



Technical and scientific capacity of Risk & Recovery Mapping

Dora Aifantopoulou – GEOAPIKONISIS S.A.P.GE.
Ioannis Papoutsis – NOA

Copernicus
Europe's eyes on Earth

Space

Outline of the Presentation

The partnership	Partners Role
	Relevant Qualifications
Service Implementation	Workflows
	Quality Management and Assessment
	Team Expertise
The Results	Areas & Risks Assessment
	Products
Quality Reviews	The Azores Archipelagos case
The Ukraine Activation	Ground Movement Assessment & Monitoring

Partners Role



GEOAPIKONISIS S.A.P.GE.

Project & Quality Management, Services Design & Implementation, Satellite Data Processing, Geospatial Data Integration & Processing, Damages Assessment, First Response Infrastructure, Mitigation, Generation of Thematic products

National Observatory of Athens (NOA)

Project (Deputy) Management, Specifications' analysis/ Products definition, Satellite Data Processing, Risks (Earthquakes, Tsunamis, Landslides, etc) Assessment, Mitigation, Generation of Thematic products

CIMA Research Foundation

Project Board, Risks (Floods) Assessment, Mitigation, Generation of Thematic products

TRE ALTAMIRA

Project Board, SAR/ InSAR developments & applications, Ground deformation mapping, Generation of Thematic products

Excellence and complementarities

International Experience

Expert Research profile (modelling, data processing, etc)

Efficient design & High capacity

Relevant Qualifications



GEOAPIKONISIS S.A.P.GE.

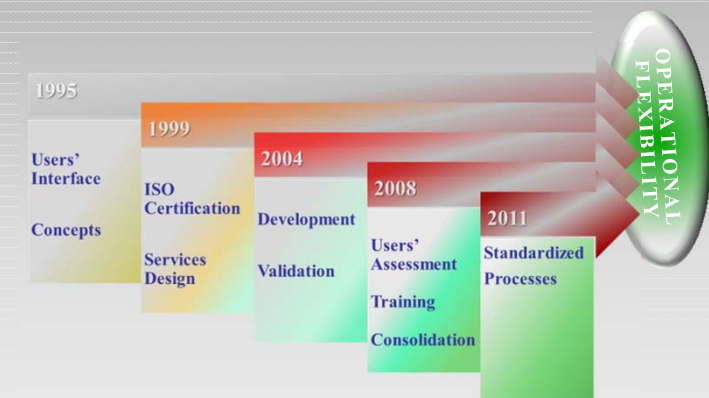
Skills & Expertise

Analysis & processing of geospatial data / Development of geo-informatics solutions & systems

Since 1995, GEOAPIKONISIS brings together wide technical and scientific experience and offers:

- Basic Services - *Information layers*
- Thematic Services – *Users' Workflows*
- Geo – Information Services & Products – *Tailor made systems & solutions*

- Project Management & Technical Support



Relevant Qualifications



GEOAPIKONISIS S.A.P.GE.

Infrastructure & Facilities

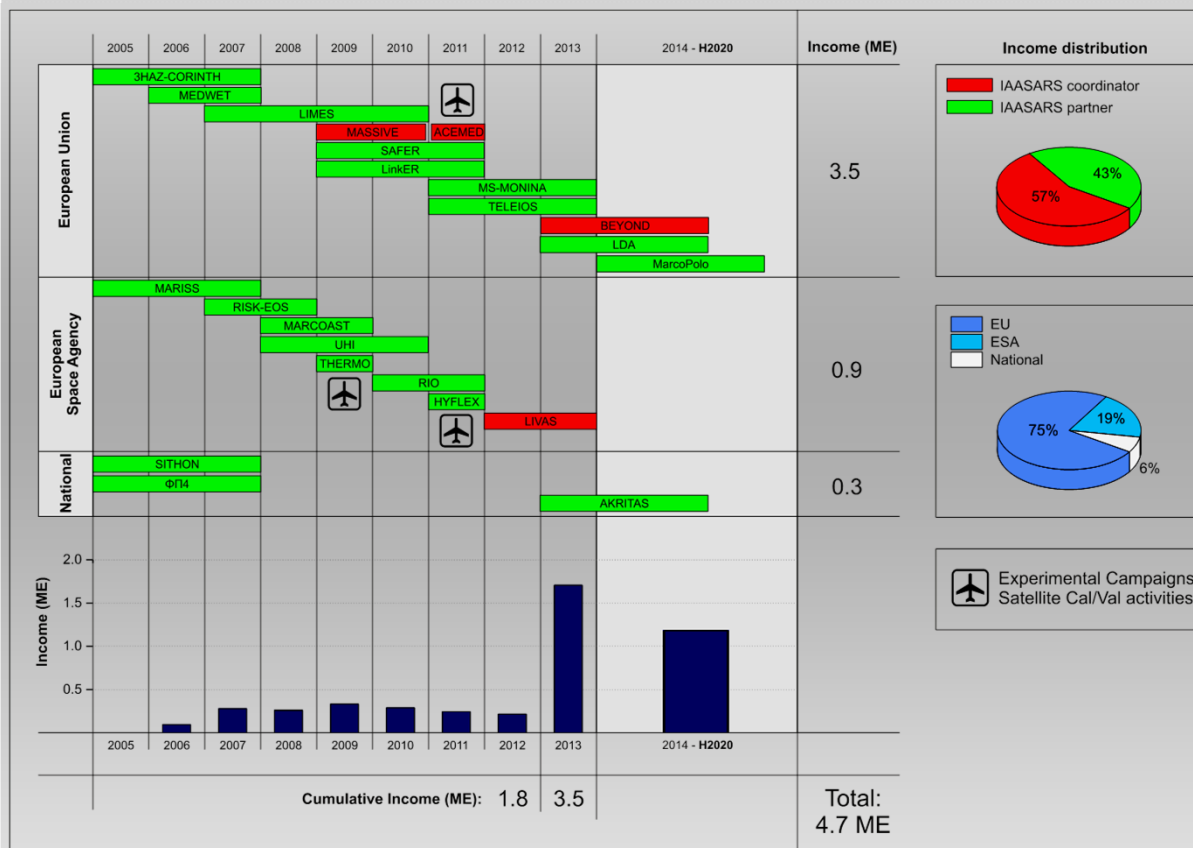
Hardware: A servers' backend infrastructure consists of 12 HP ProLiant ML350 servers, in various roles: Primary Domain Controllers, Active Directory Domain servers, DHCP, DNS, File server, Backup server, Oracle Database server, MS SQL Server Database server, Hyper-V virtualization server, Application server, FTP, Webserver, Web GIS, Firewall/VPN system

Software for data processing and handling: Enterprise Databases, Desktop/ Field (Windows Mobile)/ Web GIS (Server), Geospatial Raster Data Processing & Remote Sensing Applications support, Photogrammetric suites, dedicated GPS Data processing

Internet performance: High-speed satellite connection. One dedicated server to cover the needs of demanding online data transfer, providing up to 500Mb upload and 1Gb download speeds

Relevant Qualifications

National Observatory of Athens (NOA)



NOA Heritage

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

TELEIOS: Virtual Observatory Infrastructure for EO Data, FP7-ICT-2009-5

LinkER: Supporting the implementation of operational GMES service in the emergency management field

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

MASSIVE: Mapping Seismic Vulnerability & Risk of Cities, EC - DG ENV A.3 - Civil Protection

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

GSE RISK-EOS fire services portfolio, EarthWatch, ESA/GSE

Relevant Qualifications



National Observatory of Athens (NOA)

Infrastructure & Facilities

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

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)

NOA's in-situ monitoring seismological, magnetometer, & GPS networks

Development & Operation of NOA's Collaborative Ground Segment (Hellenic Sentinel **Data Hub-Mirror Site**) dedicated to ESA Sentinel missions (Copernicus); near real time acquisition of S-1, S-2, and future S3, S5P satellite missions

Development/ installation (state-of-the-art) multi-wavelength LIDAR [Crete – FKL].

BEYOND / EARLINET network.

24/7 Operations/ SENTINELS IntHub



Relevant Qualifications



CIMA Research Foundation

Skills & Expertise

CIMA (International Centre on Environmental Monitoring) is a foundation of active research since 2007, born from a preexisting Interuniversity Research Center

Training, research and technological development in the fields of Civil Protection, Disaster Risk Reduction and Biodiversity

Research Areas: Responsibility, Legal and Governance in Risk Management, Hydrological Forecasting, Modeling and Risk Assessment, Predictability and Predictive Capacity in Hydrometeorology, Fire and other risks related to Interaction Soil-Vegetation-Atmosphere , Dispersion and Risk of Hazardous Substances in Natural and Man-Systems, etc.

Technological tools: DEWETRA integrated system for forecast, prevention and risk monitoring /hydro-meteorological and wildfires, RISICO Fire Risk and Coordination , FLOODPROOFS (Operational Probabilistic Flood Forecasting System),etc

Relevant Qualifications



TRE ALTAMIRA

Skills & Expertise

EO company specialized in the analysis and processing of images from space, especially advanced SAR processing

Since 1999, ALTAMIRA brings together wide technical and scientific experience and offers:

- **Advanced SAR/InSAR developments and applications**
- **Distributed Information Systems and Visualization applications**
- **Operational processing of large volumes of EO data**
- **Excellent working knowledge of the procedures of international organizations**

Leading player in radar imagery processing; development & maintenance of the GlobalSARTM (own) Software

Recognized projects' partner of the most important space agencies and research groups worldwide



Relevant Qualifications



TRE ALTAMIRA

Infrastructure & Facilities

Hardware: Processing equipment Servers (4 storage (100 TB), 8 processing (150 CPU in total), 1 VMWare ESXi (32 CPU), 1 FTP (1TB disc)), Gigabit Ethernet network (1000Mbps), separation of the processing network and the user LAN to guarantee safety and ease management with remote (data) backup system

Software for data processing and handling: Diapason and Graphical User Interface for SAR data, SPN (Stable Point Network): InSAR processing chain developed and owned by Altamira Information, SW for data visualization and data handling tools development, GIS SW and converter and other format conversion tools

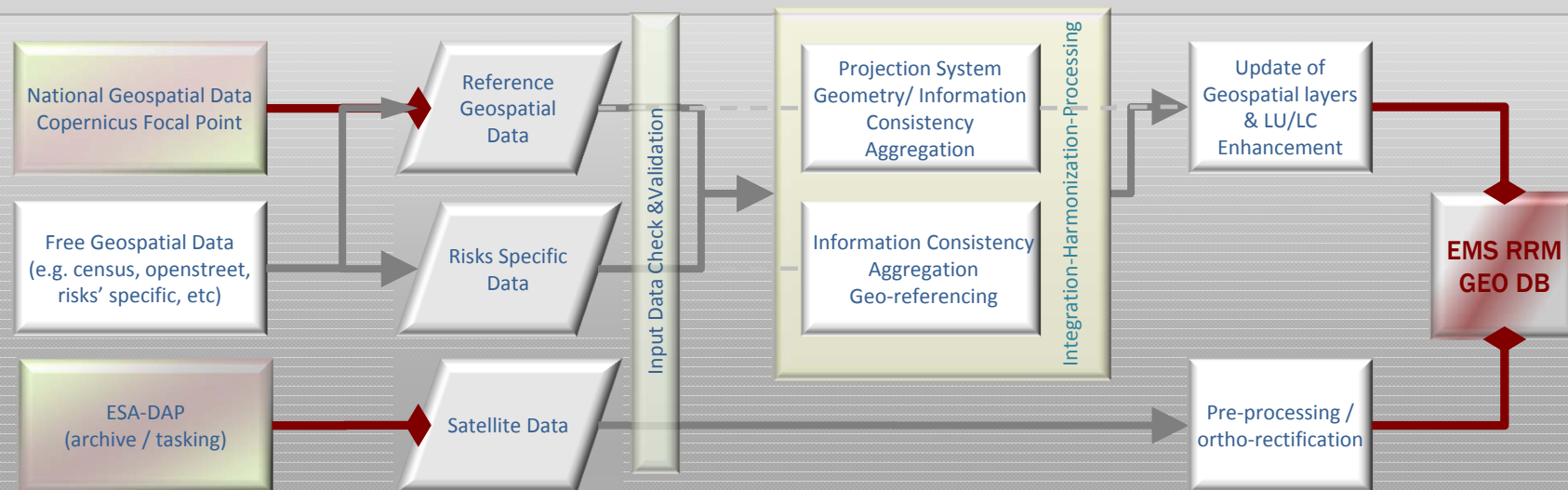
SAR Data Browsers: EOLI – data browser for ESA/ Envisat, APT – data browser for Radarsat-2, DLR EOWEB – data browser for TerraSAR-X, E-Geos - data browser for Cosmo-SKYMed, JAXA AUIG (ALOS User Interface Gateway) -data browser for ALOS, Management tools

Internet performance: 2 FFTH connections providing asymmetrical 10Mb/100Mb upload/download speeds. Associated to static IP addresses (optimized access to services), firewall IP filtering rules (security constraints). Additionally, two dedicated servers in Europe to cover the needs of demanding online data transfer, providing up to 500Mb upload and 1Gb download speeds

Outline of the Presentation

The partnership	Partners Role
	Relevant Qualifications
Service Implementation	Workflows
	Quality Management and Assessment
	Team Expertise
The Results	Areas & Risks Assessment
	Products
Quality Reviews	The Azores Archipelagos case
The Ukraine Activation	Ground Movement Assessment & Monitoring

The Workflows



☐ Data validation; gaps & quality assessment ➤ Integration/ Update approach

☐ Data Integration

- Re-projections/ Geo - referencing
- Input data harmonization; format, scale, attribute information content, Thematic information nomenclature, reference years, etc)
- Geometry – Topology match
- Spatial & attribute conformance to products' specifications
- Additional layers design & production

☐ Update Content

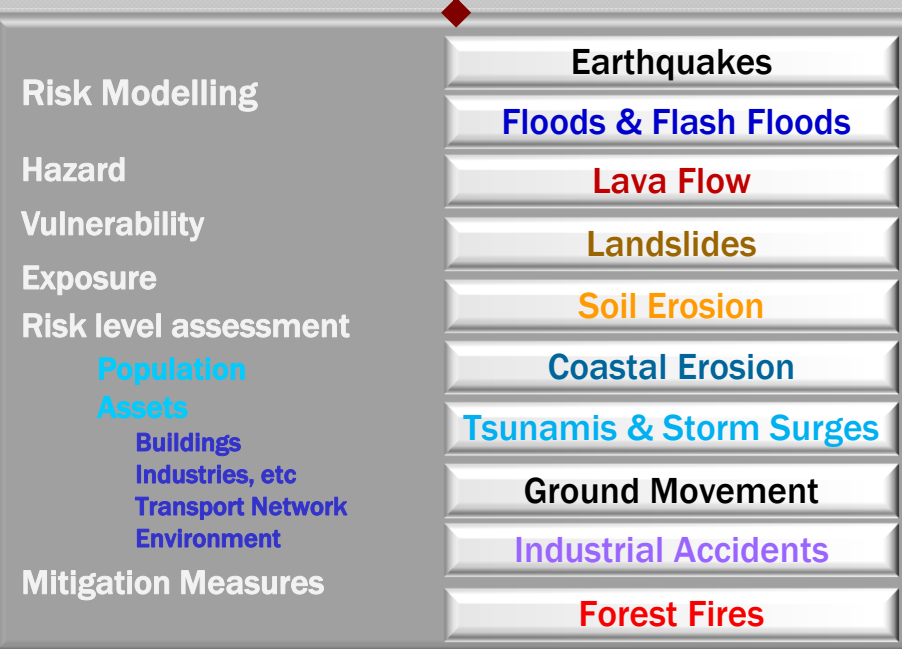
- Enrichment
- Spatial adjustments – corrections

☐ EO data ortho-rectification

BASIC/ HORIZONTAL ACTIVITIES

The Workflows

Establishment of the
Geo-spatial
Data Base



Spatial Modelling

First Response
Infrastructure

Risk Specific Activities

Risk and Recovery Data

Quality in the Services Provision

Specification

QMP/
Validation
Protocol

Applicable
Standards

Geo- spatial
DB design &
Implementation

Products/ Services Validation & Quality
Control

Internal

External

Products Release

Quality
Control
Records

Quality
Assurance
Reports

Thematic
Products

Team Expertise

ACTIVITIES	Expertise
Reference Mapping	EO & GIS
Risks Assessment & Modelling	Earthquake, Flood, Tsunami, Erosion & Landslide, Air pollution, Geology
Damages Assessment	EO (PI)
Structural Damages Assessment	Civil Engineering
Ground deformation mapping and monitoring	Multi-temporal DInSAR processing
First Response Infrastructure	EO (PI) & GIS
Mitigation	Civil Engineering & GIS

Outline of the Presentation

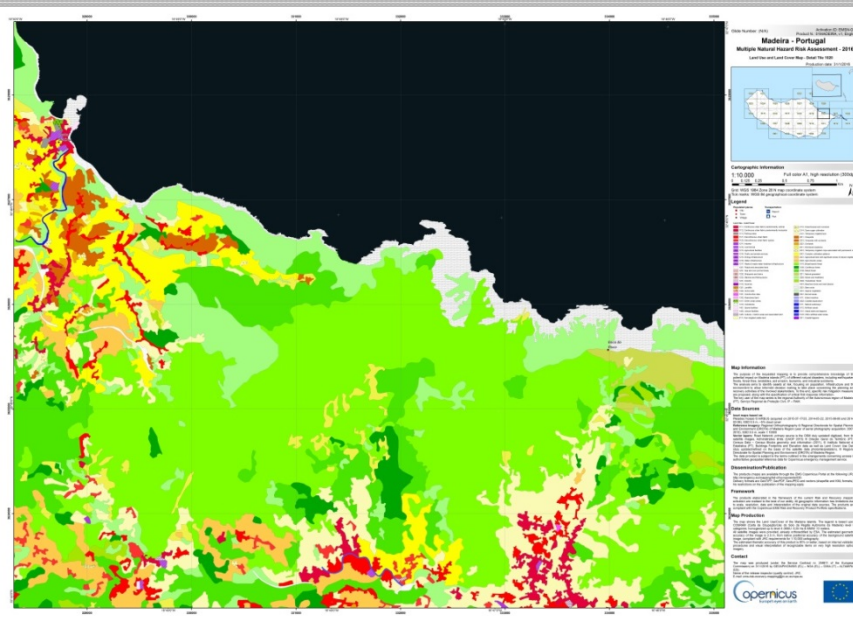
The partnership	Partners Role
	Relevant Qualifications
Service Implementation	Workflows
	Quality Management and Assessment
	Team Expertise
The Results	Areas & Risks Assessment
	Products
Quality Reviews	The Azores Archipelagos case
The Ukraine Activation	Ground Deformation Assessment & Monitoring

Areas & Risks Assessment

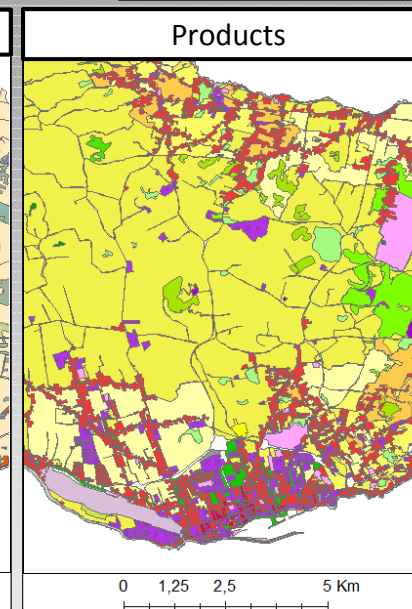
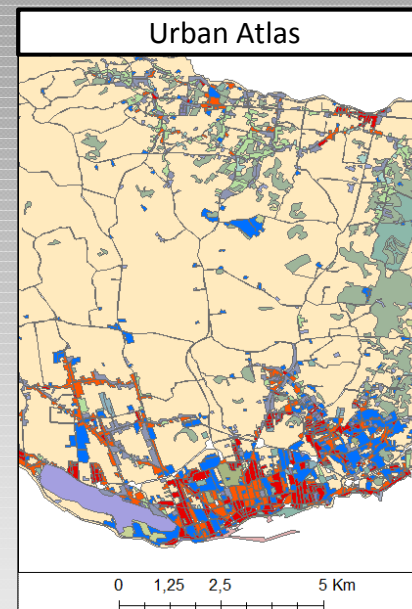
Activation	Subject	AOI/ Extent	Risks Evaluation
EMSN018	Multiple natural hazard risk assessment - Planning and Recovery	Azores Archipelagos islands (PT)/ 2.350 KM2	Seismic, Flash Flood, Landslide, Tsunami & Storm Surges, Erosion, Lava Flow
EMSN020	<i>Idem</i>	Madeira & Porto Santo Islands (PT)/ 801 KM2	Seismic, Flash Flood, Landslide, Tsunami, Erosion, Forest Fires. Industrial Accidents
EMSN021	Earthquake risk assessment Austria - Planning and Recovery	Earthquake risk assessment Austria - Planning and Recovery (AT)/ 14.171 KM2	Seismic, Flash Flood, Landslide, Industrial Accident
EMSN022	Post-disaster analysis, damage assessment, recovery & rehabilitation planning and monitoring, flood risk assessment, disaster preparedness & response mechanisms	Post event Assessment (BG)/ 140 KM2	Flood Event Assessment, Flood, Erosion & Landslide
EMSN025	Forest fire damage assessment – Planning and Recovery	Six (fire) incidents. Post event Assessment (GR)/ 75 KM2	Fire Damage, Flash Flood, Erosion, Landslides
EMSN026	Post-disaster assessment of toxic cloud dispersion after an industrial accident in Catalonia/Spain	Post event Assessment (ES)/ 55 KM2	Industrial accident
EMSN030	Ground deformation mapping & monitoring by satellite based multi-temporal DInSAR technique, Solotvyno, Ukraine	Preparedness (UA)/ 38 KM2	Landslides & Subsidence
EMSN031	Forest fire damage assessment & landslide risk	Madeira Island (PT)/ 390 KM2	Fire Damage, Landslides
EMSN037	Multiple natural hazards risk assessment for in three cities	Chile, Peru, Mozambique/ 1030 KM2	Seismic, Flash Flood, Landslide, Tsunami, Erosion

Reference Mapping

Comprehensive and Updated knowledge on the territory and relevant assets
Disaster Risk Reduction Context - Content: topographic features, assets, LU/LC, etc

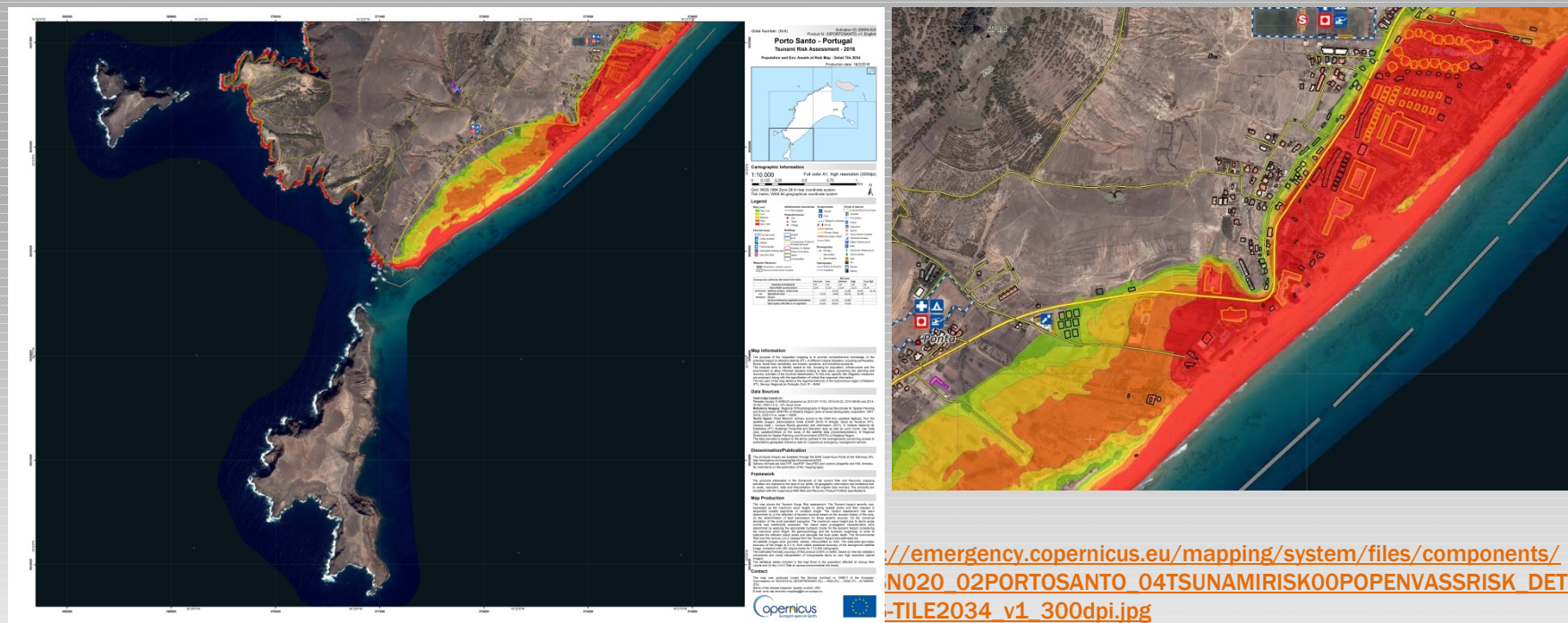


<http://emergency.copernicus.eu/mapping/list-of-components/EMSN020/LULC/ALL>



Pre-disaster situation Mapping

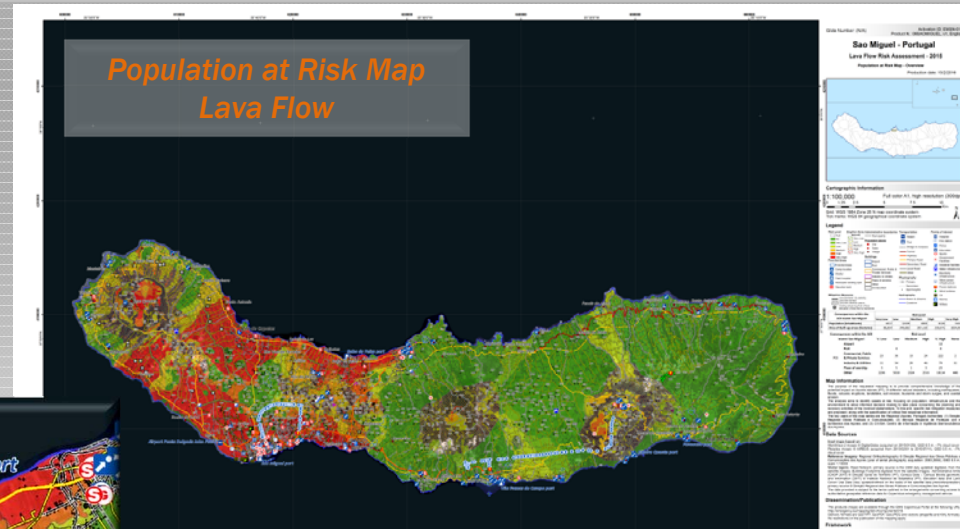
- ❑ Relevant and up-to-date thematic information to assist / focus planning for contingencies on areas vulnerable to hazards, aiming to minimise loss of life and damage
- ❑ Hazard, Exposure, Vulnerability, Risk status, Evacuation plans, Modelling scenarios



Pre-disaster situation Mapping

- ❑ Evaluation of possible damages (vulnerability of assets, areas, etc)
- ❑ Mitigation measures
- ❑ Objective and comprehensive assessment of (secondary) risks

Towards minimizing impact of future events; suggesting necessary preparedness measures with reference to: Human Life, EMS Infrastructure, Damage Extent



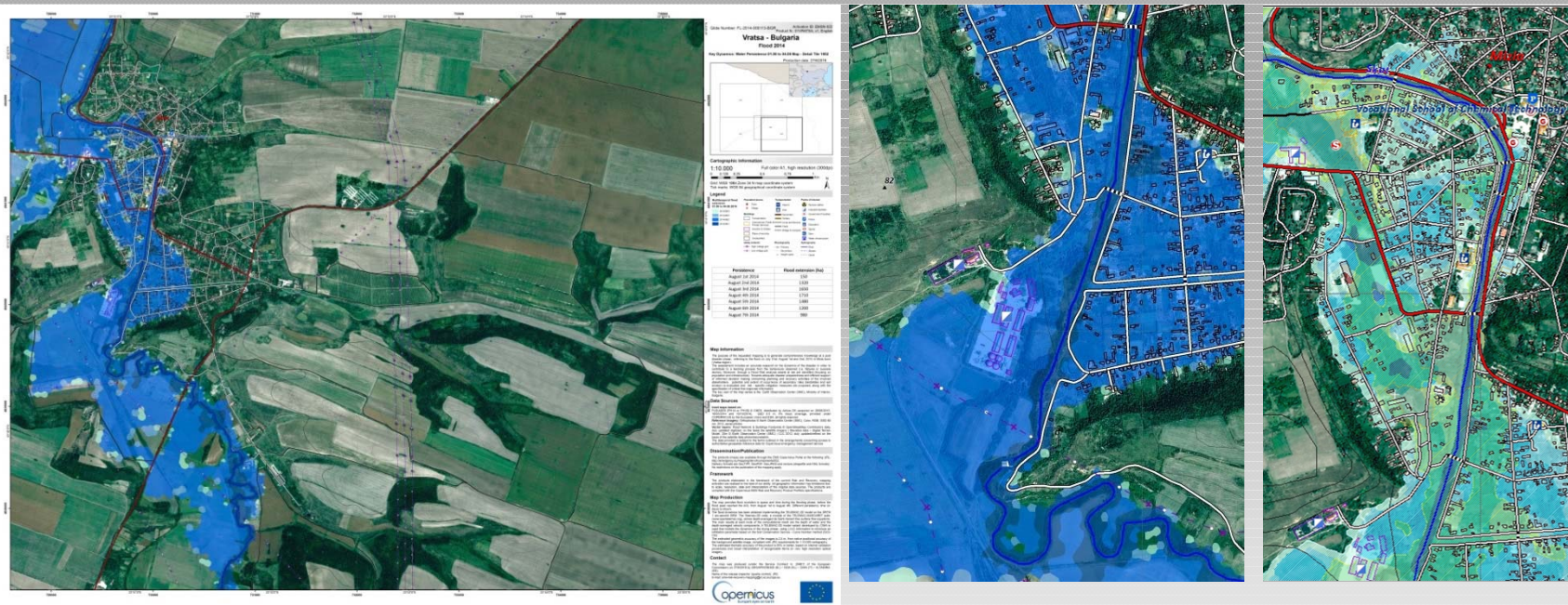
Pre-disaster situation Mapping

First response conditions (access roads, evacuation possibilities, locations of first aid and shelters, etc)



Post-disaster situation Mapping

- ❑ Relevant and up-to-date thematic information for the needs of reconstruction planning
- ❑ Progress monitoring, mapping long-term impact
- ❑ Post disaster needs assessment, recovery plans, reconstruction/rehabilitation monitoring, Internally Displaced Persons (IDP) monitoring, Refugee Camp monitoring



http://emergency.copernicus.eu/mapping/system/files/components/EMSN022_01VRATSA_02FL201403WPERSISTPRE_DETAILS-TILE1002_v1_300dpi.jpg

Outline of the Presentation

The partnership	Partners Role
	Relevant Qualifications
Service Implementation	Workflows
	Quality Management and Assessment
	Team Expertise
The Results	Areas & Risks Assessment
	Products
Quality Reviews	The Azores Archipelagos case
The Ukraine Activation	Ground Deformation Assessment & Monitoring

Towards enhancing the efficiency & objectivity of the Validation activities

- ☐ Establish a communication channel (through JRC) between the Contractor and the Validation team to address doubtful or missing information
- ☐ Improve the involvement of the end users (service recipients) in evaluating the delivered data and products and prioritize their evaluation instead of other users opinion
- ☐ Involve highly skilled experts

Specific Results

- ☐ The thematic validation of the Population exposure information shows an overall accuracy of 68.52% and a kappa (κ) coefficient of 0.58, which means a **fair grade of agreement with respect to Reprocessed Population exposure information**
- ☐ **Thematic validation of LULC data:** Results shows an overall accuracy and a kappa (κ) coefficient of 89% and 0.83 respectively, which means that there is a high grade of agreement with respect to Reference LULC
- ☐ Azorean Regional Service of Civil Protection who completed the EndU-FF comments: the final products are consistent with the activation requests, but they do not have the capacity to assess whether they are good or bad in terms of quality or thematic accuracy. Additional information layer that can help them through an emergency situation in the Azores and in future regional and local planning activities. They specially valued the risk maps about population and points of interest and especially from seismic hazard, landslides and flash floods; Usage of the vector files and provision of GeoPDFs to their planning emergency teams
- ☐ EndU (expert) of the University of Lisbon: Short knowledge on Faial, Pico and São Miguel seem to be all consistent with what he observed in loco

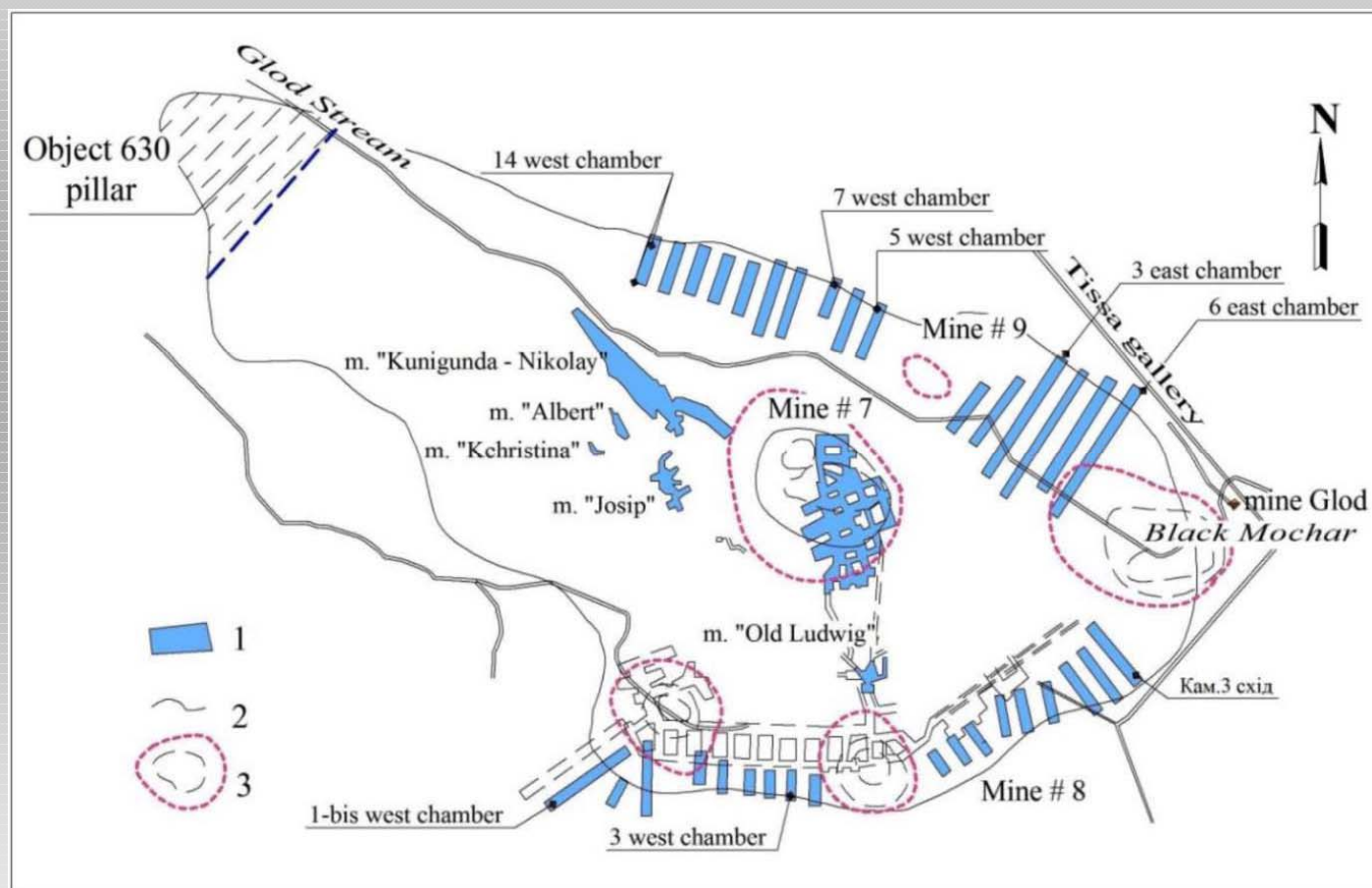
Outline of the Presentation

The partnership	Partners Role
	Relevant Qualifications
Service Implementation	Workflows
	Quality Management and Assessment
	Team Expertise
The Results	Areas & Risks Assessment
	Products
Quality Reviews	The Azores Archipelagos case
The Ukraine Activation	Ground Deformation Assessment & Monitoring

Ground Deformation Assessment & Monitoring

Framework of the Activation

- ❑ Solotvyno village stands on a giant salt dome, which, according to experts, contains 250 million tons of salt.



Ground Deformation Assessment & Monitoring

Framework of the Activation

❑ Two main subsidence expressions

- ❑ Large collapses with a diameter up to 200 meters and with a depth of about 20-30 meters. In 2015 a hole measuring 100m wide and 60m deep
- ❑ Sinkholes that are smaller collapses with a funnel shape of about 10 meters in diameter. These collapses, in a first approximation can be considered as a sudden soil movement with no prior warnings

Directorate General for European Civil Protection and Humanitarian Aid Operations of the European Commission (DG ECHO) organized a four-day scoping mission between 4-7th of July 2016 to Solotvyno (Ukraine), where the abandoned and neglected salt mine poses a significant contamination threat of the Tisza River and also threatens the livelihoods of those living in the region. The five-member scoping mission team was made up of British, Finnish, French, Hungarian and Latvian experts.



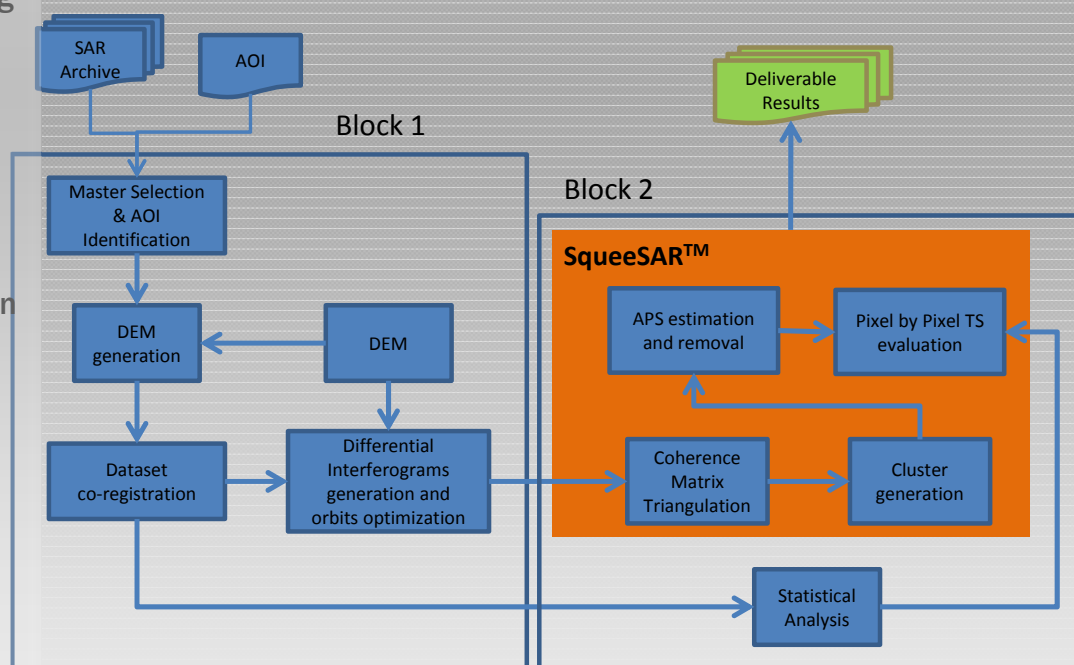
Historical analysis and Assessment of Ground Deformation Dynamics

- ❑ ERS, Envisat & Sentinel-1 imagery; **106** images in total
- ❑ Persistent Scatterers Interferometry (PSI) processing
 - ❑ Temporal decorrelation: Data quality depends strongly on time laps between acquisitions. Small & consistent revisit times allow for a better estimation of the deformation measurements
 - ❑ Monitoring time span: Linked to the temporal decorrelation. The project monitoring period is rather long (almost 20 years); Land cover changes inducing significant differences in the measurements coverage along time

- ❑ Number of acquisitions: The processing to obtain the displacement measurements is based on the statistical separation of different components. These components have different spatial and temporal statistics. Hence, the amount of acquisitions available influences the accuracy of the deformation estimation

Main Steps of the PSI Processing

- ❑ **Block-1**: Main steps, related to generation of the differential interferogram to be used as input of the SqueeSAR processing chain, are grouped together.
- ❑ **Block-2**: Main steps of the SqueeSAR algorithm which optimally process not only PS objects but also DS objects

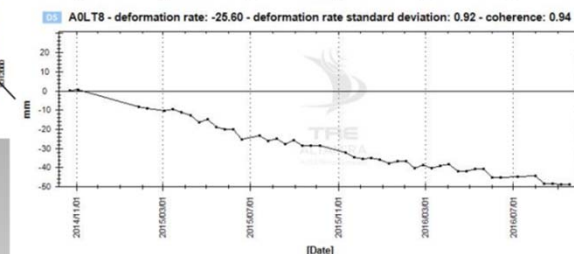
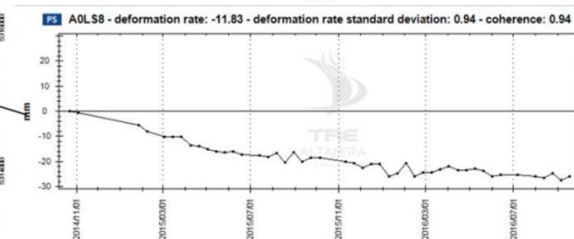
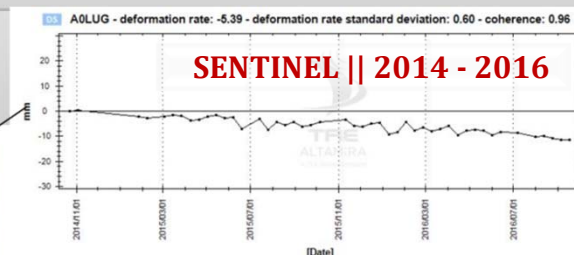
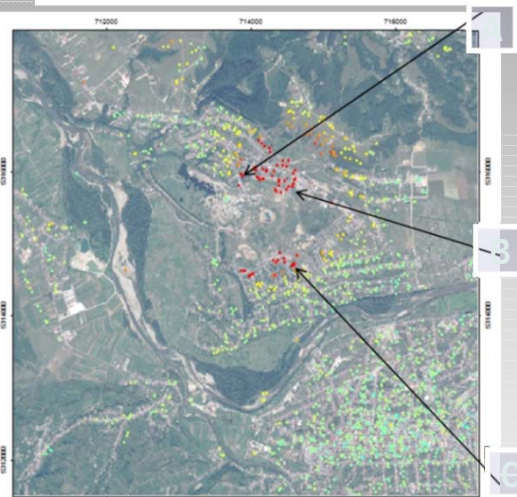
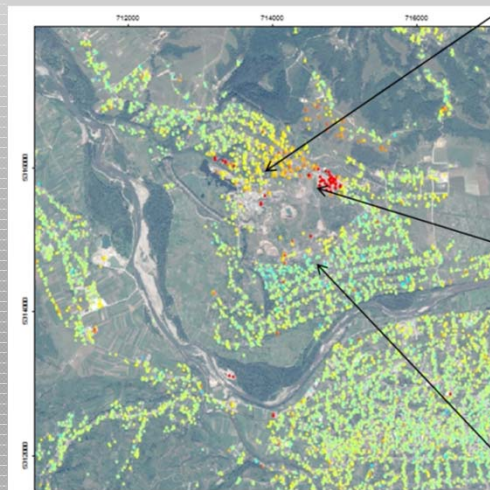
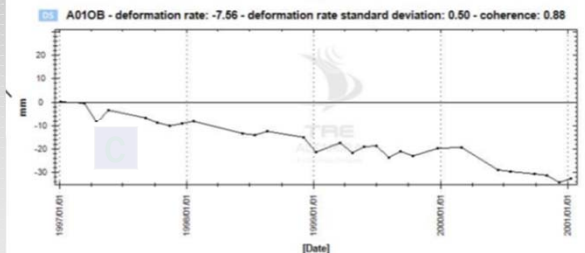
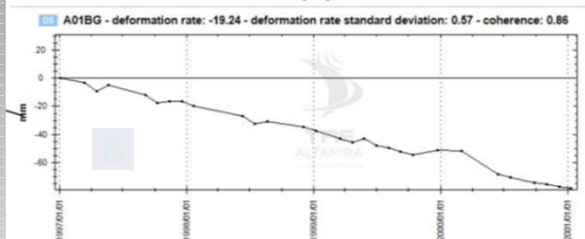
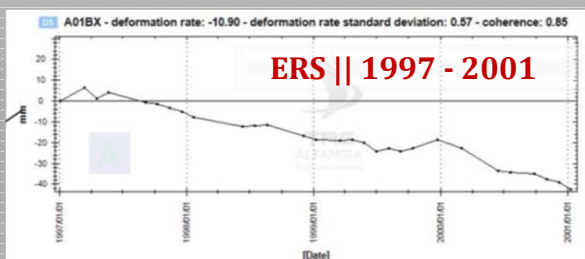


Ground Deformation Assessment & Monitoring

LOT 1 Historical Assessment

Average displacement maps & temporal motion series

The velocity standard deviation & the coherence quality indicators of the measurements



Ground Deformation Assessment & Monitoring

LOT 1 Historical Assessment

Deformation Measurements Quality series

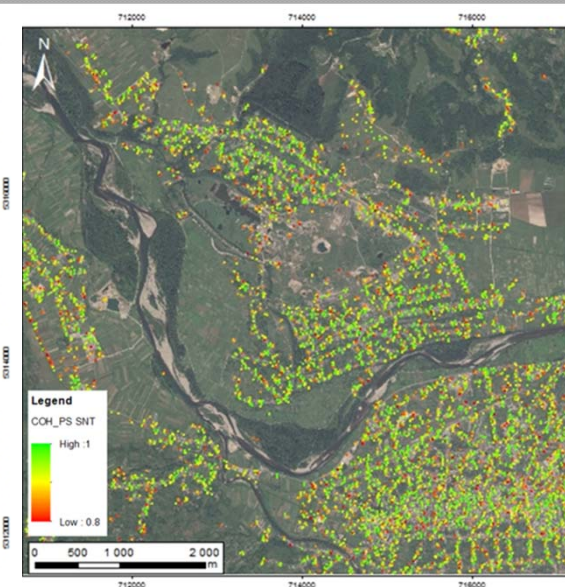
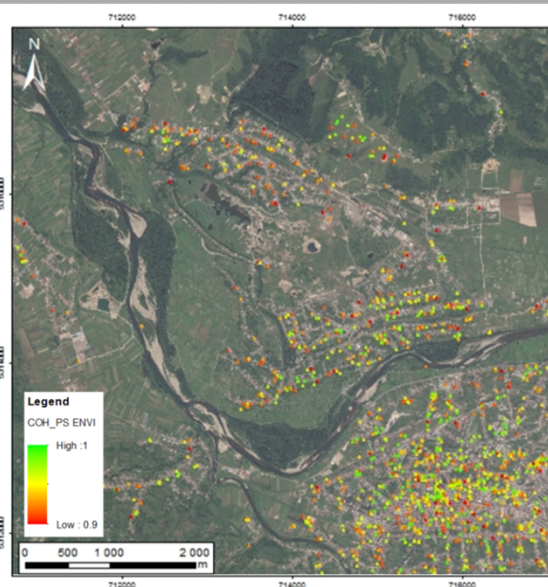
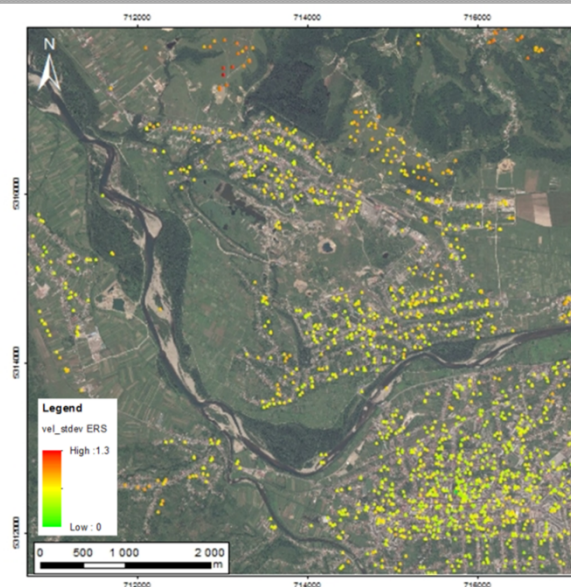
- ❑ **Velocity standard deviation:** Quality parameter related to the **annual motion rate** (mm/year).
- ❑ **Coherence:** Quality measurement of the **time series**; varies between 0 (low quality) and 1 (high quality). It is dimensionless and relative to the dataset characteristics (number of images, revisit time, ...). Non comparable between different datasets. This parameter is the one which is generally thresholded to assess the reliable measurement points (statistically assuming a very low false alarm ratio)

Coherence

ERS

ENVISAT

SENTINEL-1

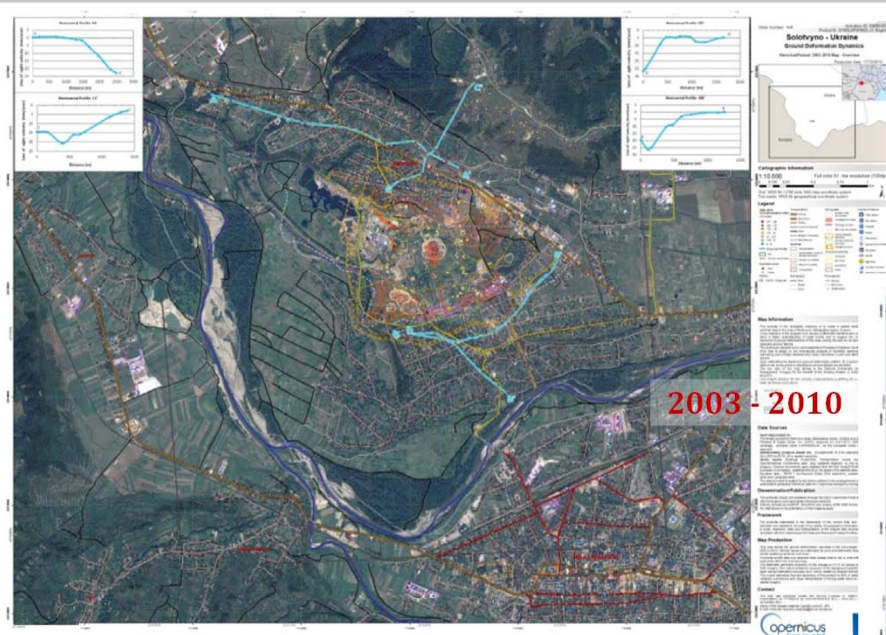


Ground Deformation Assessment & Monitoring

LOT 1 Historical Assessment

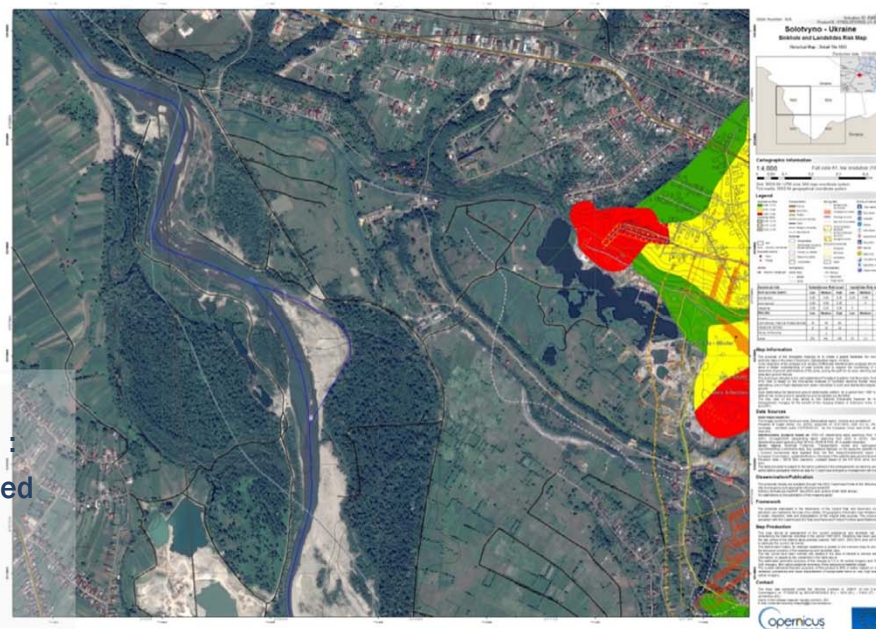
Products

Horizontal profile data over selected sites (areas most at risk or most affected) are shown as inset plots within the maps.



Sinkhole & Landslides Risk.

Expert-based analysis of the ground movement evolution
Integrated time series deformation of the stacks processed
Geospatial information of the area, mainly considering geological and geotechnical data
Assets spatial distribution



Ground Deformation Assessment & Monitoring

LOT 2 Monitoring

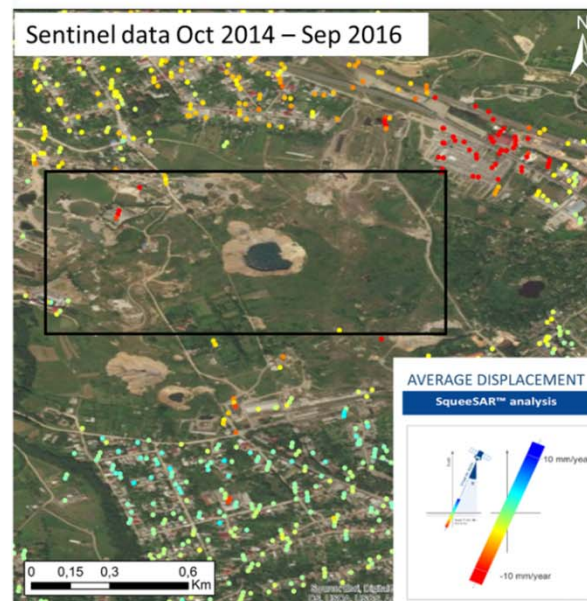
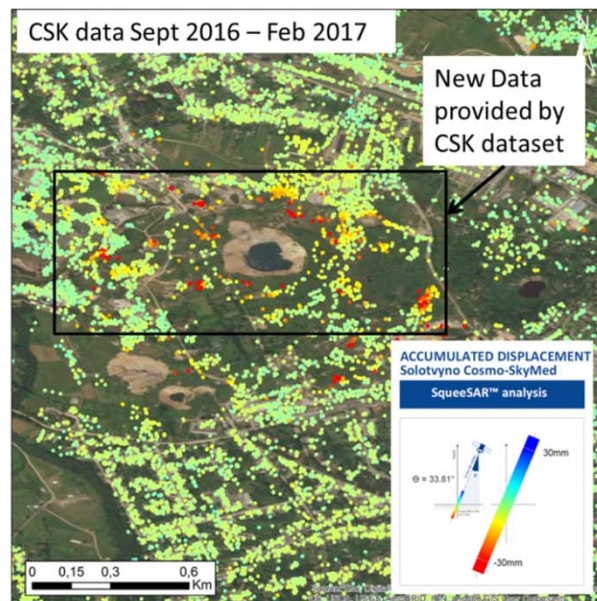
Ground Deformation Dynamics || Evaluation of Current Trends

CSK spotlight

- ❑ Short period, 4 months from 10.2016 to 02.2017. That means, less decorrelation on the signal and higher density of reliable measurement points specially on the **area around the sinkhole** (new data on the area).
- ❑ **Accumulated Values** were accounted: Average motion per year is neither reliable nor reasonable information since if we plot the VEL we are extrapolating the real data from 4 months to 1 year.

Sentinel-1

- ❑ Lack of measurement points over the **area around the sinkhole** basically due to the decorrelation of the signal during the long study period
- ❑ 2 years period, in this case the VEL field (**Averaged motion per year**) is plotted.



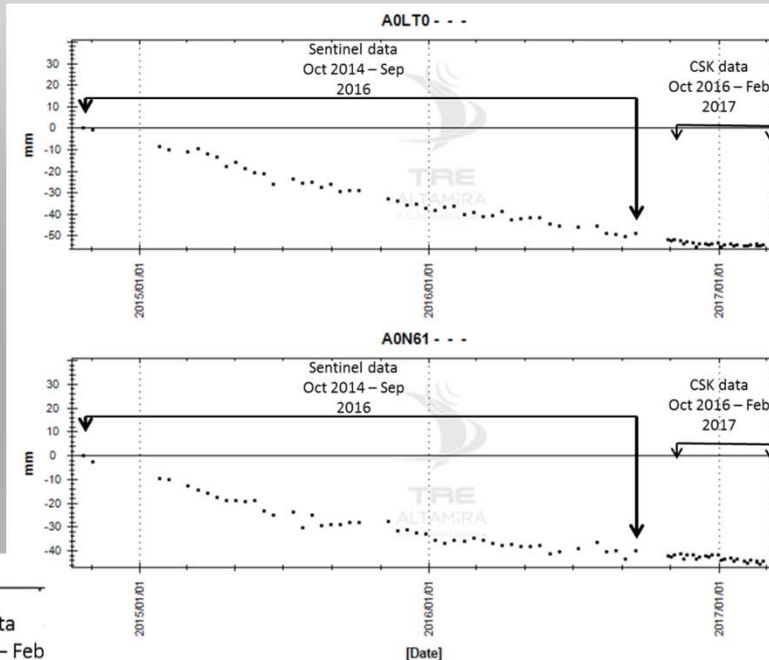
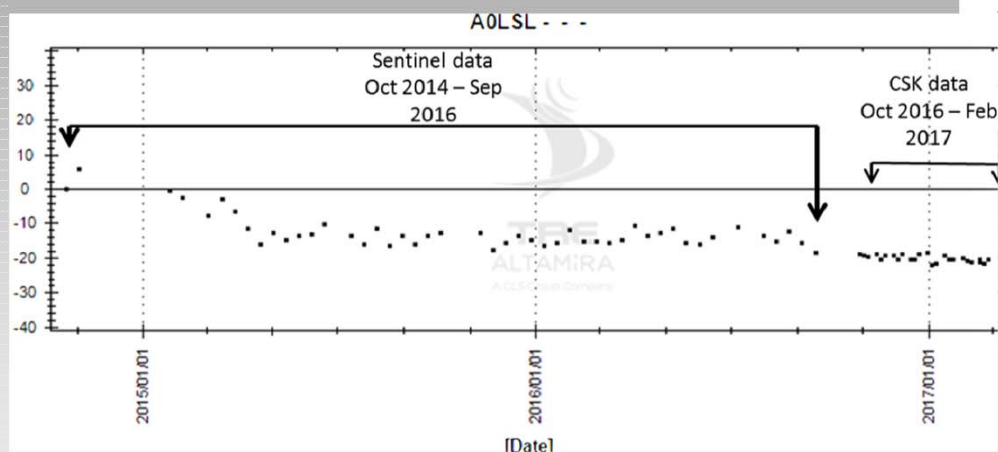
Ground Deformation Assessment & Monitoring

LOT 2 Monitoring

Ground Deformation Dynamics || Evaluation of Current Trends

Concatenated Time Series

- ❑ To facilitate the data analysis the time series of the Recent Historical (Sentinel) and the CSK data processing were concatenated
- ❑ Time series from common areas (reliable measurements only) were accounted for.
- ❑ Time series of certain points (continuity of the results)

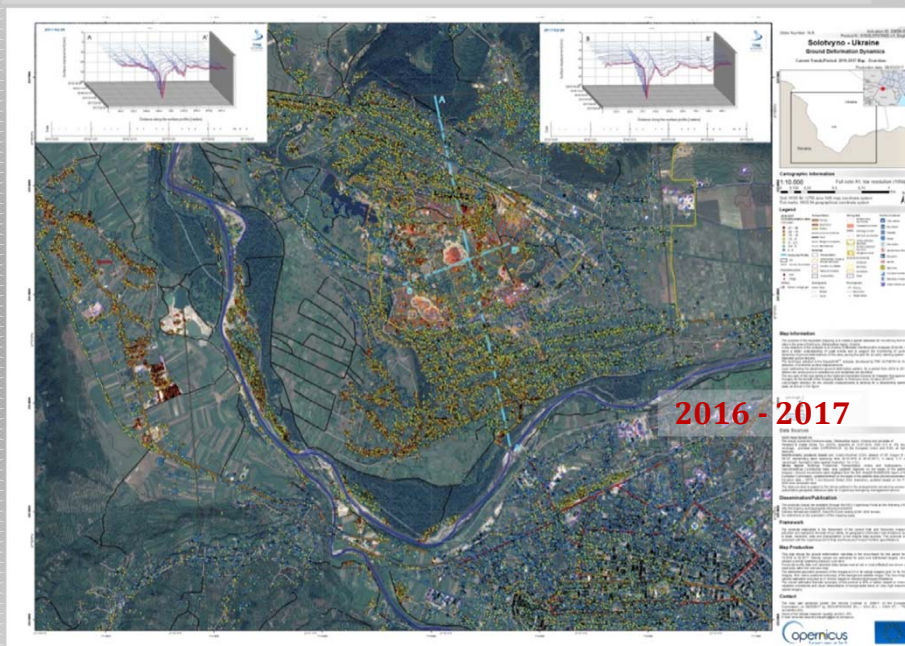


Ground Deformation Assessment & Monitoring

LOT 2 Monitoring

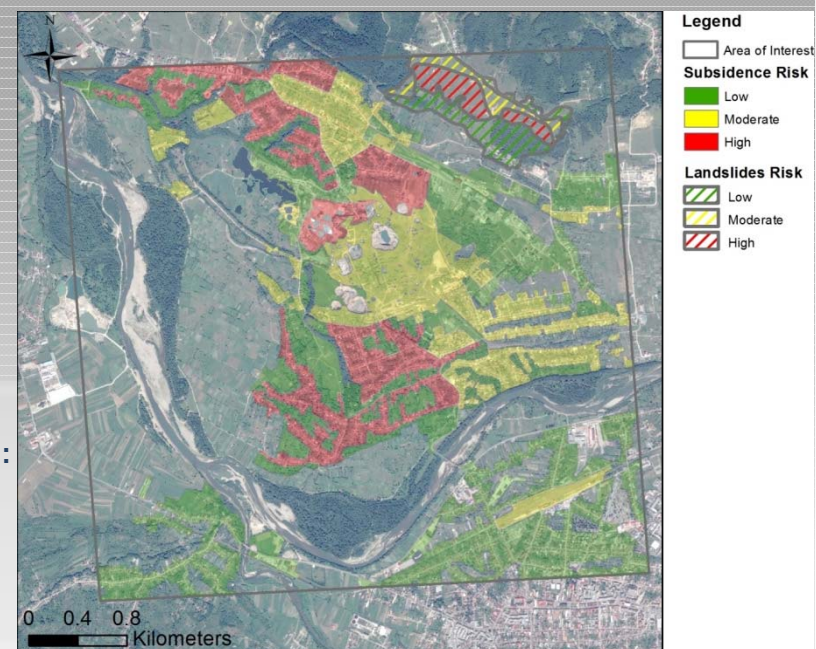
Products

Horizontal profile data over selected sites (areas most at risk or most affected) are shown as inset plots within the maps.



Sinkhole & Landslides Risk.

Expert-based analysis of the ground movement evolution :
Integrated time series deformation
Geospatial information of the area, mainly considering geological and geotechnical data
Assets spatial distribution



Thanking YOU.....



GEOAPIKONISIS S.A.
CONSULTING ENGINEERS - GEOINFORMATION APPLICATIONS

da@geoapikonisis.gr

www.geoapikonisis.gr