The University of Oxford Department of Earth Sciences

EARTHSCIENCES

UNIVERSITY OF OXFORD

Investigating local noise sources and background seismicity in London

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Overview

Local geology and seismic hazards are generally investigated through the analysis of seismic data. However, in urban environments, estimating background 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.

In recent years, urban seismology has become an active research field, not only for seismology (e.g. Green et al., 2015), but also for social science and engineering purposes (e.g. Díaz et al., 2017, 2020; Badcoe et al., 2020). Although the deployment of professional instruments has not significantly increased, the development of citizen science instruments such as Raspberry Shakes has led to a wealth of seismic data in urban environments. Despite being a fraction of the cost and easy to install, these instruments are able to capture teleseismic and local earthquakes, with background noise levels similar as on professional instruments.

During the Covid-19 pandemic, lockdowns resulted in decreased anthropogenic seismic noise, which was reliably detectable around the globe (Lecocq et al., 2020a). 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 Raspberry Shakes are capable of recording meaningful information regarding seismic noise sources, this provides an unprecedented opportunity to better estimate background seismicity in urban environments.

This project, partly funded by the Leverhulme Trust, 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 no professional seismometers are installed), subsurface movements have recently 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 understanding of anthropogenic seismic noise to isolate and investigate these seismogenic structures.

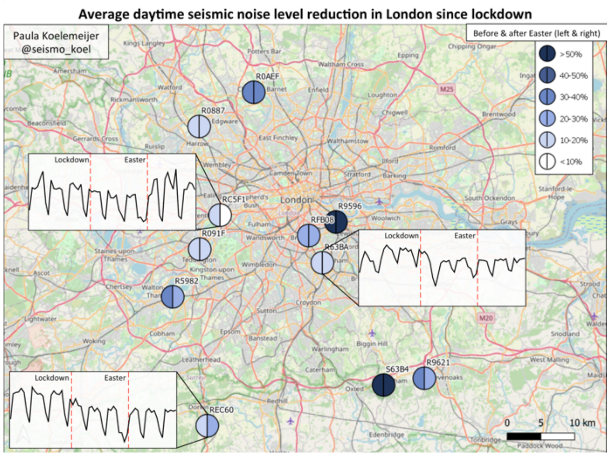

Figure showing the changes in daily seismic noise levels at different Raspberry Shake instruments around London, following the first lockdown in the UK in March 2020.

Further Information

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Methodology

The project will combine seismic data from existing instruments as well as new deployments. Particularly, we will install an array of Raspberry Shakes and other seismic instruments around London. 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 will be used to detect and analyse anthropogenic signals and natural seismicity. Noise sources will be investigated using SeismoRMS (Lecocq et al., 2020b), which analyses seismic noise as a function of time and frequency. Data from existing instruments will be incurporated and will be useful for identifying dominant sources of seismic noise by comparing data from before, during and after Covid-19 lockdowns.

Stacking techniques 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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