BEYOND, European Center of Excellence for EO based Disaster Management

The European Centre of
Observation based moni
South-Ea

BEYOND

Building a Centre of Excellence for EO-based monitoring of Natural Disasters

Funded under FP7-REGPOT-2012-2013-1
Activity: 4.1 Unlocking and developing the research poter
research entities established in the EU's Convergence regi
Outermost regions

SEVENTH FRAMEWORK PROGRAMME

Project funded by the EUROPEAN UNION

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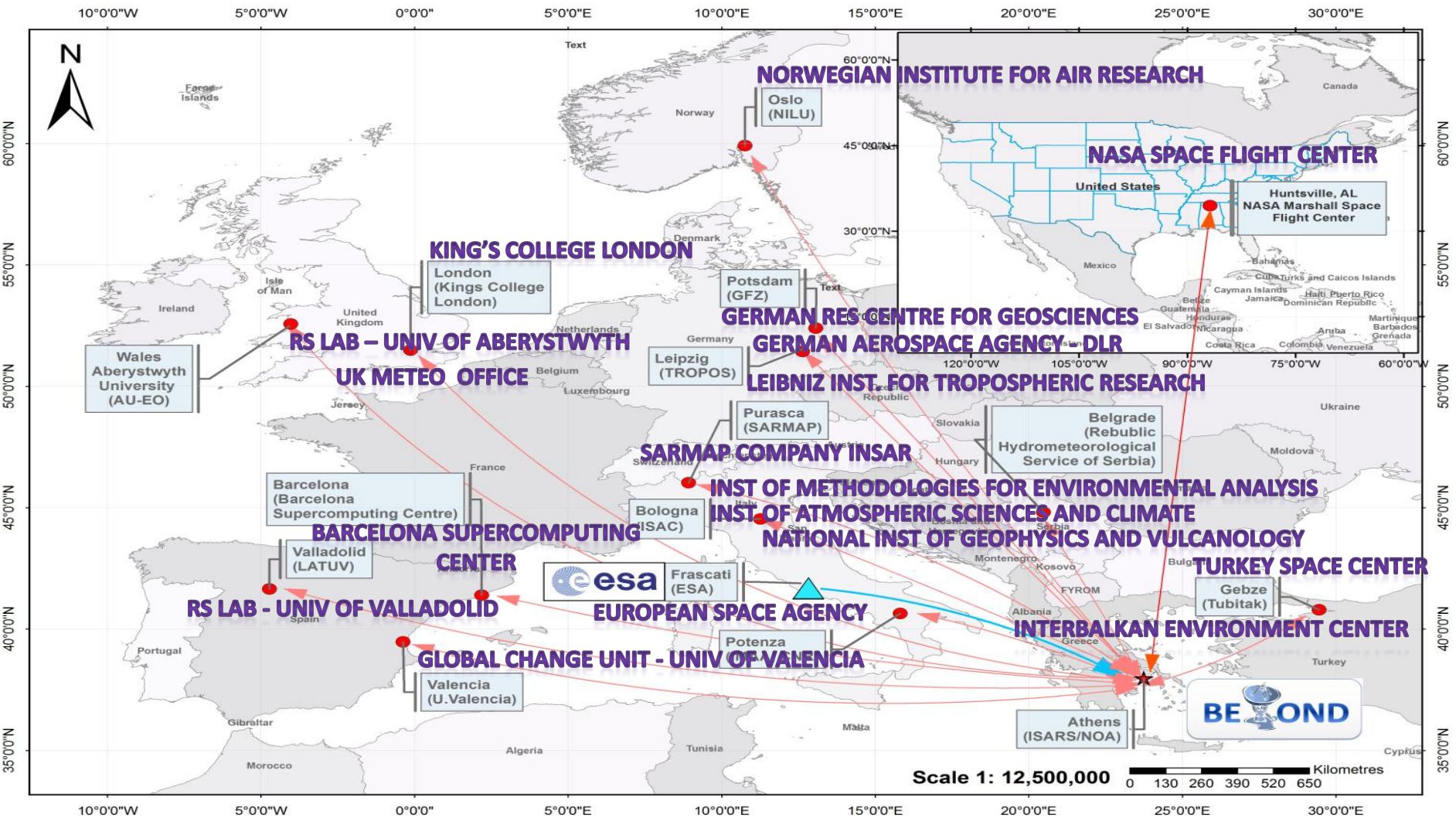
BEYOND, European Center of Excellence for EO based Disaster Management



IAASARS
Project funded by the EUROPEAN UNION
BEYOND

- **BEYOND** aspires to setting up innovative solutions for EO, allowing to a multitude of monitoring networks (space borne and in-situ) available over the region to operate in a complementary, unified, and coordinated manner
- **BEYOND** builds innovative research and skills capacity in the domain of EO through scientific exchange with European and regional partnering organisations
- **BEYOND** transforms the observations to added value products ready for down-streaming to specific societal needs in the domain of environmental monitoring and Natural Disasters
- **BEYOND** delivers online observations and higher level EO products and services to stakeholders, and international scientific and End User communities

Funding: 2.3 MEuros EC Contribution

Additional funding from Structural Funds ~270KEuros

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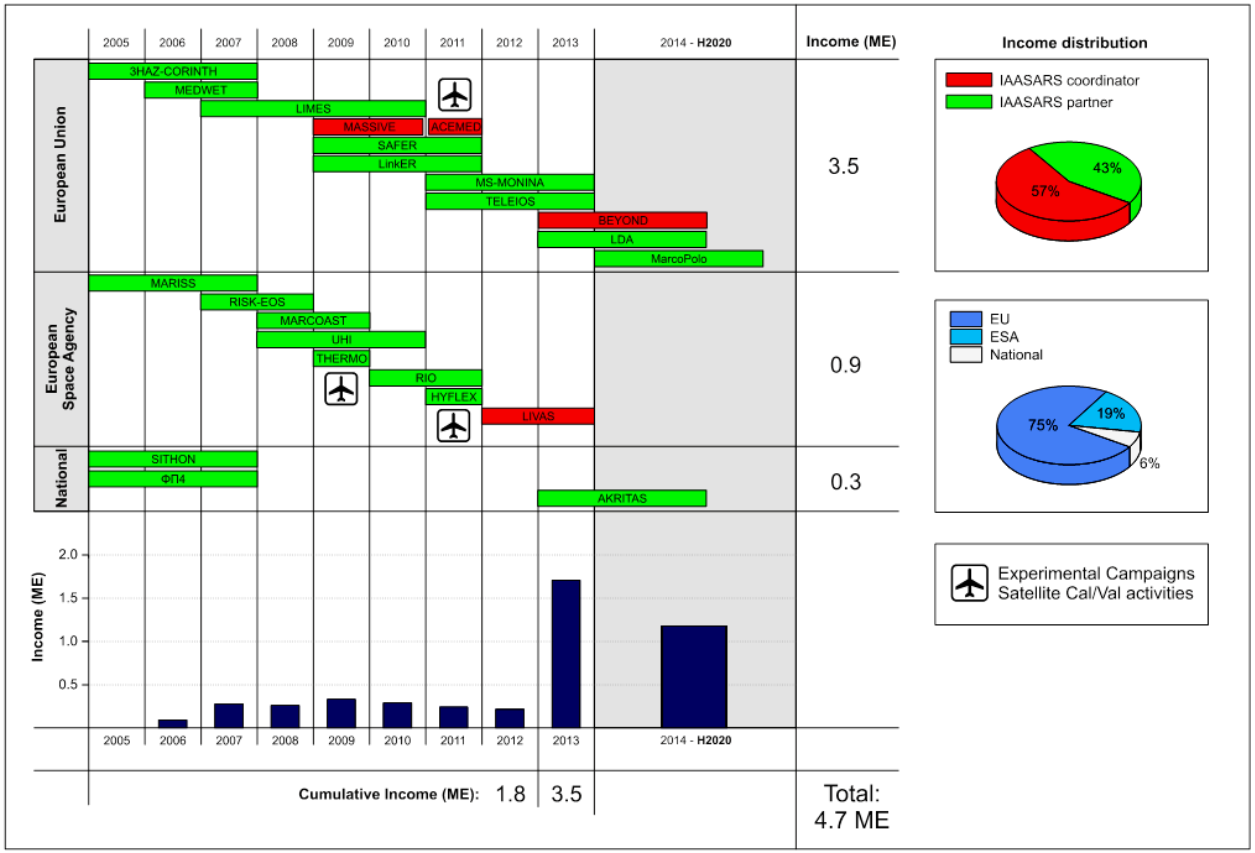
LDA Large-scale demonstrators in support of GMES and GNSS based services in Athens, Greece, GMES/DG ENTR

MASSIVE: Mapping Seismic Vulnerability and Risk of Cities, European Commission - DG ENV A.3 – Civil Protection

TELEIOS—Virtual Observatory Infrastructure for Earth Observation Data, FP7-ICT-2009-5



LinkER - Supporting the implementation of an operational GMES service in the field of emergency management, Invitation to Tender No: ENTR/08/028

LIMES (Land and Sea Integrated Monitoring for European Security/GMES / EC DG Enterprise

SAFER – EMERGENCY: Building Emergency Response Core Service, FP7-2007-SPACE-1/ GMES Collaborative Project

RISK-EOS Extension to Greece - Promotion of the GSE RISK-EOS fire services portfolio in Greece, EarthWatch GMES Services Elements, ESA/GSE

MARCOAST/ISSUE-OS - Integrated system for suspect vessels emergency tracking – OIL SPILLS

Project funded by the EUROPEAN UNION

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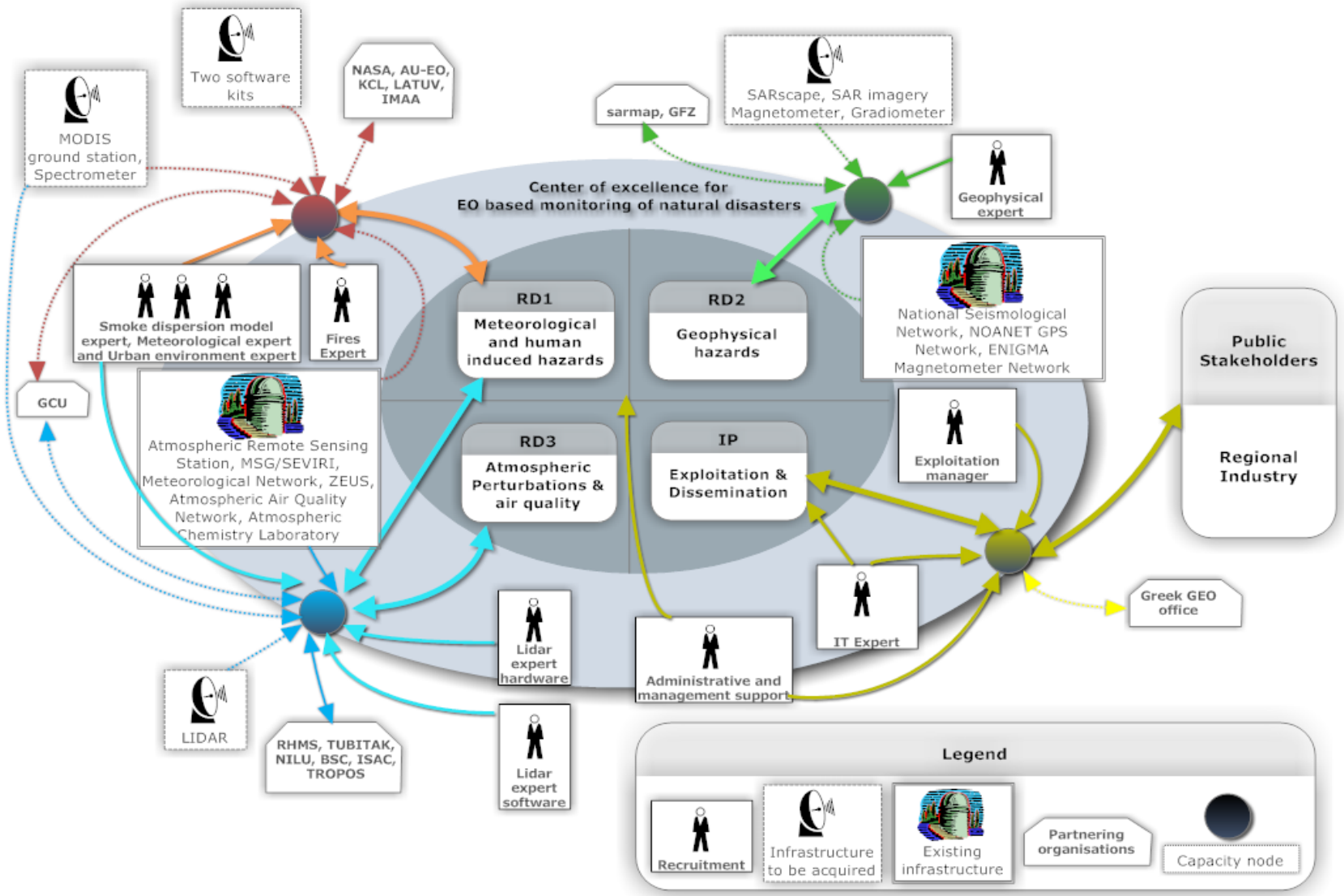
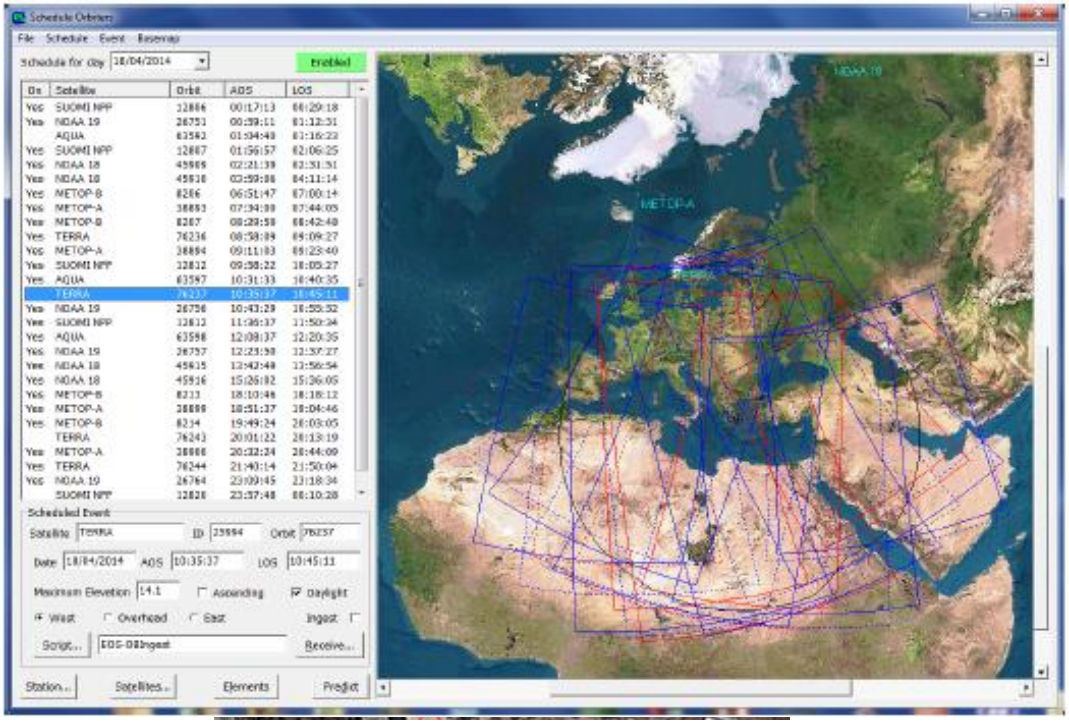


Setting up integrated satellite based observational solutions

➢**X-/L- band** acquisition station for (EOS Aqua and Terra, NPP, JPSS, NOAA, Met Op, FengYun) **(part of the DB network)**



IAASARS/NOA X-/L-band Acquisition station

Infrastructure Capacity Building

Setting up integrated satellite based observational solutions

➢**MSG SEVIRI acquisition stations of DVB-S & DVB-S2 systems exploiting high** throughput provided with the new EUMETCast Europe service, based on using the EUTELSAT 10A **(part of EUMETSAT's network)**

➢ **Access to NOA's in-situ monitoring seismological, magnetometer, and GPS networks**

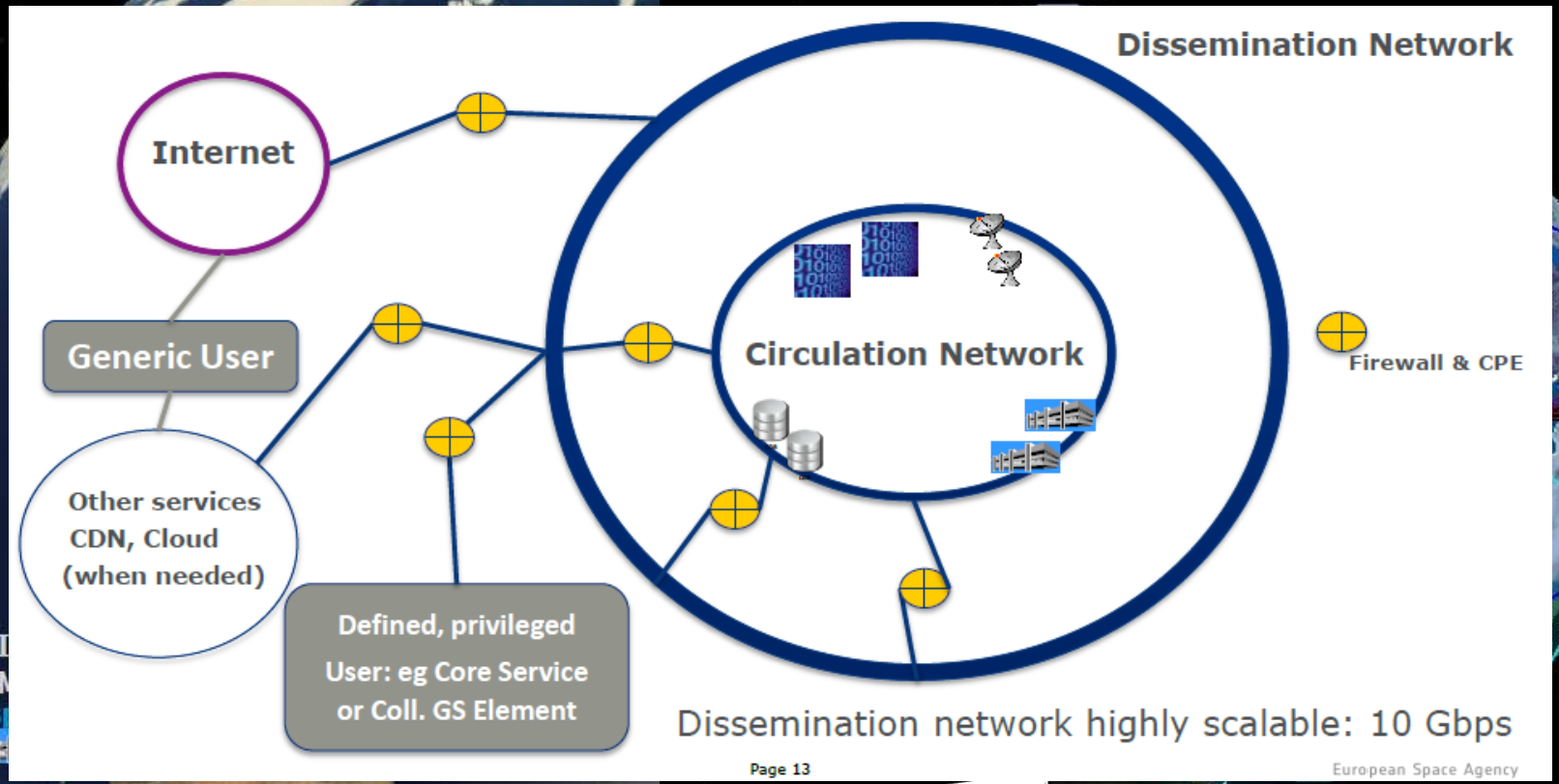
IAASARS/NOA MSG SEVIRI Acquisition station DVB-S2

Infrastructure Capacity Building

➢**Develop and Operate of NOA's Collaborative Ground Segment (Hellenic Sentinel Data Hub-**

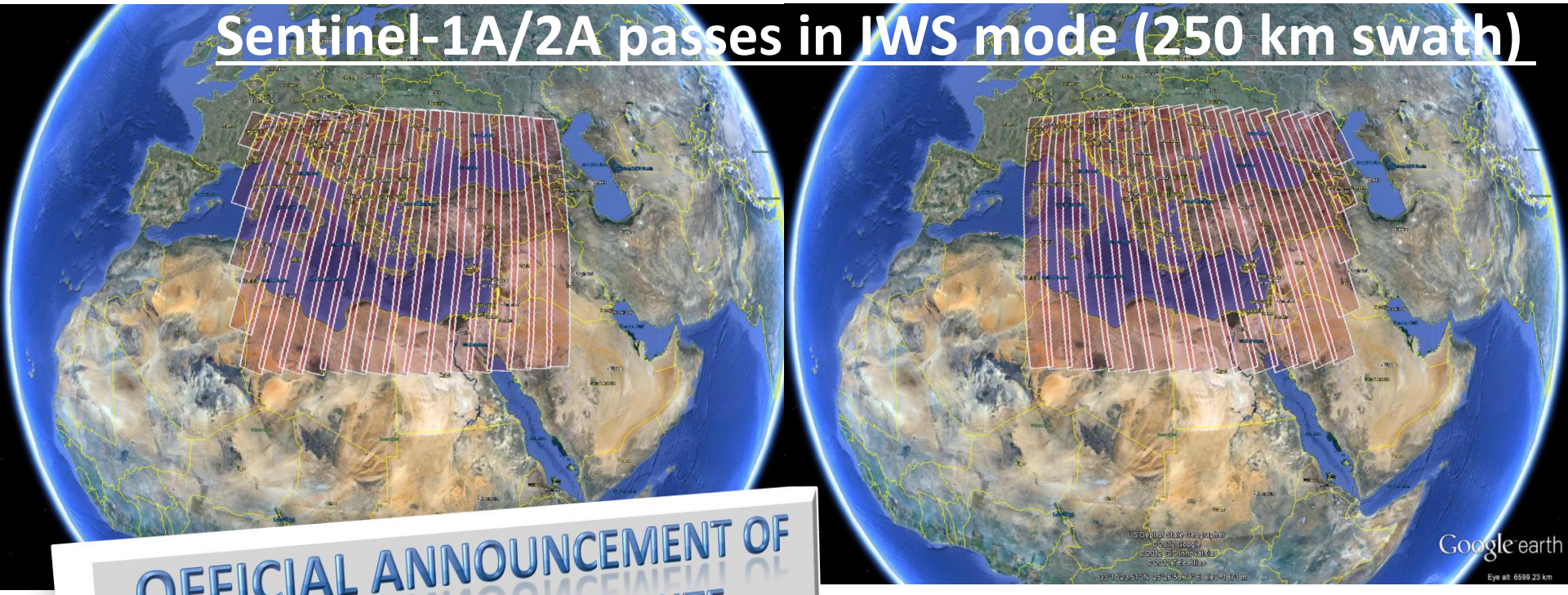
Activity in the framework of the
COPERNICUS PROGRAM
The EUROPEAN EARTH OBSERVATION FLAGSHIP PROGRAM (EU/ESA)
http://www.copernicus.eu/

- **a GSC Core Ground Segment**, with **GSC-funded Functions and Elements**, providing :
  - the primary access to Sentinel Missions data as well as
  - the coordinating access functions to Contributing Missions data



Hellenic Sentinel Data Hub- Mirror Site

Sentinel-1A/2A passes in IWS mode (250 km swath)



OFFICIAL ANNOUNCEMENT OF HELLENIC MIRROR SITE ATHENS SPACE EXPO: 28 MARCH – 5 APRIL

HTTP://SENTINELS.SPACE.NOA.GR

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SciNet

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Operation of the mobile lidar of ESA by IAASARS

Development of a state-of-the-art multi-wavelength lidar to be installed in Crete (FKL), in the framework of the BEYOND project, part of the EARLINET network.

Infrastructure Capacity Building

ACHIEVEMENTS – EO SERVICES

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Service	Status	End Users	Scale
EMERGENCY RESPONSE/EMERGENCY SUPPORT-METEO RELATED HAZARDS			
Real Time Fire Monitoring	Operational GMES Standard	Fire Brigades, Civil Protection, Public, Private Sector	National Regional
Rapid Fire Mapping	Operational GMES Standard	Fire Brigades, Civil Protection, Forestry Services, Min of Env	Regional Local
Disaster Event Mapping & Damage Ass.	Operational GMES Standard	Forestry Services, Min of Env (DG for Nat. Vegetation/Forest Protection	Local
Seasonal/Diachronic Fire Mapping & Damage Ass.	Operational GMES Standard	Forestry Services, Min of Env (DG for Nat. Vegetation/Forest Protection, Cadastral Org, Fire Brigades	National
Wild Fire Smoke Dispersion	Research/ Preoperational	Fire Brigades, Civil Protection, Min of Env	Regional Local
Saharian Dust Episodes	Research/ Preoperational	Civil Protection, Min of Env, Public	National
Flood Risk	Research/ Preoperational	National Electric Power Org, Min of Development, Local Authorities, Civil Protection	Regional Local
Heat Waves Risk	Research/ Preoperational	Min of Public Health, Local Authorities, Medical Science	Local

Web service

Web service

Delivered

To be Delivered as V1.0 in 2014

To be Delivered as V1.0 in 2015-2016

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EMERGENCY RESPONSE/EMERGENCY SUPPORT- GEO- HAZARDS				
Earthquake related crustal deformation field	Operational GMES Standard	Anti-seismic Planning& Protection Org, EQ Scientists	Local	Delivered
Volcano related surface velocity field	Operational GMES Standard	Anti-seismic Planning& Protection Org, Local Authorities, EQ Scientists	Local	
Landslide related surface velocity field	Research	Anti-seismic Planning& Protection Org, Local Authorities, Enterpreneurs, Civ. Eng, Geologists	Local	To be Delivered as V1.0 in 2014
ATMOSPHERIC DISTURBANCES - CLIMATOLOGY				
3D-Climatology	Operational GMES Standard	Cal/Val Industry, Global Atm Monitoring Networks	Global	
Atmospheric Episodes	Research	Cal/Val Industry, Global Atm Monitoring Networks,	Local	
LULC CHANGE MONITORING – UAV / AIRBORNE / SATELLITE				
Urban Mapping	Operational GMES Standard	World Bank, EIB, Min of Env, Cadastral Org	Local	To be Delivered as V1.0 in 2015-2016
UAV Damage Recording	**Research/ Preoperational**	**Anti-seismic Planning and Protection Organisation**	**Local**	
Ecosystem Monitoring and Mapping (Forests/Wetlands)	Operational	Min of Env, Hellenic Biotope & Wetlands Center, Cadastral Org	National Regional	

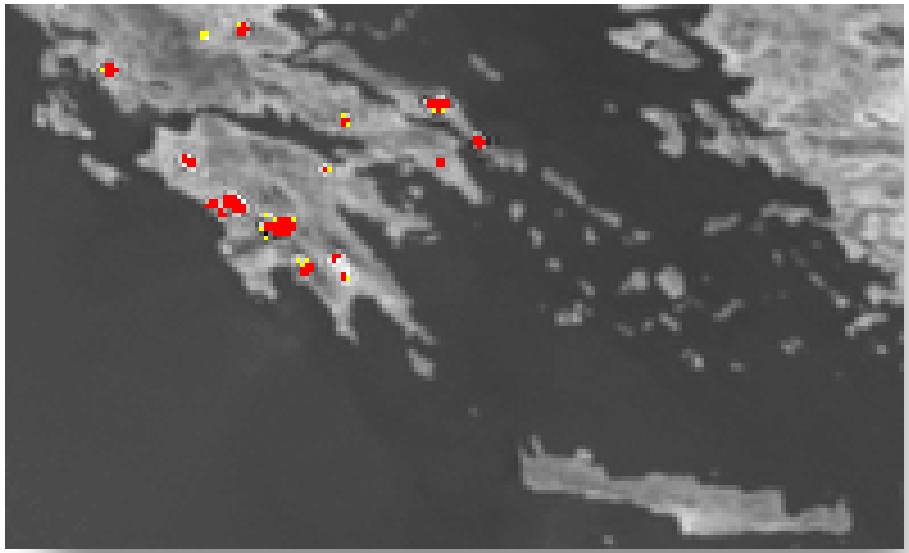
Web service

"FireHub: A Space Based Fire Management Hub "

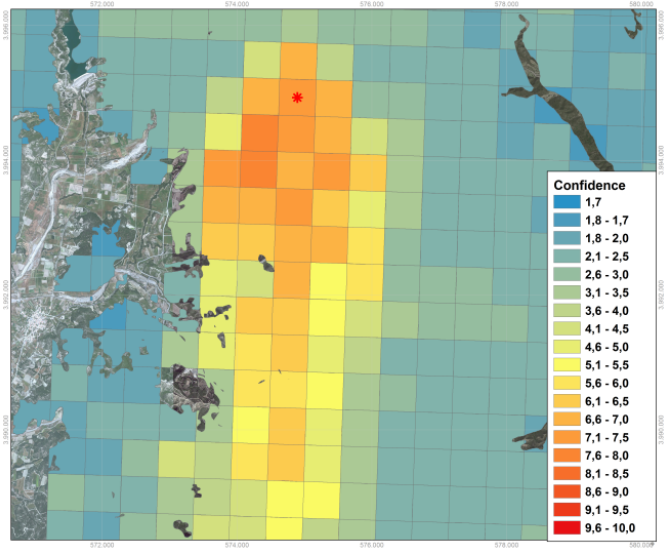
"FireHub: A Space Based Fire Management Hub "

The service consists of three pillars:

1. The real-time fire detection and monitoring application
2. The large scale Burnt Scar Mapping during and after wildfires and the Diachronic BSM
3. The fire smoke dispersion forecasting tool



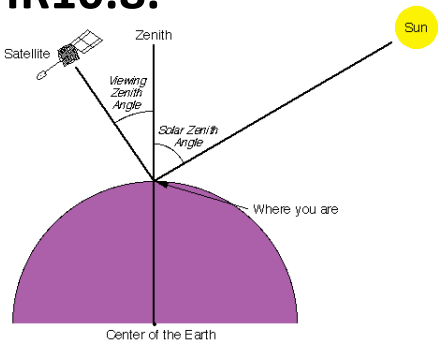
Raw resolution: 3.5x3.5 km wide pixel over entire



Refined resolution: 0.5x0.5 km wide pixel over entire Greece

CLASSIFICATION PROCESS

Classification #1: The EUMETSAT Fire mapping algorithm (FIR) based on fixed thresholding approach, applied on the spectral bands **IR 3.9** and **IR10.8.**

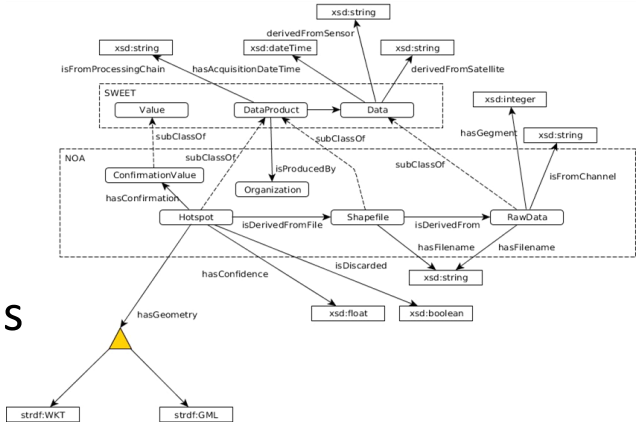


Classification enhancement # 1: **The thresholds are dynamically changing calculated** for each image and every pixel location on the basis of the seasonally variations and time depended Solar Zenith Angle.

Classification enhancement # 2 : **Create and integrate classification evidence through geo-spatial ontology schemes and reasoning queries, accounting for the**

a) thematic consistency by eliminating false alarms, and

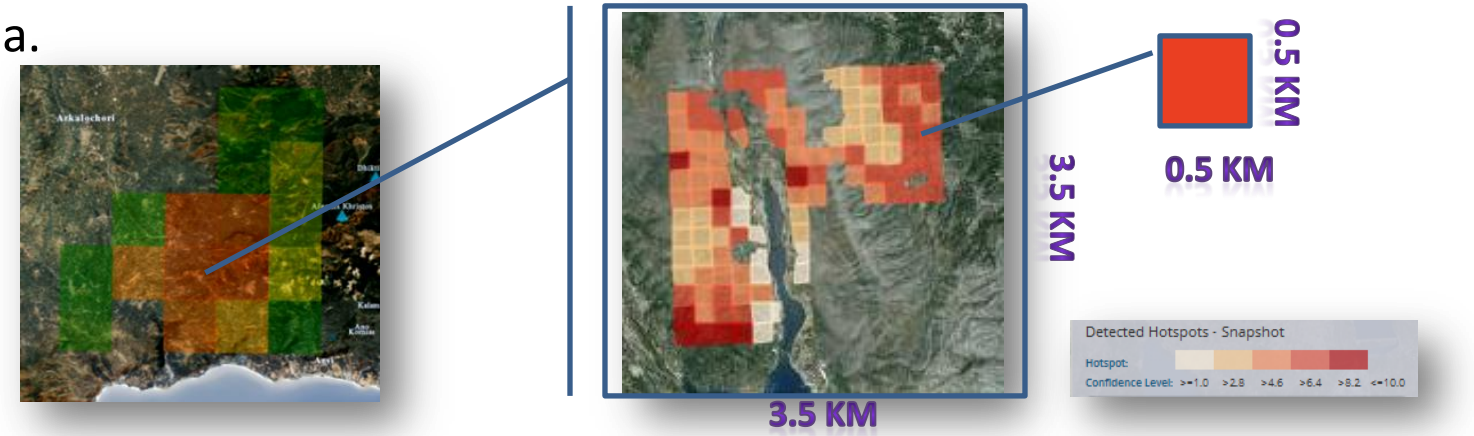
b) account for the time persistence of the fire observations



CLASSIFICATION PROCESS

Classification enhancement # 3: Downscaling the first classification output and calculate the fire occurrence probability in sub-areas of 500 m x 500 m wide, inside the initial observation area of 3.5km x 3.5 km, accounting for the real meteorological, physical / ecological, and morphological conditions in the affected area such as,

a) Wind conditions (speed/direction), **b)** Fuel types and fuel type's proneness to fire, **c)** Altitudinal zone, **d)** Slope and Aspect elements of each of the 500m x500m area.



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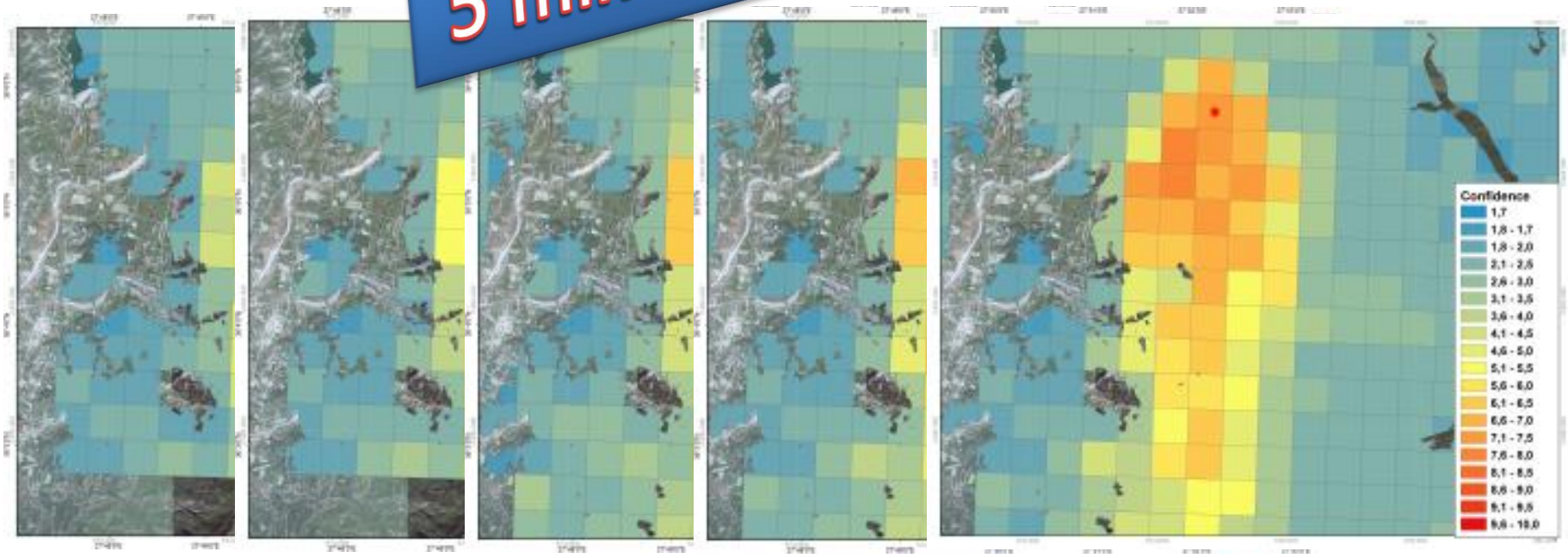
Regional Real Time Fire Monitoring - NOA's MSG SEVIRI Station

Results @ 150 minutes after fire ignition

+30’ +35’ +40’ +45’ +50’

5 minutes basis



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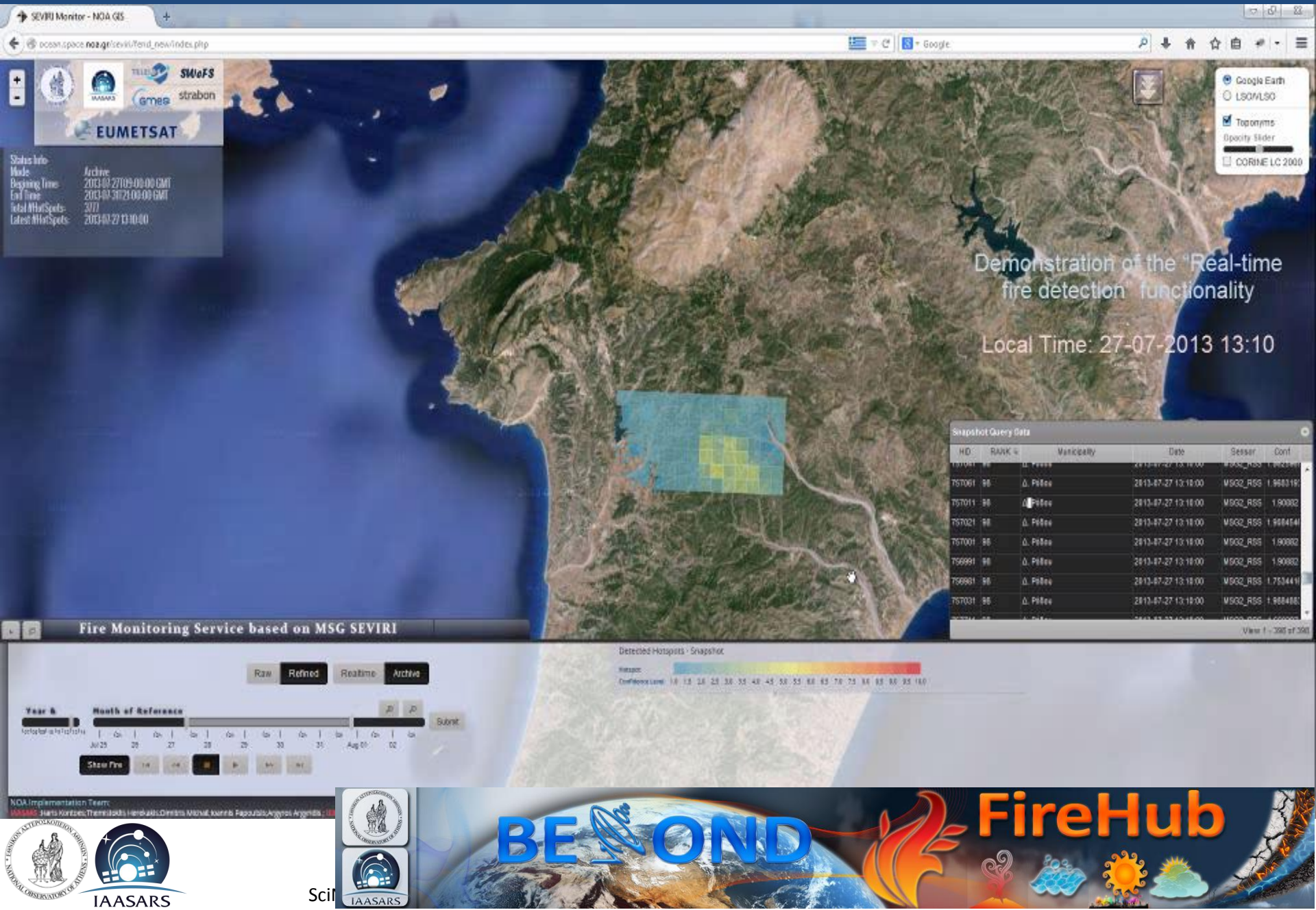

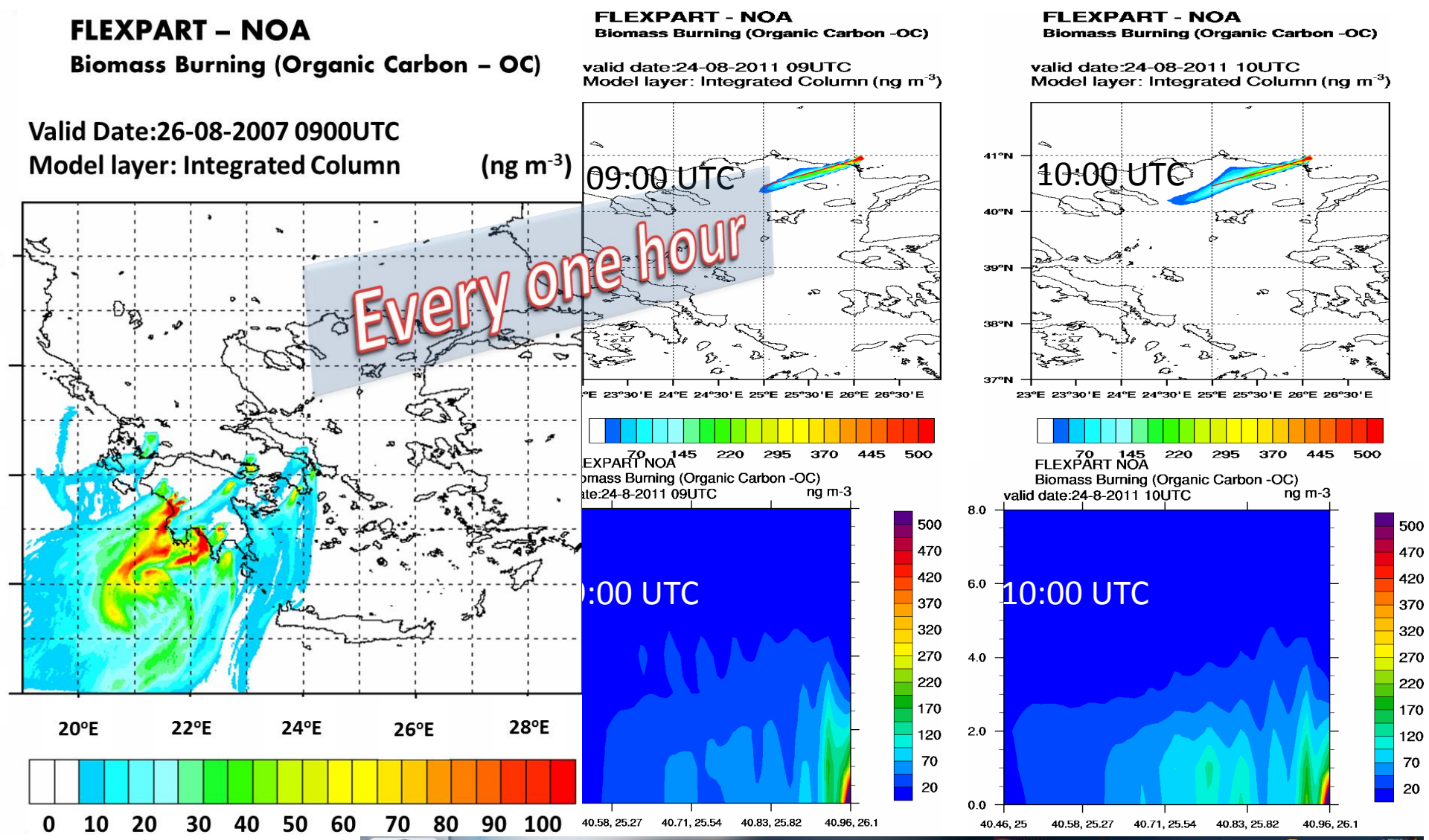
FLEXPART – NOA
Biomass Burning (Organic Carbon – OC)
Valid Date:26-08-2007 0900UTC
Model layer: Integrated Column (ng m-3)
Every one hour
20°E 22°E 24°E 26°E 28°E
0 10 20 30 40 50 60 70 80 90 100
FLEXPART - NOA
Biomass Burning (Organic Carbon -OC)
valid date:24-08-2011 09UTC
Model layer: Integrated Column (ng m-3)
09:00 UTC
23°30'E 24°E 24°30'E 25°E 25°30'E 26°E 26°30'E
70 145 220 295 370 445 500
FLEXPART - NOA
Biomass Burning (Organic Carbon -OC)
valid date:24-8-2011 09UTC
ng m-3
:00 UTC
500 470 420 370 320 270 220 170 120 70 20
40.58, 25.27 40.71, 25.54 40.83, 25.82 40.96, 26.1
FLEXPART - NOA
Biomass Burning (Organic Carbon -OC)
valid date:24-08-2011 10UTC
Model layer: Integrated Column (ng m-3)
10:00 UTC
41°N 40°N 39°N 38°N 37°N
23°E 23°30'E 24°E 24°30'E 25°E 25°30'E 26°E 26°30'E
70 145 220 295 370 445 500
FLEXPART NOA
Biomass Burning (Organic Carbon -OC)
valid date:24-8-2011 10UTC
ng m-3
10:00 UTC
8.0 6.0 4.0 2.0 0.0
500 470 420 370 320 270 220 170 120 70 20
40.46, 25 40.58, 25.27 40.71, 25.54 40.83, 25.82 40.96, 26.1

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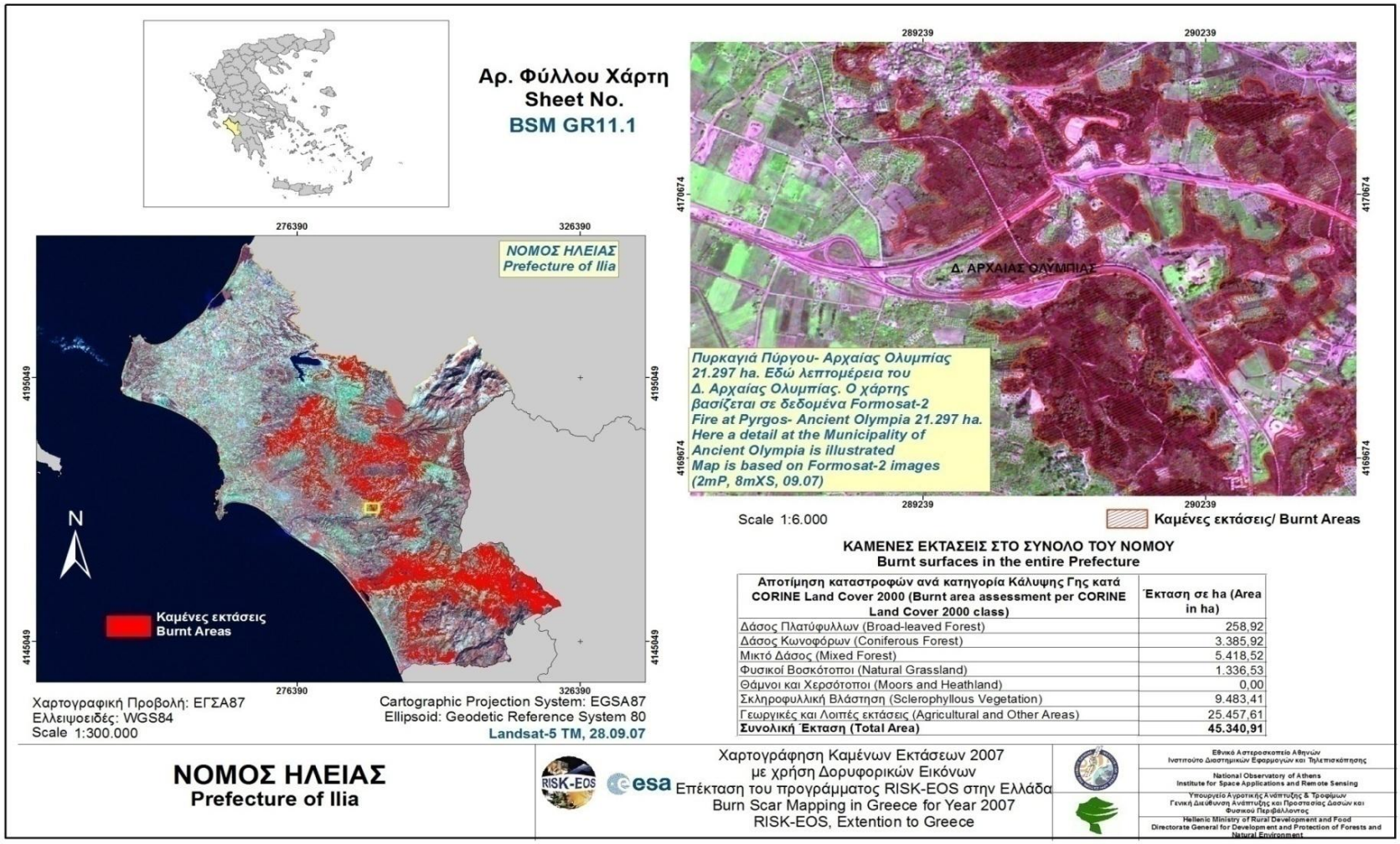
FireHub
IAASARS


Αρ. Φύλλου Χάρτη
Sheet No.
BSM GR11.1
ΝΟΜΟΣ ΗΛΕΙΑΣ
Prefecture of Ilia
Καμένες εκτάσεις
Burnt Areas
N
276390
326390
4195049
4145049
Δ. ΑΡΧΑΙΑΣ ΟΛΥΜΠΙΑΣ
Πυρκαγιά Πύργου- Αρχαίας Ολυμπίας
21.297 ha. Εδώ λεπτομέρεια του
Δ. Αρχαίας Ολυμπίας. Ο χάρτης
βασίζεται σε δεδομένα Formosat-2
Fire at Pyrgos- Ancient Olympia 21.297 ha.
Here a detail at the Municipality of
Ancient Olympia is illustrated
Map is based on Formosat-2 images
(2mP, 8mXS, 09.07)
289239
290239
4170674
4169674
Scale 1:6.000
Καμένες εκτάσεις/ Burnt Areas
ΚΑΜΕΝΕΣ ΕΚΤΑΣΕΙΣ ΣΤΟ ΣΥΝΟΛΟ ΤΟΥ ΝΟΜΟΥ
Burnt surfaces in the entire Prefecture
Αποτίμηση καταστροφών ανά κατηγορία Κάλυψης Γης κατά CORINE Land Cover 2000 (Burnt area assessment per CORINE Land Cover 2000 class)
Έκταση σε ha (Area in ha)
Δάσος Πλατύφυλλων (Broad-leaved Forest) 258,92
Δάσος Κωνοφόρων (Coniferous Forest) 3.385,92
Μικτό Δάσος (Mixed Forest) 5.418,52
Φυσικοί Βοσκότοποι (Natural Grassland) 1.336,53
Θάμνοι και Χερσότοποι (Moors and Heathland) 0,00
Σκληροφυλλική Βλάστηση (Sclerophyllous Vegetation) 9.483,41
Γεωργικές και Λοιπές εκτάσεις (Agricultural and Other Areas) 25.457,61
Συνολική Έκταση (Total Area) 45.340,91
Χαρτογραφική Προβολή: ΕΓΣΑ87
Ελλειψοειδές: WGS84
Scale 1:300.000
Cartographic Projection System: EGSA87
Ellipsoid: Geodetic Reference System 80
Landsat-5 TM, 28.09.07
ΝΟΜΟΣ ΗΛΕΙΑΣ
Prefecture of Ilia
RISK-EOS
esa
Χαρτογράφηση Καμένων Εκτάσεων 2007
με χρήση Δορυφορικών Εικόνων
Επέκταση του προγράμματος RISK-EOS στην Ελλάδα
Burn Scar Mapping in Greece for Year 2007
RISK-EOS, Extention to Greece
Εθνικό Αστεροσκοπείο Αθηνών
Ινστιτούτο Διαστημικών Εφαρμογών και Τηλεπισκόπησης
National Observatory of Athens
Institute for Space Applications and Remote Sensing
Υπουργείο Αγροτικής Ανάπτυξης & Τροφίμων
Γενική Διεύθυνση Ανάπτυξης και Προστασίας Δασών και Φυσικού Περιβάλλοντος
Hellenic Ministry of Rural Development and Food
Directorate General for Development and Protection of Forests and Natural Environment

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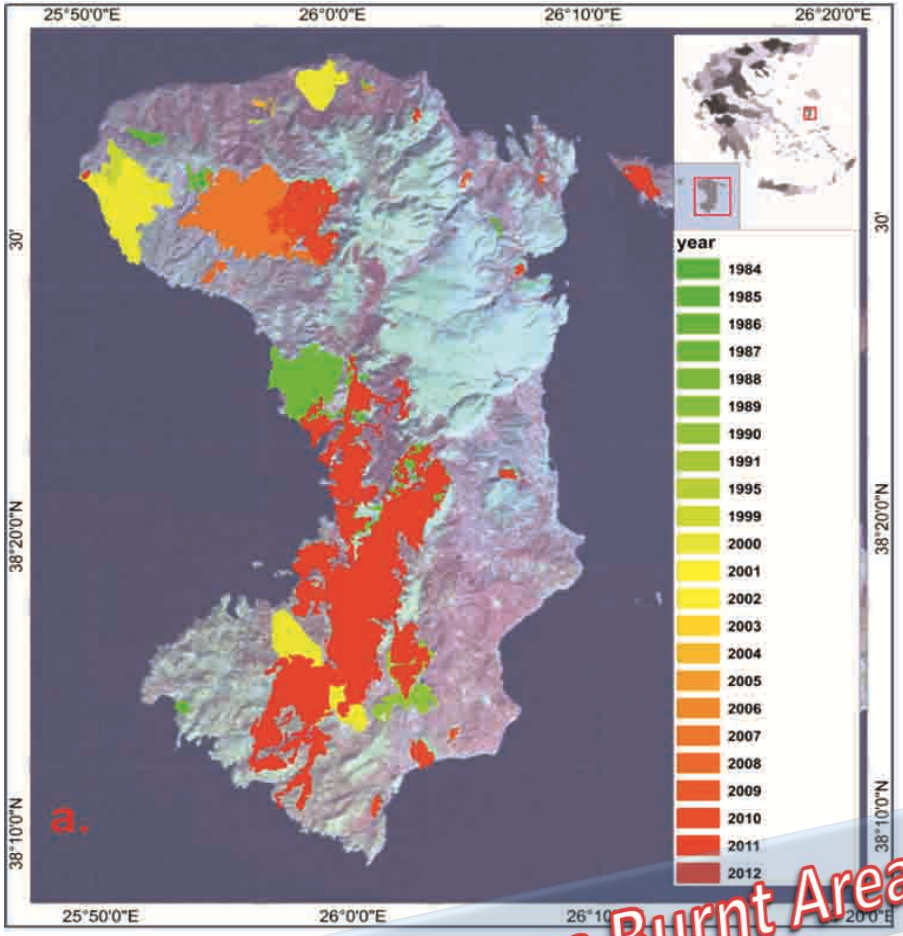

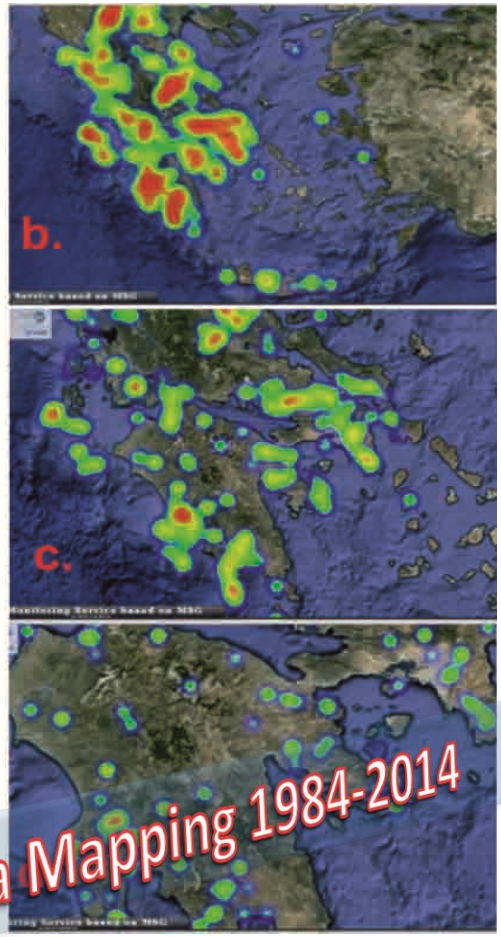

30 Years Burnt Area Mapping 1984-2014

1) More than 650 Landsat TM images acquired over Greece in the period 1984-2013 residing on USGS archives were downloaded and processed fully automatically using the NOA processing chain.

2) Yearly maps of Burned Areas have been produced

3) Yearly statistics per land cover type and administrative data have been generated

4)On-line dissemination of the produced maps and statistics through the NOA's dedicated web interface

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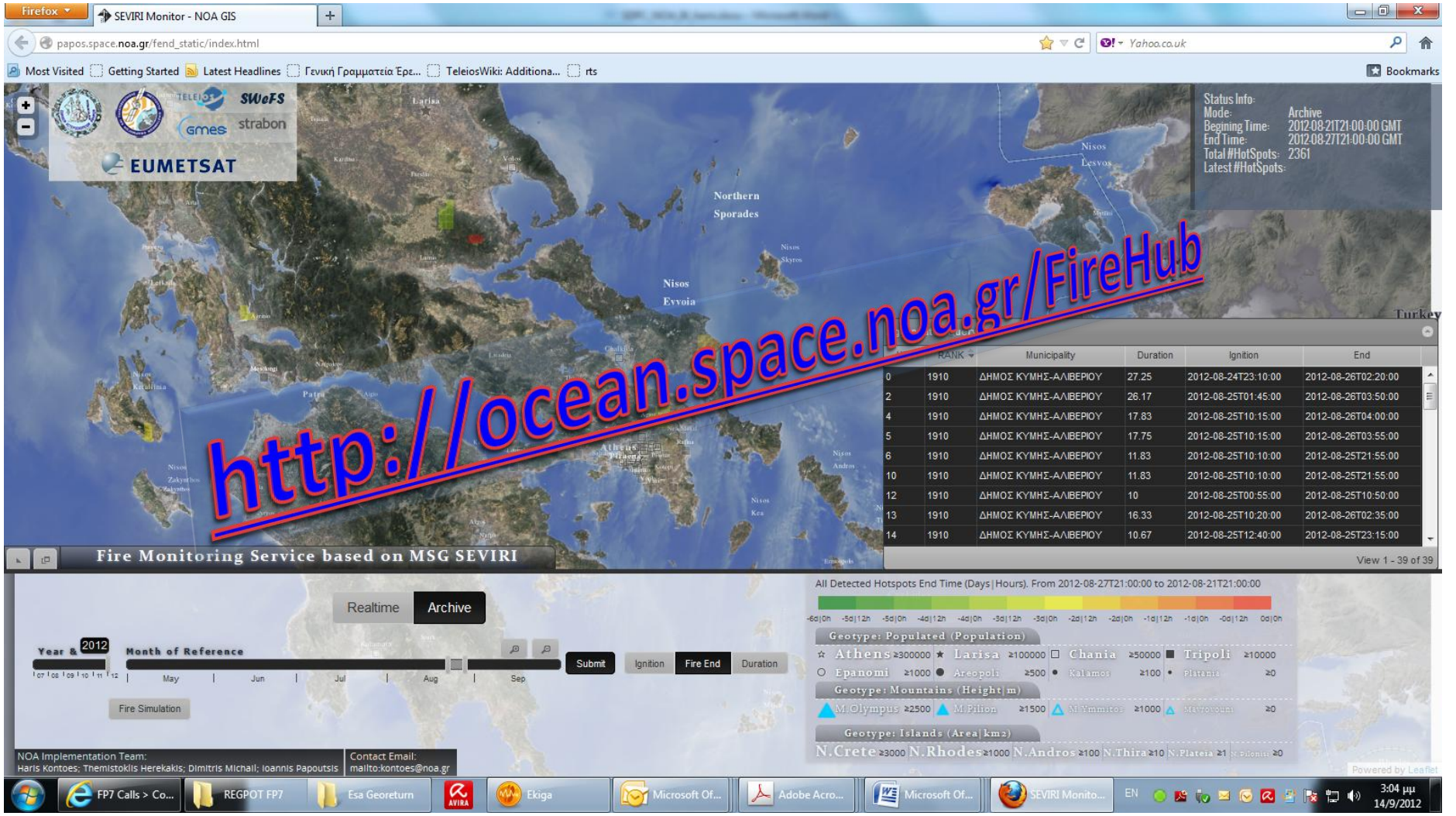
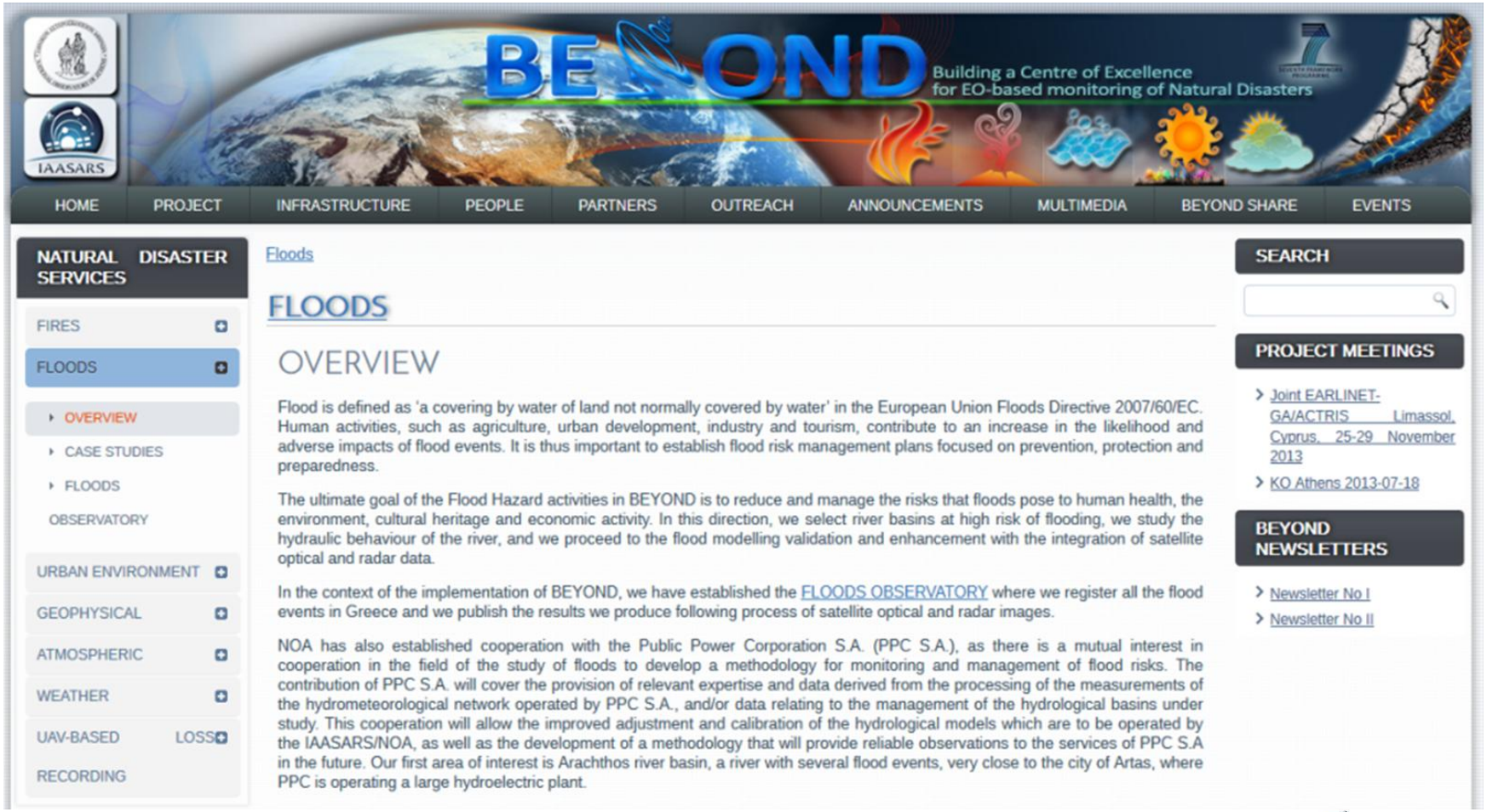


IAASARS

National Observatory of Athens
Continuous offer to the Scientific Research since 1842
Greek General Secretariat for Research and Technology
Event Logo
http://ocean.space.noa.gr/bsm
DIACHRONIC INVENTORY OF FOREST FIRES OVER GREECE FROM 1984 TO PRESENT, WITH USE OF LANDSAT 4,5,7 SATELLITE DATA
URL: http://www.noa.gr

BEYOND for flood monitoring

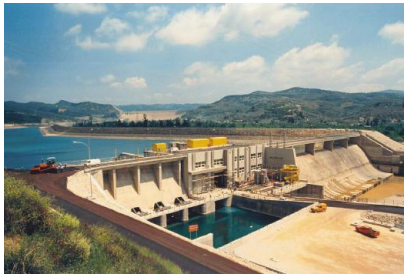


We have established the **BEYOND Floods Observatory** where we register all the major flood events in Greece and South-Eastern Europe.

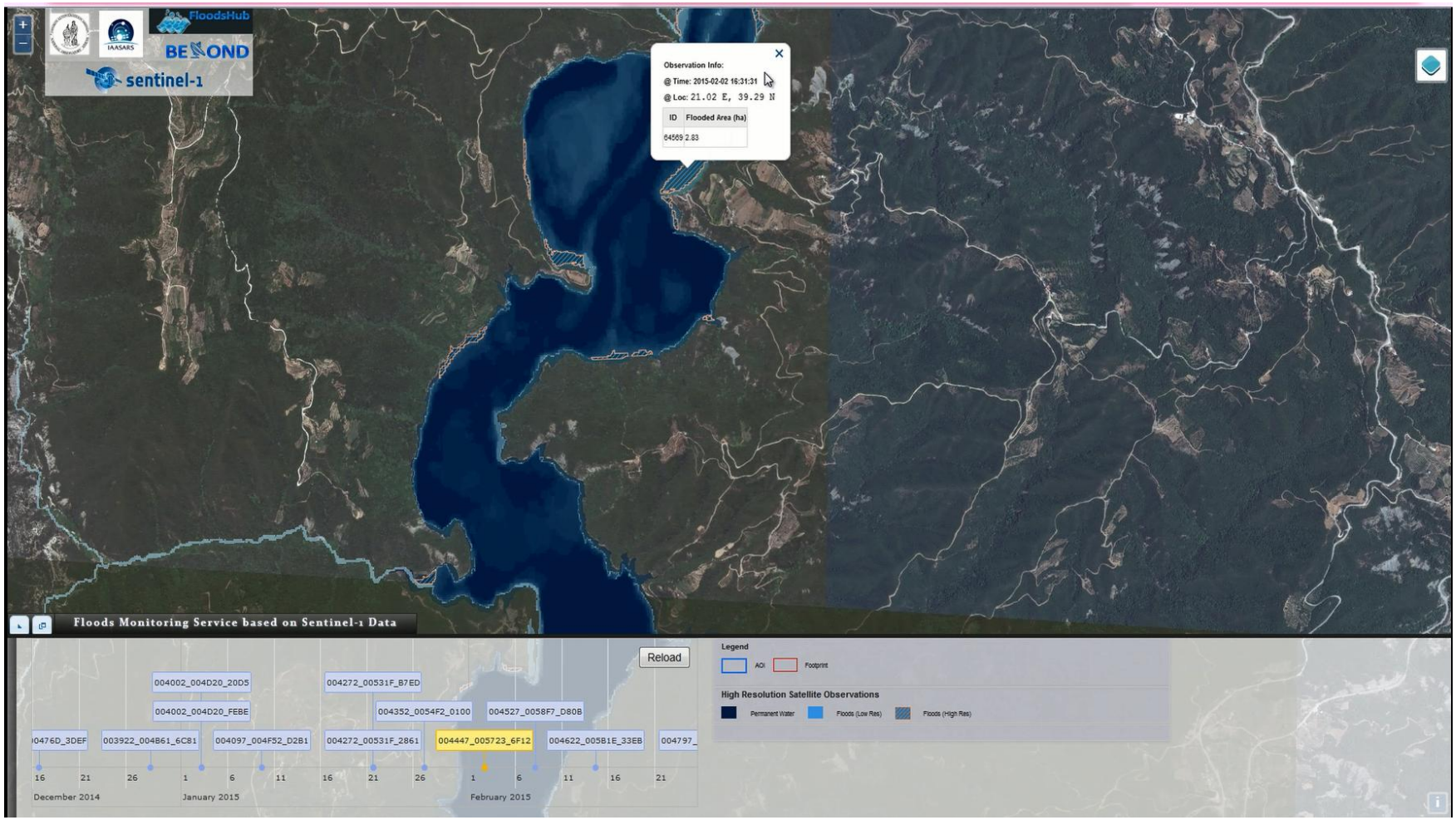
BEYOND Floods Early Warning System

This cooperation allows the improved adjustment and calibration of the hydrological and hydraulic models which are operated by NOA, as well as the development of a methodology that will provide reliable products and services to PPC S.A.

CASE STUDY:
The first case study is the river basin of Arachthos, a river with several flood events, upstream of the city of Arta, where PPC S.A. is operating two hydroelectric plants:
1) a large one known as Pournari I (effective capacity of reservoir 303 million m^3)
2) a smaller one known as Pournari II (effective capacity of reservoir 4 million m^3).

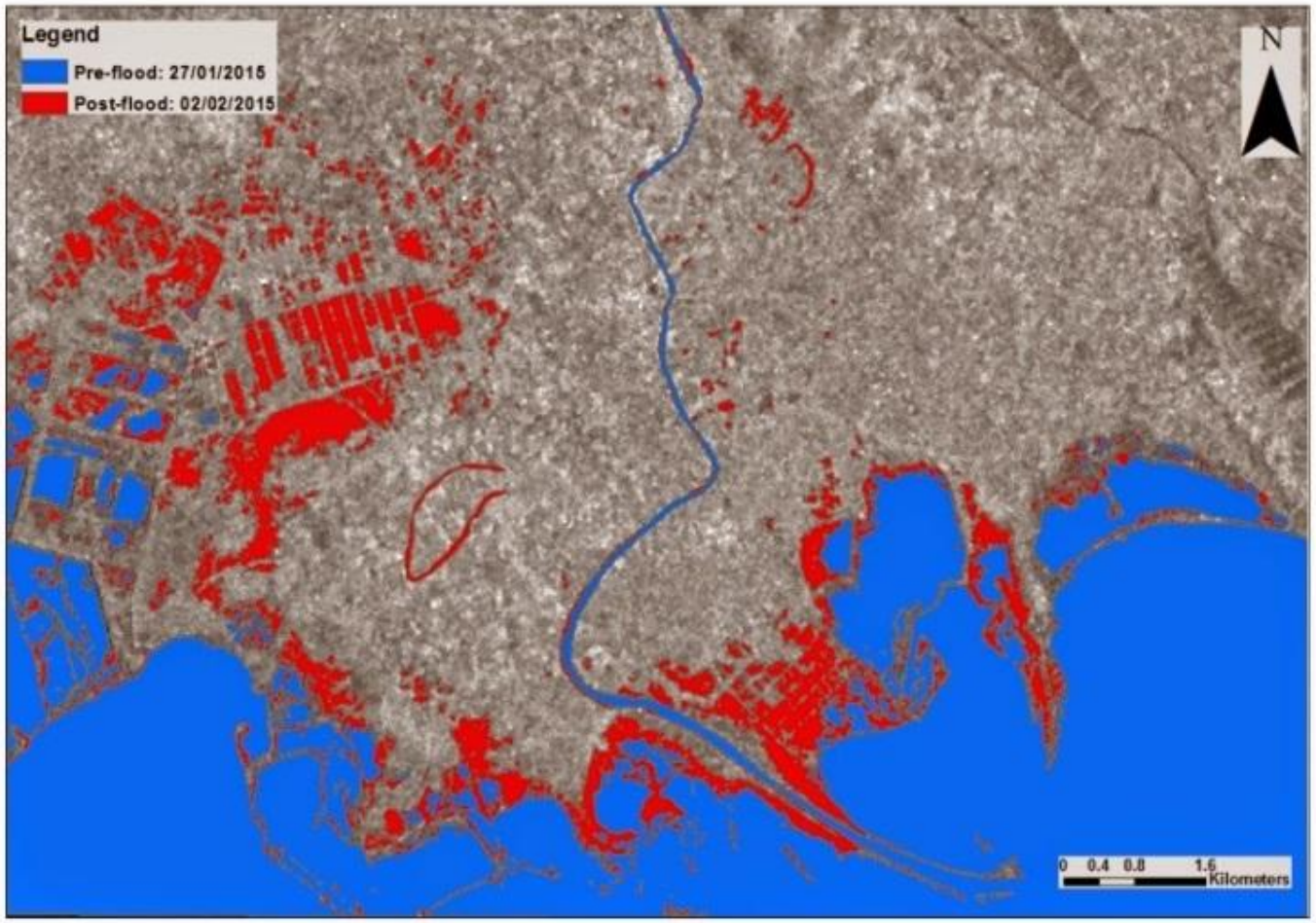


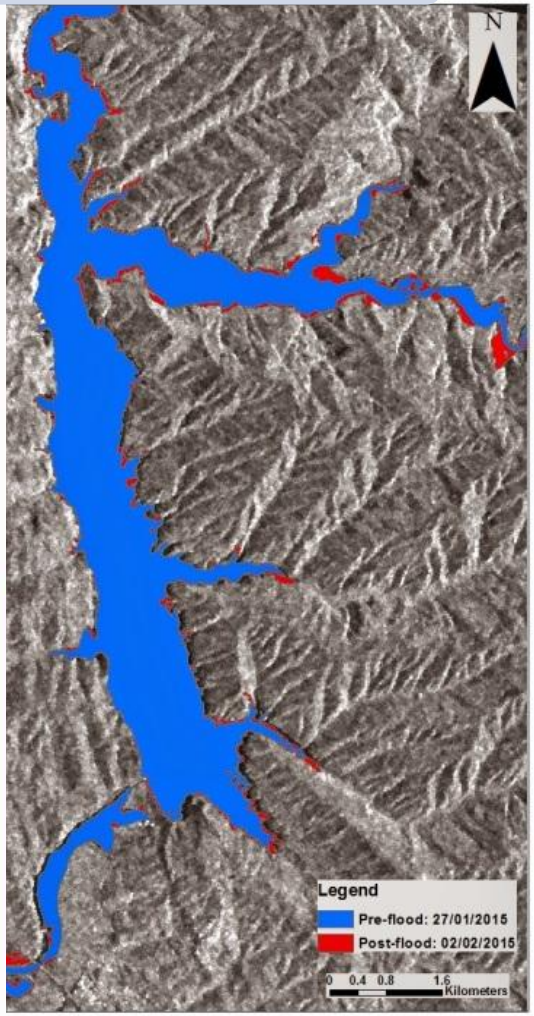
BEYOND's Floods Monitoring Service for Arachthos river basin



Project funded by the EUROPEAN UNION

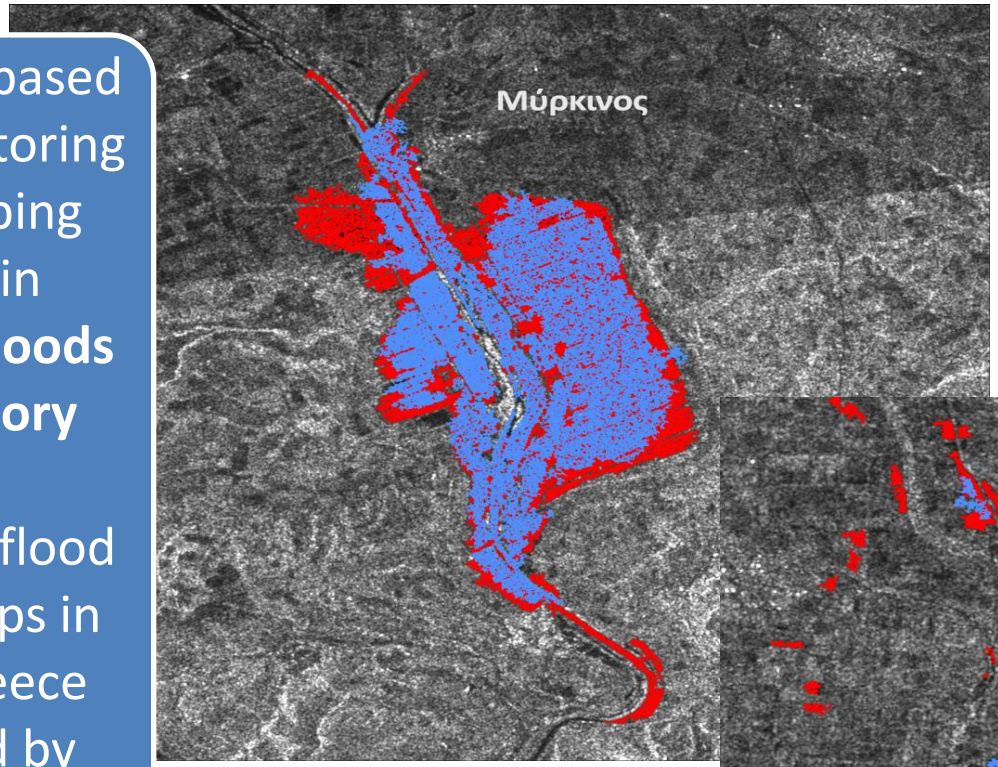
BEYOND NRT Flood Extend Assessment

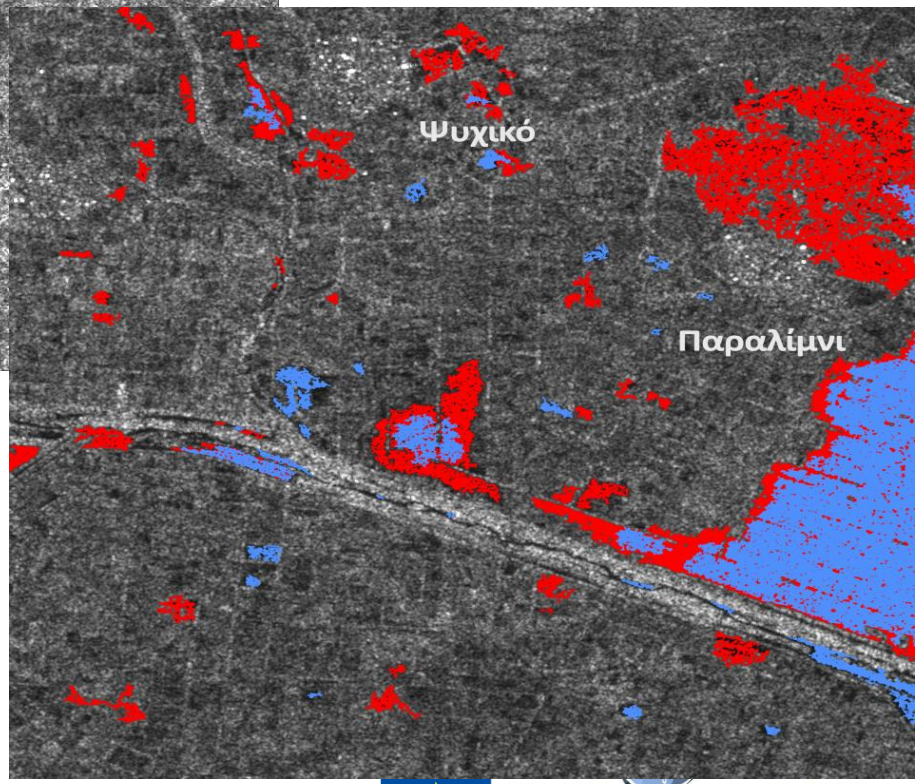




Sentinel-1 based flood monitoring and mapping service in **BEYOND Floods Observatory**

April 2015 flood extent maps in North Greece produced by automatic ingestion and processing of satellite radar images in RT





Geophysical hazards

Data & methods tier

NSN | ENIGMA | NOANET | In-situ

Earth Observation - SAR Interferometry

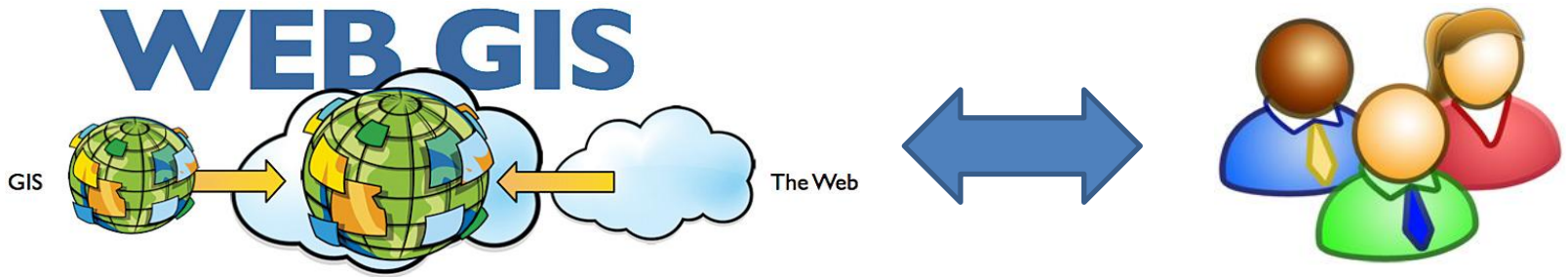
Services tier

Geodesy | Modeling | Hazard assessment | Large scale processing

Applications tier

Volcanoes | Tectonics | Landslides | Subsidence

Users tier



Geohazard services - An overview

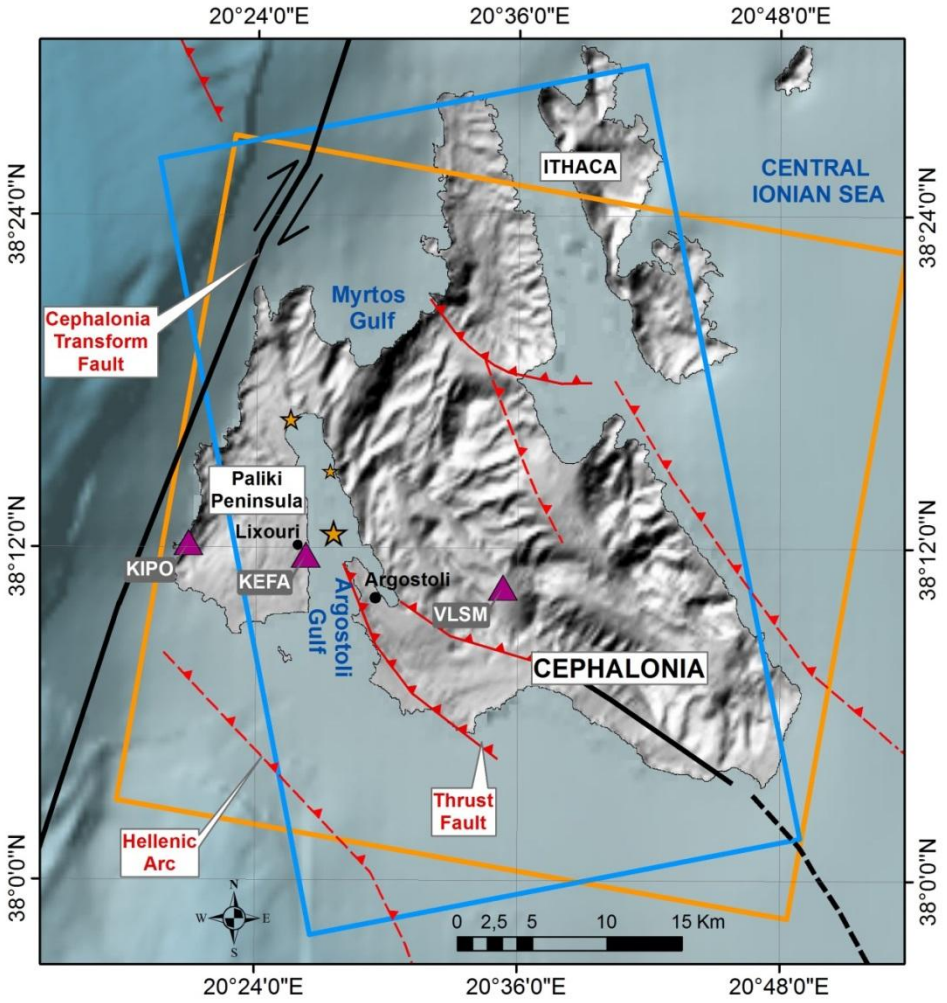
Service	Status	Input data	Scale
Mapping of large-scale ground velocities & 3D decomposition	Operational	SAR, GPS	National
Estimation of earthquke 3D crustal deformation	Operational	multi-angle SAR, GPS	Local
Seismic risk estimation	pre-operational	SAR, in-situ, GIS	Local
Mapping of tectonic hazard areas in subduction zones	Research	SAR, GPS	Regional
Monitoring of volcanic activity	Operational	SAR, GPS, in-situ	Local
Detection of new landslides	Operational	SAR	Local
Update of landslide inventory maps	pre-operational	SAR, in-situ	Local
Estimation of landslide susceptibility	pre-operational	SAR, in-situ, GIS	Local
Estimation of landslide hazard	Research	SAR, in-situ, GIS	Local
Detection of subsidence in urban & peri-urban areas due to manmade activities & physical processes	Operational	SAR, GPS	Local
Monitoring of construction activities in urban environment	Operational	SAR, GPS	Local

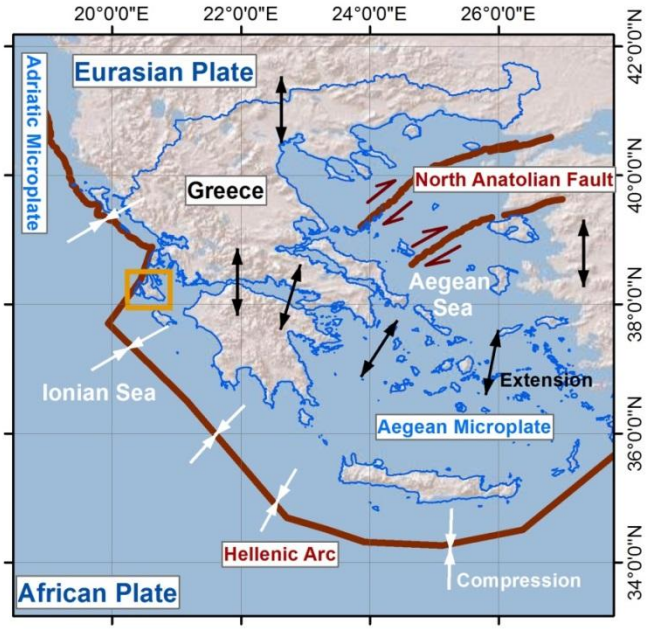
Earthquakes – Cephalonia case

Data
- NSN
- NOANET
- ENIGMA
- In-situ

Services
- Geodesy
- Modeling
- Hazard Ass.
- Large Proc.

Applications
- Tectonics
- Volcanoes
- Landslides
- Subsidence





Mapped faults
- Strike-slip inferred
- Strike-slip
- Reverse inferred
- Reverse

Main earthquake events
- 26/1/2014 ML 5,1
- 3/2/2014 ML 5,7
- 26/1/2-14 ML 5,9

GPS stations
- cGPS

SARframes
- COSMO-SkyMED
- TerraSAR-X

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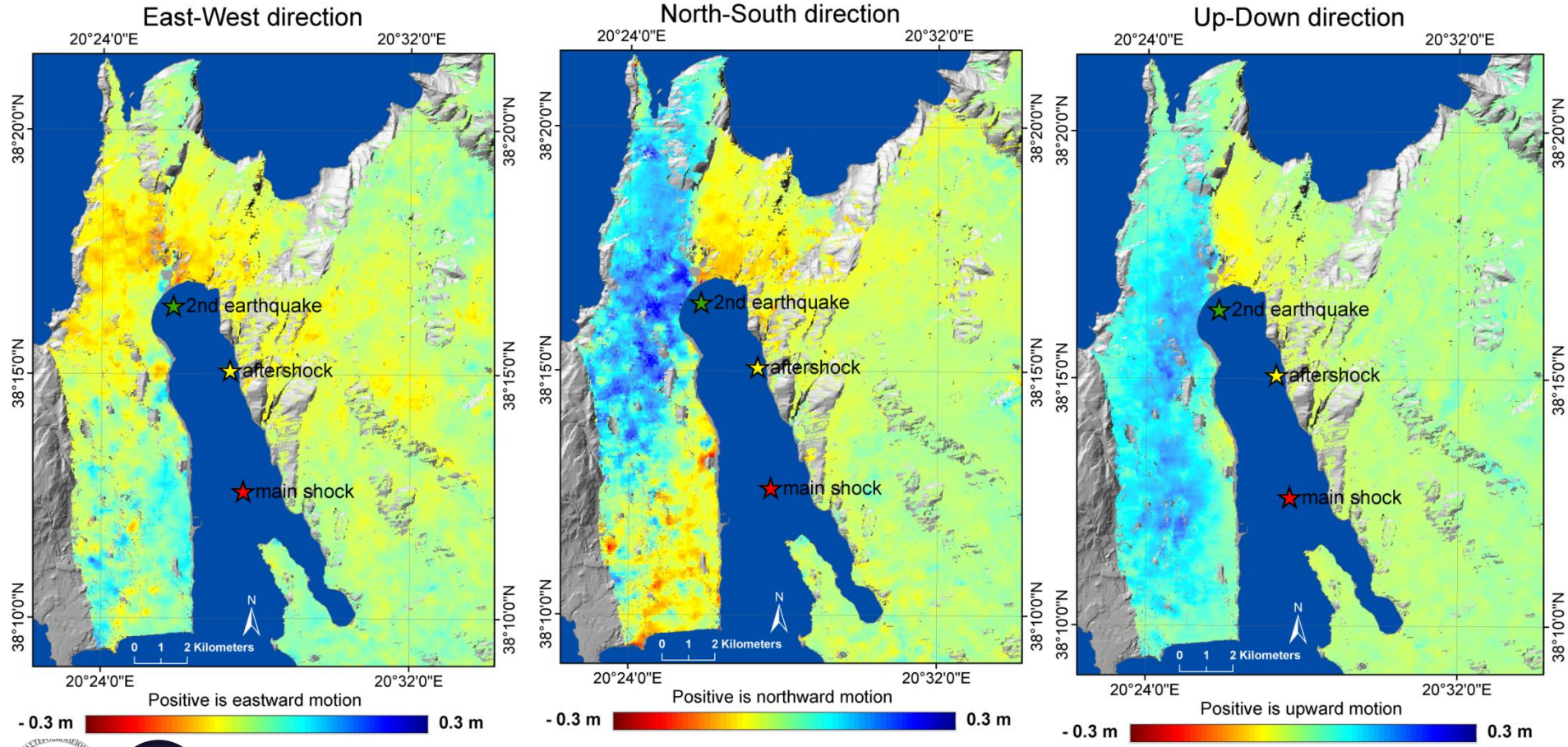
Earthquakes – Cephalonia case

- 3D crustal deformation from TerraSAR-X & COSMO-SkyMed data
- Inversion to estimate fault parameters



Merryman Boncori et al., SRL 2015

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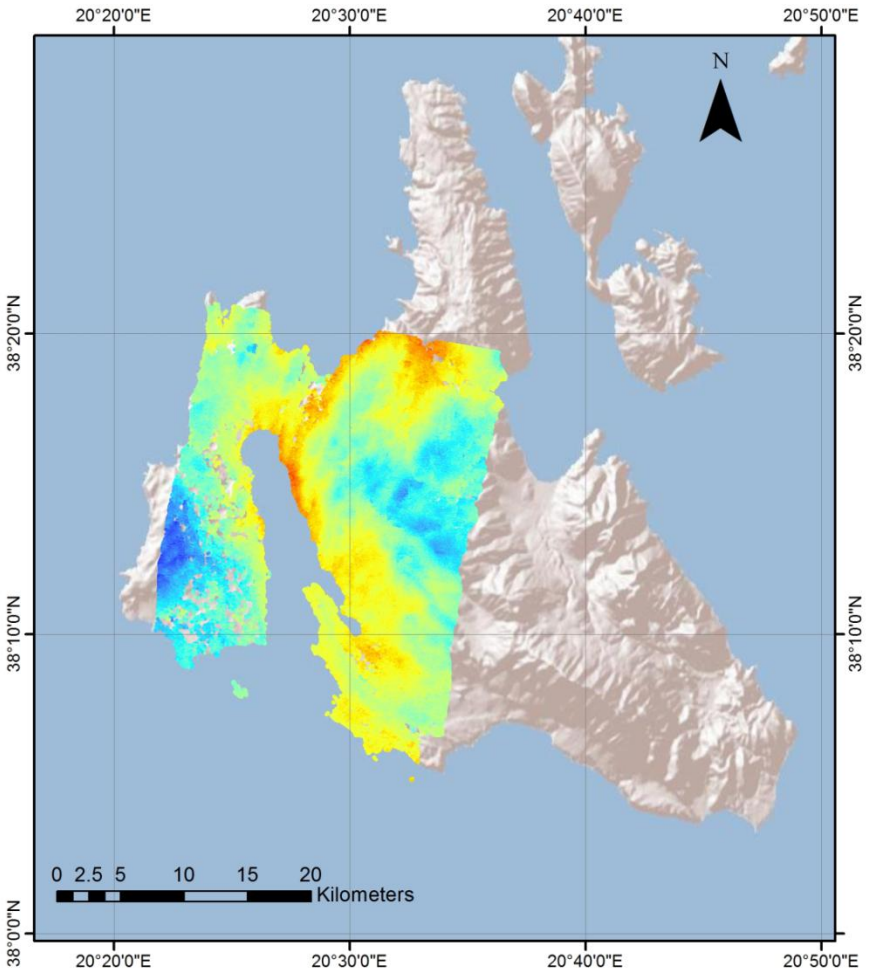
Earthquakes – Cephalonia case

Post-seismic slip, measured with COSMO-SkyMed data



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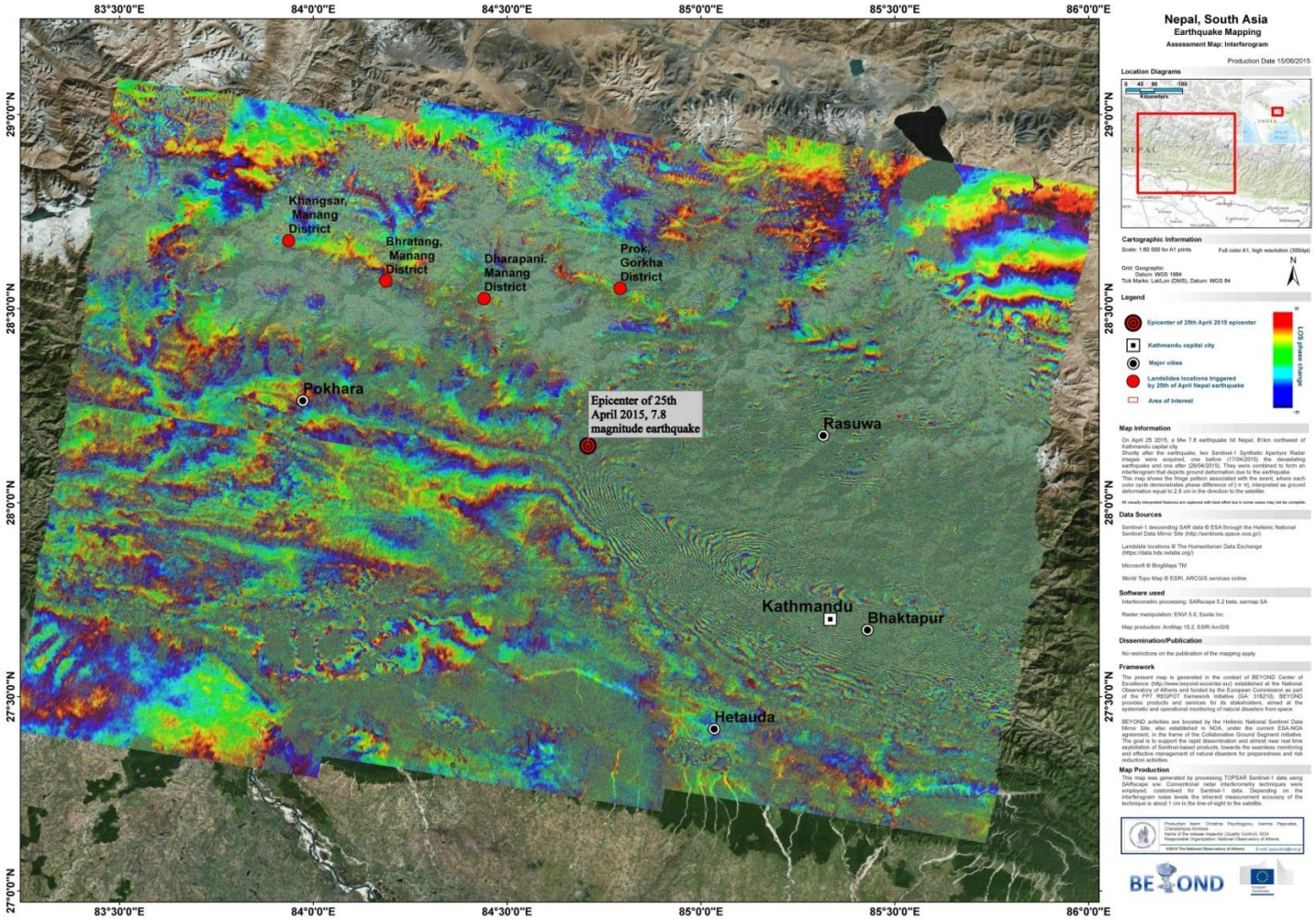
Earthquakes – Nepal

Data
- NSN
- NOANET
- ENIGMA
- In-situ

Services
- Geodesy
- Modeling
- Hazard Ass.
- Large Proc.

Applications
- Tectonics
- Volcanoes
- Landslides
- Subsidence



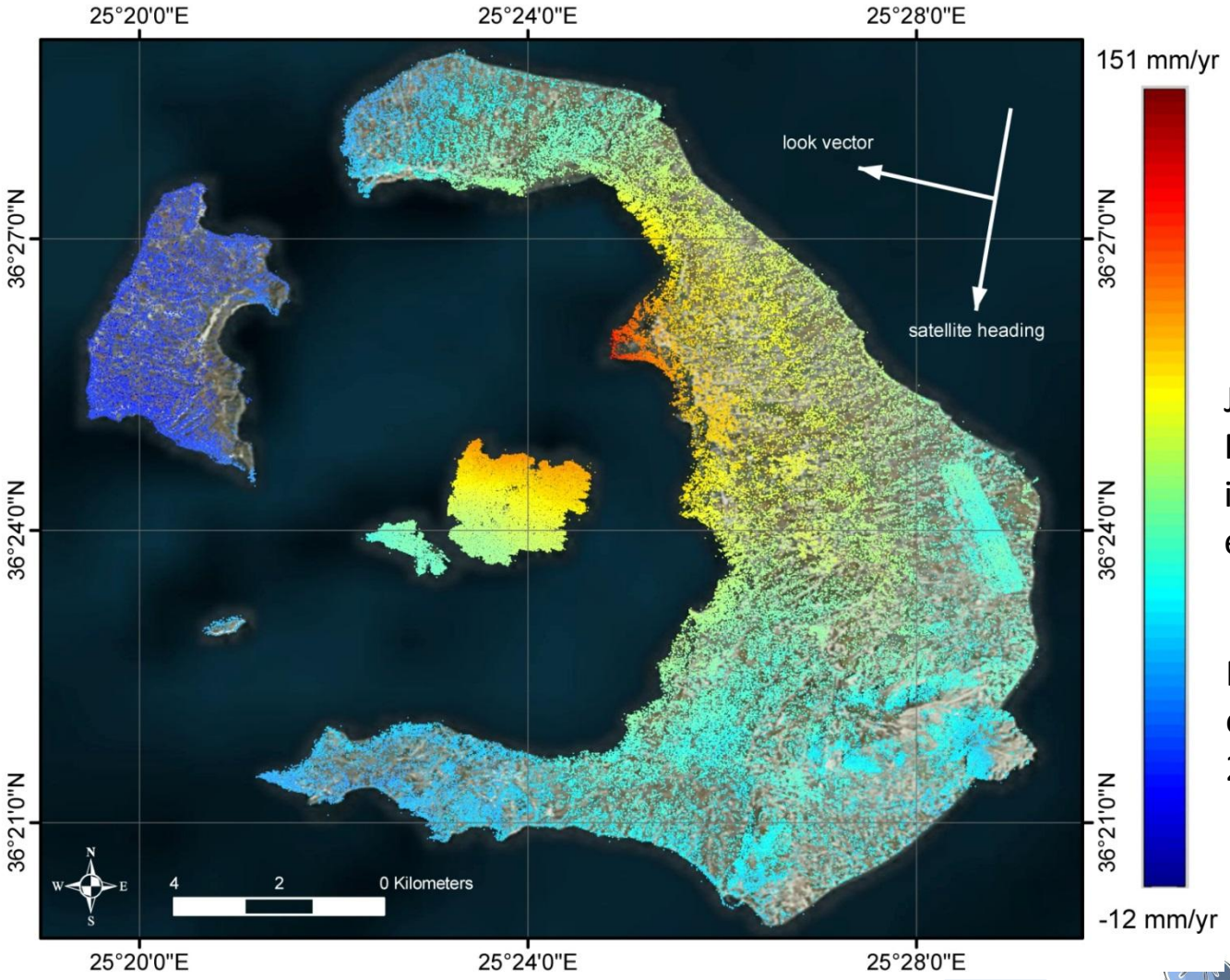
Project funded by the EUROPEAN UNION

Volcanoes – Santorini case

Data
- NSN
- NOANET
- ENIGMA
- In-situ

Services
- Geodesy
- Modeling
- Hazard Ass.
- Large Proc.

Applications
- Tectonics
- Volcanoes
- Landslides
- Subsidence



Jan. 2011 – Mar. 2012 inflation episode

Papoutsis et al., GRL 2013

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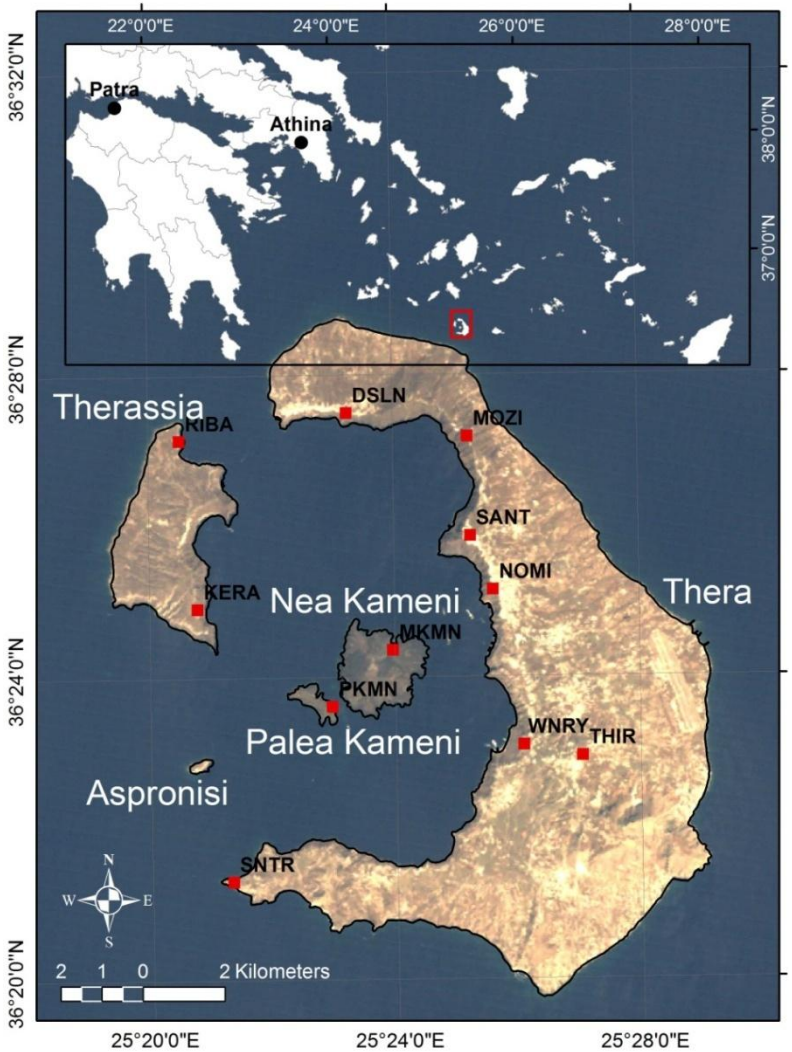
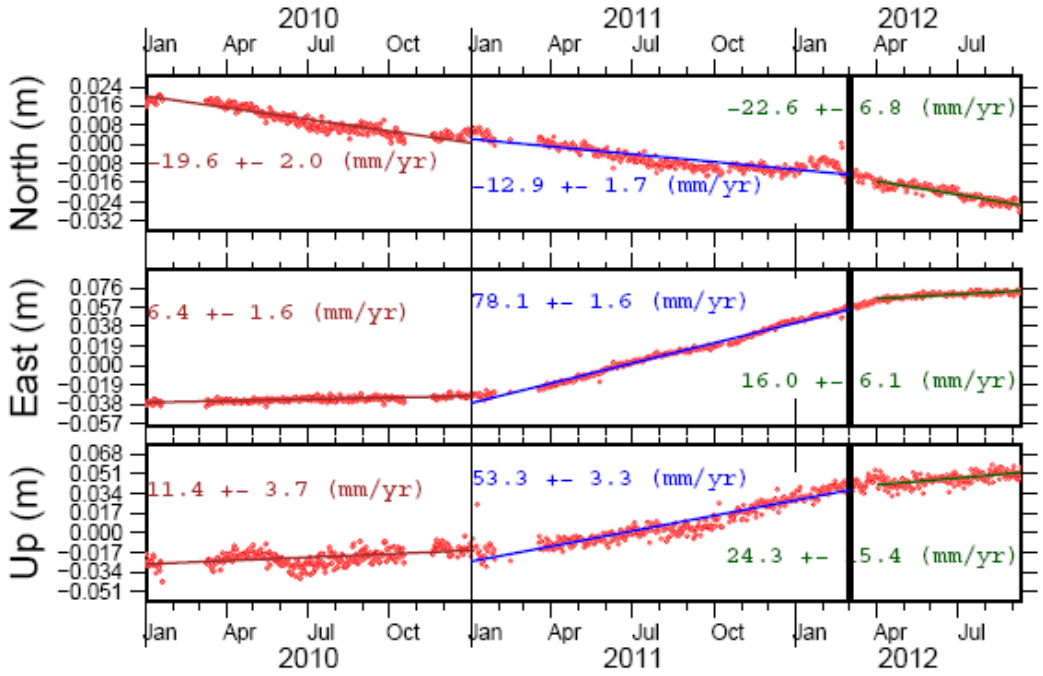
Volcanoes – Santorini case



Time-series monitoring with in-situ GPS stations



GPS data processing by Dionysos Satellite Observatory

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Subsidence

Data
- NSN
- NOANET
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- In-situ

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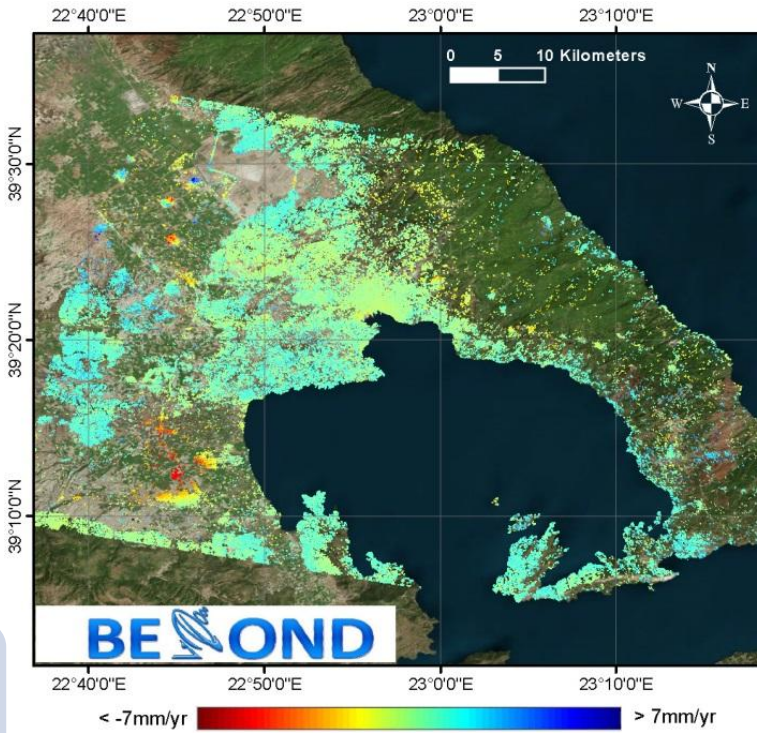
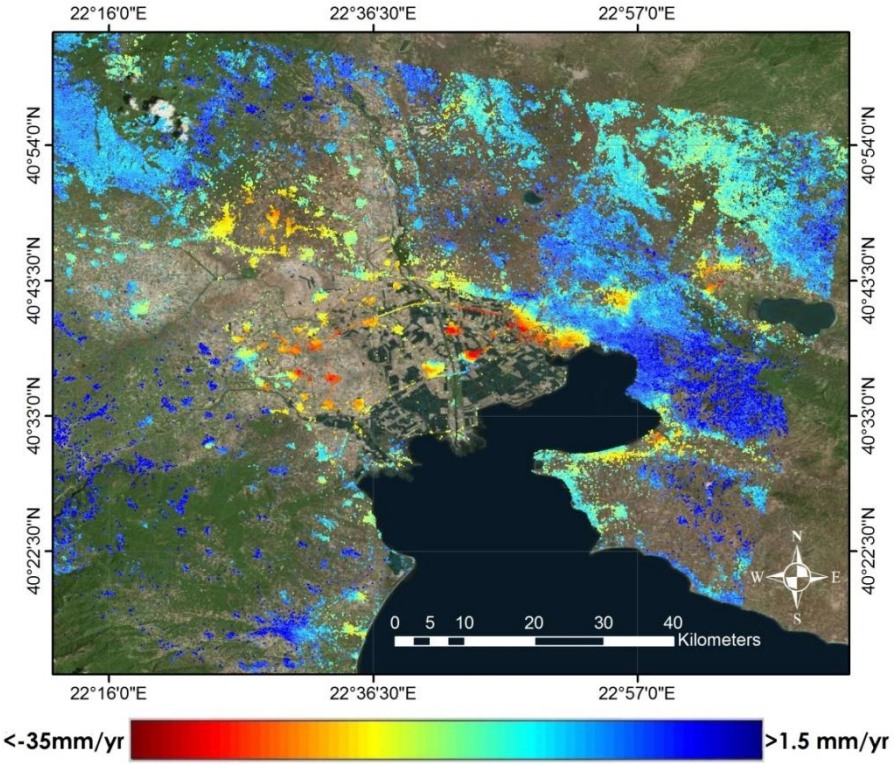
- Hazard Ass.
- Large Proc.

Applications
- Tectonics
- Volcanoes
- Landslides
- Subsidence

Volos (2002 -2010)



Thessaloniki (1992 -2001)



Driver: water over-pumping

Drivers:
- Over-pumping
- Natural compaction of deposits
- Tectonics

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Subsidence

Data
- NSN
- NOANET
- ENIGMA
- In-situ

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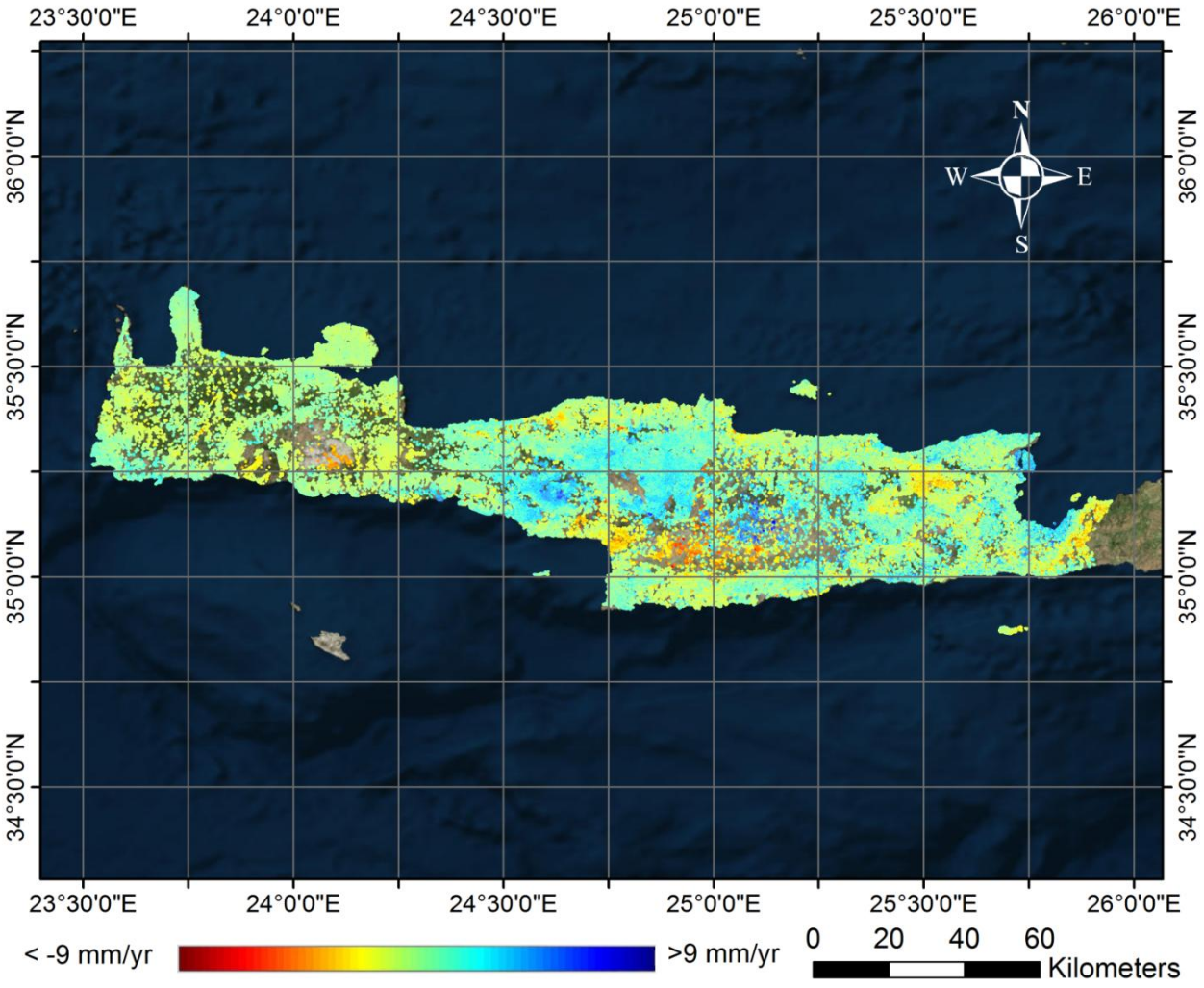
- Volcanoes
- Landslides
- Subsidence



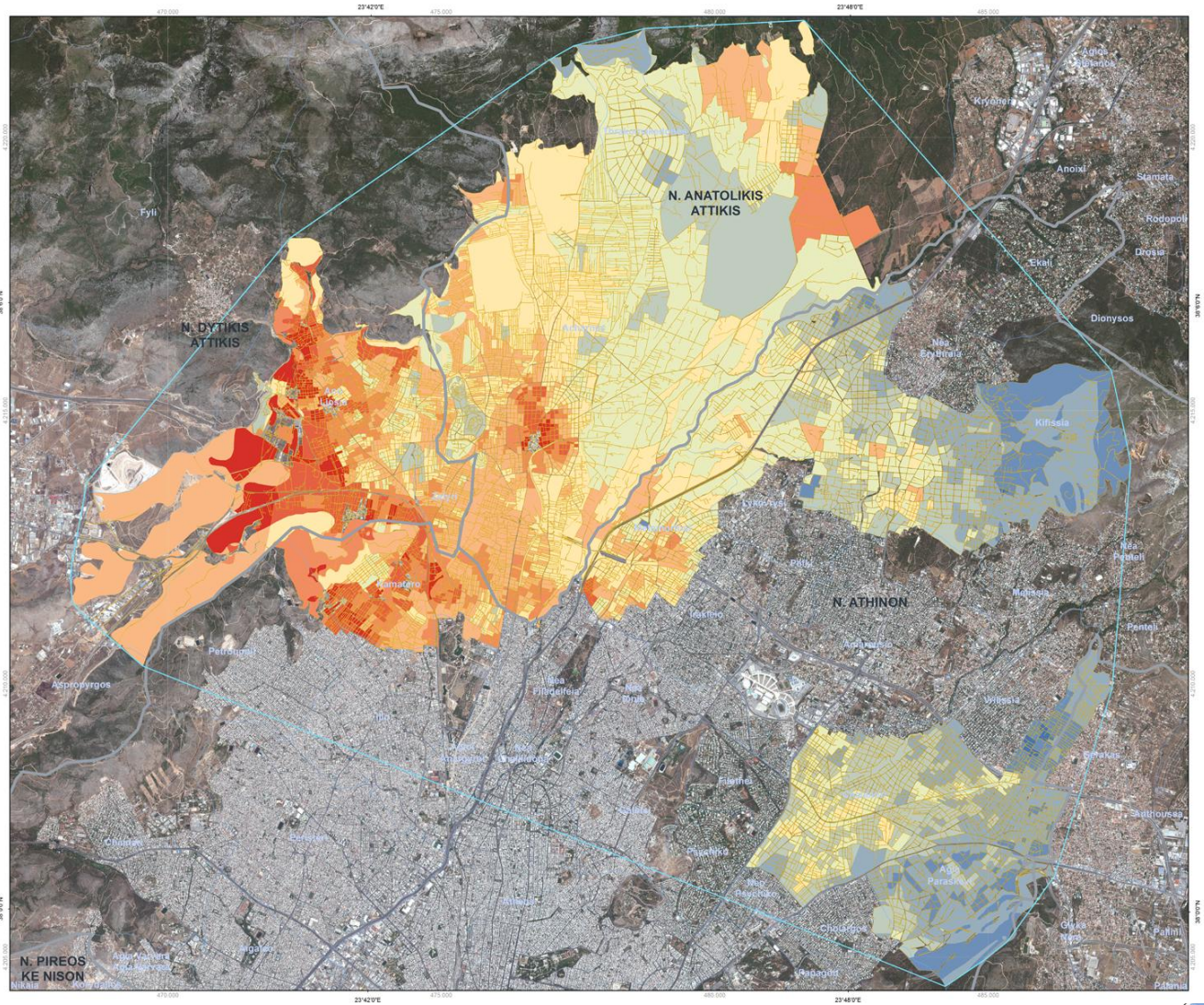
Project funded by the EUROPEAN UNION

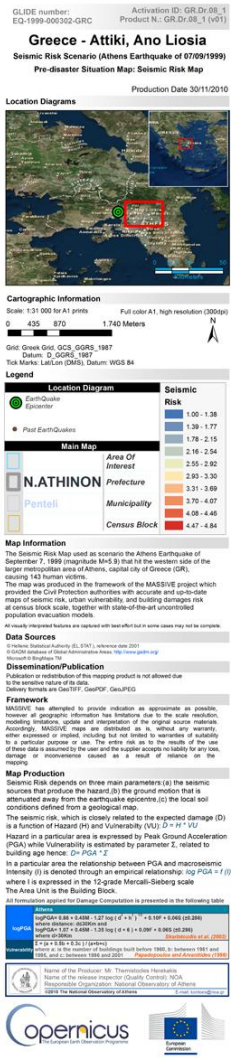
Seismic Risk – Athens

Data
- NSN
- NOANET
- ENIGMA
- In-situ

Services
- Geodesy
- Modeling
- Hazard Ass.
- Large Proc.

Applications
- Tectonics
- Volcanoes
- Landslides
- Subsidence



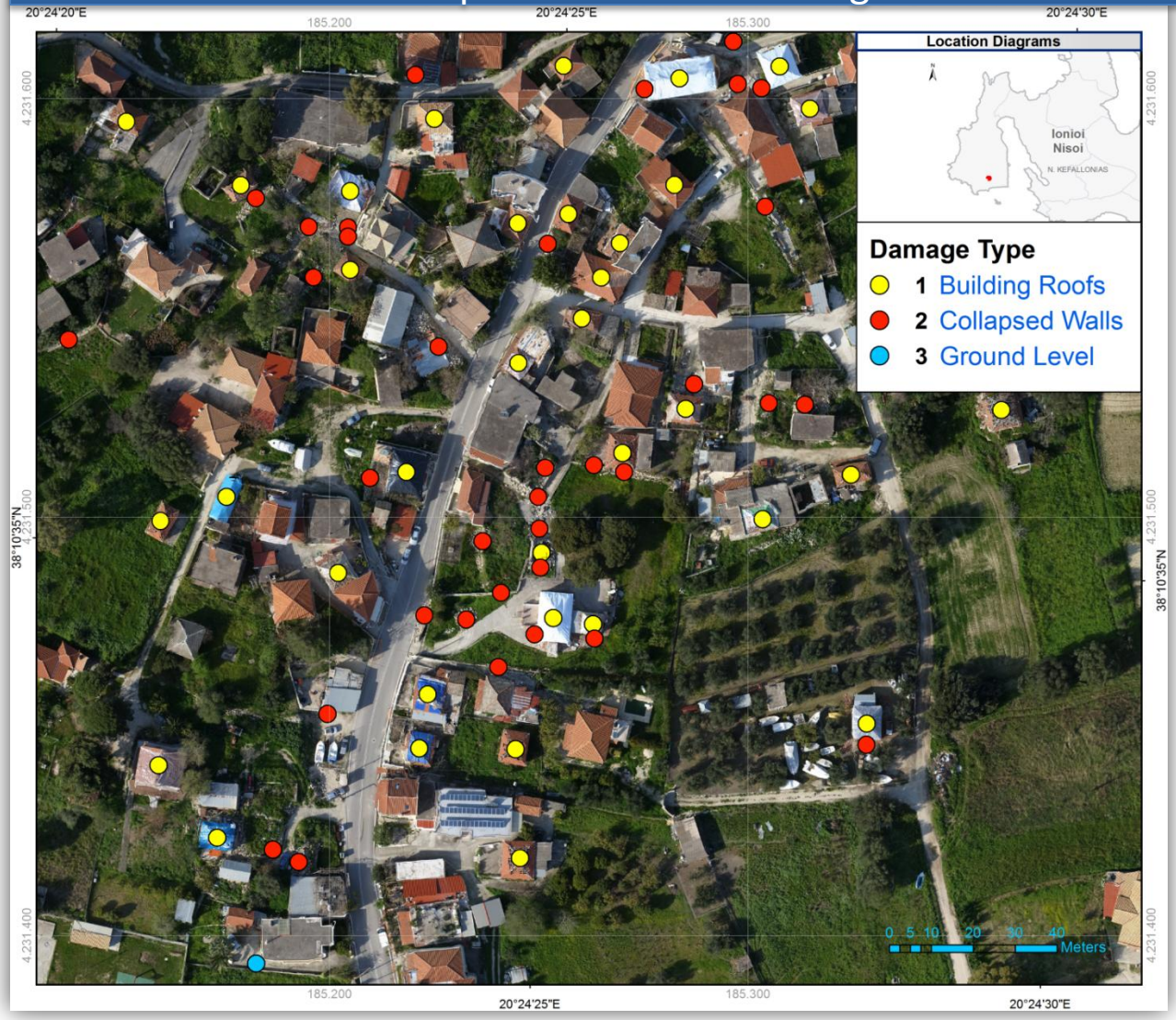


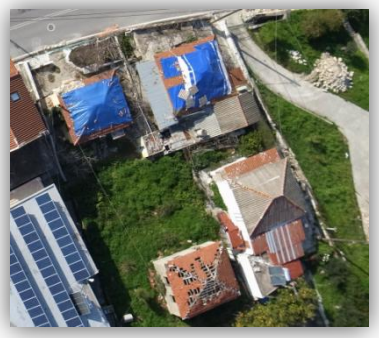
Project funded by the EUROPEAN UNION

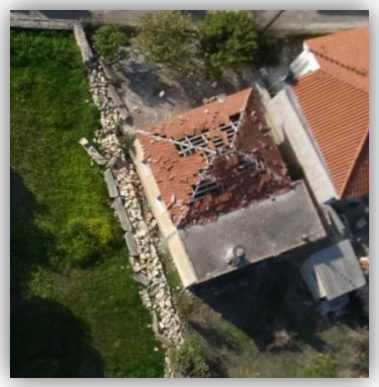
UAV Assisted Loss Recording

Cephalonia Earthquake Feb 2014

Cephalonia Island – Village of Mantzavinata







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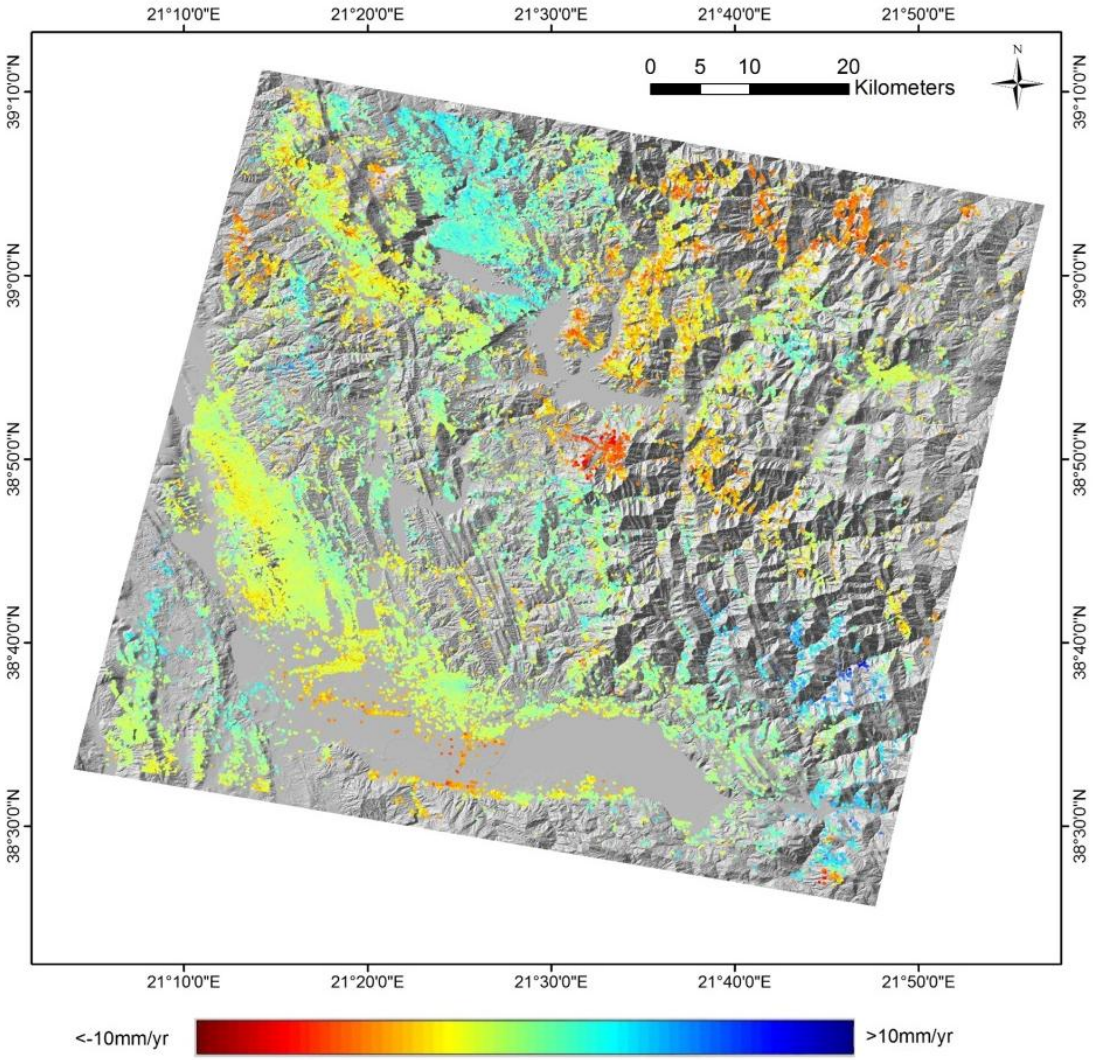
Landslides – South Pindus

Data
- NSN
- NOANET
- ENIGMA
- In-situ

Services
- Geodesy
- Modeling
- Hazard Ass.
- Large Proc.

Applications
- Tectonics
- Volcanoes
- Landslides
- Subsidence



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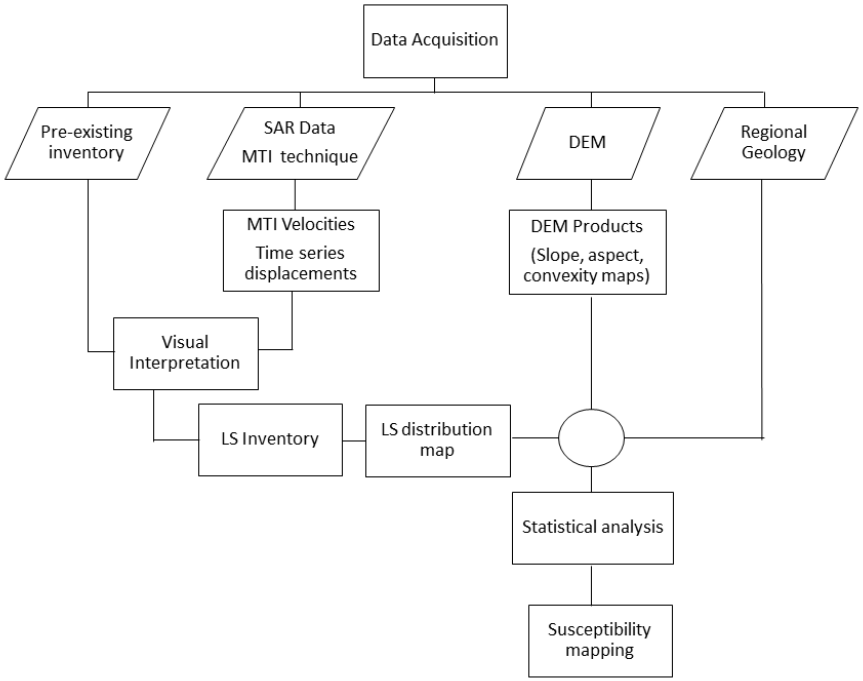
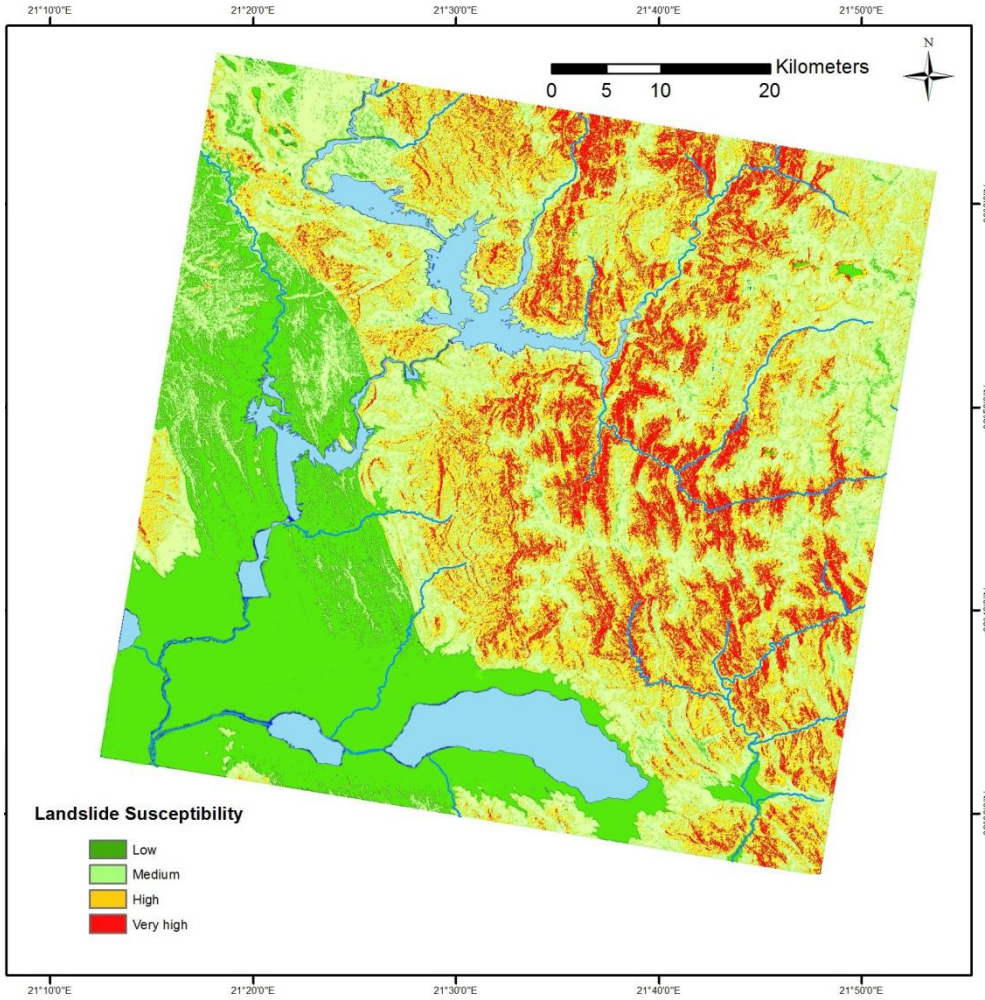
Landslides – South Pindus

Landslide susceptibility model



Landslide susceptibility map



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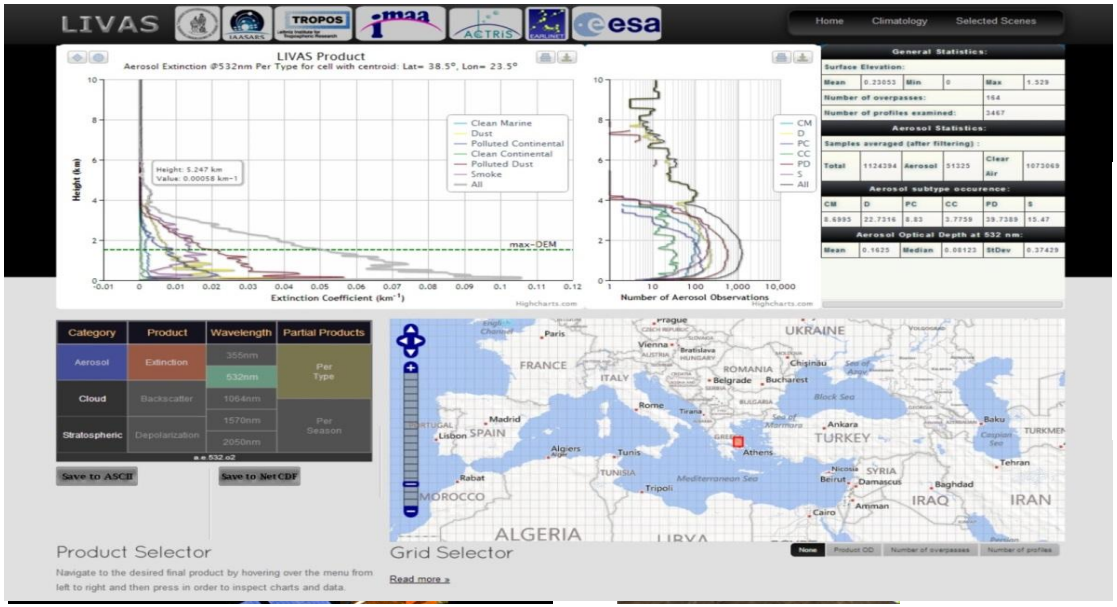
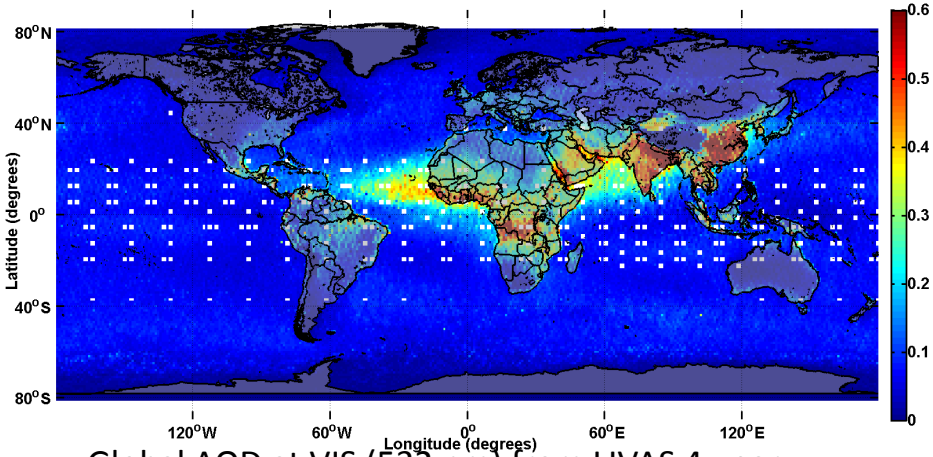
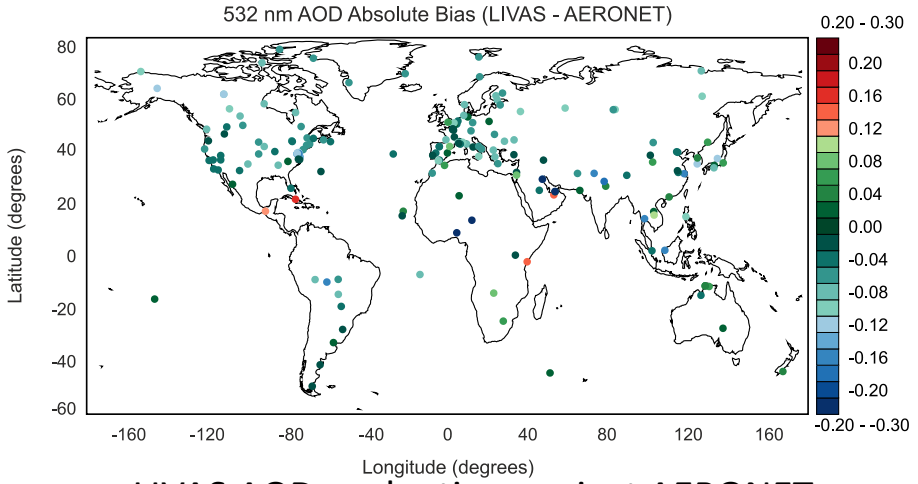


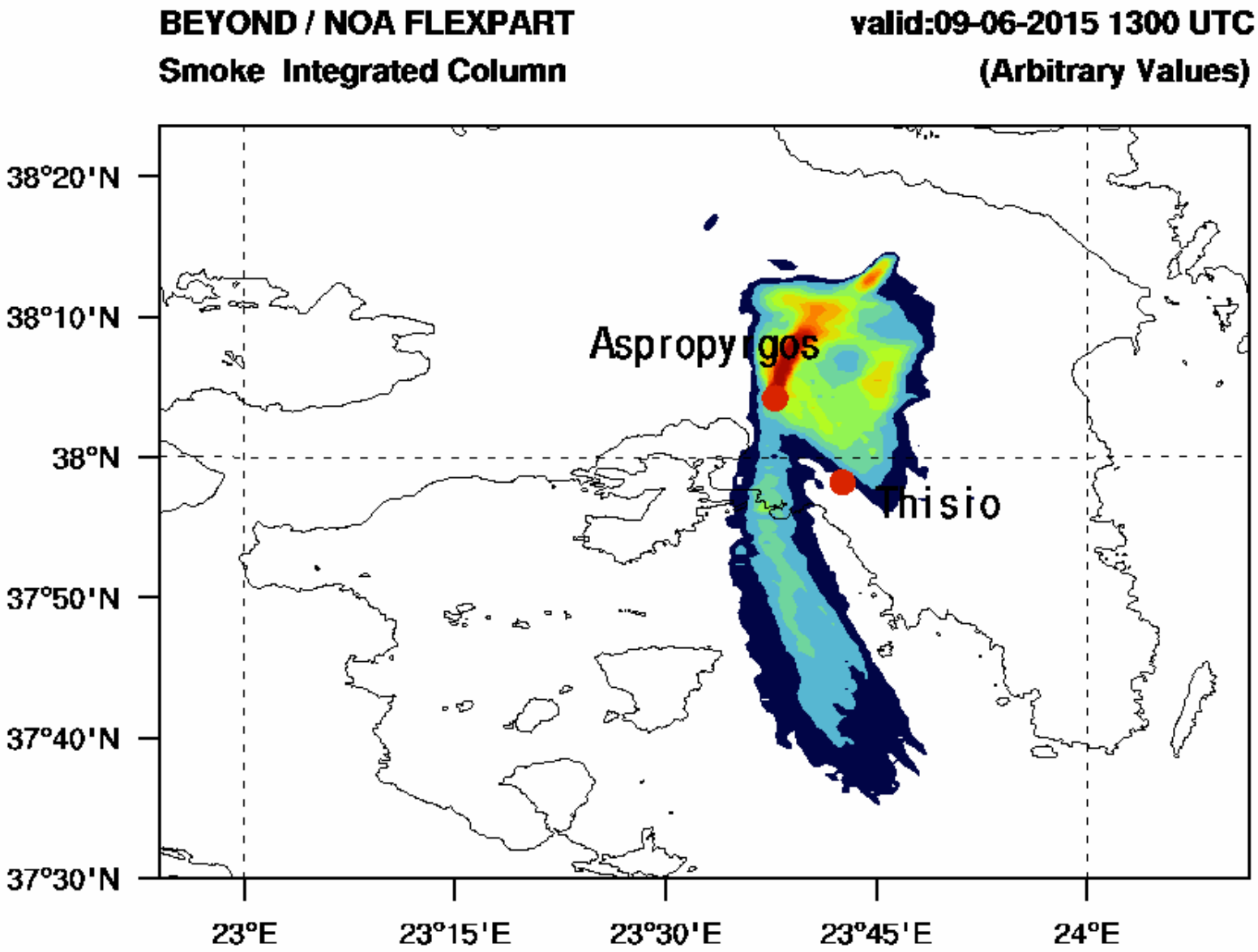
Global 3D climatology of aerosols and clouds
LIVAS portal under BEYOND (1x1 degree resolution)



Global AOD at VIS (532 nm) from LIVAS 4-year averages of CALIPSO observations



LIVAS AOD evaluation against AERONET


BEYOND / NOA FLEXPART
Smoke Integrated Column
valid:09-06-2015 1300 UTC
(Arbitrary Values)
38°20'N
38°10'N
38°N
37°50'N
37°40'N
37°30'N
23°E
23°15'E
23°30'E
23°45'E
24°E
Aspropyrgos
Thisio

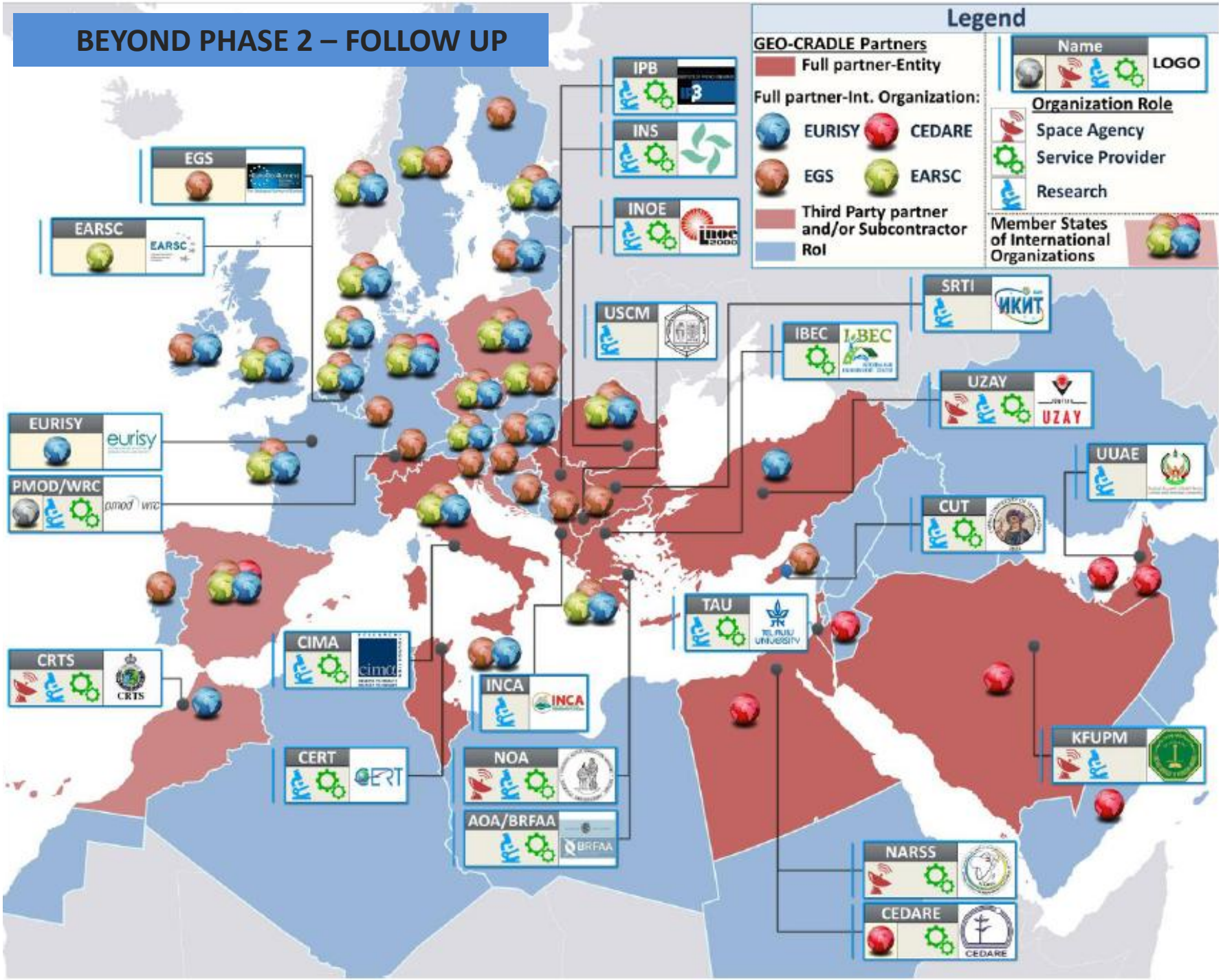
BEYOND PHASE 2 – FOLLOW UP

At the regional level …

GEO-CRADLE

ID	Participant Organisation Name	Country	Logo
13	CIMA Research Foundation (CIMA)	Italy	
14	Academy of Athens (AOA)	Greece	
15	INOSENS (INS)	Serbia	
16	European Association of Remote Sensing Companies (EARSC)	EU	
17	EURISY	EU	
18	EuroGeoSurveys (EGS)	EU	
19	University of UAE (UUAE)*	UAE	
20	King Fahd University of Petroleum and Minerals (KFUPM)*	Saudi Arabia	
21	World Radiation Center (PMOD/WRC)*	Switzerland	
22	National Authority for Remote Sensing & Space Sciences (NARSS) (subcontractor to CEDARE)**	Egypt	
23	Royal Centre for Remote Sensing (CRTS) (subcontractor "in-kind" to EURISY)**	Morocco	

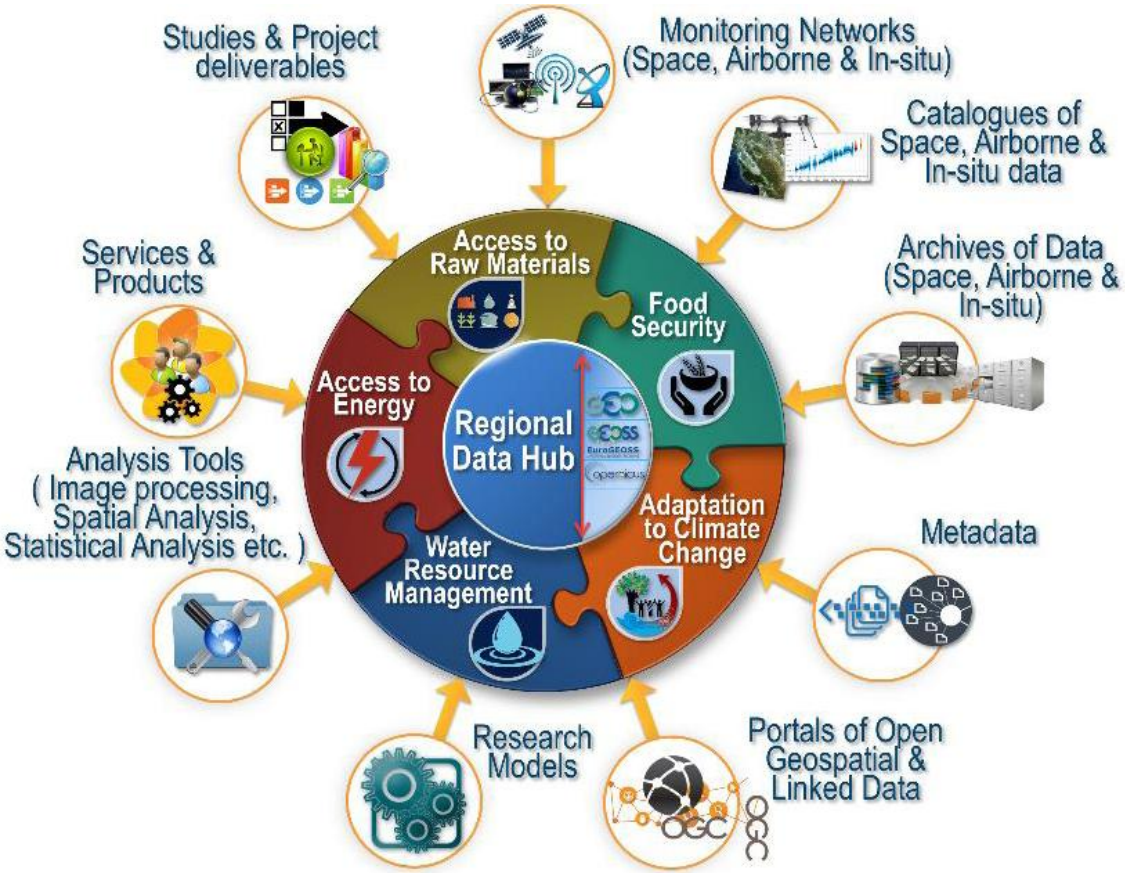
BEYOND PHASE 2 – FOLLOW UP



BEYOND PHASE 2 – FOLLOW UP

At the regional level …

GEO-CRADLE



Thank you for your attention!

For more information

http://www.beyond-eocenter.eu