant "Zi Caterina""*	

Friday, 13 May 2016		
9.30-12:00	*Presentation and interpretation of data processing results*	All lecturers and tutors
12:00-13:00	*Conclusion of the school*	Chairs

8 lectures

2 tutorials

2 field surveys

Test site
Discussion
Visit

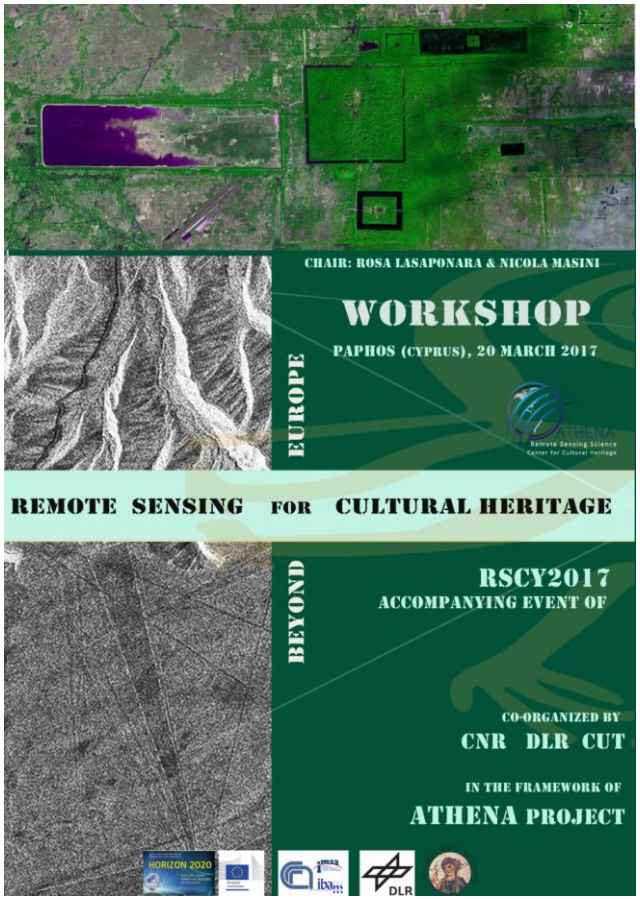
WP4 Training and Knowledge Transfer

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

Workshop. "Remote Sensing for Cultural Heritage. Beyond Europe" Paphos 20.03.2017

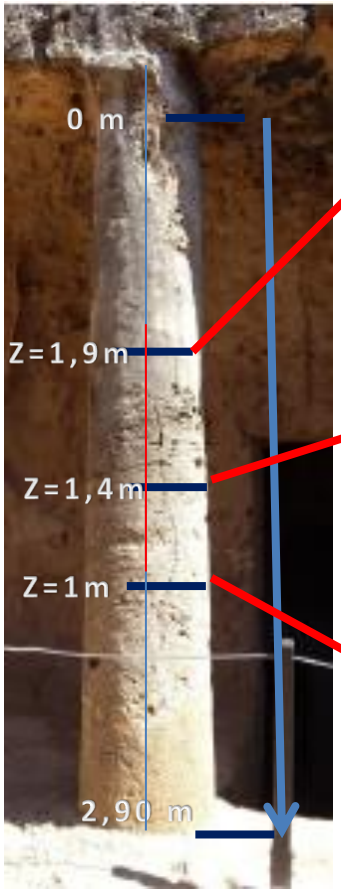
Programma
(*Solicited KeyNotes*)

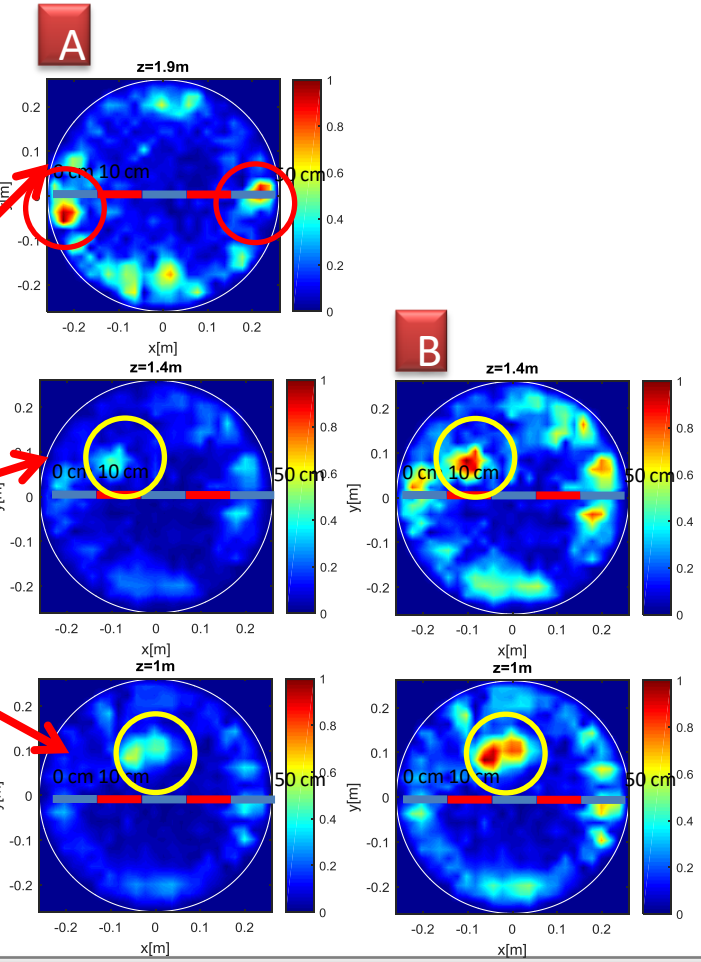
- Remote sensing for a smart management of cultural heritage from site detection tomonitoring and documentation: the case studies of Silk Road Project
  Rosa Lasaponara (CNR-IMAA)
- Sensing beyond frontiers: remote sensing applications for archaeological heritage detection and management
  Arianna Traviglia (Ca' Foscari University of Venice)
- On the use of remote sensing in the archaeological area of Petra (Jordan)
  Daniele Spizzichino et. al. (ISPRA)
- GIS and satellite data for urban sprawl close to archaeological areas in Iran
  Beniamino Murgante (UNIBAS)
- An Overview of remote sensing in Altai archaeological area
  Jean Bourgeois (Gent University)
- The Christian reuse of the Egyptian temples and keeping methods using remote sensing and GIS techniques in Luxor city, Egypt
  Osama Wafa, Abdel Ifadaly (NARSSS National Authority for Remote Sensing & Space Sciences)
- Remote sensing based archaeological research in Nasca and in Pachacamac (Perù)
  Nicola Masini (CNR-IBAM)
- Exploitation of big data cloud infrastructures for earth observation cultural heritage applications: mapping the land use changes patterns in the vicinity of "the great pyramid at Giza"
  Athos Agapiou (CUT)
- Automatic *Damage detection for sensitive Cultural Heritage Sites in Syria and Iraq*
  Daniele Cerra, Jiaojiao Tian, Vasiliki Lysandrou, Simon Plank, Thomas Krauß (DLR)
- Qualitative assessment of the medieval fortification conditions with the use of Remote Sensing data (Republic of Tatarstan)
  Gainullin, B. Usmanov, A. Sitdikov
- The Copernicus Programme and World Cultural Heritage preservation
  Gunter Schreier (DLR)
- **Round Table**



This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

Visit for testing, evaluations and discussion. GPR based investigation of Tombs of Kings – Paphos 21.03.2017





WP4 Training and Knowledge Transfer

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

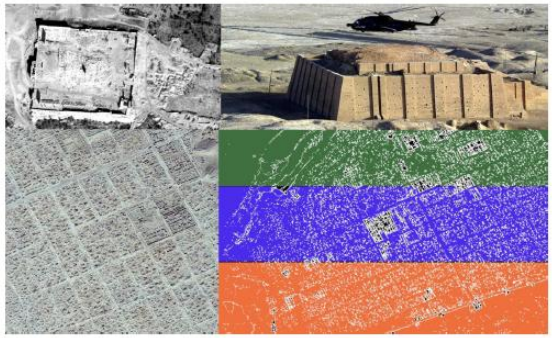
Training."Archaeological looting. Ancient problems and New approaches based on Remote Sensing"– Limassol 1.09.2017

ATHENA-Training

"Archaeological looting: Ancient problems and New approaches based on Remote Sensing"

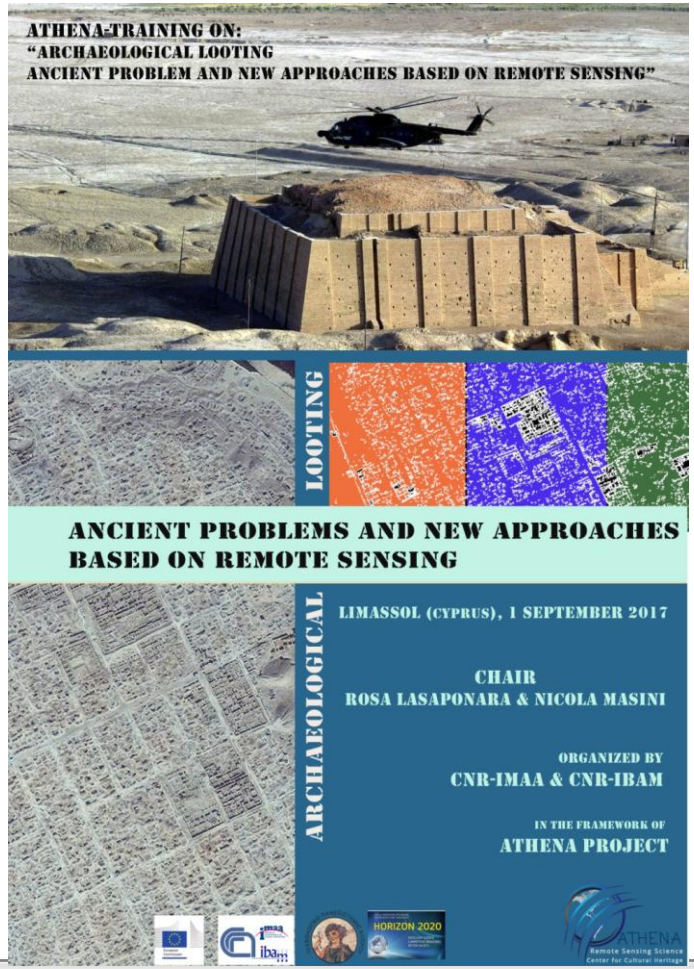
1st September 2017, CUT, Limassol, Cyprus

Conducted by Dr. Rosa Lasaponara and Dr. Nicola Masini



Agenda

Friday, September 1st	
9:30-10:30	- Archaeological looting disturbance : ethics and strategies for contrasting and monitoring
10:30-11:30	- EO technologies for looting observation, quantification and mapping
11.30-12.30	- State of Art of EO based approaches for looting monitoring
12:30-13:30 Lunch	
13:30-14:30	- Looting feature extraction : ALFEA method by Lasaponara & Masini
14.30-15:30	- Tutorial (study cases)
15:30-16:30	- Discussion of presented aspects - Identification of interesting aspects for joint studies - Ideas for joint journal paper /conference presentation



WP4 Training and Knowledge Transfer

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

Training."Integration of RS data for Cultural Heritage management in the Copernicus Era"– Paphos 2.09.2018

4th Virtual Training Agenda

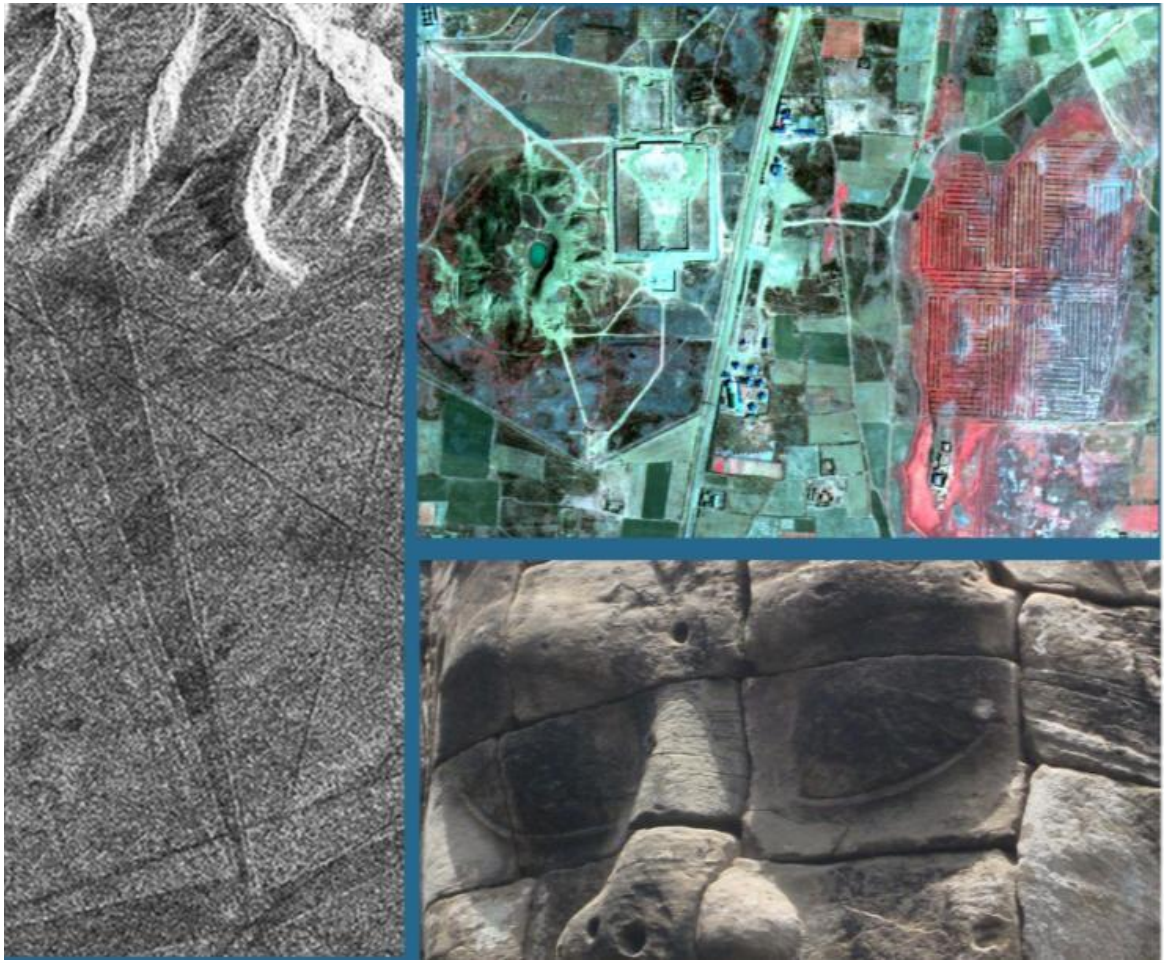
Topic: Integration of RS data for Cultural Heritage management in the Copernicus Era

Date: 3 September, 2018

Venue: Dorothea Building, 3rd floor

Hosted by: Cyprus University of Technology

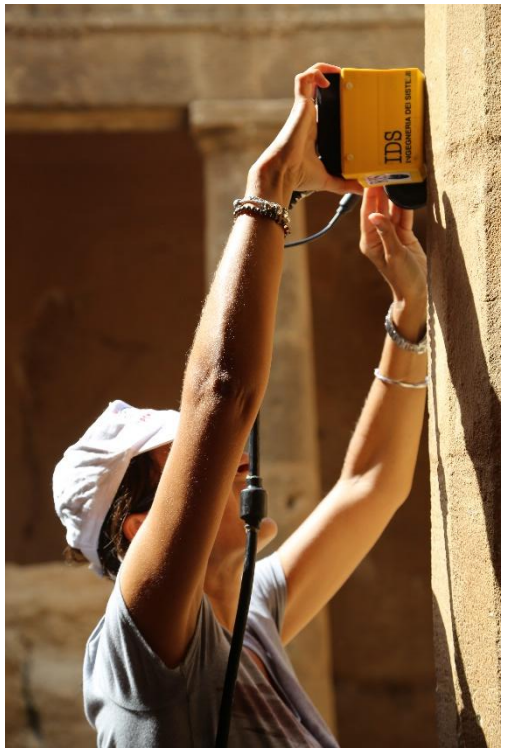
Trainer: Dr. Rosa Lasaponara (CNR-IMAA), Nicola Masini (IBAM-CNR)



DATA INTEGRATION AND FUSION: STATE-OF-THE ART AND FUTURE PERSPECTIVES FOR ARCHAEOLOGICAL PROSPECTION AND ARCHITECTURAL HERITAGE MONITORING

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

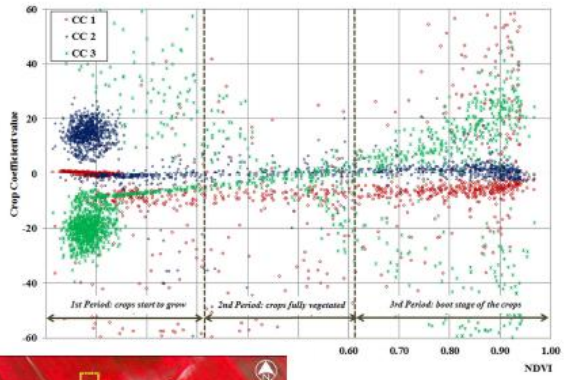
III Summer School – Geophysics for Cultural heriutage monitorjng and archaeological research – Paphos 4-5 September

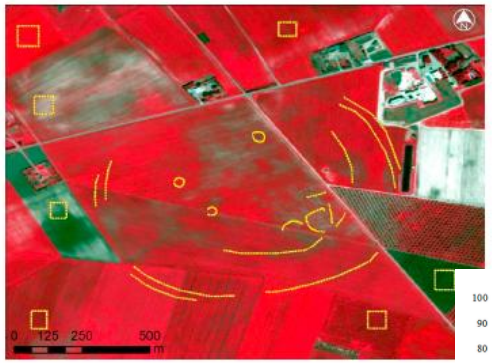


Trainer: Dr. Ilaria Catapano (CNR/IREA), Rosa Lasaponara (CNR/IMAA), Nicola Masini (IBAM-CNR), Francesco Soldovieri (CNR/IREA)

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

Comparative Performance of spectral indices for detecting archaeological crop marks





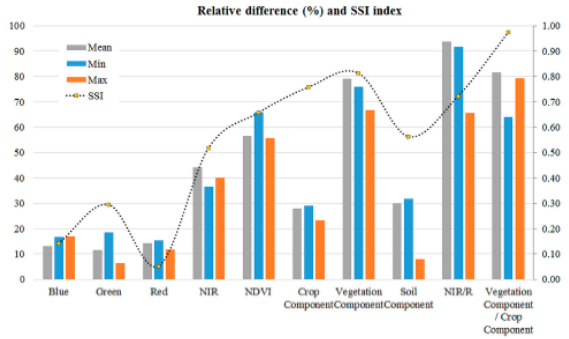


Figure 11. Relative difference and SSI index of Blue; Green; Red; NIR bands; NDVI; crop mark; vegetation; and soil coefficients as well as NIR/R and vegetation/crop mark ratios over the Lucera site.

remote sensing MDPI

Article

Study of the Variations of Archaeological Marks at Neolithic Site of Lucera, Italy Using High-Resolution Multispectral Datasets

Athos Agapiou [1,*], Vasiliki Lysandrou [1], Rosa Lasaponara [2], Nicola Masini [3] and Diofantos G. Hadjimitsis [1]

1 Remote Sensing and Geo-Environment Laboratory, Department of Civil Engineering and Geomatics, Cyprus University of Technology, 2–8 Saripolou, Limassol 3603, Cyprus; vasiliki.lysandrou@cut.ac.cy (V.L.); d.hadjimitsis@cut.ac.cy (D.G.H.)
2 National Research Council, Institute of Institute of Methodologies for Environmental Analysis, C.da S. Loya, Tito Scalo 85050, Italy; rosa.lasaponara@imaa.cnr.it
3 National Research Council, Institute of Archaeological and Monumental Heritage, C.da S. Loya, Tito Scalo 85050, Italy; n.masini@ibam.cnr.it
* Correspondence: athos.agapiou@cut.ac.cy; Tel.: +357-25-002-471

Academic Editors: Magaly Koch and Prasad S. Thenkabail
Received: 17 July 2016; Accepted: 26 August 2016; Published: 1 September 2016

Abstract: Satellite images have been systematically explored by archaeologists to detect crop marks, which are considered as a proxy for the identification of buried archaeological remains. Even though several existing algorithms are frequently applied, such as histogram enhancements and vegetation indices, the detection of crop marks still remains a difficult task, while the final interpretation results can be very poor. This paper aims to present some of the current difficulties of "remote sensing archaeology" in terms of detection and interpretation of crop marks due to the crops' phenological variations. At the same time, the presented work seeks to evaluate the recently proposed linear equations for the enhancement of crop marks, initially developed for the eastern Mediterranean region. These linear equations re-project the initial n-space spectral into a new 3D orthogonal space determined by three components: a crop mark component, a vegetation component, and a soil component. For the aims of this study, the Lucera archaeological site (southern Italy), where several Neolithic trenches have been identified, was selected. QuickBird and GeoEye high-resolution satellite images were analysed, indicating that vegetation indices may mismatch some crop marks depending on the phenological stage of the vegetation cultivated in the area of the archaeological site. On the contrary, ratios from linear equations were able to spot these crop marks even in shadow areas, indicating that improvements and developments of novel methodologies and equations based on remote sensing datasets can further assist archaeological research.

MAIN SCIENTIFIC RESULTS

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

Archaeological looting feature extraction (ALFEA)

Surv Geophys
https://doi.org/10.1007/s10712-018-9480-4

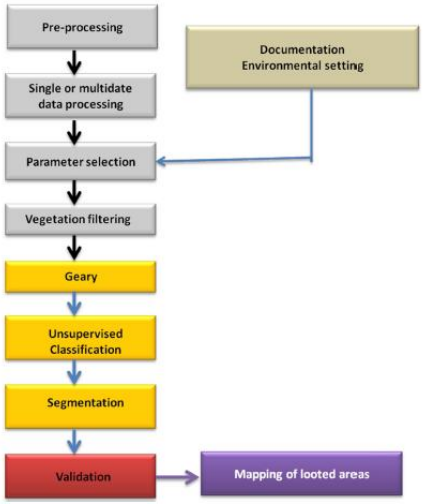
Space-Based Identification of Archaeological Illegal Excavations and a New Automatic Method for Looting Feature Extraction in Desert Areas

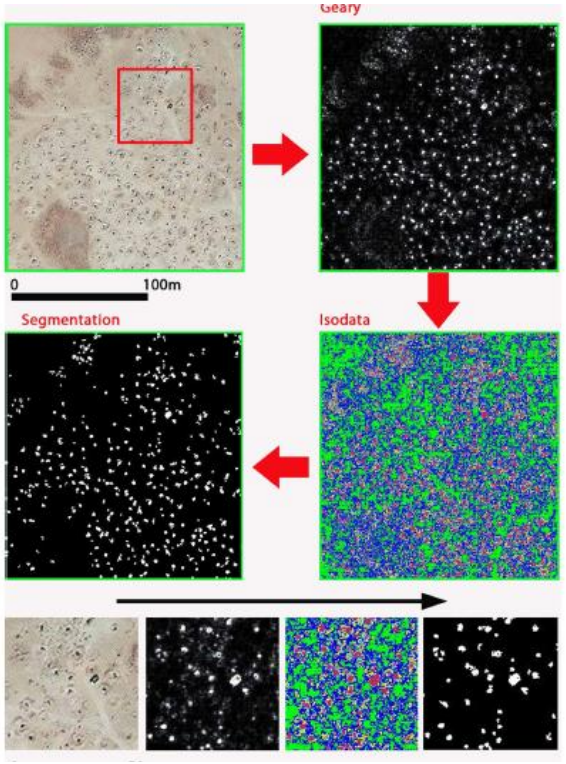
Rosa Lasaponara[1] · Nicola Masini[2]

Received: 1 March 2018 / Accepted: 30 May 2018

Abstract The identification and quantification of disturbance of archaeological sites has been generally approached by visual inspection of optical aerial or satellite pictures. In this paper, we briefly summarize the state of the art of the traditionally satellite-based approaches for looting identification and propose a new automatic method for archaeological looting feature extraction approach (ALFEA). It is based on three steps: the enhancement using spatial autocorrelation, unsupervised classification, and segmentation. ALFEA has been applied to Google Earth images of two test areas, selected in desert environs in Syria (Dura Europos), and in Peru (Cahuachi-Nasca). The reliability of ALFEA was assessed through field surveys in Peru and visual inspection for the Syrian case study. Results from the evaluation procedure showed satisfactory performance from both of the two analysed test cases with a rate of success higher than 90%.

Keywords Satellite remote sensing · Review · Archaeological looting · Automatic feature extraction · Peru · Syria





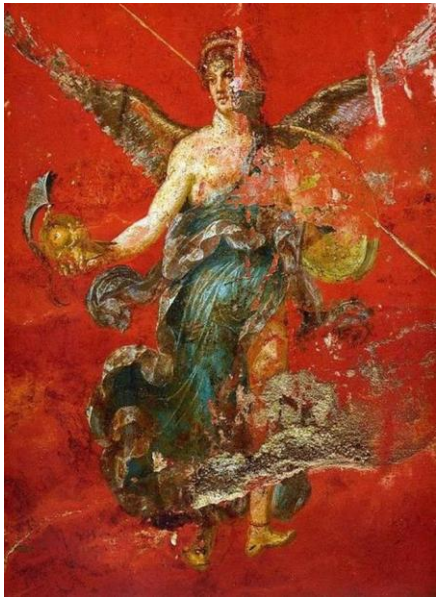
Case study: Dura Europos (Syria)

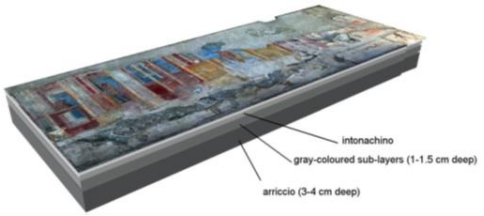
Lasaponara R., Masini N. (2018). Space-Based Identification of Archaeological Illegal Excavations and a New Automatic Method for Looting Feature Extraction in Desert Areas. Surv Geophys (2018). https://doi.org/10.1007/s10712-018-9480-4

MAIN SCIENTIFIC RESULTS

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

Multisensor, feature integration and pattern extraction based on SOM for the monitoring and diagnosis of the state of conservation of frescoes





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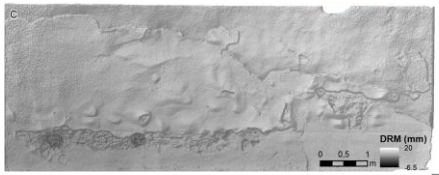
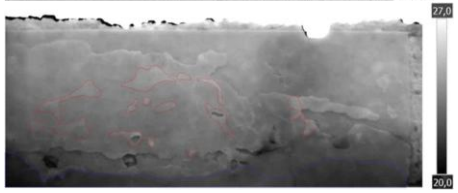
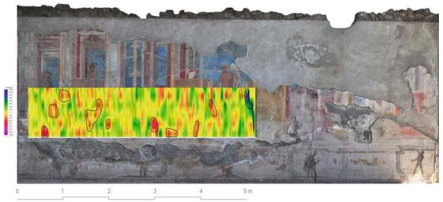


Digital Relief Model

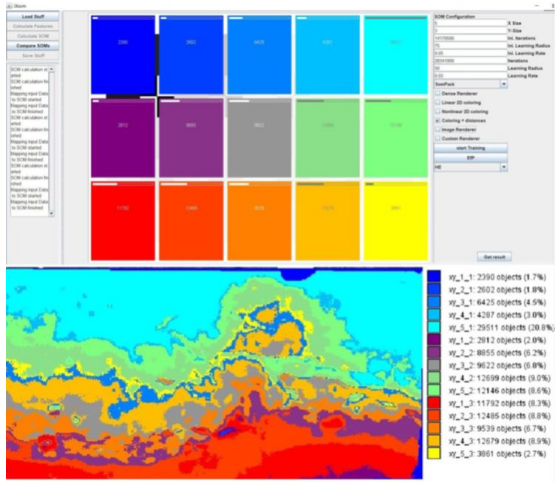


Multitemporal Infrared Thermography



Georadar

Case study: Pompeii



Surveys in Geophysics
https://doi.org/10.1007/s10712-018-9484-0

CrossMark

Geophysical Methods and Spatial Information for the Analysis of Decaying Frescoes

Maria Danese[1] · Maria Sileo[1] · Nicola Masini[1]

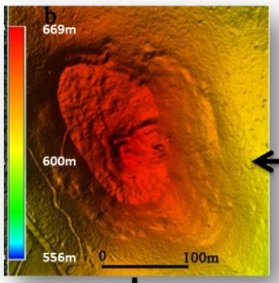
Received: 15 February 2018 / Accepted: 21 June 2018
© Springer Nature B.V. 2018

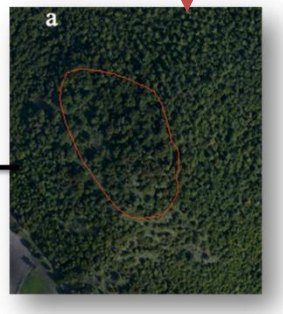
M. Danese, M. Sileo, N. Masini (2018). Geophysical Methods and Spatial Information for the Analysis of Decaying Frescoes. ***Surveys in Geophysics***, 1-18

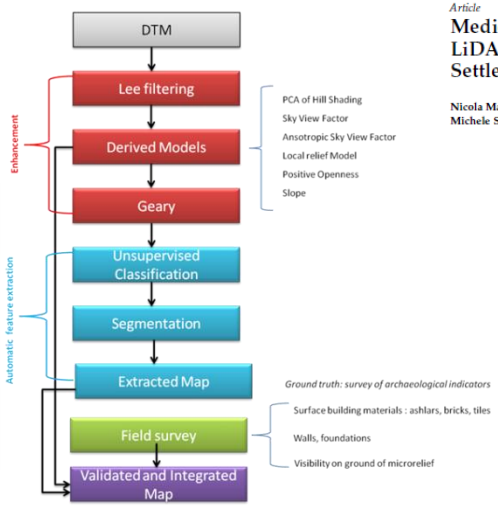
MAIN SCIENTIFIC RESULTS

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 691936 H2020-TWINN-2015-Coordination & Support Actions

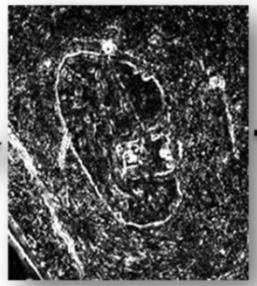
ENHANCEMENT AND FEATURE INTEGRATION FOR THE DETECTION AND INTERPRETATION OF MICROTOPOGRAPHY OF ARCHAEOLOGICAL INTEREST



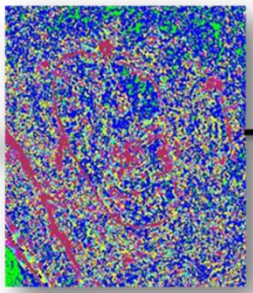




Sky View Factor

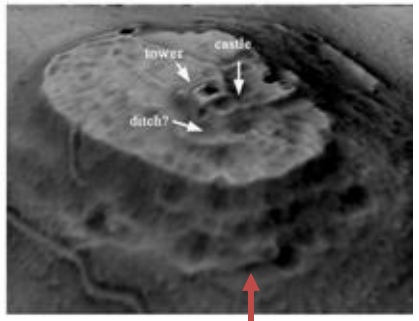


Geary



Isodata

Segmentation

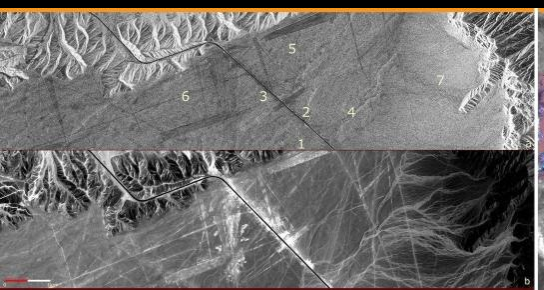


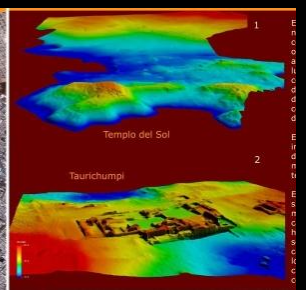
Masini, N., Gizzi et al.(2018), Medieval Archaeology Under the Canopy with LiDAR. The (Re)Discovery of a Medieval Fortified Settlement in Southern Italy, in

MAIN SCIENTIFIC RESULTS

The preservation and enhancement of natural and cultural heritage including landscape is evermore one of the topics of great economic and social significance. It is a priority to transmit cultural treasure and evidences of the human past to future generations and also to exploit them as a strategic and valuable economic asset, if inspired to **sustainable development strategies**

Copernicus has changed the paradigm with which the citizen is related to the spatial datum, because it is open access, available to all. Therefore, space is a huge opportunity for a society, today, that evolves very quickly and offers challenges and opportunities. In the light of recent sensor developments and data availability, innovative models and methodologies are needed for data analysis and the integration of different information, as well as new strategies for the exploitation





New opportunities: Copernicus

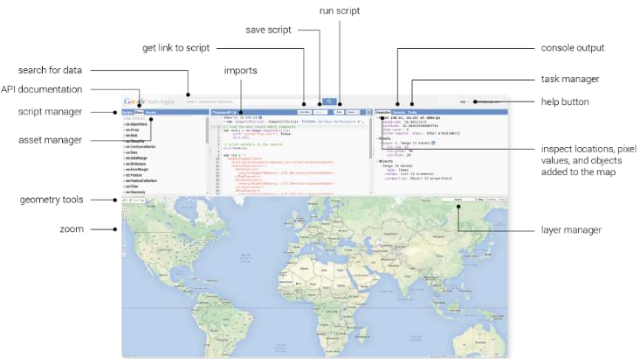
- To identify intermediate and end-users' needs in the Cultural Heritage domain, and assess and characterise space-based applications in support of Cultural Heritage at EU and global level
- To assess capabilities and outline requirements for Copernicus-based products/services in support of Cultural Heritage
- To propose and assess implementation scenarios for a structured Copernicus-based approach for Cultural Heritage support

New opportunities: Big Data Infrastructures for RS applications

Helix Nebula

ESA

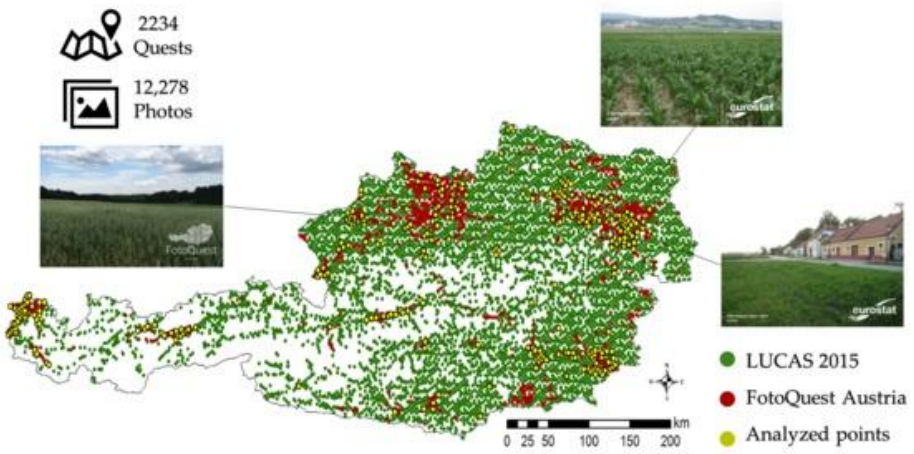
GloudEO



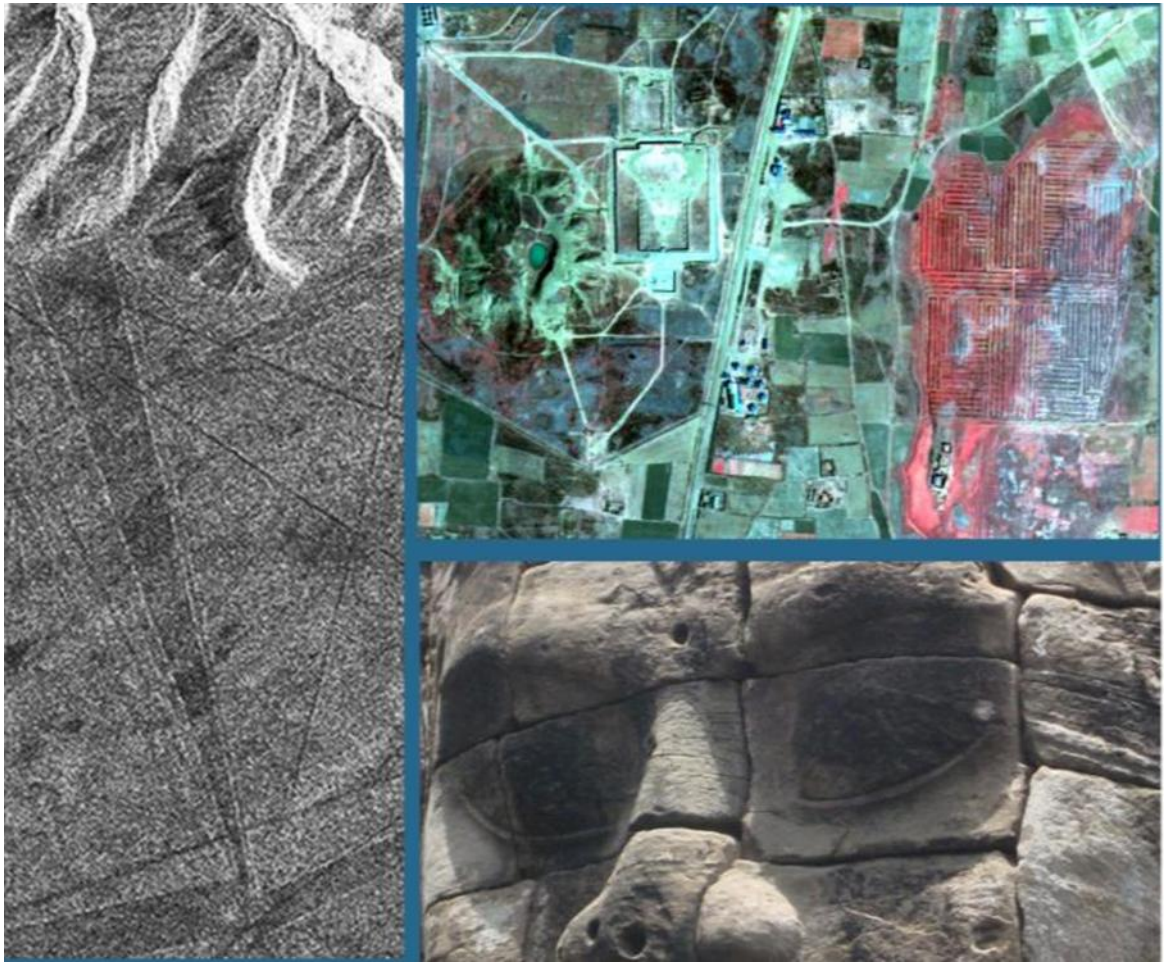
Google Earth Engine

Amazon

New opportunities: Citizen Science and Earth Observation



Juan Carlos Laso Bayas et al. 2017 / Remote sensing



Thank you for your attention

Overview of Earth Observation Programmes and Missions

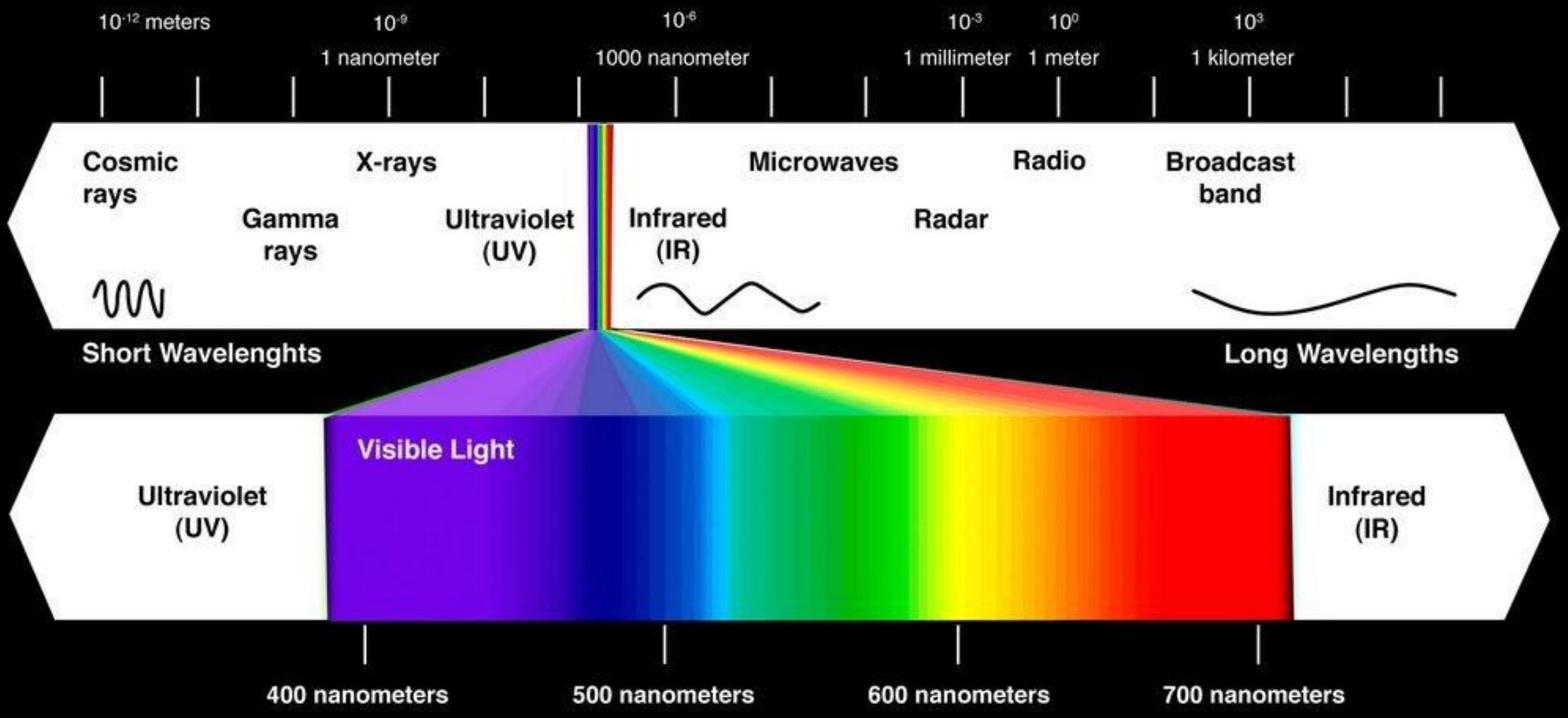
ATHENA: Remote Sensing and Archaelogy: Future and Expectations
Workshop during EUROMED 2018;
October 30,2018

Gunter Schreier

German Aerospace Center (DLR)
Earth Observation Center (EOC)
German Remote Sensing Data Center (DFD)

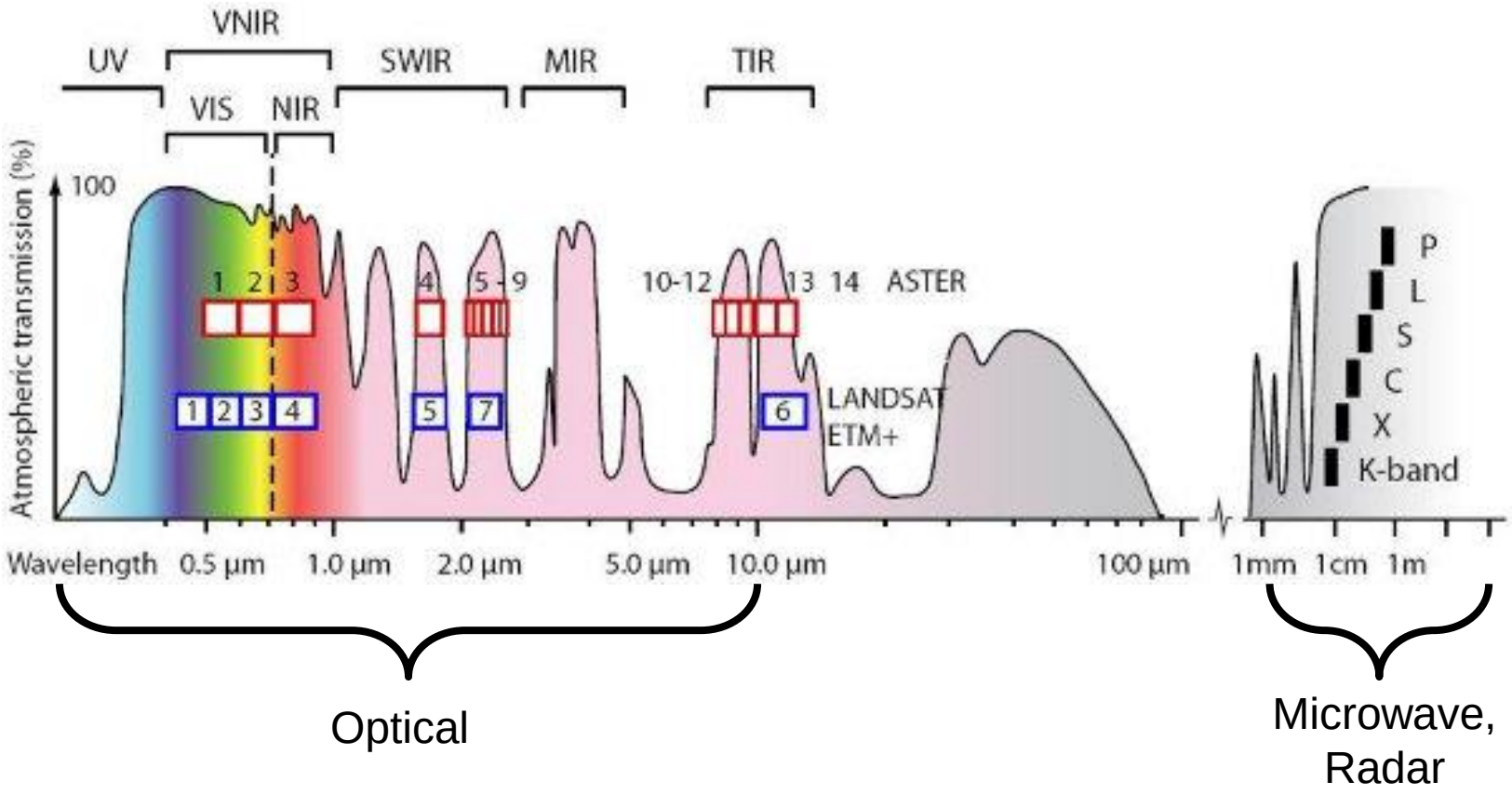
Earth Observation


COL03
NASA

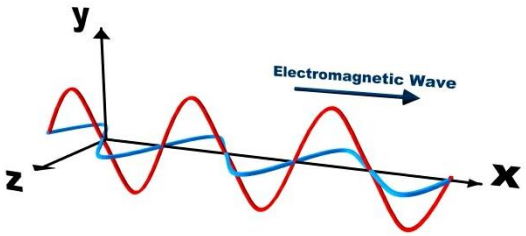


www.quora.com

Electromagnetic spectrum used in Earth observation

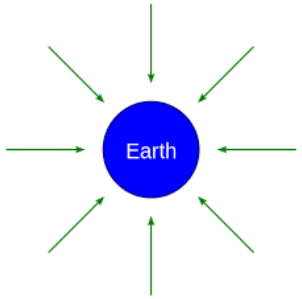


Earth Observation Observation Technologies



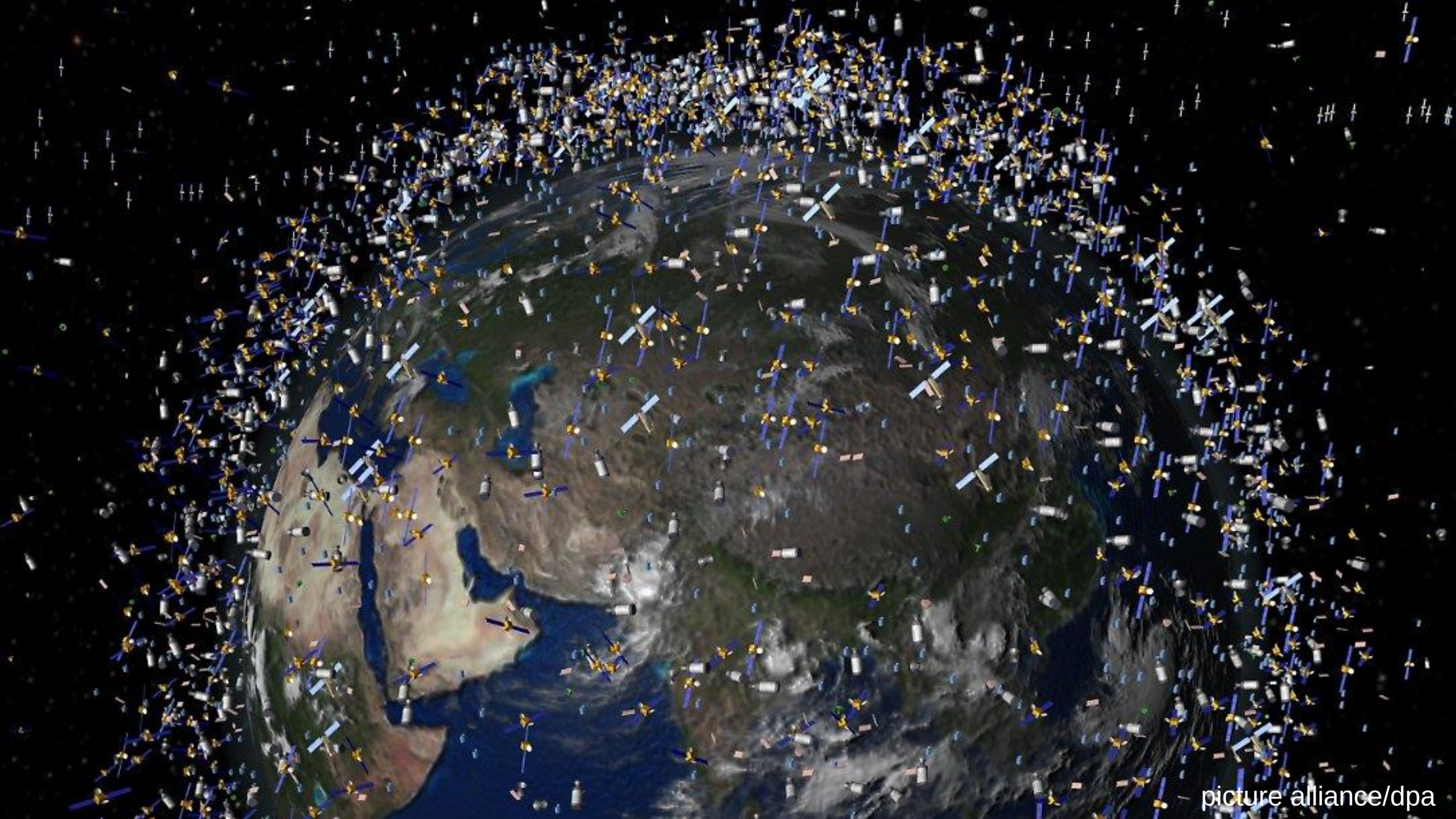
Measurement of EM radiation

- Passive
  - Optical
    - Radiometer
    - Spectrometer
  - Mikrowave
    - Radiometer
- Active
  - Optical
    - LASER
  - Mikrowave
    - Synthetic Aperture Radar
    - Real Aperture Radar
    - Altimeter



Measurement of fields

- Gravimeter
- Magnetometer
- Orbitography

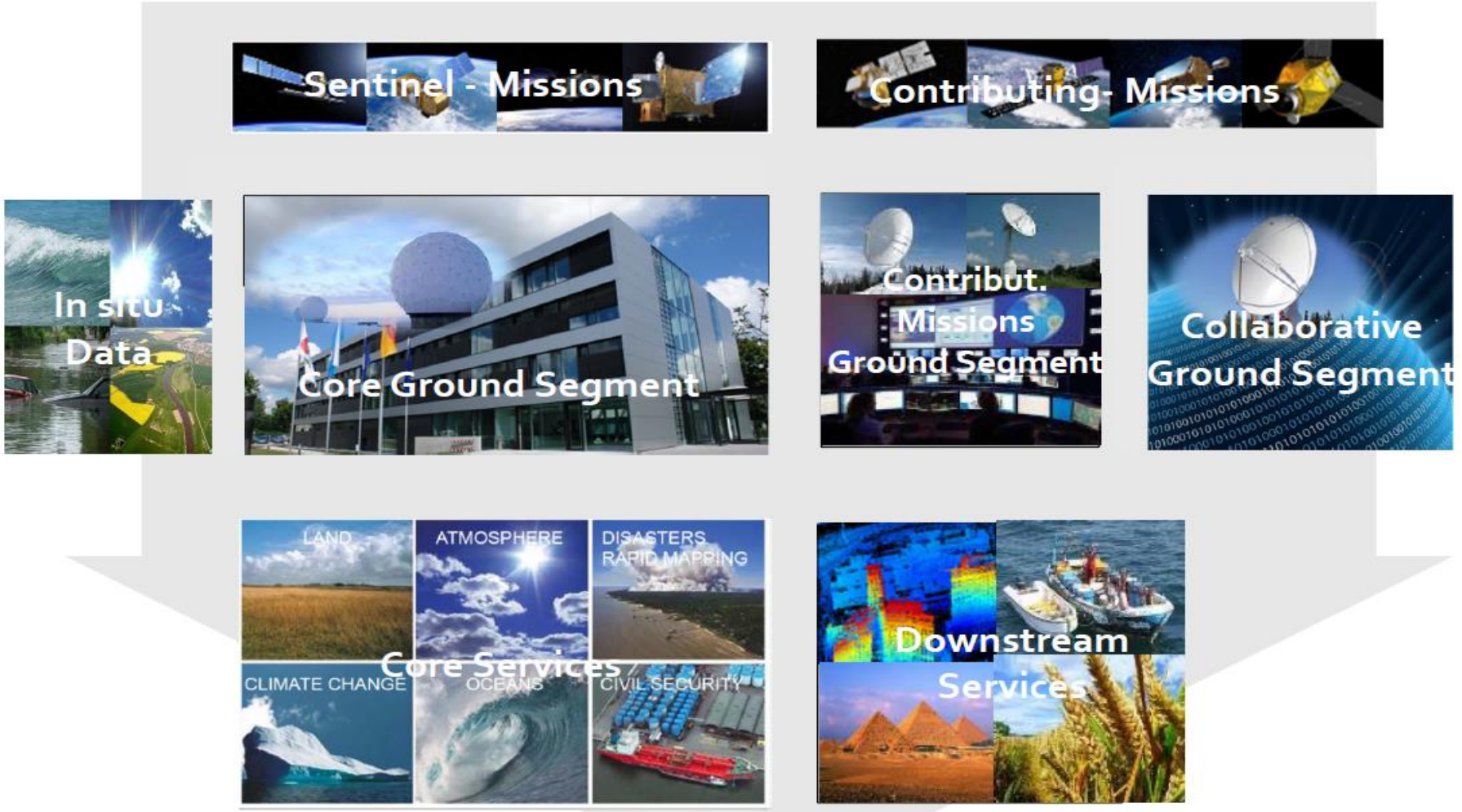


picture alliance/dpa

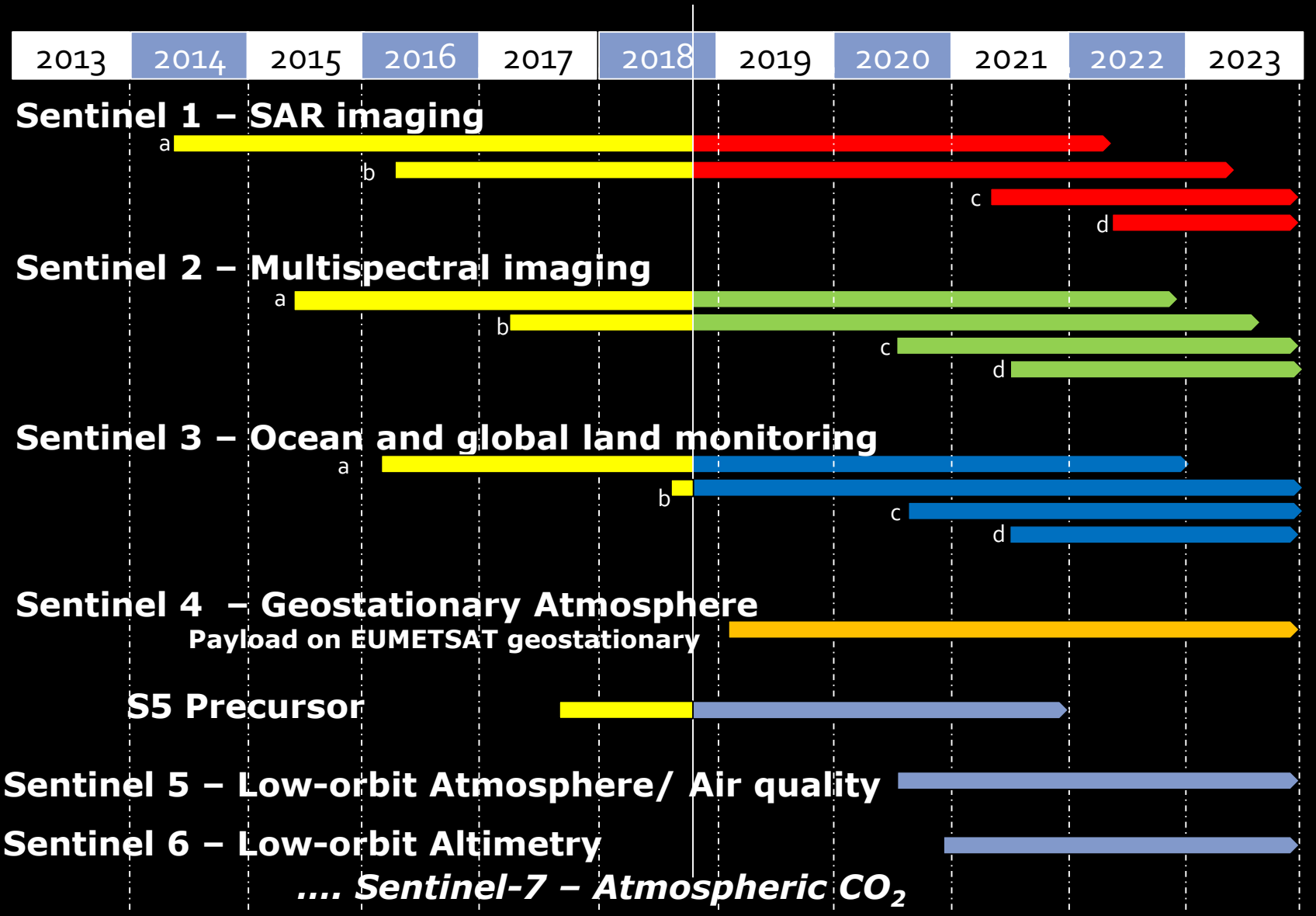
Copernicus

The European Earth Observation Programme

The Copernicus Programme



The Copernicus Sentinel Missions



Sentinel – 1 (A, B, ..)

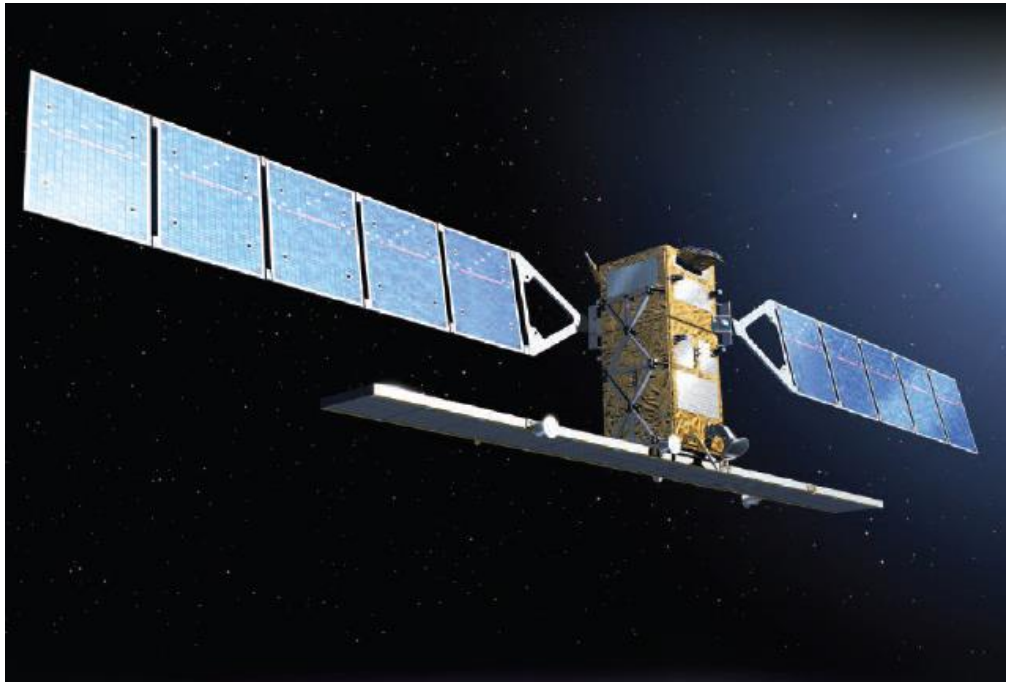
European polar orbiting radar observatory providing continuity of SAR data for operational applications.

Sentinel-1A launcher: Soyuz from Kourou

7 years lifetime (consumables for 12 years)

Sun-sync orbit at 693 km altitude; Inclination: 98.18º

C-Band SAR
Polarisation: VV+VH,HH+HV
Incidence angle: 20º - 45º

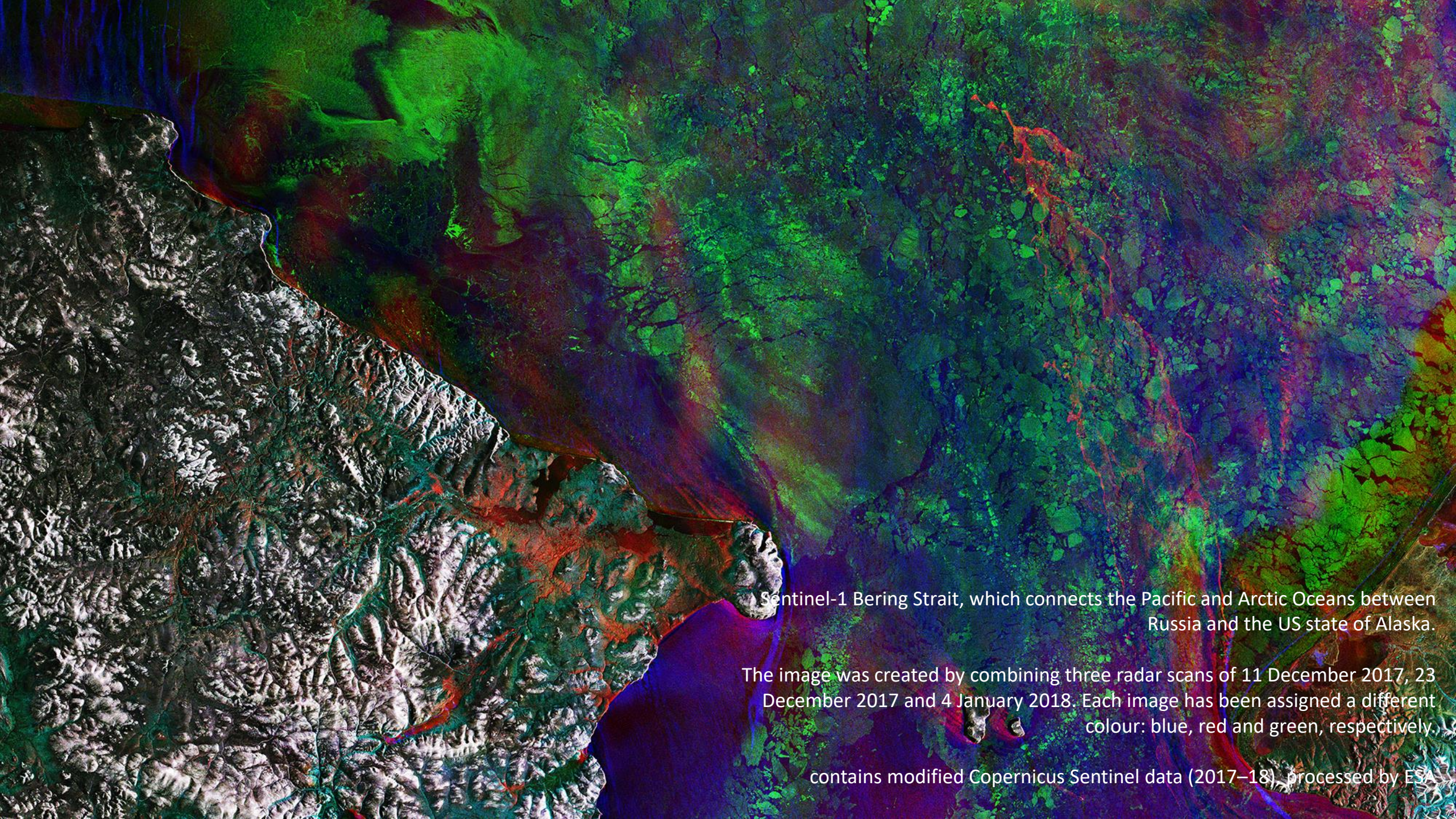


Strip Map: 80 km swath @ 5x5 m

Interferometric Wide-Swath: 250 km swath, 5x20 m; burst sync. for interferometry

Extra-Wide-Swath:400 km swath & 20x40 m

Wave; 5x5 m; leap-frog sampled images of 20x20 km at 100 km



Sentinel-1 Bering Strait, which connects the Pacific and Arctic Oceans between Russia and the US state of Alaska.

The image was created by combining three radar scans of 11 December 2017, 23 December 2017 and 4 January 2018. Each image has been assigned a different colour: blue, red and green, respectively.

Sentinel 2 (A, B, …)

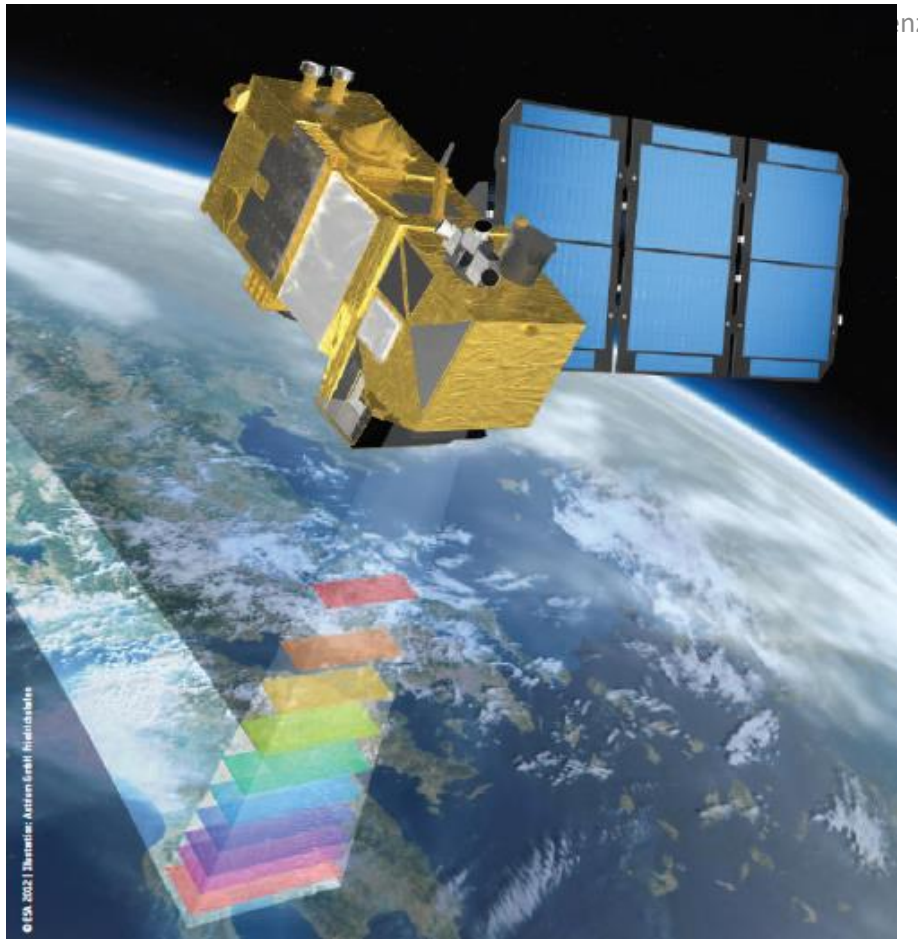
European wide-swath high-resolution super-spectral imaging mission designed for data continuity for operational land and security services.

7 years lifetime (consumables for 12 years)

Sun Synchronous Orbit at 786 km mean altitude

Mean Local Time at Descending Node: 10:30;

Global revisit time: 5 days with 2 satellites on the same orbit, 180o apart



MSI (Multi Spectral Instrument)
13 spectral bands: 443 nm– 2190 nm (including 3 bands for atm corrections)
Spectral resolution: 15 nm– 180 nm
Spatial resolution: 10 m, 20 m and 60 m
Swath: 290 km

The Copernicus Sentinel-2 mission takes us over part of the Yukon Delta in the US state of Alaska.
recorded on 29 August 2017

contains modified Copernicus Sentinel data (2017), processed by ESA

Sentinel 3 (A, B, …)

European global land and ocean monitoring mission. 2 day global coverage Earth observation data for sea and land applications.

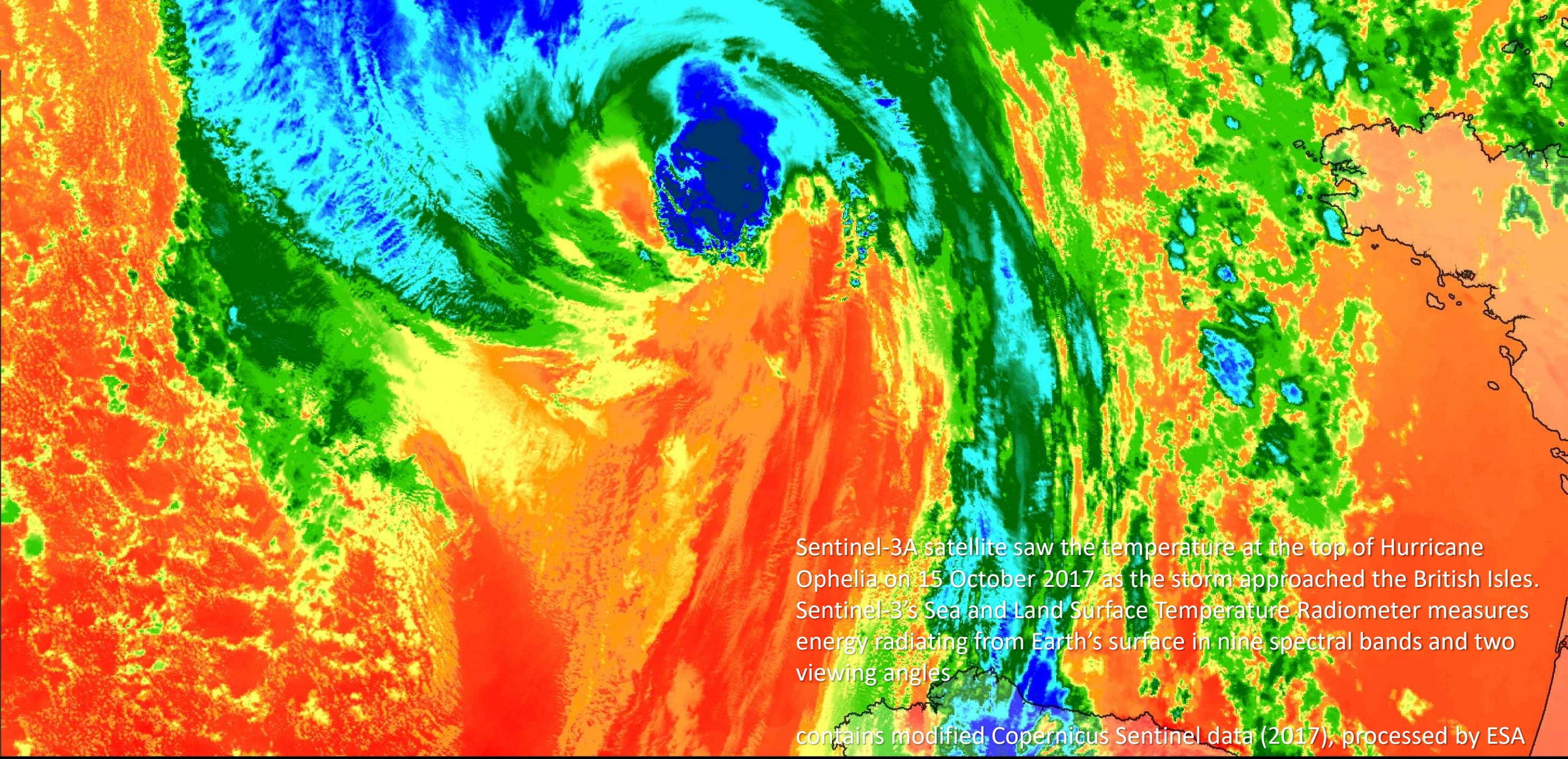
Rockot from Plesetsk; S3B: Vega from Kourou;
7 year lifetime (consumables for 12 years)

Sun-synchronous orbit @ 814.5 km over geoid

Mean LST: 10:00 at Desc Node;
Inclination 98.65o

27-days repeat cycle (14+7/27 orbits per day)

OLCI (Ocean and Land Colour Instrument)
Swath width: 1270 km; 5 tilted cameras
Spatial sampling: 300 m @ SSP
Spectrum: 21 bands [0.4-1.02] µm
SLSTR (Sea and Land Surface Temperature Radiometer)
Swath width: dual view scan, 1420 km/ 750 km
Spatial sampling: 500 m (VIS, SWIR), 1 km (MWIR, TIR)
Spectrum: 9 bands [0.55-12] µm
SRAL (Sentinel-3 Ku/C Radar Altimeter)
Radar measurement modes: LRM and SAR
MWR (MicroWave Radiometer)
dual 23.8/36.5 GHz
POD (Precise Orbit Determination)
GPS, LRR and DORIS


Sentinel-3A satellite saw the temperature at the top of Hurricane Ophelia on 15 October 2017 as the storm approached the British Isles. Sentinel-3's Sea and Land Surface Temperature Radiometer measures energy radiating from Earth's surface in nine spectral bands and two viewing angles
contains modified Copernicus Sentinel data (2017), processed by ESA
-50
-30
-10
0
15
Top of atmosphere
brightness temperature (°C)
250 km

Sentinel 5 (Precursor)

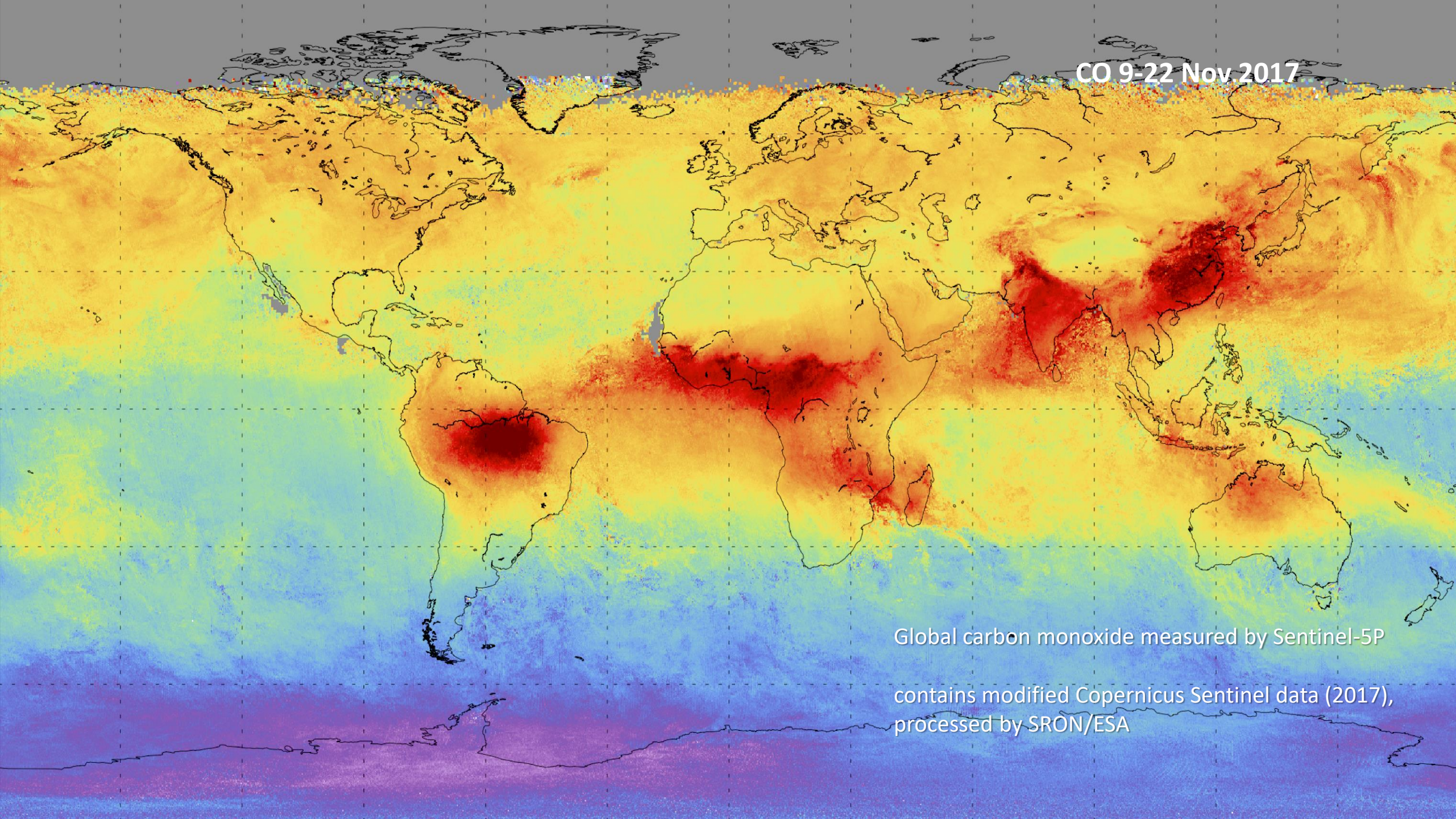
UV-VIS-NIR-SWIR spectrometer payload (with S-5 specifications), e.g. priority to spectral resolution, coverage, spatial sampling distance, signal-to-noise ratio and only high priority bands
Bridging the gap between Envisat/EOS Aura and Sentinel-5 (the latter expected to be launched in 2020)
Providing measurements of ozone, NO2, SO2, CO and aerosol.

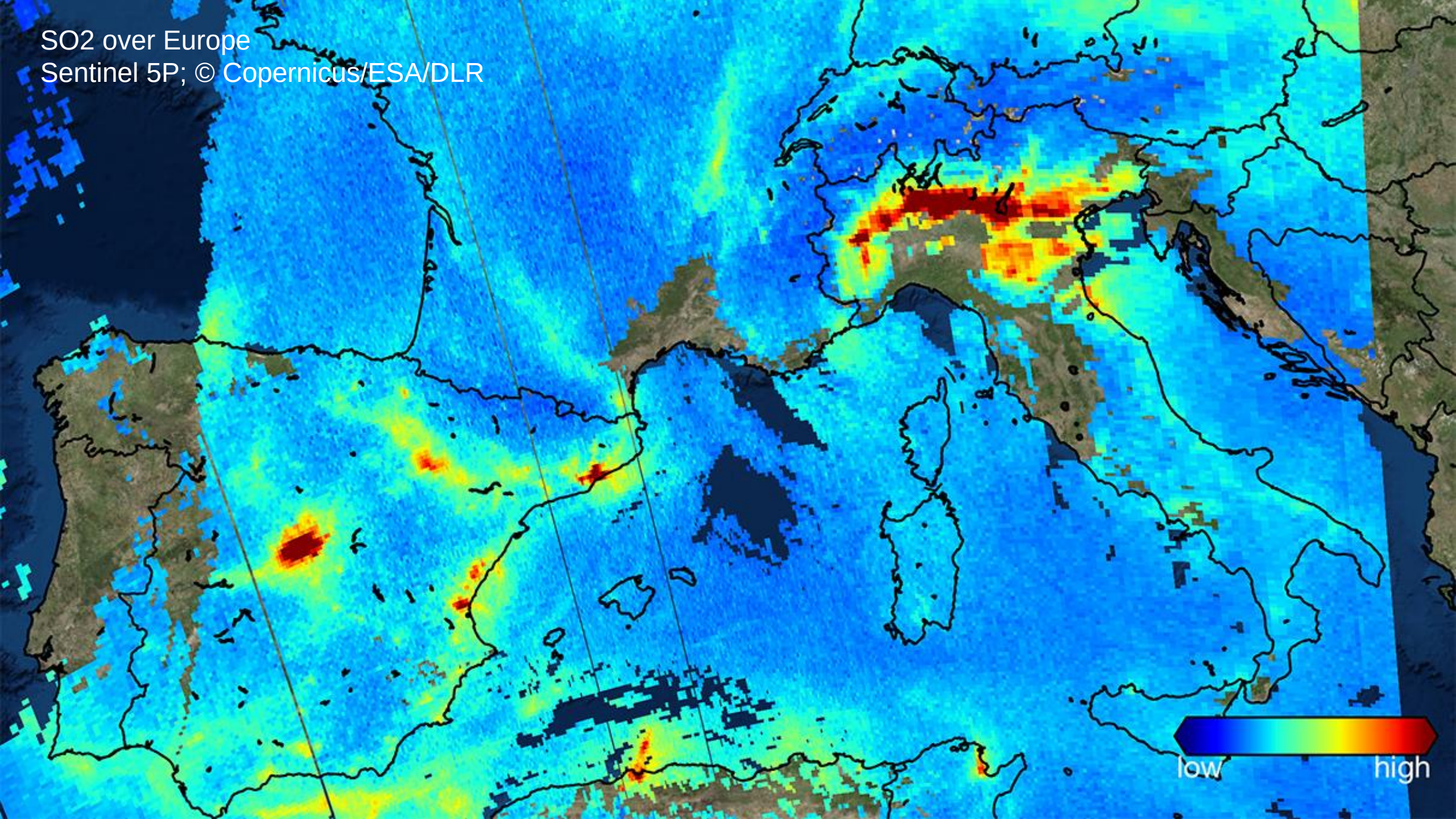
Lifetime: 7 years

Orbit: sun-sync, 824 km, 13:30 h LTAN

Inclination: 98.742 deg.

TROPOMI
UV-VIS-NIR-SWIR push-broom grating: Number of Channels: 4
Spectral Range: 270-495 nm, 710-775 nm, 2305-2385 nm
Spectral Resolution: 0.25-0.55 nm
Observation Mode: Nadir, global daily coverage
ground pixel 7x7 km^2


CO 9-22 Nov 2017
Global carbon monoxide measured by Sentinel-5P
contains modified Copernicus Sentinel data (2017),
processed by SRON/ESA

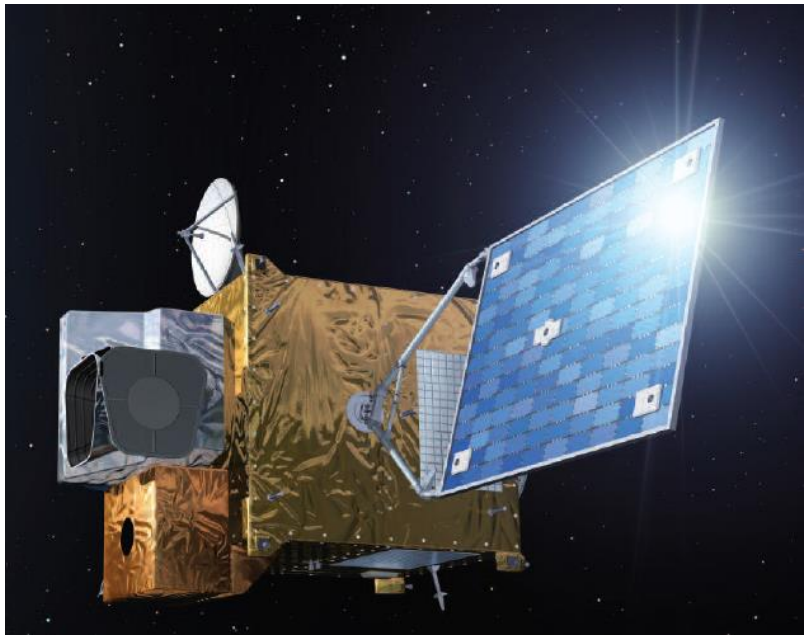

SO2 over Europe
Sentinel 5P; © Copernicus/ESA/DLR
low
high

Sentinel 4

Covers the needs for continuous monitoring of the atmospheric chemistry from the geostationary orbit. The main data products will be O3, NO2, SO2, HCHO and aerosol optical depth, generated with high temporal resolution (~ 1 hour).

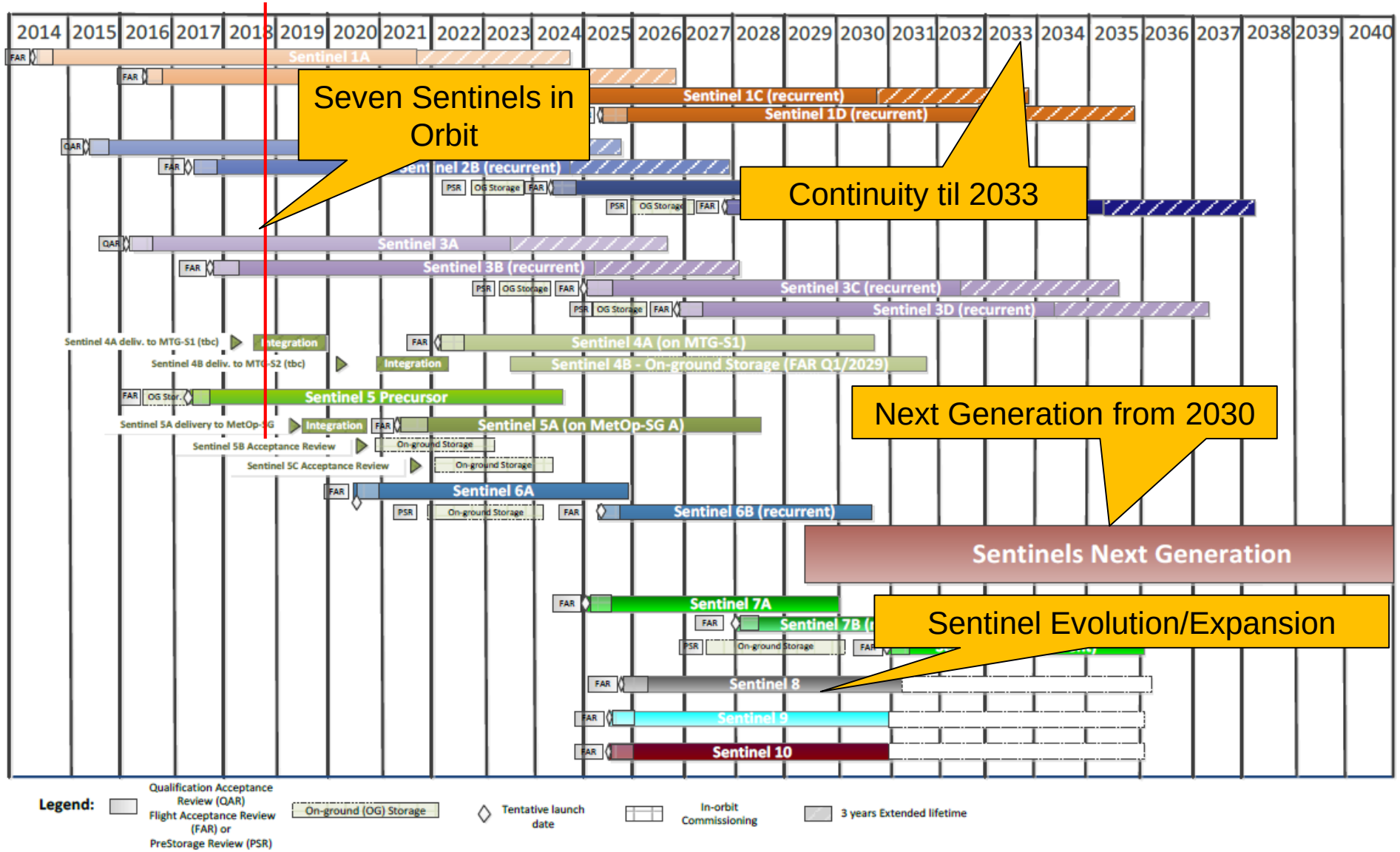
The UVN instrument will be embarked on the Meteosat Third Generation (MTG) – Sounder satellite. Coverage is achieved by scanning with a fast repeat cycle over Europe and North Africa (Sahara) of 60 minutes (goal 30 minutes).

To be launched with MTG-S1 and MTG-S2.



UVN instrument:
high resolution spectrometer covering
ultraviolet (305-400 nm)
visible (400-500 nm)
near-infrared (750-775 nm) bands.
spatial sampling: 8 km
spectral resolution between 0.12 nm and 0.5 nm (depending on the band).

Sentinels next generation



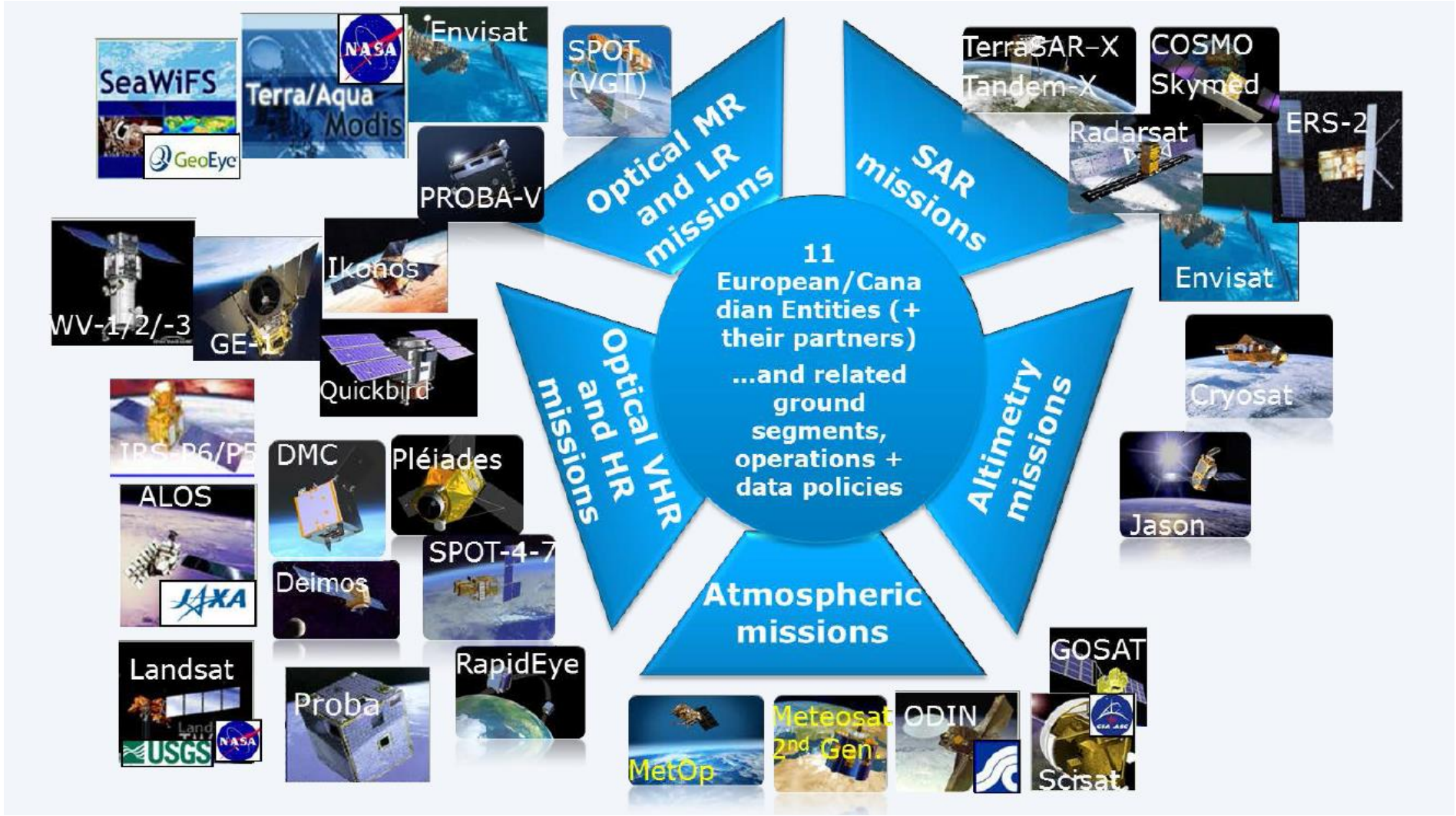
Sentinel Evolutions (from 2025 onwards)

Potential new Sentinel	Objective
Sentinel-7	multi-satellite mission to measure the anthropogenic contribution to the CO_2 cycle
Sentinel-8	Observations at high spatio-temporal resolution in the thermal infrared region of the optical spectrum in order to complement and expand the current Sentinel-2 measurements
Sentinel-9	New measurements on critical parameters of interest for the polar regions, such as sea ice/floating ice concentrations and surface elevation
Sentinel-10	Optical observations with hyper-spectral imaging capabilities to expand the current Sentinel-2 measurements

Sentinel Data Policy = FREE and OPEN access

- **EU Delegated Act** on Copernicus Data and Information Policy has been published in the EU's Official Journal on 19 November 2013. Approved by PB-EO on 24/25 Sep 2013. Main principles of Sentinel data policy:
  - **Open** access to Sentinel data by anybody and for any use
  - **Free** of charge data licenses
  - **Restrictions possible** due to technical limitations or security constraints
- All Sentinel data is available to **anybody** (worldwide) **at no costs**
- Same for all Copernicus **Core Service** Products
- "Restricted" free access to EC purchased data from **contributing missions**

Copernicus Contributing Missions – not just Sentinels

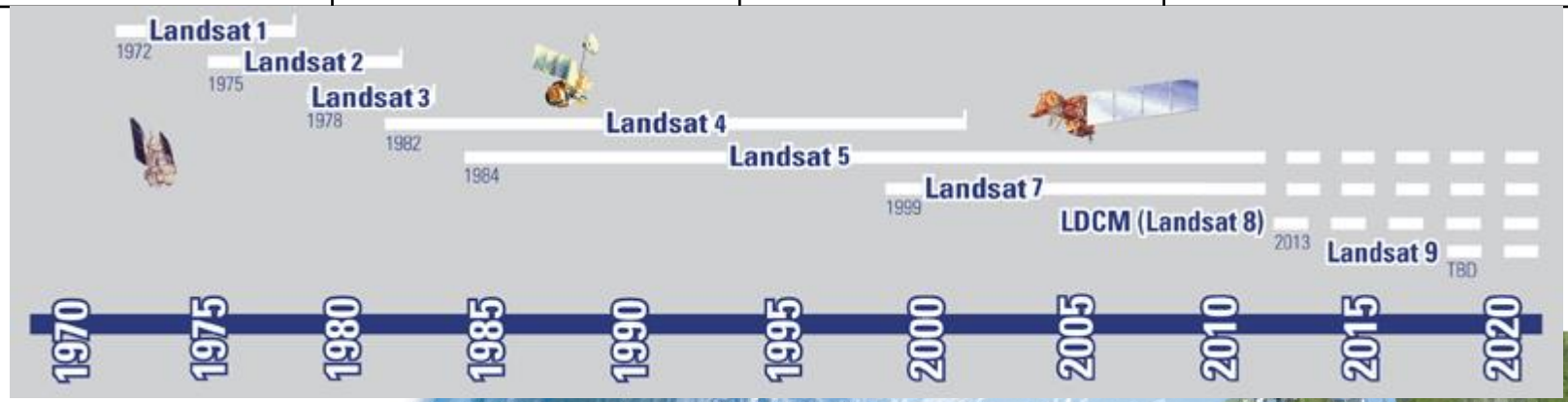


From ESA Presentation 2016


Landsat 8 OLI
Resolution: 30 metres
Acq. Date: 18 May 2014

Landsat Series overview

	LANDSAT 4,5 (1-3)	LANDSAT 4,5	LANDSAT 7	LANDSAT 8
Abtast-System	Multispectral Scanner(MSS)	Thematic Mapper(TM)	Enhanced ThematicMapper Plus (ETM+)	Operational Land Imager (OLI) und Thermal Infrared Sensor (TIRS)
Betrieb	seit 1972	seit 1982	seit 1999	seit 2013
Pixelgröße	79 x 79 m	30 x 30 m	30 x 30 m	30 x 30 m
Spektralkanäle	1 (4) 0,50 - 0,60 µm, Grün2 (5) 0,60 - 0,70 µm, Rot 3 (6) 0,70 - 0,80 µm, nahes Infrarot 4 (7) 0,80 - 1,10 µm, nahes Infrarot	1 0,45 - 0,52 µm, Blau-Grün2 0,52 - 0,60 µm, Grün 3 0,63 - 0,69 µm, Rot 4 0,76 - 0,90 µm, nahes Infrarot 5 1,55 - 1,75 µm, mittleres Infrarot 7 2,08 - 2,35 µm , mittleres Infrarot	1 0,45 - 0,52 µm, Blau-Grün2 0,53 - 0,61 µm, Grün 3 0,63 - 0,69 µm, Rot 4 0,78 - 0,90 µm, nahes Infrarot 5 1,55 - 1,75 µm, mittleres Infrarot 7 2,09 - 2,35 µm , mittleres Infrarot	1 0,433 – 0,453 µm, Küste und Aerosol2 0,450 – 0,515 µm, Blau 3 0,525 – 0,600 µm, Grün 4 0,630 – 0,680 µm, Rot 5 0,845 – 0,885 µm, nahes Infrarot 6 1,560 – 1,660 µm, mittleres Infrarot 7 2,100 – 2,300 µm, mittleres Infrarot 9 1,360 – 1,390 µm, Cirrus
Thermalkanal		6 10,4 - 12,5 µm (120 x 120 m)	6 10,4 - 12,5 µm (60 x 60 m)	10 10,30 – 11,30 µm (100 x 100 m)11 11,50 – 12,50 µm (100 x 100 m)
Panchromatischer Kanal			8 0,52 - 0,90 µm (15 x 15 m)	8 0,500 – 0,680 µm (15 x 15 m)



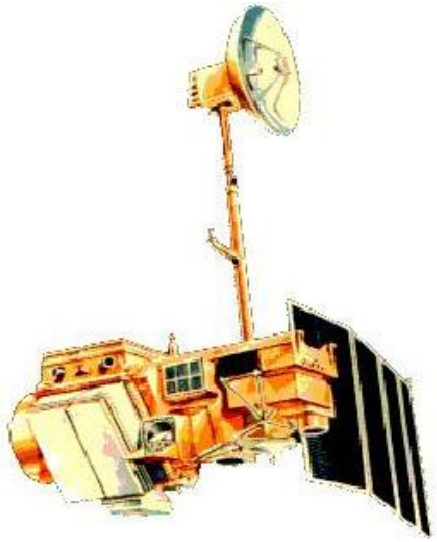
Landsat 5 World Record

For the record

Who: Landsat 5

What: Longest-operating Earth observation satellite

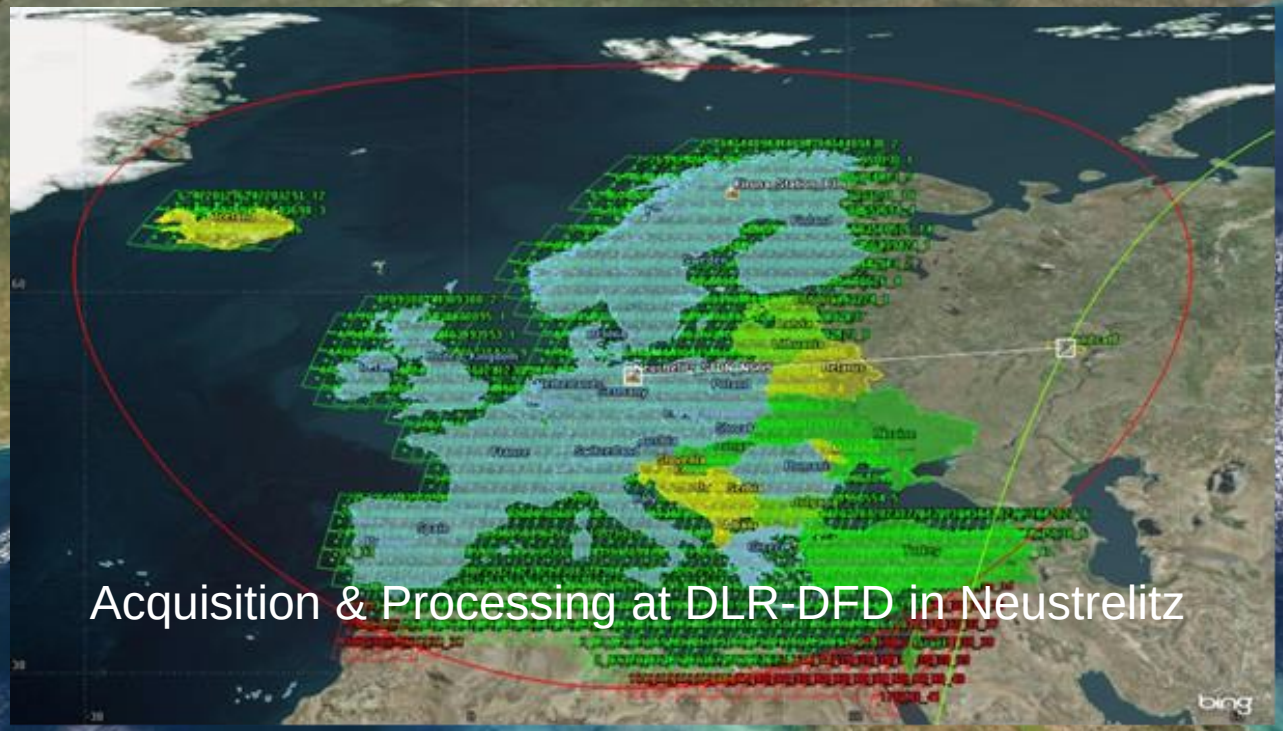
When: 01 Jan 2013



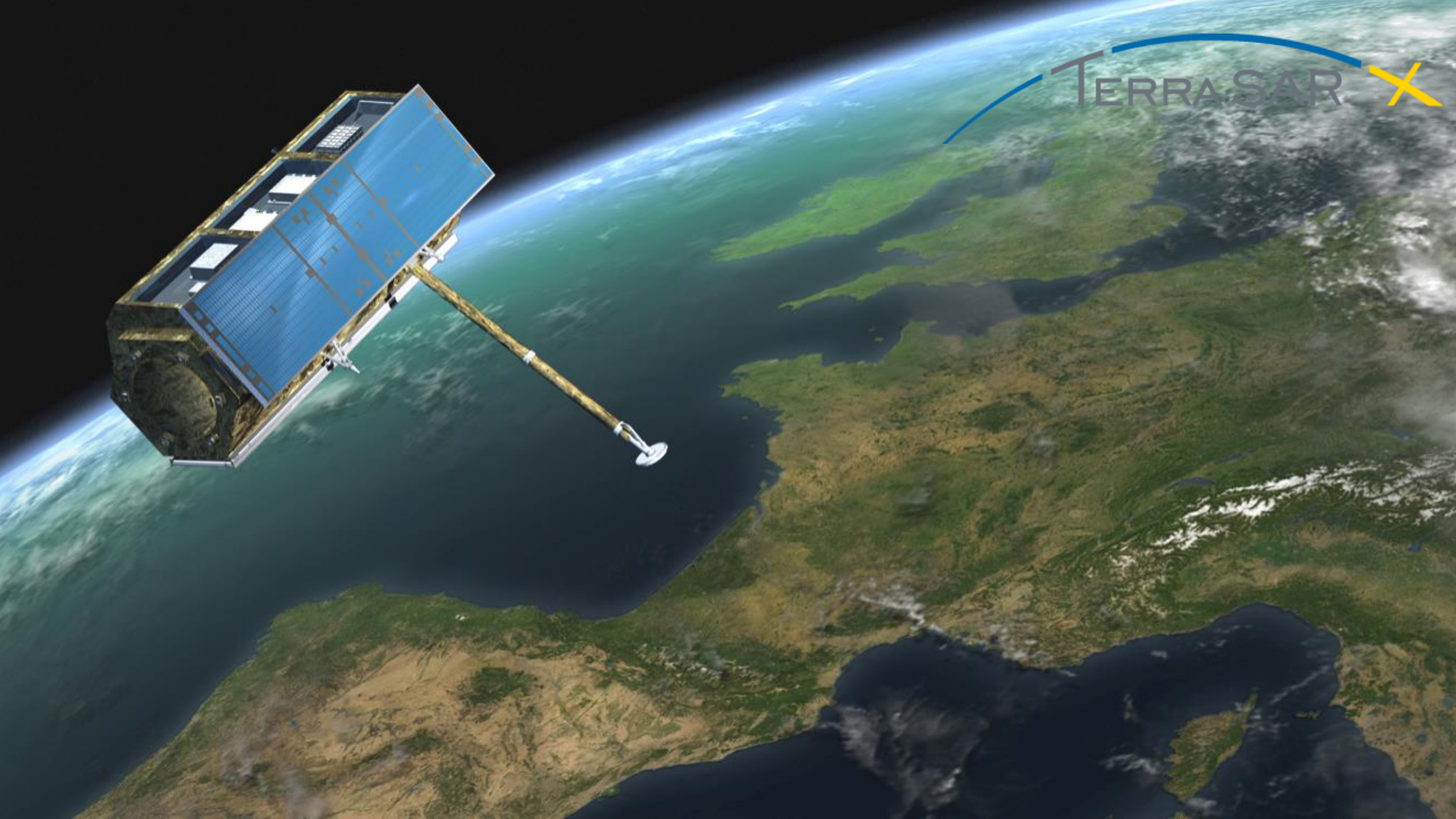
Landsat 5, which will be retired in the next few months*), launched on March 1, 1984 and has long outlived its initial three-year mission. The satellite has circled Earth more than 150,000 times during its nearly 29 years in space, and has snapped more than 2.5 million images of the planet's surface along the way.

*) June 5th, 2013

Landsat 8
Launched; Feb 11, 2013

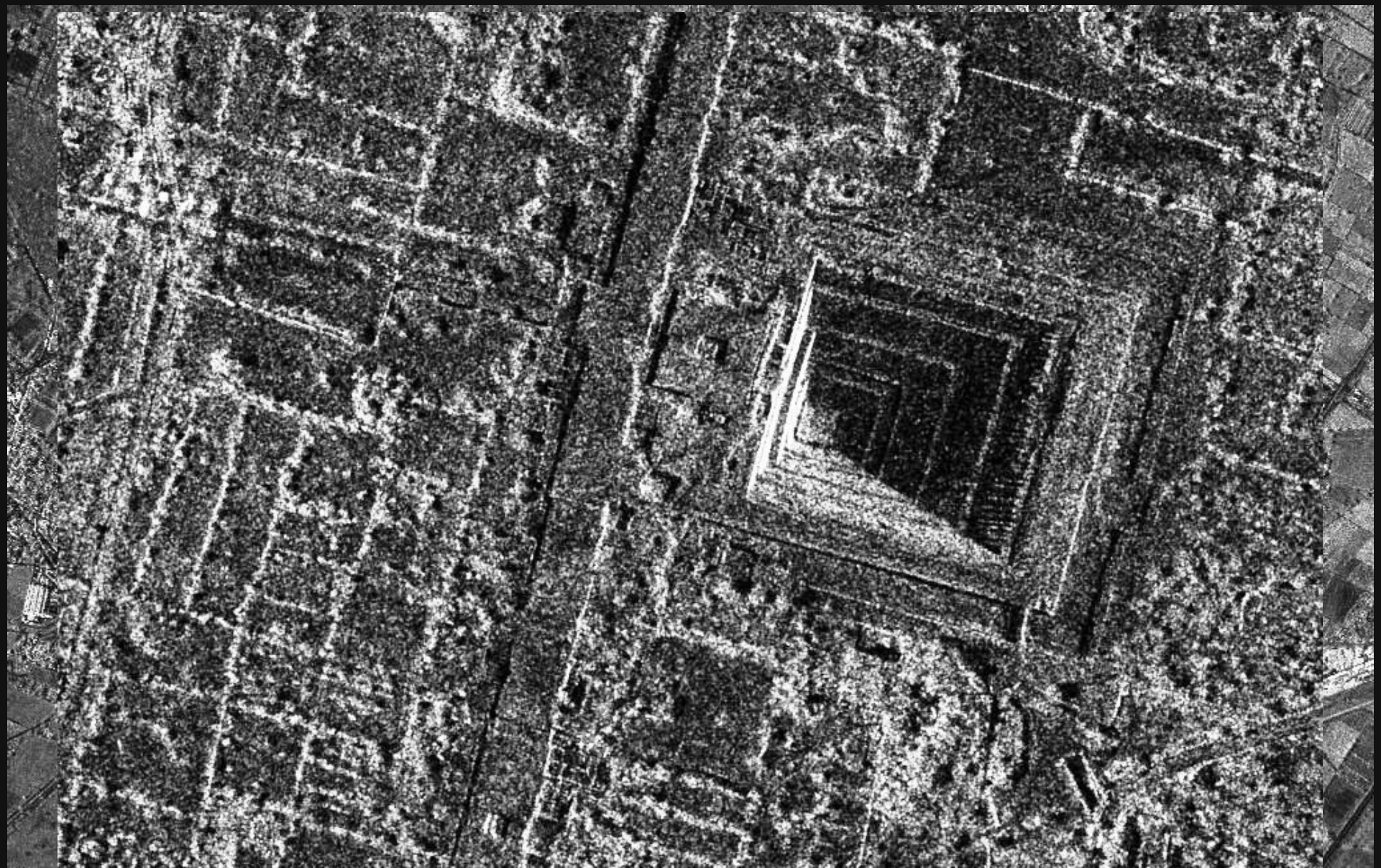


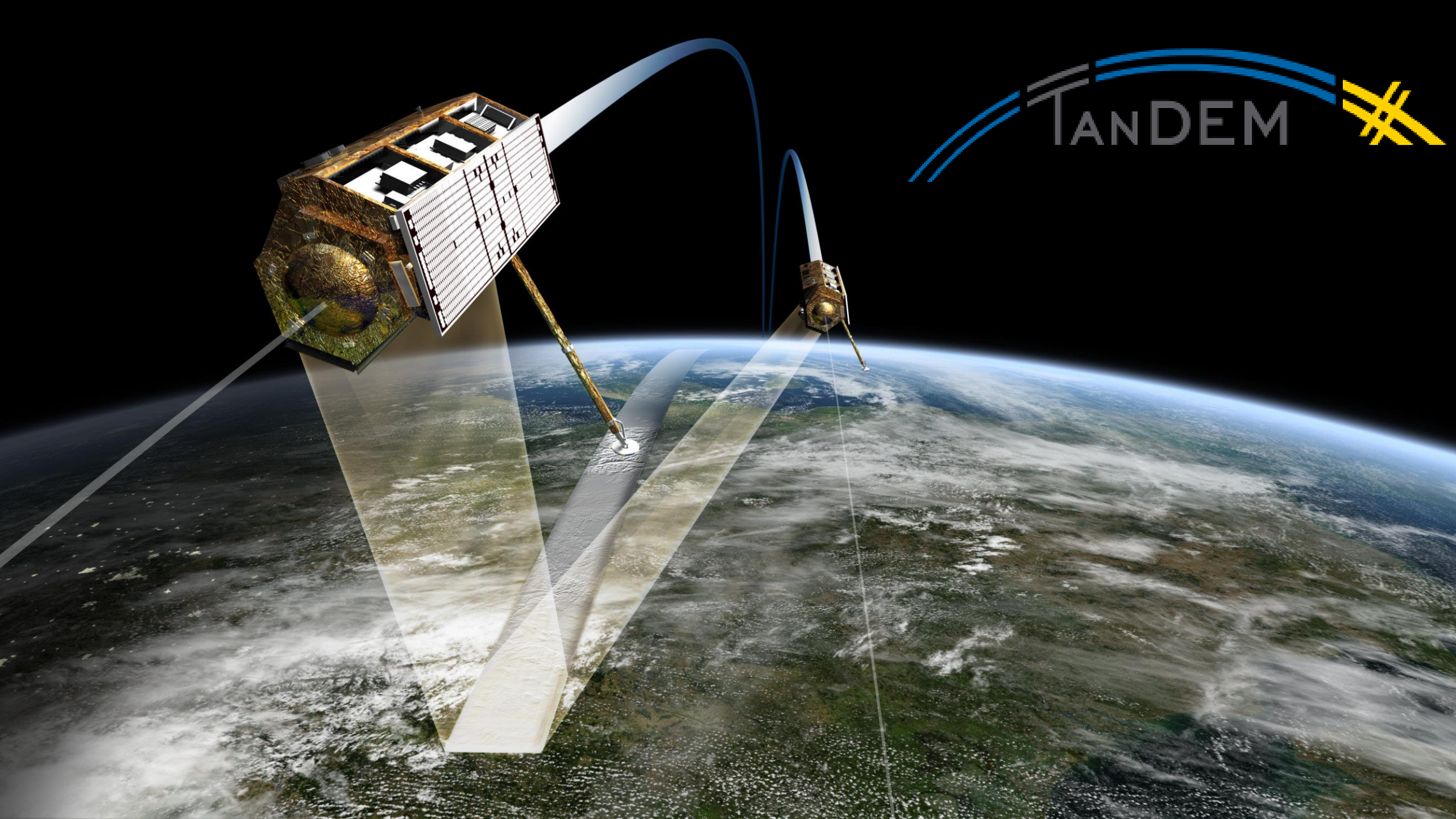
Acquisition & Processing at DLR-DFD in Neustrelitz


TERRASAR X

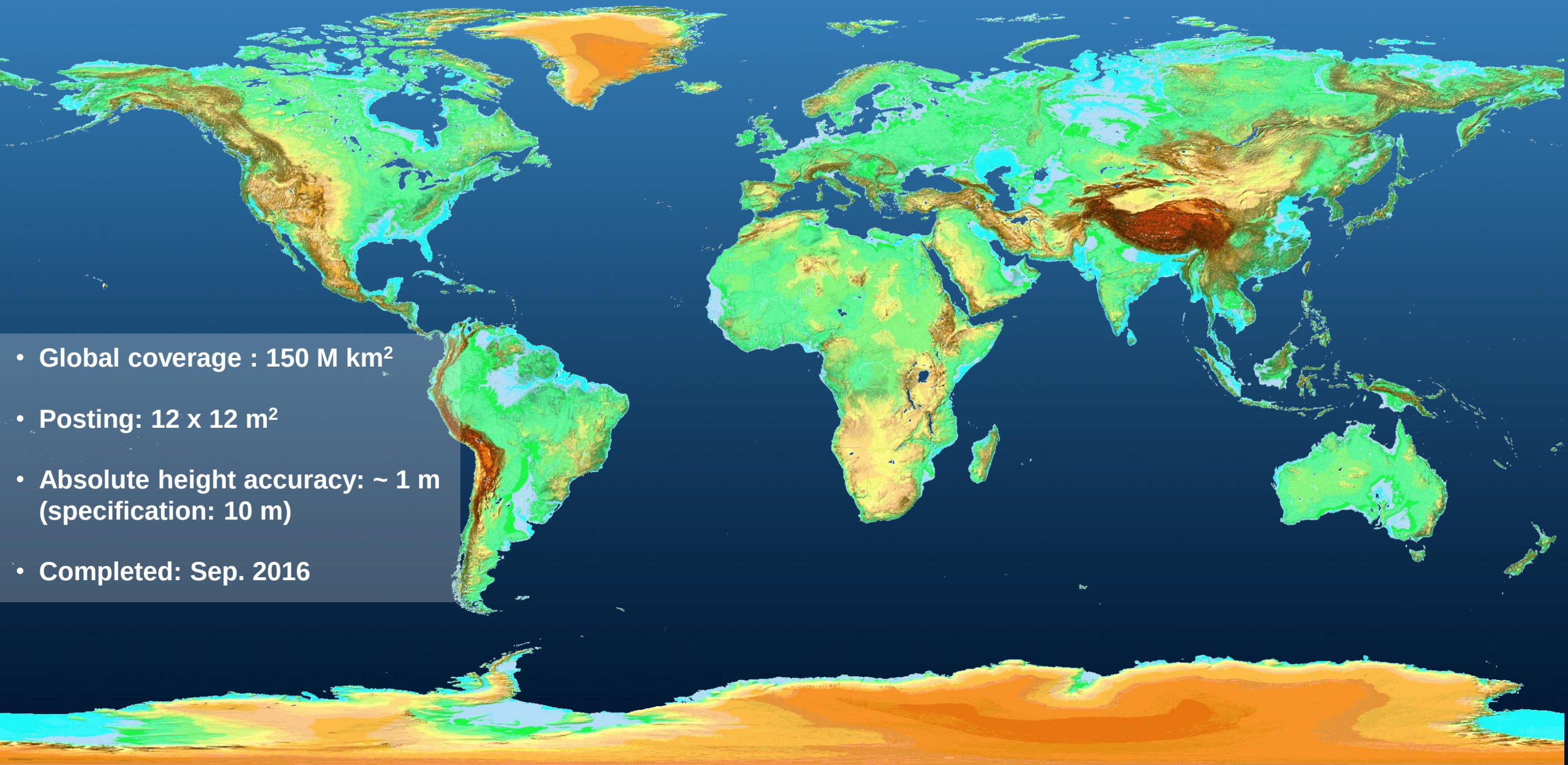
TerraSAR-X multitemporal Spotlight Image: Gizeh, Egypt

TerraSAR-X Spotlight Image: Teotihuacán, Mexico
January 20, 2008




TanDEM

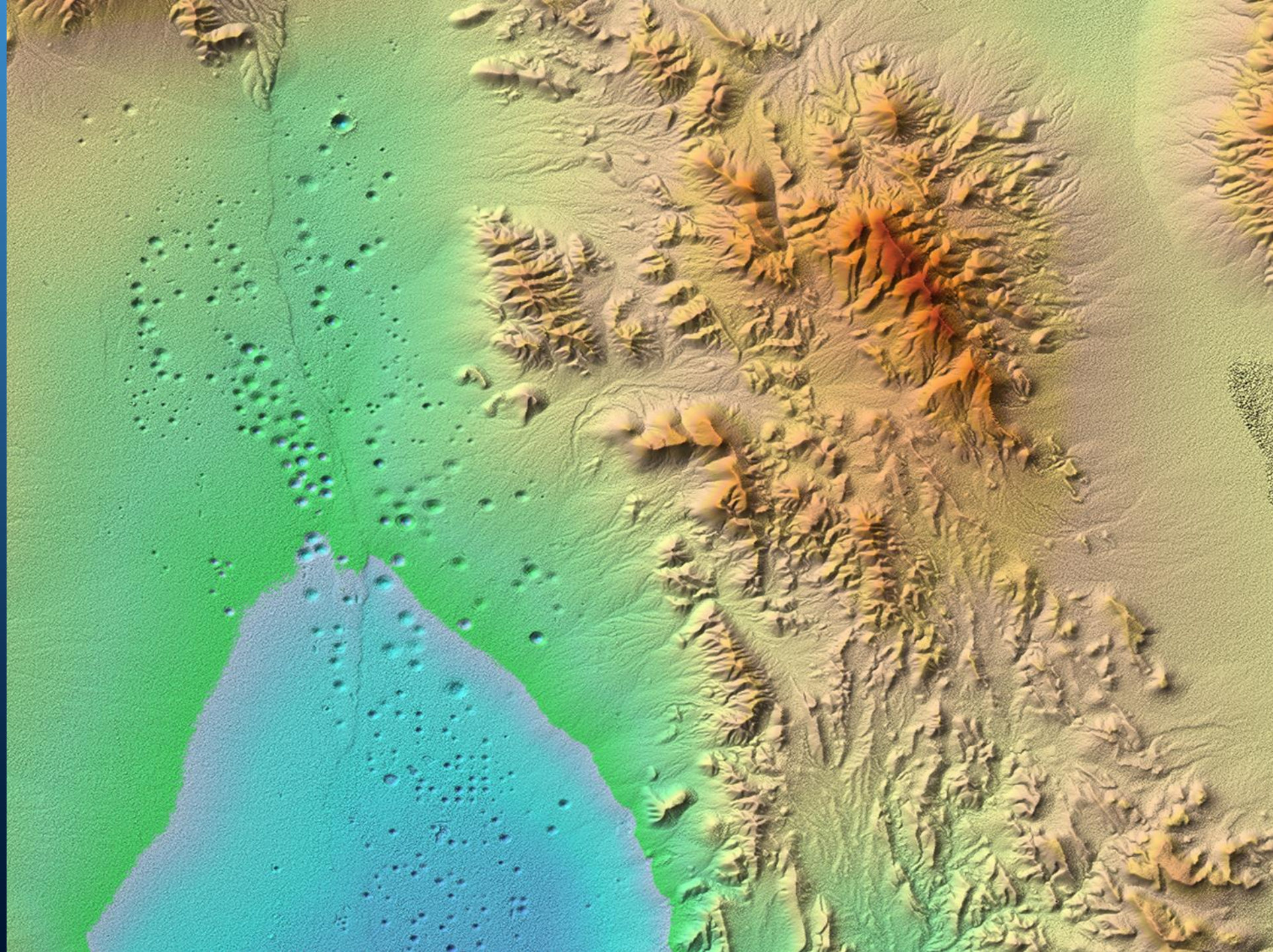
The Global TanDEM-X DEM



- Global coverage : 150 M km^2
- Posting: 12 x 12 m^2
- Absolute height accuracy: ~ 1 m (specification: 10 m)
- Completed: Sep. 2016

TanDEM-X Elevation Model

Nuclear Test Site
Nevada, USA



The DigitalGlobe/ MAXAR WorldView Constellation

2000 2010 2016 2020 2030

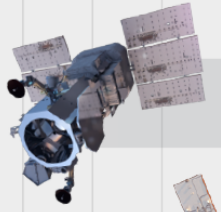
IKONOS

QUICKBIRD

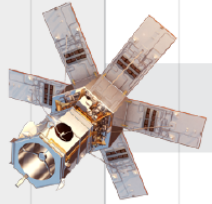
WORLDVIEW-1

GEOEYE-1

WORLDVIEW-2



WORLDVIEW-3



WORLDVIEW-4

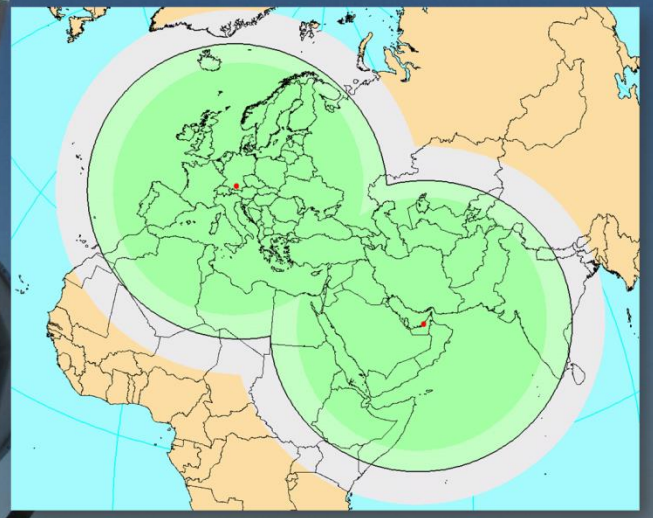
IMAGERY IN ARCHIVE

FUTURE COLLECTION*

Over 10 years partnership DLR – European Space Imaging & Space Imaging Middle East

Station and logistics operations from Oberpfaffenhofen for:

- GeoEye-1
- WorldView-1
- WorldView-2
- WorldView-3
- WorldView-4



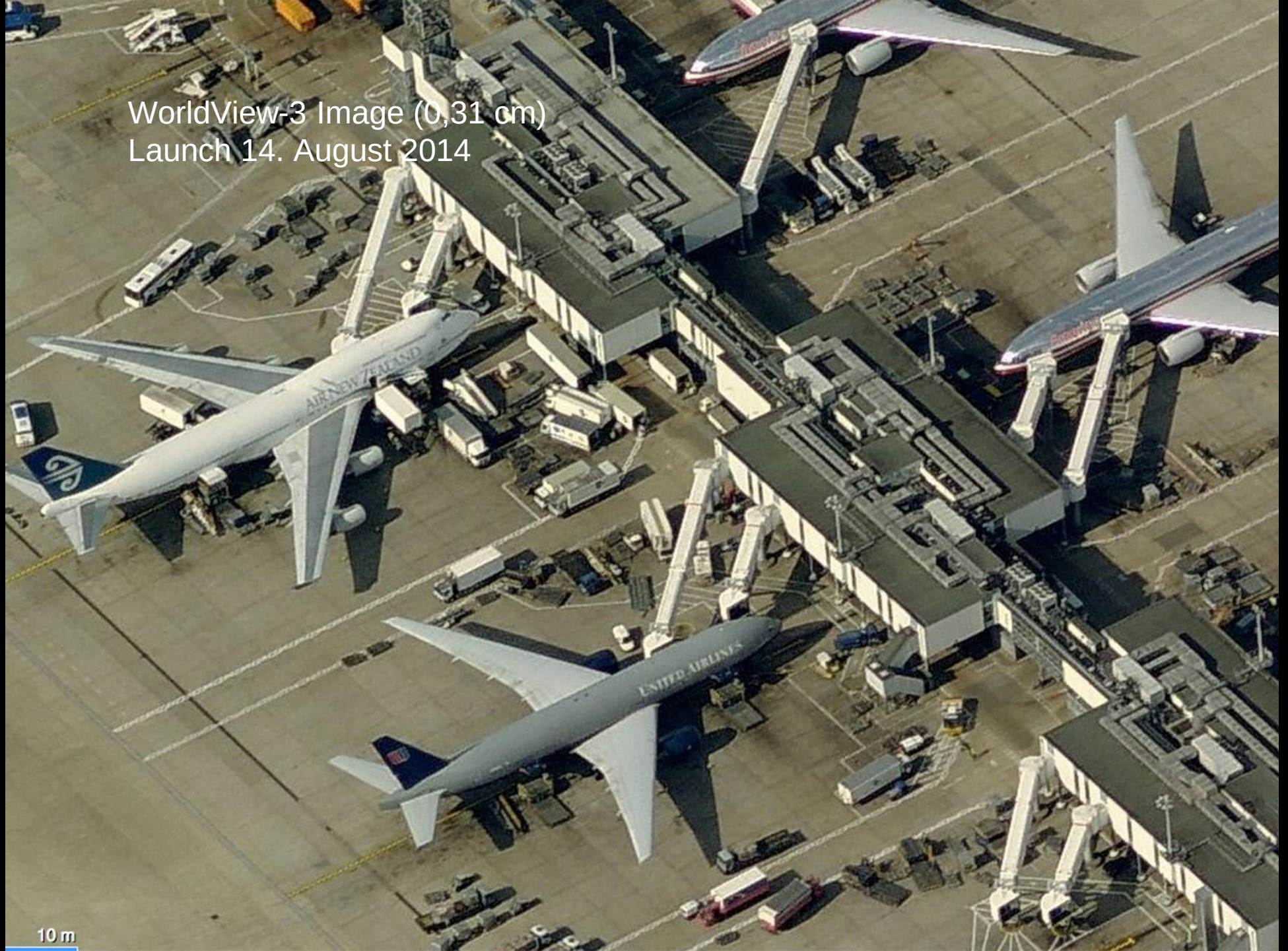
Partnership in:

- Image analysis
- Emergency and crisis services

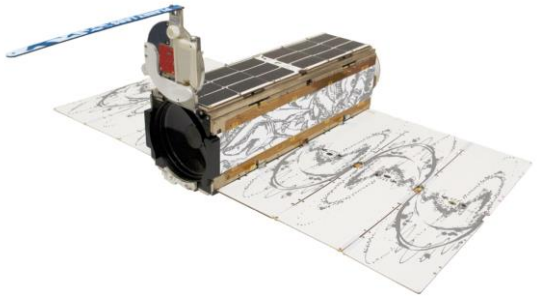
EUROPEAN SPACE IMAGING®

DLR/EUSI X-Band Antenna in Oberpfaffenhofen, Germany

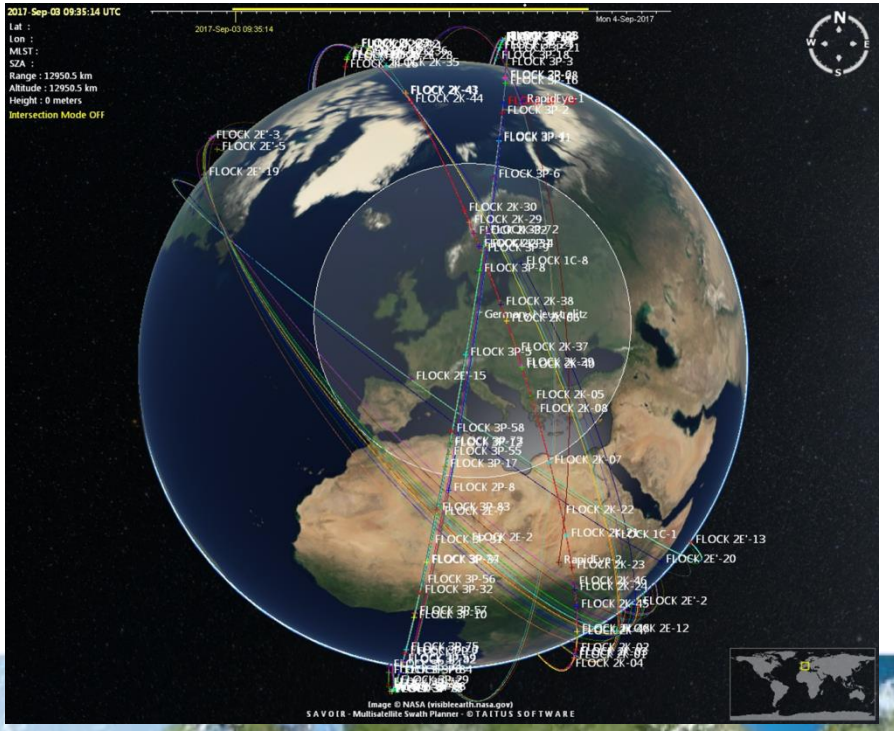

Area : Airport - Madrid, Spain
Sensor : WorldView-3
Acquisition Date : August 21, 2014
Resolution (GSD): 40cm


WorldView-3 Image (0,31 cm)
Launch 14. August 2014
AIR NEW ZEALAND
UNITED AIRLINES
10 m

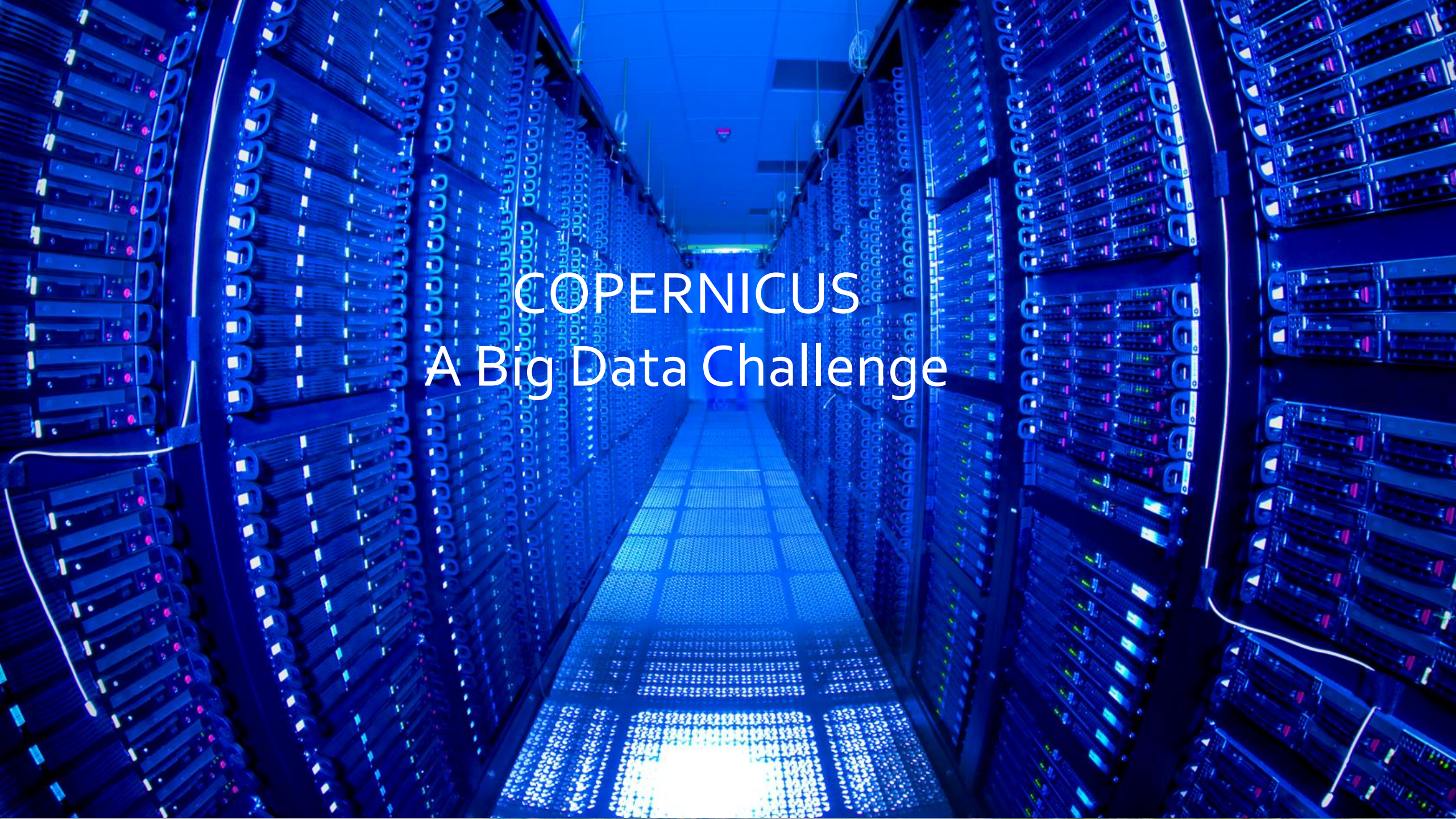
Doves - Planet



- **Owner**
  - Planet, USA (founded 2010)
  - Venture Capital 183mioUS$ (Oct 2015)
- **Constellation**
  - Multiple of 3U cubsats: doves
  - > 200 doves launched (~ 100 still active)
  - (multiple) daily global coverage
- **Lauch**
  - Various, piggy pack to ISS supply and other launchers
- **Prime Instrument**
  - Optical red, green, blue @ 12 bit
  - 3-5 m res.




planet.


COPERNICUS
A Big Data Challenge

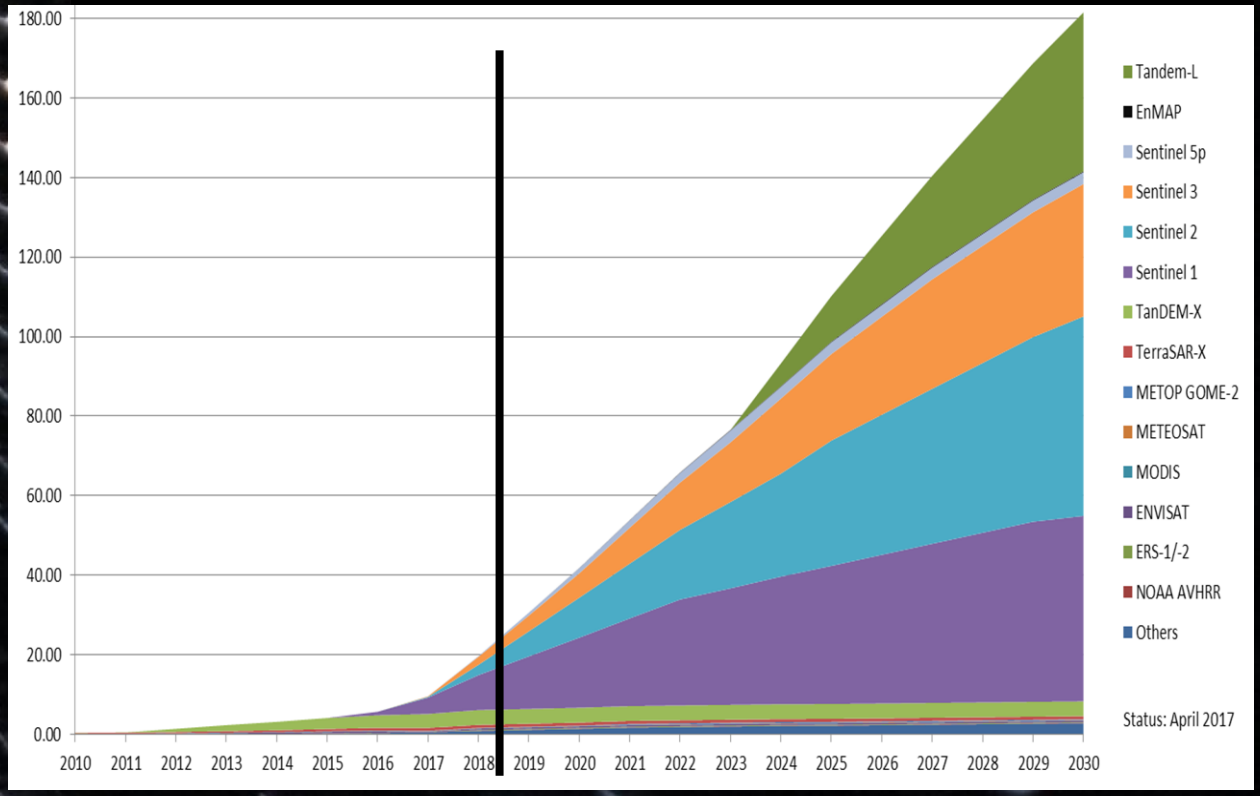
EO-Data Access and Processing

Sentinel PAC Archive

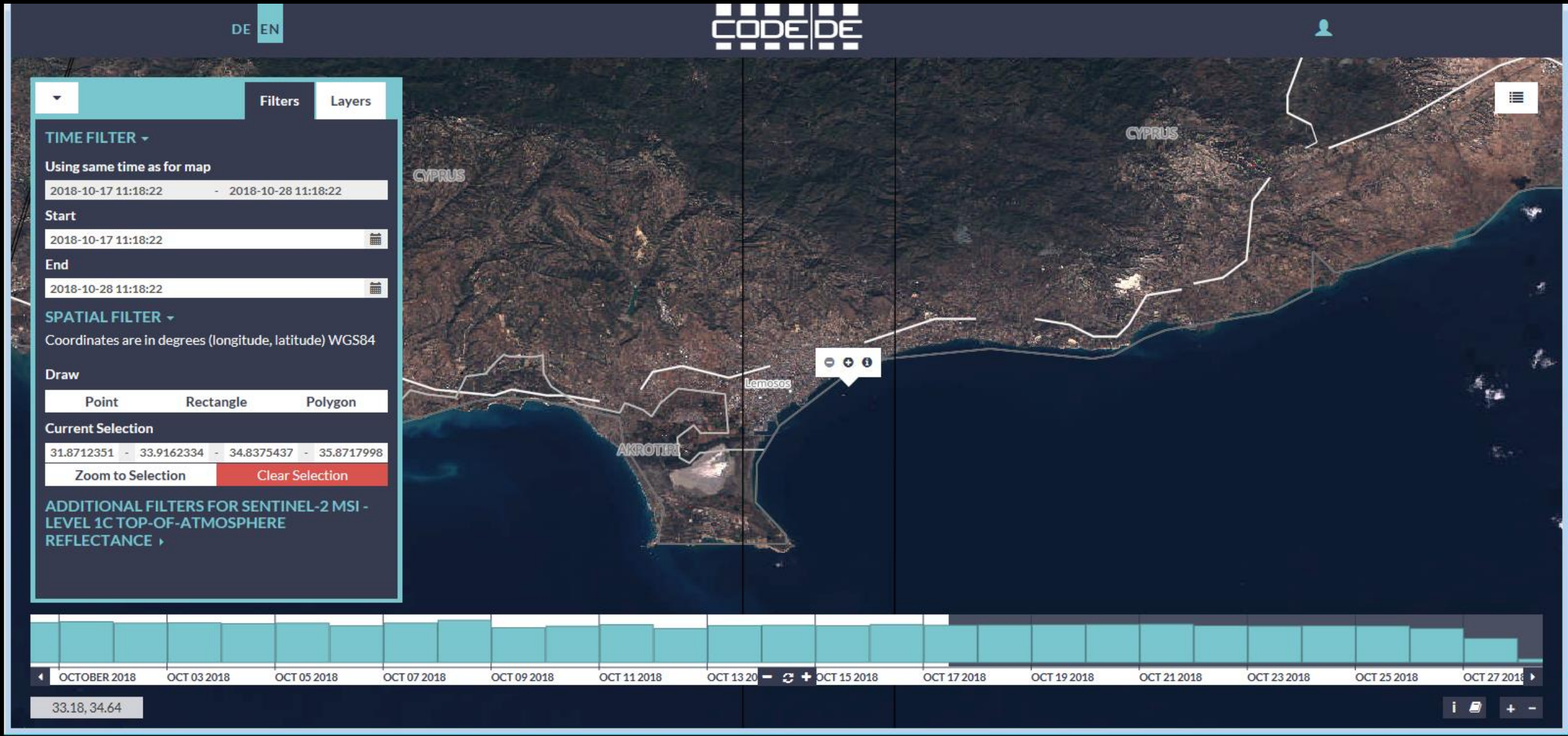
50 (+33) PetaByte storage capacity
Based on current LTO tape technology

Separated locations:
Oberpaffenhofen & Neustrelitz

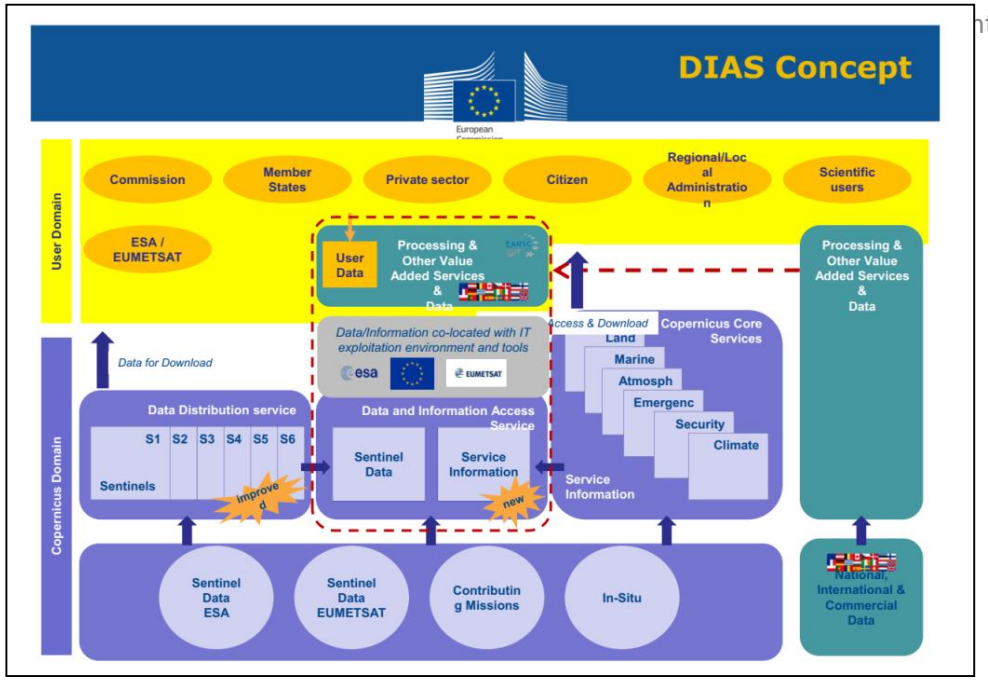
- Feb 2016: 1 PB of S1a data after 14 months of operations (> than entire 10yrs of ENVISAT ASAR)
- Feb 2018: ~ 7 PB on S1a/b and S3 OLCI data

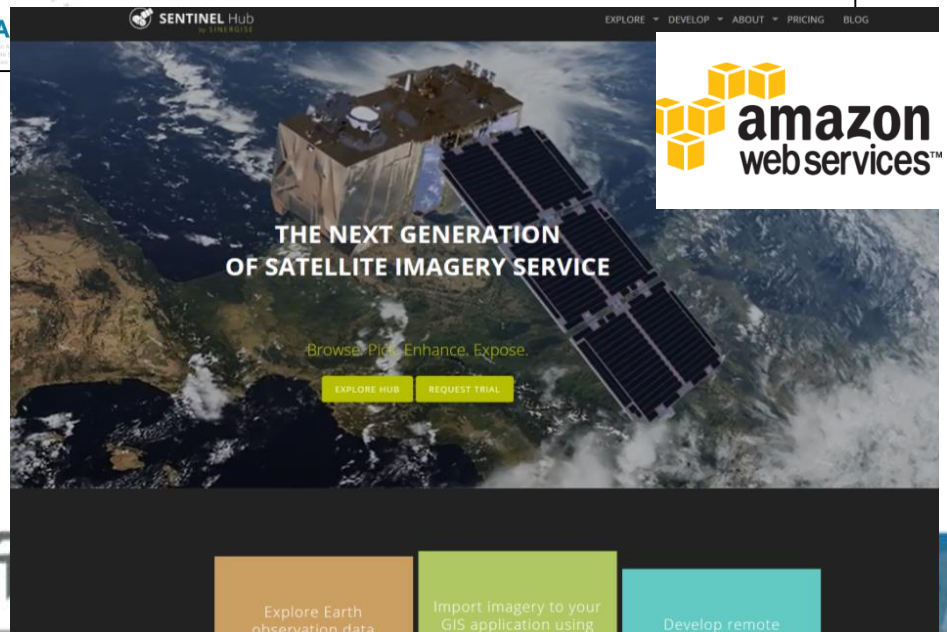


CODE-DE: Search for most recent Sentinel-2 over Cyprus (www.code-de.org)



… a variety of systems





amazon web services™

Copernicus Services

The European Earth Observation Programme

Atmosphere
(CAMS)

Marine Environment
(CMEMS)

Land
(CLMS)

Climate Change
(C3S)

Emergency Management
(EMS)

Security

DLR Earth Observation Center:

Center for Satellite-based Crisis Information - ZKI

- Development of Copernicus Core „Emergency Mapping Service“
- National duties under Federal Ministery of Interior
- 24/7 staff availability
- Pooling DLR Earth Observation expertise in georisks and sensor technologies
- Member of the „ International Charter on Space and Major Disasters“

International Charter „Space and Major Disasters“

DLR-ZKI in Charter in 2017

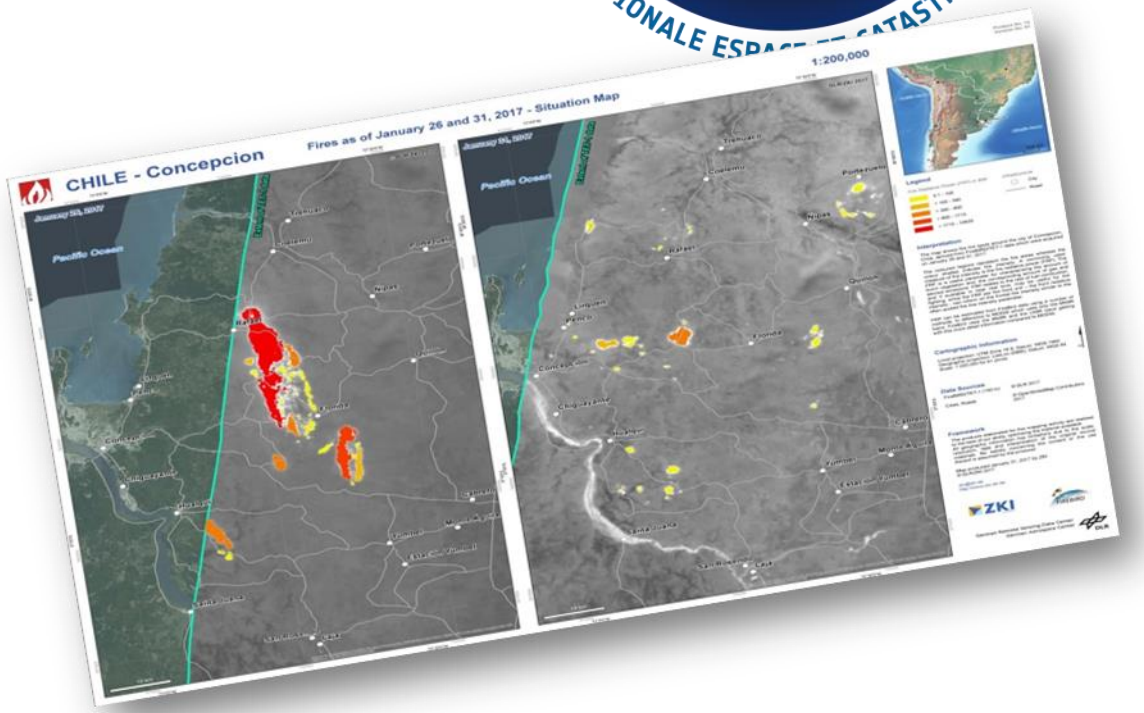
33 Charter activations in 2017

352 Data sets delivered

- **124** TerraSAR-X data,
  (30 pre-disaster, 94 post-disaster)
- **228** RapidEye data,
  (82 pre-disaster, 146 post-disaster)

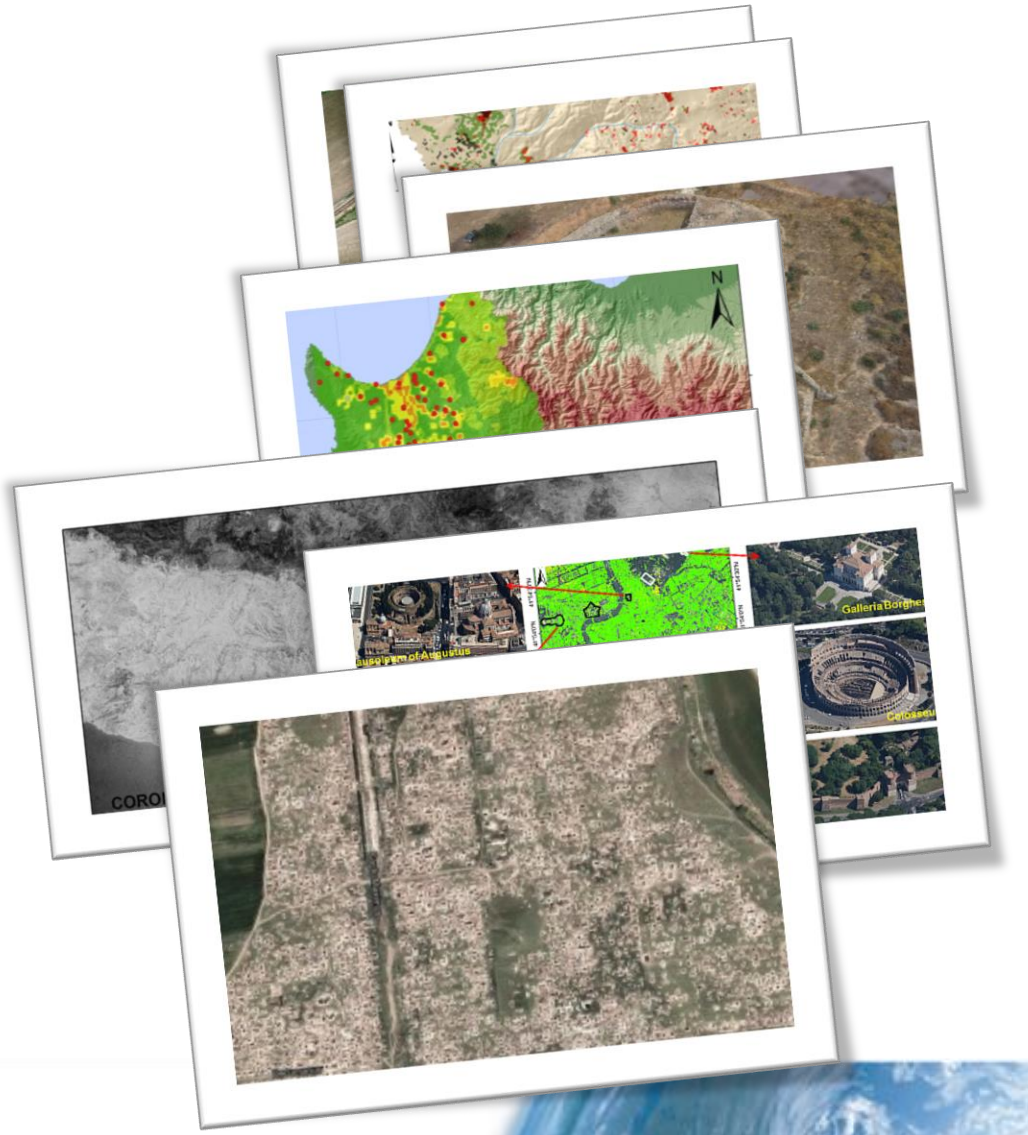
5x „Emergency On-Call Officer“ (ECO)

1x „Project Manager (PM)



Palmyra – Temple of Bel: destroyed by IS (30.08.2015)

H2020 ATHENA: Pre-Cursor for an improved service



Copernicus
The European Earth Observation Programme

PATRIMONIO MUNDIAL • WORLD HERITAGE • PATRIMOINE MONDIAL

Gunter Schreier
German Aerospace Center • DLR
Earth Observation Center • EOC
German Remote Sensing Data Center • DFD

CULTURAL HERITAGE
A CHALLENGE FOR EUROPE

PROTHEGO

Protection of European Cultural Heritage from Geo - Hazards

Choirokoitia archaeological site: experiences and activities on protection from geo-hazard

Kyriacos Themistocleous

Cyprus University of Technology

ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

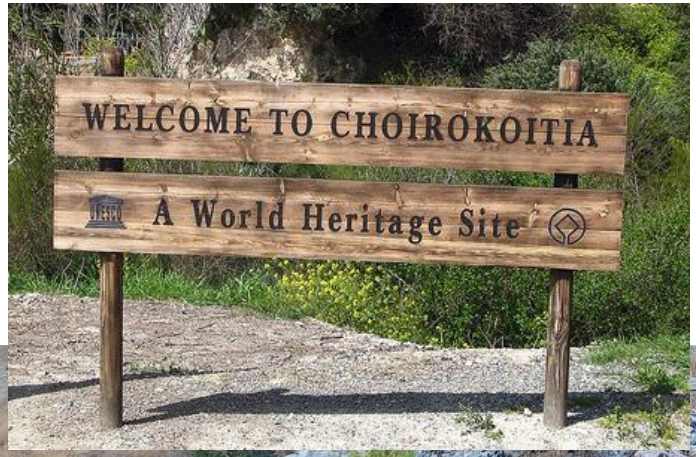
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Instituto Geológico y Minero de España

Choirokoitia

Choirokoitia demonstration site

- The methodology will be used for the **Choirokoitia** demonstration site.
- Neolithic settlement, occupied from the **7th to the 4th millennium B.C**.
- Located in the District of Larnaka, about 6 km from the southern coast of Cyprus, the Neolithic settlement of Choirokoitia lies on the slopes of a hill partly enclosed in a loop of the Maroni River
- Excavations have shown that the settlement consisted of circular houses built from mudbrick and stone with flat roofs and that it was protected by successive walls



Choirokoitia

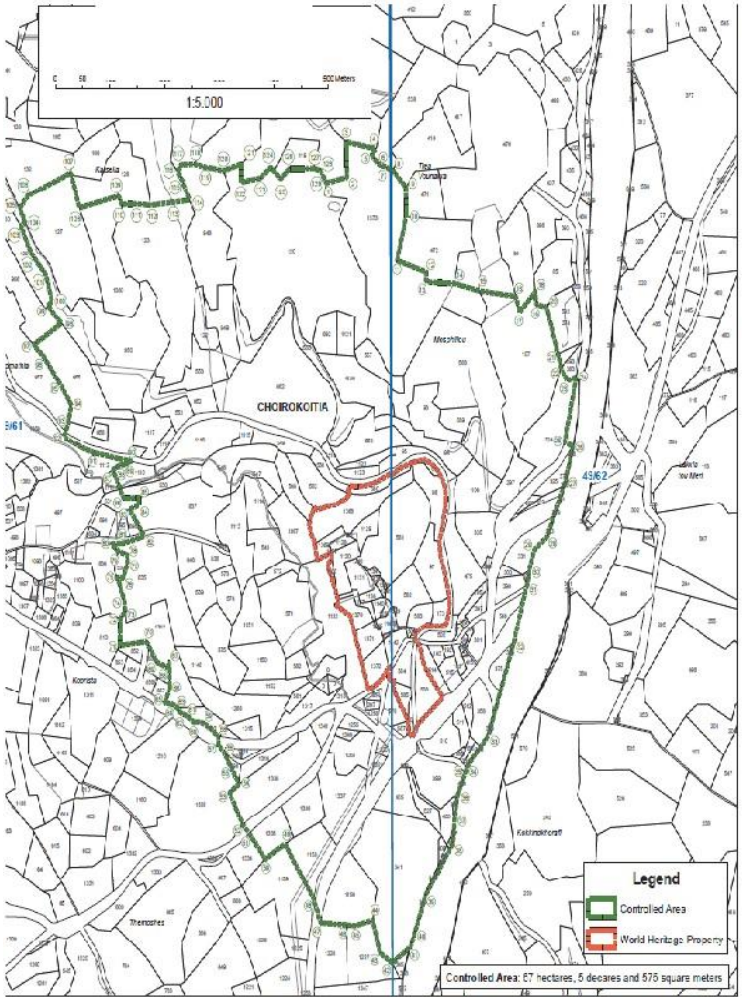
Current Condition of Site

Reconstruction of houses based on the site remains

Choirokoitia

Aerial view of the Choirokoitia site

Choirokoitia



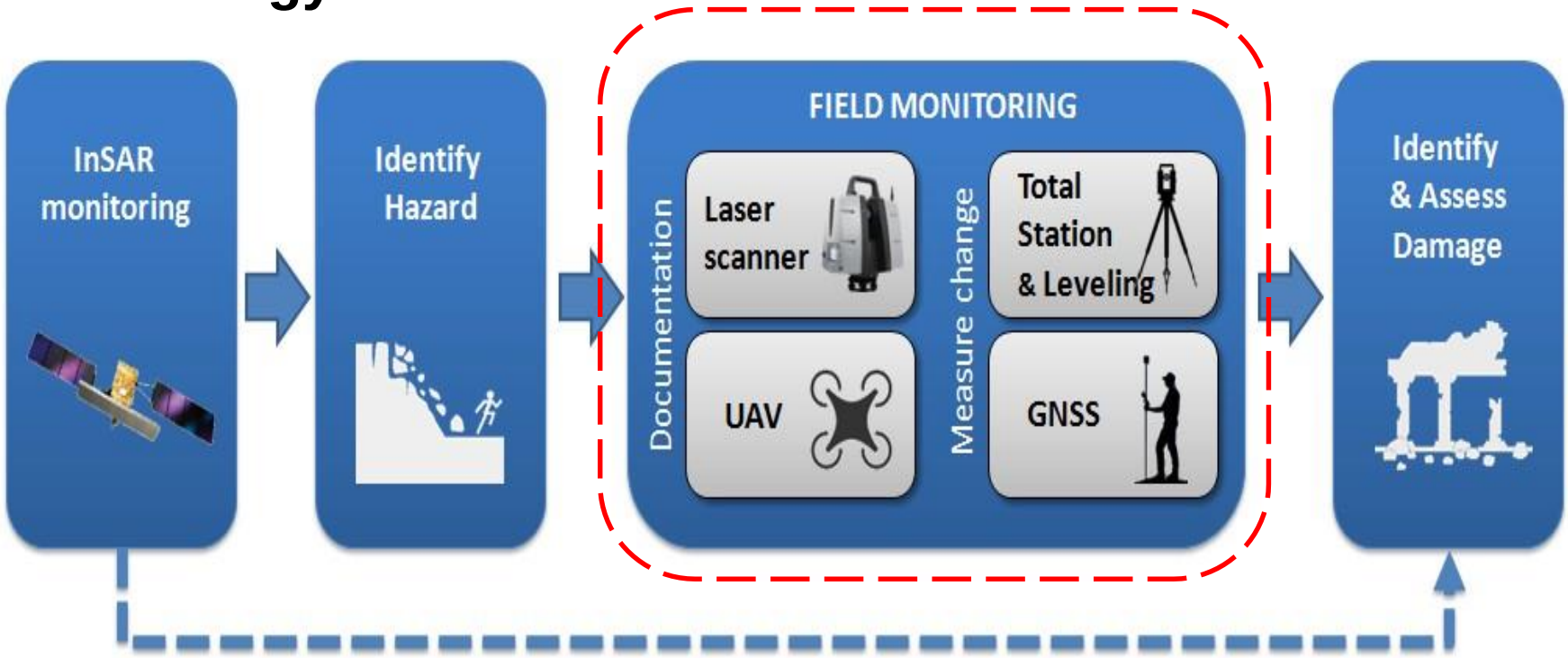
Monitoring

Innovative methods of monitoring include:

- ✓ **Satellite and aerial imagery**
- ✓ **Field surveying** using sensors and wireless networks
- ✓ **GNSS control network**
- ✓ **3D modelling and simulation**

Choirokoitia

Methodology



- Establishment of a SAR Reflector network
- Establishment of a GNSS control network
  (The number of points is a function of site vulnerability parameters as indicated by geology specialists)
- Monitoring environmental conditions and movements using sensors

Local Site Monitoring

- Drone survey and creation of 3D model
- Establishment of a GNSS control network.
  (The number of points is a function of site vulnerability parameters as indicated by geology specialists)
- The total station will be used for validation of potential displacements.

Choirokoitia

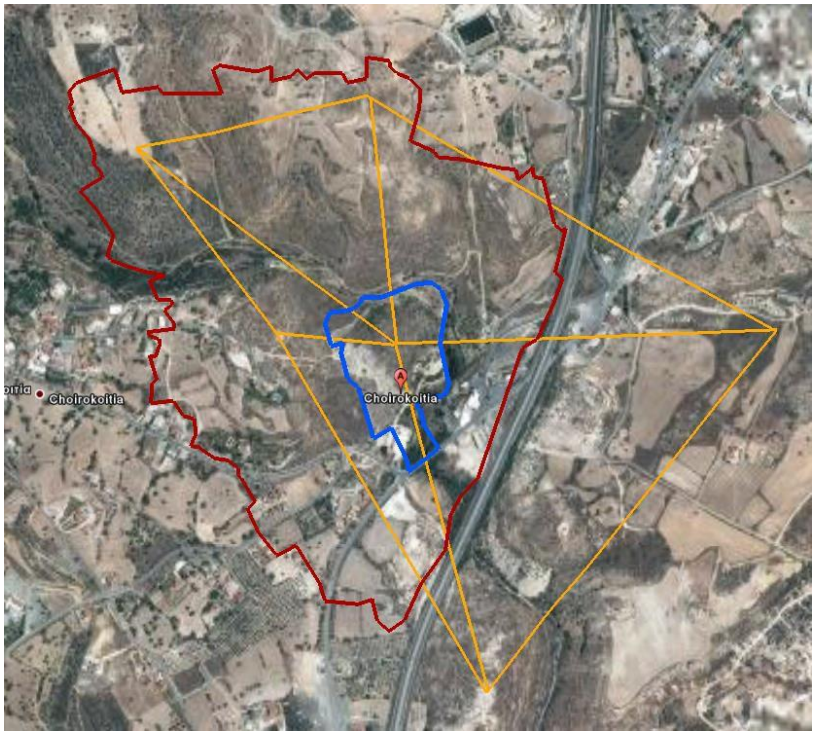
Establishment of a GNSS control network

(The number of points is a function of site vulnerability parameters as indicated by geology specialists)

Choirokoitia

Field Monitoring

- A local geodetic network needs to be established within the CH site.
- The network should consist of a reference point and additional nodes, established at specific points of interest (i.e. points on peaks or ridges that may indicate/warn of a potential hazard).
- Network points will be measured regularly using satellite (GNSS) and ground measurements (via high precision total stations and levels) to estimate the potential relative motion with respect to the network reference point, during the life-span of PROTHEGO.



Choirokoitia

Choirokoitia






Establishment of a GNSS control network

Choirokoitia

The **Trimble Zephyr 2 GNSS** offers robust low elevation tracking and sub-millimeter phase center repeatability.

- Ideal for base station applications
- Can withstand shock and vibration
- Capable of multipath reduction
- Low elevation satellite tracking
- Support sub-millimeter phase centre accuracy
- Support Signals: GPS L2C/L5, GLONASS, Galileo, OmniSTAR, and SBAS

Choirokoitia

Choirokoitia

Choirokoitia

Leica GS15 Smart GNSS Receivers

This smart antenna adjusts to any environment and delivers the most accurate results.

Multi-frequency : GPS / GLONASS / Galileo / BeiDou

Static (phase) with long observations: Hz 3 mm + 0.1 ppm / V 3.5 mm + 0.4 ppm

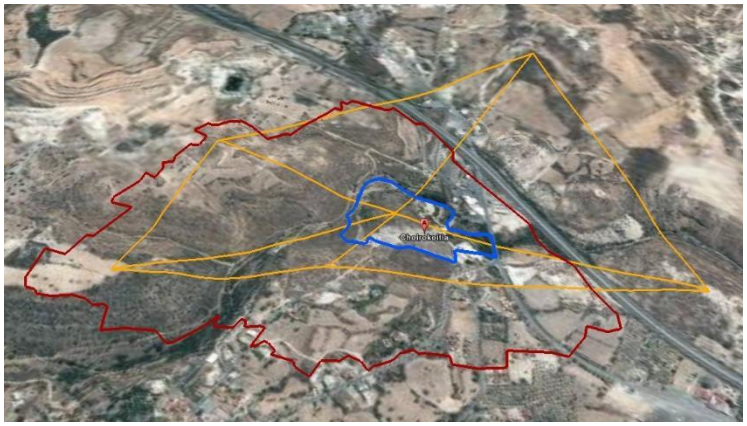
External data links GSM / GPRS / UMTS / CDMA and UHF / VHF modem

Choirokoitia

Field Monitoring

Horizontal displacements will be measured using the Topcon MS05AXII industrial-grade total station, with 0.5” angular accuracy, and 0.5mm range accuracy, combined with specifically designed prisms and reflective targets to achieve maximum accuracy will be used for validation of potential displacements.

Vertical motion can be measured using a Leica DNA03high-precision digital level.



Choirokoitia

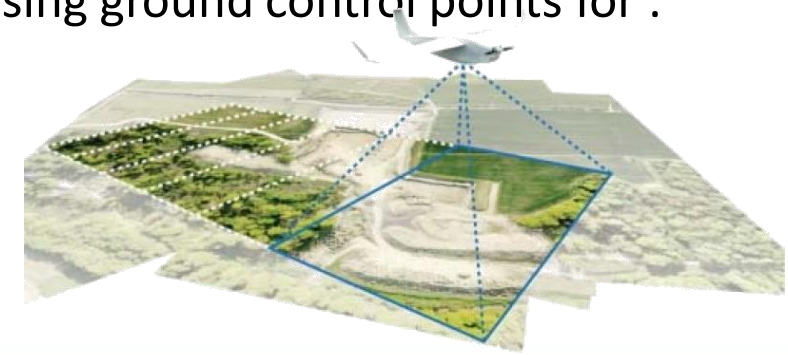
Site Documentation and Monitoring using UAV and photogrammetry

Choirokoitia

Use of UAV to document cultural heritage sites with cm accuracy.

Use of drones with high resolution cameras using ground control points for :

- Creation of ortho-photos
- Creation of dense cloud
- Creation of 3D model
- Creation of Digital Elevation Modeling



Choirokoitia

Choirokoitia

Mission Planning

Choirokoitia

Choirokoitia

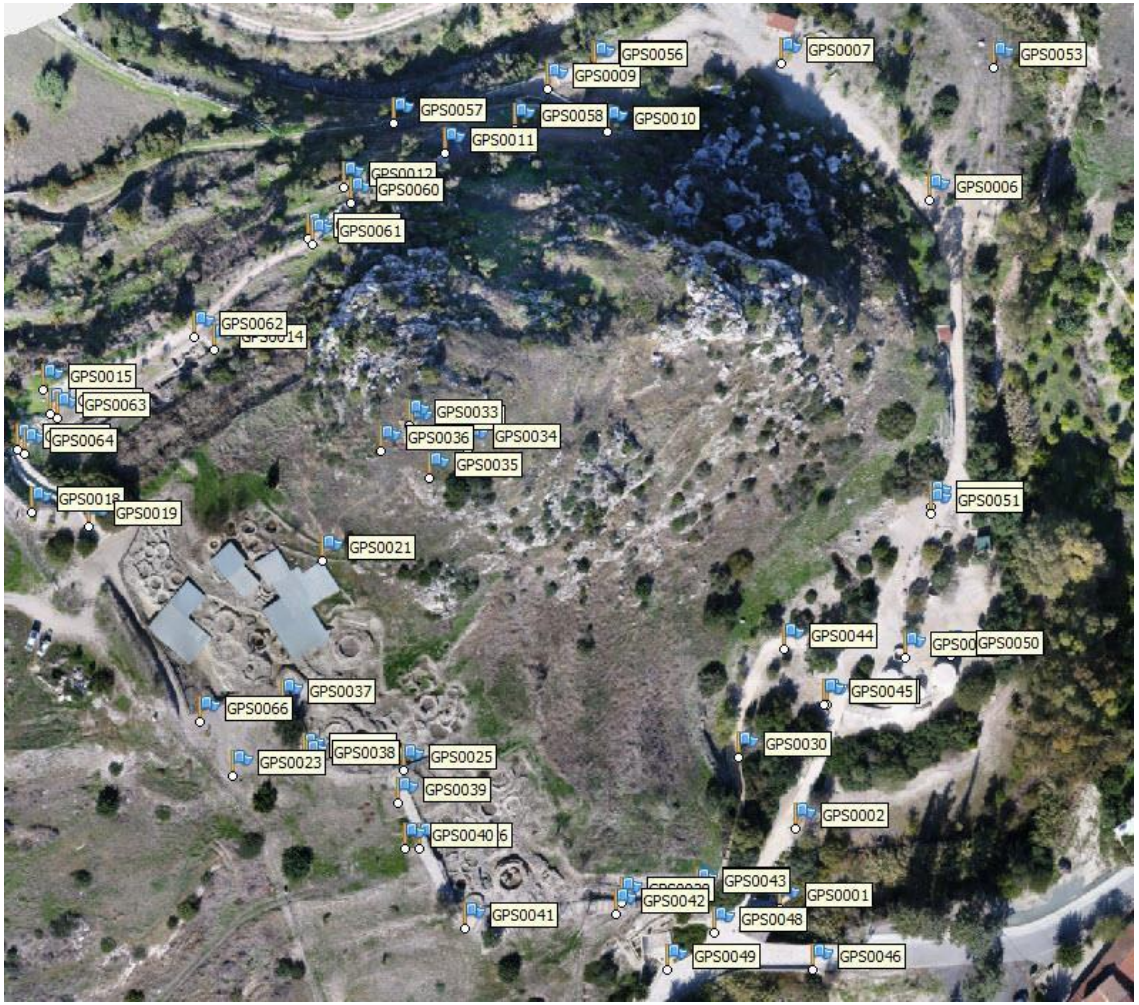
UAV Data from Choirokoitia site 29 October, 2016

Orthophoto of site (2.26 cm/pix)

Choirokoitia

Choirokoitia

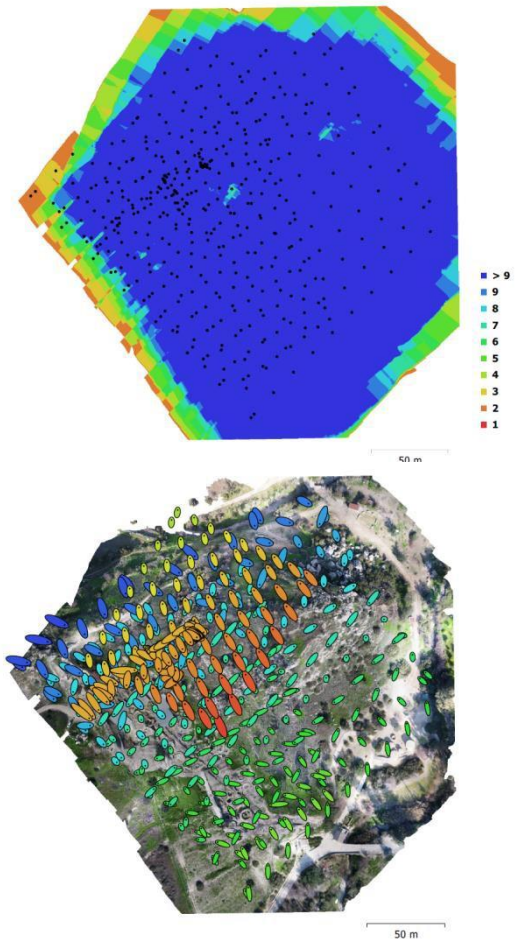
UAV Data from Choirokoitia site

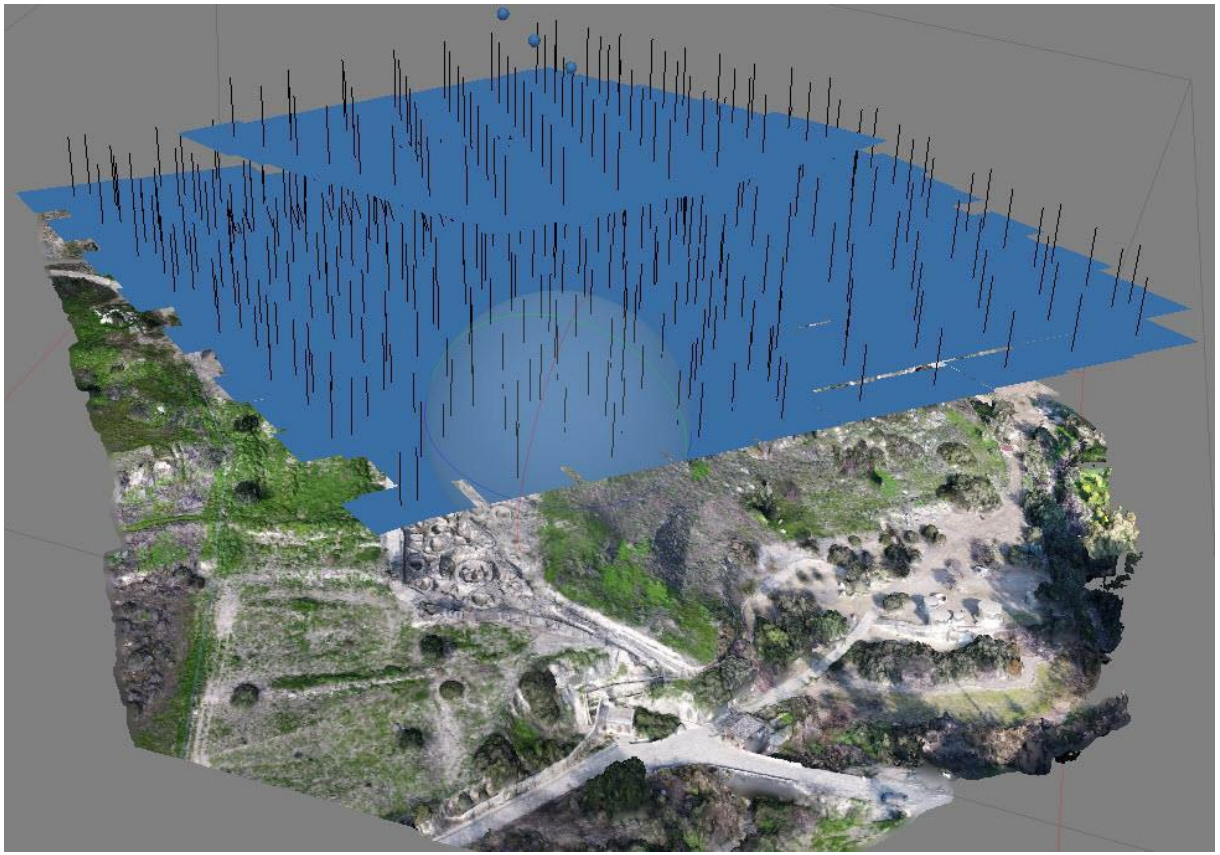


Ground control points

Choirokoitia

UAV Data from Choirokoitia site



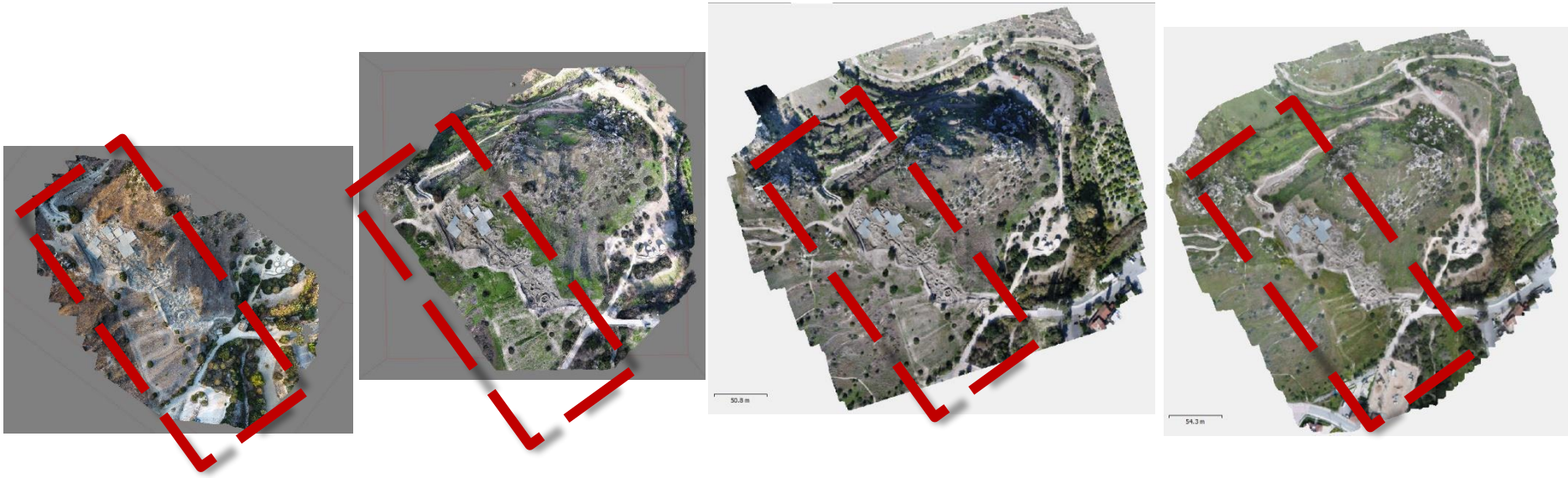


Camera locations – 461 images

Choirokoitia

UAV Data from Choirokoitia site

Point Cloud generation

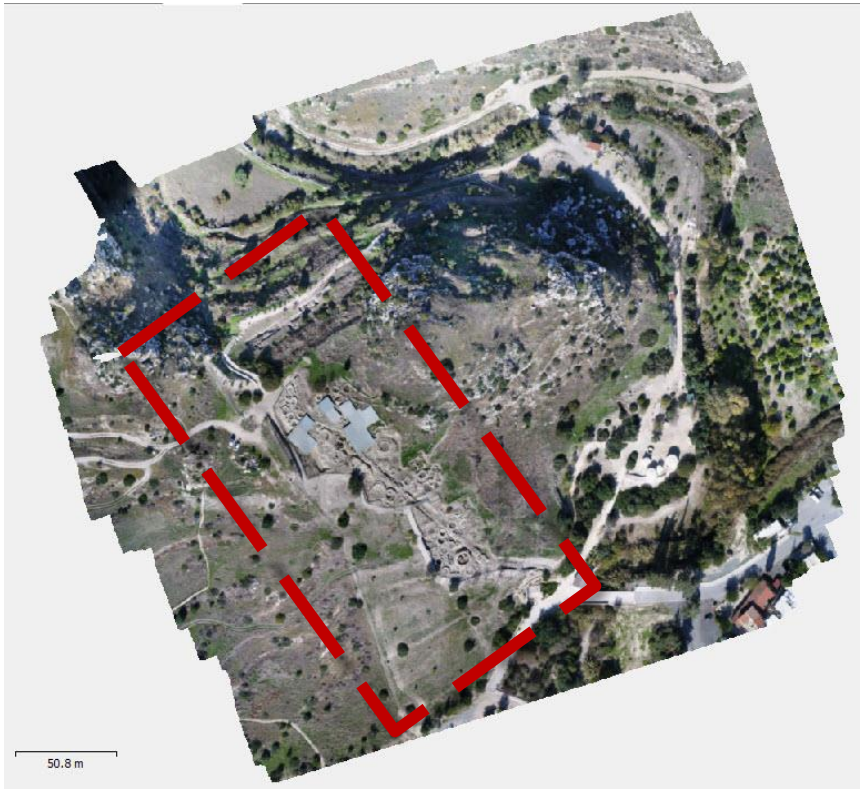


29 October, 2016 **2 February, 2017** **11 November, 2017** **7 March, 2018**

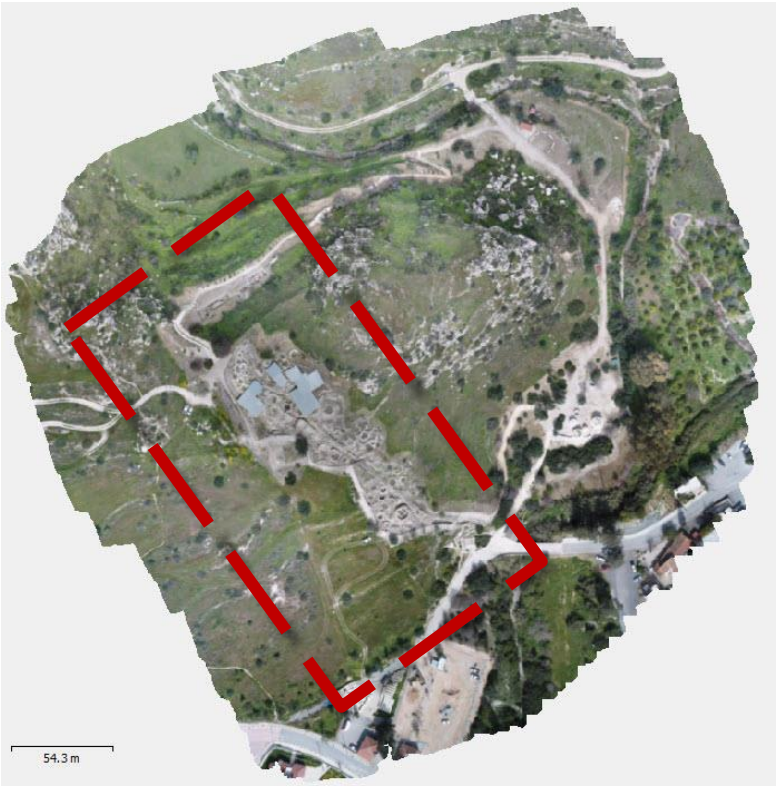
Choirokoitia

UAV Data from Choirokoitia site

Point Cloud generation



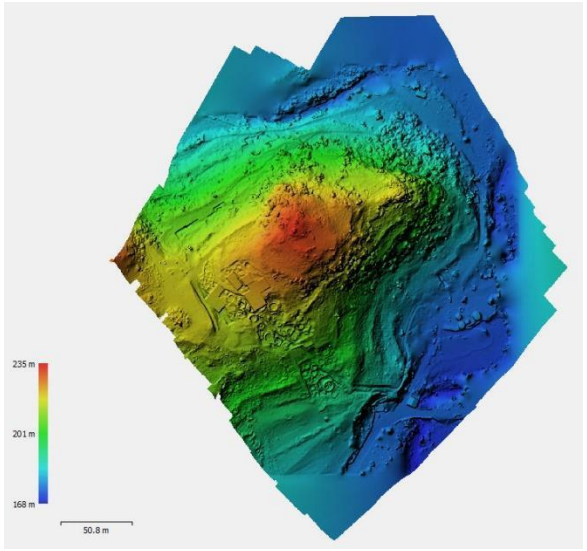
11 November, 2017

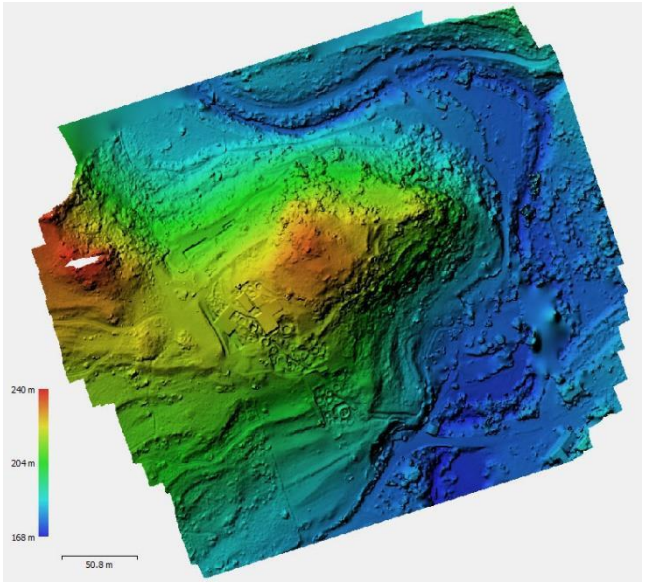


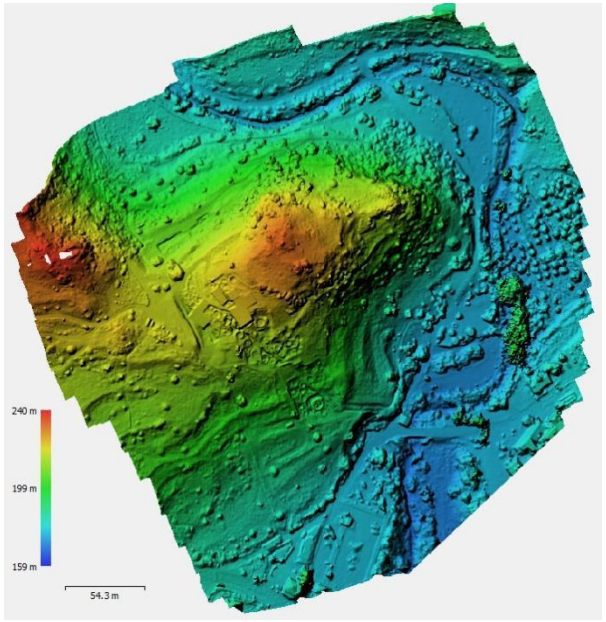
7 March, 2018

Choirokoitia

UAV Data from Choirokoitia site





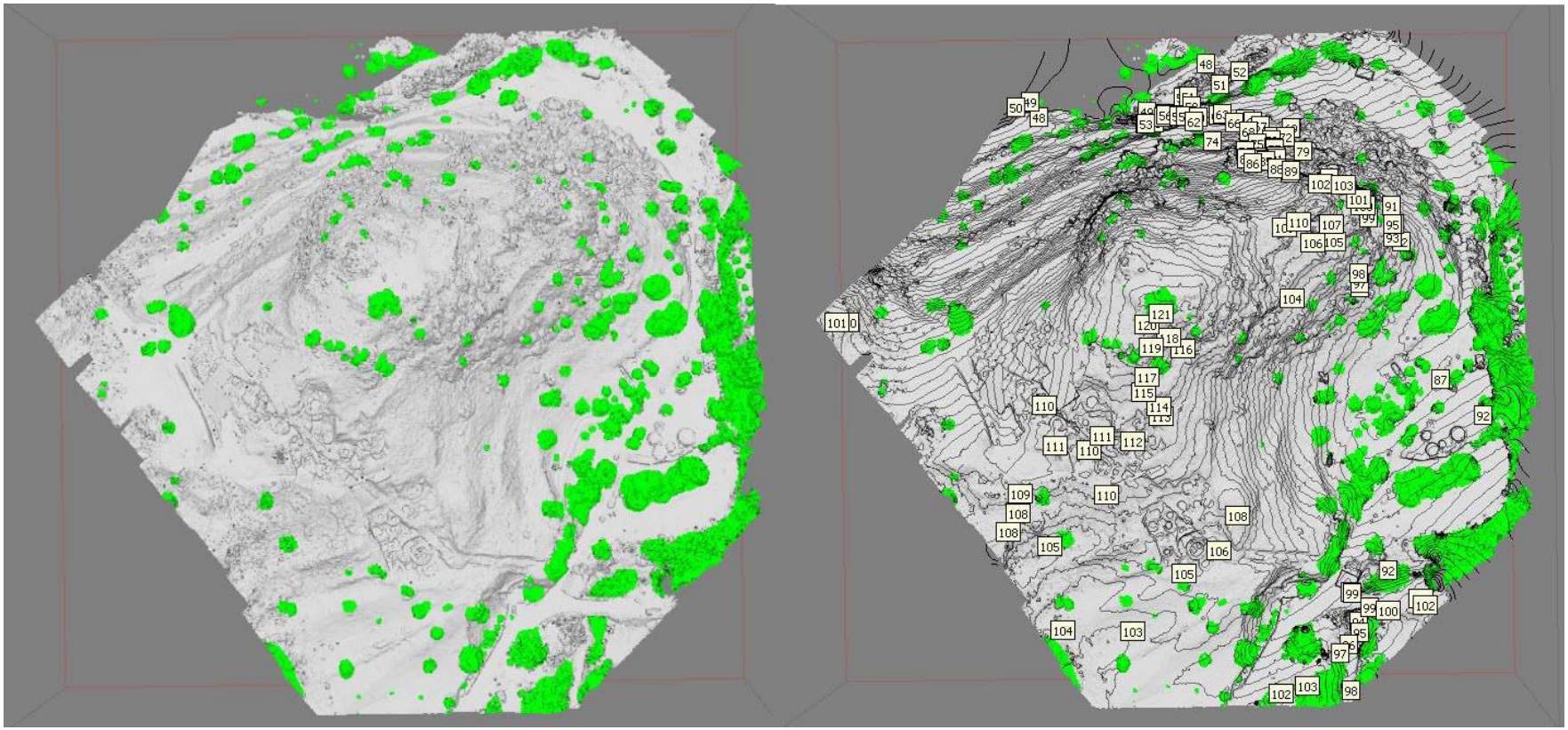


2 February, 2017 **11 November, 2017** **7 March, 2018**

Digital Elevation Model

Choirokoitia

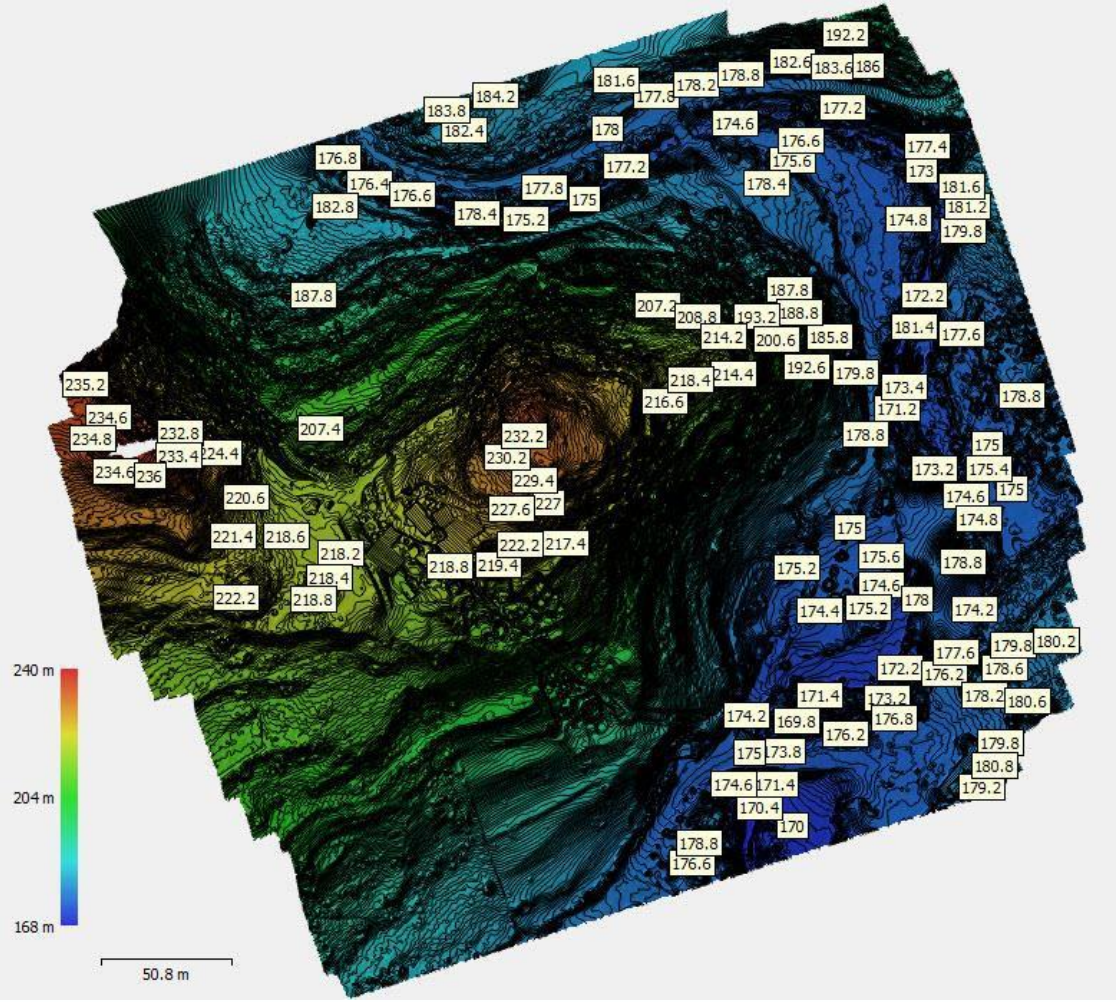
UAV Data from Choirokoitia site



Vegetation subtraction and contour generation

Choirokoitia

UAV Data from Choirokoitia site



11 November, 2017

Digital Elevation Model

Choirokoitia

11 November, 2017

Ortho-image

Choirokoitia

PSI Analysis of Choirokoitia Area

Choirokoitia

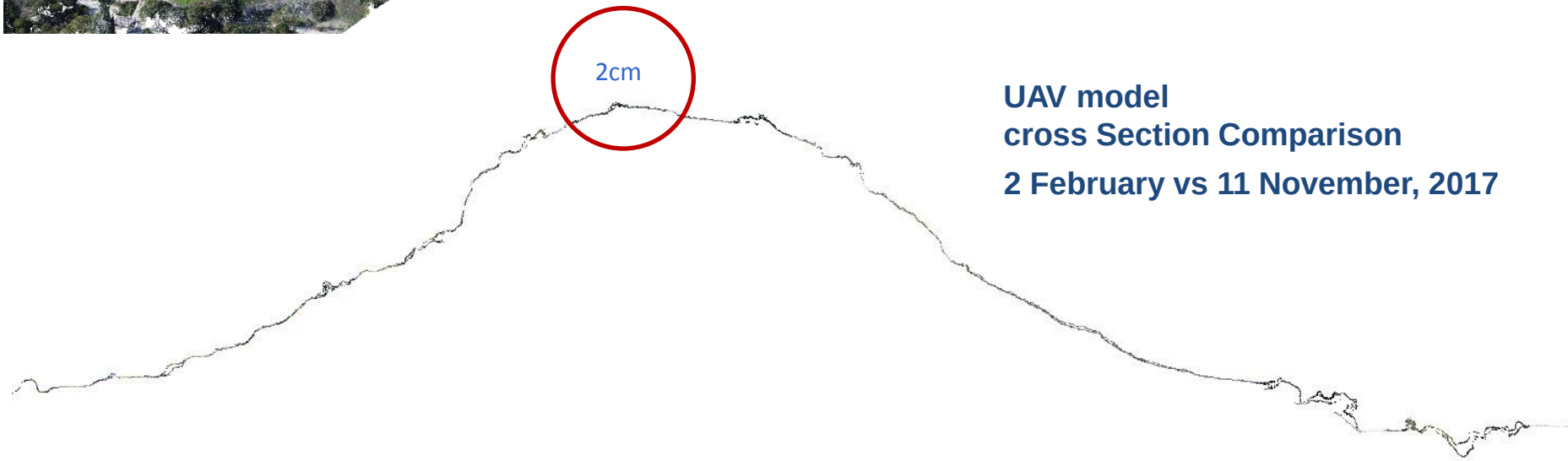
There were 4 GPs sites which measured displacement east (DE), Displacement North (DN) and Displacement Up (DU).

Results of GNSS Control network

Site	Coordinates	DE	DN	DU
GPS1	231524.820 / 352001.675	+0.0023	-0.0025	-0.0027
GPS2	231314.725 / 351974.690	+0.0022	-0.0001	+0.0017
GPS3	231344.434 / 351922.148	+0.0000	+0.0000	+0.0000
GPS4	231453.791 / 351980.692	+0.0024	+0.0001	**-0.0203**

The results of the GNSS control network found a change of 2cm during the 24 months of the monitoring period of the site

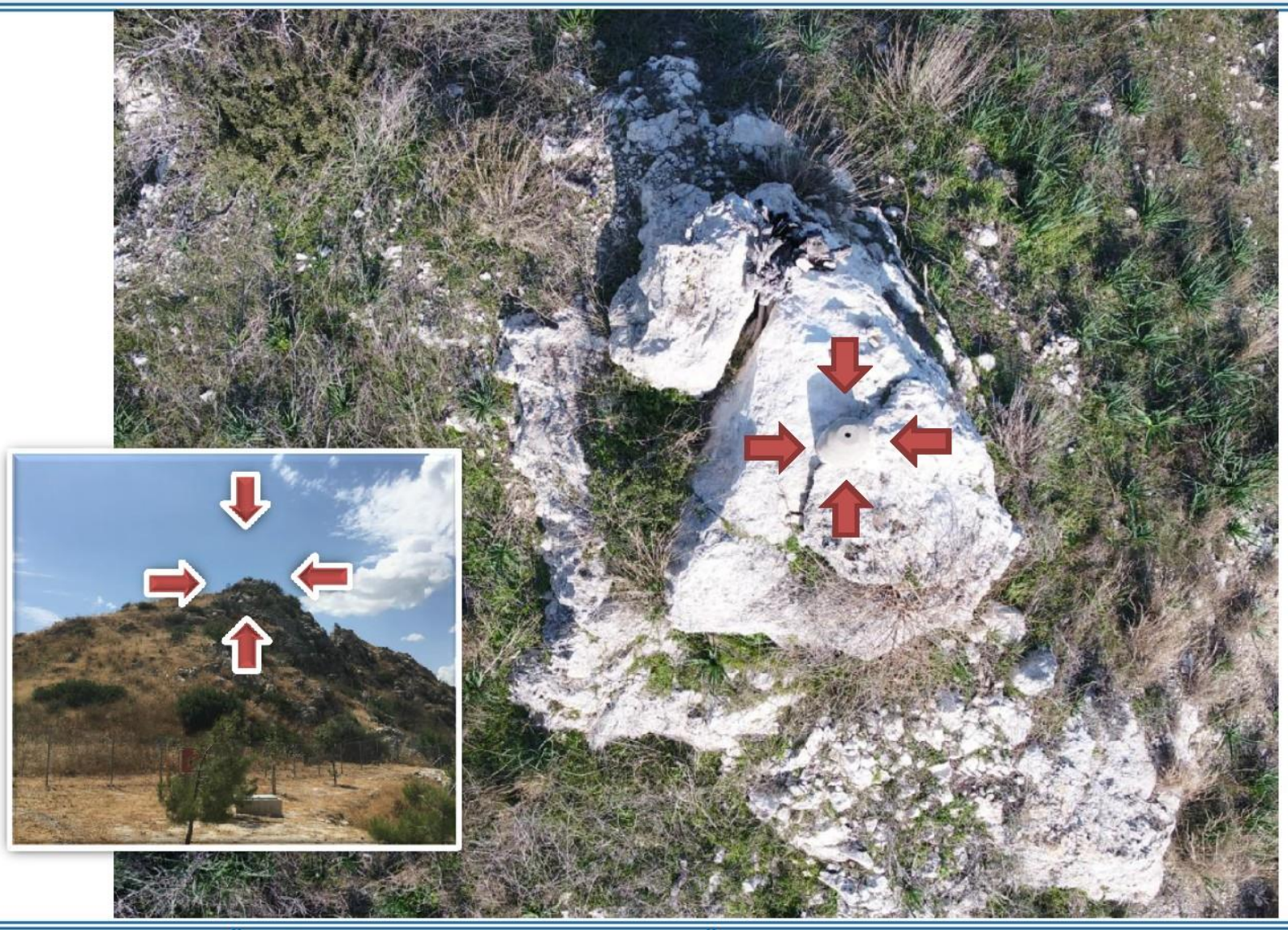
GNSS control network



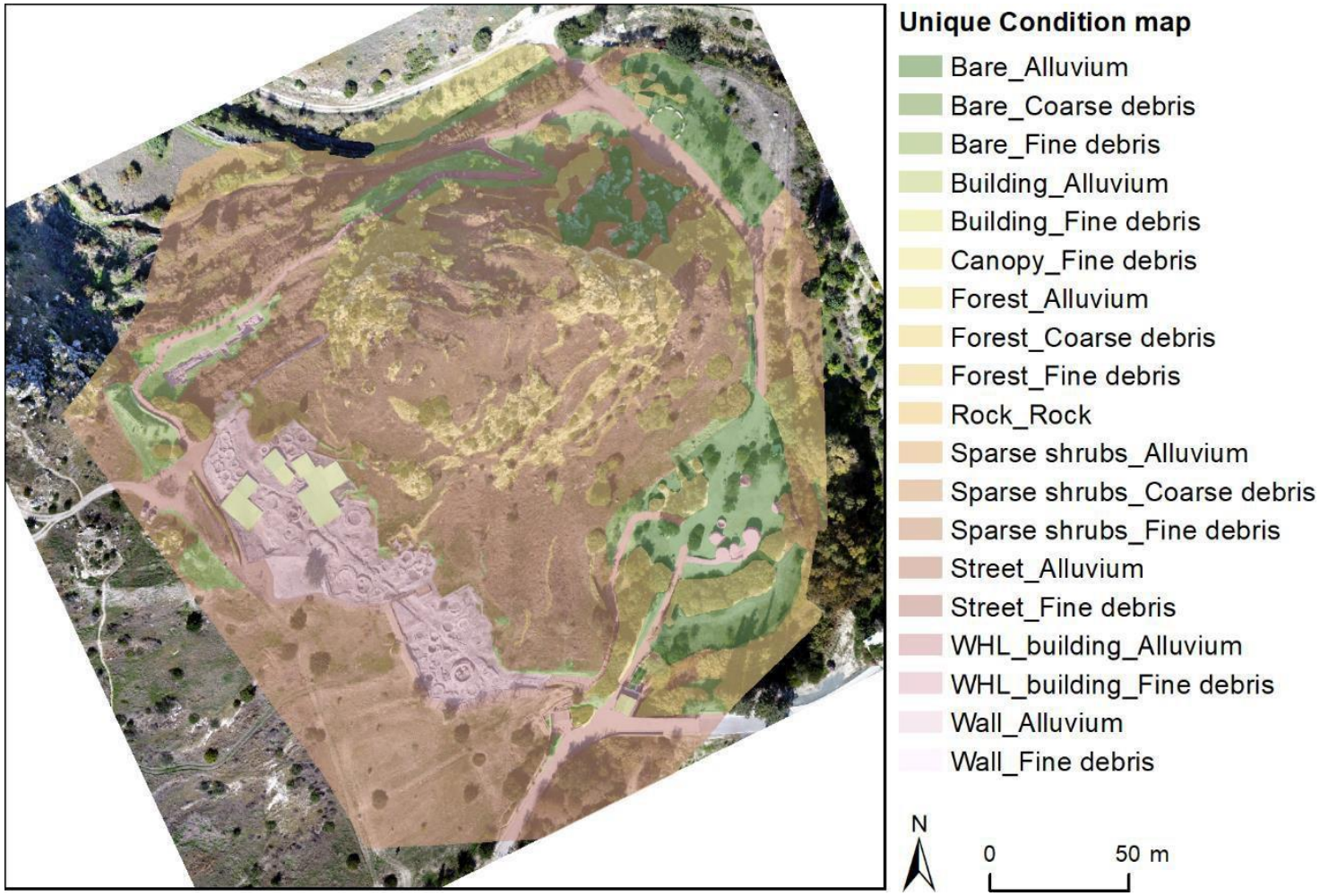
UAV model
cross Section Comparison

2 February vs 11 November, 2017

Choirokoitia

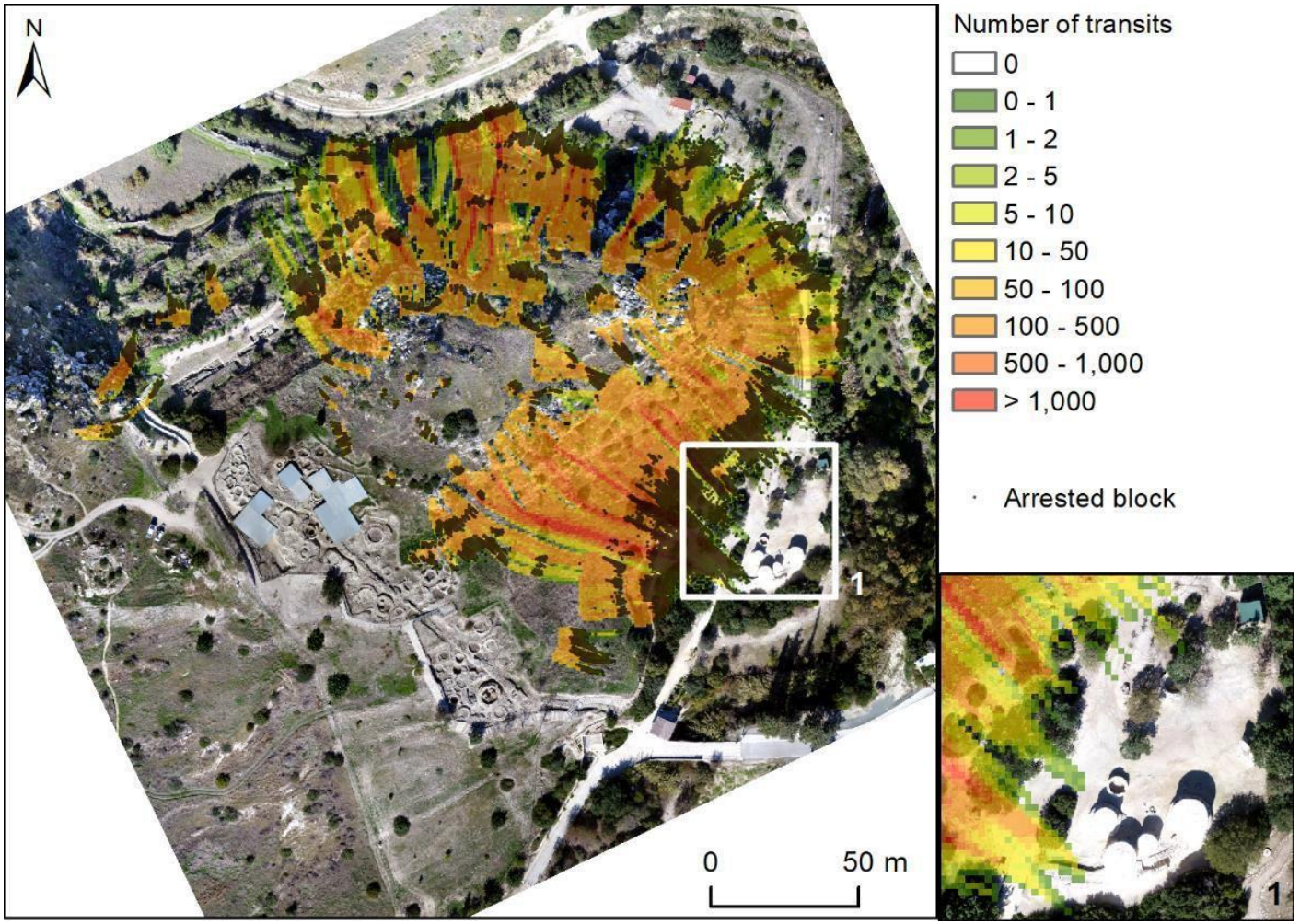


Choirokoitia Rockfall Modelling



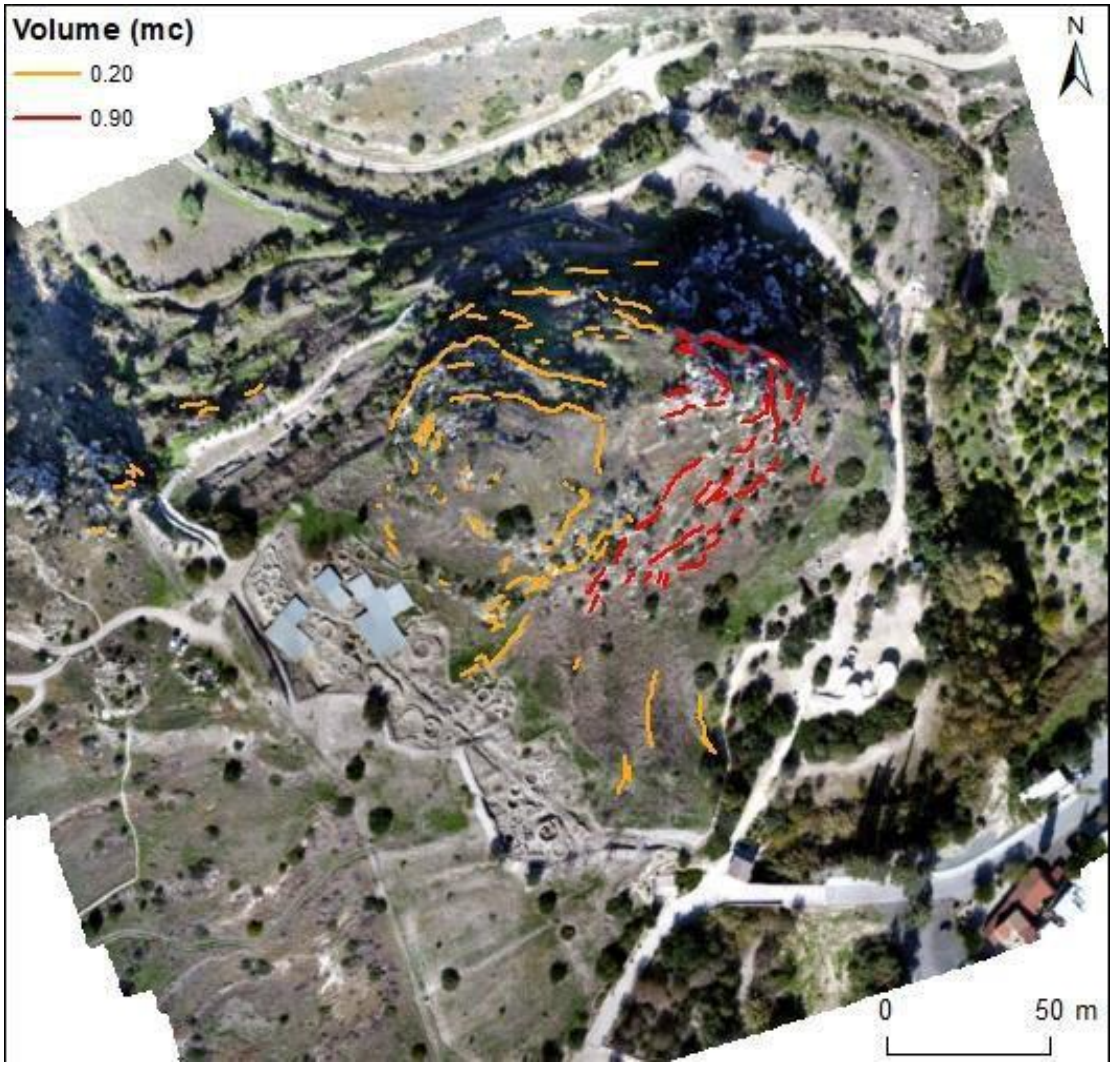
"Unique Condition" map derived from the combination of the lithological map and landuse

Choirokoitia Rockfall Modelling



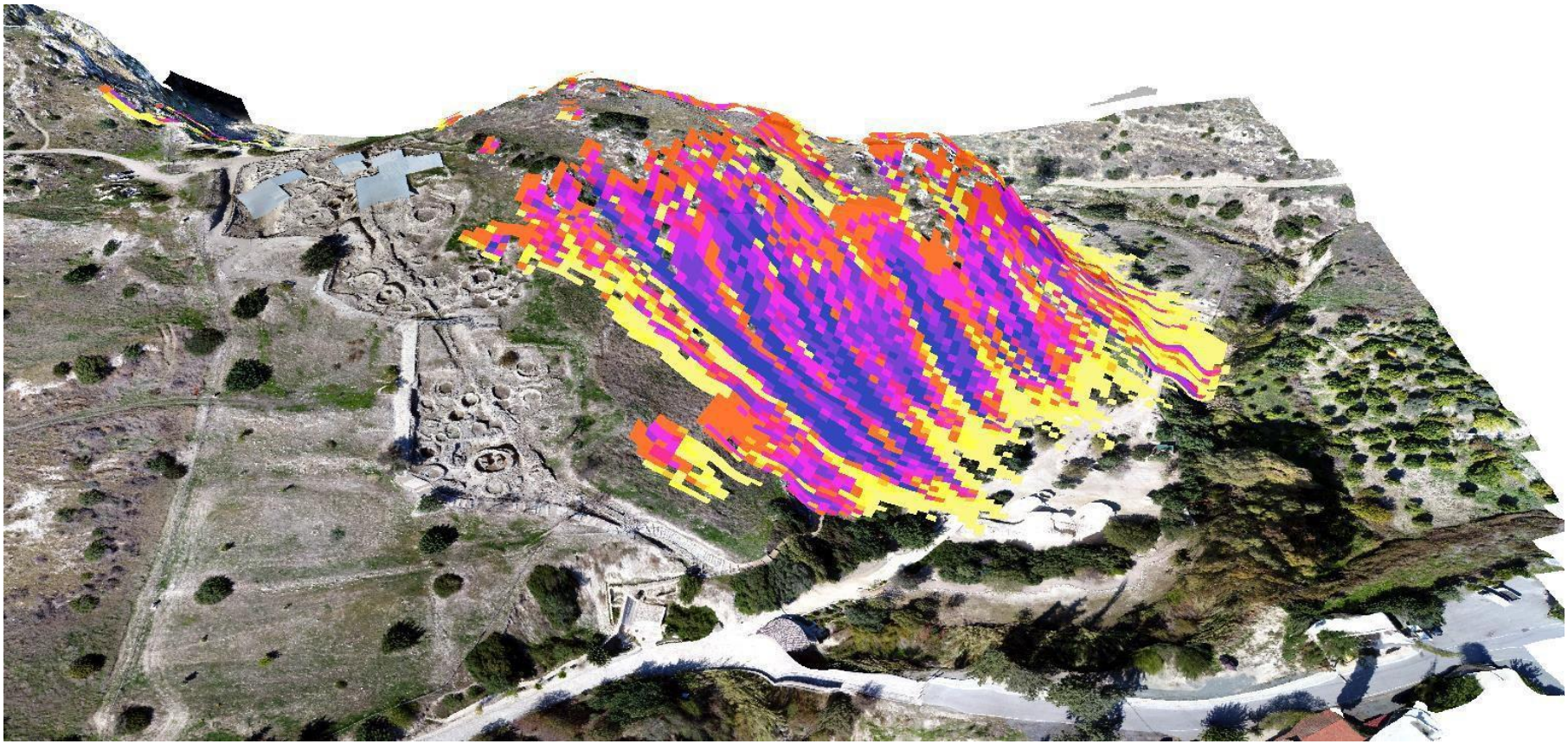
Number of transit for each cell of the DEM and arrested location of the blocks on the slope

Choirokoitia Rockfall Modelling



Source areas for the rockfall simulation

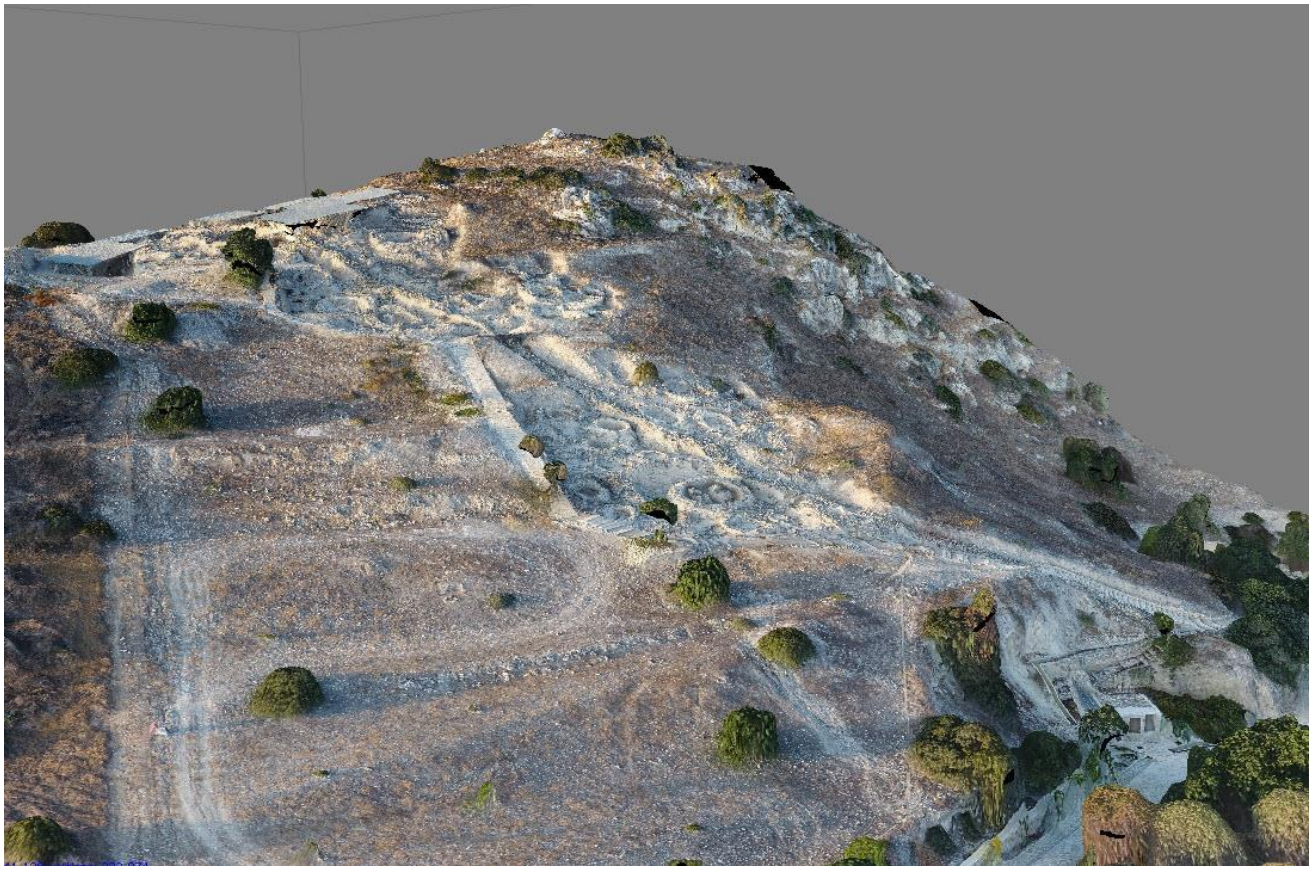
Choirokoitia Rockfall Modelling



Results of HY- STONE Rockfall Analysis of Choirokoitia

Choirokoitia

UAV Data from Choirokoitia site 29 October, 2016



3D model

Choirokoitia

Thank you for your attention!

Cultural Heritage as potential new Copernicus Service

Nicosia, 30 October 2018

Oriana Grasso
EC-DG GROW Unit I2, Copernicus

Copernicus
Europe's eyes on Earth

Space

Copernicus EU
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www.copernicus.eu

Copernicus eye on CH

OBJECTIVES:

- Identify intermediate and end-user needs in the cultural heritage field, and assess and characterise space-based applications in support of cultural heritage in Europe and globally
- Assess capabilities and outline requirements for Copernicus based products/services in support of cultural heritage
- Propose and assess implementation scenarios for a structured Copernicus-based approach for cultural heritage support

WS Results and recommendations

All the 6 Copernicus core services (merging satellites earth observation capabilities, in-situ measurements, modelling approaches and data management systems) can contribute at various degrees to address :

- preventive conservation
- operative standard for assets safeguard and conservation
- landscape conservation and monitoring
- geo-mapping of cultural heritage
- related vulnerability and environmental risk
- support to emergency intervention in historical and protected areas.

Examples of Copernicus support to CH management

- Natural subsidence, shifting ground, earthquakes
- Pollution attacking artefacts
- Buried archaeological sites
- Destruction of sites/looting
- Urban sprawl
- Climate change
- Land use changes

Copernicus

T

2018 EUROPEAN YEAR OF CULTURAL HERITAGE #EuropeForCulture

The Copernicus Interim evaluation released in 2017suggested to reach **non-EO specialist communities**.

Promoting the use of Copernicus for **Cultural Heritage preservation, monitoring and management** would be the **1st attempt to reach non-EO specialist communities**.

Copernicus Europe's eyes on Earth

European Commission

EC study on "Copernicus for Cultural Heritage"

OBJECTIVES

- Assess current Copernicus capabilities in support of Cultural Heritage activities, on the basis of identified end-user needs;
- Outline requirements for Copernicus products/services for the creation of a dedicated portfolio in support of Cultural Heritage;
- Propose and assess an implementation scenario for a structured Copernicus solution for Cultural Heritage;
- Provide recommendations for future evolution of Copernicus in supporting Cultural Heritage preservation, monitoring and management needs.

Copernicus

PHASE 1

User needs and requirements identification

- Definition of the value chain and user communities
- Identification of user needs & requirements
- Translation into technical specifications

Match with Copernicus capabilities

- Review of Copernicus capabilities
- Match analysis

Copernicus Europe's eyes on Earth

European Commission

Copernicus

PHASE 2

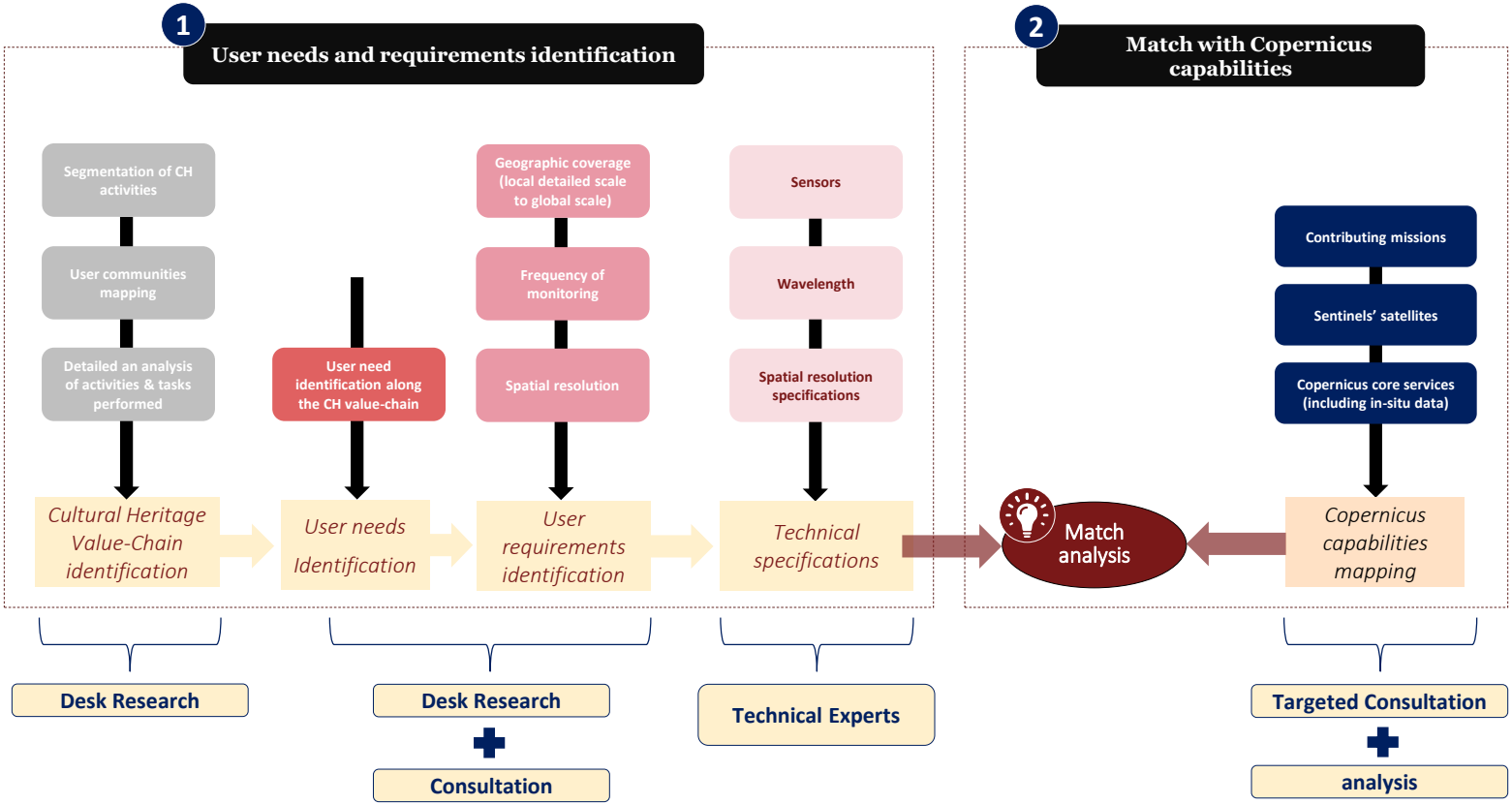
- **Options characterization**
- **Evaluation of high level impact**
- **Comparison of options and recommendations**

Copernicus Europe's eyes on Earth

European Commission

The first phase of the study aimed at collecting CH user needs & requirements and perform an assessment to understand to what extent Copernicus capabilities could respond to them

Phase 1 | *Approach*



Highlights

- User requirements have been translated into **technical specifications to support the match analysis** with the **Copernicus capabilities**.
- This match analysis has been carried out on **three different levels**: Copernicus core services products, Sentinels capabilities and Copernicus contributing mission capabilities.
- The output of the match analysis was a list of **CH user requirements that could be fully, partially or not covered by Copernicus capabilities (**core services products, Sentinel capabilities and/or contributing missions), taking into consideration products characteristics, sensors & wavelength, spatial resolution and temporal resolution.

The analysis relies on a triangulation of data, bringing together secondary data (desk research) and primary data extracted from web-based and direct consultation

Phase 1

Data sources

Desk Research

Literature review

Reports

19 projects funded by the EC and/or ESA **related to the utilization of EO for Cultural Heritage** purpose were analysed in depth (e.g. HERCULES, Artek, ITACA, Prothego, ARROWS, SASMAP, etc.).

Consultation

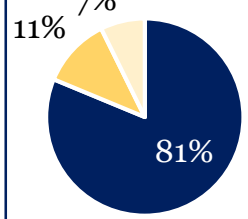
Web-based consultation

400 entities directly contacted
Plus public access from Copernicus, NEREUS, EURISY and EARSC websites

Direct consultation

22 entities engaged in direct consultation (phone or face-to-face)

Geographic coverage of the consultation



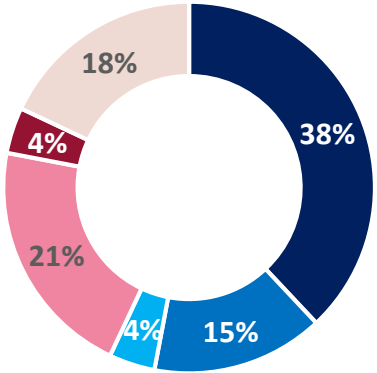
- 1 EU country
- 2 Non EU country
- 3 International Organisation

5 non-EU Countries

14 EU Countries

4 International Organisations

User Communities repartition

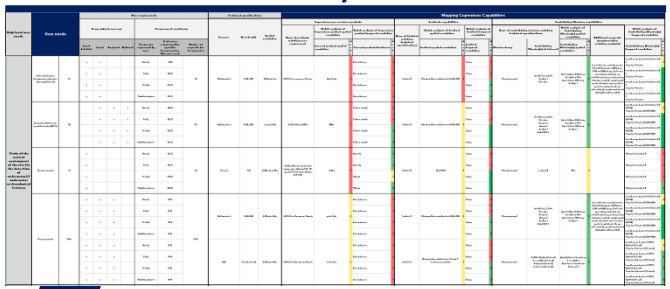


- Cultural Heritage professional user community
- Natural sciences user community
- National, Regional o Local authority user community
- Site operator user community
- Urban planner user community
- Downstream user community

The Copernicus programme could be covering most of the CH user requirements through Copernicus core services products, Sentinel data and contributing missions data.

Phase 1 | ***Results***

Match analysis matrix



Spatial resolution is expressed in range (e.g. 0,3m up to 5m) so in some cases Copernicus products or data can be partially covering requirements.

User needs & requirements

- **9 high level user needs (HLUN) (i.e. purpose) have been identified (e.g. observation of damage on a built structure)**
- **From these 9 HLUNs, 83 user needs have been identified. Some user needs can appear in several HLUNs.**
- **Out of these 83 user needs, 51 unique user needs can be isolated.**
- **These 83 user needs have been translated into 373 user requirements.**

Match analysis results

Current Copernicus core services products:

- **7,5%** of CH user requirements can be fully covered by existing Copernicus core services products.
- **35%** of CH user requirements can be partially covered;

Through the utilization of **Sentinels capabilities**:

- An additional 3,2% of CH user requirements can be **fully covered**, leading **to a total of 11% of overall CH user requirements that can be fully covered by Copernicus core services and Sentinel capabilities**

Through the utilization of Copernicus contributing missions:

- An **additional 39%** of CH user requirements can be **fully covered** by contributing missions, leading to a **total of 50% of CH user requirements that can be fully covered by current Copernicus capabilities**
- **14%** of CH user requirements could be partially covered by contributing missions
- **36%** of CH user requirements could **not be covered**

EC study on "Copernicus for Cultural Heritage"- Options

1. A better user uptake campaign to make the CH user community aware of the potential of Copernicus and of specific ready-to-use products

2. Re-organise the existing products within the existing services in a dedicated catalogue for CH use with a dedicated access platform

3. A new Copernicus service implemented as the existing ones through a delegated body or a public-private consortium

Thank you!

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