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Challenges of DAS measurements in seismic urban areas: case study at Etna volcano eastern flank

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We present the use of distributed acoustic sensing of telecommunication fibre to perform seismic monitoring on the lower eastern flank of Etna volcano. Eastern flank of Etna is structurally characterized by the existence of many faults until under the sea. One of the clearest morphological feature is the Timpe Fault System (TFS) crossing highly populated urban areas. The TFS is formed by several main segments producing shallow seismicity with a dominant normal faulting style and a right-lateral component, related to WNW-ESE regional extension. This area is highly seismogenic, with occurrence of a very frequent seismic activity punctuated by destructive earthquakes with magnitude ranges $4.3 \leq ML \leq 5.1$ and a mean recurrence time of about 20 years.

To monitor the seismic response of this area we deployed an “intelligent” Distributed Acoustic Sensing (iDAS) system (SILIXA) in order to interrogate a 12-km-long telecommunication fibre-optic cable, managed by TELECOM Italia internet provider. The telecom cable runs from Linera to Zafferana villages along two primary directions roughly N-S and E-W and crosses the Santa Venerina and the Fiandaca faults, both part of the TFS. The former was entirely hidden until the 2002 eruption when a ML 4.4 earthquake exposed the fault at the surface and heavily damaged Santa Venerina village. The latter has been reactivated during the 2018 Etna activity, when a ML4.8 earthquake strongly damaged the Fleri village.

The iDAS was in acquisition for three months (11 September - 9 December 2019) and recorded the strain rate from natural and anthropogenic sources at a sampling frequency of 1 kHz with 2-m spatial resolution and a gauge length of 10 m. A second fibre in the same cable, was interrogated simultaneously by a FEBUS A1 system (FEBUS OPTICS) from 2 to 9 December 2019 with a spatial resolution and a gauge length of 5 m at a sampling frequency of 200 Hz. To validate the DAS measurements, gathered by both systems, two broadband seismometers (Trillium Compact 120 s) were deployed in the vicinity of the cable. We located using hammer shots along the cable at key positions.

During the acquisition period more than 800 local seismic events occurred on Etna with ML ranging between 0.4 and 3.4. Several regional earthquakes from Greece and Albania also occurred

up to ML6.1. These seismic sources allows for investigating the response of the fibre and the detectability thresholds of iDAS and FEBUS A1 in urban areas with heterogeneous installation conditions of the telecommunication cable (cased conduit, attached conduit, aerial track). We perform data analysis to characterize DAS amplitude and frequency responses to better estimate the coupling of the fibre to the ground.