ARISTOTLE eENHSP

enhanced European Natural Hazard Scientific Partnership

Using GEM products to support rapid loss assessment: *the case of ARISTOTLE eENHSP*

GEM CONFERENCE
Bergamo, 14 June 2023

Alberto Michelini (INGV), Group Leader representative

ARISTOTLE *e*ENHSP Terminology

ARISTOTLE

- **All Risk Integrated System TOwards Trans-boundary hoListic Early-warning**

ENHSP:

- **European Natural Hazards Scientific Partnership**

ARISTOTLE *e*ENHSP in pills

Scientific expert advice *service*

- 24/7, multi-hazard
- provided to the EC Emergency Response Coordination Centre (ERCC)
- operated by 21 national and 3 international institutions (most institutions have a national mandate)

Three modalities:

- Emergency Response - ERM
- MH 3x/week Routine Monitoring – ROM
- STAF mechanism (Scientific Technical Assistance Facility)

European Natural Hazards Scietific Partnership - ENHSP

When major natural events occur there is a strong need for **Authoritative**, **Timely**, **Multi-Hazard Advice**

REGULATION (EU) 2021/836 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

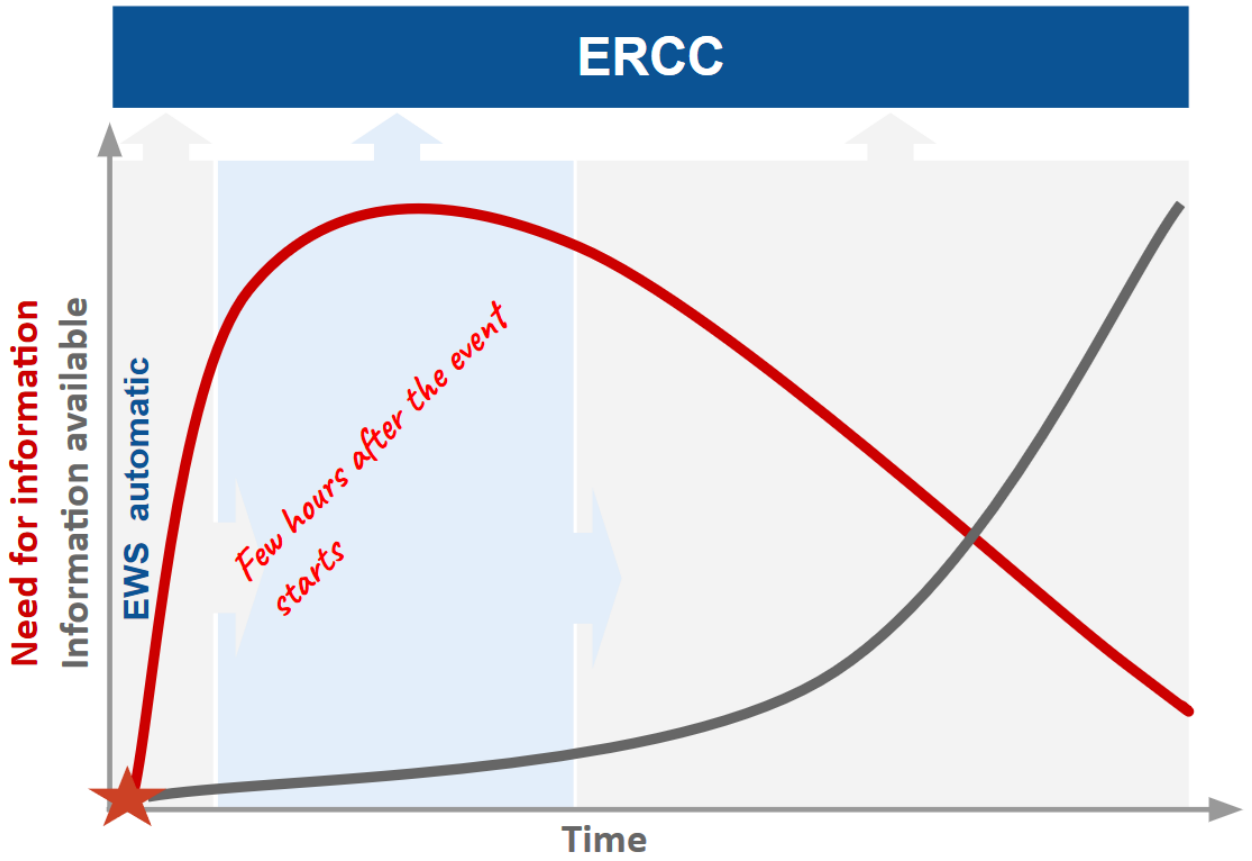
of 20 May 2021

amending Decision No 1313/2013/EU on a Union Civil Protection Mechanism

Article 7
Emergency Response Coordination Centre

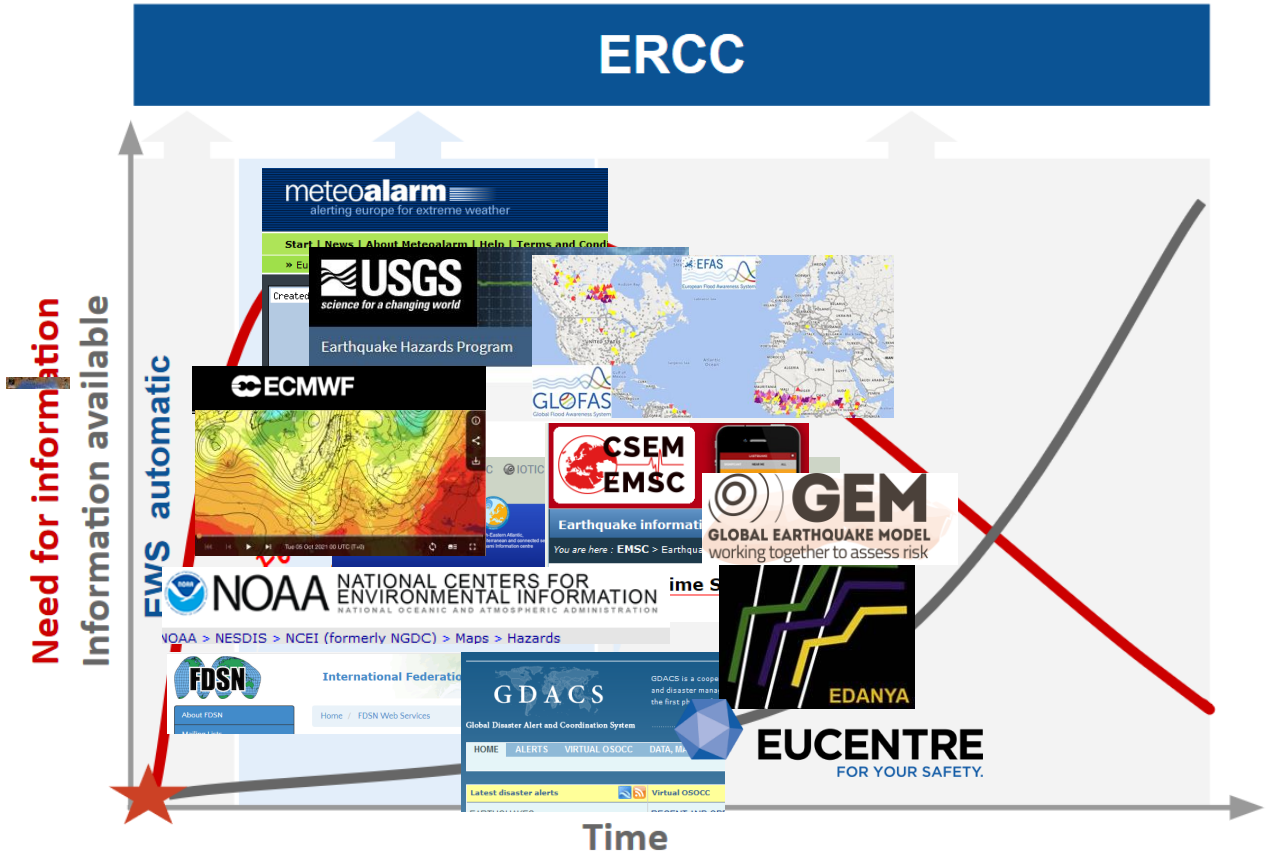
Article 8
General preparedness actions of the Commission

The rationale behind (1/2)



Source ERCC

The rationale behind (2/2)

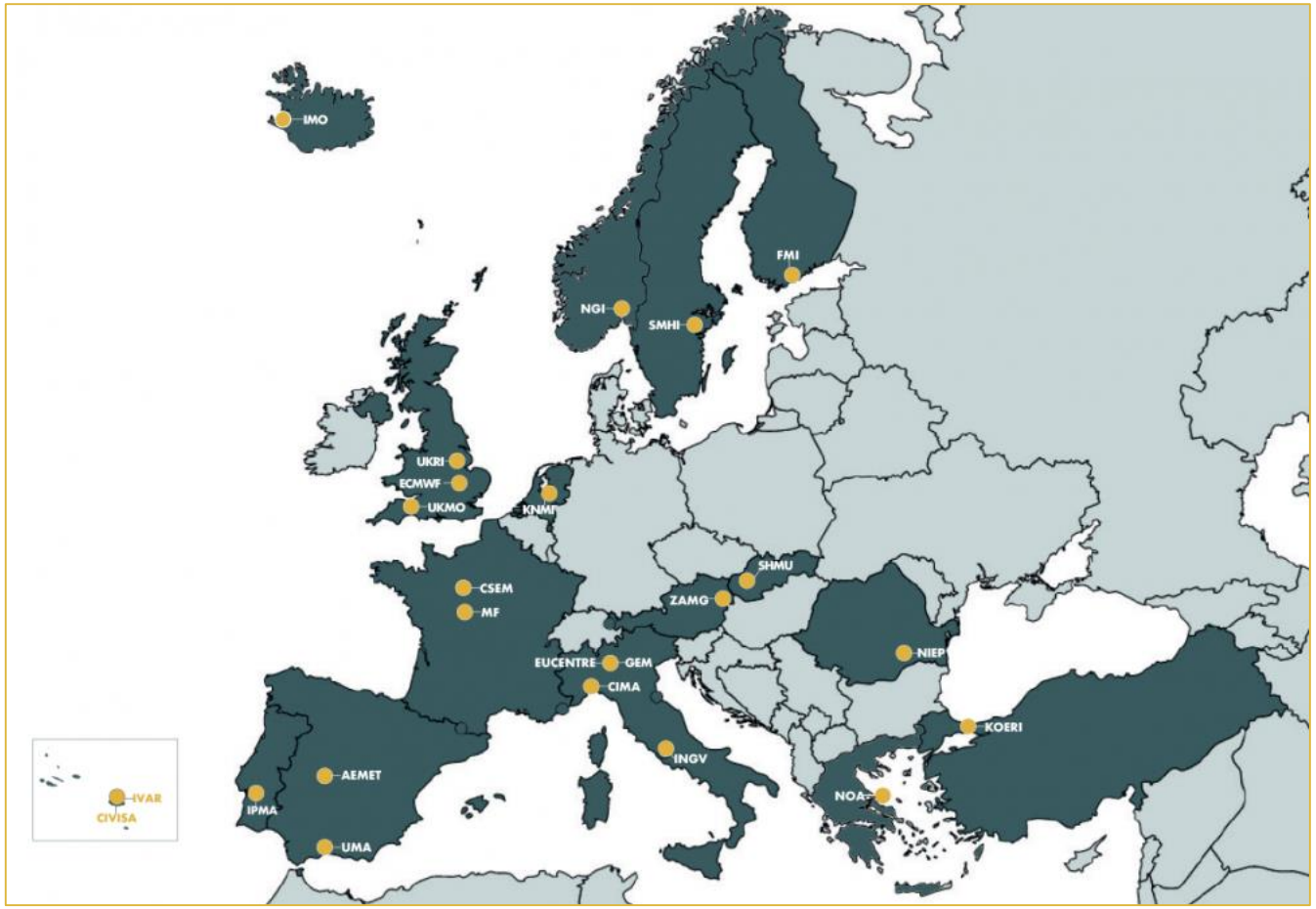


- Multiple sources of information in different locations
- Requirement: From data/information to **WHAT IT MEANS**

ARISTOTLE

COMPREHENSIVE OPERATIONAL 24*7 MULTI-HAZARD SCIENTIFIC ADVICE INTO ERCC/EC

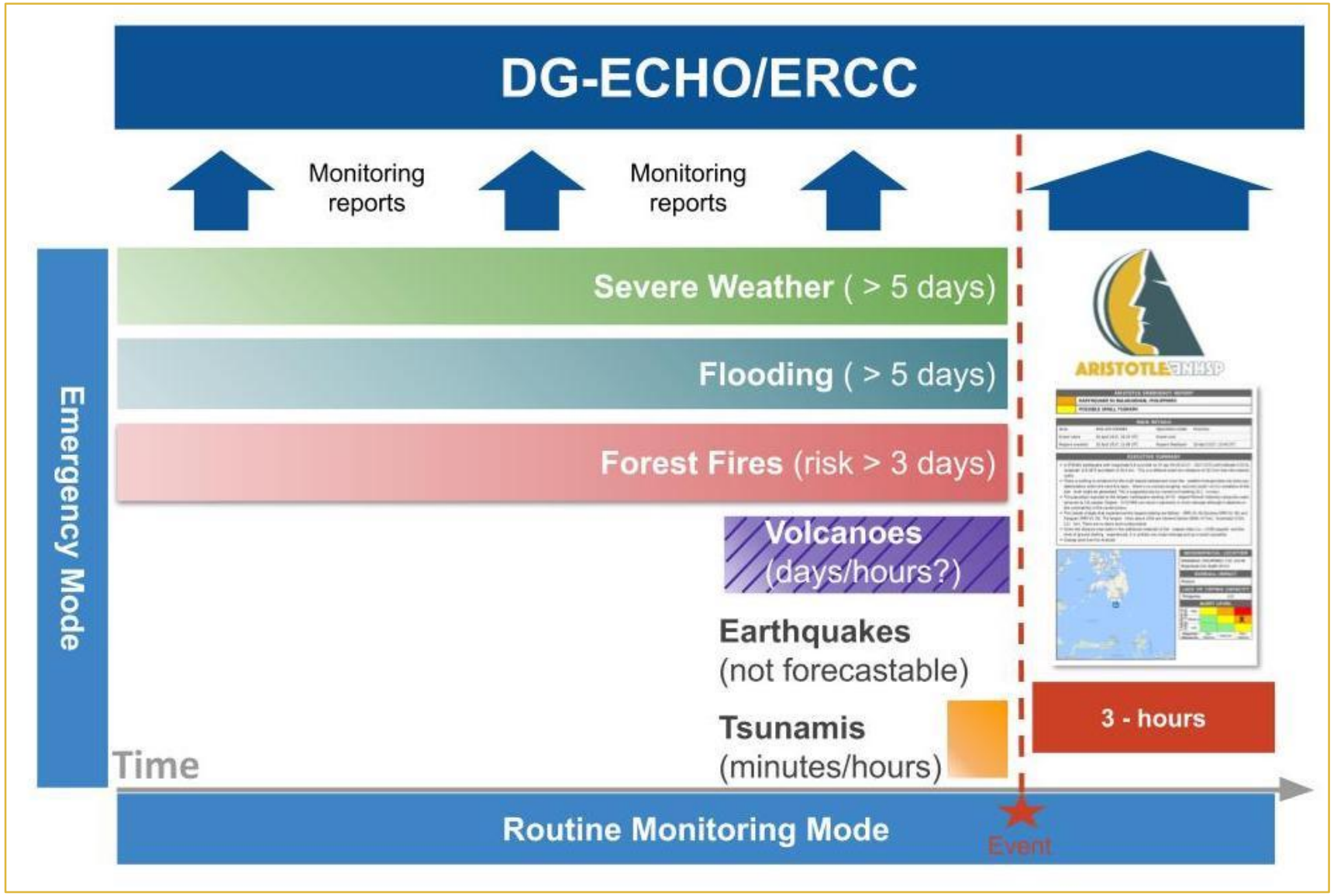
The ARISTOTLE-*e*ENHSP Consortium



- **24 Partners** (21 national + 3 international organizations)
- **15 Countries**

INGV · IPMA Instituto Português do Mar e da Atmosfera · KANDILLI Rasathanesi ve Deprem Araştırma Enstitüsü 1868 · National Observatory of Athens · cima Research Foundation · Royal Netherlands Meteorological Institute Ministry of Infrastructure and Water Management · Met Office · Icelandic Met Office · SMHI · Universitas Malacitana · Universidad de Málaga · INFP · METEO FRANCE · GeoSphere Austria · ECMWF · AEMet Agencia Estatal de Meteorología · EUCENTRE For your safety · BGS British Geological Survey · NGI · GEM Global Earthquake Model working together to assess risk · Ilmatieteen Laitos Meteorologiska Institutet Finnish Meteorological Institute · csem emsc · CIVISA Centro de Informação e Vigilância Sismovulcânica dos Açores · UAc Universidade dos Açores · SHMU

Hazard Timescales



ARISTOTLE-ENHSP: Map of the Activations
(10/2020-2/2023)

Monitoring activities since 10/2020	# of reports
Full reports	42
Light reports	34
Multi-hazard routine monitoring reports	373

ARISTOTLE-ENHSP: Activations and Reporting statistics

Emergency Reports (2/2017 – 3/2023)

REPORTS	
Earthquake	60
Severe weather	67
Flooding	27
Volcanic	32
Forest Fire	2
Totals of reports assembled	**188**
ACTIVATIONS	
EQ activations	54
SW activations	53
FL activations	20
VO activations	21
FF activations	2
Total # activations	**150**

Emergency Reports (10/2020 – 3/2023)

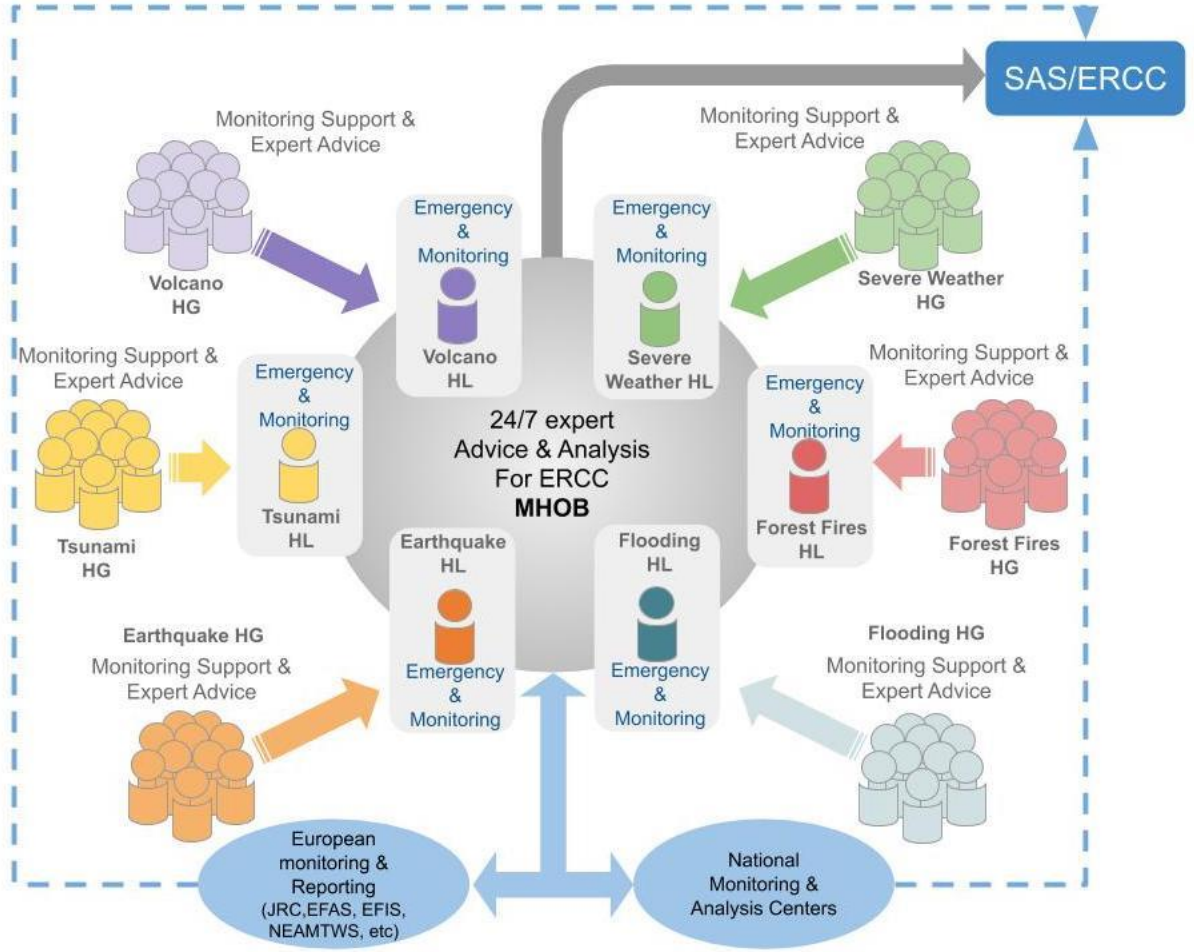
REPORTS	
Earthquake	19
Severe weather	30
Flooding	15
Volcanic	21
Forest Fire	2
Totals of reports assembled	**87**
ACTIVATIONS	
EQ activations	17
SW activations	20
FL activations	11
VO activations	10
FF activations	2
Total # activations	**60**

432 Multi-hazard Routine Reports (5/2021 – 3/2023)

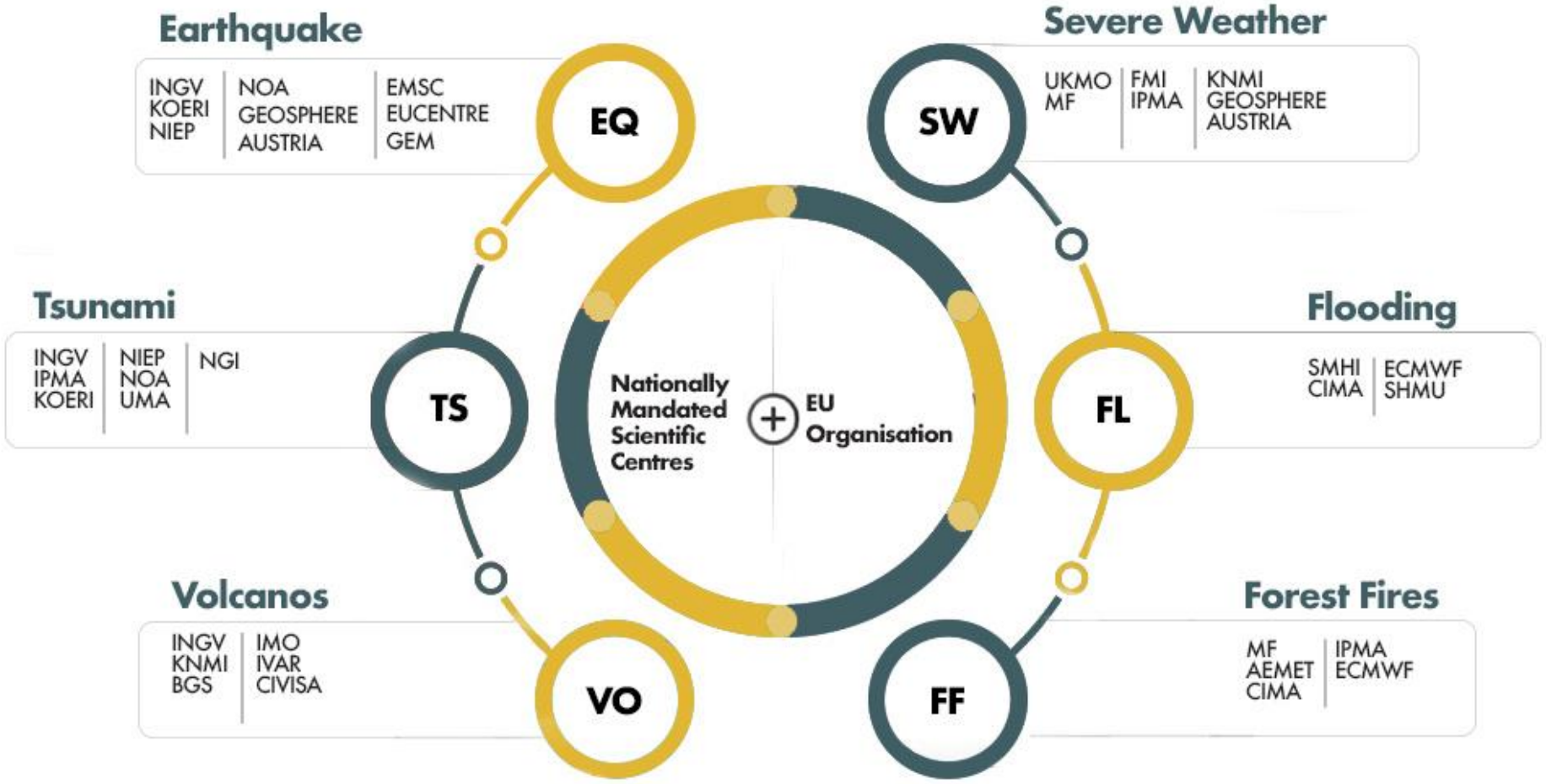
Multi Hazard Operational Board
(i.e., a virtual operation room)

operations

- Based on a **pool of experts**
- **Multi-hazard approach**
- **Tailored products**
- Fully **scalable design**



Multi Hazard Operational Board (partners)



ERM - Emergency Reporting: example

The Turkey-Syria M7.8 Earthquake on the 02/06/2023

Dear Colleagues,

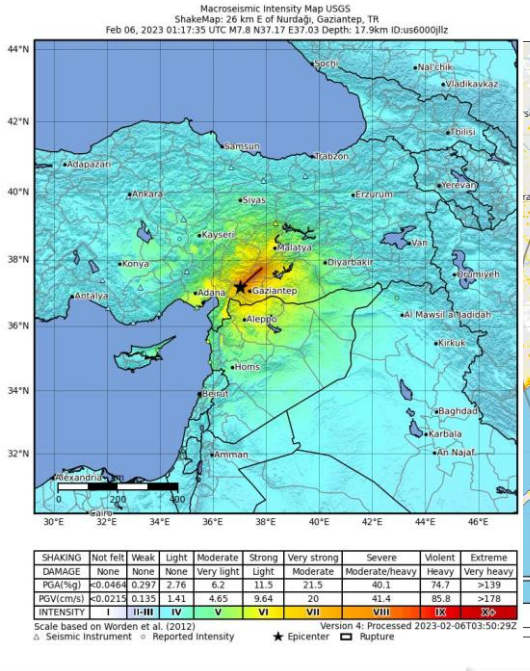
A new emergency has been created:

Emergency Details:

Activation Code:	**AR0108**
Title:	**Earthquake**
Request Date:	**2/6/2023 2:08:33 AM UTC**
Event Date:	**2/6/2023 1:54:27 AM UTC**
Event Type	**Earthquake**
Alert Level	**Red**
Requested Report Type	**Full emergency MH report**
Deadline	**Full emergency MH report should be uploaded within the next 3 hours!**
Created by	**Sien VANLOMMEL**

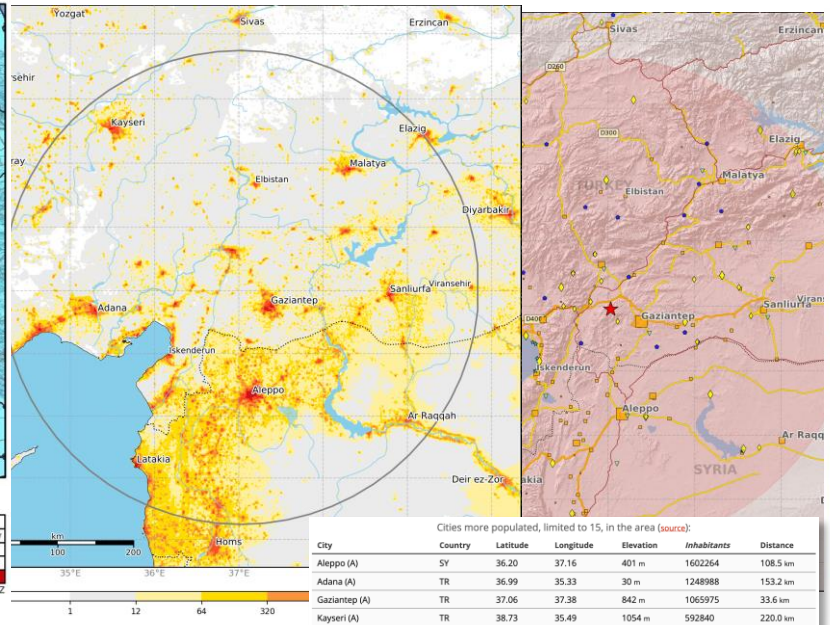
ARISTOTLE

Activated - reactive mode



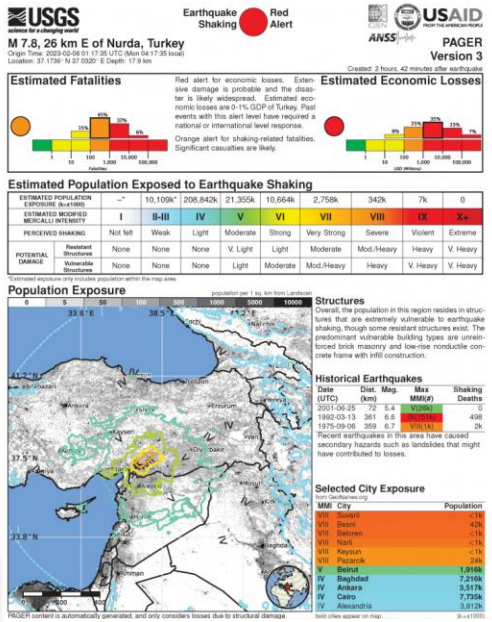
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	None	None	None	Very light	Light	Moderate	Moderate/heavy	Heavy	Very heavy
PGA(%g)	<0.0464	0.297	2.76	6.2	11.5	21.5	40.1	74.7	>139
PGV(cm/s)	<0.0215	0.135	1.41	4.65	9.64	20	41.4	85.8	>178
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based on Worden et al. (2012) Version 4: Processed 2023-02-06T03:50:29Z
△ Seismic Instrument ○ Reported Intensity ★ Epicenter ▭ Rupture



Cities more populated, limited to 15, in the area (source):

City	Country	Latitude	Longitude	Elevation	*Inhabitants*	Distance
Aleppo (A)	SY	36.20	37.16	401 m	1602264	108.5 km
Adana (A)	TR	36.99	35.33	30 m	1248988	153.2 km
Gaziantep (A)	TR	37.06	37.38	842 m	1065975	33.6 km
Kayseri (A)	TR	38.73	35.49	1054 m	592840	220.0 km
	TR	36.81	34.64	10 m	537842	216.8 km
	Y	35.13	36.76	270 m	460602	227.9 km
	R	37.17	38.79	528 m	449549	156.5 km
	R	38.35	38.32	963 m	441805	172.8 km
	R	37.58	36.93	564 m	376045	46.6 km
	Y	35.53	35.79	29 m	340181	213.6 km
	R	36.92	34.89	21 m	256482	192.4 km
	R	37.76	38.28	678 m	223744	128.1 km
	R	36.21	36.16	104 m	210000	132.8 km
	R	37.07	36.25	128 m	202837	70.6 km
	Y	35.95	39.01	259 m	177636	222.8 km

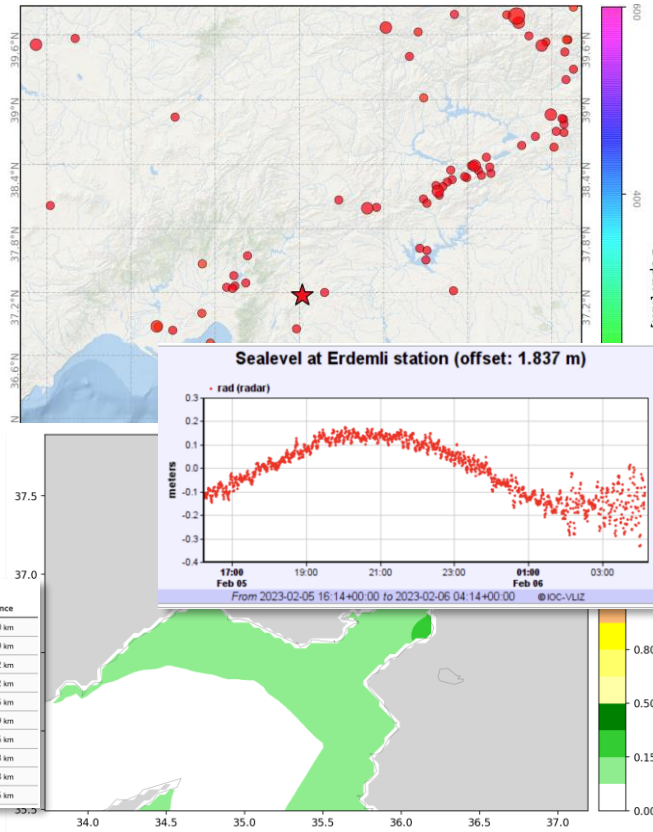


ESTIMATED POPULATION EXPOSURE (k=x1000)	–*	10,109k*	208,842k	21,355k	10,664k	2,758k	342k	7k	0
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE: Resistant Structures	None	None	None	V. Light	Light	Moderate	Mod./Heavy	Heavy	V. Heavy
POTENTIAL DAMAGE: Vulnerable Structures	None	None	None	Light	Moderate	Mod./Heavy	Heavy	V. Heavy	V. Heavy

*Estimated exposure only includes population within the map area.

Top 10 largest events from the NEIC/USGS catalogue since 1900 (source):

Datetime	Latitude	Longitude	Depth	*Magnitude (type)*	Distance
1939 Dec 26, 23:57:23	39.771	39.577	20.0 km	7.8 (mw)	364.0 km
1905 Dec 04, 07:05:30	38.153	38.645	10.0 km	6.8 (mw)	178.9 km
2020 Jan 24, 17:55:14	38.39	39.081	11.91 km	6.7 (mww)	225.2 km
1992 Mar 13, 17:18:39	39.71	39.605	27.2 km	6.7 (mwb)	360.2 km
1938 Apr 19, 10:59:21	39.508	33.872	10.0 km	6.6 (mw)	378.5 km
1918 Sep 29, 12:07:14	35.077	35.608	15.0 km	6.6 (mw)	265.9 km
1998 Jun 27, 13:55:52	36.878	35.307	33.0 km	6.3 (mwc)	156.6 km
1909 Feb 09, 11:23:57	39.665	38.027	15.0 km	6.3 (mw)	290.3 km
1986 May 05, 03:35:38	37.993	37.806	9.6 km	6.1 (mw)	113.8 km
2003 Jan 27, 05:26:23	39.5	39.878	10.0 km	6.1 (mwc)	358.5 km



Population exposed to Mercalli intensity levels:

≥ IV	≥ V	≥ VI	≥ VII	≥ VIII
127 414k	37 701k	15 075k	3 599k	62k

Population exposed by interval to Mercalli intensity levels:

IV	V	VI	VII	≥ VIII
89 713k	22 626k	11 476k	3 537k	62k

Population within different distances (km):

200	< 100	< 50	< 20
549k	5 751k	2 842k	56k

Population by interval within different distances (km):

0-200	50-100	20-50	< 20
798k	2 909k	2 786k	56k

ERM - Emergency Reporting: detail

ARISTOTLE-EENHSP EMERGENCY REPORT (AR0108)

EARTHQUAKE 7.8 TURKEY

MAIN DETAILS

Area	Turkey (Asia)	**Operation mode**	Reactive
Event start	6 February 2023, 01:17 UTC	**Event end**	-
Report created	6 February 2023, 02:44 UTC	**Report finalized**	6 February 2023, 05:11 UTC

EXECUTIVE SUMMARY

- A MAJOR earthquake with magnitude 7.8 occurred on Mon Feb 6 01:17:35 2023 (UTC) with latitude 37.17°N, longitude 37.03°E and depth of 17.9 km. This is a inland event at a distance of 86.4 km from the nearest coast.
- According to the most recent USGS ShakeMap, the maximum estimated intensity in the epicenter area was IX, corresponding to severe shaking and moderate to heavy damage, approximately 7 000 people being exposed to this intensity. More than 340k people experienced intensities larger than VIII (severe shaking - significant damage), while about 2.7 million people experienced intensities larger than VII (very strong shaking, moderate damage).
- The maximum felt intensity was IX (violent shaking- serious damage) according to the USGS "Did You Feel It" responses of 1513 eyewitnesses.
- The USGS-PAGER issued an ORANGE alert for shaking-related fatalities and RED for economic losses indicating significant casualties are probable and extensive damage likely widespread. GDACS reported a RED alert, indicating a high humanitarian impact.
- The earthquake is expected to be followed by numerous aftershocks for some weeks and it cannot be excluded that events as large could occur within the same broader area. At the time of this report, there have been 9 aftershocks with magnitude above 5, the strongest being 6.7. The aftershocks could increase the losses and also can affect the number of displaced people.
- Tallies from various officials put the toll at at least 38 dead in Turkey and 62 in Syria. The death toll is expected to rise in the following hours as rescue operations are going on.
- At least 130 buildings tumbled down in Turkey's Malatya province, neighboring the epicenter, Gov. Hulusi Sahin said. In the Turkish city of Diyarbakir, at least 15 buildings collapsed. Overall, the population in this region resides in structures that are extremely vulnerable to earthquake shaking, with predominant unreinforced brick masonry and low-rise non-ductile concrete frame with infill construction.
- Based on tsunami simulation results, maximum expected wave amplitudes are between 0.1 and 0.3 m in the bay of Iskenderun. Tide gauges in Iskenderun and Erdemli in Turkey have recorded waves of amplitudes of up to 20 cm, with potential for currents, bore, recession, damage in harbors, small inundation on beaches. However, coastal inundation cannot be excluded, particularly in the bay of Iskenderun.
- Secondary hazards such as landslides, liquefaction or gas pipeline explosions are possible and can contribute to additional losses.
- Outbreaks of rain, heavy at times, will affect the region with thunderstorms also possible. The rain will fall as snow on higher ground through Monday with heavy accumulations building up. Temperatures will be around 5 degrees Celsius lower than what is expected for February in this region, with daytime temperatures no higher than 3 degrees Celsius and with overnight temperatures lowering to around Minus 8 degrees Celsius.
- Based on the preliminary information provided above, we assess that the earthquake resulted in a major impact and it affected a large portion of Turkey and Syria. Considering the overall situation concerning the other hazards (severe weather), we assign a Red alert to this event, expecting that international resources may be necessary.

GEOGRAPHICAL LOCATION

TURKEY: 37.17N 37.03E.
Magnitude: 7.8. Depth: 17 km.

OVERALL IMPACT

High

LACK OF COPING CAPACITY

Syria	MEDIUM	(5.5)
Turkey	LOW	(3.2)

ALERT LEVEL

Likelihood of major impact				
	High			X
	Medium			
	Low			
Required Resources	Sub-national	National	Inter-national	

Basic description

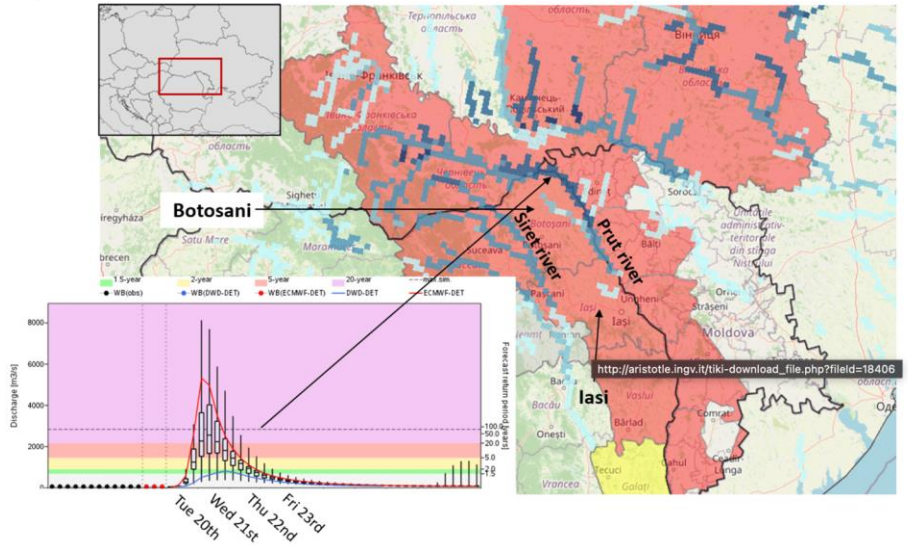
Potential cascading effects / Weather assessment and forecast

Impact assessment with the available information within 3 hours

Potential evolution

ERM – Lite reports

Image caption | Latest EFAS forecast over Ukraine, Romania and Moldova, darker blue shades represent a higher probability of flooding within the next 48 hours, red areas show administrative regions where flood impacts are possible



ARISTOTLE-eENHSP Lite report
Flooding Hazard Group

Date created: July 20, 2021 - 13:07
Author e-mail: aristotleGF at ecmwf.int

Geographic location: Ukraine, Romania and Moldova
Event timing: 20 July 2021 to 23 July 2021

Description | Violent thunderstorms broke out in Romania last night (19th July) and this morning (20th July). They are moving northwards and associated precipitation is expected to increase considerably this afternoon and tonight : 70-100 mm are possible in 6 hours locally according to ECMWF model, especially over the extreme south of Ukraine, near the border area with Romania and Moldova. Other regions of these three countries will also be affected by severe thunderstorms but the rainfall intensities should be less. During the next 24 hours (from D 12 to D+1 12 UTC), accumulations of 100 to 200 mm could be reached in places. The thunderstorms will then continue their course towards the northeast and will ease a bit. Flash flooding is possible across the affected area as well as severe gusts, large hail and frequent lightning.

This heavy rainfall over north-eastern Romania, south-west Ukraine and eastern Moldova is also likely to lead to river flooding in the upper reaches of the Prut and Cipem/Siret rivers, both are tributaries of the Danube. Over the next 48 hours streamflows will begin to rise in the upper reaches of both rivers in the regions of Chernivtsi and Ivano-Frankiv'sk in Ukraine, Suceava and Botosani in Romania and Edinet, Briceni, Donduseni and Ocnita in Moldova. There is a high probability of extreme streamflows which will peak by Wednesday 21st July 2021. After this no further heavy rain is expected and the high streamflows will move downstream where they may affect the regions of Iasi, Vaslui and Galati in Romania and eastern regions of Moldova.

Flood warnings have been issued by the Romanian National Institute of Hydrology and Water Management valid from 11:00 (CEST) on the 20th July until 15:00 (CEST) on the 22nd July. These include a red alert for flooding in the regions of Isai and Botosani between 14:15 and 21:00 (CEST) today (20th July). A red alert has also been issued for the region of Galati for hail, lightning and torrential rain hazards.

Basic description

Weather assessment and forecast

Flood assessment with the available information

Potential evolution

ROM - MH 3x/week Monitoring reports: detail

ARISTOTLE-eENHSP
MULTI-HAZARD IMPACT ORIENTED BRIEF

Date: September 24, 2021
Report Secretary: ZAMG_EQ, María del Puy Papí Isaba, aristotle_eq@zamg.ac.at

HEADLINES

- Volcanic eruption at Cumbre Vieja Volcano, La Palma, Spain
- New escalation of the eruptive activity, Fuego, Guatemala

SUMMARY

Likelihood				
	High	Monitor	Prepare	Act
	Medium	Nil	Monitor	Prepare
	Low	Nil	Nil	Monitor
Decision Matrix		Sub-national	National Resources	International Resources
		Estimated Resources		

Based on the Decision Matrix, the **16** events in this report are grouped as follows:

0 "Act" (red) - **2** "Prepare" (orange)
5 "Monitor" (yellow) - **9** "Nil" (green)

ROM - MH 3x/week Monitoring reports: detail

1: Lava fountains, Lava flows, Tephra fall, Gas emissions - Cumbre Vieja, La Palma, Spain

Description

The eruption that started on 19 September continues in the form of lava fountains and lava flows emitted by a single fissure. Lava flows are still moving W in two lobes, the northern one almost stopped (1 m/h) and the southern one continues moving at a speed of 4-5 m/h. The fountaining activity has been intense producing an ash-rich plume reaching 4,500 m height. The seismic activity continues but at lower rates, along with SO2 emissions producing an SO2 cloud detected by TROPOMI (1,2,3,4). The director of the Geological Risks Area of INVOLCAN issued a statement on 17 Sep about the current stability of the volcanic edifice (5). Toulouse VAAC continues issuing multiple ash advisories daily reporting fountaining with ash emissions up to 3.1 km a.s.l. and SO2 cloud moving eastward.

Likelihood vs Impact

Impacts

Lava flows have invaded 154.37 ha of land as of 23 September (4) and damaged 300 buildings (7). Given the thickness of the lava flows, their front may collapse and, on steep slopes, this can generate rock falls and small rock avalanches (courtesy of INVOLCAN). A ArcGIS map of the lava flows has been made available (8). A lava flow hazard map was published by IGN (9).

5,700 people have been evacuated, of which 135 were housed in the El Fuerte barracks (Breña Baja) and of these, 86 have been relocated to a hotel in Fuencaliente. The 49 people are still in the shelter, 28 of them are in charge of the Canary Health Service and the other 19 have preferred to continue in that location (4).

On 20 September the Maritime Captaincy established an exclusion radius to 2 nautical miles due to the hazard posed by lava flows entering the sea. The authorities maintain the exclusion radius of 2.5 km around the emission points and recommend staying away from the lava flows (4). ENAIRE has closed the airspace in the municipalities of El Paso and Los Llanos de Aridane in the land and sea below 3,000 feet (4).

Lava flows entering the sea can cause explosions and further gas emissions. Ongoing gas emissions can affect air quality although there have been no reports of air quality being affected so far (7).

Potential impacts from lava fountains, lava flows, gas emissions, forest fires triggered by lava are possible based on previous eruptions.

References:

(1)https://twitter.com/involcan
(2)https://www.facebook.com/INVOLCAN
(3)https://www.ign.es/web/ign/portal/vlc-serie-palma
(4)https://www3.gobiernodecanarias.org/noticias/
(5)https://elapuron.com/noticias/opinion/155823/la-estabilidad-cumbre-vieja/

2: Lava flows, Rock avalanches, Pyroclastic flows - Fuego, Guatemala

Description

On 23 September INSIVUMEH reported a new increase of the eruptive activity, with Strombolian activity with two lava flows of 350 and 250 metres length advancing in the Ceniza, Seca and Trinidad ravines, respectively. The lava flow produced avalanches of incandescent blocks in the Ceniza, Trinidad and Santa Teresa ravines. A pyroclastic flow descended the Ceniza ravine up to a distance of 4-6 km. Washington VAAC reported constant ash emissions up to 4.9 km a.s.l. dispersing SW (1).

Likelihood vs Impact

Impacts

In the special reports INSIVUMEH (2,3) recommended CONRED to increase the alert level and take all precautionary measures against the pyroclastic flows that can continue; particular attention should be dedicated to the communities in the vicinity of the ravines Ceniza, Taniluyá and Trinidad. They recommended PROVIAL to close the crossing of the National Road 14 on the southern flank of Fuego (Las Lajas) and the Civil Aviation to take the measures for air traffic due to the presence of ash up to 6,000 m a.s.l. in the vicinity of Fuego within a radius of 30 km, which may increase in the next hours. Finally they recommended IGUAT and the municipalities of Alotenango, Acatenango and San Pedro Yepocapa to ban the access of tourists and visitors to the Acatenango and Fuego volcano.

CONRED (4) recommended the population to avoid the ravines of Fuego, to prepare in case of preventive evacuations, to take measures against ash fall, to be prepared to move to the closest hotel if necessary.

References:

(1)https://www.ssd.noaa.gov/VAAC/messages.html
(2)https://insivumeh.gob.gt/2021/09/?cat=41
(3)https://twitter.com/insivumehgt
(4)https://twitter.com/ConredGuatemala/status/1441029320583962633/photo/1

Scientific Technical Assistance Facility (STAF)

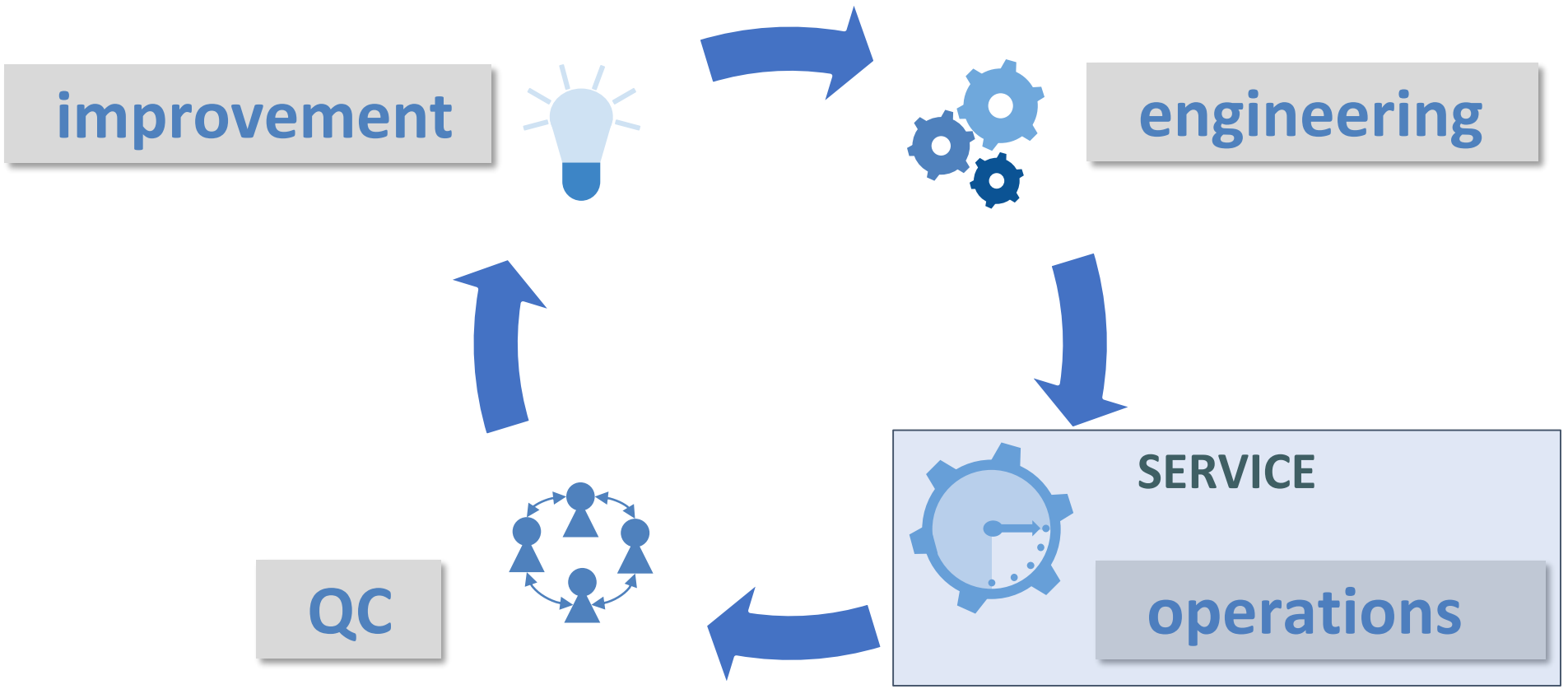
Layer 1 “Fast-Track service”

A remote service to provide informal scientific expert advice (by phone, video-conference, e-mail) to the Situational Awareness Sector (SAS) in ECHO A3 on the possible impact of a disaster event and recommended measures to address it before, during and after the disaster

Layer 2 “Medium-Term service”

Scientific and scenario-based support on specific subjects (e.g. targeted studies on disaster-related topics such as impact of heatwaves on urban areas or scientific contributions to disaster scenarios)

Service vs Research: The ENHSP concept (general)



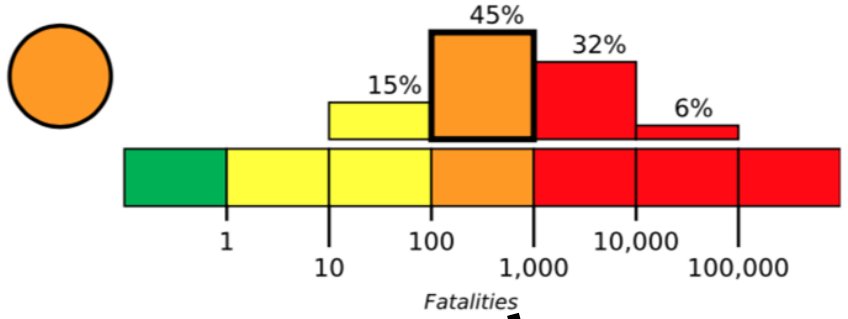
Challenges (1/2)

Rapid **MH impact assessment requires specific tools and products** to be refined or developed (i.e., R&D)

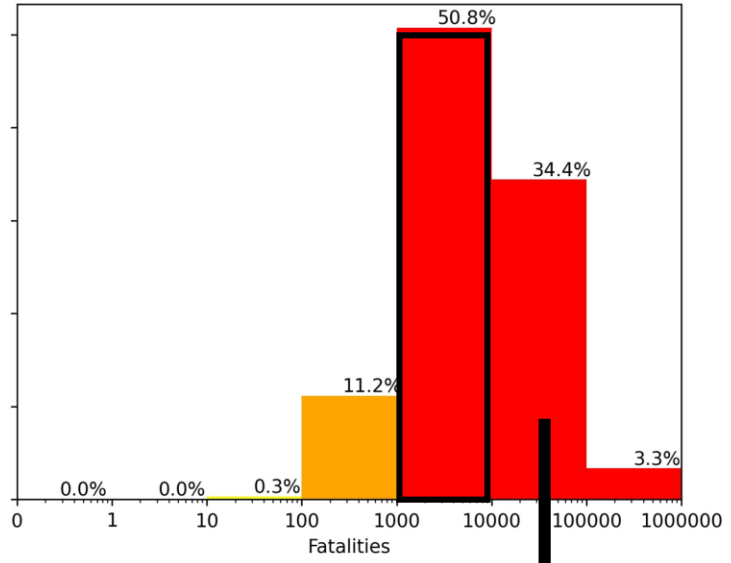
- Need for **uncertainties** and **probabilistic estimates**
- Need for **adjourned authoritative databases**
- Need for **homogenization across hazards**

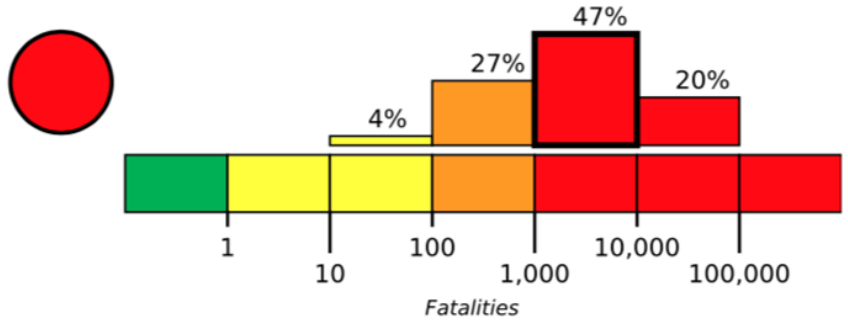
EXAMPLE OF NEW SERVICES IN THE ARISTOTLE eENHSP SERVICE

USGS PAGER vs ARISTOTLE EUCE/GEM Fatality Estimates (2/6/2023 Turkey earthquake)

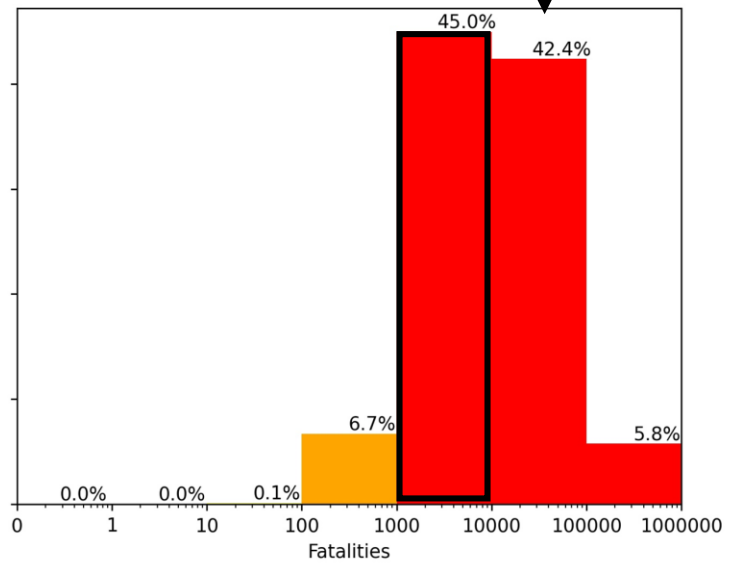


Version 3 (2 hours, 42 mins after event, ‘scheduled repeat’)

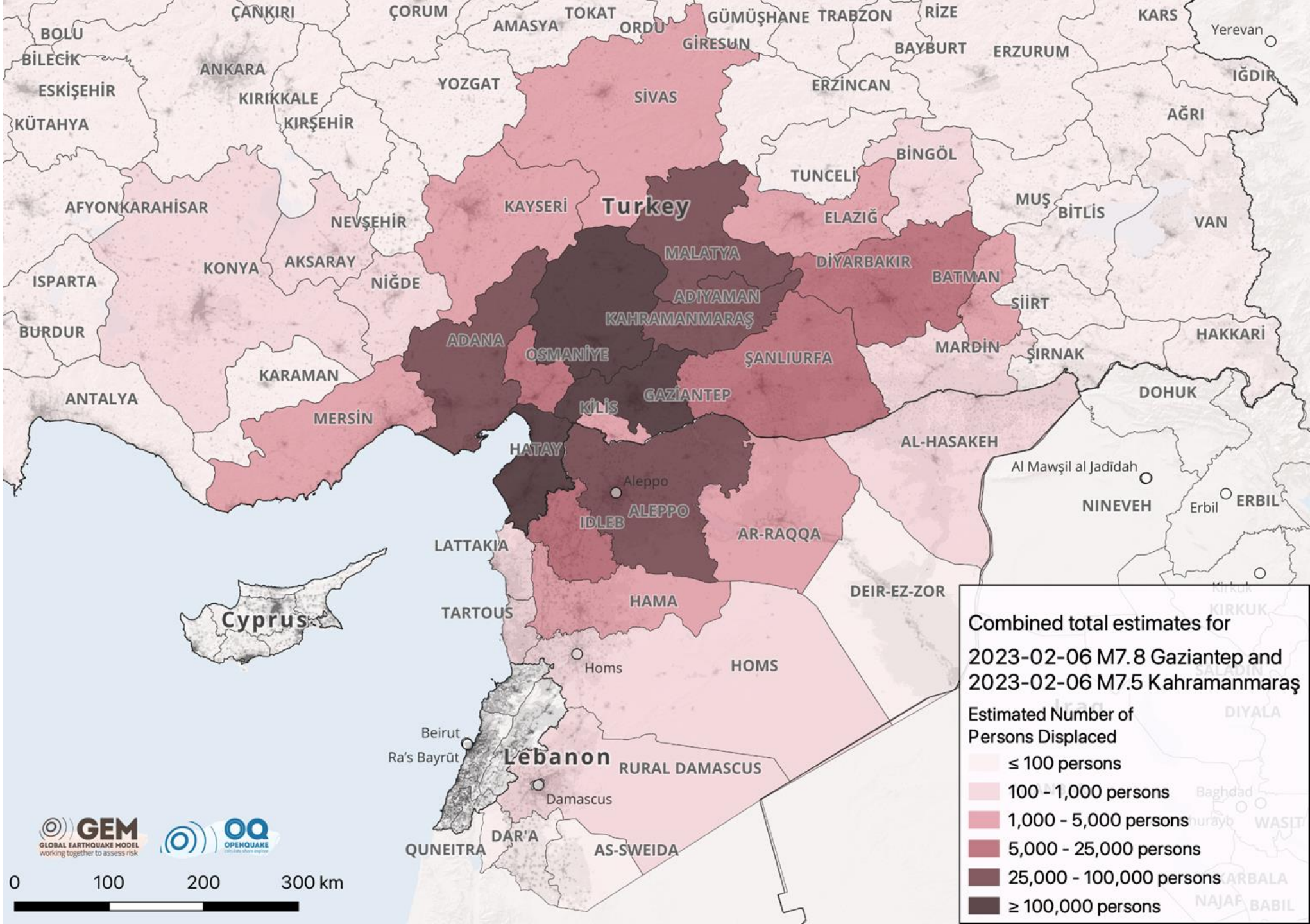




Version 4 (4 hours, 5 mins after event, ‘finite fault v1’)



Population displaced using conditioned ground motion fields



Challenges (2/2)

Potentially **sensitive information** deriving from impact estimates (e.g., number of fatalities, amount of damage) **must be treated carefully** and be **consistent** with similar ones provided at **national level** in order to avoid possible inconsistencies

- Need for close **synergy between ARISTOTLE and national national Early Warning Systems and CPAs**

ARISTOTLE *e*ENHSP has matured experience during its operational activities and it can provide important research directions to be pursued towards improving early warning activities from the scientific perspective

ARISTOTLE-ENHSP
enhanced European Natural Hazard Scientific Partnership

The service is managed by the Service Mgt. Team and provided by about ~100 very dedicated expert scientists and technologists that participate actively to a «de facto» multi-hazard, European 7/24h virtual emergency room and their essential contribution is greatly acknowledged.

Thank you for the attention

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