

Schweizerischer Erdbebendienst
Service Sismologique Suisse
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Swiss Seismological Service

ETH zürich

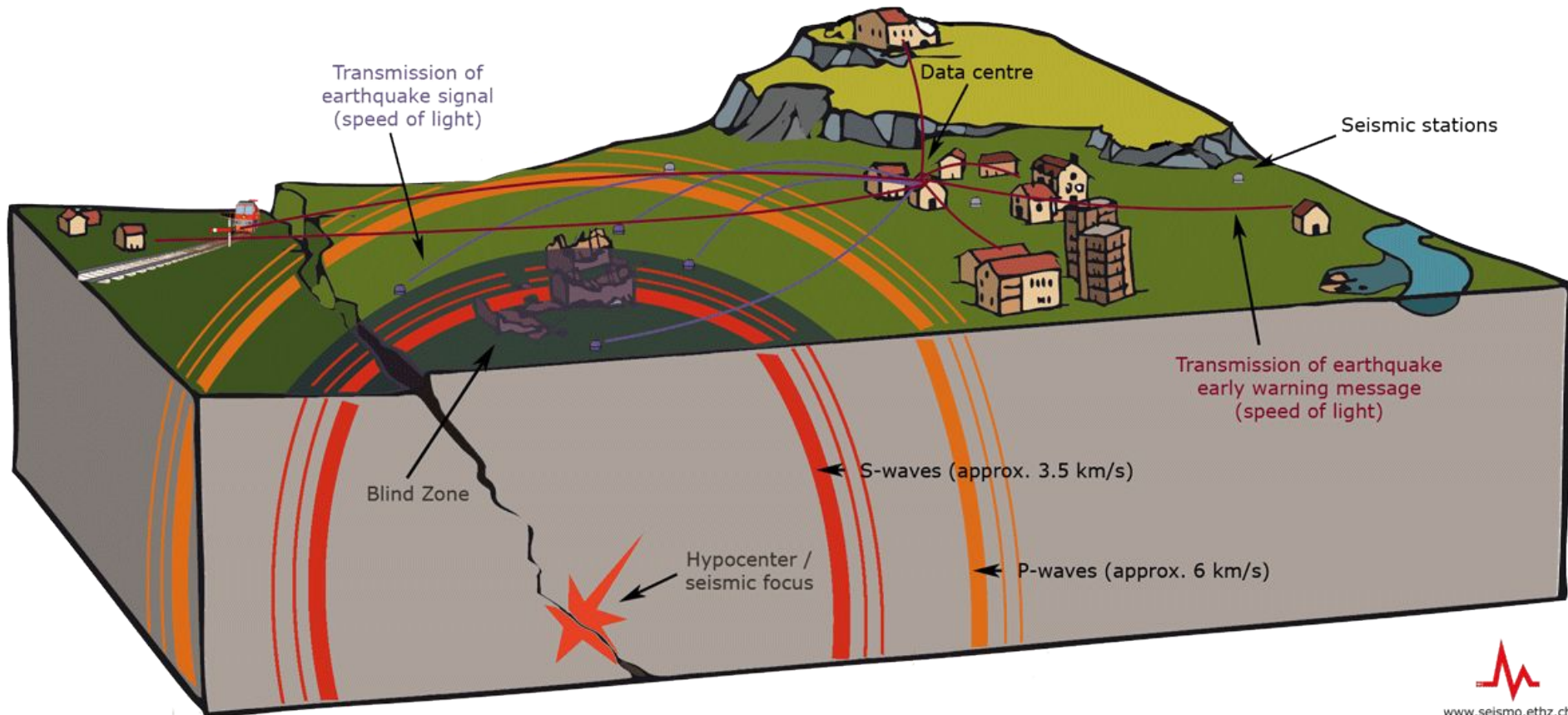
Towards the public release of a national Earthquake Early Warning System in Greece

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Network, National Observatory of Athens



What is EEW?



Types of application

Using seconds to tens of seconds warning for...



1. Personal safety

- moving to a safe zone



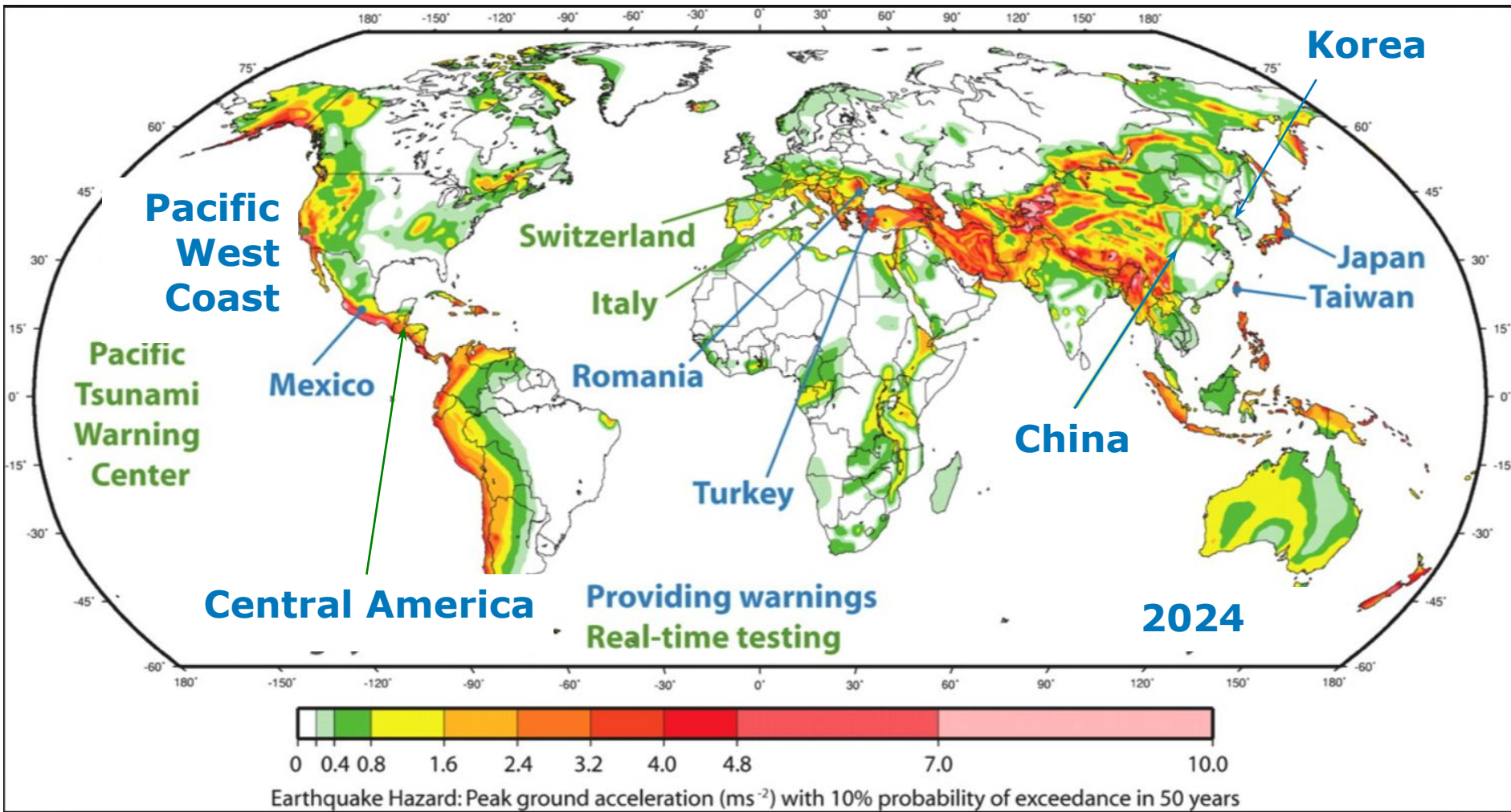
2. Automated control

- slowing/stopping/isolating sensitive systems



3. Situation awareness

- initiating response before shaking



EEW | What can we expect?

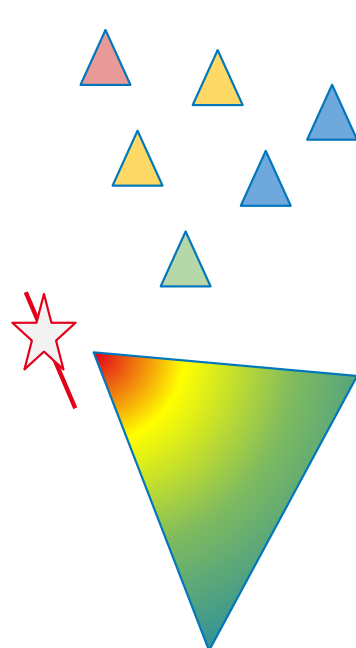
- ❖ Recent research suggests that on average over many damaging earthquakes, EEW systems can reduce casualties by **15-20%**

*Can improve this number with **increasing lead time** & **optimising public response**
But not by more than a few %*

- ❖ Best strategy to prevent casualties in earthquakes is to have **earthquake proof buildings!**



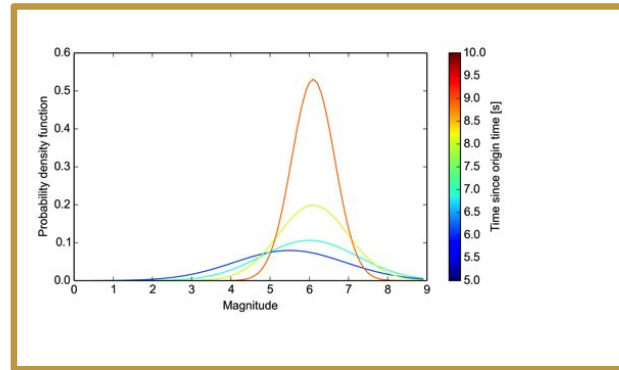
Building EEW systems



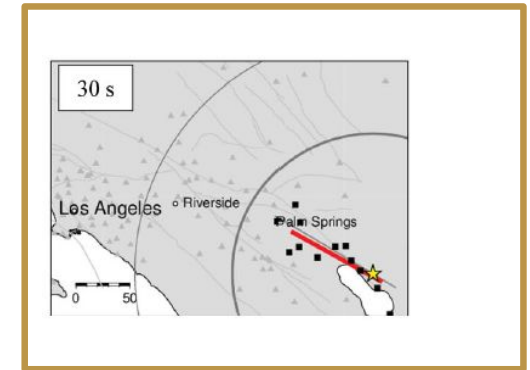
<i>Core Element</i>	<i>Challenges</i>	<i>Greece</i>
<i>Instrument networks</i>	★ Always on, always fast ★ High quality data ★ Expert instrumentation staff	<i>Greek seismic networks at NOA</i>
<i>EEW processing centers:</i> ■ EEW algorithms ■ Products	★ Robust & high-availability ★ Expert IT and scientists	<i>NOA, operating ETH-built EEW software on SeisComP</i>
<i>Public messaging system:</i> ■ Availability ■ Accessibility ■ Security	★ Social science ★ Communication strategy ★ Public guidance for EEW ★ Public training for EEW	<i>EEW mobile app developed by ETH operated at NOA</i>

ETHZ EEW Approach | Algorithms and Software

- Research in making EEW faster and more reliable : combining different EEW algorithms to evolve from as-fast-as-possible (*single-station*) point source to finite fault (*network*) estimates in a fully probabilistic EEW system



**Point Source:
Virtual Seismologist**

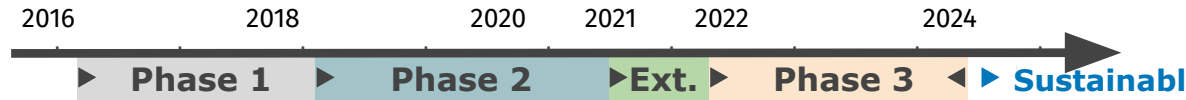


**Finite Fault:
FinDer**



- Software:** ESE is integrated in SeisComP, the standard earthquake management software already used in most seismic networks, making implementation / management as easy as possible.

ATTAC | Project Overview



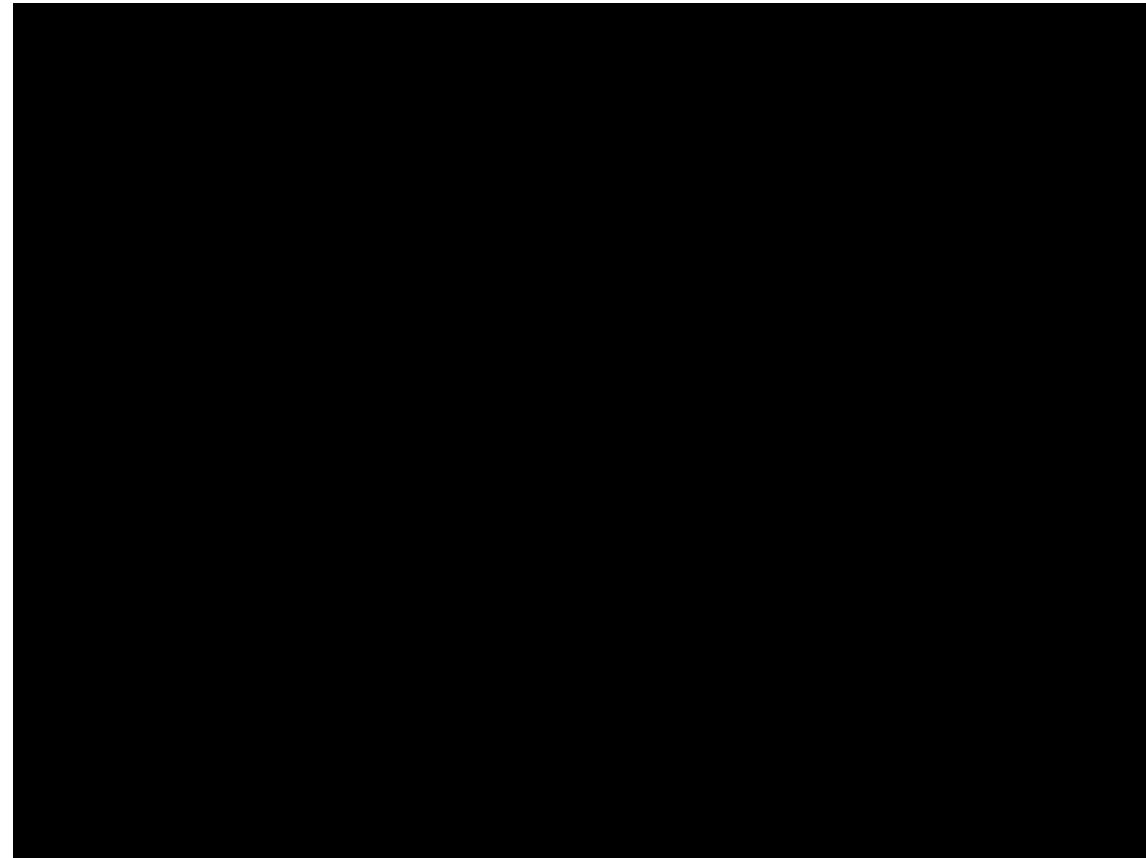
- ❖ Decadal EEW build-out in Central America funded by Swiss Development and Cooperation (SDC)
- ❖ Ended 5.2024 - sustainability with national funding continues to be sought

Resources:

- ❖ Each country runs a **standalone ESE** system (Costa Rica, Nicaragua, Guatemala, El Salvador)
- ❖ **Permanent** national seismic networks
- ❖ Strong regional **data sharing** & partnerships
- ❖ Limited resources: 2 IT experts, 1 scientist, 1 PhD student

Achievements:

- ❖ **EEW is operating in all 4 countries with public app**
- ❖ Improved seismic networks, hub performance & staff training
- ❖ Regional coordination

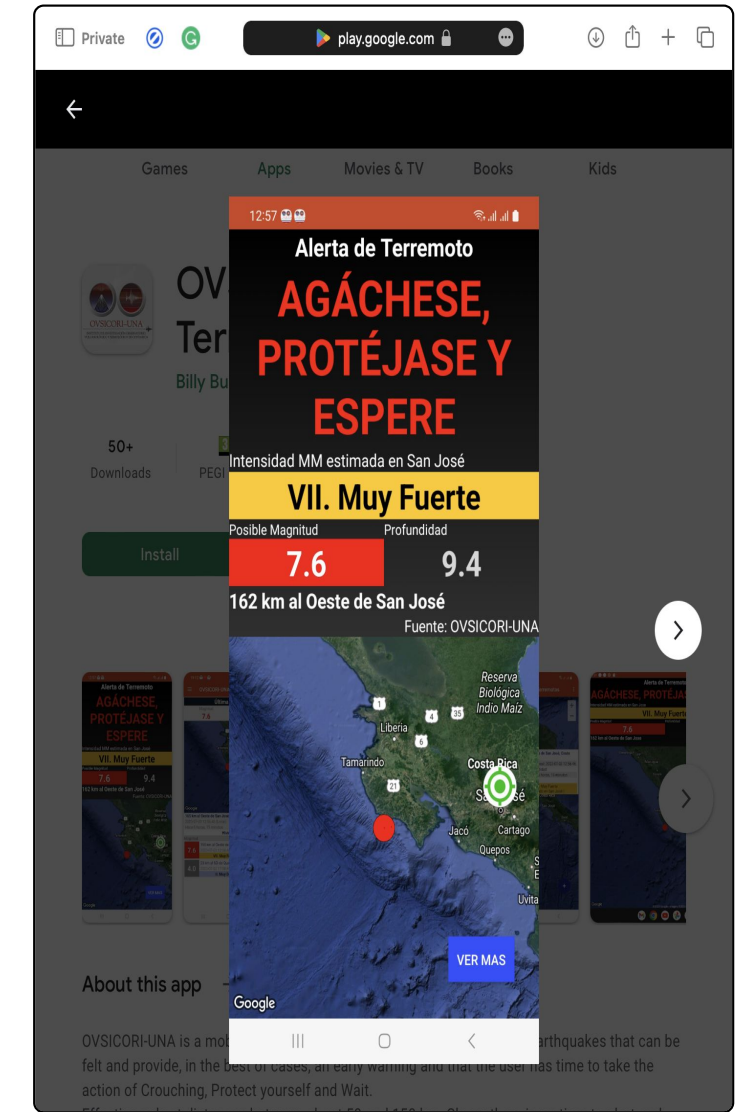


Real-time performance during the M5.3 earthquake in October 2023 in Costa Rica (from OVSICORI).

Our short-term focus on alert dissemination is via a cell phone app

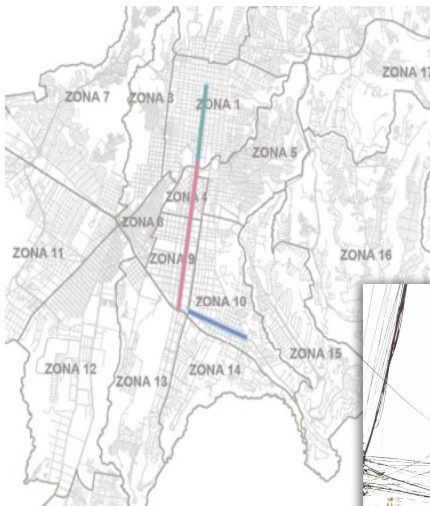
- Each of 4 partner agencies operates their own app
- **Public in Costa Rica, Nicaragua since June 2023, Guatemala since Feb 2024, El Salvador since Sept 2024.**
- Uses google firebase, supporting both Android and iPhone
- Collects user data (**delays** from events and daily silent notification; and **felt reports** from events) at each agency
- $MMI \geq V$: **RED notification** (loud announcement)
- $III \geq MMI > V$: **ORANGE notification** (phone ping)
- App successful but requires constant maintenance!

	Total Active Users	Android	iOS
OVSICORI	100k (2%)	65k	35k
INETER	5k	5k	0
MARN	70k (1%)	40k	30k
INSIVUMEH	500k (5%)	400k	100k



Sirens

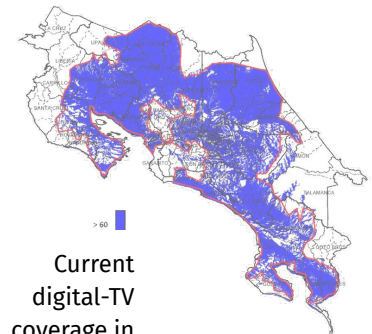
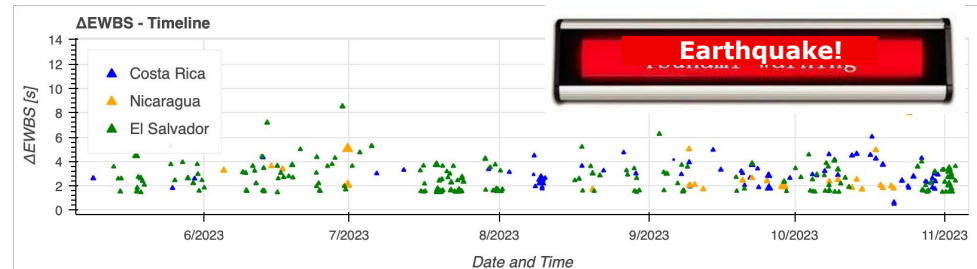
- ❖ Delivered software to trigger emerging siren system in Guatemala City
- ❖ Continued discussions with Municipality of Guatemala, political discussion on when to activate alerts.



Existing ~5km long set of siren corridors in business district of Guatemala-City (operated by municipality)

Digital TV (EWBS)

- ❖ Promising technology from Japan* that if adopted at national level can scale to public.
- ❖ **Nicaragua:** currently sending messages to 30+ sites in Managua
- ❖ **Costa Rica & El Salvador:** continuous test & monitoring



Current digital-TV coverage in Costa Rica (SINART).

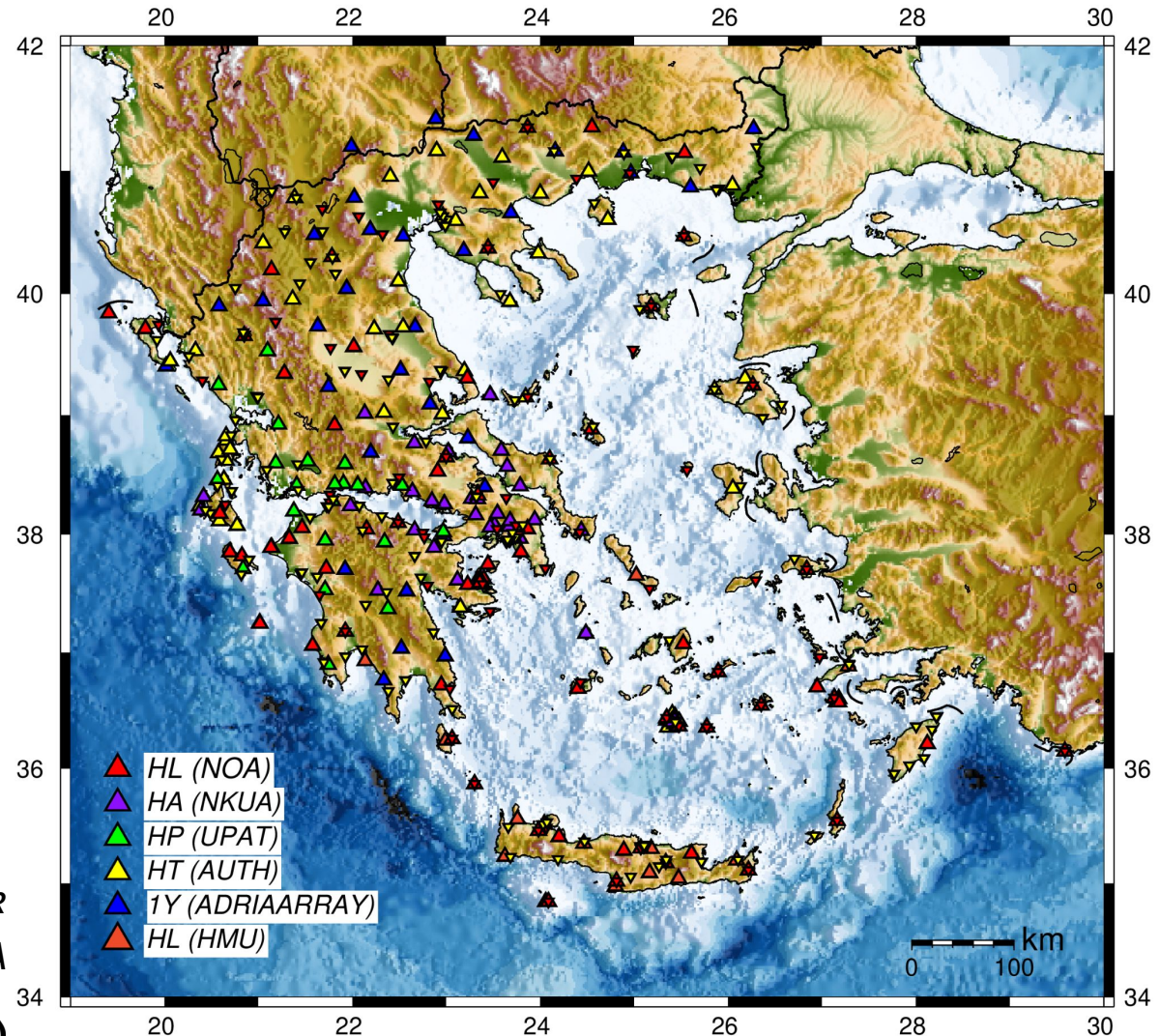
TRANSFORM2:

- ❖ Aims to create EEW systems in many parts of Europe, focusing on NFOs
- ❖ ETH is collaborating with NIEP and NOA to create end-to-end EEW systems for the public in Switzerland, Romania and Greece(Cyprus
- ❖ EEW algorithm handover / training began in 5.2025

Current HUSN seismic network stations in realtime at NOA

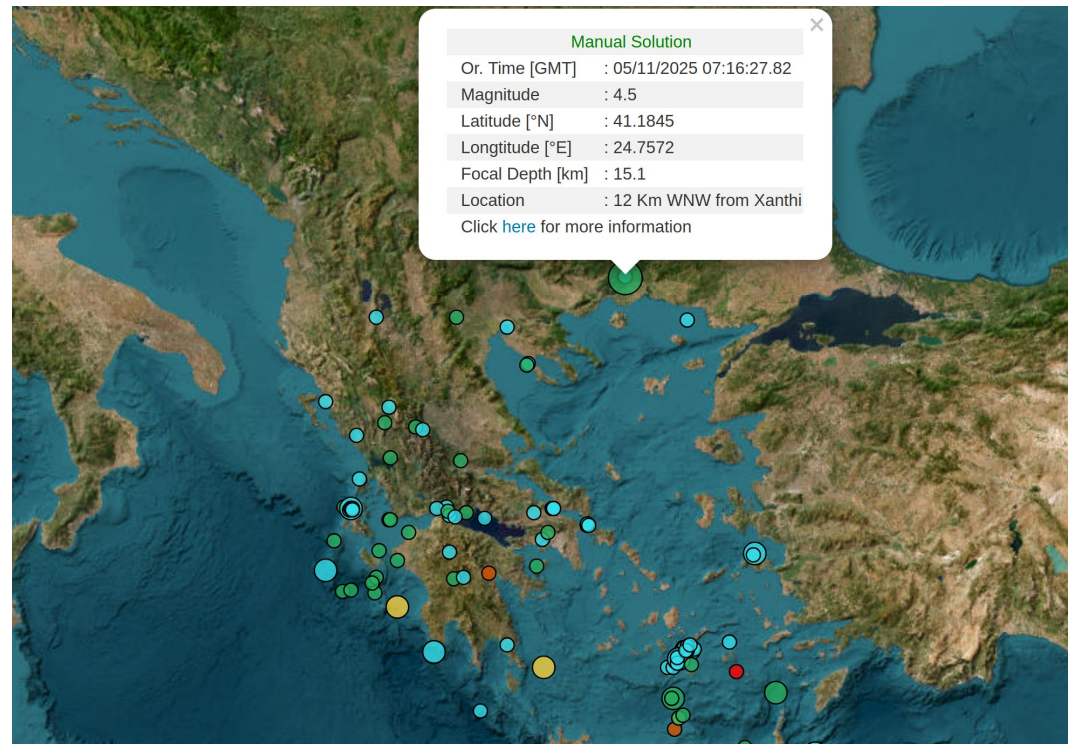
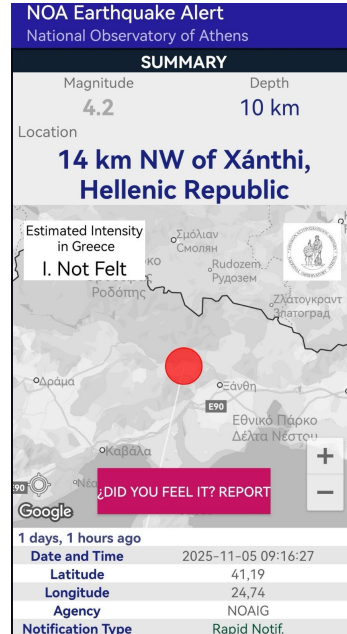
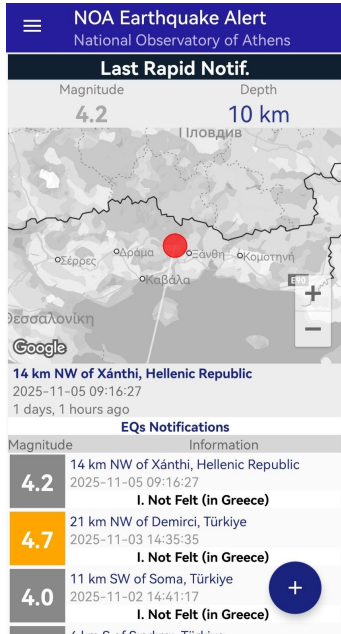
Total: 420 stations (240 EEW-ready)

HUSN 2025



TRANSFORM2:

- ❖ 05/11/2025 Xanthi 4.5ML
- ❖ 1st VS EEW solution:
M4.6 after 4.5s



- ❖ images from 1st version of Android app

TRANSFORM2:

Next steps: **App Release**

- ❖ *end Nov*: release iOS and Android version for project scientists and key stakeholders
- ❖ *spring 2026*: improve Greek version, tailor features for use in Greece, begin to communicate to public so they have correct expectations on an EEW system
- ❖ *from mid-2026*: expect to be ready for public release, schedule to be determined by NOA
- ❖ *post release*: monitor app usage growth and minimise delays, collect feedback from users on app performance following significant events

Next steps: **EEW system**

- ❖ continue to monitor EEW alert performance, optimise algorithm for Greek seismicity (especially deep subduction zone events)
 - ❖ densify seismic network, upgrade stations to improve alert speed and stability
 - ❖ continue to strengthen NOA staff in EEW science and software
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Challenges

- ❖ need to maintain and improve seismic network, processing center, to ensure reliable alerts
- ❖ EEW operator (NOA) should ensure they have expertise and ownership of system.
- ❖ In particular, app is fragile and resources needed to ensure its future beyond end of project
- ❖ alerts need to be sent from other systems: cell broadcasting; digital TV; sirens. This technology needs investment and knowledge outside our project
- ❖ a solid public EEW system needs active coordination with scientists, civil defense and government, clear ownership and liability
- ❖ public need to be informed about the system, and trained how to respond to alerts, and have reasonable expectations on performance

Opportunities

- ❖ effective EEW can save lives and reduce losses during the inevitable earthquakes that will strike Greece.
- ❖ accurate and prompt EEW messages can reduce information vacuum after significant events
- ❖ EEW system demonstrates level of technological success / maturity for seismology in Greece