

Earth Observation (EO) based emergency mapping for local and regional risk management

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ICube-SERTIT



- How can emergency mapping, through the Copernicus Emergency Management Service system, aid in crisis management?

Le SERTIT, SERvice de Traitement d'Image et de Télédétection

- Founded in 1986, SERTIT is a technological transfer & service platform in Remote Sensing
- Since 2015 we are part of ICube Laboratory
- Personnel: 23



Copernicus Emergency Management Service system, aid in crisis management



What is a disaster?

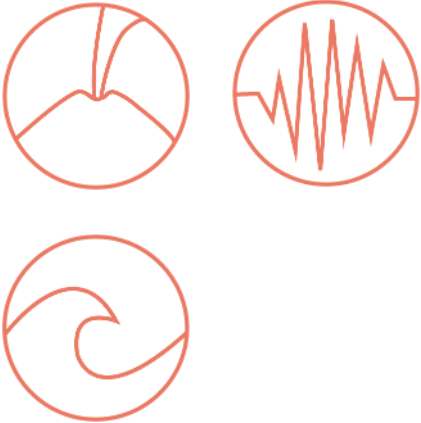
Disaster = hazard + exposure + vulnerability

Climate



A collection of eight circular icons representing climate-related hazards. The icons include: a snowflake with a diagonal slash, a cloud with a slash and two trees, a fire with trees, a house on water, a tornado, a wind turbine, a plant growing from a cracked ground, and a circular arrow.

Earth activity



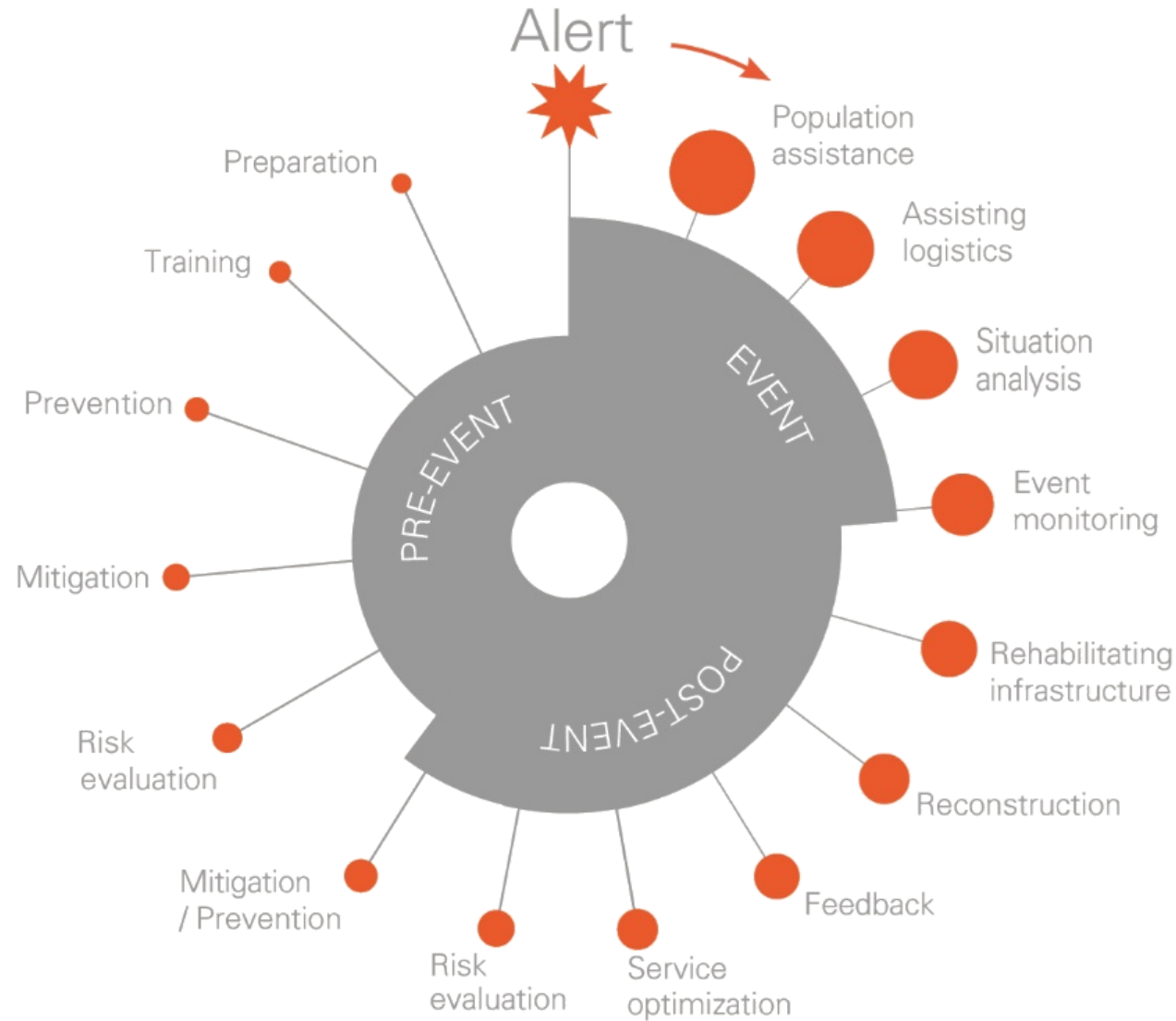
A collection of three circular icons representing earth activity hazards. The icons include: a volcano, a seismic wave, and a cyclone.

Human

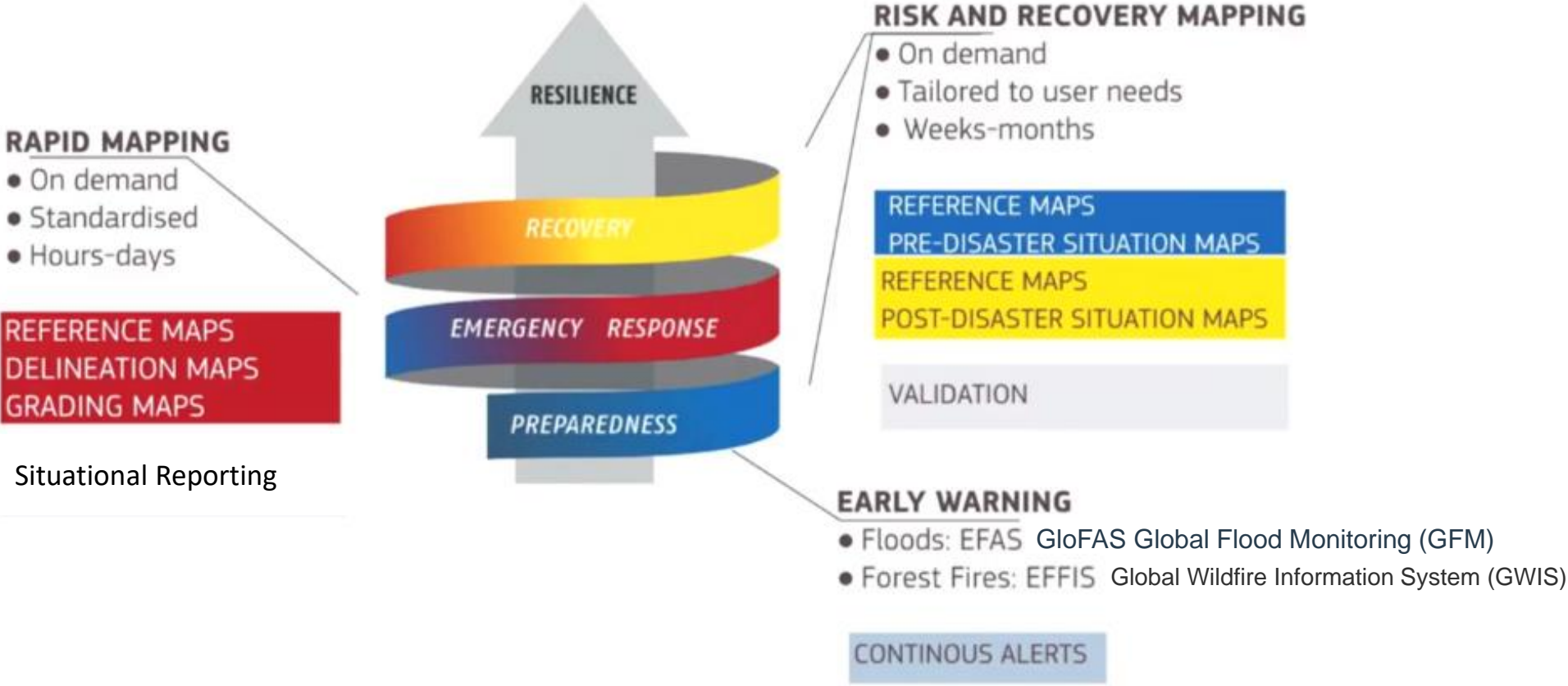


A collection of five circular icons representing human-related hazards. The icons include: a factory with smoke, a fire with trees, a house on water, a plant growing from a cracked ground, and a barrel with a spill.

Disaster management cycle



Copernicus Emergency Management Service system



<https://emergency.copernicus.eu/mapping/>

Copernicus Emergency Management Service system, aid in crisis management



Contribution of remote sensing (pre-event)

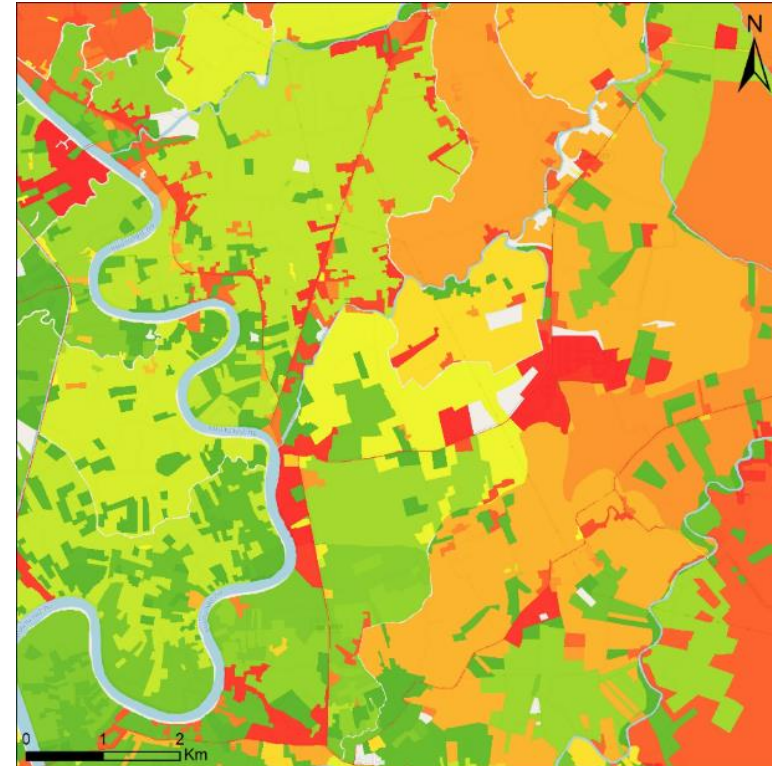


Pre-event activities	Contribution of Earth Observation data exploitation
Risk evaluation	Assets, vulnerability and historical hazard mapping Use of risk evaluation
Mitigation	
Prevention	
Training	
Preparation	

Risk evaluation (pre-event)

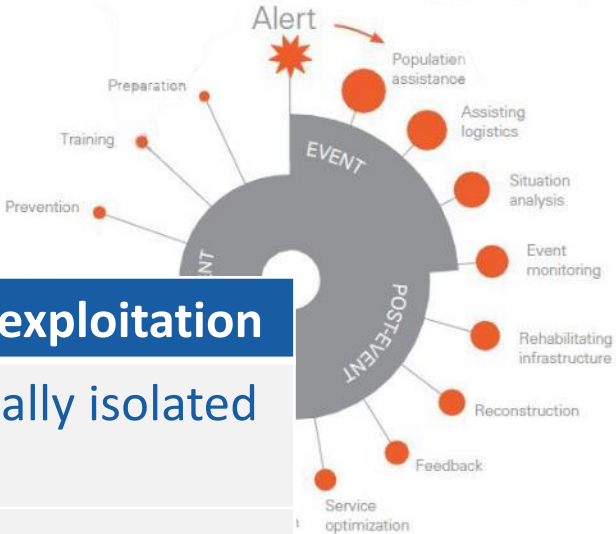


Economic exposure map in Morocco
World Bank project
© ICube-SERTIT 2019



Risk index in Thailand
Airbus DS Geo project
© ICube-SERTIT 2022

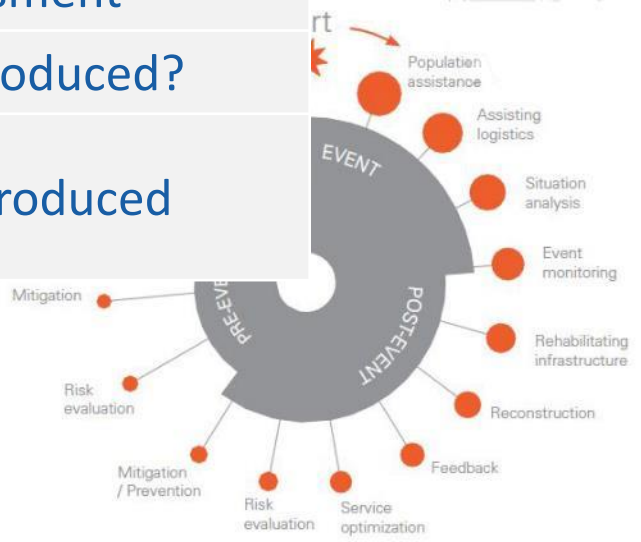
Contribution of remote sensing (event)



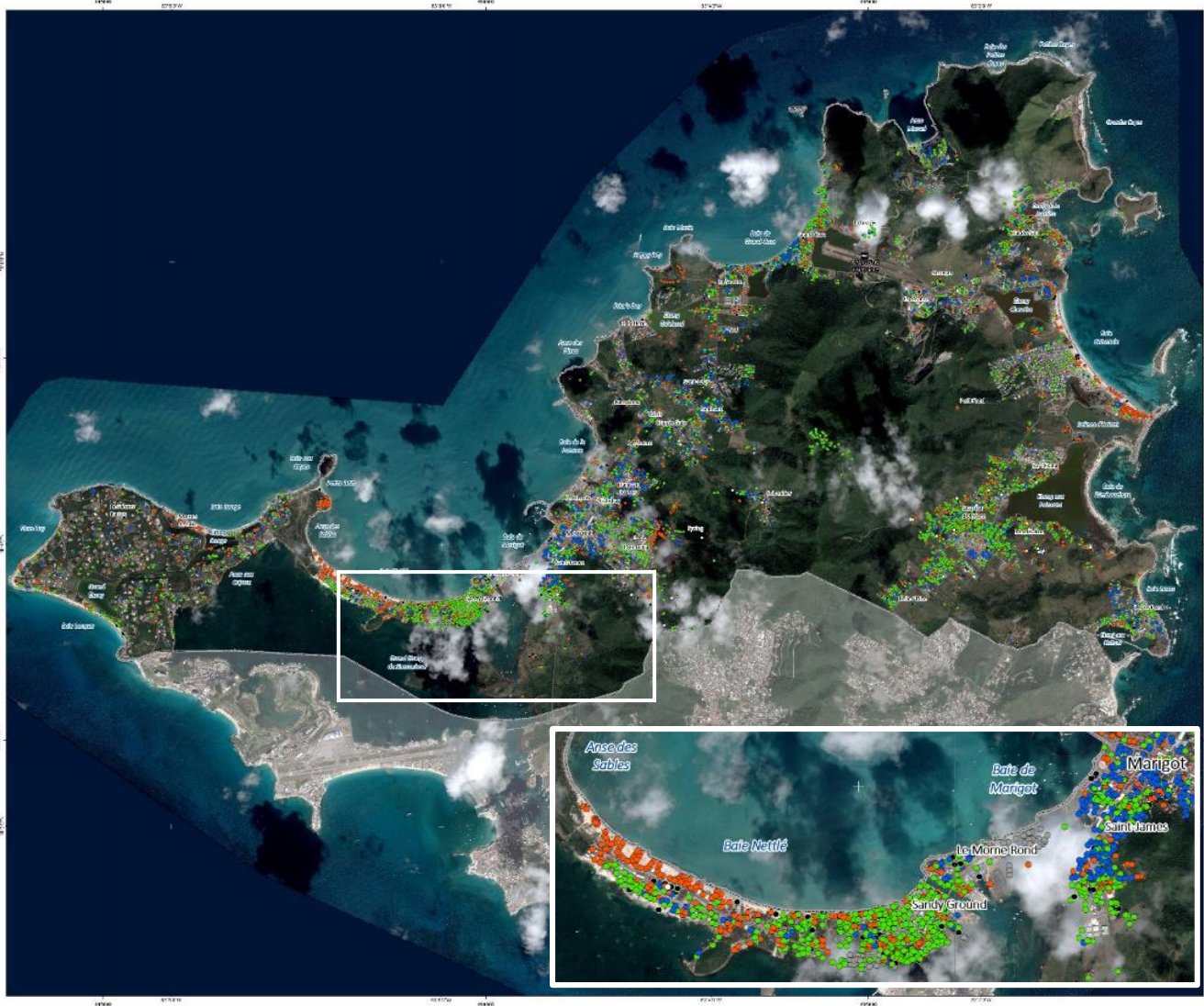
Event activities	Contribution of Earth Observation data exploitation
Population assistance	Location of affected settlements, especially isolated ones not yet rescued
Assisting logistics	Reference mapping Damage assessment of transportation facilities (runways, roads, etc.)
Situation analysis	Disaster extent, damage assessment
Event monitoring	Disaster extent monitoring

Contribution of remote sensing (post-event)

Post-event activities	Contribution of Earth Observation data exploitation
Rehabilitating infrastructure	Recovery monitoring
Reconstruction	Reconstruction monitoring
Feedback	Detailed damage and loss assessment
Service optimization	Use of all event geo-information produced?
Risk evaluation	Use of all event geo-information produced
Mitigation / Prevention	



Contribution of remote sensing (post-event)



Projet N°: 05SAINTMARTIN_SMT_EVOLUTION_201709_201710

Saint-Martin - FRANCE

Suivi de la reconstruction post-ouragan Irma

Evolution entre le 14/09/2017 et le 15/12/2017

Information cartographique
1:23 000 Fil color A1, High resolution (200dpi)

Projeteur: UTM - Zone 18 Pseudo-Cylindrique
Projeteur géocentrique: WGS 84 (Lambert métrique)

Légende

Evolution de l'état du bâti entre le 14/09 et le 15/12/2017

- En construction
- En reconstruction
- Nouveaux bâtiments
- Reconstruit
- Travaux en cours
- Non détruit
- Prévisionnel (bâti en débris)
- Etat administratif

Contexte
L'IRMA a été classé en catégorie 5, à l'échelle des SUDROS le 14 septembre 2017. Il est le plus puissant et plus destructeur jamais enregistré dans l'océan Atlantique et le bassin des Caraïbes. Parmi plus de 100 millions de personnes touchées par l'ouragan, plus de 100 000 ont été tués ou blessés. Les îles de Saint-Martin et de Saint-Eustache ont été touchées par l'ouragan le 7 septembre 2017. Saint-Martin a été l'un des plus touchés, les destructions importantes affectant plus de 90% de la zone bâtie. Le total des sinistrés et de la zone touchée de l'île est estimé à 100 000.

Source des données
Evolution de l'état des bâtiments
Service de l'Etat, Direction des Services Précoatifs (DSPA) de Saint-Martin les 14, 15, 16, 17 et 18 septembre 2017 après le passage de l'ouragan Irma et le 15 septembre 2017 et le 15/12/2017.

Etat de l'état
Projet N°: 05SAINTMARTIN_SMT_EVOLUTION_201709_201710
Projeteur: UTM - Zone 18 Pseudo-Cylindrique
Projeteur géocentrique: WGS 84 (Lambert métrique)

Description de la carte
Cette carte présente l'évolution de l'état des bâtiments construits sur l'île de Saint-Martin, France, depuis le passage de l'ouragan Irma le 7 septembre 2017. Elle est basée sur les données de l'Etat de Saint-Martin et de la Direction des Services Précoatifs (DSPA) de Saint-Martin. Les données sont actualisées au 15 décembre 2017. La carte est destinée à être utilisée en complément des autres données de l'Etat de Saint-Martin et de la Direction des Services Précoatifs (DSPA) de Saint-Martin. Les données sont actualisées au 15 décembre 2017. La carte est destinée à être utilisée en complément des autres données de l'Etat de Saint-Martin et de la Direction des Services Précoatifs (DSPA) de Saint-Martin.

Evolution de l'état des bâtiments	Nombre de bâtiments	%
En construction	10	0,1
En reconstruction	20	0,2
Nouveaux bâtiments	10	0,1
Reconstruit	200	2,0
Travaux en cours	200	2,0
Non détruit	200	2,0
Prévisionnel (bâti en débris)	20	0,2
Etat administratif	20	0,2

Contact
Cet état de l'état des bâtiments est le fruit de la coopération entre le CNRS CERISES (UMR 5175, CNRS - Université de Strasbourg) et l'Etat de Saint-Martin.

Si vous avez des remarques ou des suggestions, n'hésitez pas à nous contacter. La responsabilité de l'état de l'état des bâtiments est de l'Etat de Saint-Martin. La responsabilité de l'état de l'état des bâtiments est de l'Etat de Saint-Martin.

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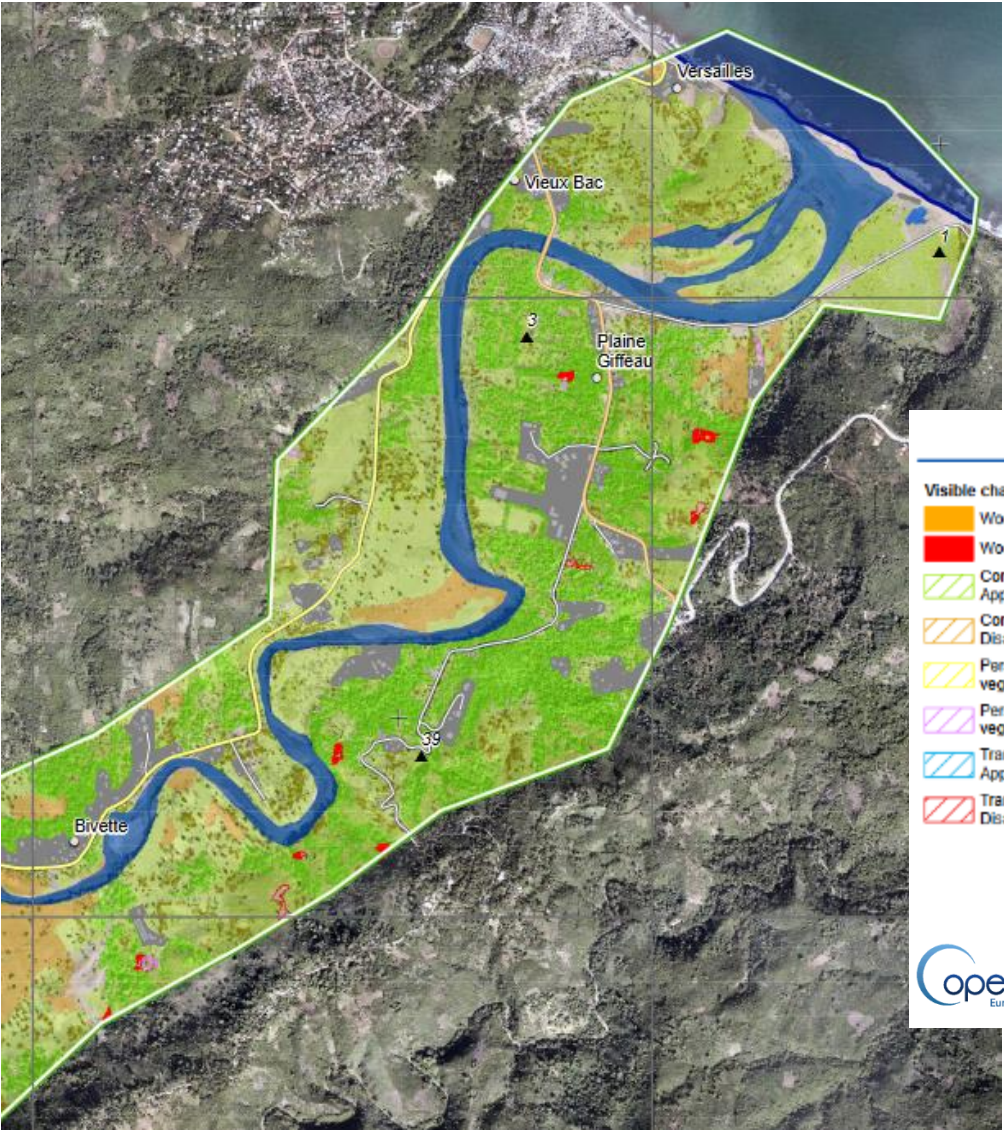
© 2017 CNRS - Université de Strasbourg

➤ Reconstruction monitoring

➤ Irma hurricane

- Under construction
- Under reconstruction
- New
- Rebuilt
- Still damaged
- Cleared
- Not analysed

Contribution of remote sensing (post-event)



- Vegetation recovery monitoring
- Matthew hurricane, Haiti

Legend

Visible changes	Land-use	General information
Woodland - Regression	Persistent low-lying vegetation	Area of Interest
Woodland - Disappeared	Complex cultivation	Settlement
Complex cultivation - Appeared	Mixed forest	Place names
Complex cultivation - Disappeared	Copse	Buildings footprint
Persistent low-lying vegetation - Appeared	Isolated trees	Built up area
Persistent low-lying vegetation - Disappeared	Transitional woodland shrub	Hydrography
Transitional woodland shrub - Appeared	Bare soil	Coastline
Transitional woodland shrub - Disappeared	Water courses	Stream
	Water bodies	Physiography
	Sea and ocean	Spot Elevation Point (m)
		Elevation Contour (m)
		Transportation
		Primary Road
		Secondary Road
		Local Road



International frameworks

- Copernicus Emergency Management Service (EMS)
- International Charter 'Space and major disasters'
- Sentinel Asia
- CEOS WG Disasters – Recovery Observatory, CNES
- UN-SPIDER

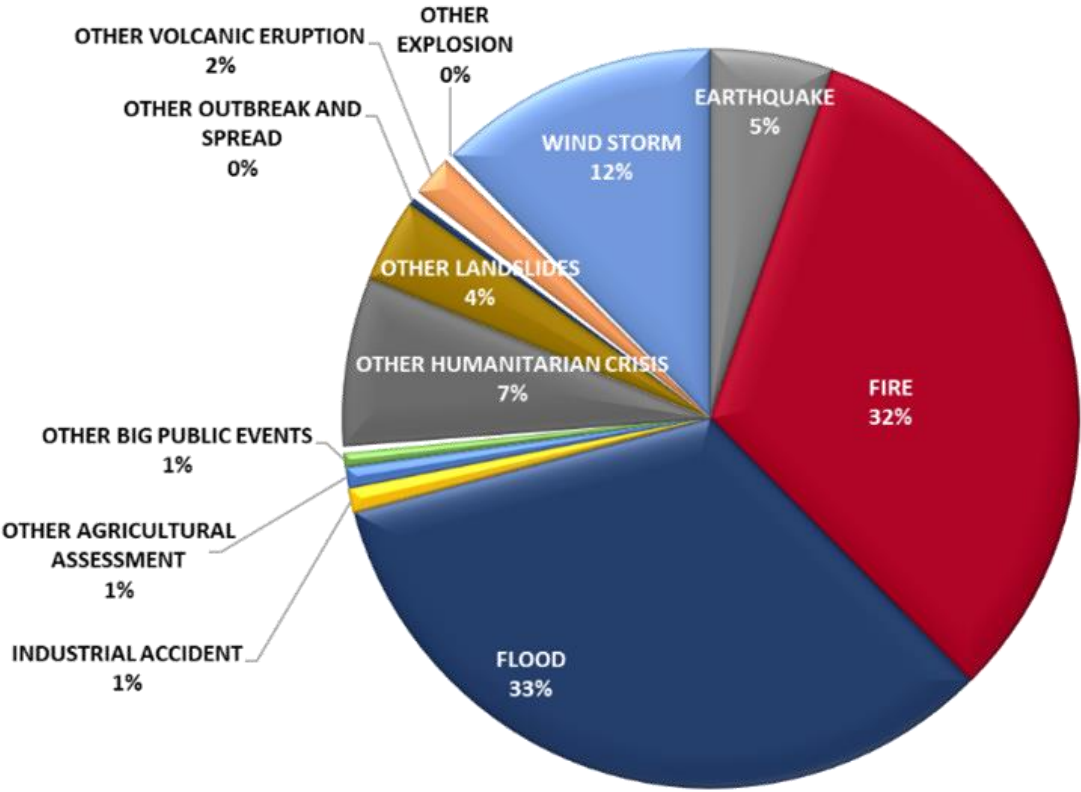
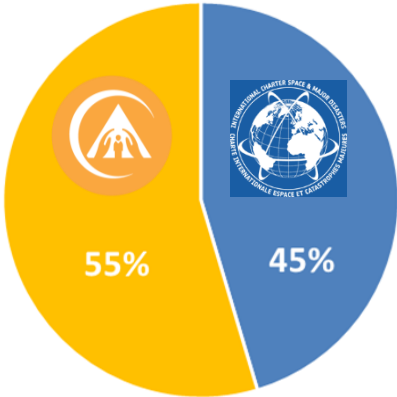
Charter Space and Major Disasters

The International Charter is a worldwide collaboration, through which satellite data are made available for the benefit of disaster management

<p>20 in 2020</p> 	<p>17 members</p> 
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SERTIT's Emergency mapping

- 91% nature related disasters
- Floods, fires... & earthquakes
- High levels of activity
- International, national, local and insurance clients



➤ Early Warning

EFAS/GLOFAS - Hydrological warning and predicted flood,
EFFIS/GWIS - Forest fire danger and extent mapping
EDO/GDO – Drought monitoring

➤ Rapid Mapping (event phase)

Provision of geospatial information within hours or days from the activation in support of emergency management activities immediately following a disaster

➤ Risk & Recovery Mapping (pre and post event)

On-demand provision of geospatial information in support of Disaster Management activities not related to immediate response. This applies in particular to activities dealing with prevention, preparedness, disaster risk reduction and recovery phases.

Copernicus EMS Risk & Recovery - Fires



Emergency Management

CEMS On-demand Mapping products to support Recovery from wildfire events



WILDFIRES RECOVERY SUPPORT



Biomass loss

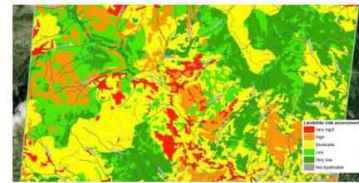
Table 10. Vegetation biomass loss- Monsenvacia site

Land Cover (pre-fire) Vegetation type	DENSITY	Total Affected Area (sqm)
Pinus	High (70-100%)	68 074.43
Pinus	Medium (40-70%)	545 744.16
Shrubland	Medium (40-70%)	1 663 222.30
Shrubland	Low (10-40%)	5 952 004.08
Brushwood	Low (10-40%)	23 020 060.36
Permanent crops	Low (10-40%)	14 742 464.77

Land Cover (pre-fire) Vegetation type	Biomass Loss Severity	Total Affected Area (sqm)
Pinus	Medium loss	613 818.59
Shrubland	Low loss	7 615 226.38
Brushwood	Low loss	23 020 060.36
Permanent crops	Low loss	14 742 464.77

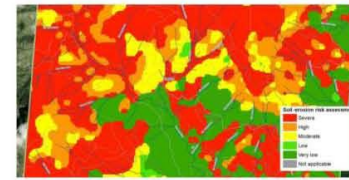
Example: <https://emergency.copernicus.eu/mapping/en/compans/EM-SHO25>

Landslide risk analysis



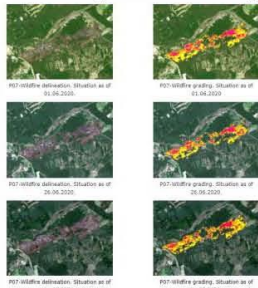
<https://emergency.copernicus.eu/mapping/en/rrm-portofino-p17>

Soil erosion risk analysis



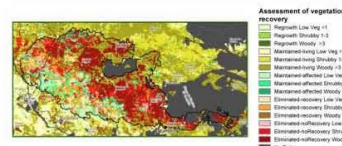
<https://emergency.copernicus.eu/mapping/en/rrm-portofino-p16>

Grading monitoring



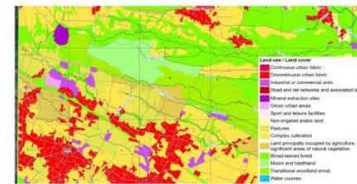
<https://emergency.copernicus.eu/mapping/en/rrm-portofino-p07>
Example: EMSN077. Post-disaster mapping of forest fires in De Meinasse National Park

Monitoring of vegetation recovery



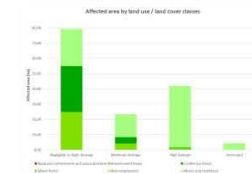
Example: EMSN060. Monitoring areas damaged by forest fires in Andia luis, Spain

LULC update



<https://emergency.copernicus.eu/mapping/en/rrm-portofino-p04>

Detailed impact assessment analyses on agriculture/forest stands/... (1:5.000)



<https://emergency.copernicus.eu/mapping/en/rrm-portofino-p15>
Example: EMSN077. Post-disaster mapping of forest fires in De Meinasse National Park

Copernicus EMS Risk & Recovery - Floods

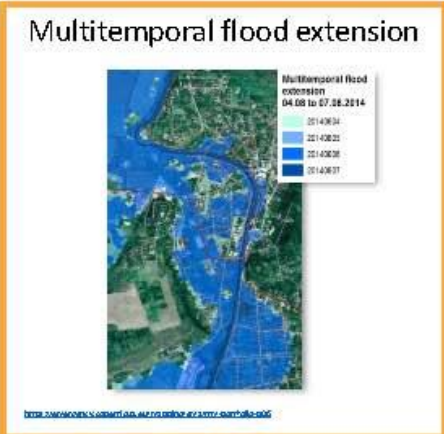
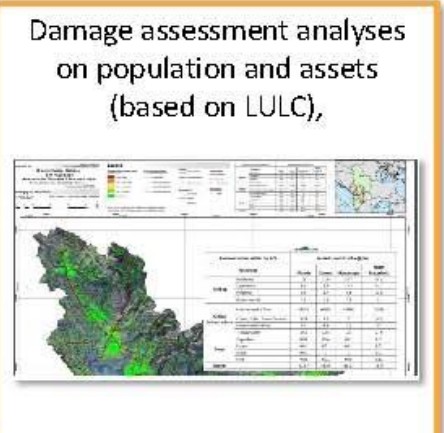
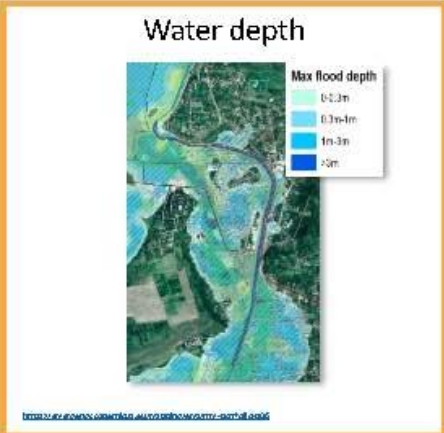


Emergency Management

CEMS On-demand Mapping products to support Recovery from flood events



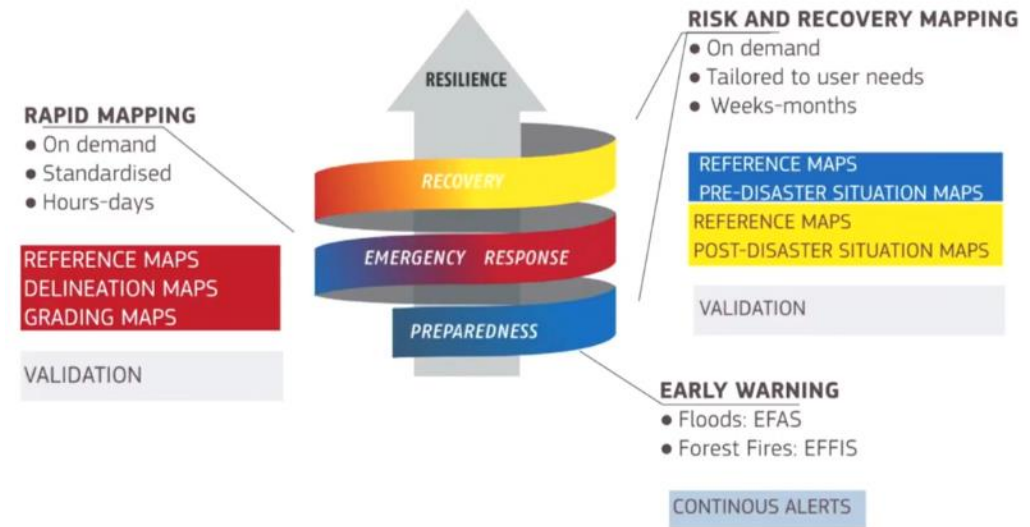
FLOODS RECOVERY SUPPORT



Copernicus EMS – Rapid Mapping

➤ 24/7/365 service

➤ Night and week-end work



Product type	Content	Vector
Reference	Pre-event situation	10
First Estimate	Fast impact assessment	2
Delineation	Detailed assessment of the impacted area (extent)	7
Grading	Detailed damage assessment (extent of the impacted area and damage grade)	10

T0: satellite data reception

Copernicus EMS – Rapid Mapping



- European funding
- Coordinated by JRC for European Commission (Joint Research Center)
- Authorised Users: NFPs, EC services plus other countries and international institutions through DG-ECHO/ERCC
- Operated by 7 companies in Europe (Italy, France, Germany, Spain, Portugal)
- Service managed by e-GEOS and helped by SERTIT

Emergency Mapping – A very busy Summer

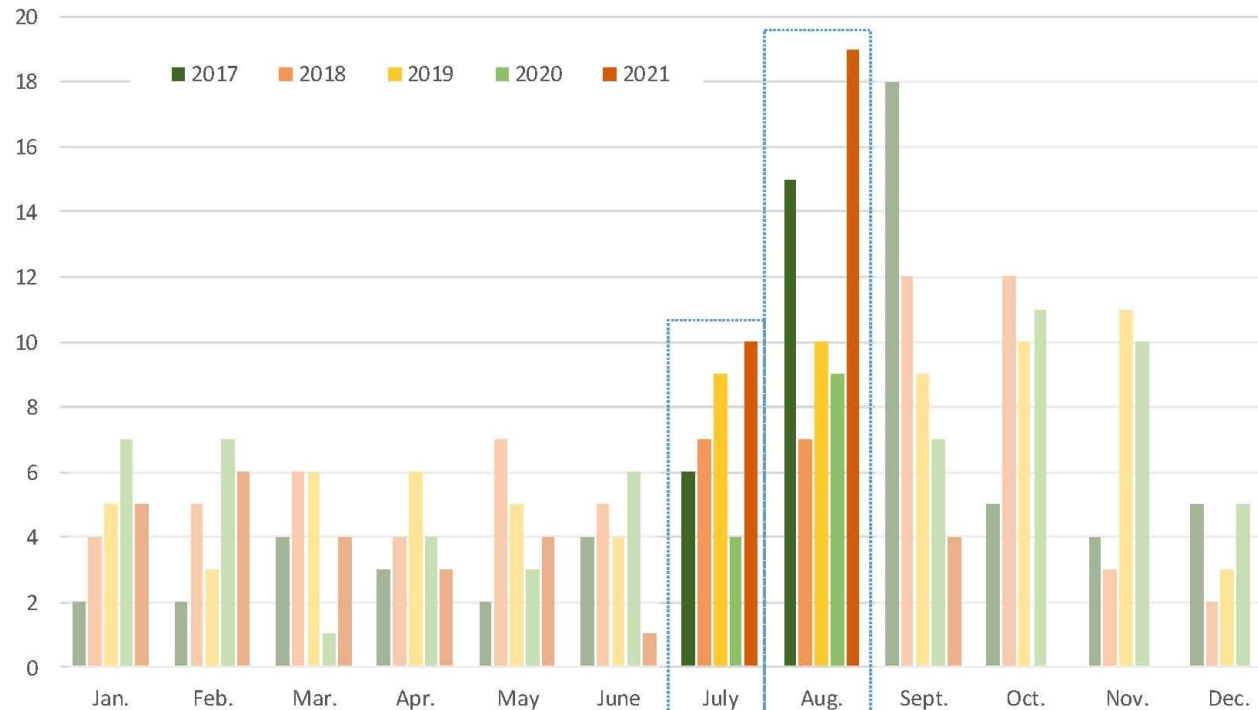


Emergency Management



CEMS On-demand Mapping supporting Emergency response

Number of Rapid Mapping activations per month



Mostly for flood and fire events in Europe

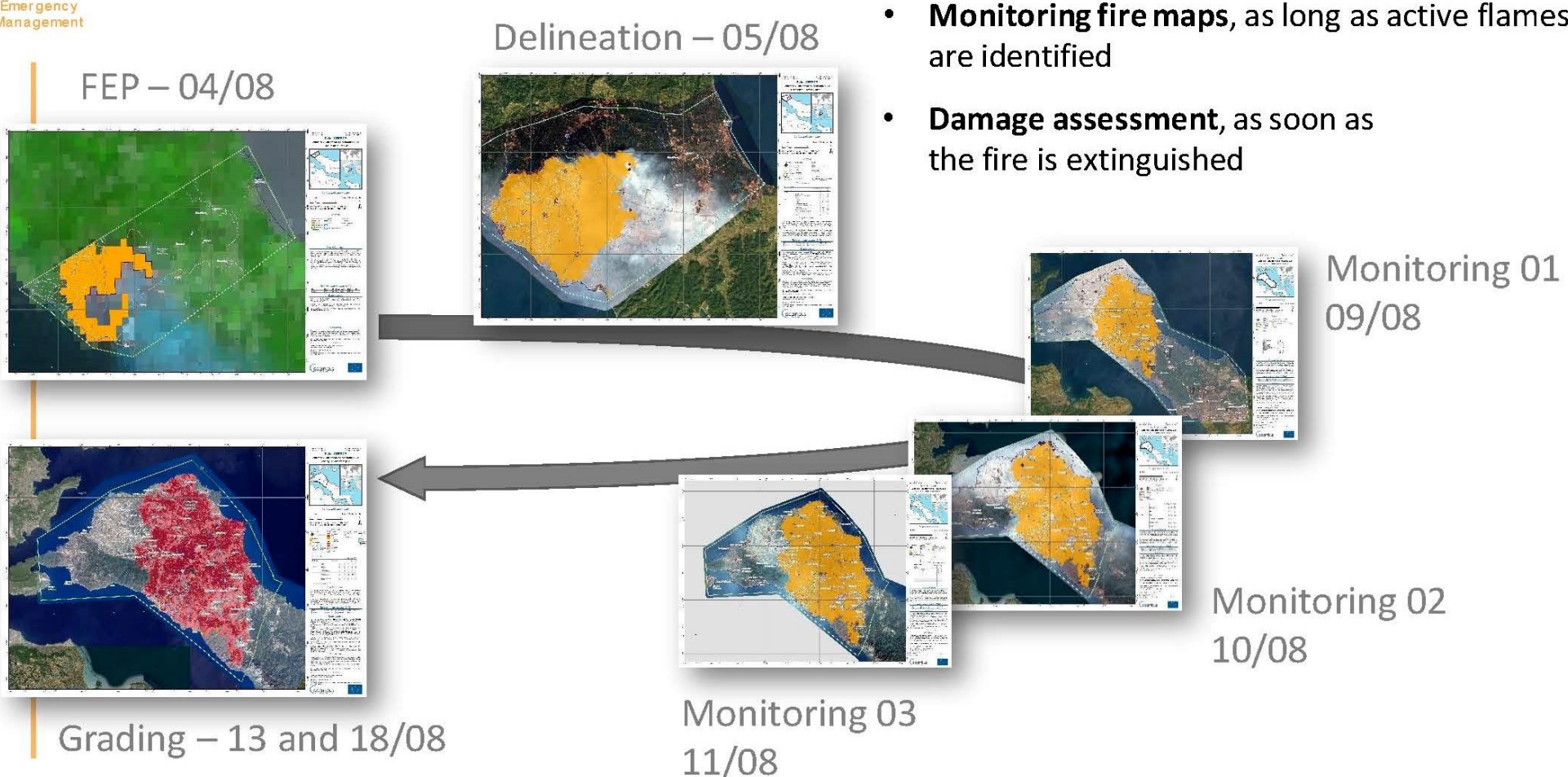
Copernicus Emergency Management Service system, aid in crisis management

Copernicus EMS RM – Classic Production cycle



Emergency Management

Fire events in the Mediterranean region



Rapid mapping products portfolio

- **Disaster extent // Delineation** of the event's geospatial extent
(+ monitoring)

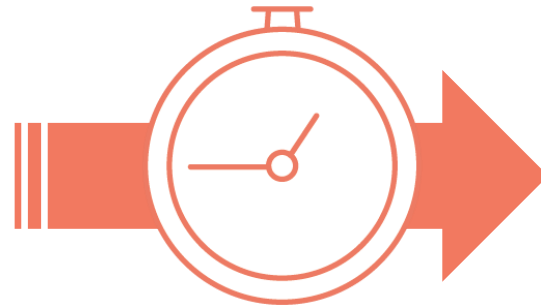
- **Damage assessment // Damage grading** of urban areas, transportation, facilities and land cover

Rapid mapping products portfolio

➤ Disaster extent // Burnt areas

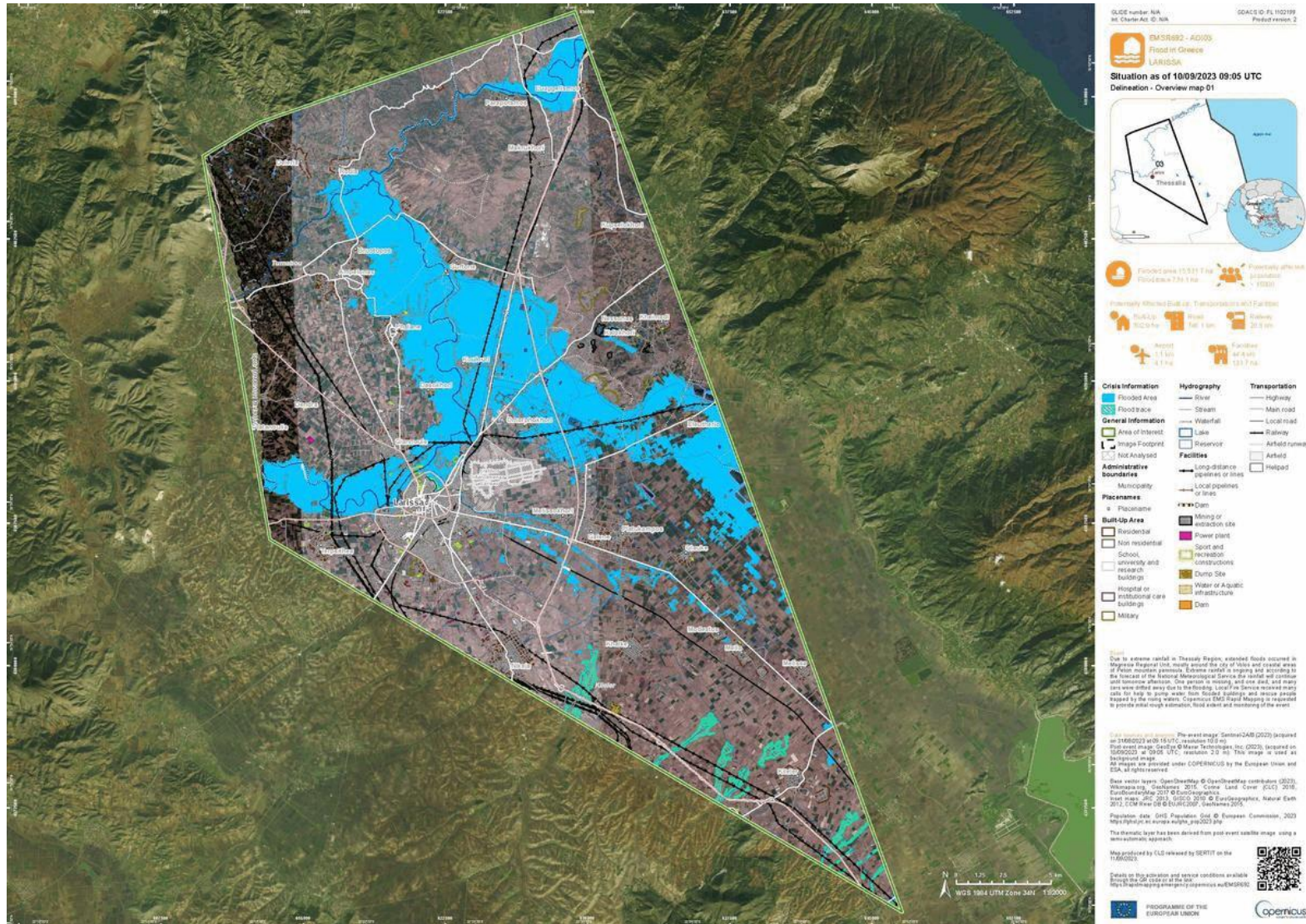


SPOT-6/7 ©Airbus DS GEO



©Icube-SERTIT

Delineation, monitoring



Copernicus Emergency Management Service (© 2023 European Union), EMSR692
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Damage assessment // Damage grading

EMSR695 - Earthquake in Marrakesh-Safi Region, Morocco

SEARCH ACTIVATIONS Emergency Management

VIEWER PRODUCTION STATUS DETAILS & DOWNLOAD SITUATIONAL REPORTING

Event extent:

- Grading
 - Legend
 - Statistics
- 05 Aourir
 - Grading
 - Legend
 - Statistics
- 06 Imzilene
 - Grading
 - Legend
 - Statistics
 - Built Up Points
 - Residential building, Destroyed
 - Residential building, Damaged
 - Residential building, Possibly damaged
 - No residential building, Destroyed
 - No residential building, Damaged
 - No residential building, Possibly damaged

R214

Lat: 0.0000, Lon 0.0000 Product details

Copernicus Emergency Management Service system, aid in crisis management

Damage assessment // Damage grading



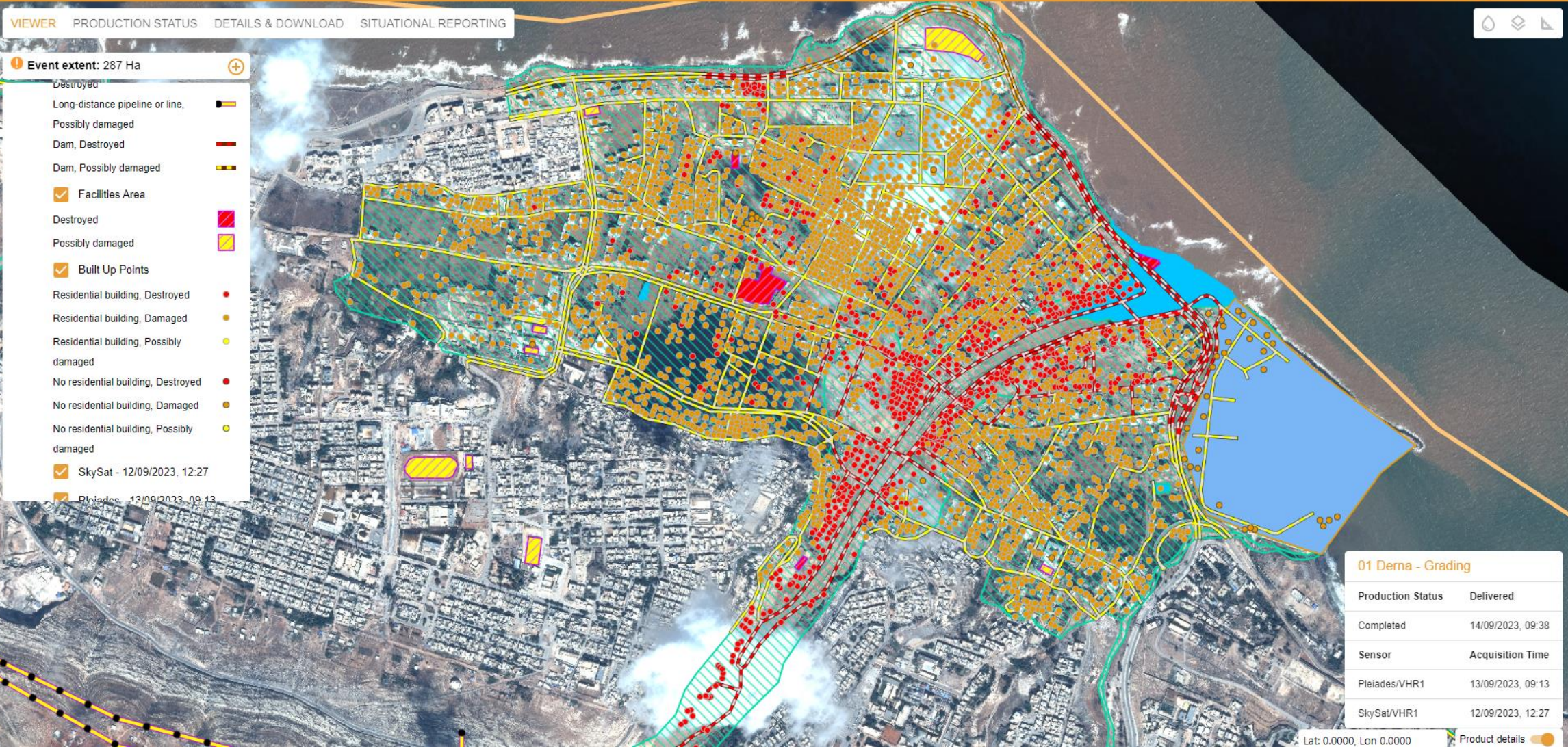
EMSR696 - Flood in Libya

SEARCH ACTIVATIONS



VIEWER PRODUCTION STATUS DETAILS & DOWNLOAD SITUATIONAL REPORTING

- Event extent: 287 Ha
- Destroyed
 - Long-distance pipeline or line, Possibly damaged
 - Dam, Destroyed
 - Dam, Possibly damaged
 - Facilities Area
 - Destroyed
 - Possibly damaged
 - Built Up Points
 - Residential building, Destroyed
 - Residential building, Damaged
 - Residential building, Possibly damaged
 - No residential building, Destroyed
 - No residential building, Damaged
 - No residential building, Possibly damaged
 - SkySat - 12/09/2023, 12:27
 - Pleiades - 13/09/2023, 09:13



01 Derna - Grading

Production Status	Delivered
Completed	14/09/2023, 09:38
Sensor	Acquisition Time
Pleiades/VHR1	13/09/2023, 09:13
SkySat/VHR1	12/09/2023, 12:27

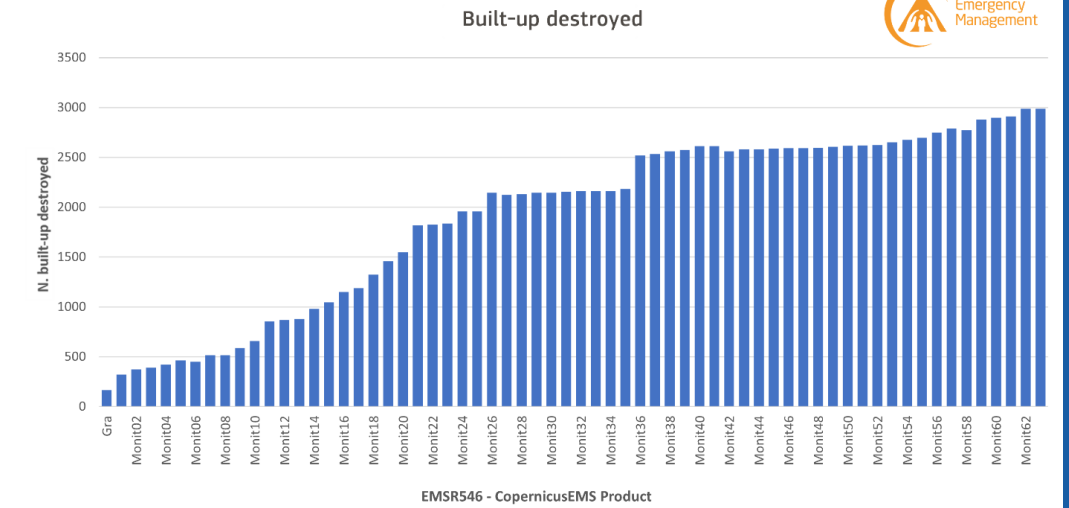
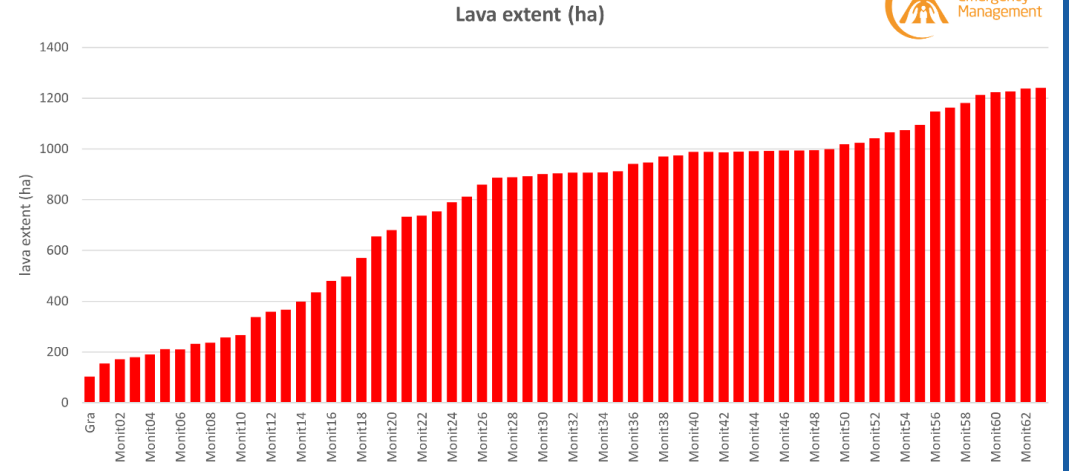
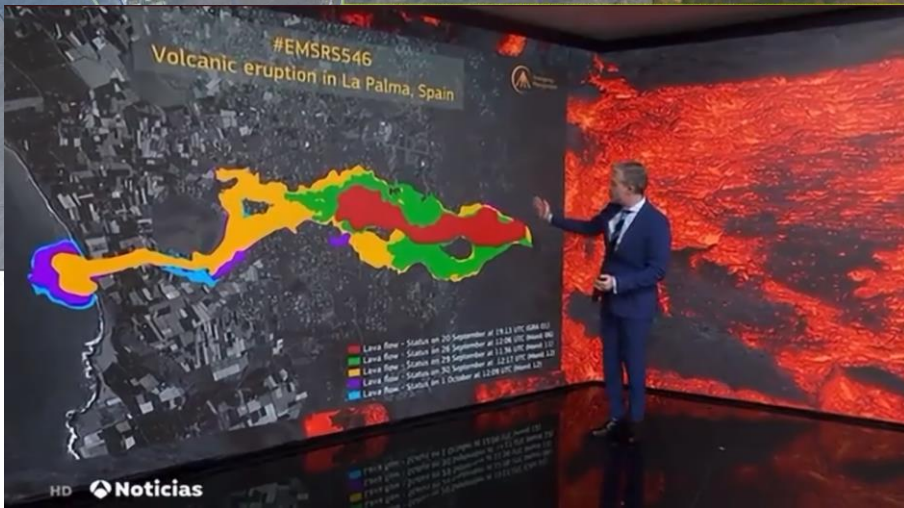
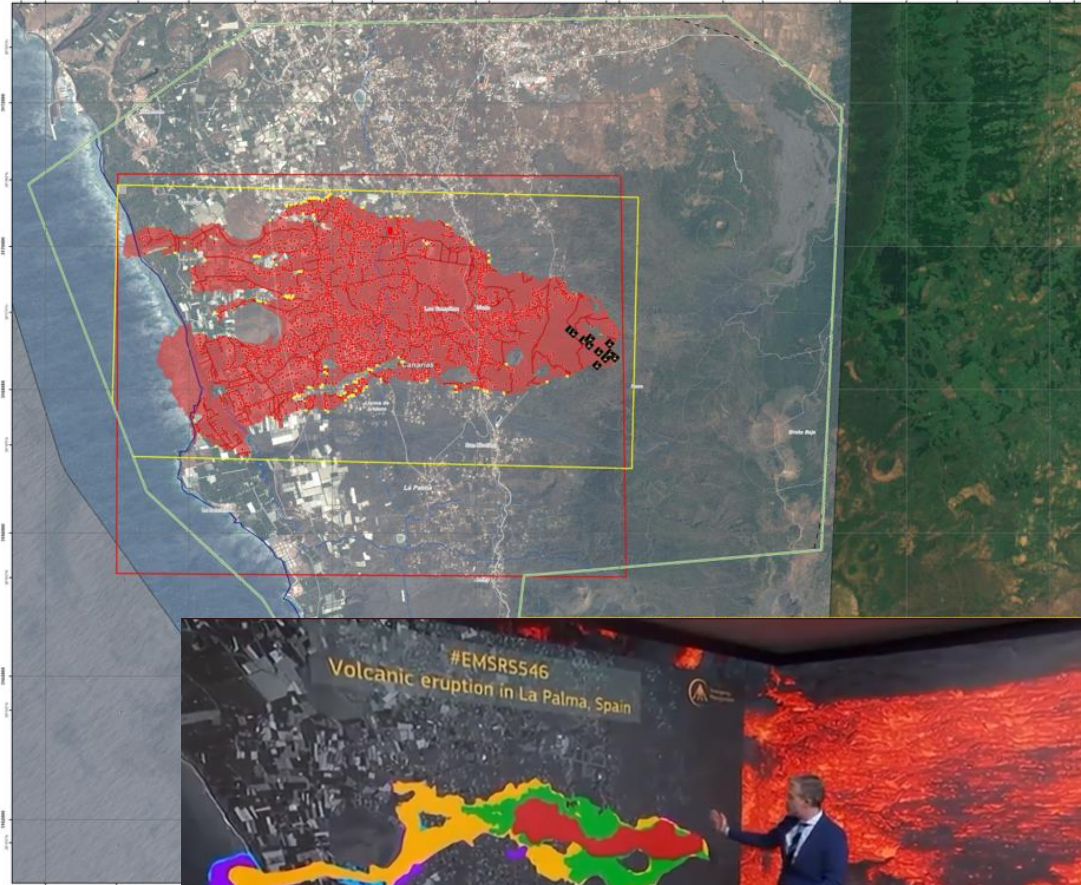
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Product details

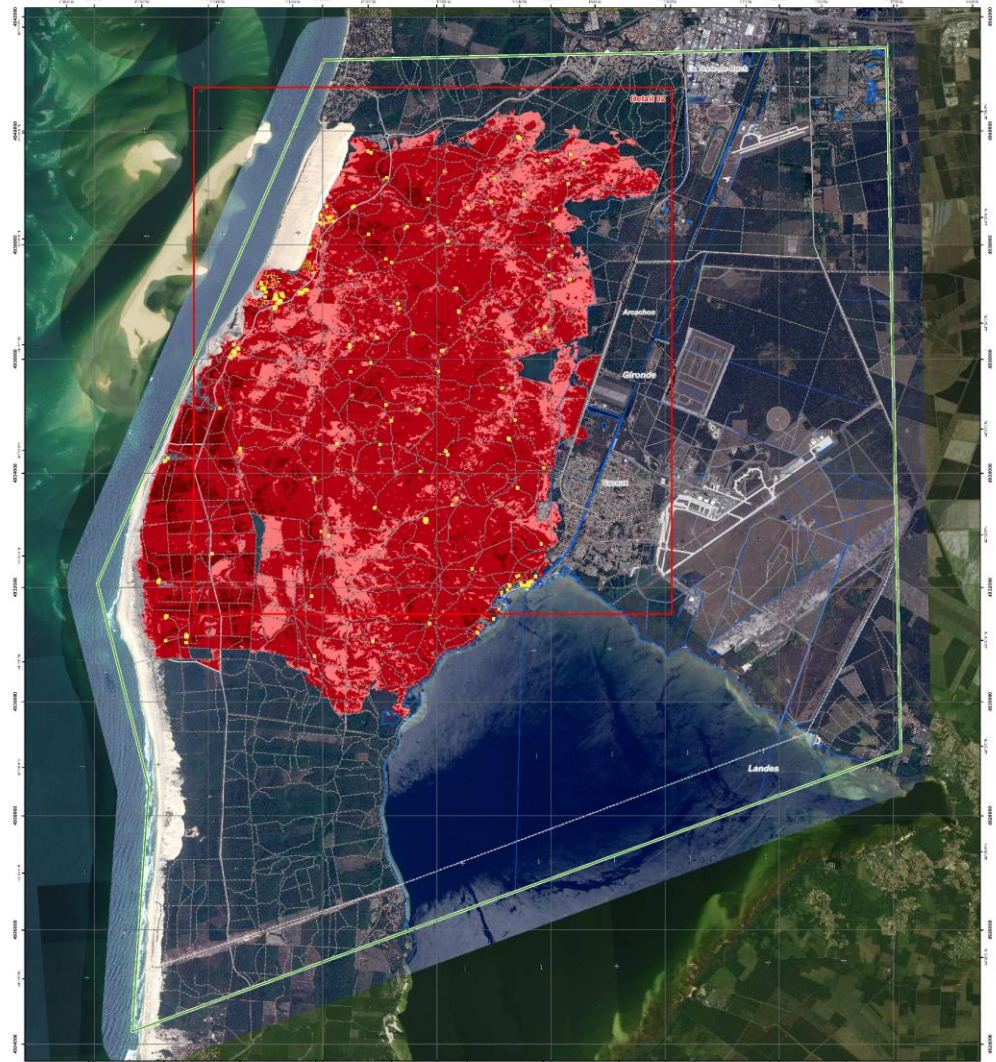
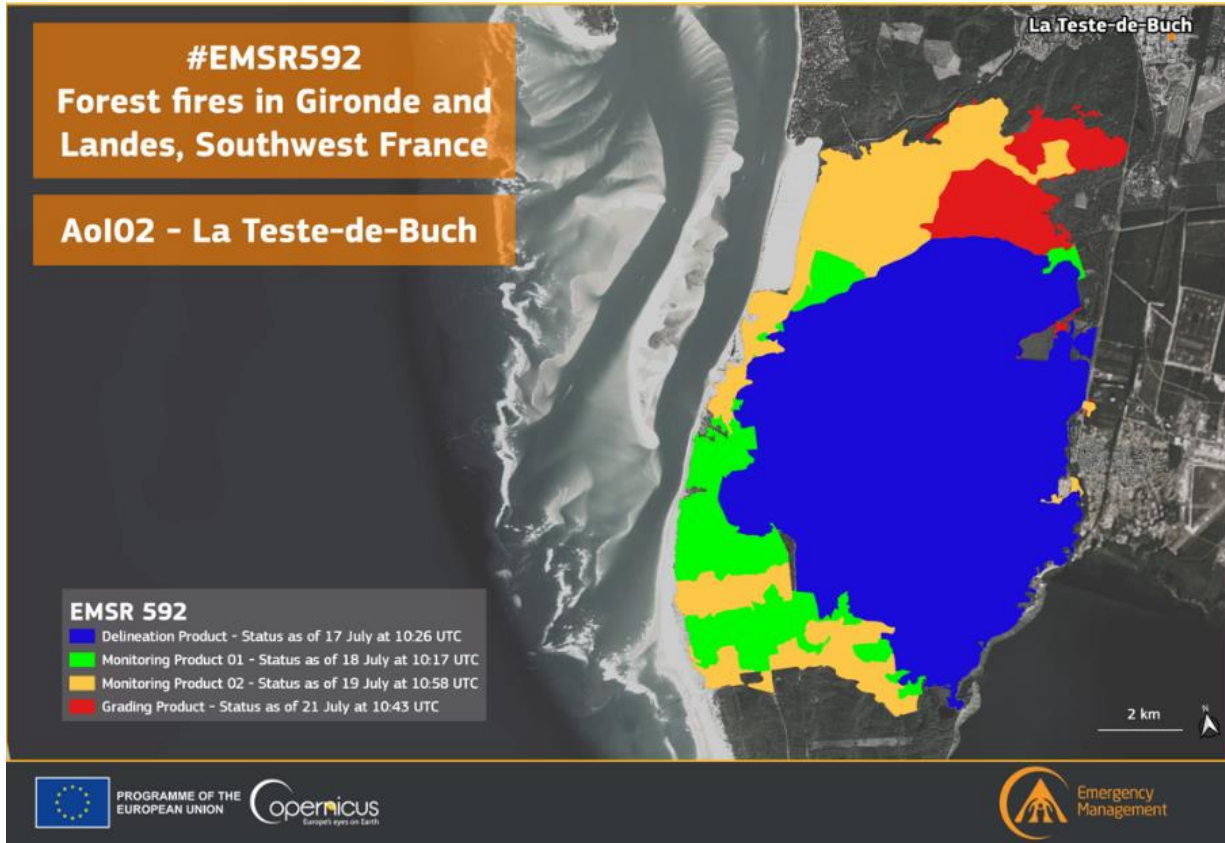
Copernicus Emergency Management Service system, aid in crisis management



Volcanic eruption in La Palma, 2021



Wildfire in France, July 2022



Map Information
This map was generated on 21 July 2022 at 10:43 UTC. The data is derived from the Copernicus Emergency Management Service (EMS) and is subject to change without notice. The map is provided for information only and should not be used for navigation or other critical applications. For more information, please visit the Copernicus Emergency Management Service website.

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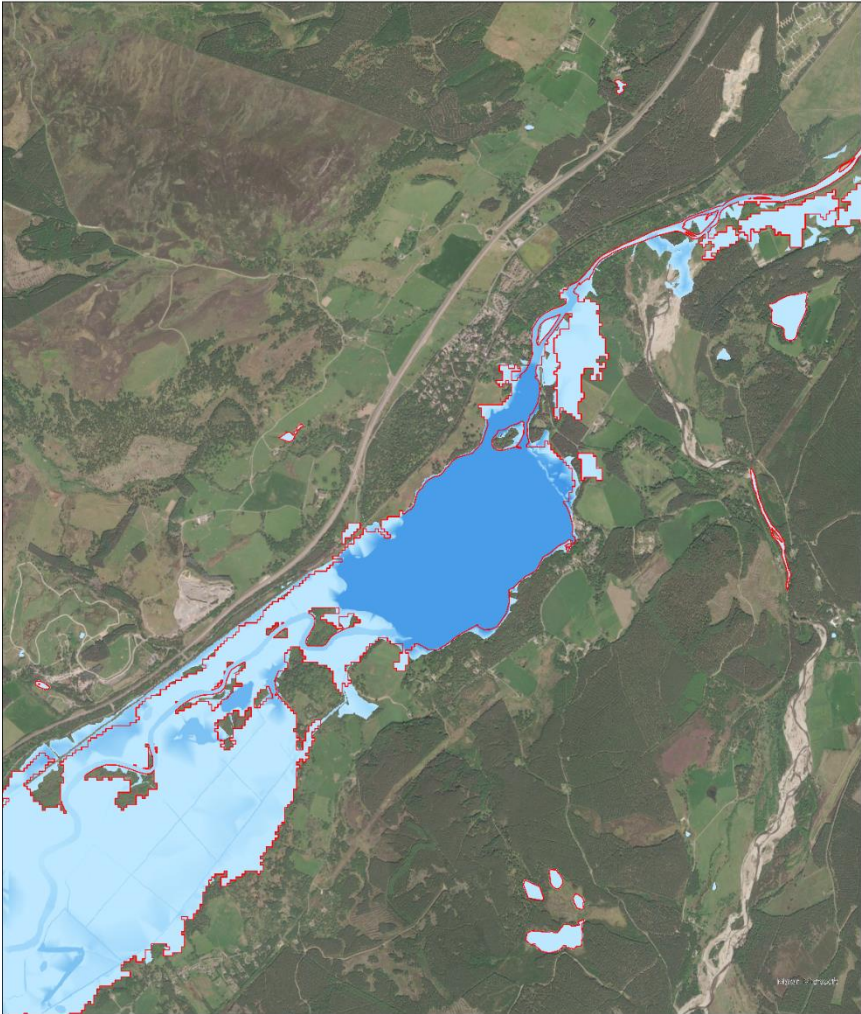
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Relevant date records (UTC)

Date	Event	Product
2022-07-17 10:26	Delineation Product	EMSR 592
2022-07-18 10:17	Monitoring Product 01	EMSR 592
2022-07-19 10:58	Monitoring Product 02	EMSR 592
2022-07-21 10:43	Grading Product	EMSR 592

Copernicus Emergency Management Service system, aid in crisis manag

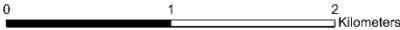
Latest News - Water depth



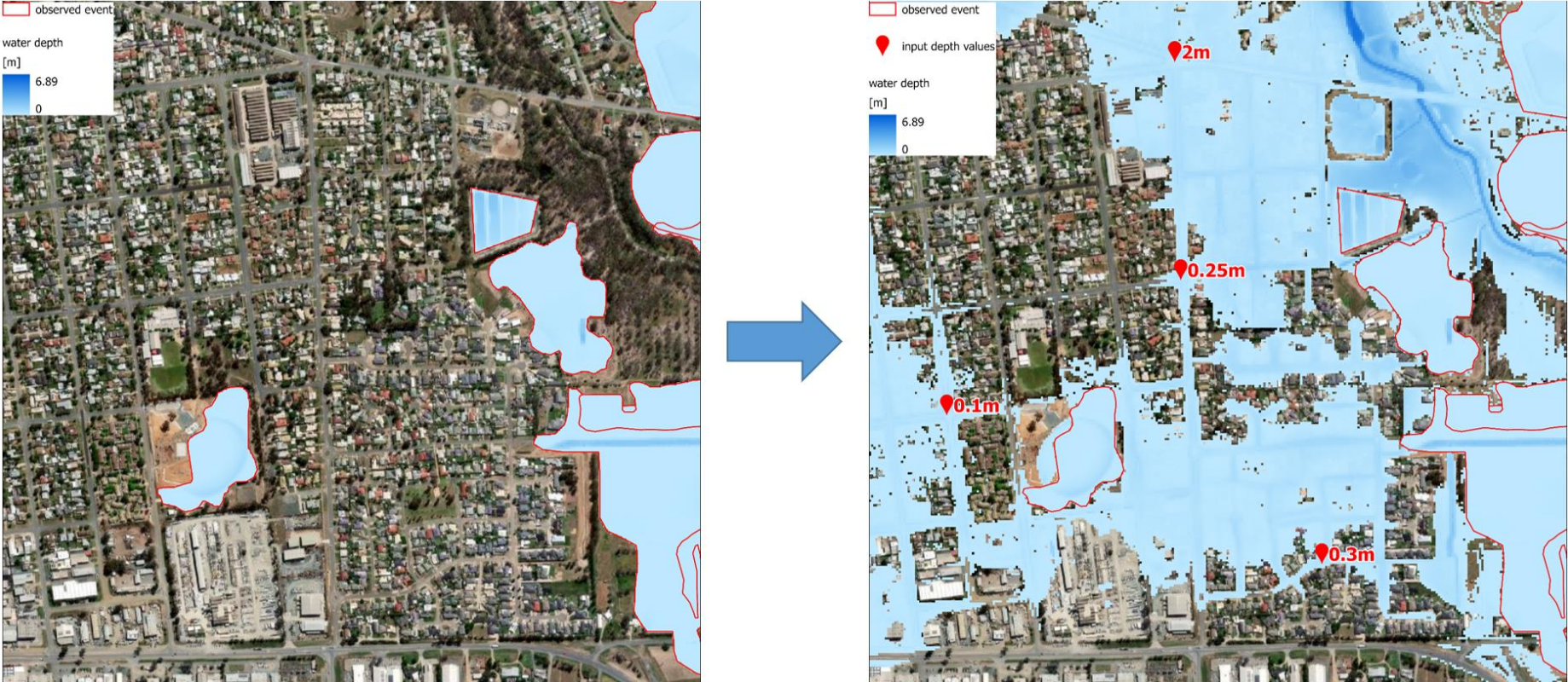
water extent

Water depth final

Value



Service Evolution



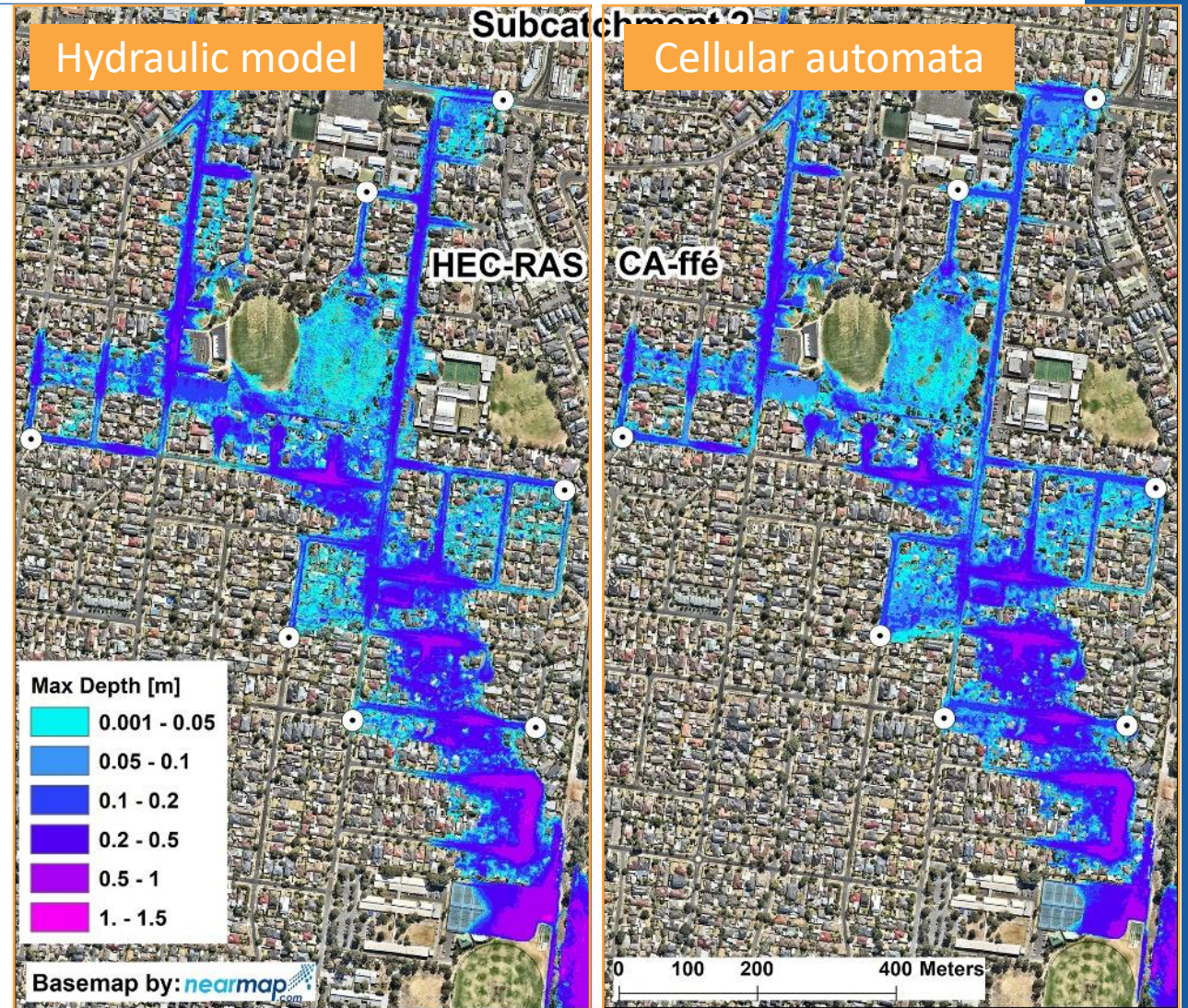
Interpolated 2 modelled water depth, urban

Service Evolution

Urban flood modelling

- Slow modelling using hydraulic models:
 - More traditional and good confidence in the results.
 - Could be used for validating fast modelling during pre-production, while still remaining a staple in RRM.

Jamali, B., Bach, P. M., Cunningham, L., & Deletic, A. (2019). A Cellular Automata Fast Flood Evaluation (CA-ffé) Model. In *Water Resources Research* (Vol. 55, Issue 6, pp. 4936–4953). American Geophysical Union (AGU).



Service Evolution

Urban flood modelling

- Integration of ancillary data:
 - Social media markers (Hensoldt).
 - Water gauges.
 - Flood risk maps.
 - Flood forecasting.
 - Precipitation data.
- All could be used for calibrating our tools, estimating the expected modelling error, and indicating which areas were the result of observations or modelling.

