Using submarine cables to detect earthquakes

February 6 2020

Credit: AI-generated image (disclaimer)

Installing seismic sensors on the ocean floor can be a difficult and expensive task. But what if seismic activity could be monitored by using something that's already down there – pre-existing submarine telecommunications cables? Partially supported by the EU-funded FINESSE project, an international team of geoscientists has used fiber optic communications cables at the bottom of the North Sea as a giant seismic network. The team tracked both earthquakes and ocean waves.

Their research was published in the journal *Nature Communications*. "We have presented and analyzed our observations of seismic and ocean waves on an ocean-bottom DAS [distributed acoustic sensing] array offshore Belgium, demonstrating that DAS arrays utilizing existing ocean-bottom fiber optic installations can offer high-value seismographic and oceanographic data products."

Quoted in a news release by the California Institute of Technology (Caltech), study lead author Ethan F. Williams says: "Fiber optic communications cables are growing more and more common on the sea floor. Rather than place a whole new device, we can tap into some of this fiber and start observing seismicity immediately."

DAS, the technique used by the researchers, was developed for energy exploration but was repurposed for seismology. It employs a photonic device that sends short pulses of laser light down the fiber optic cable. The Caltech news release states: "Tiny imperfections in the cable reflect back miniscule amounts of the light, allowing the imperfections to act as 'waypoints.' As a seismic wave jostles the fiber cable, the waypoints shift minutely in location, changing the travel time of the reflected light waves and thus allowing scientists to track the progression of the wave." The DAS instrument used in this study was built and operated by a team from FINESSE project participant University of Alcalá. "Seafloor DAS is a new frontier of geophysics that may bring orders-of-magnitude more submarine seismic data and a new understanding of the deep Earth's interior and major faults," says Zhongwen Zhan, assistant professor of geophysics and study co-author.

Transforming windfarms into a seismic network

Led by researchers from Caltech, the team employed a 40 000-m section of fiber optic cable that connects a North Sea wind farm to the shore, according to the same news release. "With the flip of a switch, we have an array of 4,000 sensors that would've cost millions to place," Williams

says.

Williams adds that the fiber network could detect and record an earthquake of magnitude 8.2 near Fiji in August 2018, which "proves the ability of the technology to fill in some of the massive blind spots in the global seismic network," as noted in the news release.

The FINESSE (Fibre Nervous Sensing Systems) project that supported the study will run until September 2020. The project website states: "The objective behind FINESSE … is to mimic the nervous system of living bodies by turning man-made and natural structures into objects that are sensitive to external stimuli owing to advanced distributed fiber-optic sensor technology, with the objective to either give early warning in case of possible danger or occurrence of damage, or to optimize the operation of the structure to allow for a sustainable use of natural resources and assets."

More information: FINESSE project website: itn-finesse.eu/ Ethan F. Williams et al. Distributed sensing of microseisms and teleseisms with submarine dark fibers, *Nature Communications* (2019). DOI: 10.1038/s41467-019-13262-7

Provided by CORDIS