EARTHSCIENCES

Seismic noise sources and background seismicity in London

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Research theme(s):	• Geophysics and Geodynamics • Geodesy, Tectonics, Volcanology and related hazards
Eligible courses for this project:	• DPhil in Earth Sciences • Environmental Research (NERC DTP) • Intelligent Earth (UKRI CDT)

Overview

Local geology and seismic hazards are generally investigated through the analysis of seismic data. In urban environments, estimating back-ground seismicity and seismic imaging is complicated by high levels of anthropogenic seismic noise, i.e. noise generated by our daily lives and activities. Consequently, we only have a poor understanding of subsurface structures and their potential seismic risk under metropoles such as London, even though these may affect the lives of millions of people.

During the Covid-19 pandemic, lockdowns resulted in decreased anthropogenic seismic noise, which was reliably detectable around the globe (Lecocq et al., 2020). Data from this period have significantly improved our understanding of anthropogenic noise sources and, accordingly, our ability to isolate and detect natural seismicity (De Plaen et al., 2021). Combined with the finding that low-cost seismometers are capable of recording meaningful information regarding seismic noise sources, this provides an unprecedented opportunity to better estimate background seismicity in urban environments.

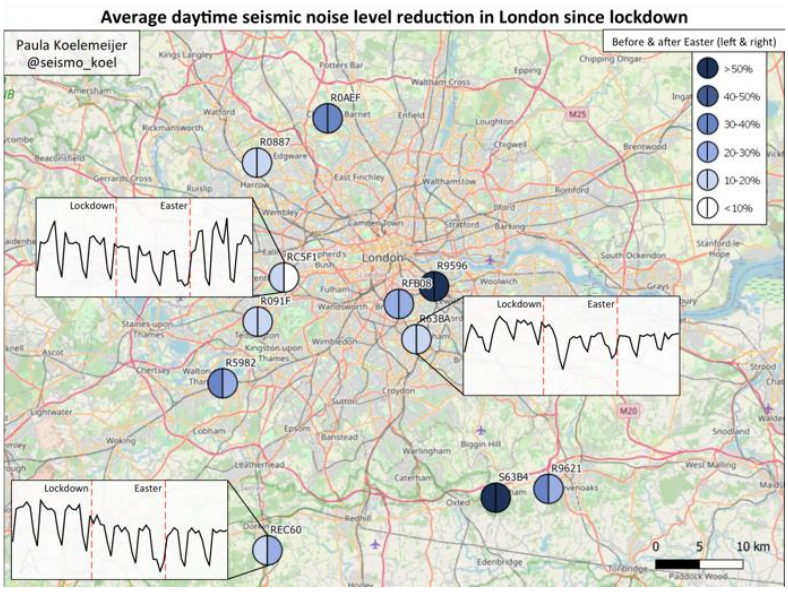

Figure showing the changes in daily seismic noise levels at different citizen-science instruments around London, following the first lockdown in the UK in March 2020.

This project aims to better characterise the sources of seismic noise and background seismicity levels in London. Although London is not usually considered to be tectonically active (and thus typically has had no professional seismometers installed), subsurface movements have been observed on previously unknown fault structures, with implications for engineering projects and seismic hazard maps (Morgan et al., 2021). This project will take advantage of our new under-standing of anthropogenic seismic noise to isolate and investigate these seismogenic structures.

Methodology

The project will combine seismic data from existing instruments as well as new deployments. Particularly, we have 20 Raspberry Shakes instruments and 180 STRYDE nodes available for longer and short-term deployments around London, which supplement existing sensors installed recently. These will be installed both underground and above ground (using existing contacts of the supervisors) to optimise station coverage and obtain a larger seismic data set.

Existing Python packages such as SeismoRMS (Lecocq et al., 2020) will be used to detect and analyse anthropogenic signals. Data from existing instruments will be incorporated and will be useful for identifying dominant sources of seismic noise by comparing data from before, during and after Covid-19 lockdowns. Stacking techniques (e.g. QuakeMigrate) will be used to search for small local seismic events, with power law relationships subsequently utilised to characterise background seismicity. Depending on time and data quality, seismic velocity may be developed using noise correlations or microseismicity. The outcomes of these endeavours will be compared to observations of subsurface faults and recent surface deformation (Morgan et al., 2021).

Timeline

Year 1: Doctoral training courses, literature review, deployment of seismic sensors, start of existing Raspberry Shake data analyses.

Years 2 and 3: Seismic data analyses, including analyses of seismic noise sources, identification of microseismicity, continued servicing of seismic equipment. Possible development of seismic velocity models.

Year 4: Integration of seismic data with surface deformation data and geology, thesis writing and presentation of results at international conferences.

Training & Skills

The successful candidate will join the seismology group at the University of Oxford, and benefit from interactions with existing PhD students, postdocs and faculty who work on similar topics.

The PhD student will receive training in computational methods and the processing of large seismic data sets, as well as the analysis of seismic noise and seismicity. In addition, they will be mentored on how to prepare scientific results at (inter)national conferences, how to write manuscripts for publication in international journals and how to communicate their science to a general audience.

In addition to the training in these transferable skills and research skills, the student will be provided with advice on funding applications and career support.

References & Further Reading

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Further Information

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