

Citizen Seismology and its Contribution to Seismic Risk Reduction: Year 2

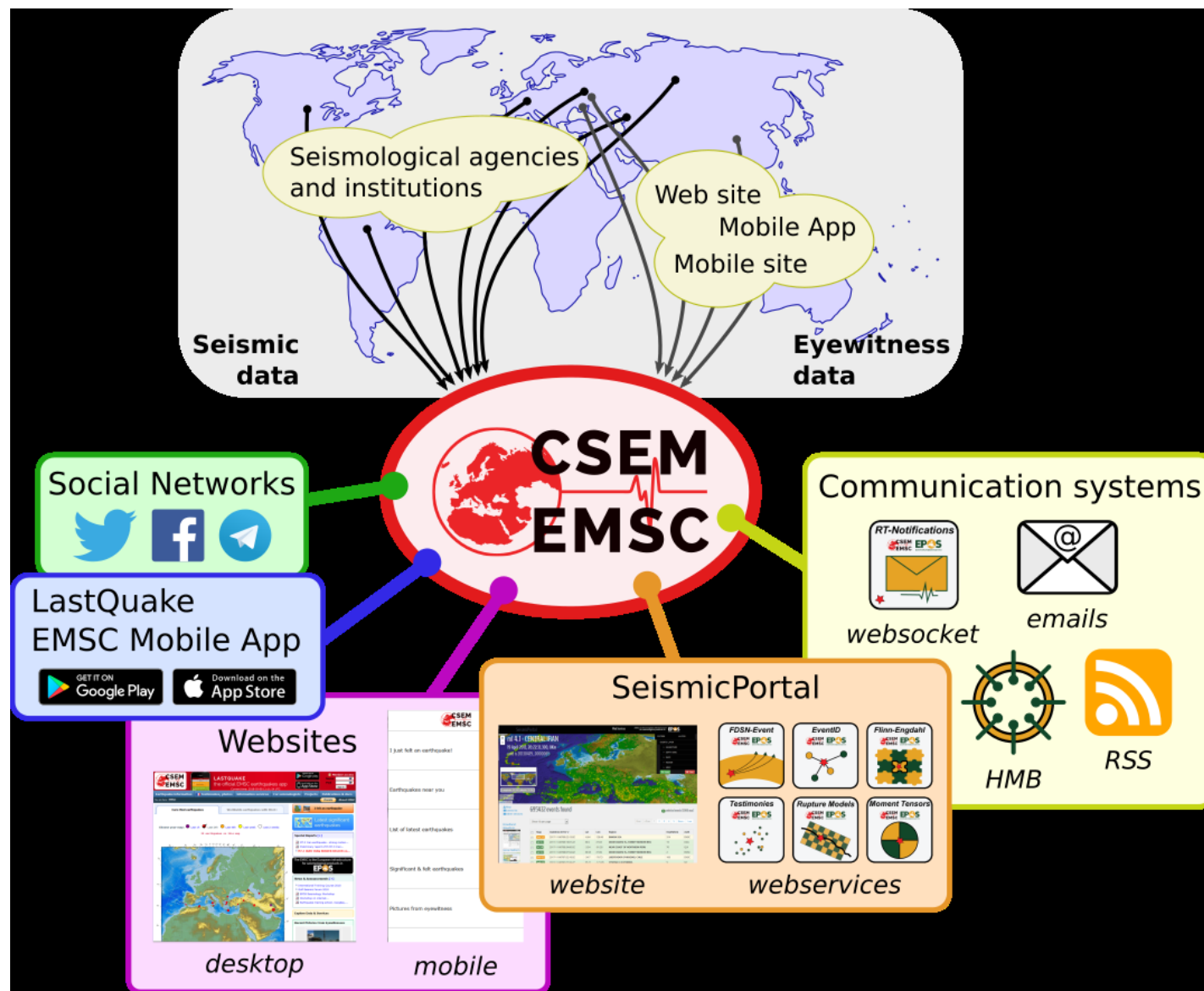
R. Bossu and the EMSC Team

European-Mediterranean Seismological Centre

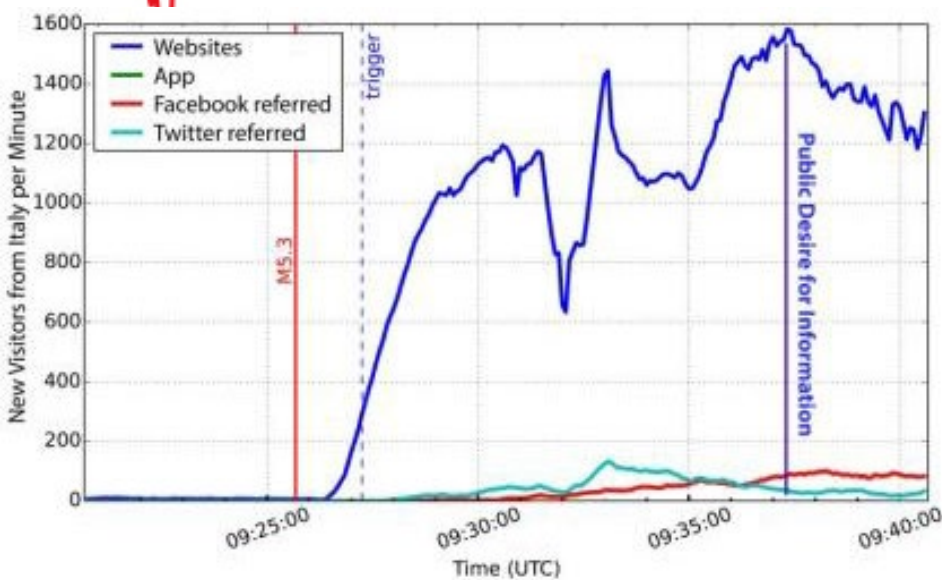
LastQuake:



One of Top Earthquake Information Centre

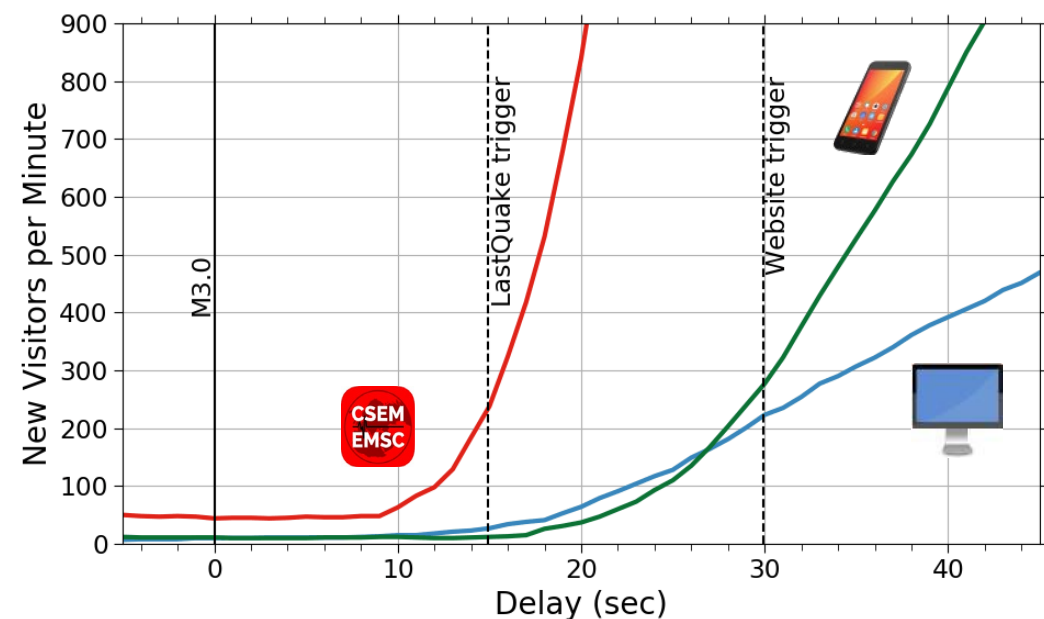


Internet as the Digital Nervous System of our Planet!



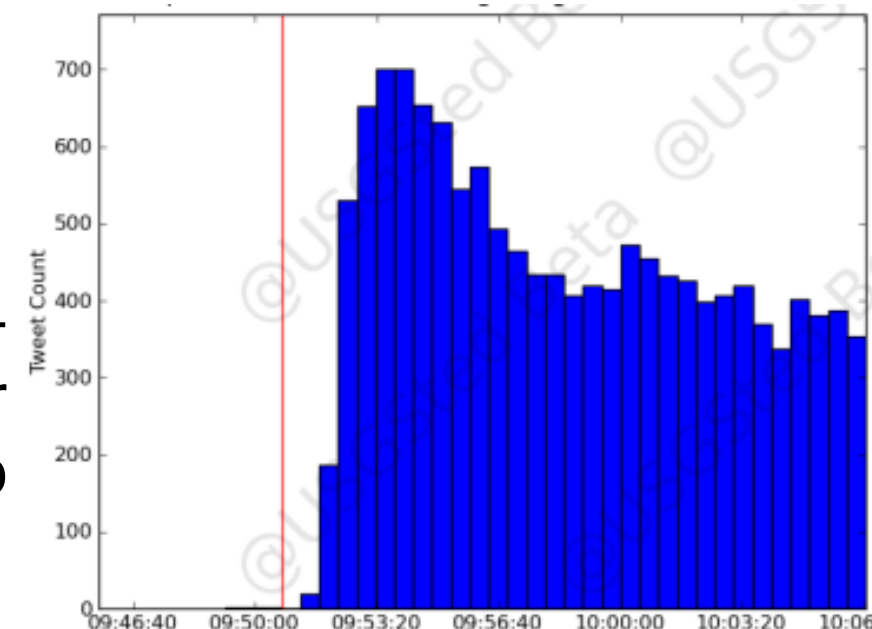
EMSC Website Traffic Monitoring:

- Since 2006
- Works at global scale
- IP location at city level



Twitter EQ Detection (USGS):

- Since 2014
- Where Twitter is popular
- Poor geographical Info

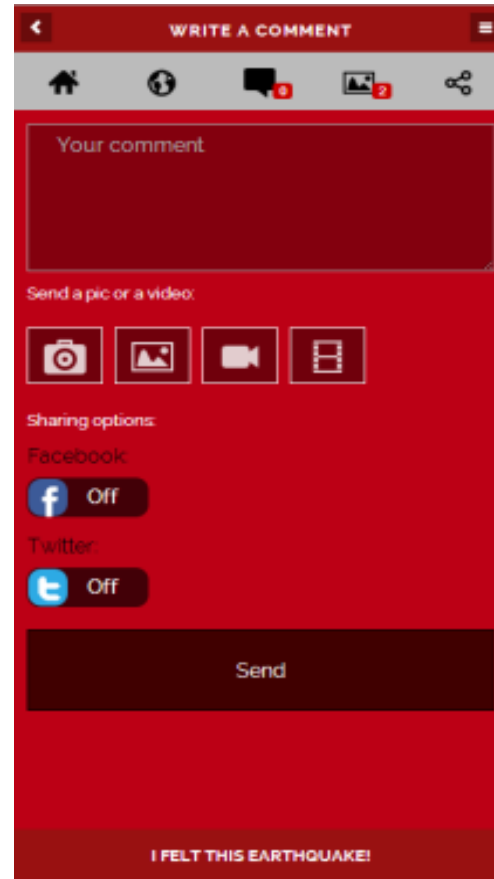


LastQuake App EQ Detection:

- Since 2016
- Where LastQuake app is popular
- Accurate locations



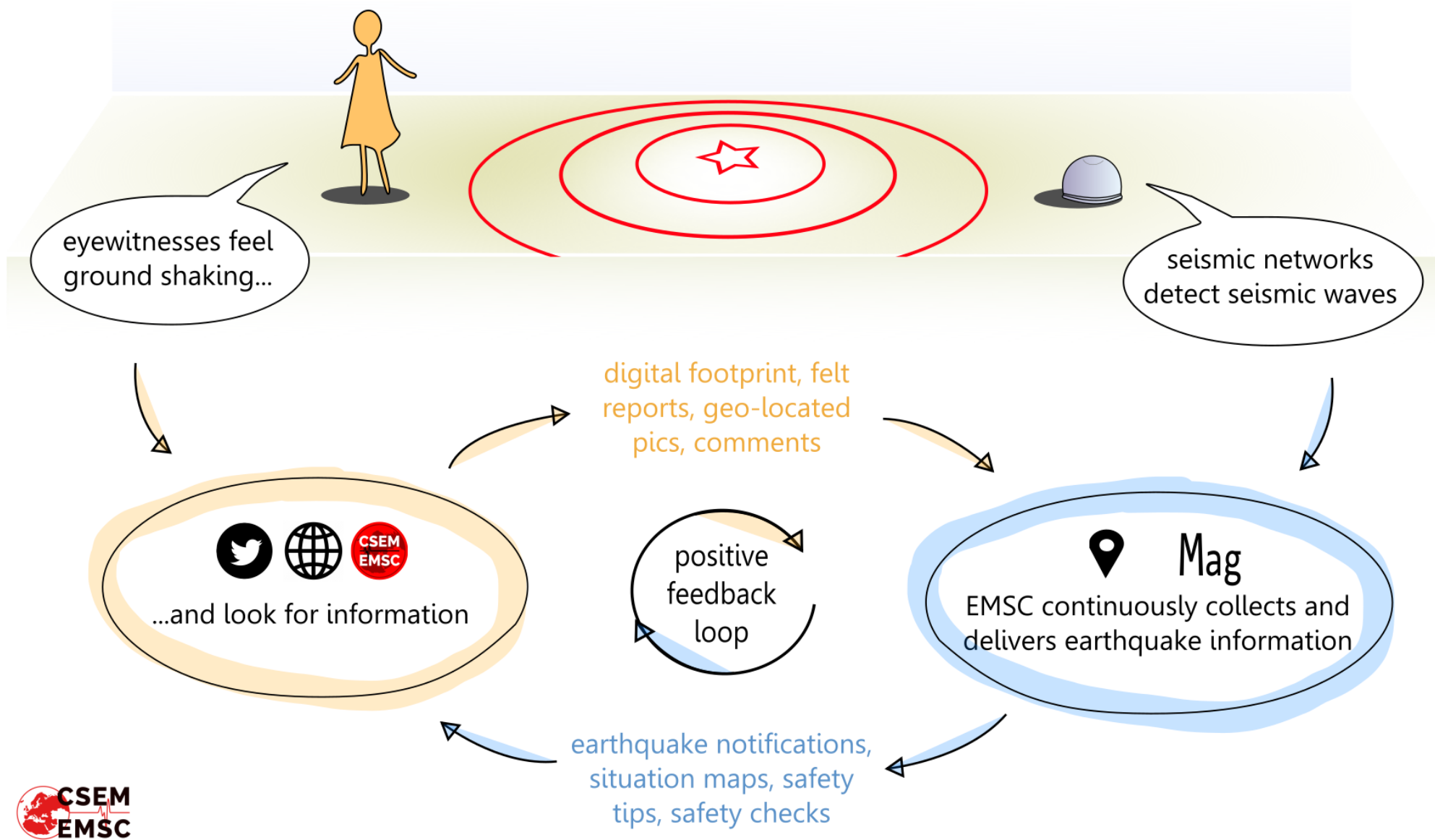
LastQuake App: FELT EQ only!



- Questionnaires replaced by cartoons
- Best way to collect geolocated pics & videos
- Comments shared on Facebook, Twitter
- 1M+ users worldwide, 40 languages



The LastQuake System: Info on Demand!



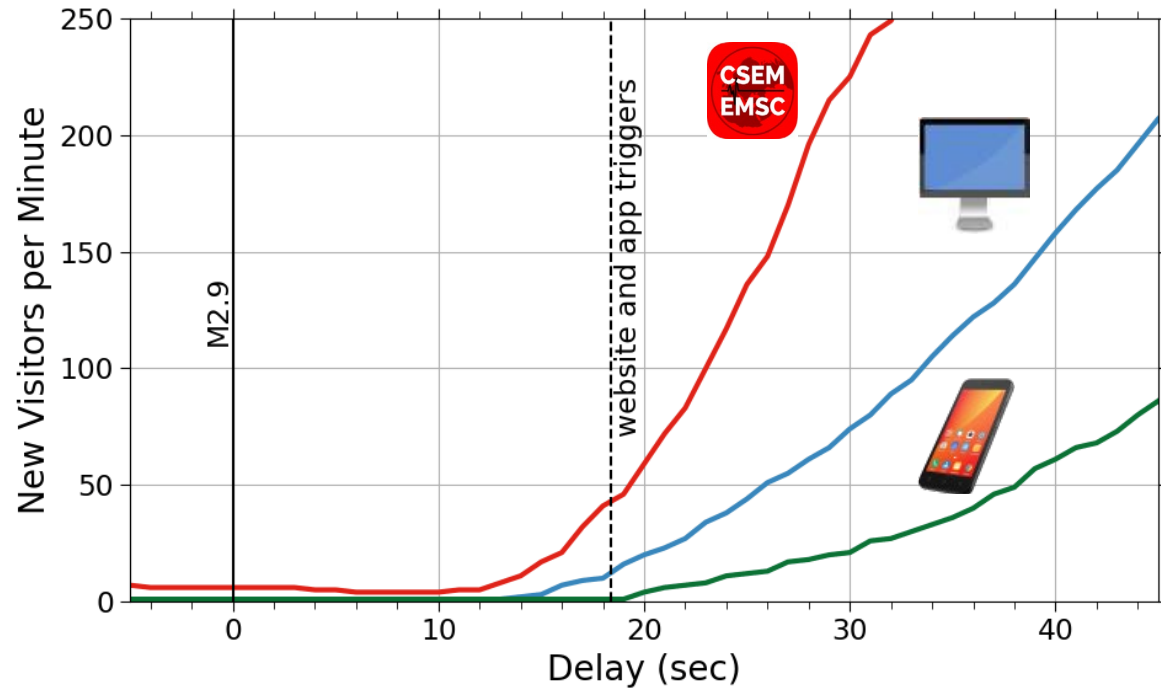
The Reach of LastQuake Components

Dec. 29th 2020, M6.4 Petrinja Croatia earthquake

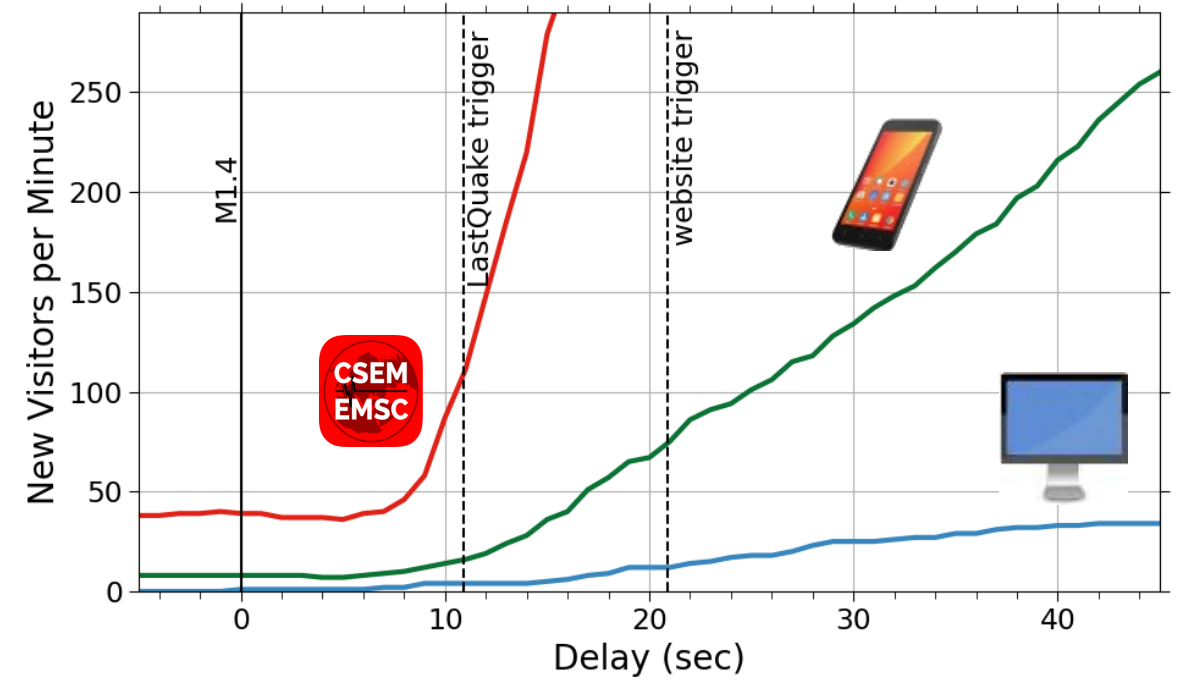
	Views	Unique Visitors
App	10M	320k
Twitter	9M	>200k
Website (mobile)	4M	260k
Website (desktop)	1,2M	110k



Societal Importance of Small FELT earthquakes!



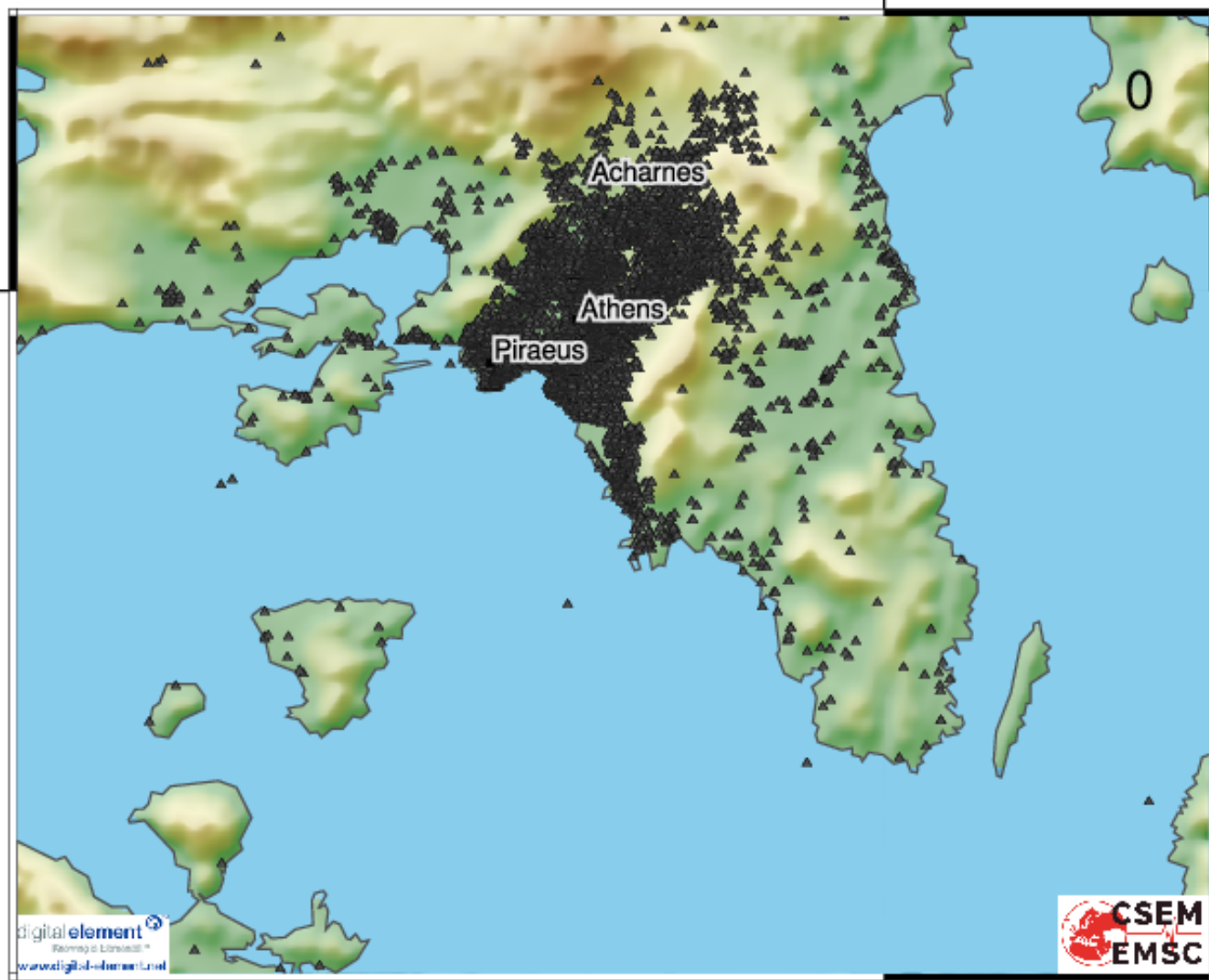
M2.9 Athens Oct. 25th 2021



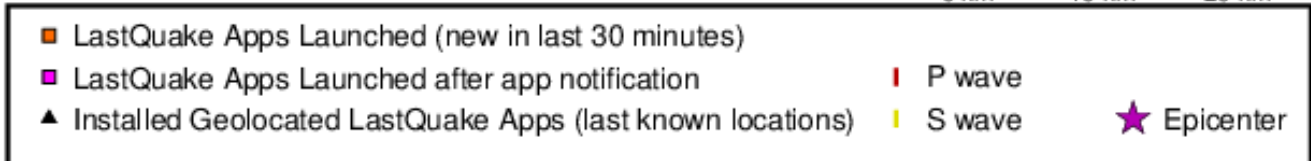
M1.4 Zagreb April 3rd 2020



M2.9 Athens, Greece, Oct. 25th, 2021, 12:52 UTC



Visitors within 0:00 minutes of earthquake occurrence



Updated on 2021/11/18 10:15:22 UTC



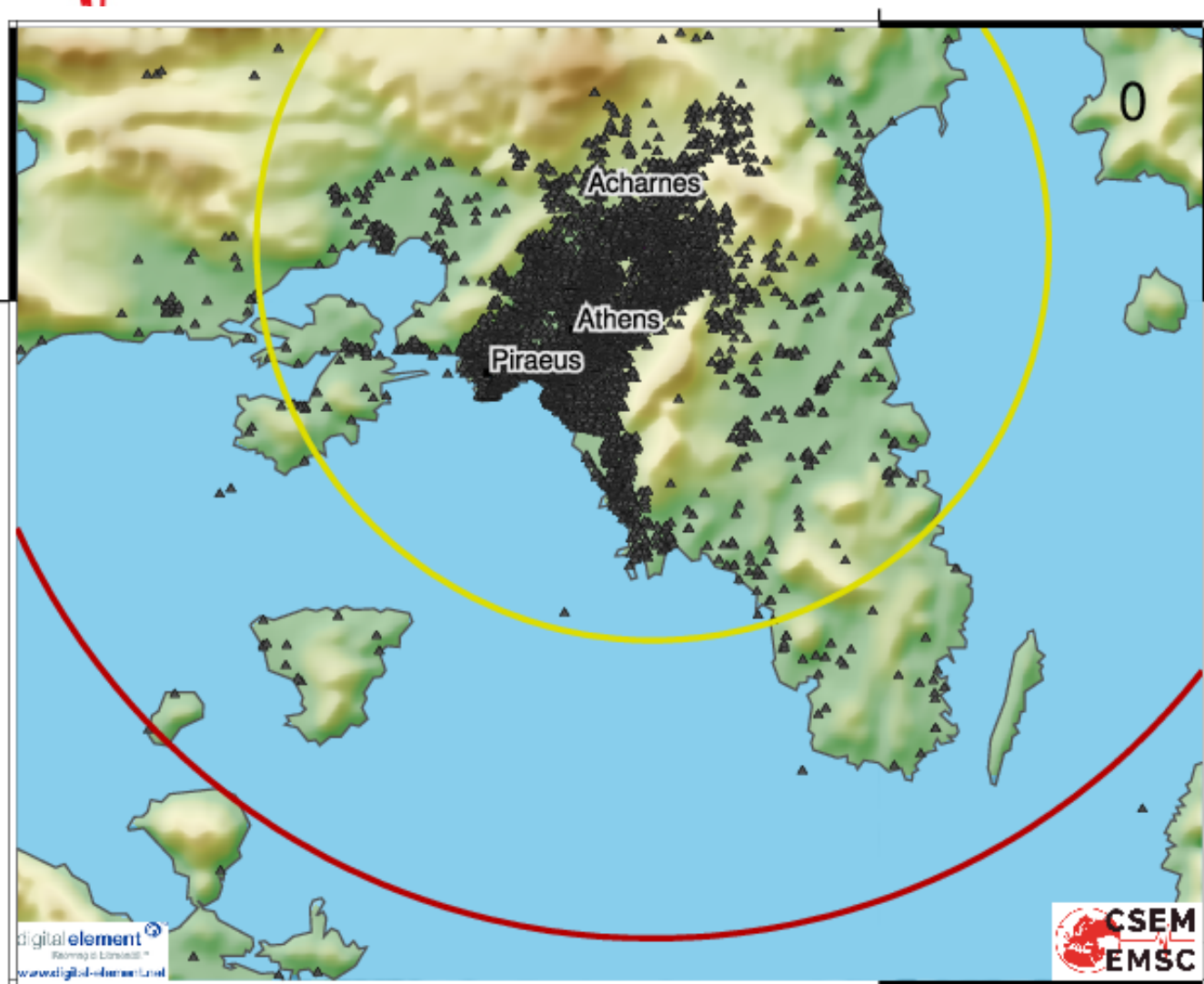
Visitors within 0:00 minutes of earthquake occurrence



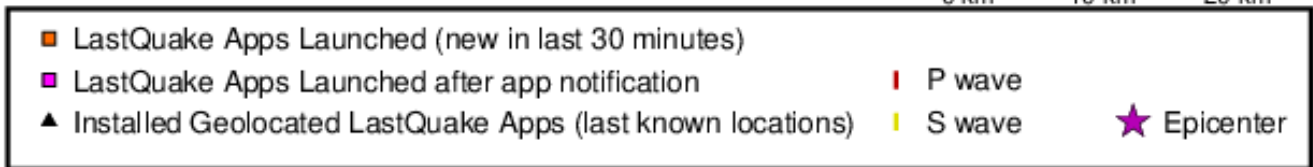
Updated on 2021/11/18 10:26:59 UTC

M2.9 Athens, Greece

T0 + 010s



Visitors within 0:10 minutes of earthquake occurrence



Updated on 2021/11/18 10:15:22 UTC



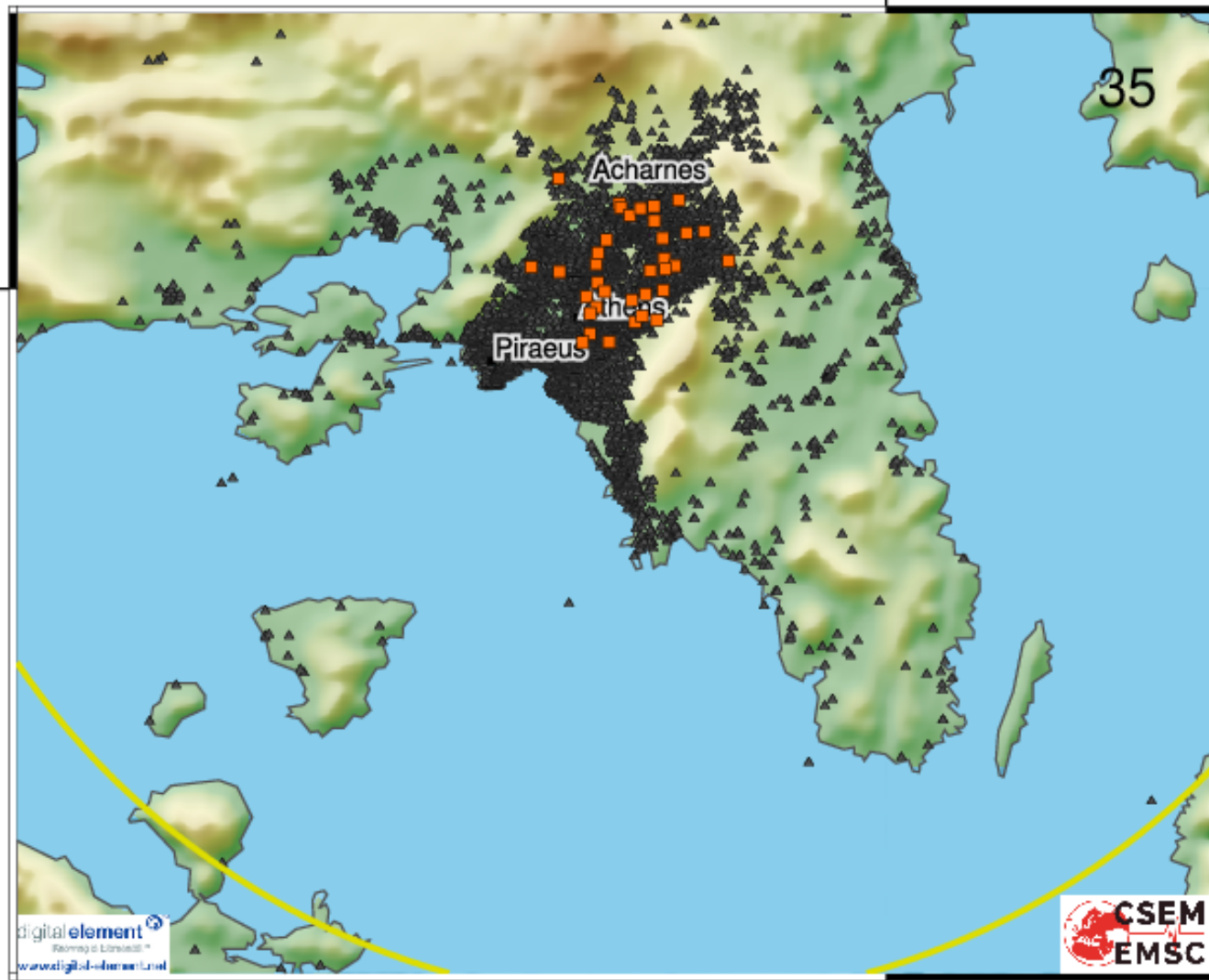
Visitors within 0:10 minutes of earthquake occurrence



Updated on 2021/11/18 10:26:59 UTC

M2.9 Athens, Greece

T0 + 018s



Visitors within 0:18 minutes of earthquake occurrence

- LastQuake Apps Launched (new in last 30 minutes)
- LastQuake Apps Launched after app notification
- ▲ Installed Geolocated LastQuake Apps (last known locations)
- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:15:22 UTC



Visitors within 0:18 minutes of earthquake occurrence

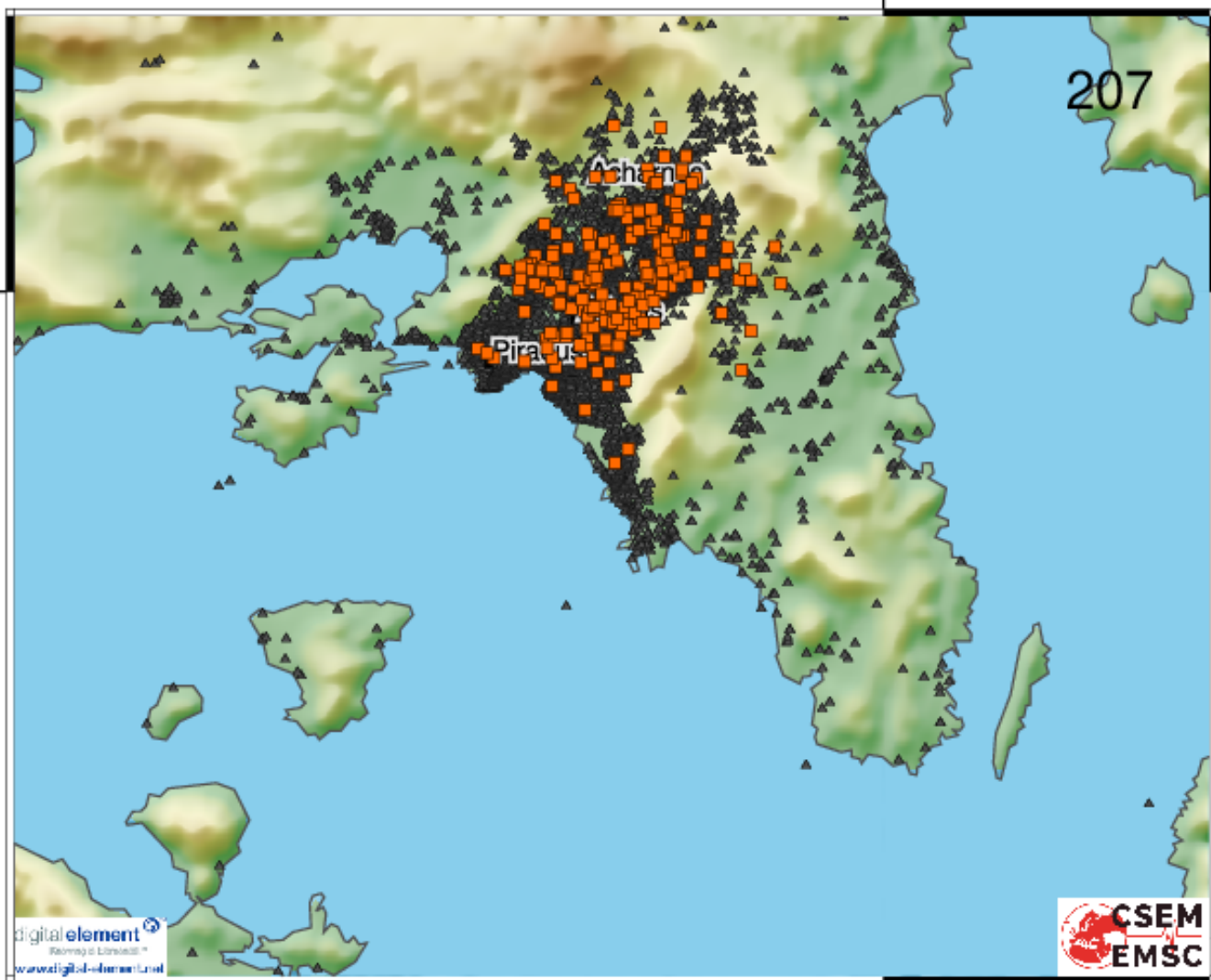
Reported as:

- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:26:59 UTC

M2.9 Athens, Greece

T0 + 030s



Visitors within 0:30 minutes of earthquake occurrence

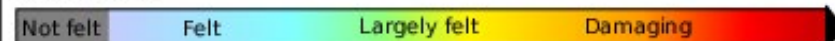
- LastQuake Apps Launched (new in last 30 minutes)
- LastQuake Apps Launched after app notification
- ▲ Installed Geolocated LastQuake Apps (last known locations)
- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:15:22 UTC



Visitors within 0:30 minutes of earthquake occurrence

Reported as:

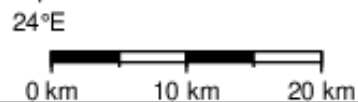
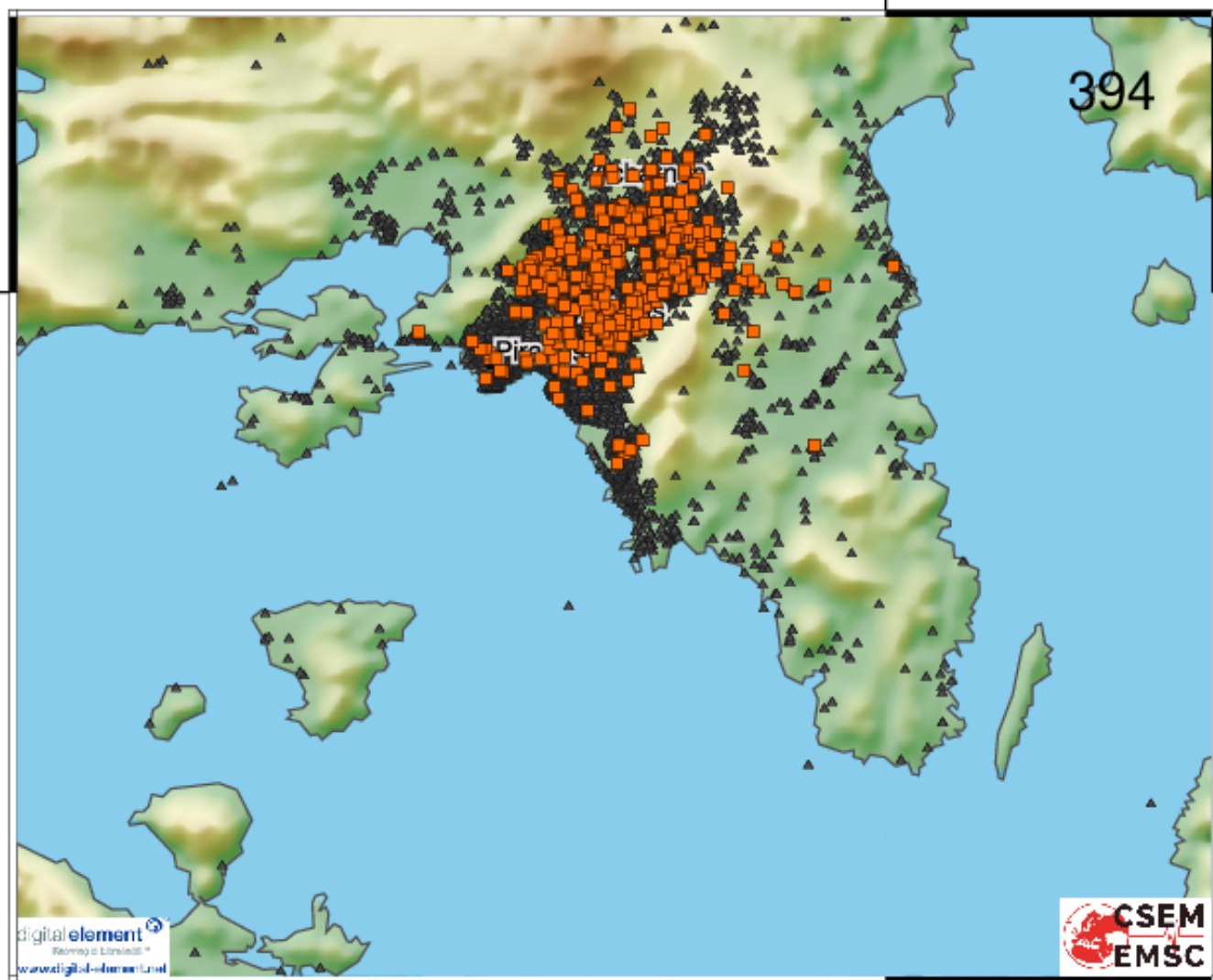


- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:26:59 UTC

M2.9 Athens, Greece

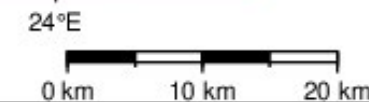
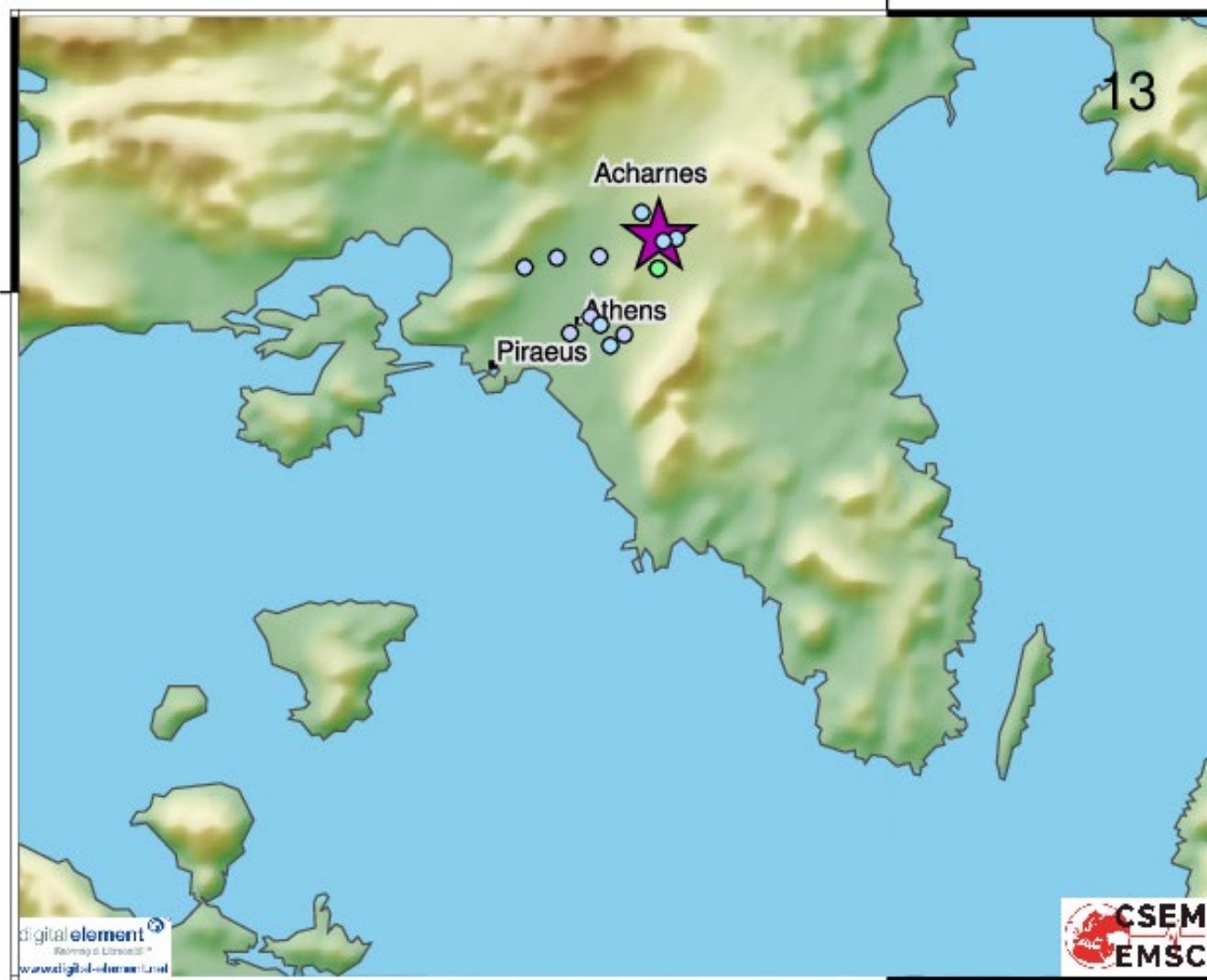
T0 + 040s



Visitors within 0:40 minutes of earthquake occurrence

- LastQuake Apps Launched (new in last 30 minutes)
- LastQuake Apps Launched after app notification
- ▲ Installed Geolocated LastQuake Apps (last known locations)
- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:15:22 UTC



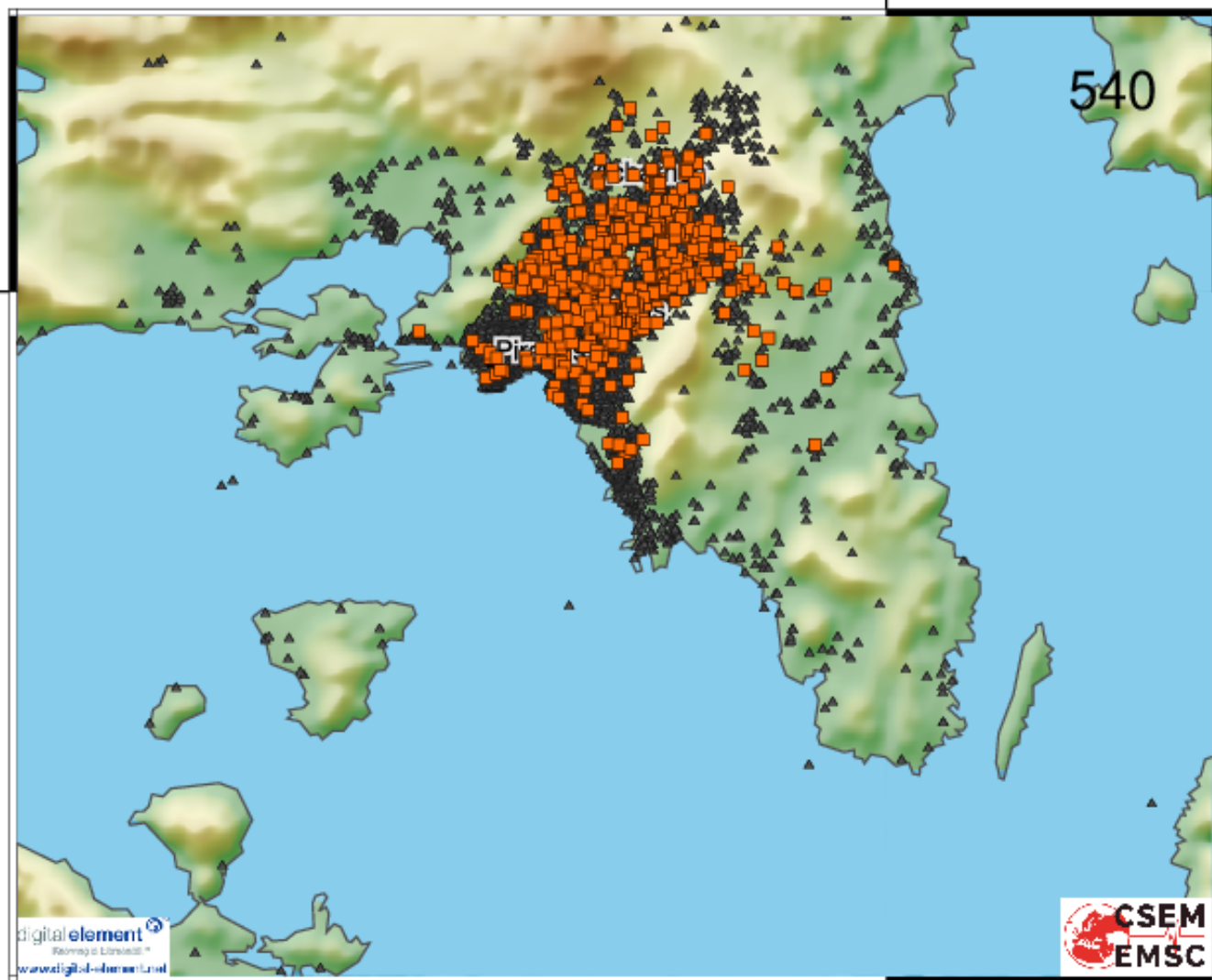
Visitors within 0:40 minutes of earthquake occurrence

- Reported as:
-
- P wave
 - S wave
 - ★ Epicenter

Updated on 2021/11/18 10:26:59 UTC

M2.9 Athens, Greece

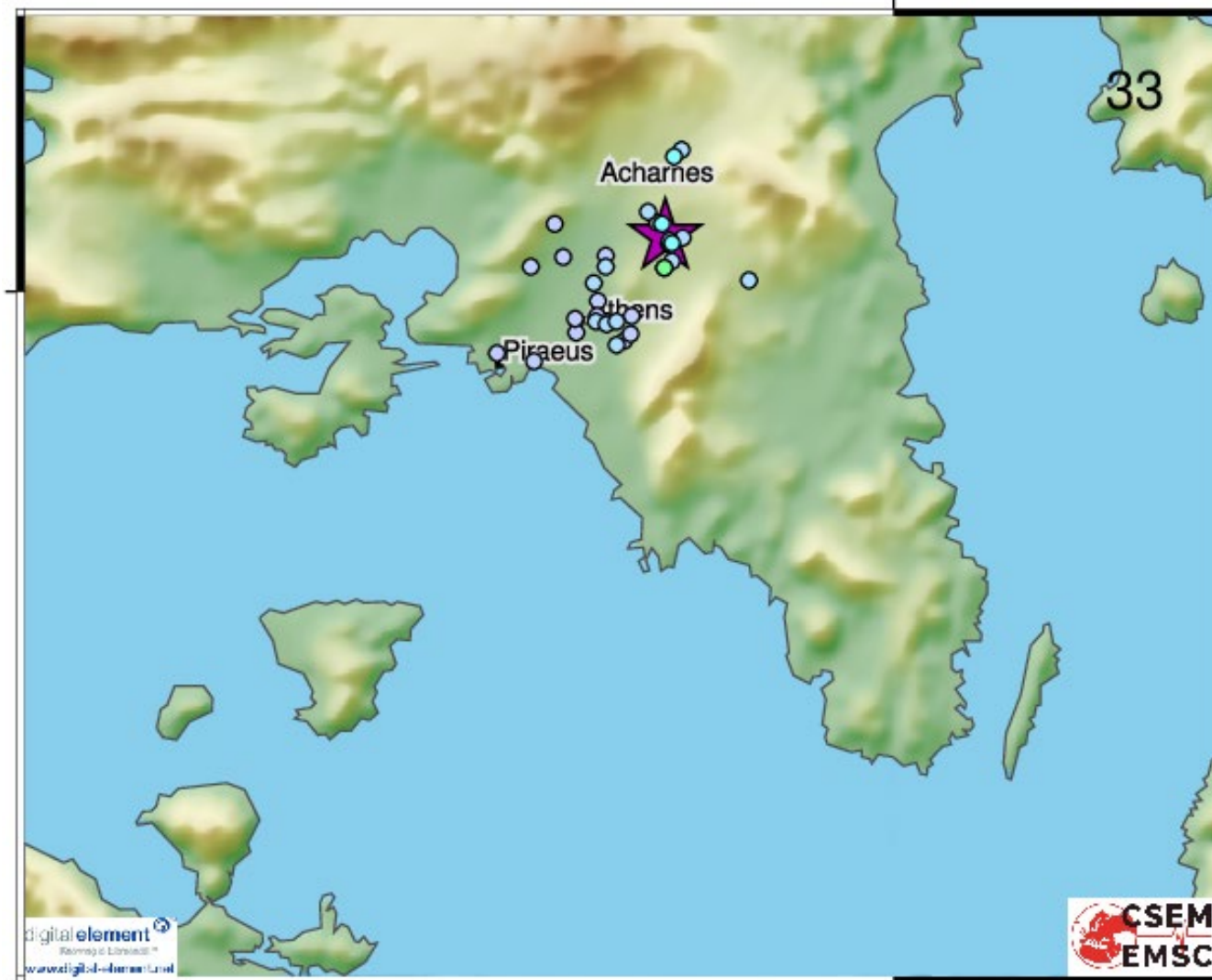
T0 + 050s



Visitors within 0:50 minutes of earthquake occurrence

- LastQuake Apps Launched (new in last 30 minutes)
- LastQuake Apps Launched after app notification
- ▲ Installed Geolocated LastQuake Apps (last known locations)
- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:15:22 UTC



Visitors within 0:50 minutes of earthquake occurrence

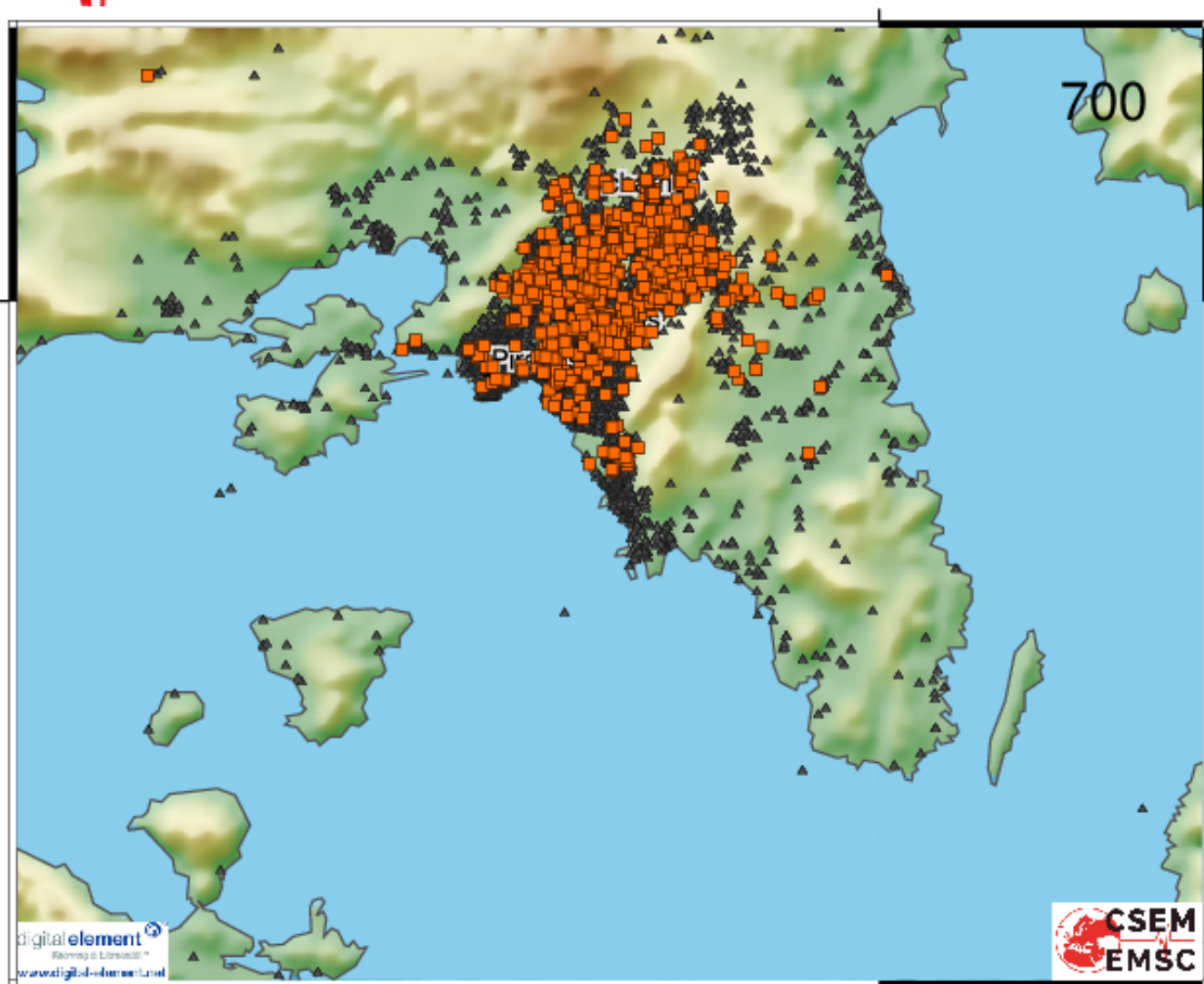
Reported as:

- Not felt
- Felt
- Largely felt
- Damaging
- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:26:59 UTC

M2.9 Athens, Greece

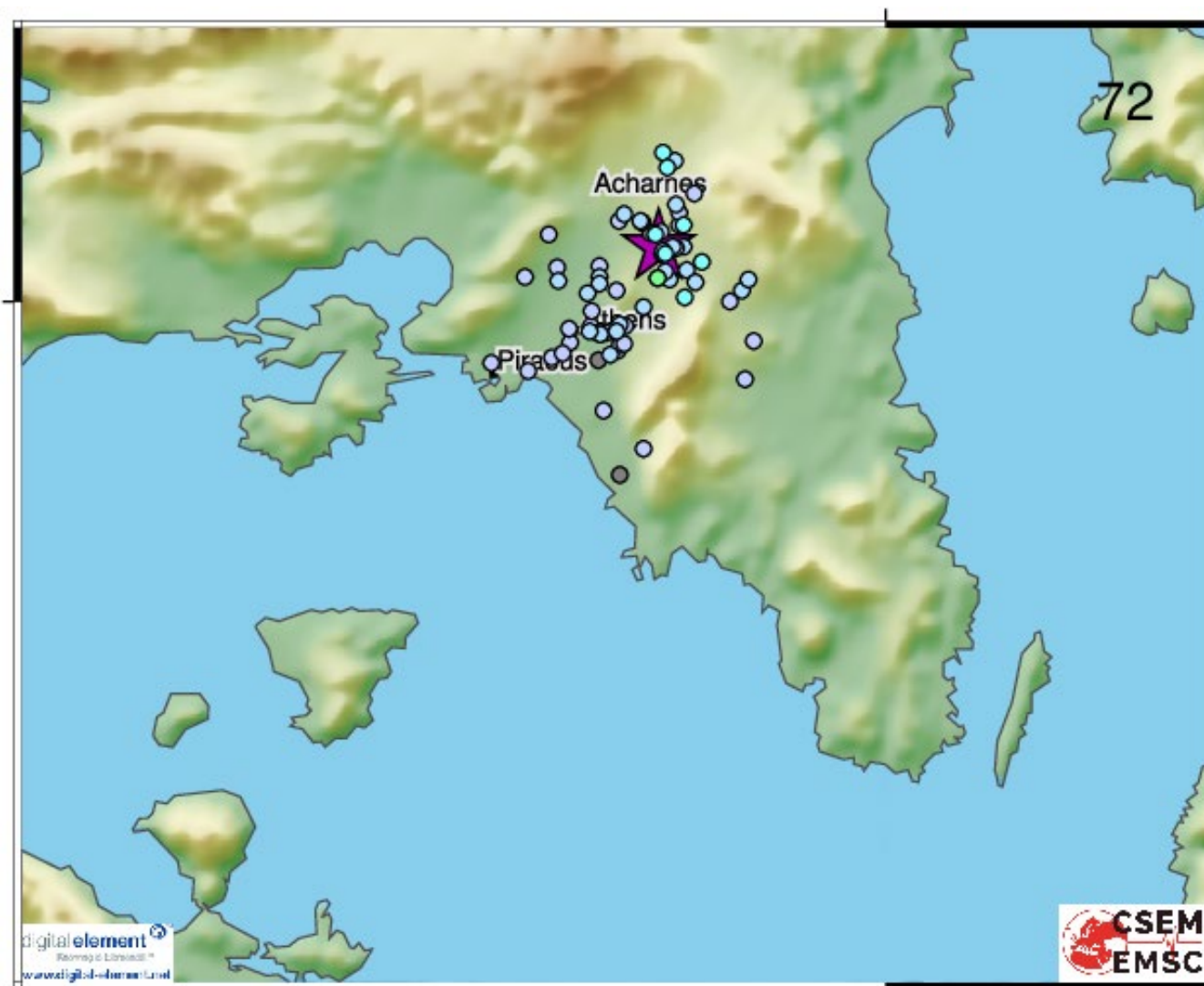
T0 + 060s



Visitors within 1:00 minutes of earthquake occurrence

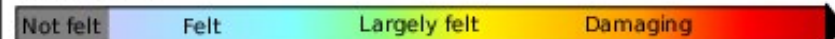
- Orange square: LastQuake Apps Launched (new in last 30 minutes)
- Purple square: LastQuake Apps Launched after app notification
- Black triangle: Installed Geolocated LastQuake Apps (last known locations)
- Red vertical bar: P wave
- Yellow vertical bar: S wave
- Purple star: Epicenter

Updated on 2021/11/18 10:15:22 UTC



Visitors within 1:00 minutes of earthquake occurrence

Reported as:

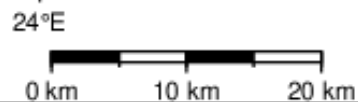
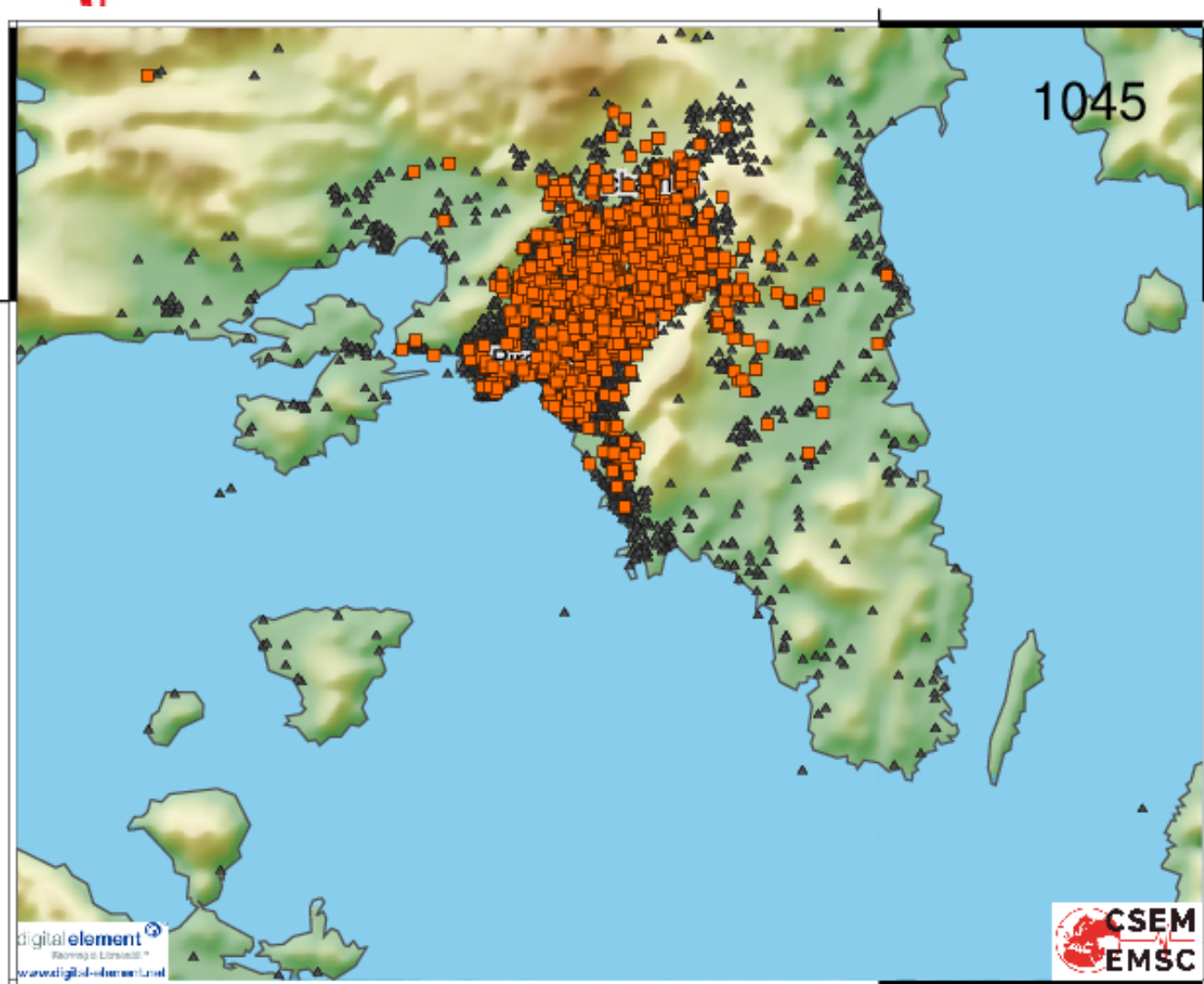


- Red vertical bar: P wave
- Yellow vertical bar: S wave
- Purple star: Epicenter

Updated on 2021/11/18 10:26:59 UTC

M2.9 Athens, Greece

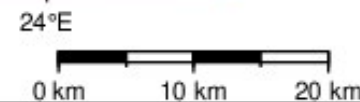
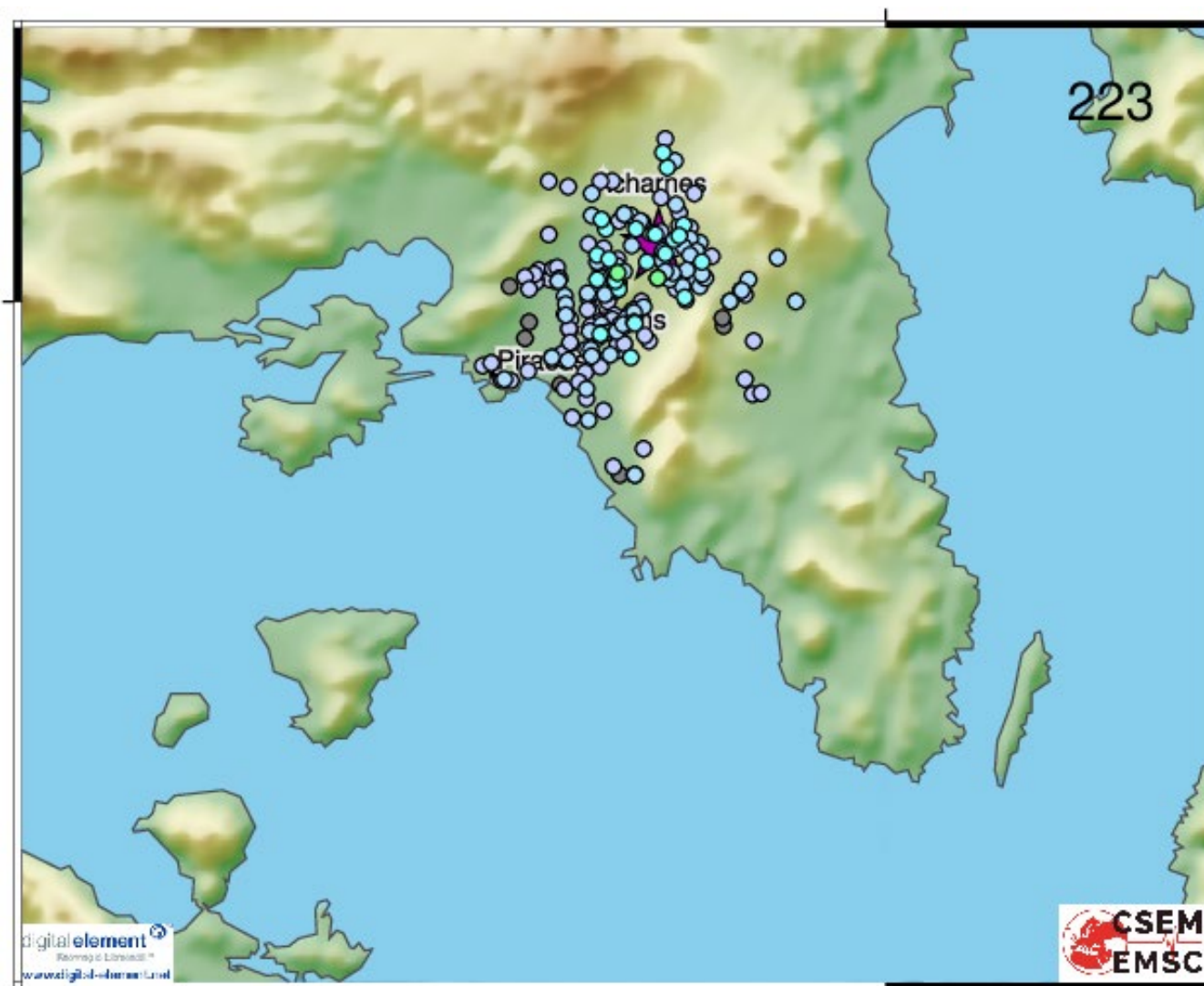
T0 + 090s



Visitors within 1:30 minutes of earthquake occurrence

- LastQuake Apps Launched (new in last 30 minutes)
- LastQuake Apps Launched after app notification
- ▲ Installed Geolocated LastQuake Apps (last known locations)
- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:15:22 UTC



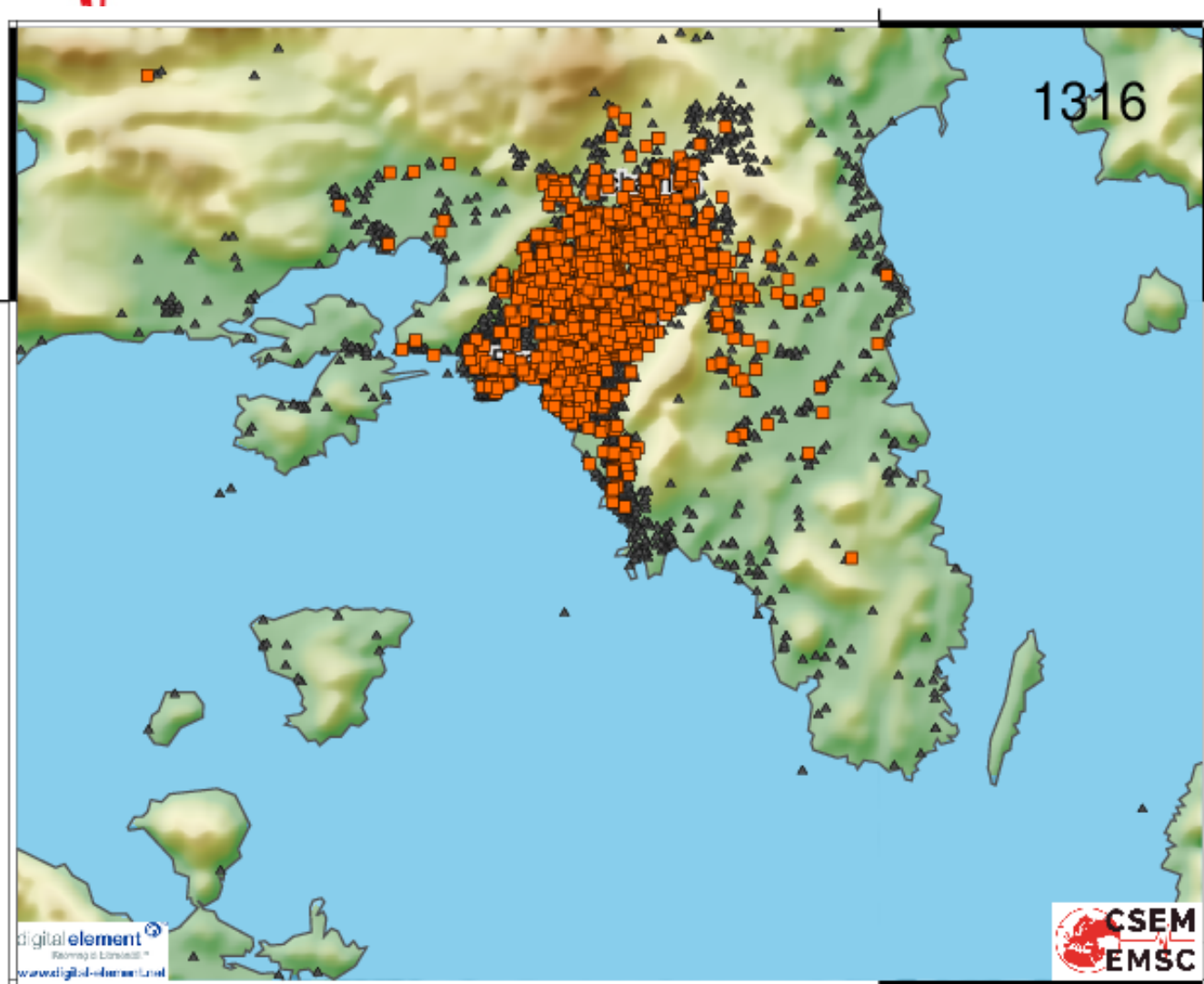
Visitors within 1:30 minutes of earthquake occurrence

- Reported as:
-
- P wave
 - S wave
 - ★ Epicenter

Updated on 2021/11/18 10:26:59 UTC

M2.9 Athens, Greece

T0 + 120s

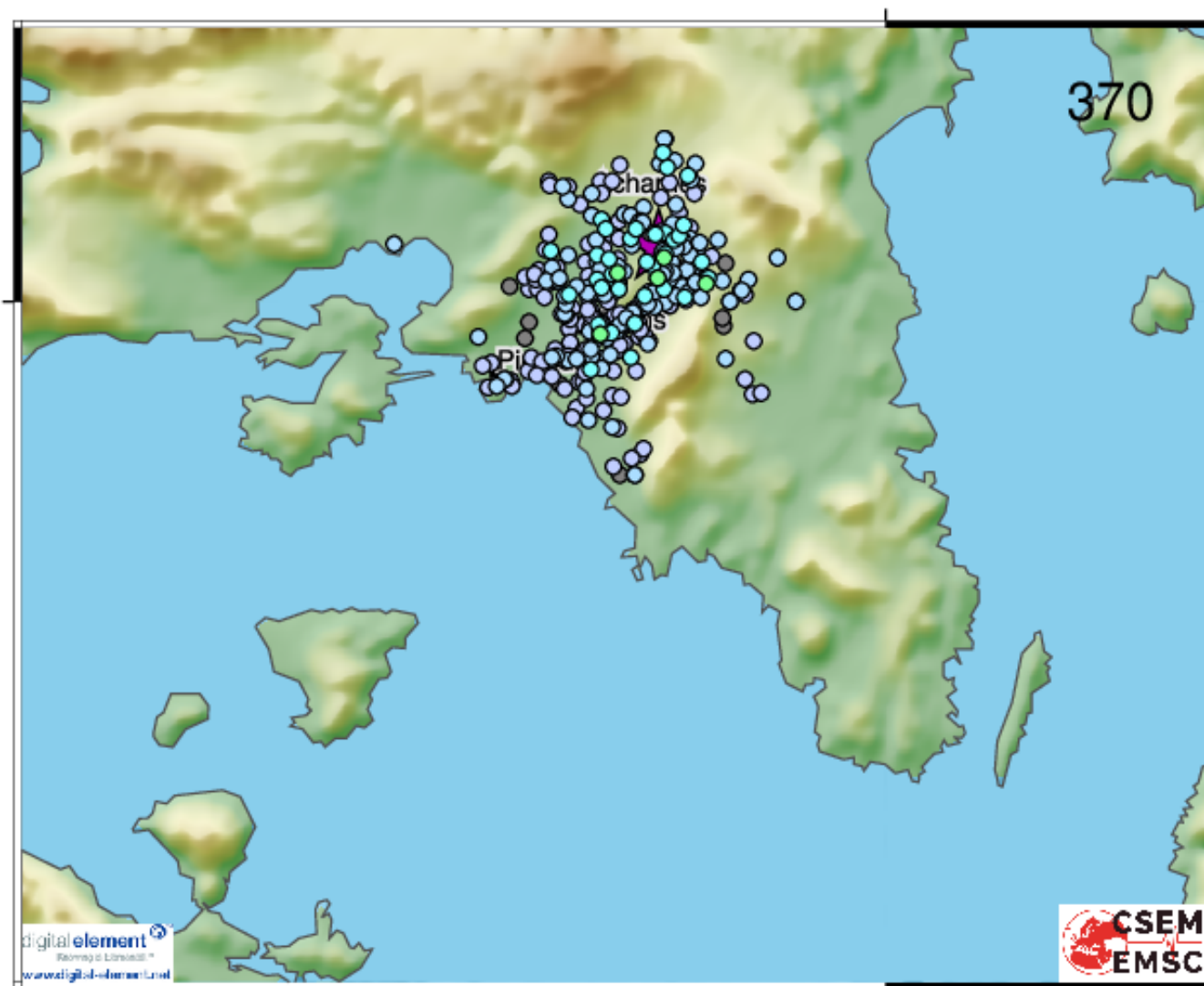


24°E
0 km 10 km 20 km

Visitors within 2:00 minutes of earthquake occurrence

- LastQuake Apps Launched (new in last 30 minutes)
- LastQuake Apps Launched after app notification
- ▲ Installed Geolocated LastQuake Apps (last known locations)
- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:15:22 UTC



24°E
0 km 10 km 20 km

Visitors within 2:00 minutes of earthquake occurrence

Reported as:

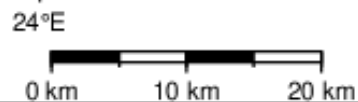
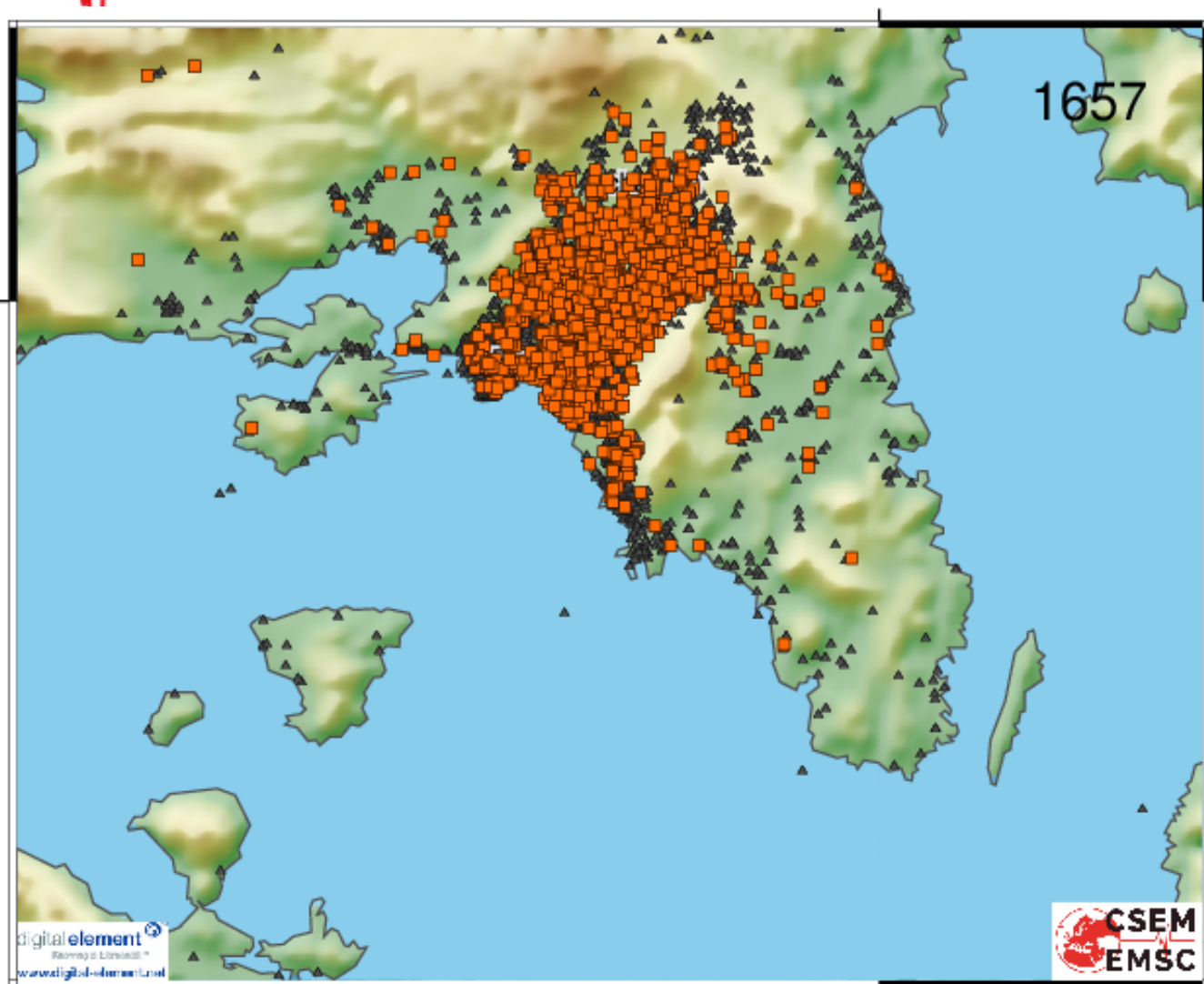
Not felt Felt Largely felt Damaging

- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:26:59 UTC

M2.9 Athens, Greece

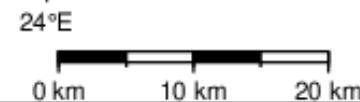
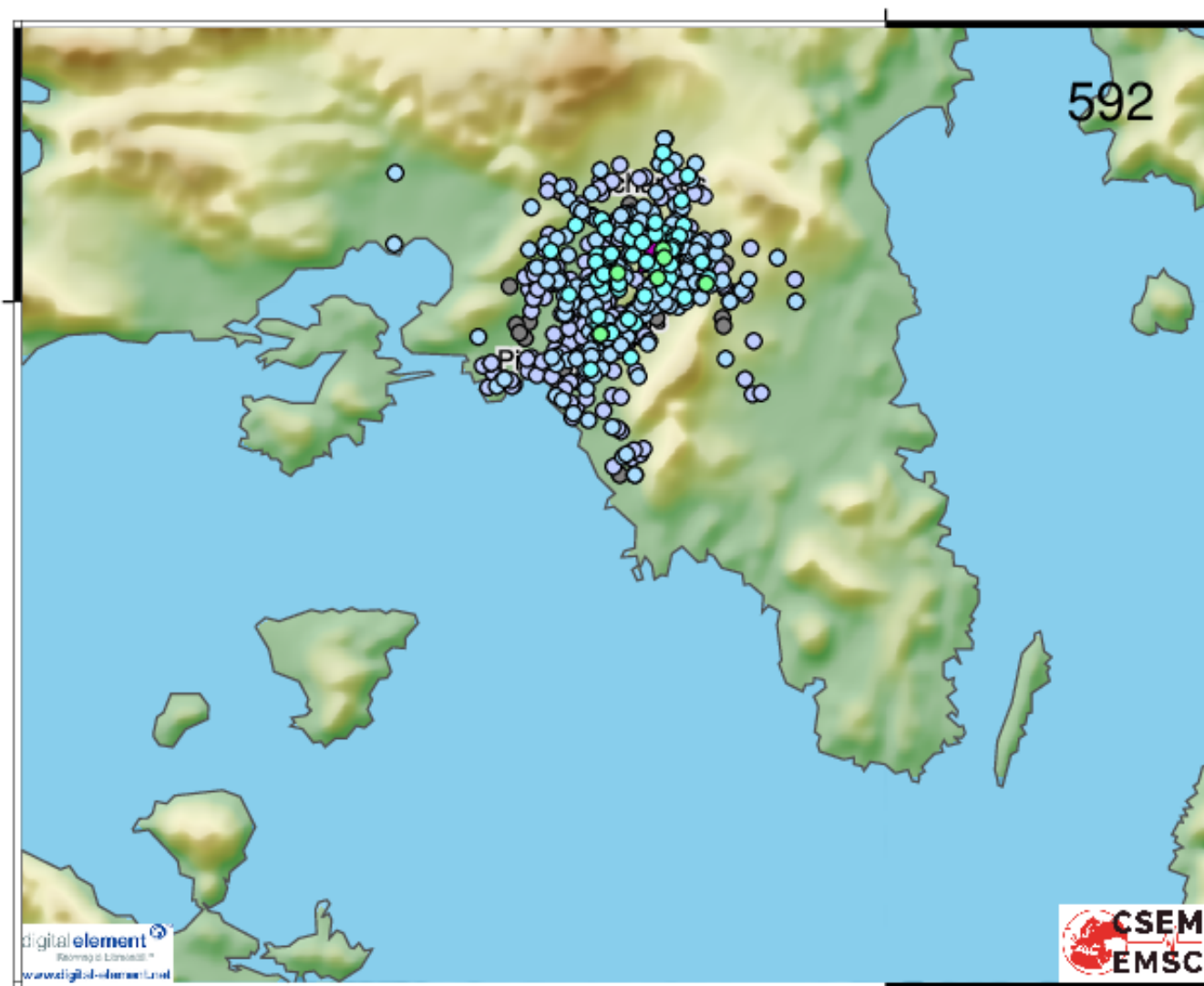
T0 + 180s



Visitors within 3:00 minutes of earthquake occurrence

- LastQuake Apps Launched (new in last 30 minutes)
- LastQuake Apps Launched after app notification
- ▲ Installed Geolocated LastQuake Apps (last known locations)
- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:15:22 UTC



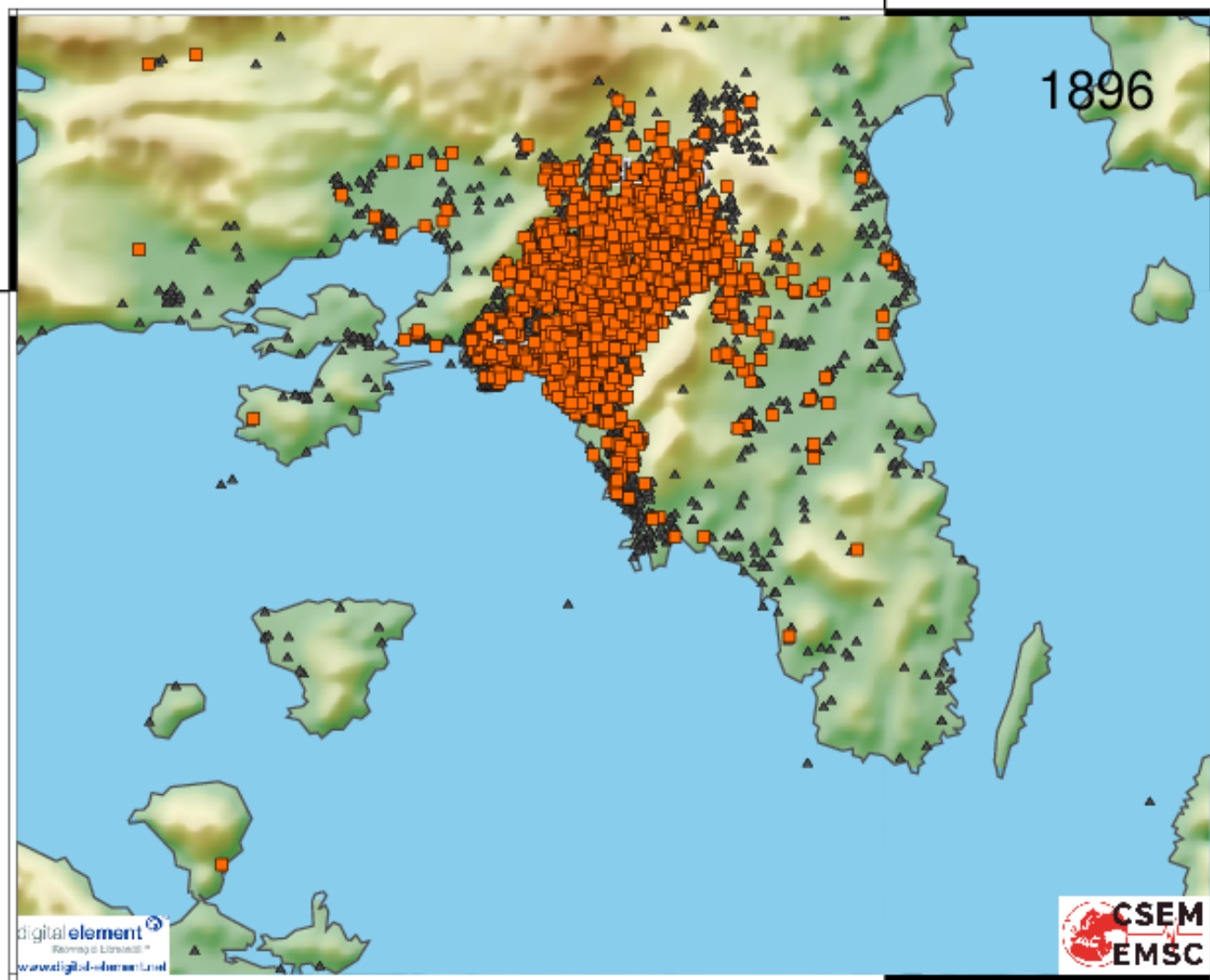
Visitors within 3:00 minutes of earthquake occurrence

- Reported as:
-
- P wave
 - S wave
 - ★ Epicenter

Updated on 2021/11/18 10:26:59 UTC

M2.9 Athens, Greece

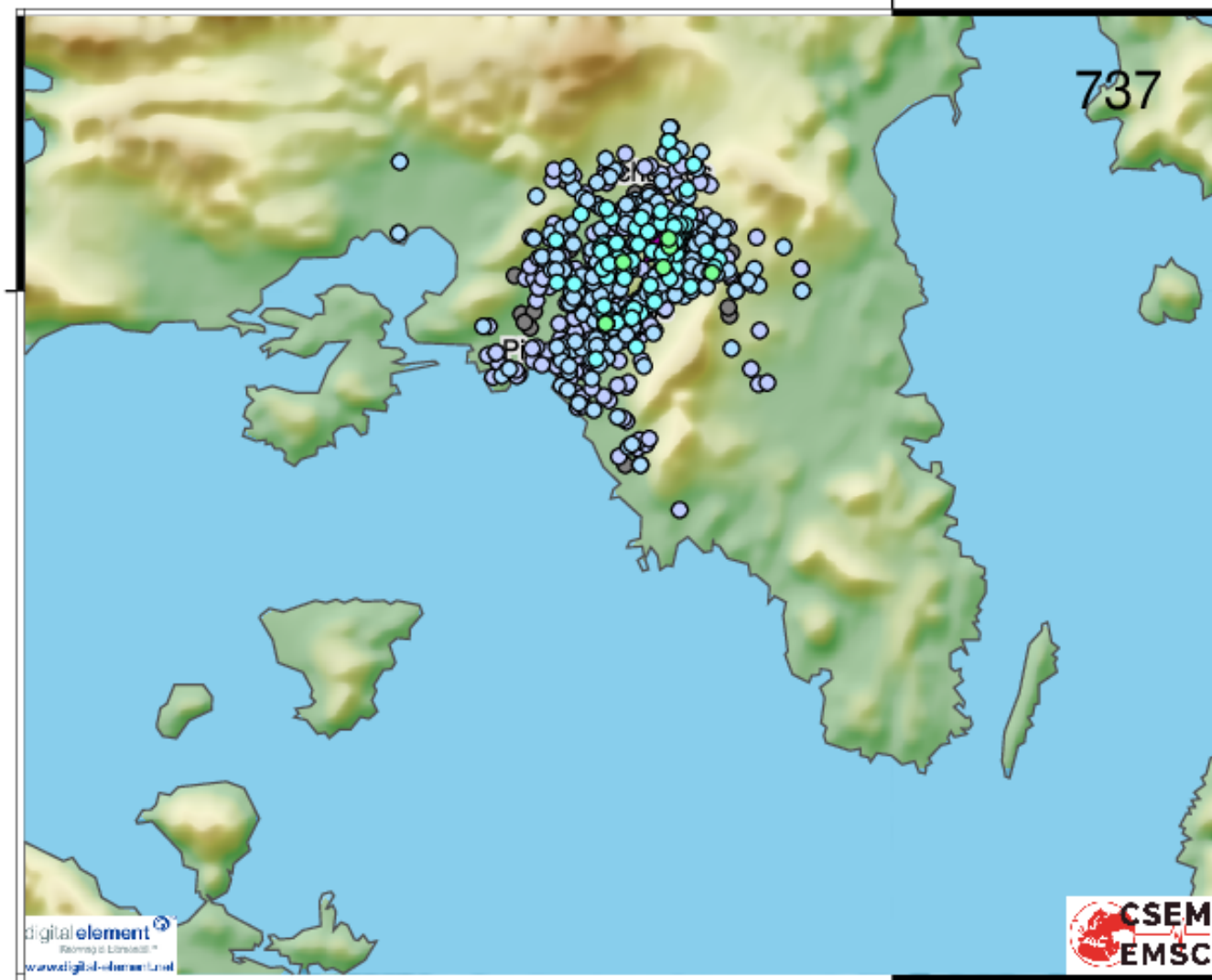
T0 + 240s



Visitors within 4:00 minutes of earthquake occurrence

- LastQuake Apps Launched (new in last 30 minutes)
- LastQuake Apps Launched after app notification
- ▲ Installed Geolocated LastQuake Apps (last known locations)
- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:15:22 UTC



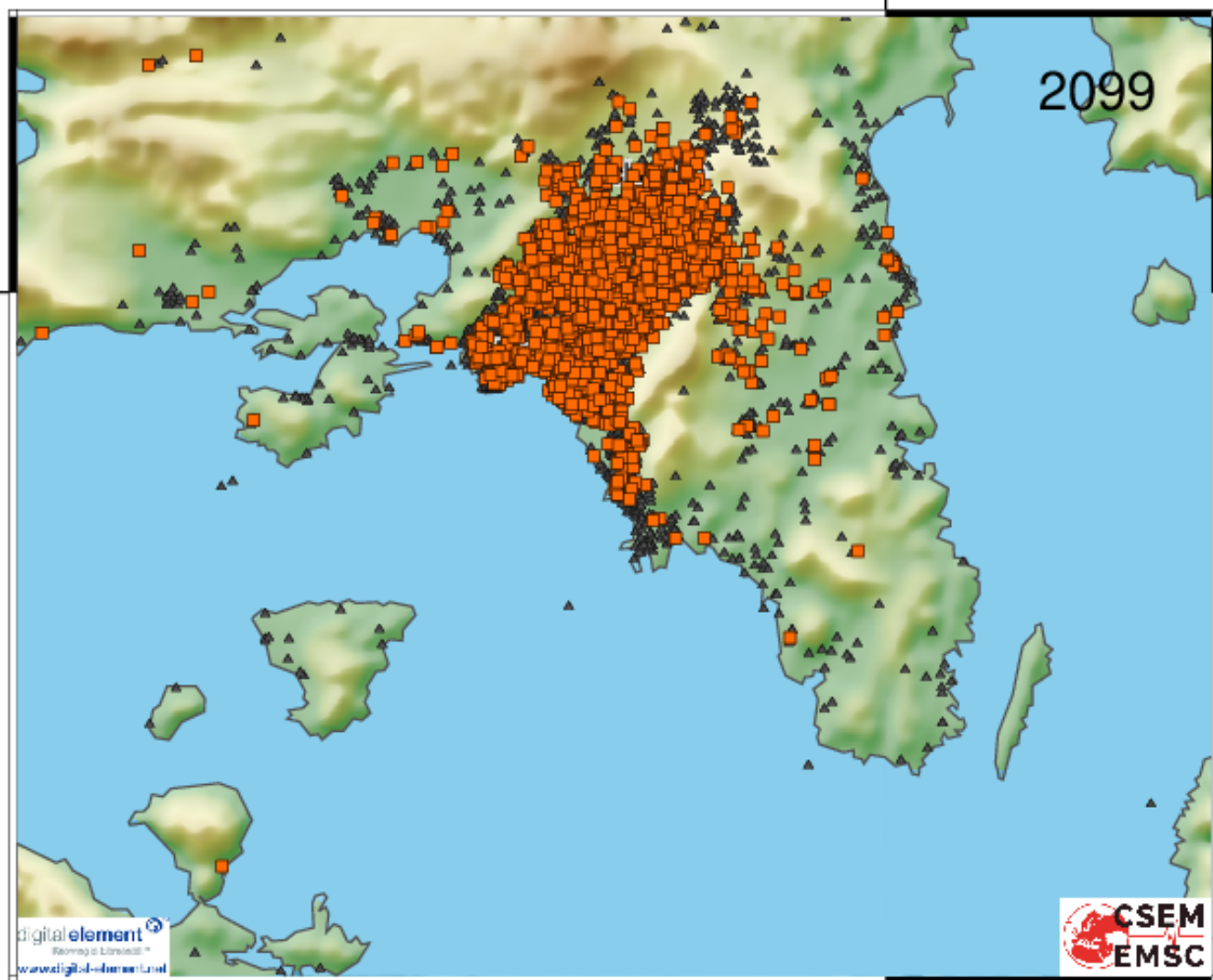
Visitors within 4:00 minutes of earthquake occurrence

- Reported as:
- Not felt
 - Felt
 - Largely felt
 - Damaging
 - P wave
 - S wave
 - ★ Epicenter

Updated on 2021/11/18 10:26:59 UTC

M2.9 Athens, Greece

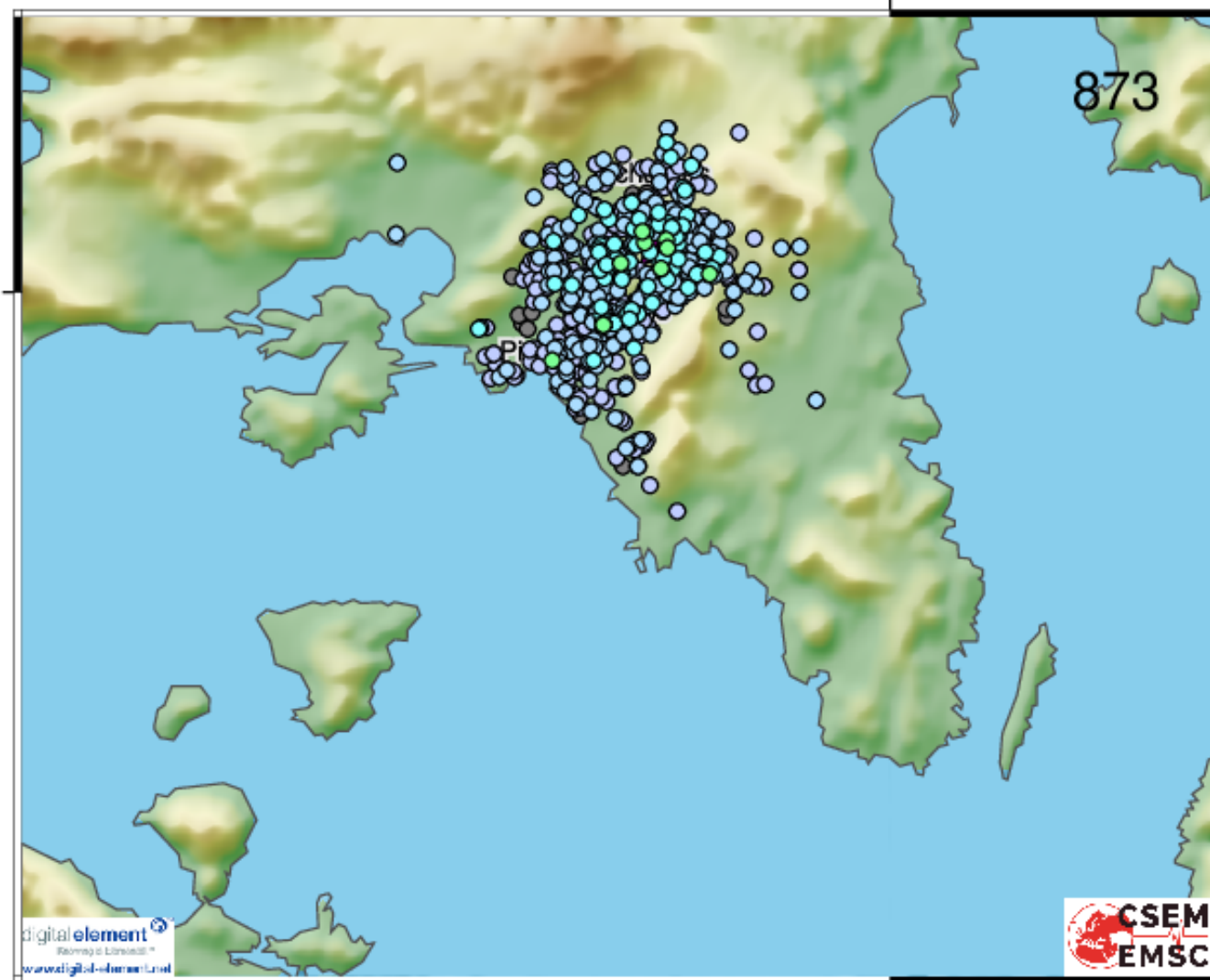
T0 + 300s



Visitors within 5:00 minutes of earthquake occurrence

- LastQuake Apps Launched (new in last 30 minutes)
- LastQuake Apps Launched after app notification
- ▲ Installed Geolocated LastQuake Apps (last known locations)
- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:15:22 UTC



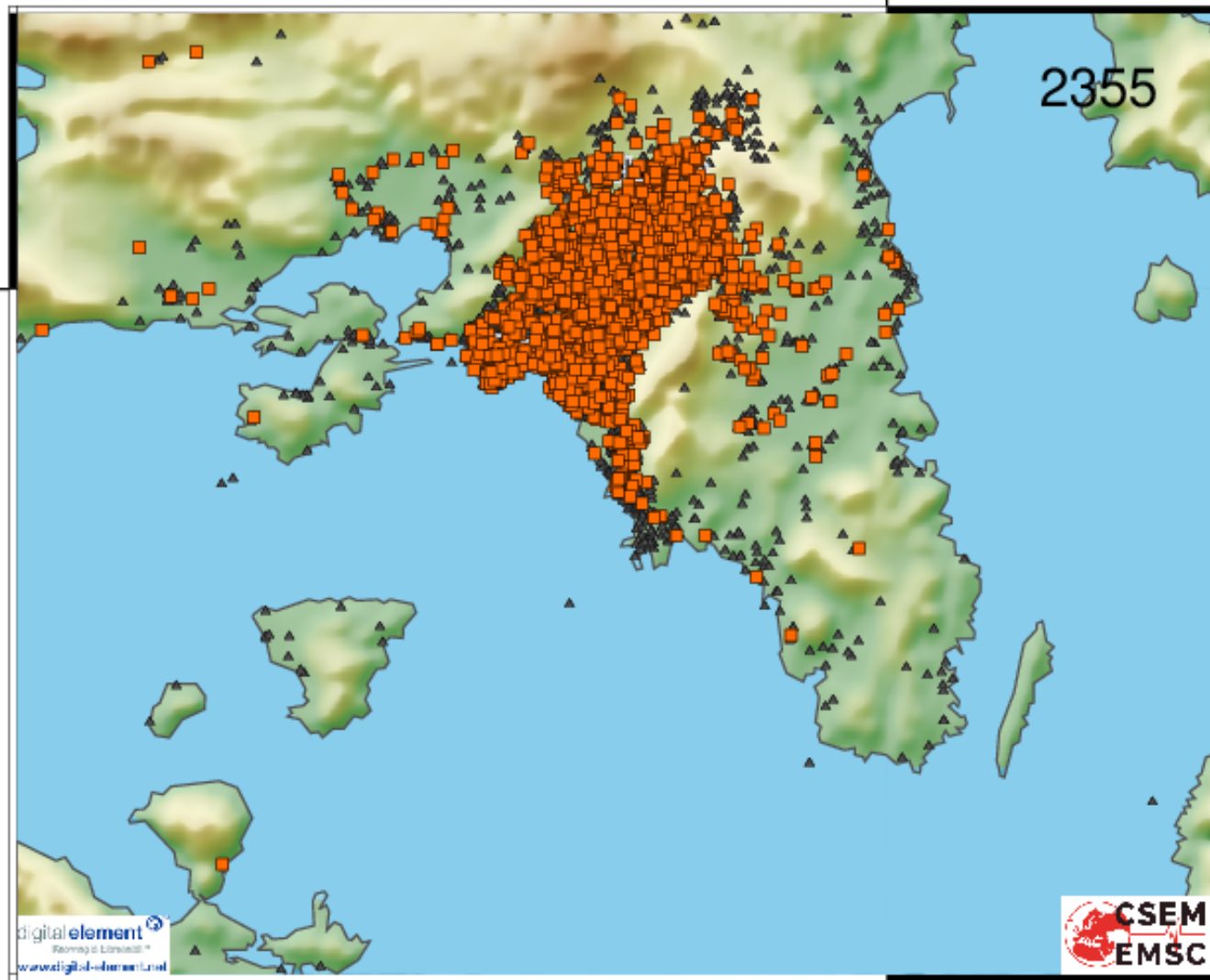
Visitors within 5:00 minutes of earthquake occurrence

- Reported as:
- Not felt
 - Felt
 - Largely felt
 - Damaging
 - P wave
 - S wave
 - ★ Epicenter

Updated on 2021/11/18 10:26:59 UTC

M2.9 Athens, Greece

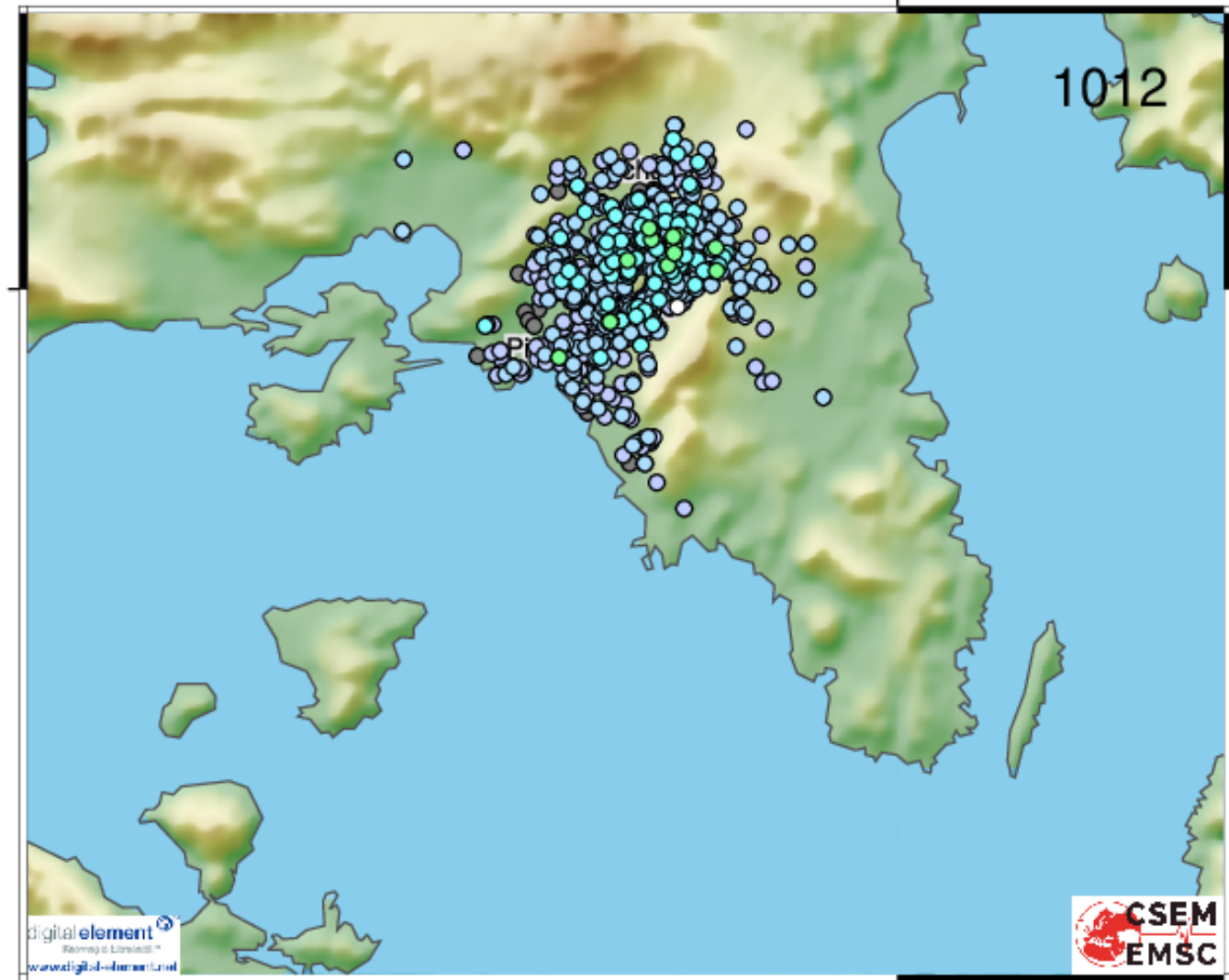
T0 + 400s



Visitors within 6:40 minutes of earthquake occurrence

- LastQuake Apps Launched (new in last 30 minutes)
- LastQuake Apps Launched after app notification
- ▲ Installed Geolocated LastQuake Apps (last known locations)
- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:15:22 UTC



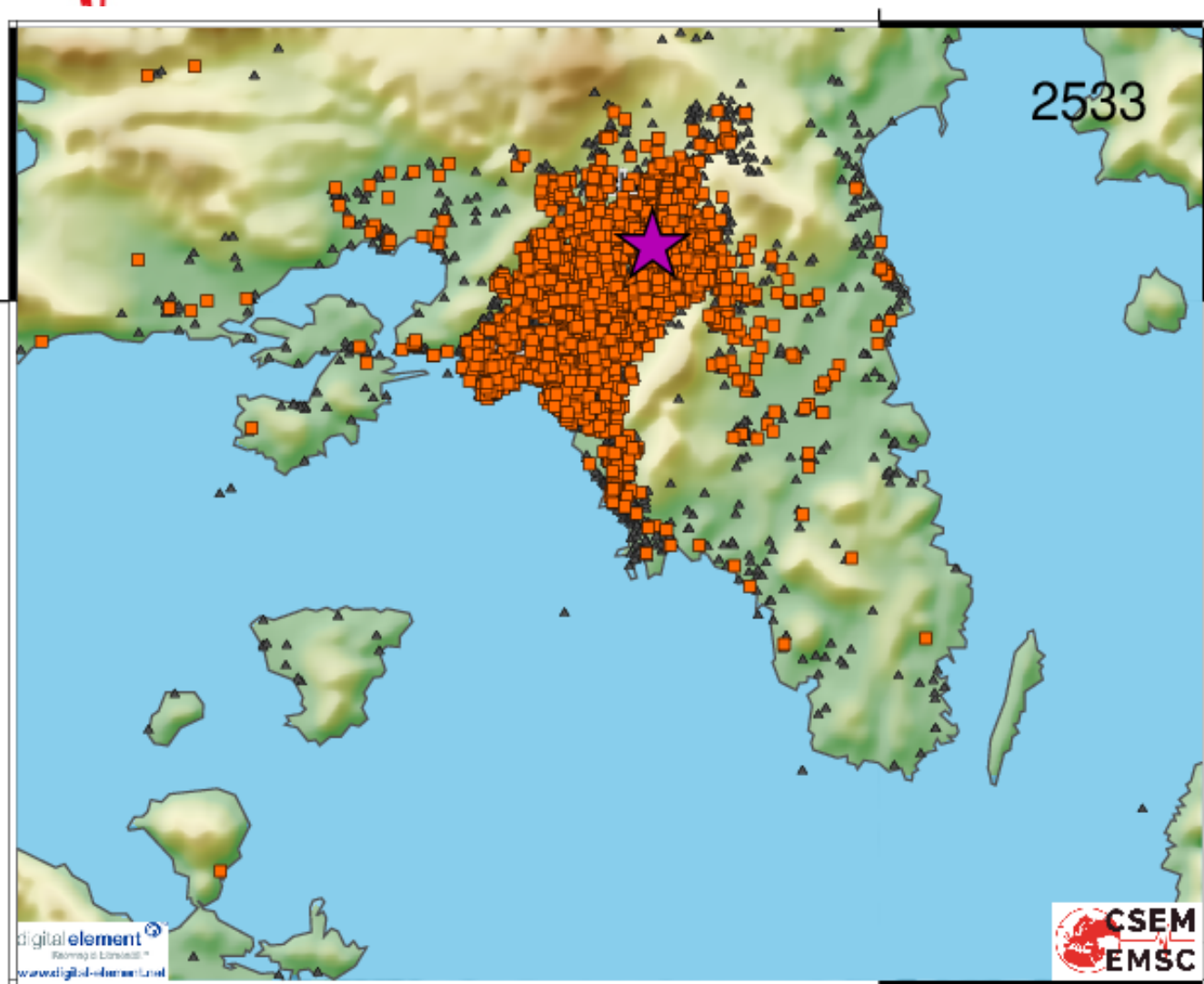
Visitors within 6:40 minutes of earthquake occurrence

- Reported as:
- Not felt
 - Felt
 - Largely felt
 - Damaging
 - P wave
 - S wave
 - ★ Epicenter

Updated on 2021/11/18 10:26:59 UTC

M2.9 Athens, Greece

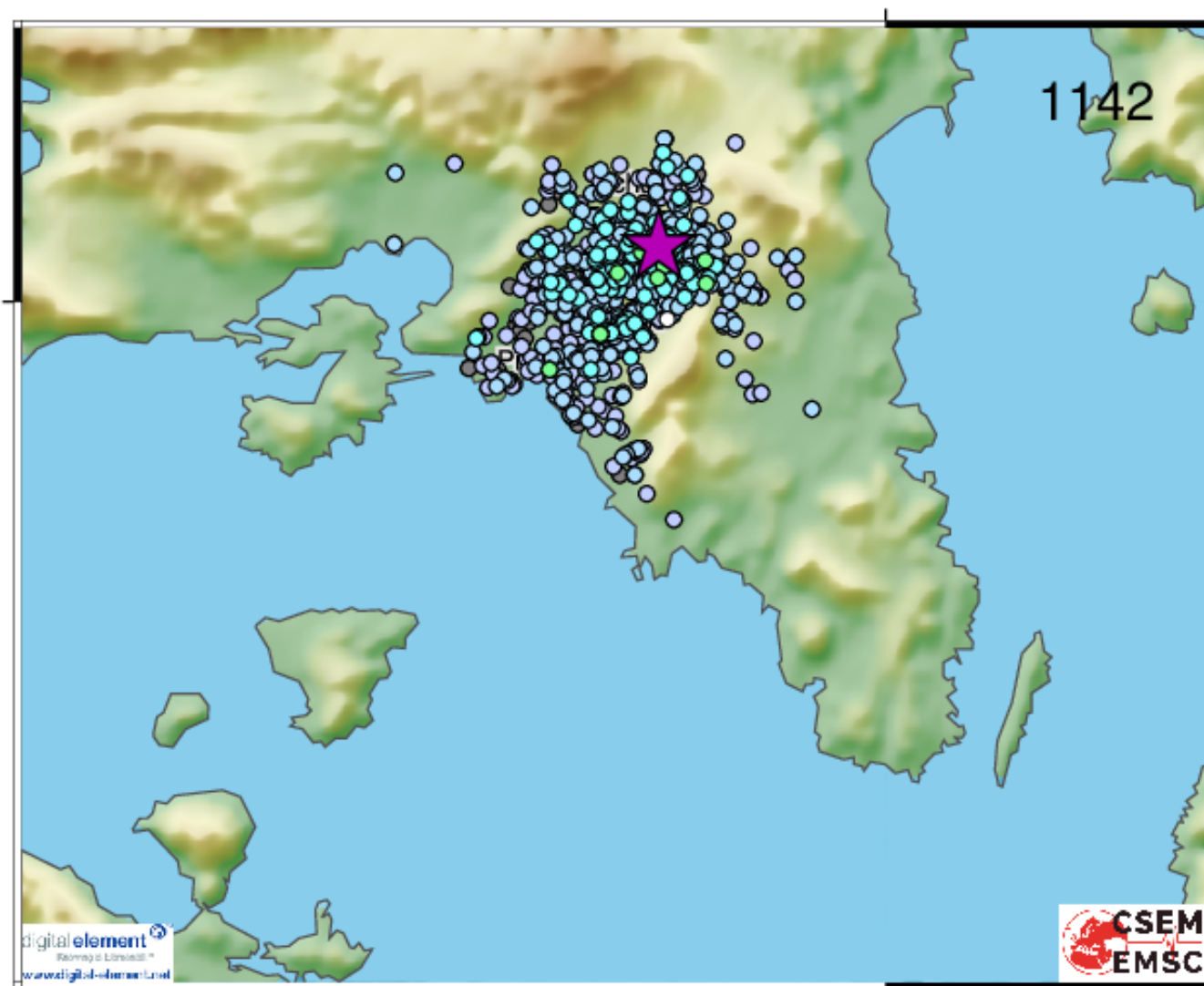
T0 + 533s



Visitors within 8:53 minutes of earthquake occurrence

- LastQuake Apps Launched (new in last 30 minutes)
- LastQuake Apps Launched after app notification
- ▲ Installed Geolocated LastQuake Apps (last known locations)
- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:15:22 UTC



Visitors within 8:53 minutes of earthquake occurrence

Reported as:



- P wave
- S wave
- ★ Epicenter

Updated on 2021/11/18 10:26:59 UTC

M2.9 Athens. Felt Reports: 80% BEFORE Notification!



1460 felt reports on this map

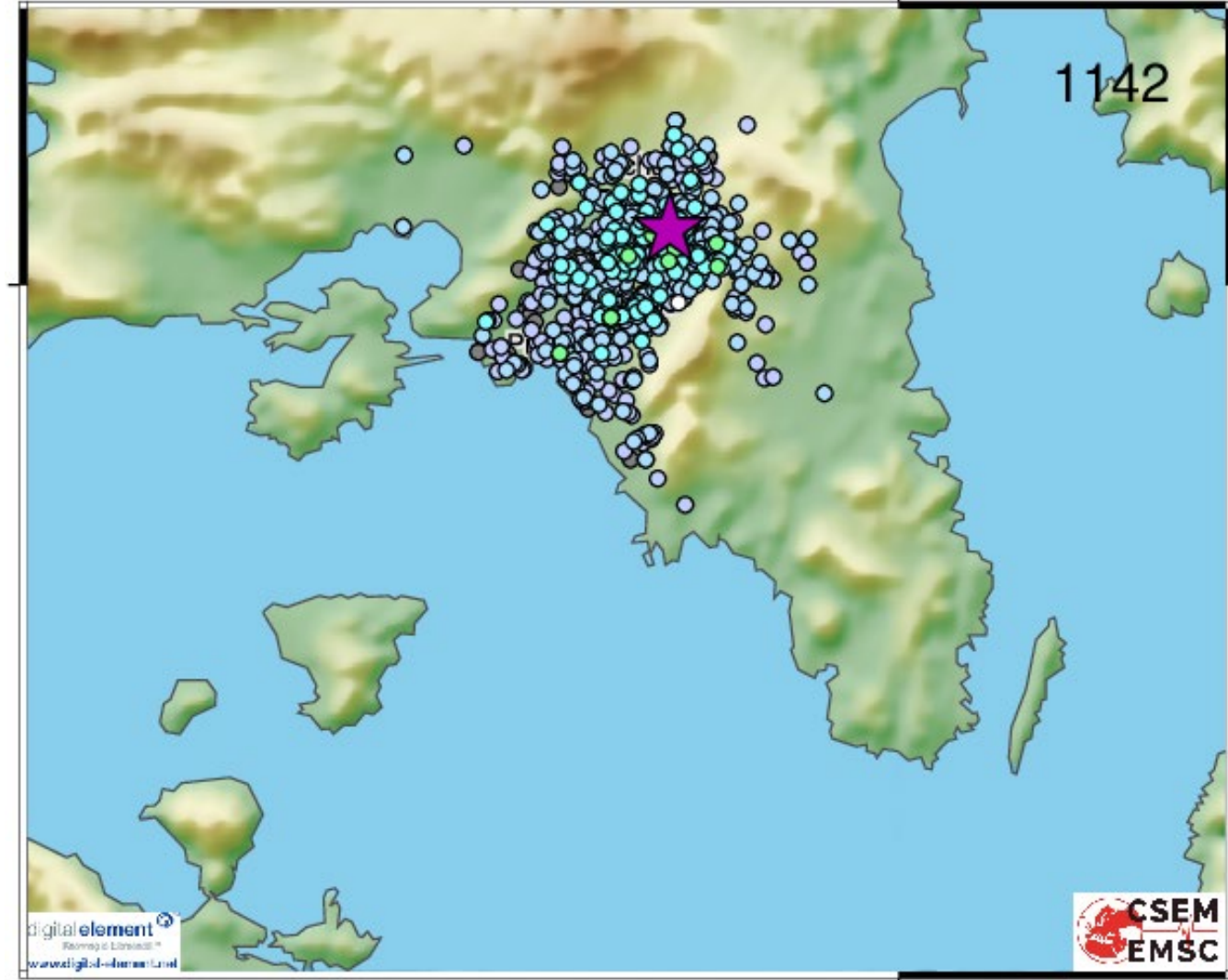
20 km

Updated on 26/10/2021 at 16:36 UTC

★ Epicentral location

Reported as: Not felt Felt Largely felt Damaging

1 460

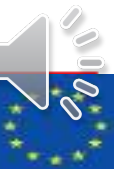


Visitors within 8:53 minutes of earthquake occurrence

24°E

0 km 10 km 20 km

1 142



Objectives with the SCOR Foundation

- Improve public info & service reliability
 - IT infrastructure
 - Rapidity & accuracy of earthquake information
- Widen audiences
 - Public: Geographically
 - Scientists: New collaborations
- Contribute to risk reduction
 - Rapid impact assessment (for efficient response)
 - Improving preparation and awareness among the public



Key Performance Indicators

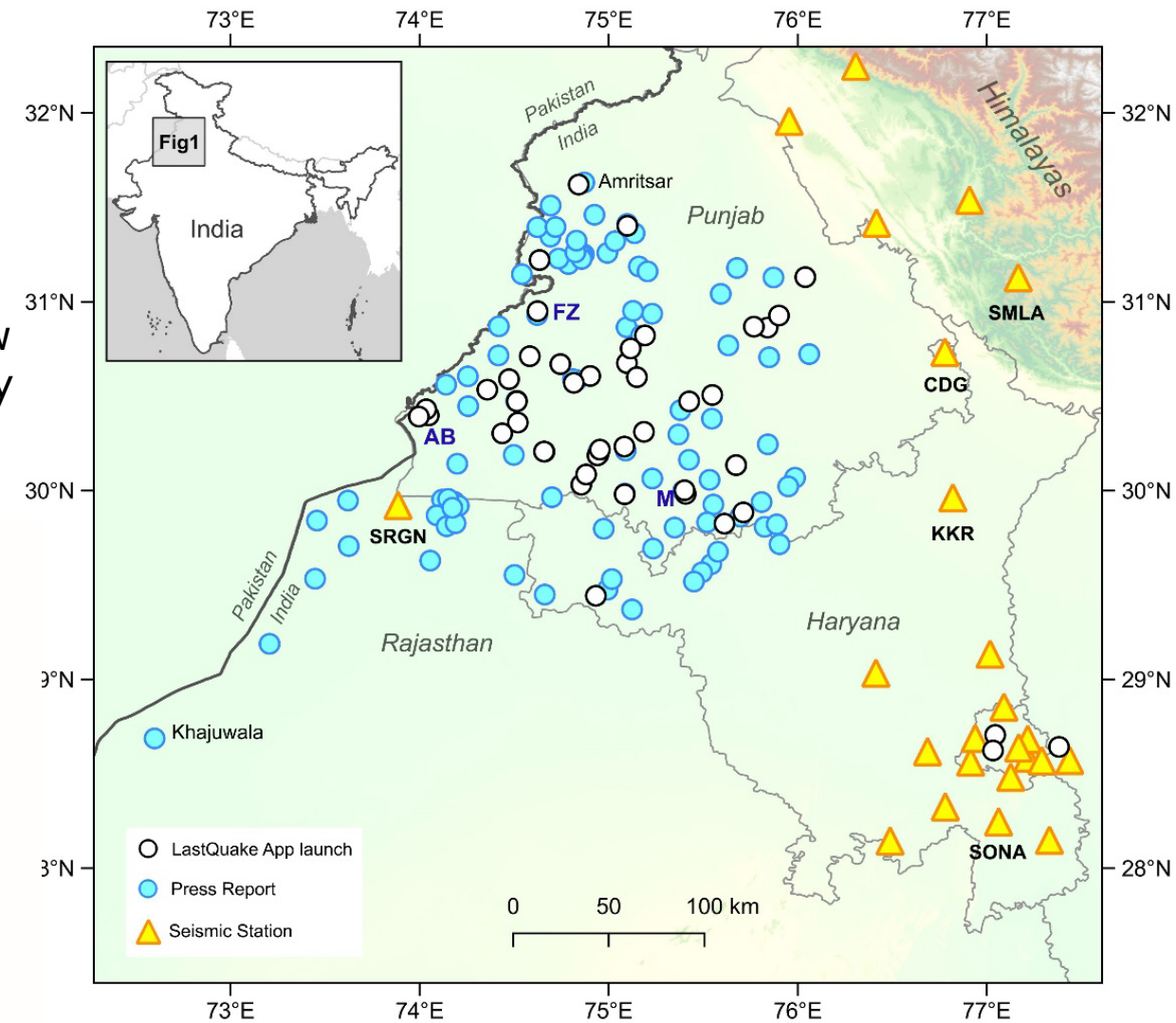
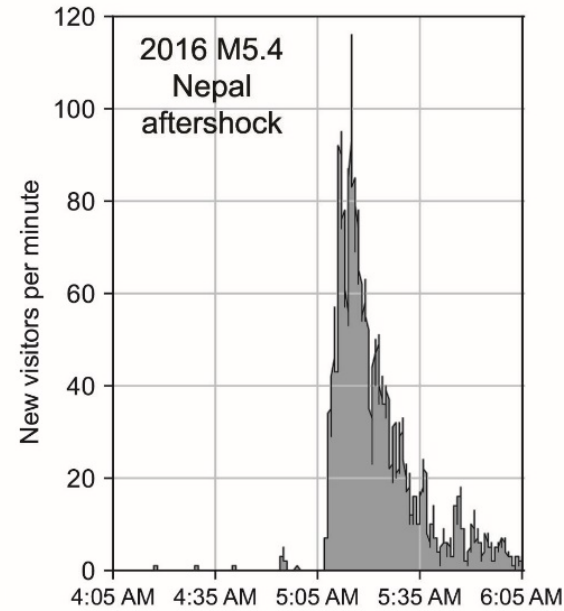
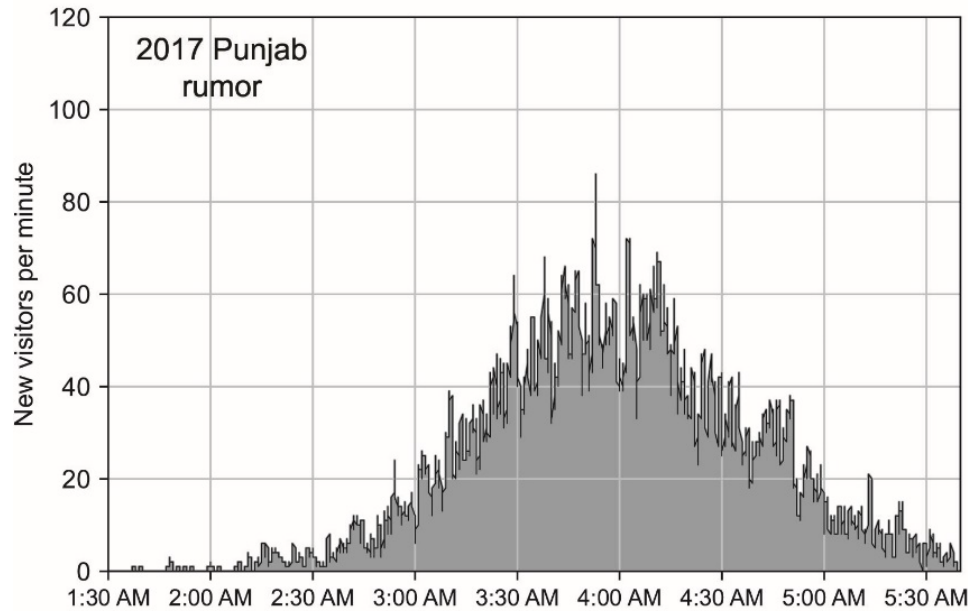
	Project start	2022
@LastQuake Twitter followers	110k	210k
@LastQuake Twitter views	64.4M	157M
Monthly website visits	1.5M	1.5M
LastQuake App users	440k	889k
LastQuake app Views (Android)	28.7M	121.4M
LastQuake app Views (ios)	702k	3.2M
Number of Felt Reports	125k	334k
Median felt report collection time	12.5 min	9.6 min
App rating (ios/Android)	4.7/4.7	4.7/4.64



When Punjab Cried Wolf

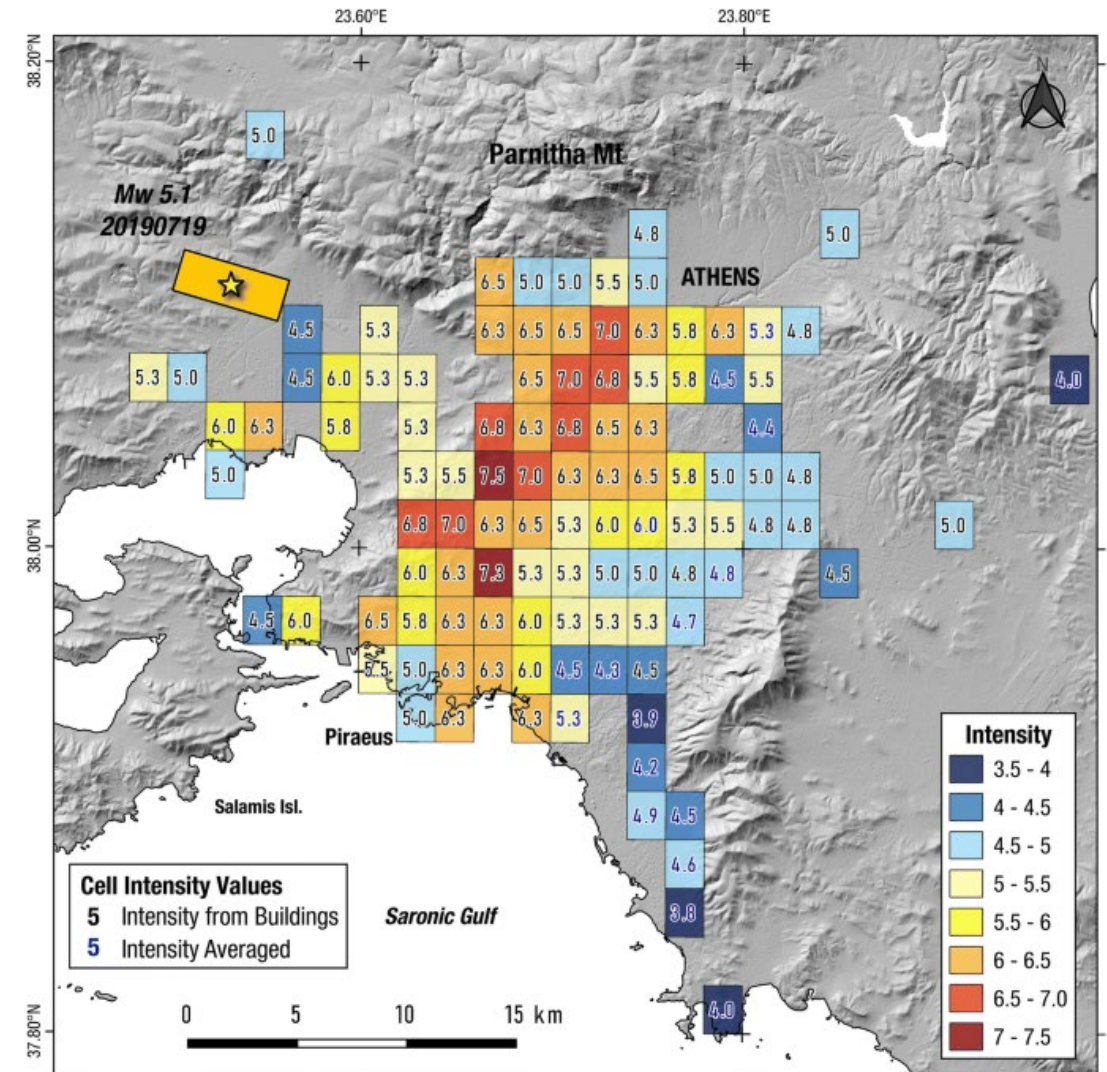
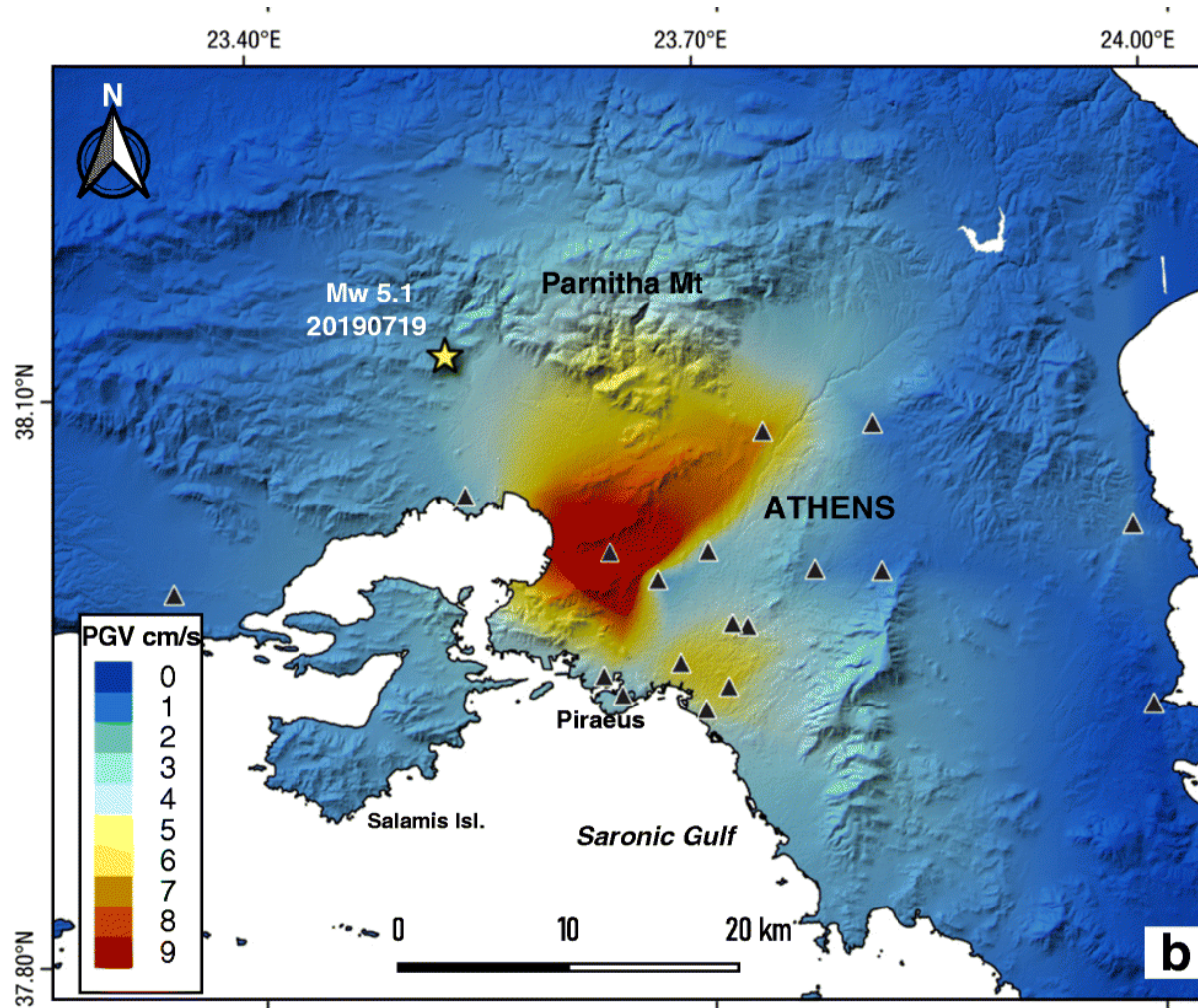
- Public reaction at the time of a predicted earthquake

Martin, S. S., Bossu, R., Steed, R., Landès, M., Srinagesh, D., Srinivas, D., & Hough, S. E. (2021). When Punjab Cried Wolf: How a Rumor Triggered an "Earthquake" in India. *Seismological Society of America*, 92(6), 3887-3898

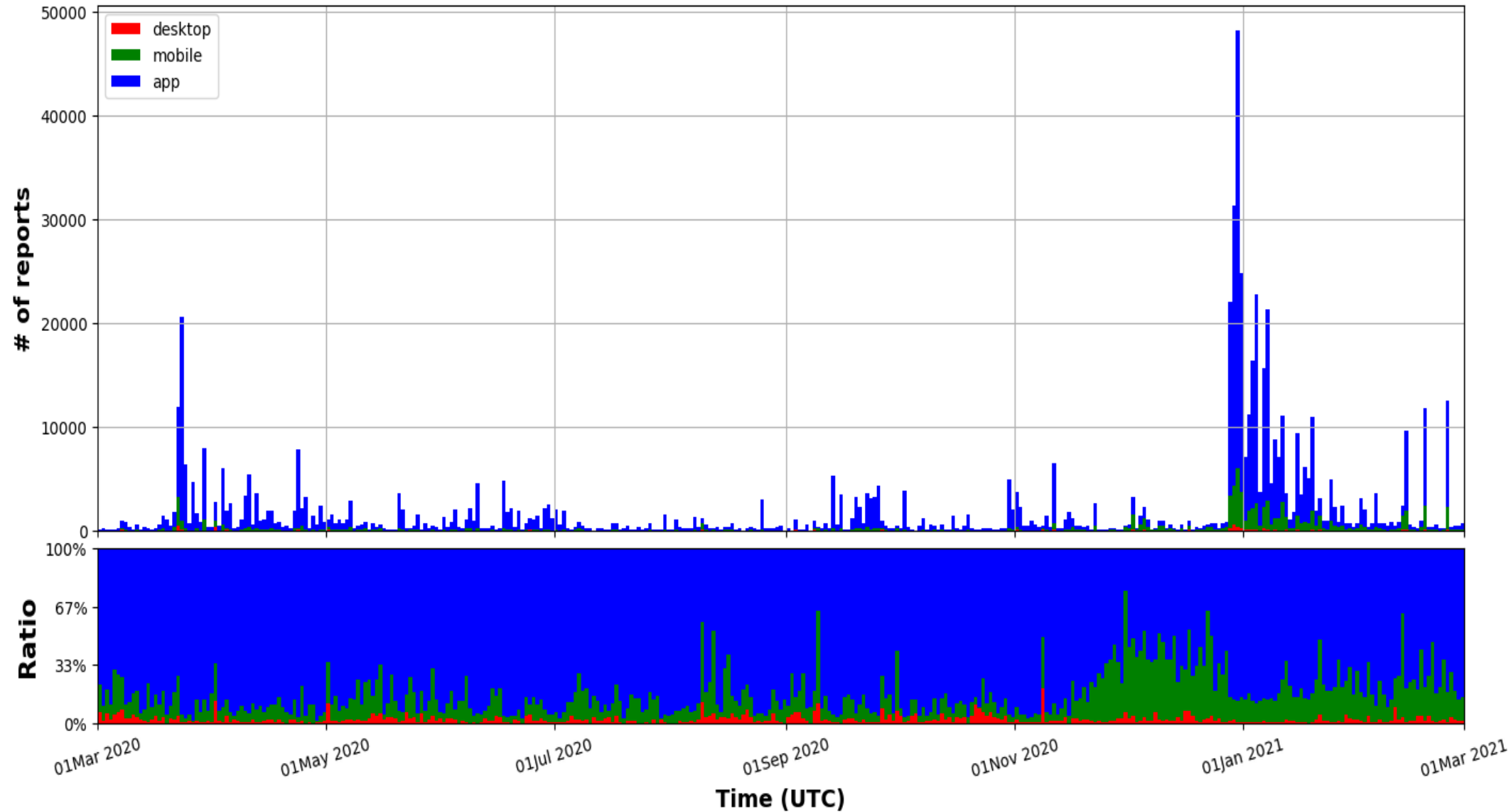


Instrumental & Macroseismic Data: 19/07/2019, Greece M5.1

Kouskouna, V., Ganas, A., Kleanthi, M., Kassaras, I., Sakellariou, N., Sakkas, G., ... & Bossu, R. (2021). Evaluation of macroseismic intensity, strong ground motion pattern and fault model of the 19 July 2019 Mw5.1 earthquake west of Athens. *Journal of Seismology*, 25(3), 747-769



New Website for Mobile Devices



New Twitter @LastQuake QuakeBot (Jan. 2022)

- Rate, duration and content of publication vs societal importance of quake
- Diversity of threads (alternative Tweets)
- Exploitation of teachable moments for improved awareness & preparedness and fight misinformation
- Extending audience beyond eyewitnesses (e.g. journalists)
- Nudging eyewitnesses to share their experience
- Monitoring performances of tweets (e.g. engagement level) to steer future evolutions

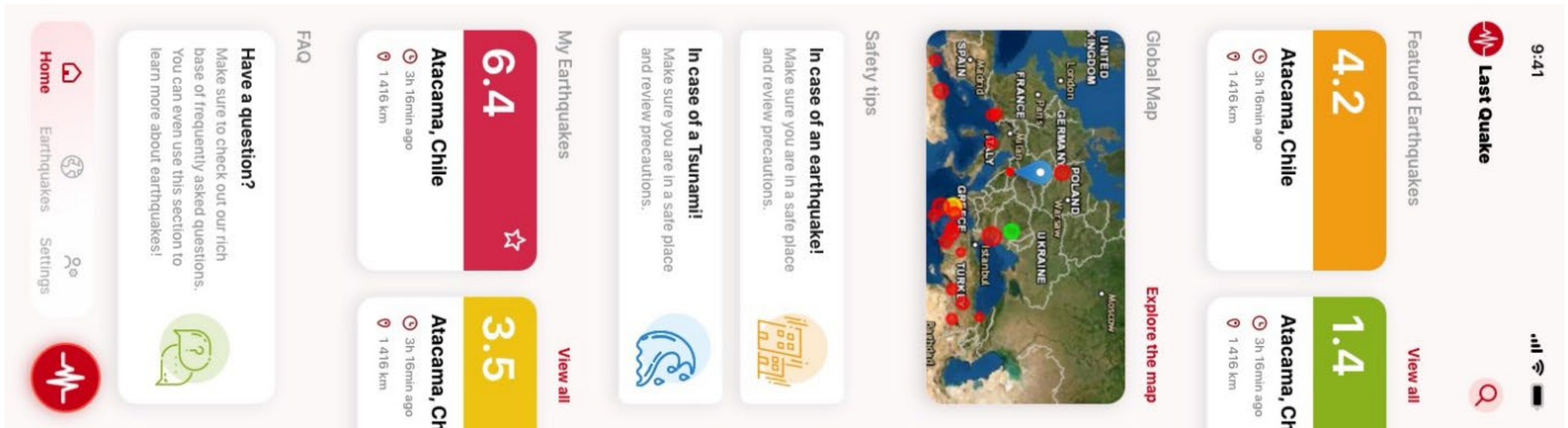


 **Bobby Laurie**
@BobbyLaurie

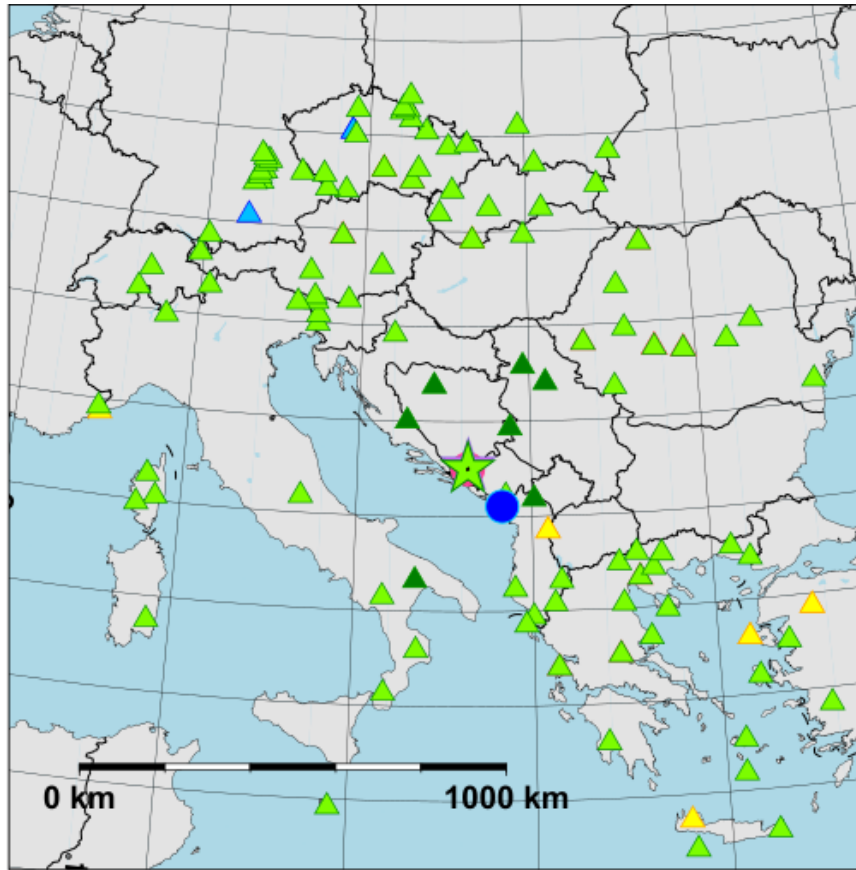
PEOPLE: Listen to your flight attendants! ALMOST EVERYONE in this photo from @SouthwestAir #SWA1380 today is wearing their mask WRONG. Put down the phone, stop with the selfies.. and LISTEN. **Cover your NOSE & MOUTH. #crewlife #psa #listen #travel #news #wn1380



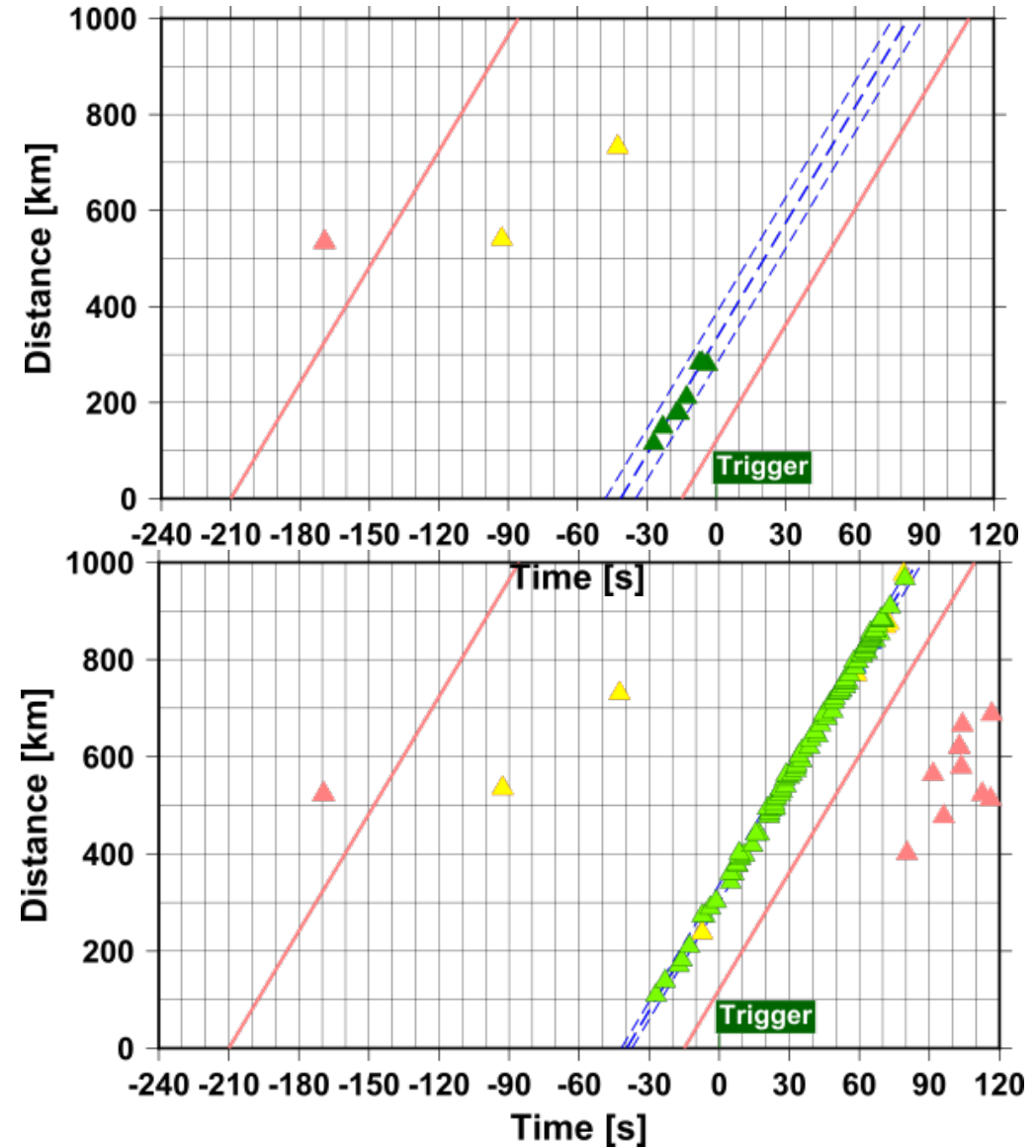
New Website for desktops and New App



Fast & Reliable Location of Global Felt Earthquakes



- Crowdsourced location
- ★ CsLoc
- ▲ used in location
- ▲ unassociated
- ▲ outside of search region
- ak135
- 3 x MAD
- search region

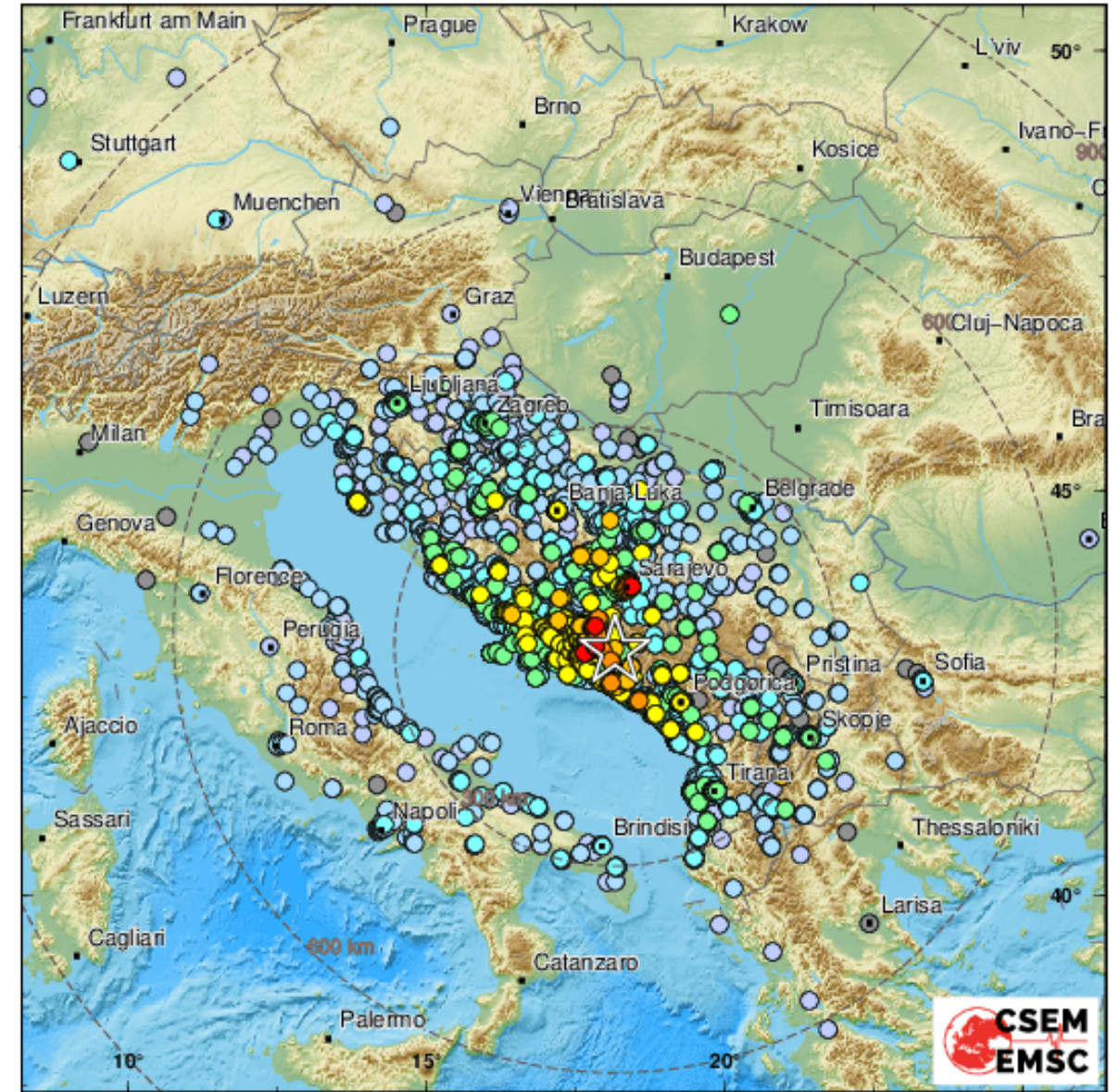
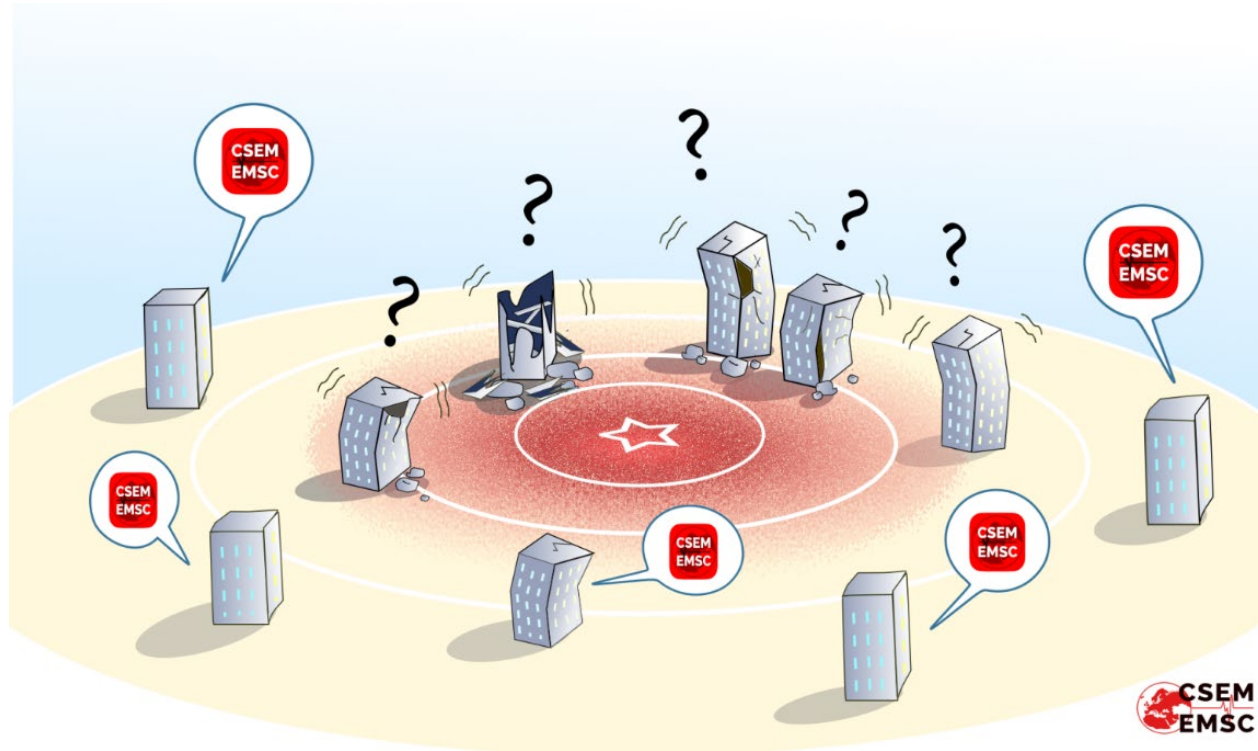


Median: 102s, 10km



Crowdsourced Data for Rapid Impact Assessment

- Ingestion of felt reports in ShakeMaps
- Doughnut effect



14085 felt reports on this map

300 km

Updated on 05/05/2022 at 07:59 UTC

★ Epicentral location

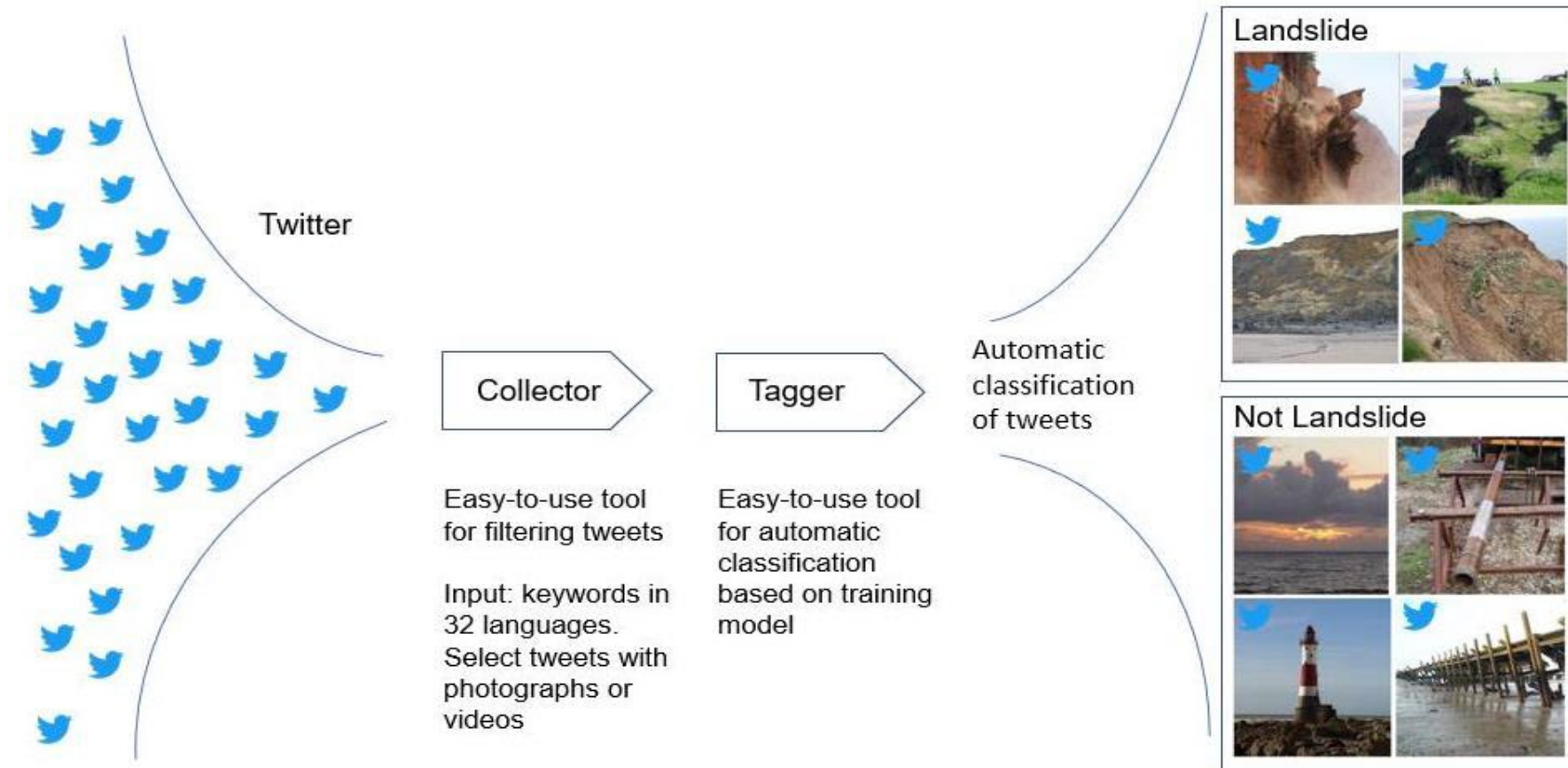
Reported as: Not felt Felt Largely felt Damaging



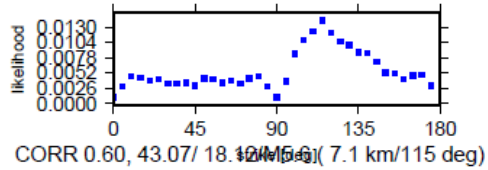
Landslide Detection on Twitter

- Call for feedback from landslide community
- Collaboration with Landslides Tracker (satellite data)

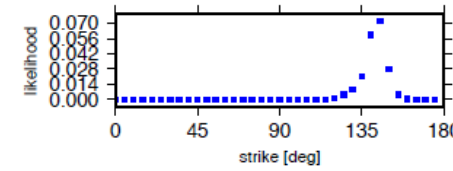
<https://landslide-aidr.qcri.org/service.php>



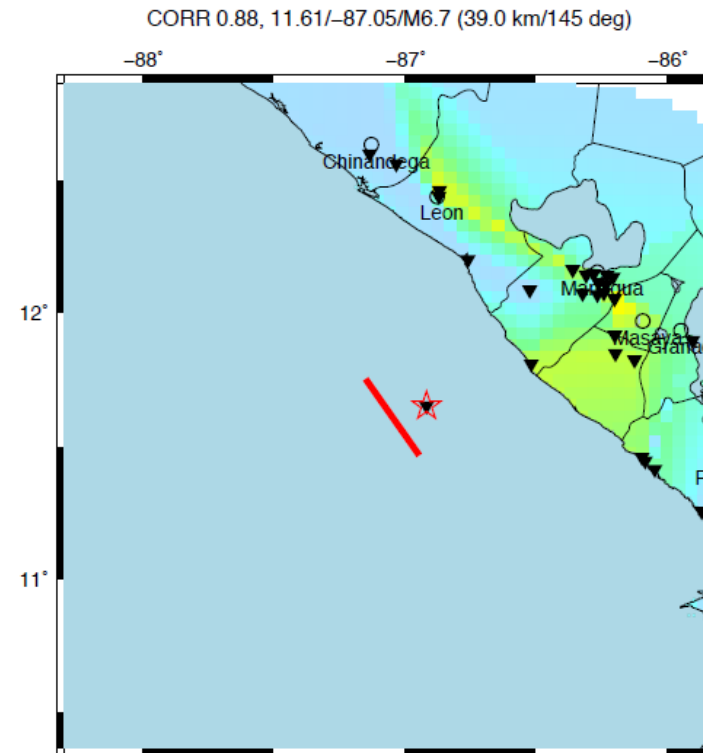
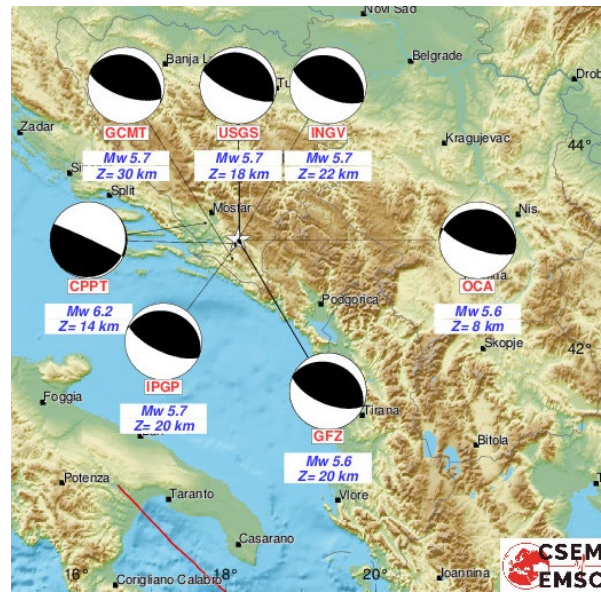
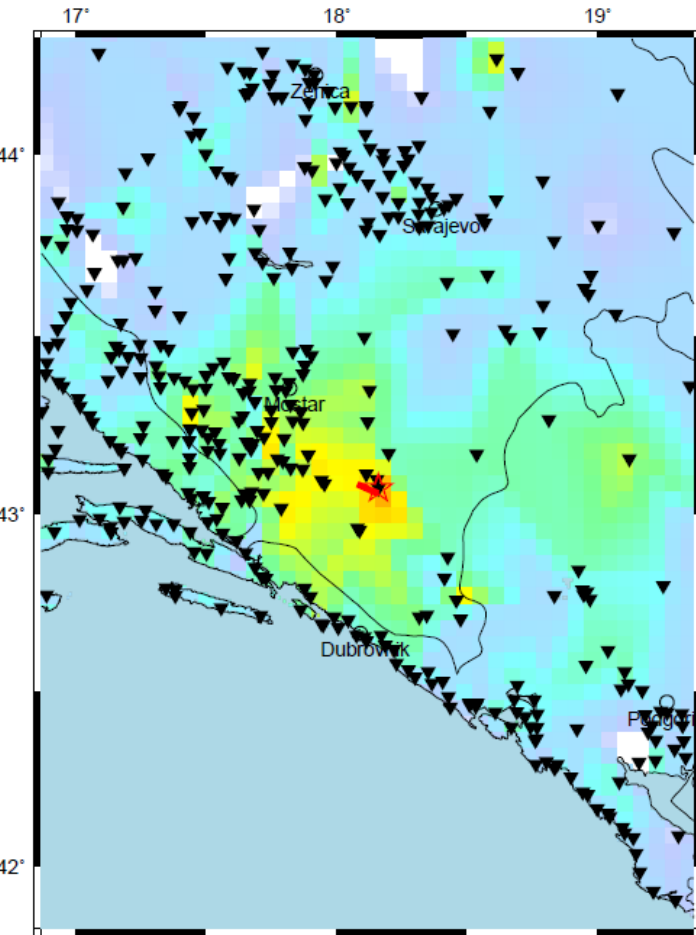
Finite Rupture from Felt Reports



Finder: 115° 7.1 km
 MT: 110° < Strike < 119°
 T0+10min
 N: 14 000
 M5.7

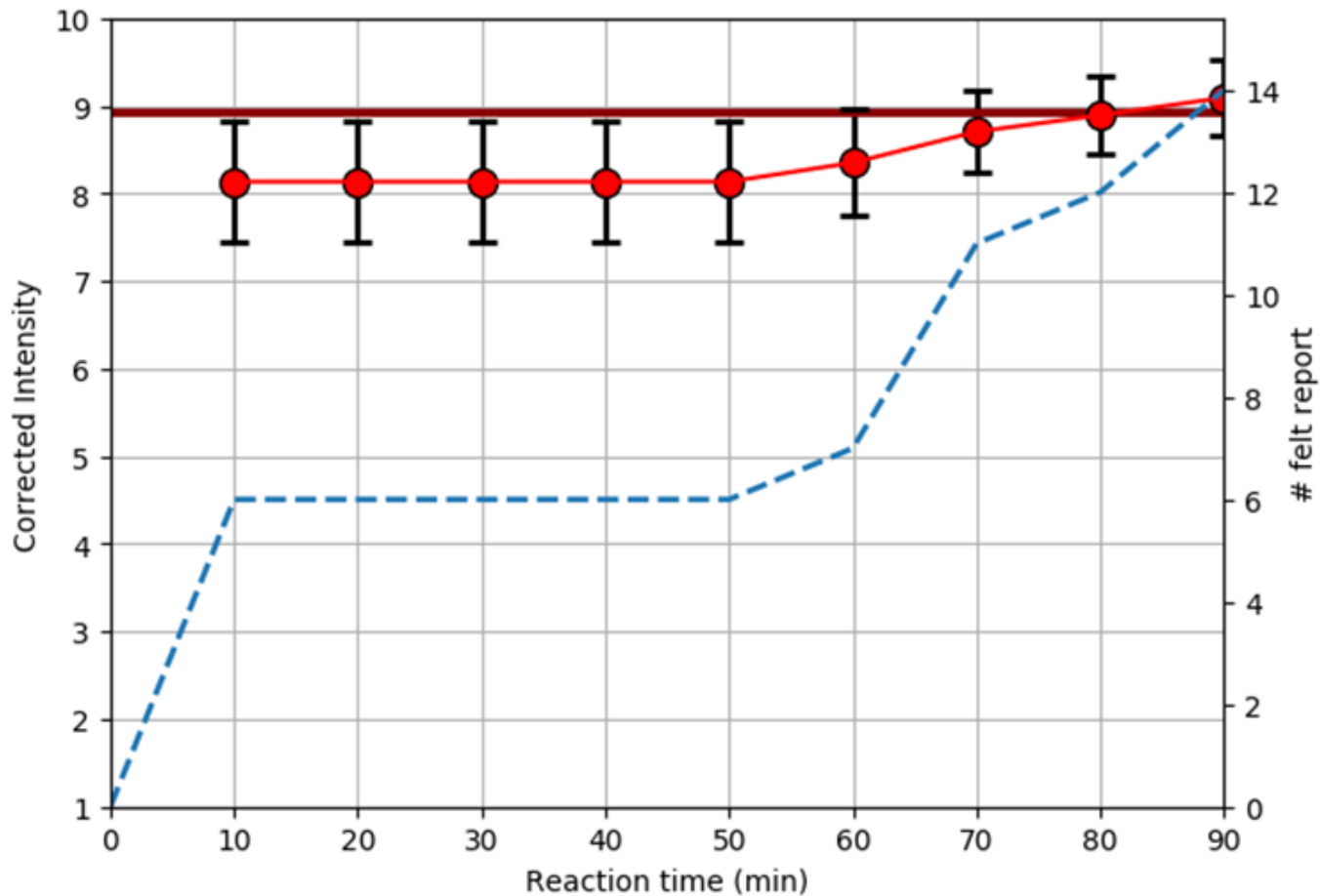


Finder: 145° 39 km
 MT: 125° < Strike < 143°
 T0+40min
 N: 96
 M6.7

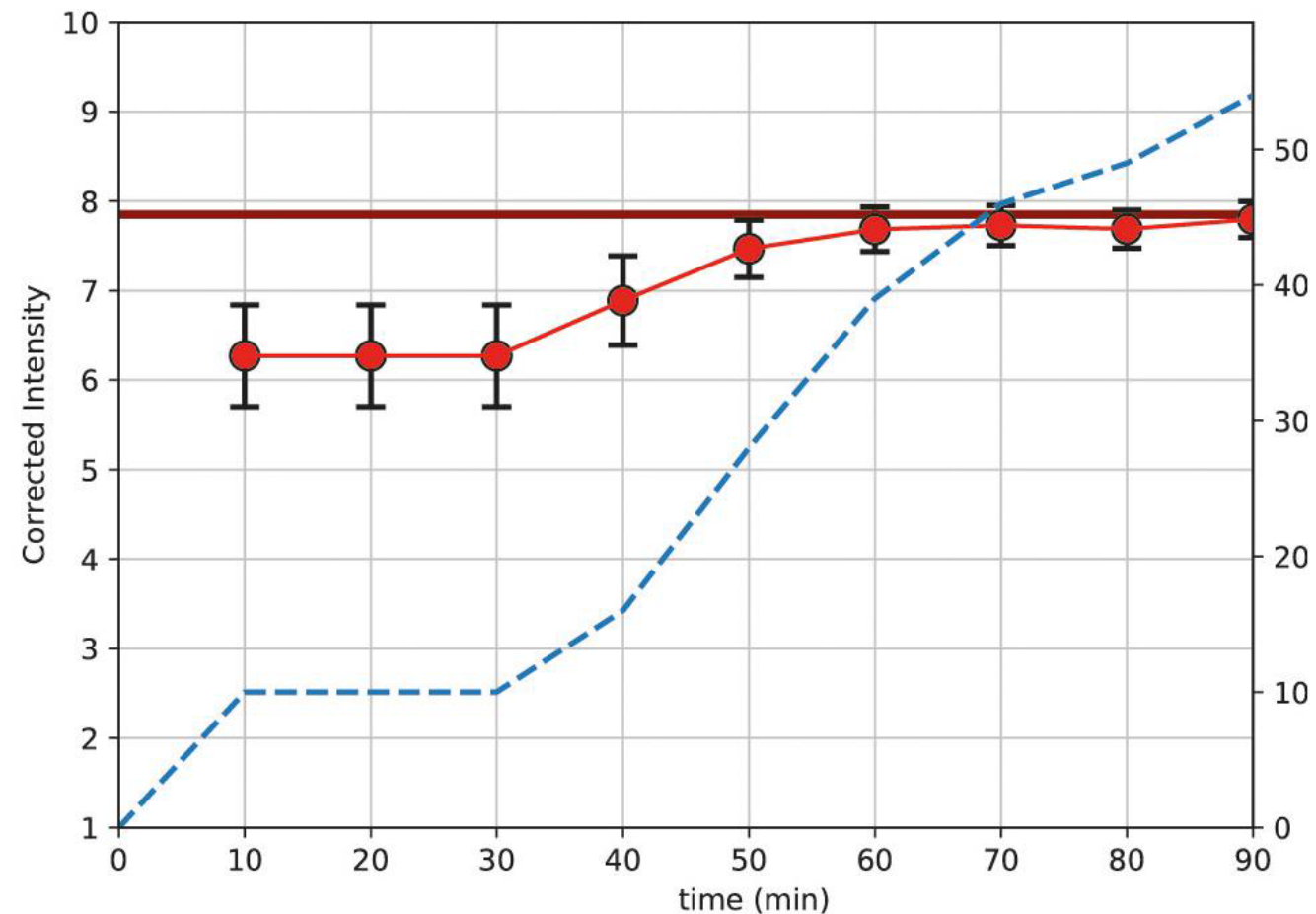


Doughnut Effect: Time Evolution of Epicentral Intensity

Croatia 2020

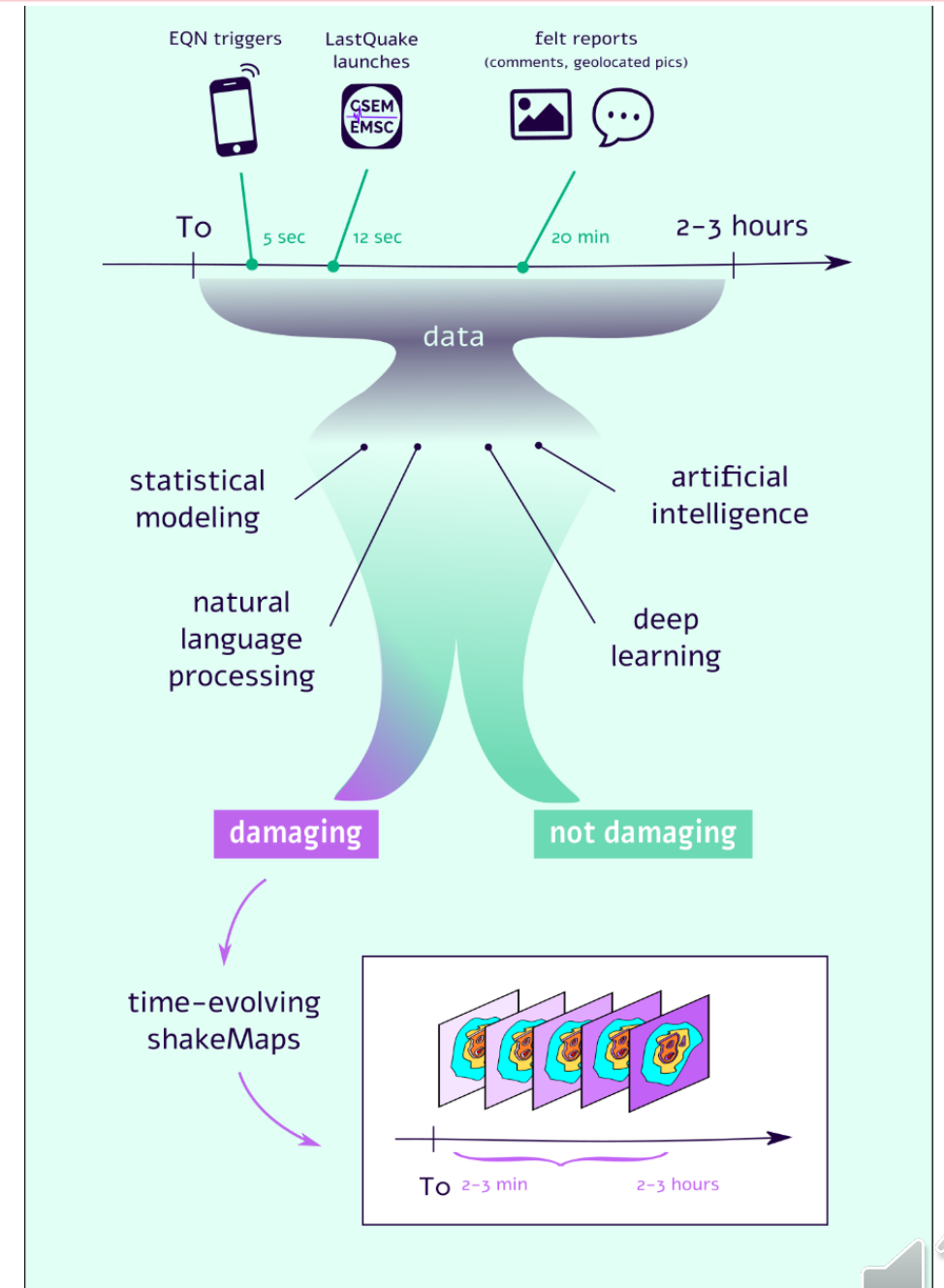


Albania 2019



Time evolving ShakeMaps and Impact scenarios

- Artificial Intelligence for automatic processing of crowdsourced data



Achievements & Next Steps

- Python 2 -> Python 3; GMT 3 - > GMT 6; Oracle -> Postgres
- New: CsLoc Service, website for mobile devices, Twitter quakebot
- Video and article for the SCOR Foundation
- Two scientific papers acknowledging SCOR Foundation's support
- Still to come:
 - New version of the seismic data processing
 - New app, new website for desktops
- First WhatsApp quakebot (Haïti)?

