BEYOND
Centre of EO Research
and Satellite Remote Sensing

The Center of Earth Observation Research and Satellite Remote Sensing BEYOND for Disaster Management and Civil Protection

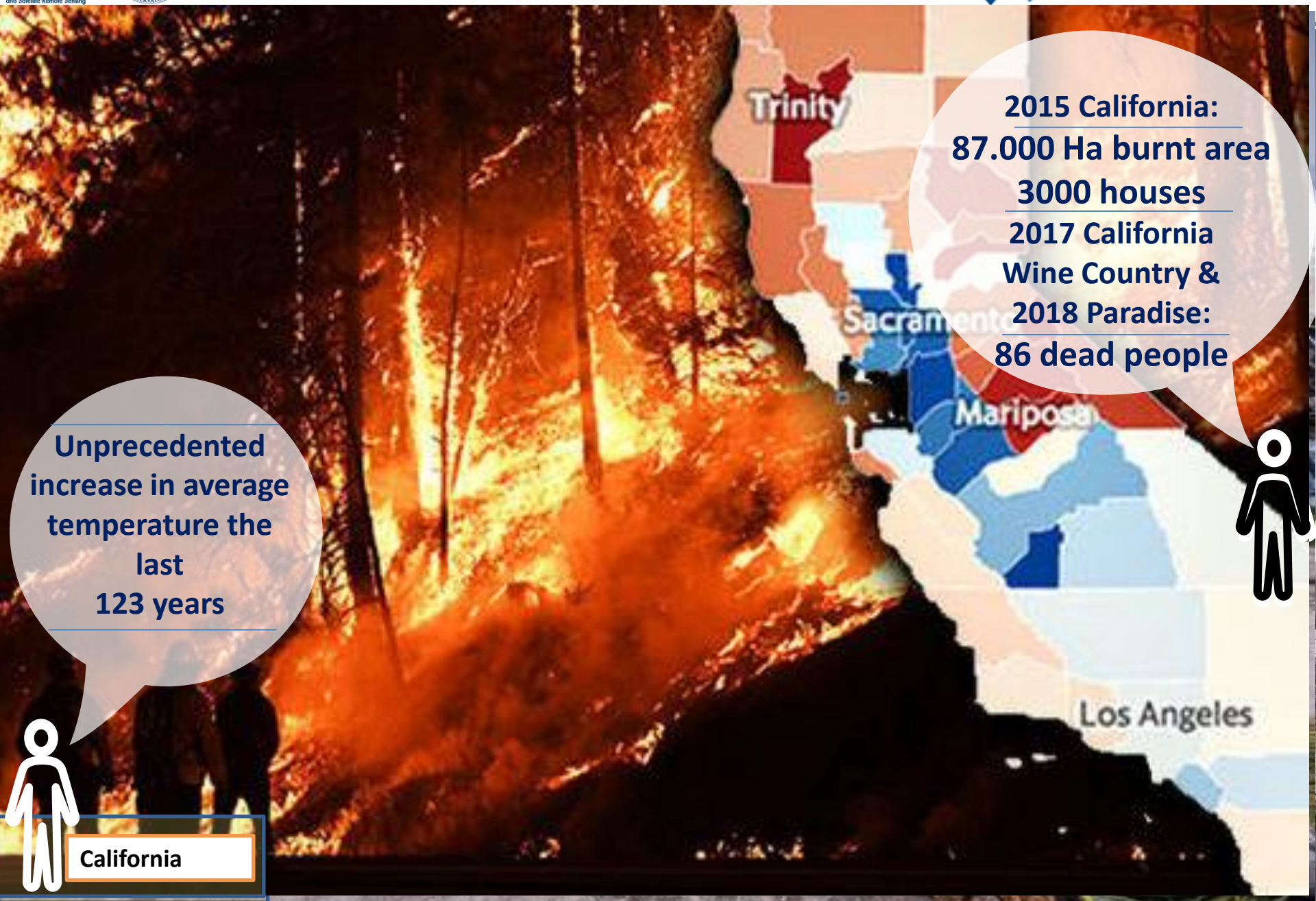
Leveraging Copernicus big satellite data and space technology for societal resilience. The generation of science and innovation in the context of EXCELSIOR for the ultimate benefit of the citizens

Dr Haris Kontoes, Research Director, National Observatory of Athens


Six years of continuous drought in Guatemala, Honduras, El Salvador, Nicaragua
> 2.500.000 without food
> 3.5000.000 without income
Unprecedented increase and doubling of the drought period per year over the last six years (from 3 to 6 months / year)
C. AMERICA


2011, 2017, 2019
Prolonged drought
Ethiopia, Kenya, Somalia:
> 15,000,000 without food and water
Unprecedented rise in sea level with simultaneous rise in temperature in the Horn of Africa
Horn of Africa


2019 Cyclone Idai
Zimbabwe, Malawi, Mozambique:
Million homeless
people without food
>10000 dead people
Cyclone Kenneth
6 days later in Mozambique
Tropical cyclone in the area for the first time
S. Africa


Trinity
Sacramento
Mariposa
Los Angeles
2015 California:
87.000 Ha burnt area
3000 houses
2017 California
Wine Country &
2018 Paradise:
86 dead people
Unprecedented
increase in average
temperature the
last
123 years
California


Are the fires of 12.000.000 Ha of burnt area in Australia due to Climate Change? 2019-2020
Unprecedented drought and high temperature
Dramatic decrease of rain
Increase in average temperature 1oC?
Australia

BEYOND
Centre of Excellence
for EO Sciences and Services

Centre of EO Research & Satellite Remote Sensing
National Observatory of Athens

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
AMBASSADE DE FRANCE EN GRECE

INSTITUT FRANÇAIS
GRÈCE

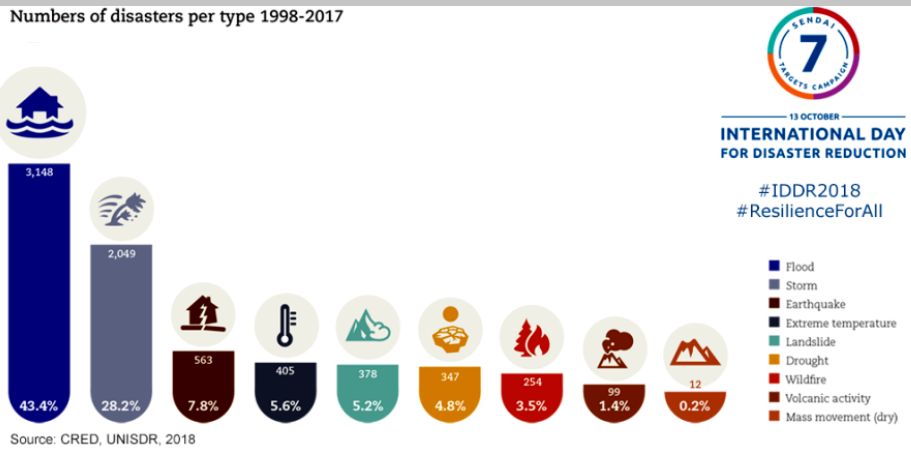
ΚΕΝΤΡΟ ΕΡΕΥΝΗΣ ΦΥΣΙΚΗΣ
ΤΗΣ ΑΤΜΟΣΦΑΙΡΑΣ
& ΚΛΙΜΑΤΟΛΟΓΙΑΣ ΤΗΣ
ΑΚΑΔΗΜΙΑΣ ΑΘΗΝΩΝ

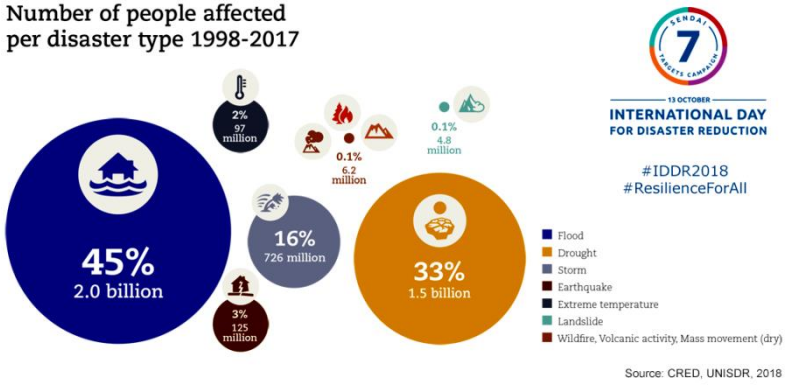
2018 Mati Attica
1260 acres burnt areas
70 % burnt buildings
103 dead people

Unprecedented rapid winds from the West with speed> 100 km / h
> 25 years the appearance of westerly winds in the area

GREECE

- **1 in 9 people** are forced to migrate due to climate change and natural disasters
- **1 billion people** will be forced to flee Africa over the next 30 years due to drought and desertification





Challenge

The continuous provision of **useful, accurate and timely information** through coordinated and sustained **Earth Observation**

is a **key enabler** for **informed decision making**,

in response to global and regional challenges and towards the achievement of the **UN SDGs** and the implementation of the relevant **EU and Global Directives for Societal Benefit** including the **Sendai Framework for DRR, and Paris Agreement to combat climate change**

Challenge

To efficiently process big volumes of satellite, in-situ, and crowd data provided from Copernicus Sentinels and third party satellite missions but also low cost sensor networks and media, providing high spatial and temporal resolution ranging from centimeters to up to a few meters on the ground.

Big Data: More than 110 TiB of satellite data are acquired only in one month, a volume that is equivalent to the entire 7-year archive of the Envisat mission

Building upon the efficient employment of High Performance Cloud Computing (HPC) resources, Datacubes/ Array Data Bases, and ML/AI new capabilities are available for the effective processing of big data to estimate with high accuracy the ongoing physical processes, derive information from data and lead to a data driven decision making

Addressing the Challenge

We established the **Center of Exellence BEYOND**, hosted and operated at the premises of the **National Observatory of Athens**, providing prototype research and solutions to **Copernicus EU Space program and Global Institutional Users** in the domains of Natural Disasters, Energy, and Agriculture, through **real time web based services** such as **FireHub, FloodHub, Emergency Management Service Risk&Recovery, EFFIS, geObservatory, DustHub, SolarHub**

The **services offers to the communities of citizens and civil protection authorities ready-to-use information products, but also knowledge to deal with the DRR issue**

BEYOND: EO Based An EU Center for DRR

Floods | Land-slides | Earthq uakes-Erosion | Fires | Extreme Weather | Volca-noes | Toxic Emissions | Tsounami

Tasks

Real Time Monitoring of Natural Disaste

Area of Intere

SE Europe, Mediterranean N. Africa, M. E Balkans

Tasks

Risk & Damage Assessment and Mitigation Measures

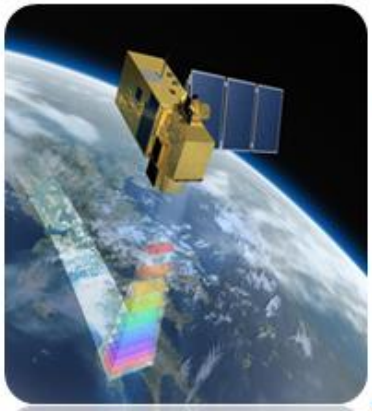
Area of Interest:

Global Level

www.beyond-eocenter.eu

Project funded by the EUROPEAN UNION

Monitoring Systems

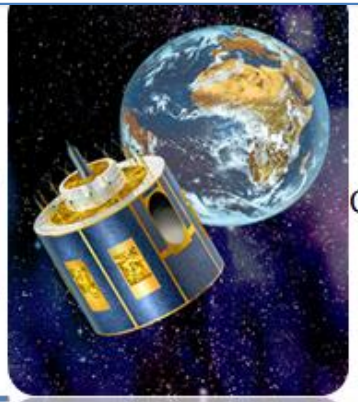


Satellites
Polar Orbit

X-/L-band
Station

Sentinel
Mirror Site

DATA → ANALYSIS/ PROCESSING → INFORMATION/ RESULTS



Satellites
Geostationary
Orbit

MSG Seviri

in-situ

Aerial Vehicle
or Unmanned
Aerial Vehicle

Terrestrial
Platforms and
Networks

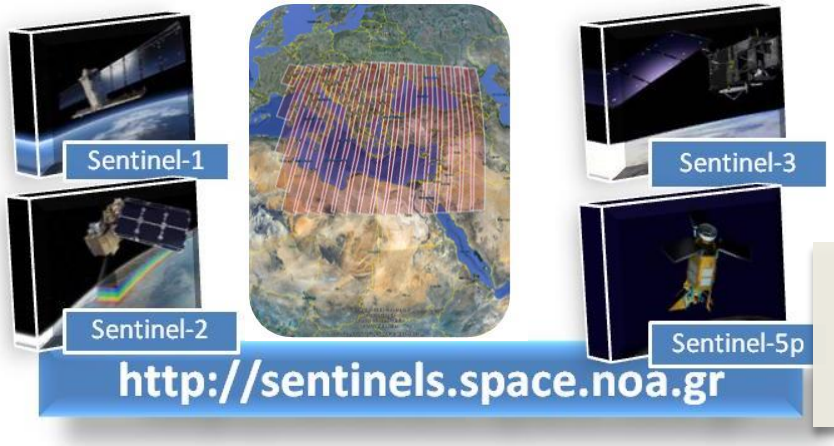
BEYOND
Centre of EO Research and Satellite Remote Sensing

EXCELSIOR

COPERNICUS DATA HUB
Operations Center

SENTINELS GREEK HUB

- INTHUB #1
- COLHUB #3
- DIASHUB #3
- AfricaCastHub
- S-5p PreOps Hub
- S-5p Expert Users Hub
- TMPHUB #1
- HNSDMS



80 VMs
storage: 800 TiB,
680 CPU cores,
2.2 TiB RAM

Distributes 55 TB / Day
Operations 24/7/365
GEANT up to 10Gbits

A **550 TB** network filesystem for storing > **500 thousand** Sentinel products at any time

FireHUB Real-time forest fire monitoring service - Diachronic Burnt Scar Mapping (> 35 years) - Fire risk mapping http://beyond-eocenter.eu/index.php/web-services/firehub

DustHUB Desert Dust, Smoke and Toxic Gases Detection and Dispersion Service http://beyond-eocenter.eu/index.php/web-services/dusthub)

FloodHUB Real-time Flood monitoring service and analysis of flood events http://beyond-eocenter.eu/index.php/web-services/floodhub

GeoHUB Service for monitoring, early warning and assessment of geophysical disasters (earthquakes, landslides, volcanoes) http://beyond-eocenter.eu/index.php/web-services/geohub

SolarHUB ATLAS Real-time solar energy estimation and nowcasting service http://beyond-eocenter.eu/index.php/web-services/solarhub

European Forest Fire Information System (EFFIS) http://beyond-eocenter.eu/index.php/web-services/effis

Copernicus Emergency Management Service (EMS) (http://beyond-eocenter.eu/index.php/thematic-areas/disasters/ems-activations)

BEYOND
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EXCELSIOR

Implemented by the European Commission as part of the Copernicus Programme

Copernicus
Europe's eyes on Earth

Emergency Management Service

Activation of the BEYOND in the Copernicus Emergency Management Service EMS

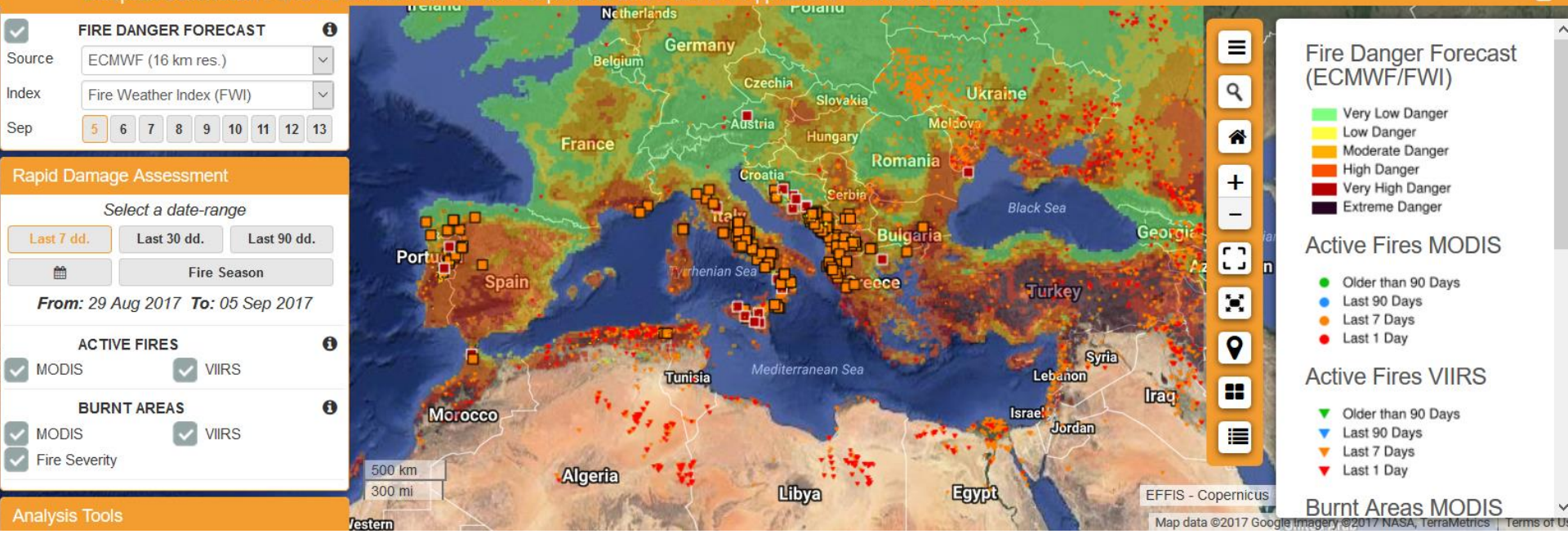
Prevention – Preparedness – Assessment – Response – Recovery

https://emergency.copernicus.eu/mapping

BEYOND EO CENTER SERVES COPERNICUS EMS:
EUROPEAN FOREST FIRE INFORMATION SYSTEM (EFFIS)

COPERNICUS
Emergency Management Service

European Commission > JRC EU Science Hub > DRM > Copernicus EMS > EFFIS > Applications > Current Situation Viewer



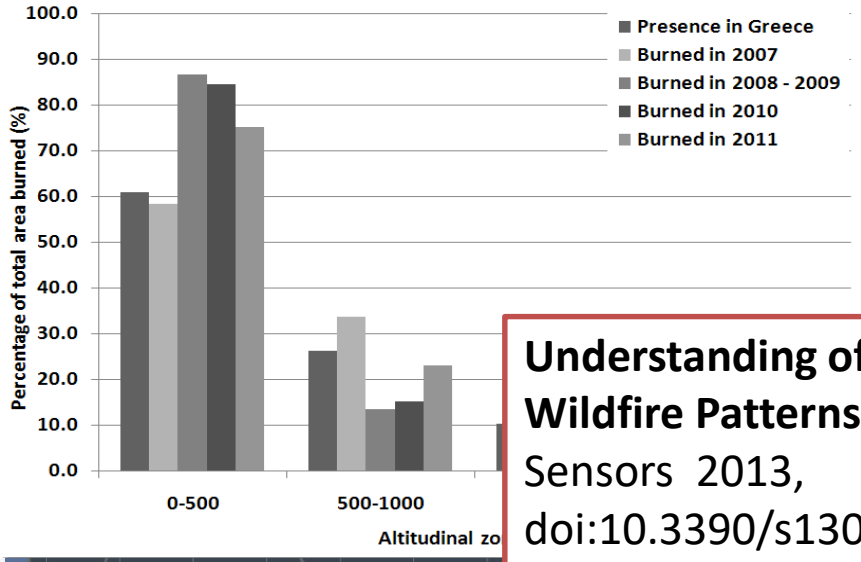
Early Warning

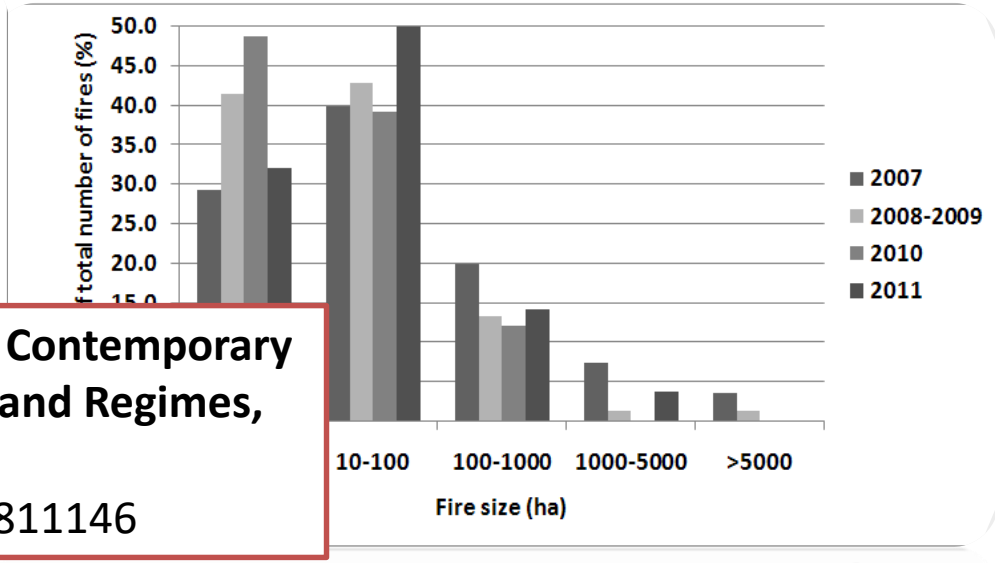
DAILY ACTIVE FIRES & BURNED AREA MAPPING OVER EUROPE, N. AFRICA, M. EAST, BALKANS

Early Warning

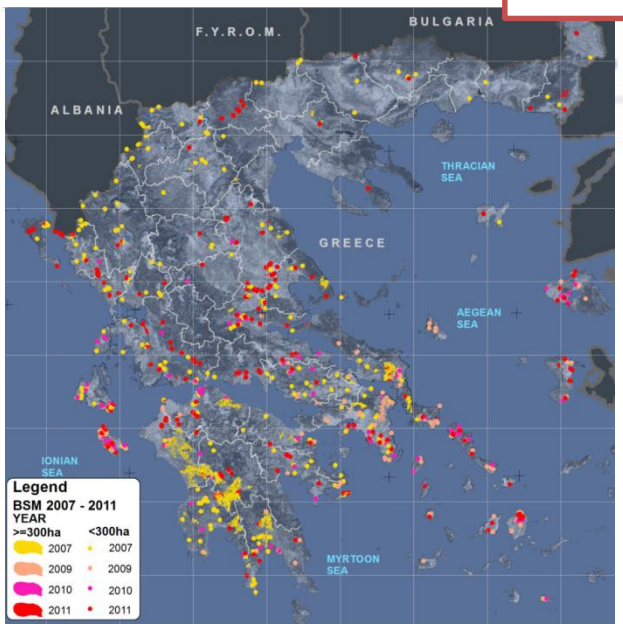
Risk Assessment

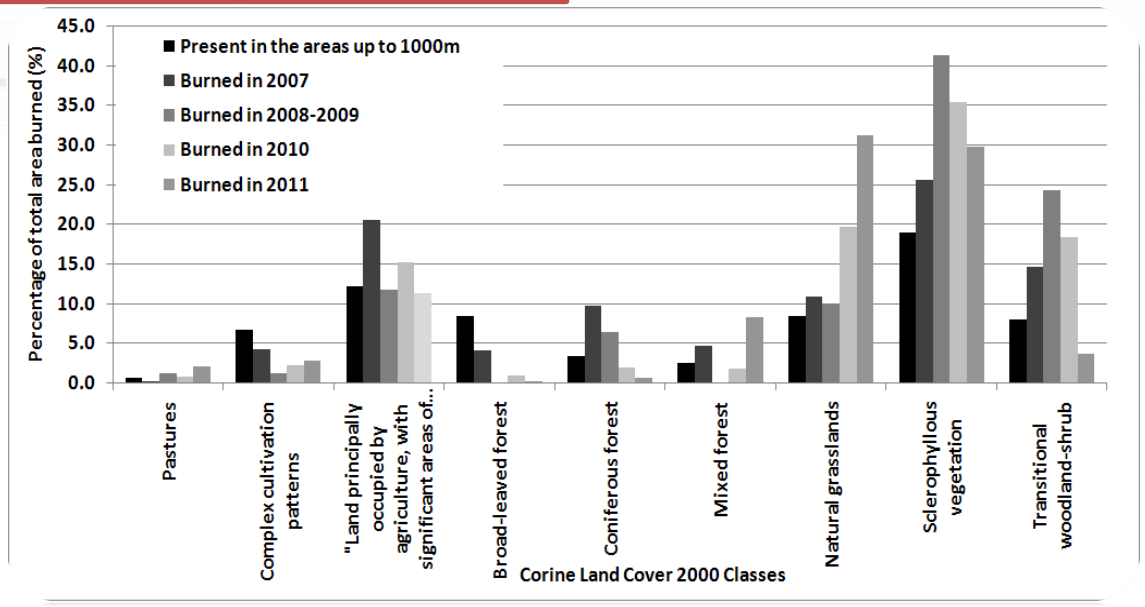
1. Build upon the knowledge emerging from historical events
2. Process long archives of satellite and attribute data
3. Create long time series, and geo-Data Bases, of environmental essential parameters, e.g. Burned Areas, Water Bodies, Land Surface Temperatures, Air temperatures, Vegetation Indexes, Precipitation, Soil Moisture, Evapotranspiration, Cloud Coverage, Aerosol Optical Depth, to mention a few
4. Perform analytics of data and correlate with reported damaging events and extreme situations (e.g. fires, floods, epidemics, heat waves, solar irradiation)



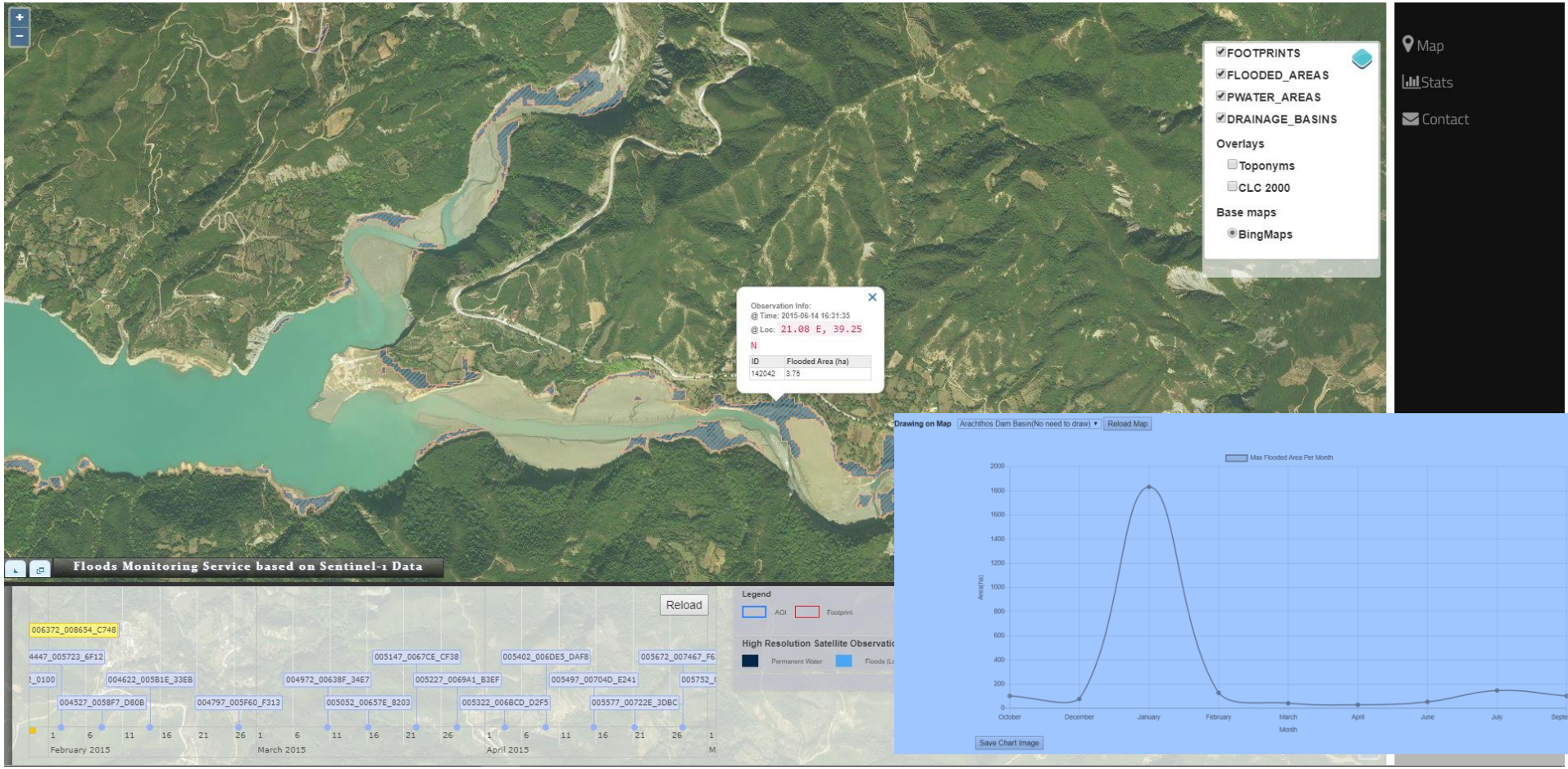


Understanding of Contemporary Wildfire Patterns and Regimes,
Sensors 2013,
doi:10.3390/s130811146





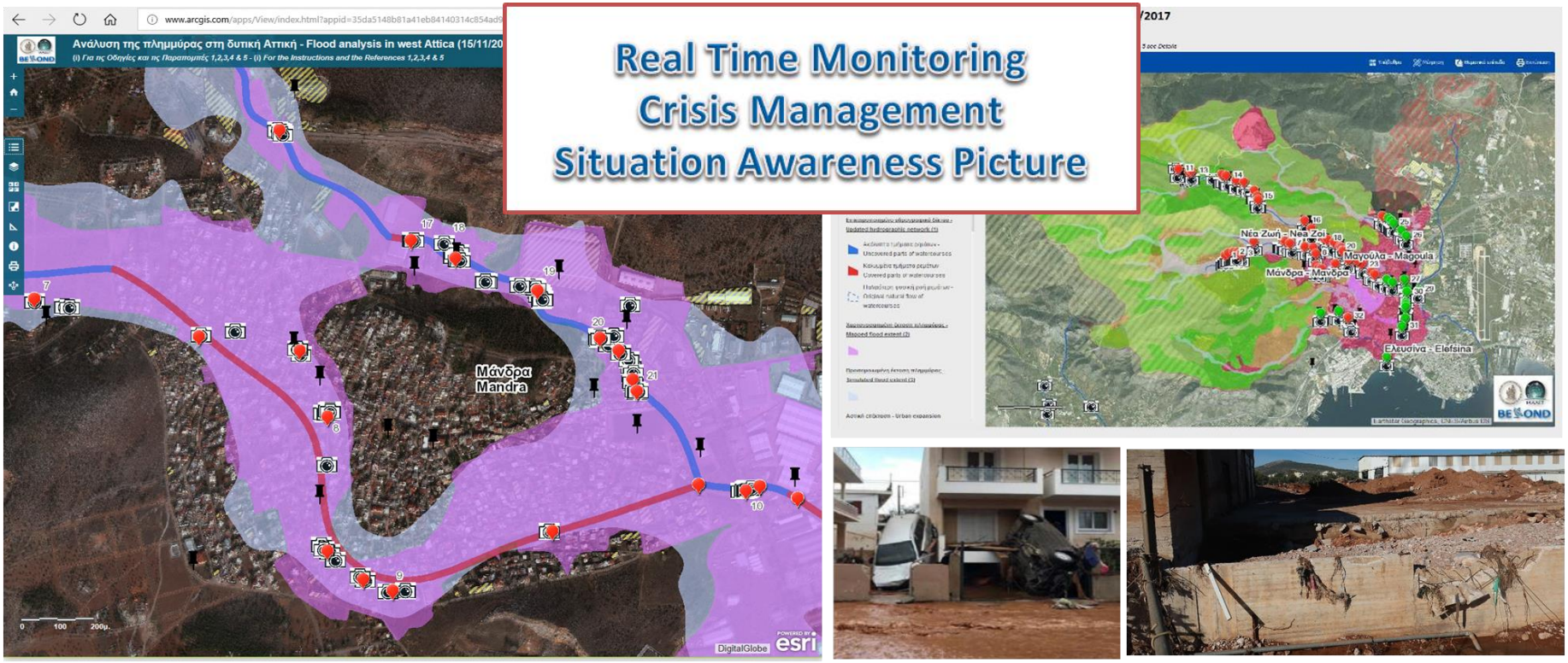
Historical Analysis of flooded areas in the Arachthos river basin for the needs of the Public Power Corporation S.A. Hellas (DEH AE) over the past 5 years based on Sentinel-1 data (Hellenic Mirror Site)



Speed up the process using ANN to enable millions of model simulations in one minute and address dynamic awareness

Examples from ongoing research projects and services showcase that:

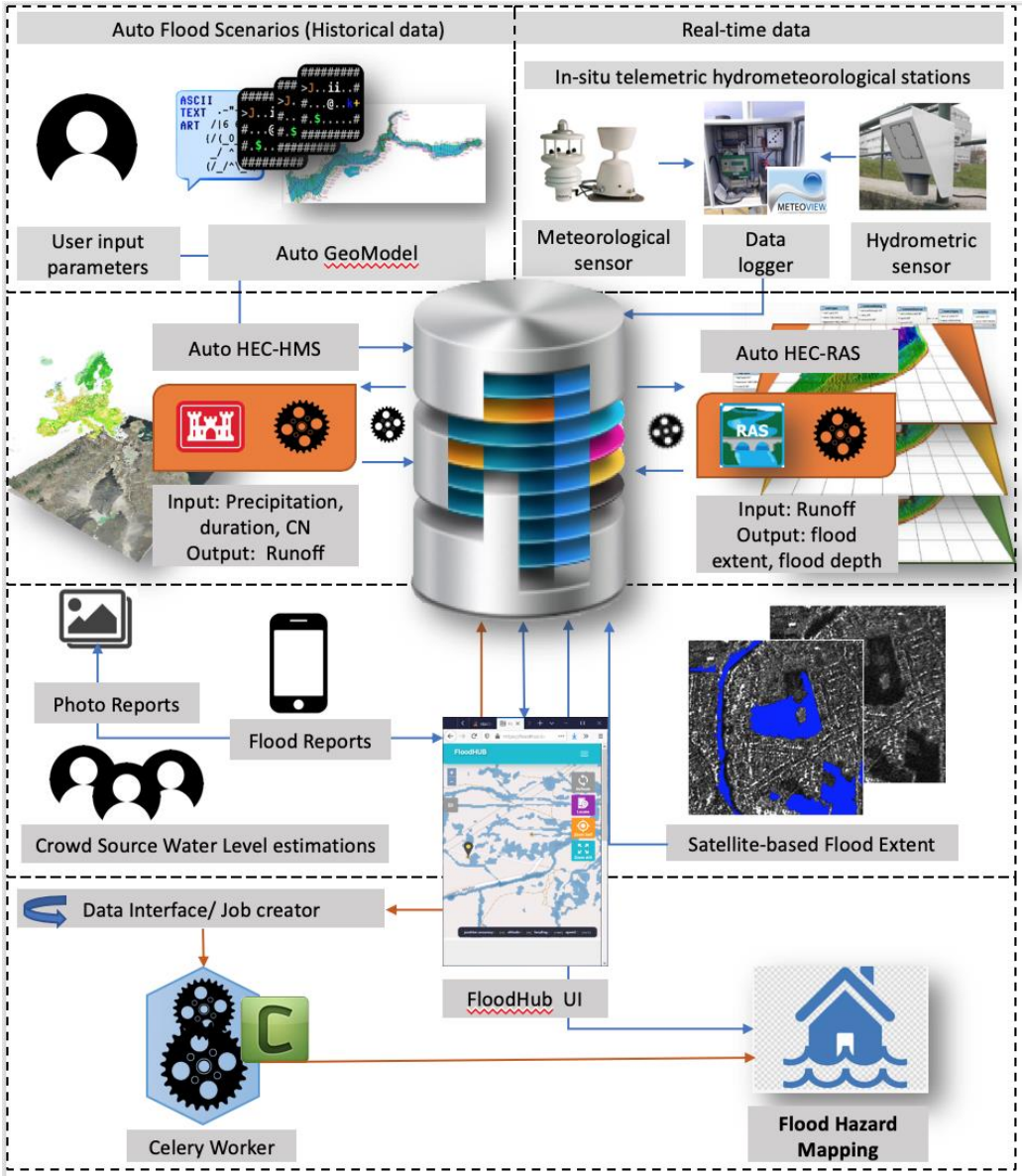
The FloodHub service employs a NN trained from a library of HEC-RAS runs, find the flood scenario that best fits to current flood conditions (e.g. triggering factors) and based on this perform in only a few minutes a large number of model runs assimilating crowd (peers) data so as to create NRT situation awareness pictures



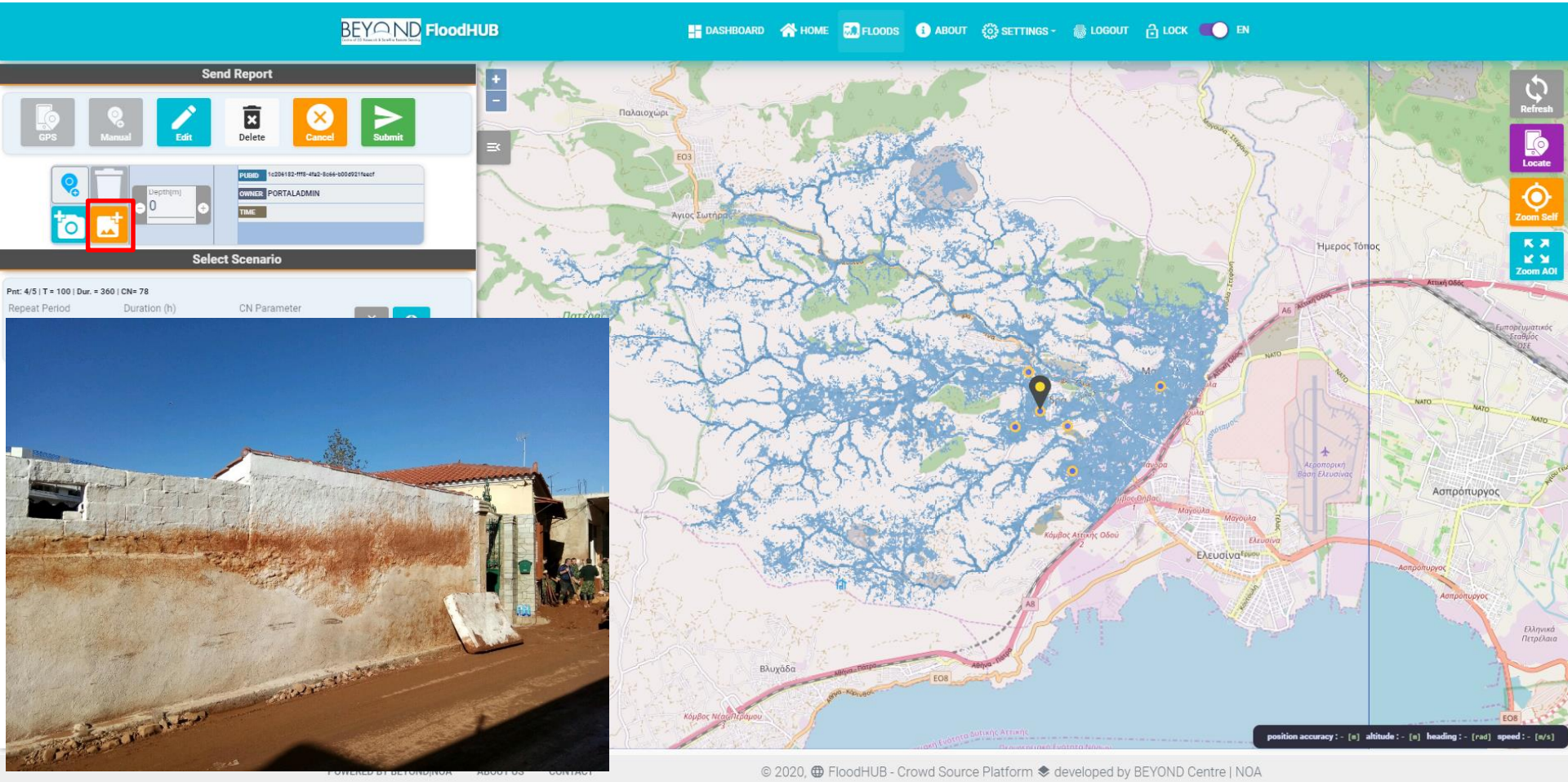
http://beyond-eocenter.eu/index.php/web-services/floodhub

Earth Observation for Disaster-Resilient Societies (EO4DisasteRS) led by IAASARS/NOA

The focus is on flash flood mapping at large scale (city level) and creation of operational awareness pictures for crisis management in real time by assimilating in flash flood models multiple sources of data including mostly satellite data (Sentinel), in-situ sensors, and crowdsourced data.

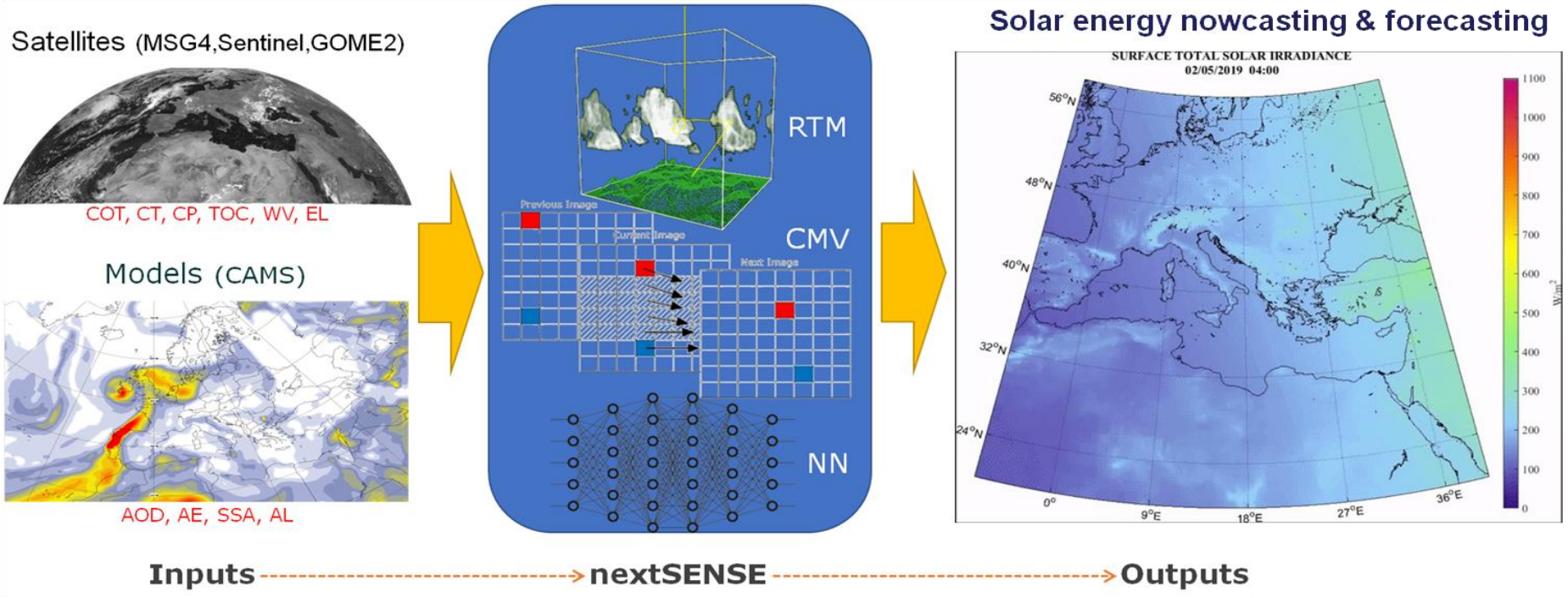


Real-Time Flood Monitoring service for Mandra, Attica

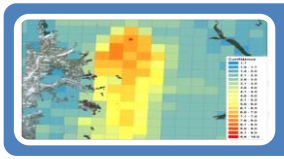


Speed up the process using ANN to enable millions of model simulations in one minute and address dynamic phenomena

SolarHub (SENSE) of BEYOND integrates data as MSG4 (Cloud Optical Thickness), S-2 (Cloud/Albedo), GOME-2 (Ozon), CAMS modeled data for Aerosols and applies a high resolution (5kmx5km) RTM using a NN that performs 1.5 million simulations in less than a minute



FIREHUB: A SPACE BASED HUB OF FIRE MANAGEMENT SERVICES

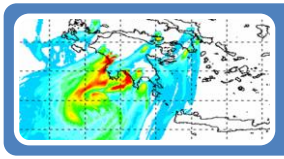


Early fire detection and real-time fire monitoring

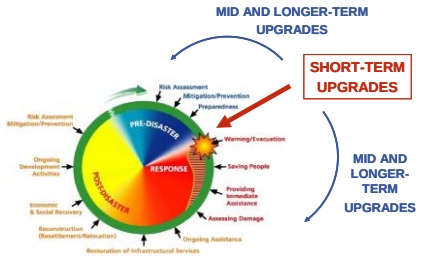
Rapid Burnt Scar and Fire Severity Mapping during crisis

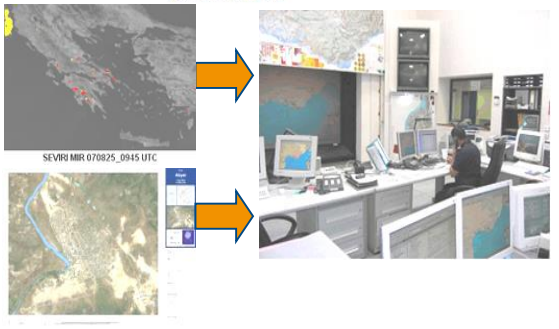
Detailed Burnt Area Mapping and Damage Assessment

Diachronic Burnt Area Mapping and Damage Assessment



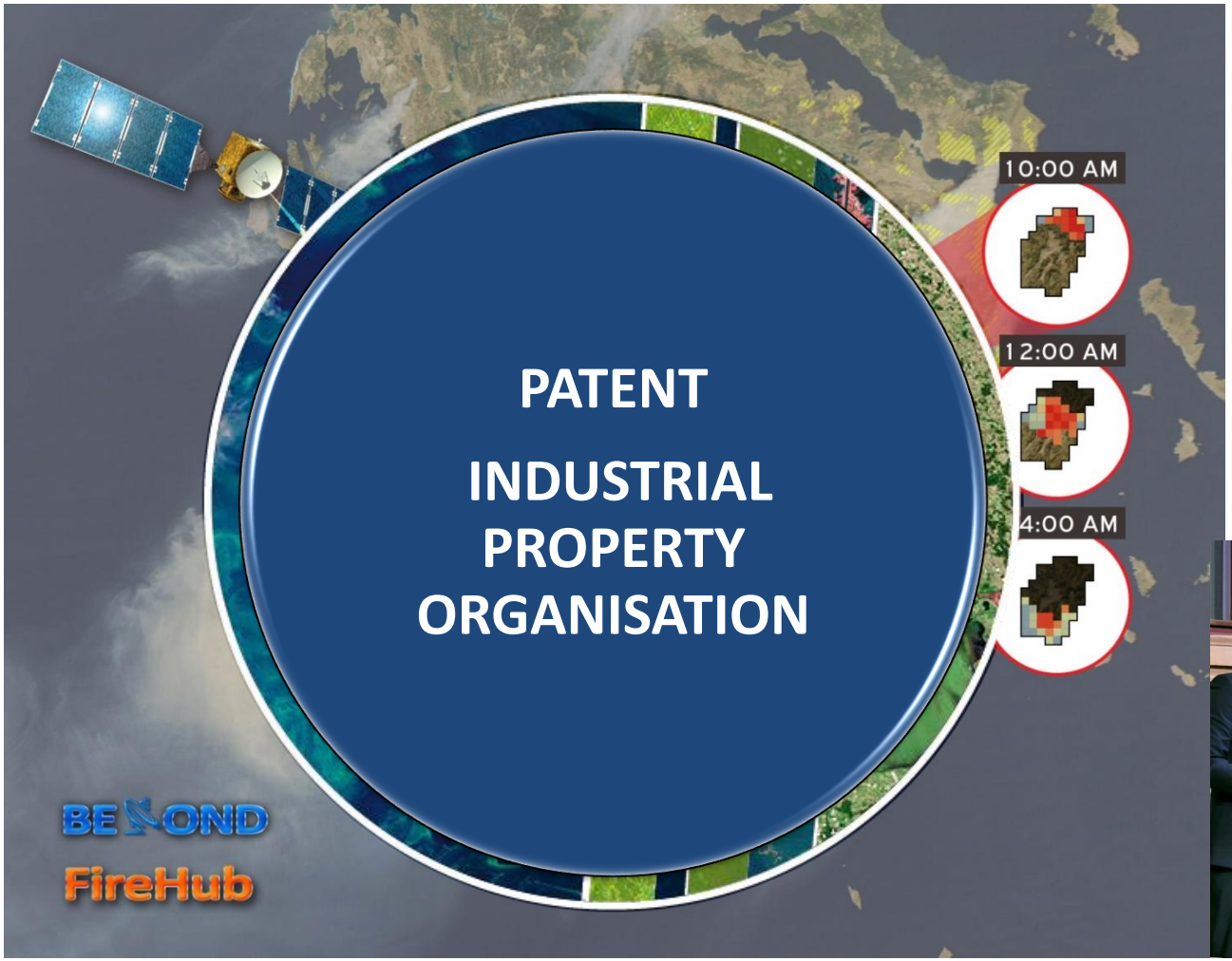
Hourly Forecasting of Fire Smoke Dispersion during crisis

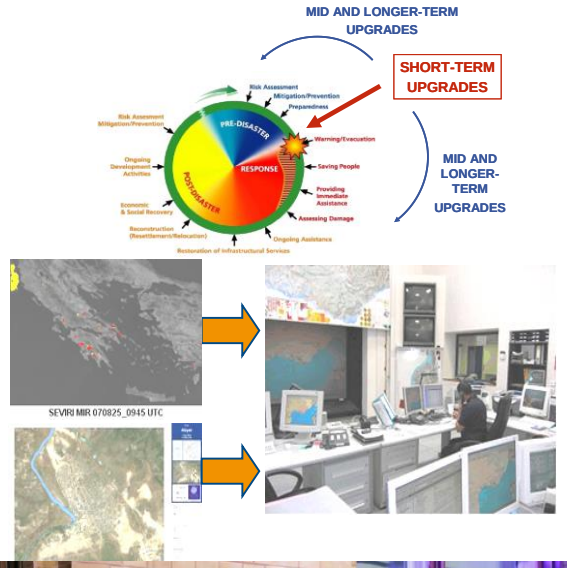




http://ocean.space.noa.gr/FireHub

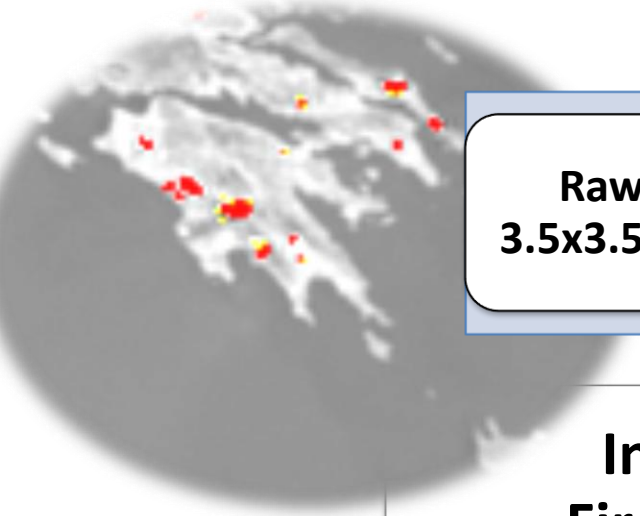
FIREHUB: A SPACE BASED HUB OF FIRE MANAGEMENT SERVICES





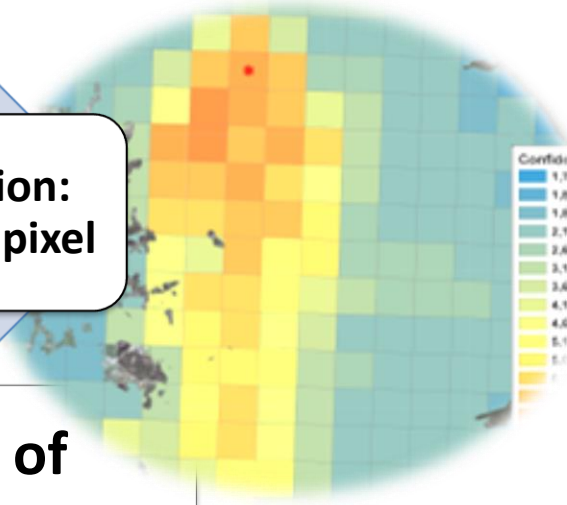
http://ocean.space.noa.gr/FireHub

FIREHUB: INNOVATIVE EARLY DETECTION AND RT FIRE MONITORING



Raw resolution:
3.5x3.5 km wide pixel

Refined resolution:
0.5x0.5 km wide pixel



Increased Spatial Resolution of Fire Monitoring by 50 Times – (500mx500m) – Multi Source Multi Resolution EO Data Fusion in RT

Meteo Data (Wind Forecasts direction, speed)

Detailed Fuel Maps & Historical Assessments of Fuel Vulnerability

Geographic Aspects: Altitudinal Zones, Slope/Aspect

Fire Spread Modelling Assimilation with RT SEVIRI Observations

Regional Real Time Fire Monitoring - NOA's MSG SEVIRI Station – Raw Resolution mode

SEVIRI MIR 070823_1030 UTC

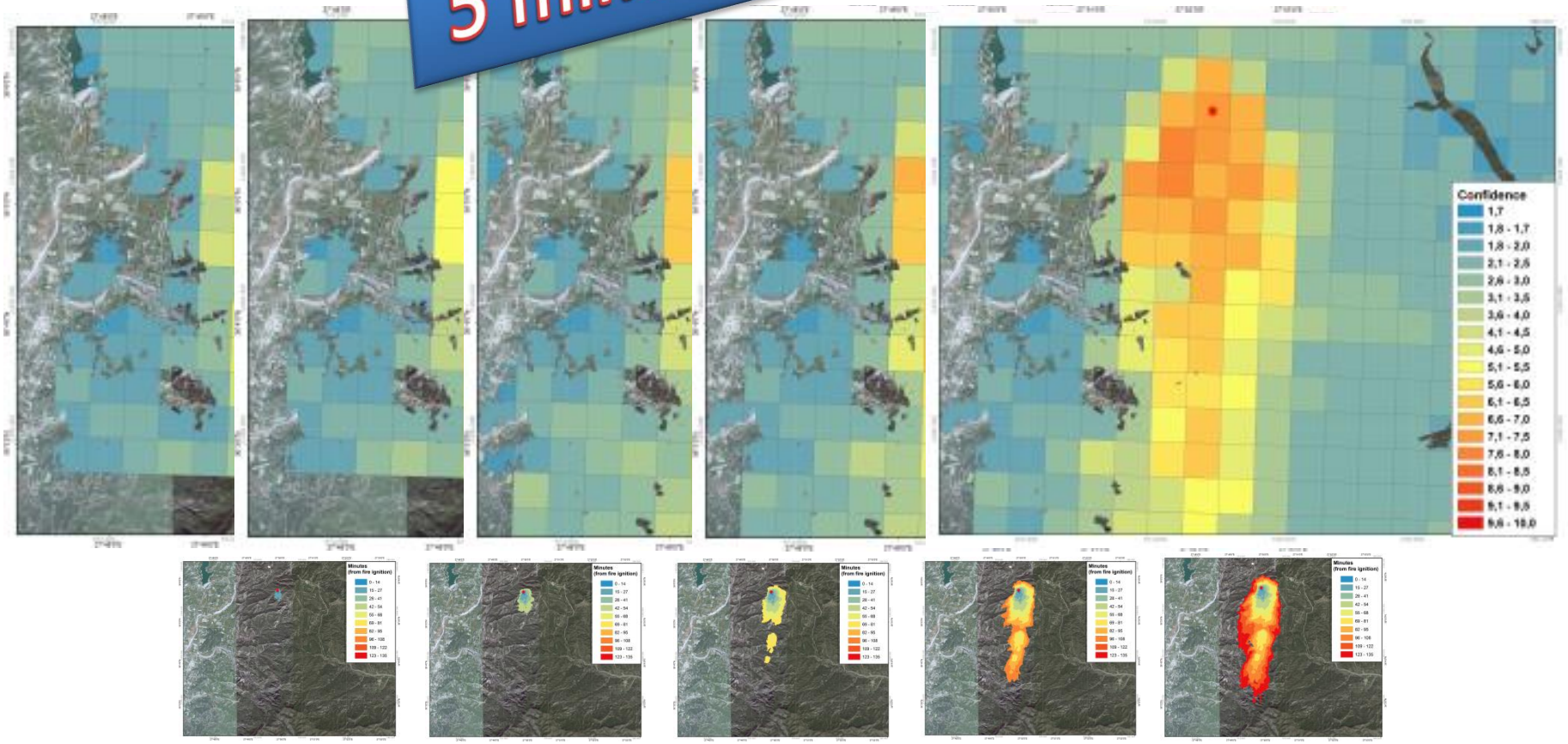
POTENTIAL FIRE

CONFIRMED FIRE

Results @ 150 minutes after fire ignition

+30’ → +35’ → +40’ → +45’ → +50’

5 minutes basis




Emergency
Rhodes Island
27/7/2013
SEVIRI Monitor - NOA GIS
EUMETSAT
SWeFS
strabon
Demonstration of the "Real-time fire detection" functionality
Local Time: 27-07-2013 13:10
Fire Monitoring Service based on MSG SEVIRI
Raw
Refined
Realtime
Archive
Month of Reference
Show Fire

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EXCELSIOR

BEYOND

Fire Smoke Dispersion Service
A FireHub Module

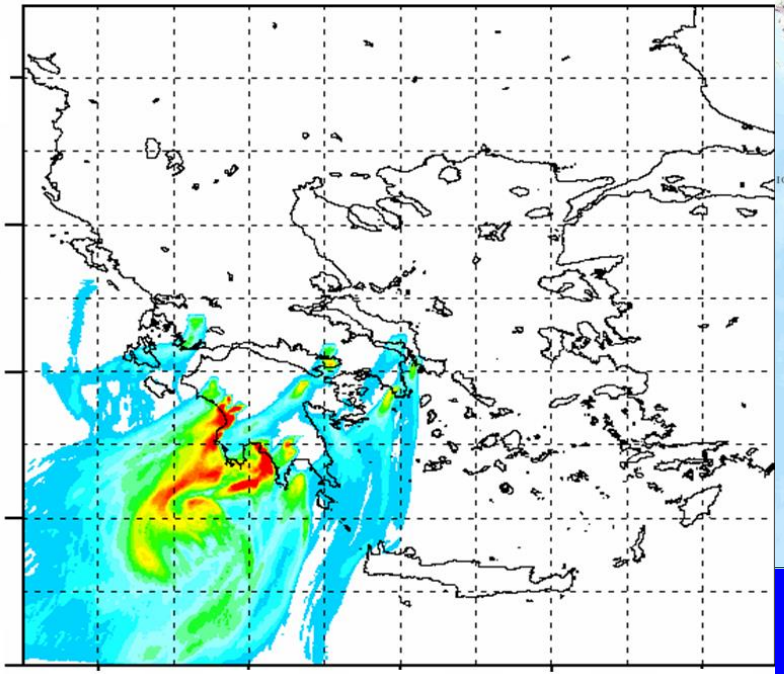
IAASARS

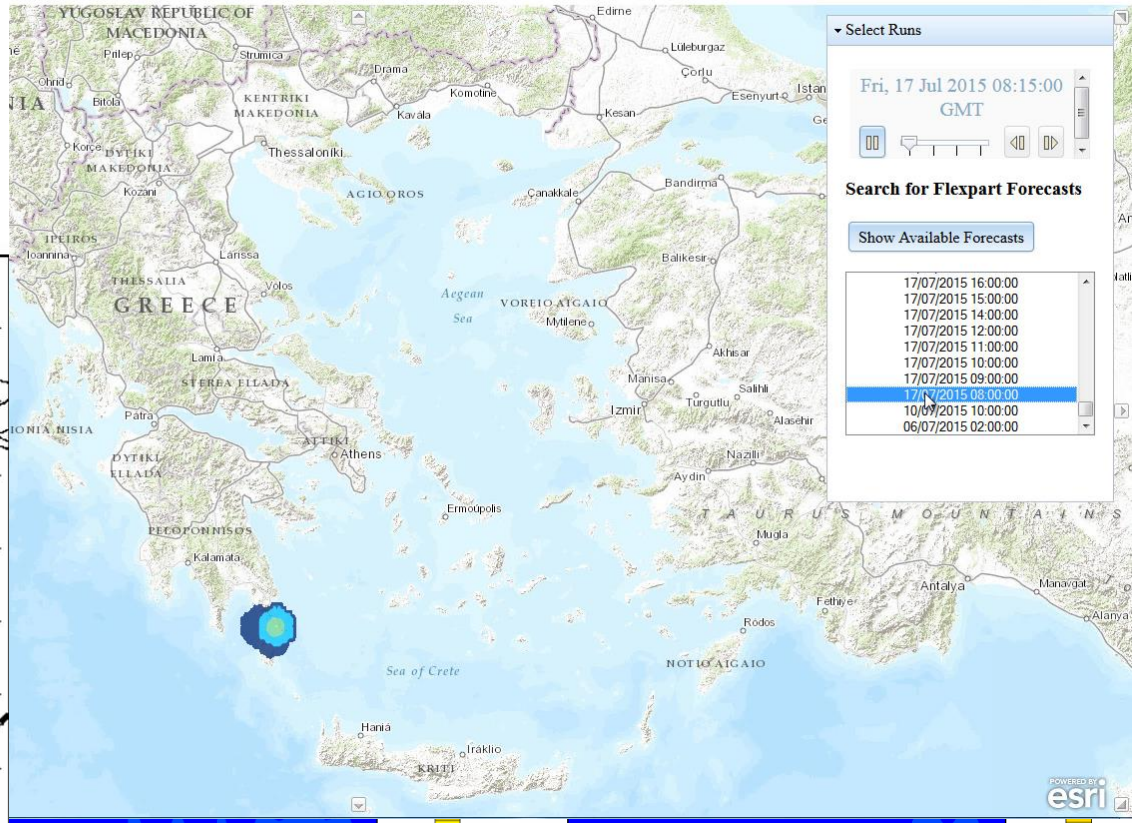
FLEXPART – NOA

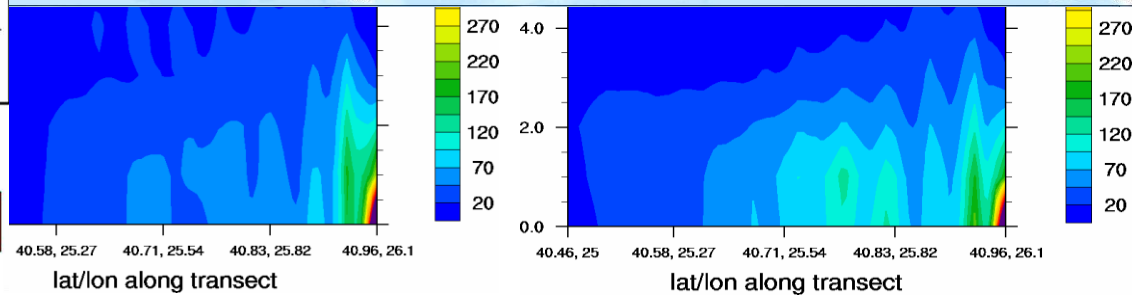
Biomass Burning (Organic Carbon – OC)

Valid Date:26-08-2007 0900UTC

Model layer: Integrated Column (ng m^{-3})

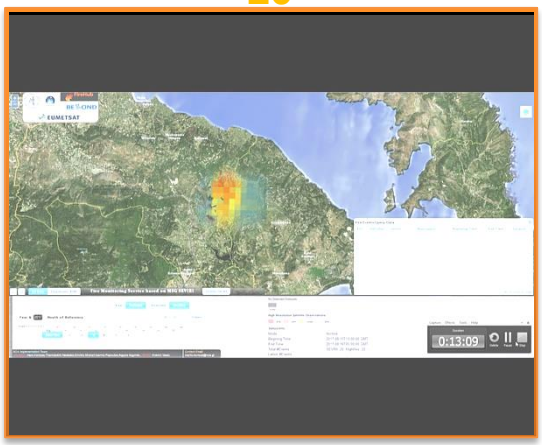






FIREHUB: RT FIRE MONITORING COMBINED WITH BURNED AREA MAPPING IN RUSH MODE

First Detection in 10’

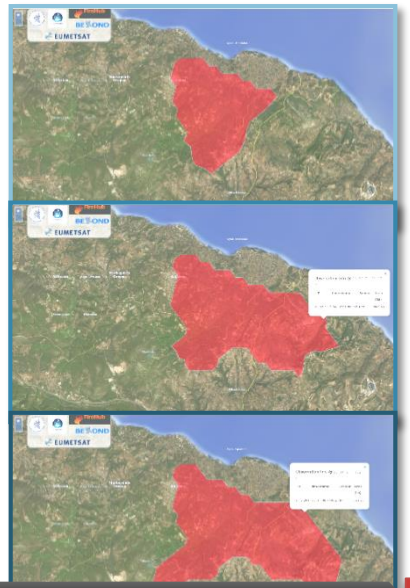


Meteosat SG –SEVIRI

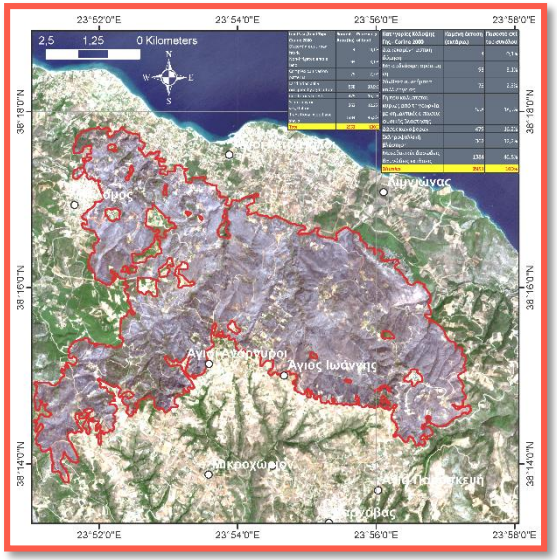
Day #1
NPP-VIIRS
MR=375m
20170817 11:14

Day #2
MODIS-Terra
MR=250m
20170818_1055

Day #3
NPP-VIIRS
MR=375m
20170819_1057



Day #4 Sentinel-2 HR-10 m



P1 Detection - Monitoring
Active Fires - Resolution 500 m/5 minutes

P2 Rapid Daily Mapping in Medium Resolution
2-3 times /day

P3 Rapid Daily Mapping in High Resolution
every 5 days

T0 minutes

Fire Ignition

Detection of active fires using FireHUB

T10 minutes

KALAMOS
13/08/2017
2953
HECTARES

T1 Day

Perimeter of burned area
Medium Resolution (375μ)

Perimeter of burned area
Medium Resolution(250μ)

T2 Day

T3 Day

Perimeter of burned area
Medium Resolution(375μ)

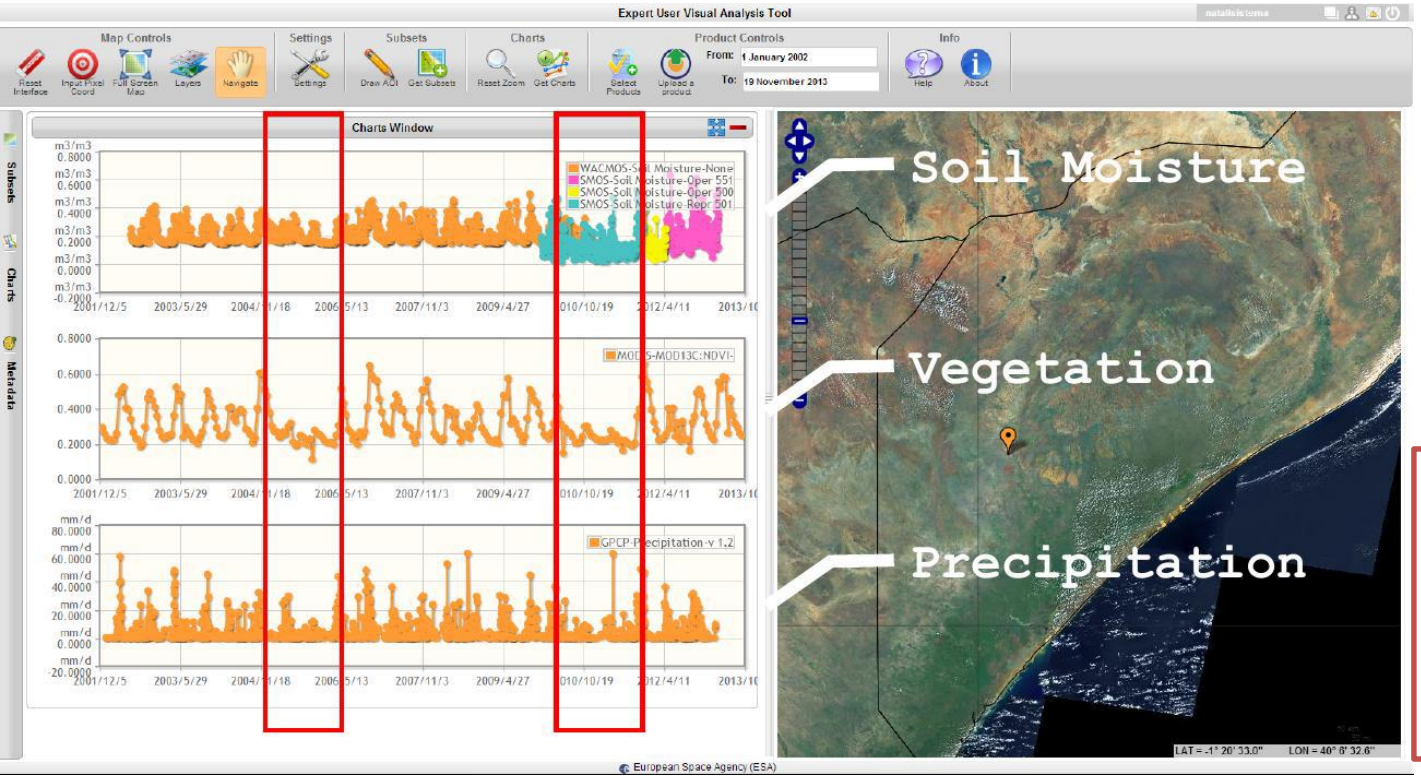
Perimeter of burned area
High Resolution (10μ)

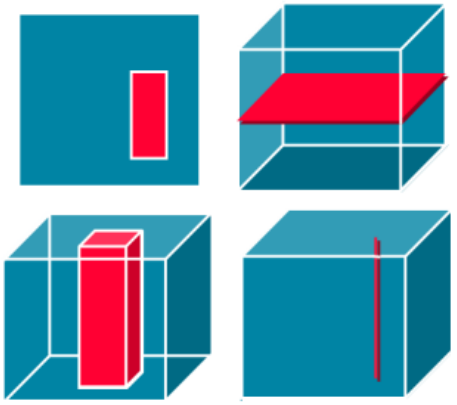
T4 Day

FIREHUB: DETAILED BURNED AREA & DAMAGE ASSESSMENT MAPPING (RUSH&NON RUSH MODE)

Very High Spatial Resolution (3,5 cm)- Daily delivery

Moving towards integrating Datacubes = Central Building Block for next-generation “analysis-ready“ services





Datacubes treat all axes alike, irrespective of an axis having a spatial, temporal, or other semantics

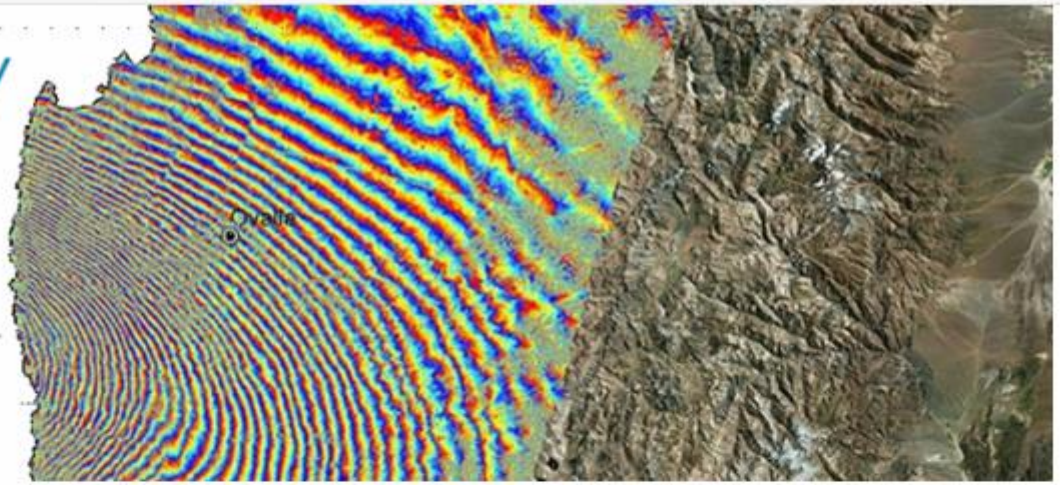
BEYOND
Centre of EO Research and Satellite Remote Sensing

EXCELSIOR

geObservatory

IAASARS

BEYOND



HOME | HOW DOES IT WORK? | SENTINEL DATA | DISCLAIMER | CONTACT

Recent Events

Historic Events

geObservatory | Cloud based and Scalable DinSAR Solution

Pilot context:
Automation of a demanding processing chain, using big stack of Sentinel-1 data (download S-1 data, pre-processing, generation of interferograms & ground velocities).

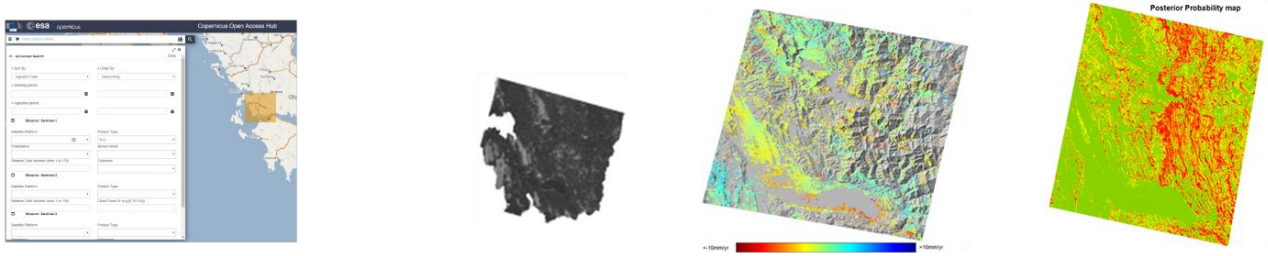
For 2 years of S-1 (Ascending & Descending) over a single pilot area, approximately 2,2 TB.

1st part: Stack of interferograms
- Select and download Sentinel 1 SLC data
- Run ISCE s/w
- Generation of stack (Input for the 2nd part)

2nd part: Ground velocities
- Data Preparation for StaMPSv4
- StaMPSv4 Parallel processing
- StaMPSv4 aggregation and final processing
- Generation of ground velocities

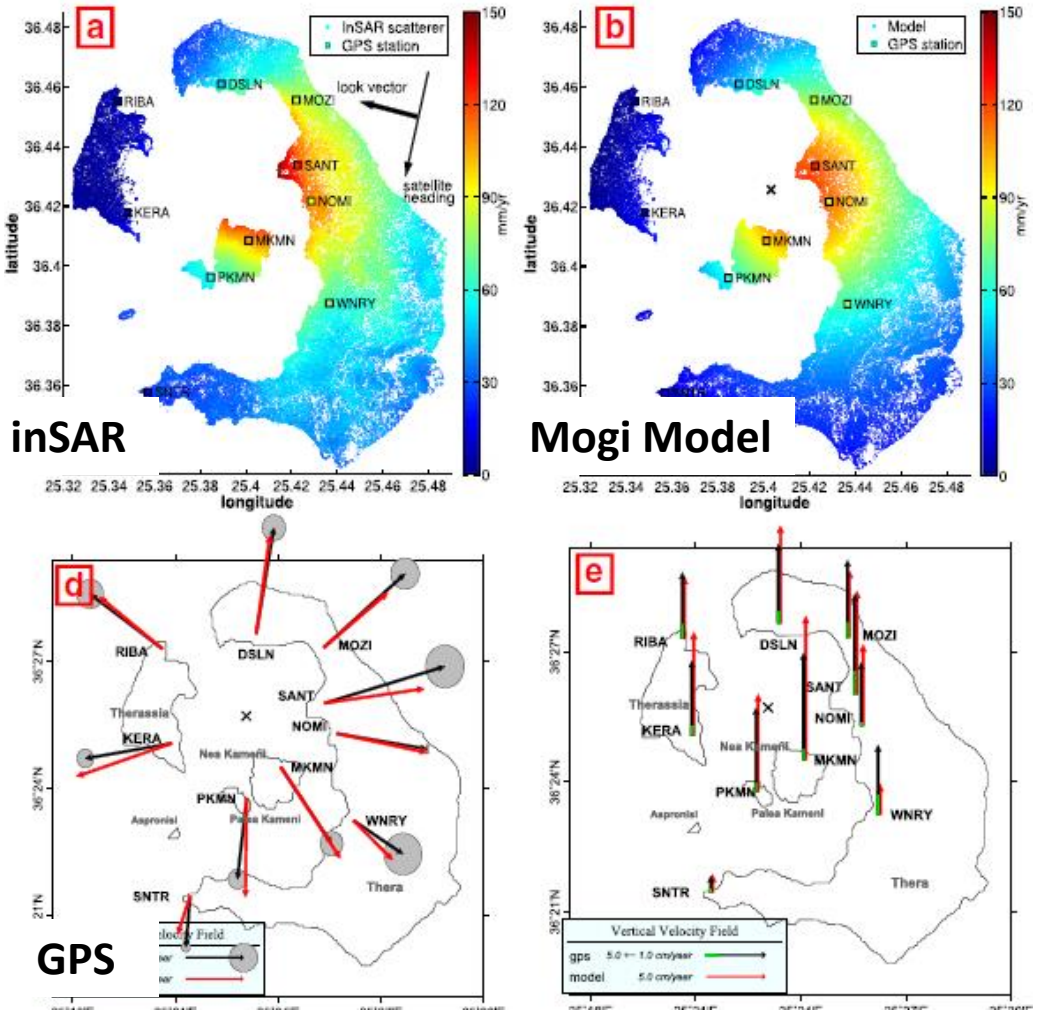
3rd part: Update landslide inventory
- Transform ground velocities into new landslides
- Update the Landslide inventory

4th part: Updated susceptibility map
- Execute the enhanced landslide model
- Generation of updated susceptibility map



Interferometric Synthetic Aperture Radar

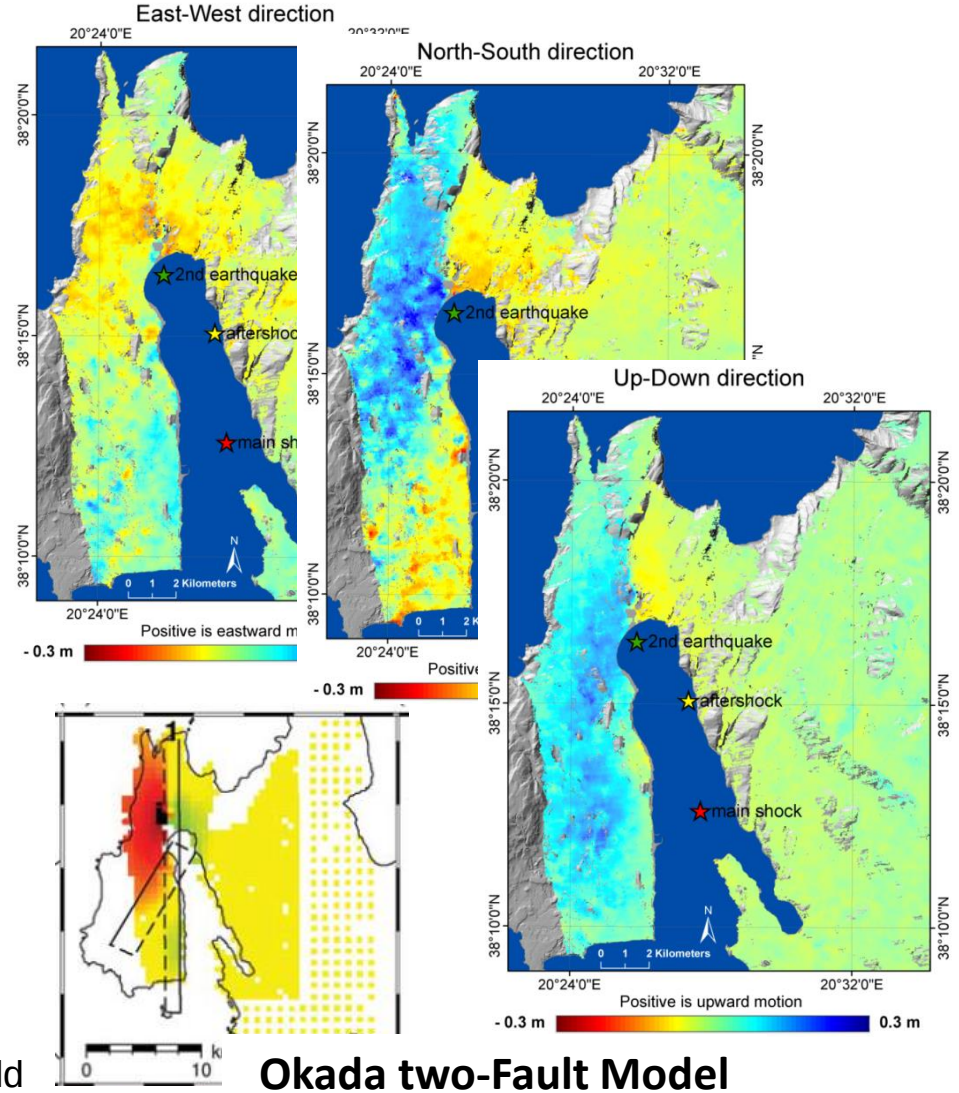
Mapping inflation of Santorini volcano, Greece, from 01/2011 to 02/2012 **using GPS and InSAR (ENVISAT Data processed with PSI&SBAS techniques).** A clear and large inflation signal, **up to 150mm/yr in the LOS direction**, with a radial pattern outward from the center of the caldera is observed. The deformation pattern was model using a Mogi source located north of the Nea Kameni island, at a depth **between 3.3km and 6.3km and with a volume change rate in the range of 12million m³ to 24 million m³ per year** **(by BEYOND GeObservatory)**



Papoutsis et al, Mapping inflation at Santorini volcano, Greece, using GPS and InSAR, GRL, Vol. 40, 267–272, doi:10.1029/2012GL054137, 2013

InSAR for measuring ground deformation after abrupt events

The complex sequence of EQs that struck the island of Cephalonia, Greece, started on 26 January 2014 at 13:55 UTC, Mw 6.0, and followed five hours later by an Mw 5.3 aftershock and by an Mw 5.9 event on 3 Feb 2014 at 03:08 UTC. SAR image pairs spanning the second mainshock were acquired on **descending and ascending passes**, by the **COSMO–SkyMed and TanDEM-X** satellite missions. **East, North, and Up displacement** components associated with the EQ, indicate a **strong horizontal and vertical displacement of up to 30 cm**. Using Okada model a two-fault model reproduced the observed DInSAR surface displacements **(by BEYOND GeObservatory)**

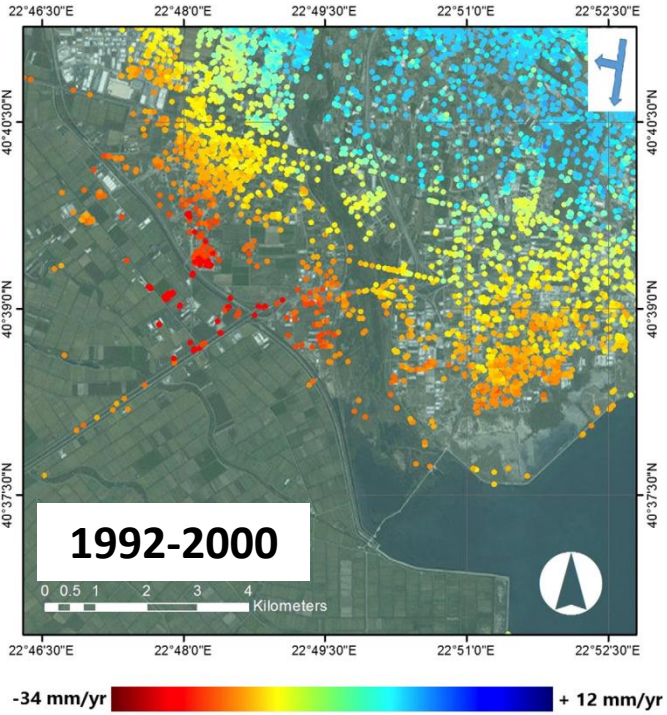


Okada two-Fault Model

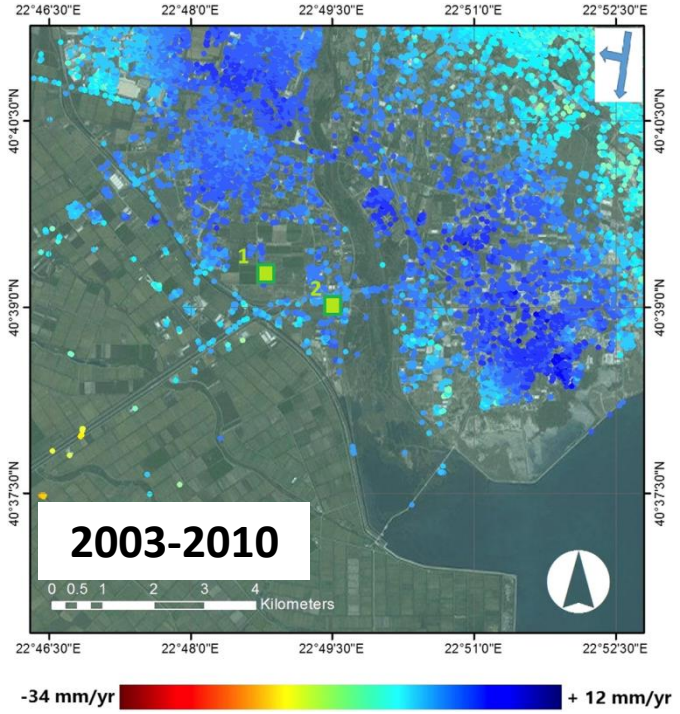
J.P. Merryman Boncori et al, The February 2014 Cephalonia Earthquake (Greece): 3D Deformation Field and Source Modeling from Multiple SAR Techniques, **SRL, Vol86, No 1,** 2015

InSAR for measuring land subsidence due to excessive water pumping

InSAR based land subsidence in the western side of Thessaloniki, recorded since the early 1960s and **reaching gradually up to 3–4 m** was assessed**. PSI and SBAS multi-temporal Interferometry** was applied to analyse the **20 year ERS 1, 2 and ENVISAT** data. The ERS dataset depicted **subsidence up to 35mm/year for the period 1992-2000**.



Svigkas Nikos et al, Land subsidence rebound detected viamulti-temporal InSAR in Kalochori and Sindos regions, Northern Greece, **Engineering Geology 209 (2016) 175–186**



The ENVISAT data (2003–2010) showed that there was a change **from subsidence to uplift, a motion that is well correlated with hydrogeological data that showed a synchronous rise of the aquifer level**. The dominating driver of the human factor concerning the land subsidence phenomena for the last 55 years is obvious

THANK YOU FOR YOUR ATTENTION!

ANY QUESTIONS?