Report of Transnational Access Projects

(Note: the information here will be publicly disclosed in the Geo-INQUIRE website, do not include sensitive information)

Project ID: *C1_TA3-84-1_1*

Principal investigator: *Lucía Escudero Palencia, Universidad Complutense de Madrid (Spain)*

Project team (if applicable):

Project title: Feasibility of an impact based-based Early Warning System for Ibero-Magrebian Region

Project acronym: *FAIRWAY-IMR*

Hosting installation: *TA3-84-1, Università di Napoli Federico II, Physics Department*

Hosting team: *Gaetano Festa[1], Antonio Scala[1], Aldo Zollo[1], Luca Elia[1], Sonia Sorrentino[1]*

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Period of access: *From 20/10/2024 to 16/11/2024*

Report of activities:

Earthquakes Early Warning Systems (EEWS) are one of the most effective tools to prevent and mitigate the damage that can be caused by earthquakes. This study presents the implementation and testing of a new P-wave shaking-forecast-based EEWS, called QuakeUp (Zollo et al., 2023; https://doi.org/10.1029/2022EA002657), in the Ibero-Maghrebian Region (IMR), covering southern Iberia and northern Morocco and Algeria, a tectonically complex zone at the Eurasian–African plate boundary (Fig. 1a).

*QuakeUp not only provides an early estimation of the hypocenter and magnitude, but also integrates **Peak Ground Velocity (PGV)** predictions derived from observed P-wave amplitudes together with a region-specific **Ground Motion Prediction Equation (GMPE)**. These predictions are continuously updated as new information on the earthquake's location and magnitude becomes available. As a result, QuakeUp produces a P-wave-based shake map that is updated over time, offering a real-time, evolving map of the Potential Damage Zone (PDZ) defined as those zones where the Instrumental Intensity (IMM)—calculated in terms of PGV—exceeds a previously defined threshold.*

*This EEWS method has been validated using data from the **2016 Alborán Sea seismic series (M_w 5.0–6.4)**, based on records from seismic stations belonging to Instituto Geográfico Nacional (IGN) (doi: 10.7914/SN/ES), Western Mediterranean (WM) (doi: 10.14470/JZ581150), and Instituto Português do Mar e da Atmosfera*

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(IPMA) (doi: 10.7914/SN/PM) seismic networks (shown in red, blue, and green, respectively, in Fig. 1a). Minimal discrepancies were observed in origin time, hypocenter, and magnitude estimates when compared with previous studies.

*A retrospective performance analysis for the **M_w 6.4 mainshock** (black star, Fig. 1a) shows lead-times ranging from **14 to 62 s** for a PGV threshold of **0.20 cm/s (corresponding to I_{MM} = IV)**, with lead-times increasing with distance (Fig. 1b). At a higher threshold of **0.60 cm/s (I_{MM} = V)**, the lead-time reached **20 s** at distances up to 170 km. These warning times would be more than sufficient to implement preventive actions such as…*

*Figures **1c** and **1d** show the I_{MM}-based shake maps generated by QuakeUp at two different times after the origin time (OT), as reported in each panel. In both maps, the PDZ—defined for an intensity threshold of I_{MM} = V—is outlined in black. The PDZ evolves as new P-wave data arrive: The PDZ is initially shown only in North Africa, whereas at later times, it extends to southeast Iberia (Fig. 1c–d).*

Despite some limitations due to focusing on moderate-magnitude earthquakes ($M_w \leq 6.4$), QuakeUp has proven effective for offshore events in regions with sparse instrumentation.

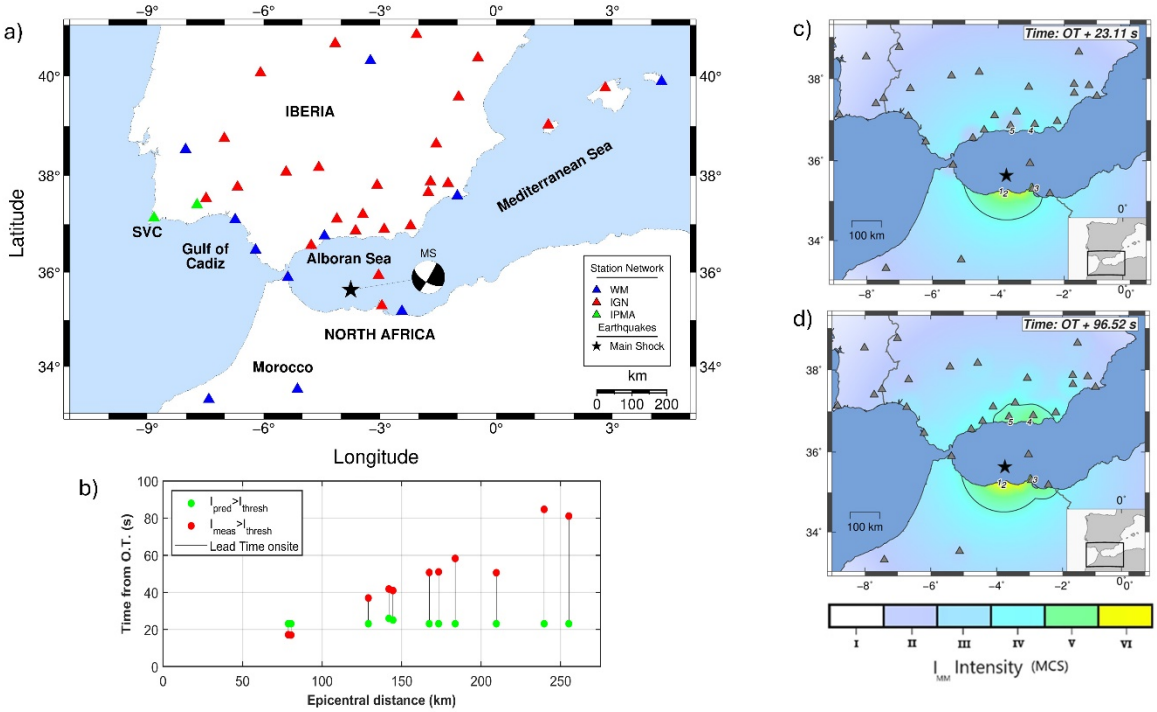

Figure 1: a) Epicenter of the main shock of the 2016 Alboran seismic series (MS, black star), along with its focal mechanism (Buforn *et al.*, 2017; https://doi.org/10.1016/j.tecto.2017.06.033). Triangles are the seismic stations used for the playback analysis (modified from Escudero *et al.*, 2025. **b)** Lead-time as a function of the epicentral distance for an intensity threshold of I_{MM}=IV (Escudero *et al.*, 2025). **c-d)** P-wave based shake maps for the main shock (black star) at different times after OT. The stations (Fig. 1a) are represented by gray triangles. The contour line delineates the PDZ for an intensity threshold of I_{MM}=V (Escudero *et al.*, 2025).

Project outcomes:

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Integrated data can be openly accessed through the EPOS CREW (Earthquake Early Warning Testing Center) platform at the following weblink: https://tinyurl.com/C1-TA3-84-1-1-GeoInquire (DOI: https://doi.org/10.5281/zenodo.19370972). Data are distributed under CC-BY 4.0 license.

The results of this study have been published in Seismological Research Letters*:* ***Escudero, L., A. Zollo, M. Mattesini, R. Rea, L. Elia, S. Colombelli, and E. Buforn (2025). Performance of an Impact-Based Earthquake Early Warning System in the Alboran Sea, Seismol. Res. Lett. 96, 3063–3075, doi:*** *https://doi.org/10.1785/0220240474*

Note: Data, products, software and publications resulting from TA activities must be publicly accessible under a CC-BY 4.0, GPLv3 or equivalent open license. No embargos beyond June 2026 are allowed. They must cite Geo-INQUIRE as the source of funding. Minimal citation: "*Geo-INQUIRE is funded by the European Union (GA 101058518)*".