Storm-induced signals are sensed by DAS fiber-optic sensors

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Natural hazard events (windstorms and floods) could threaten life and property in populated areas. Estimating the disaster level in different parts of the affected zone will facilitate timely and precise warning and benefit risk management. Currently only limited meteorological monitoring stations are available in cities. Recent studies have shown that seismometers are sensitive to noise induced by wind and rain. Distributed acoustic sensing (DAS) could turn existing optic fibers into dense seismic arrays in cities and can serve real-time sensors to detect vibrations at the meter scale over the long distance. The goal of this study is to search for and characterize the storm-induced seismic signals in DAS recordings in urban areas.

In this study, we identify numerous weather-induced signals from distributed acoustic sensing (DAS) recordings from an underground fiber-optic array in State College, PA. These signals show agreement with meteorological data (wind speed and rainfall) from nearby weather stations. We interpret that surface objects (light poles) swaying in the wind could generate seismic noise in low-frequency band (0.5-10 Hz). The energy decay fast while propagating in the shallow subsurface. We further characterize seismic noise during two types of rain events: moderate rain and heavy rain from Hurricane Ida. We observe strong noise in the frequency band of 2-8 Hz during both rain events, which is likely related to the interaction between accumulated water and air/sewer bases. During heavy rain like short-duration rainstorms, or rainfall from Hurricane Ida, we observe strong low-frequency and high-frequency noises up to 100 Hz, which is likely the acoustic energy from the rush stormwater runoff falling into the manhole. The detailed characteristic of weather-induced signals from DAS sensors could help us understand the weather processes temporally and spatially. Our results show the potential application of real-time monitoring of severe weather events using DAS with pre-existing telecom fiber-optic cables in urban areas.