Seismic noise reduction in Tokyo urban area due to social activity reduction for COVID-19

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In order to deal with COVID-19 pandemic, social activities have been reduced around the world. Tokyo metropolitan area is no exception, where more than 30 million people live. Self-restraint was requested in various situations by local and Japanese governments, which drastically changed our life. Working from home or layoff was introduced in many companies. Shopping malls were closed. The movement of people was reduced, and economic activities stagnated.

A part of noise observed by seismometers is due to human activities including transportations and machine vibrations. It is well known that seismic noise level in the daytime is higher than in the nighttime. The social activity reduction for COVID-19 is expected to decrease seismic noise in a different way from regular pattern, which would provide us a good opportunity to improve our understanding of seismic noise. Better understanding of seismic noise may also provide us a new way to monitor human activities using seismic observations. This study investigated continuous record of seismic stations in Metropolitan Seismic Observation network (MeSO-net) maintained by National Research Institute for Earth Science and Disaster Resilience (NIED). Seismic stations of MeSO-net are settled at the bottom of shallow borehole (~20 m) in the Tokyo metropolitan area. We measured hourly seismic noise level and compared its temporal changes with a timeline of COVID-19 in Tokyo metropolitan area.

We observe two types of seismic noise reduction associated with different causes in MeSO-net stations. The first one is often observed in frequency bands higher than 20 Hz. This seismic noise reduction started at the beginning of March 2020. This timing corresponds to when Japanese government closed schools. As many MeSO-net stations are settled in school property, human activities there are considered to influence seismic records of MeSO-net stations strongly in a high frequency band. The second seismic noise reduction is often observed in lower frequency band between 1-20 Hz. This seismic noise reduction started on April 13th 2020. This timing corresponds to the first beginning of week after the Japanese government declared a state of emergency in Tokyo metropolitan area on April 8th 2020. Seismic noise reduction in lower frequency band is expected to be related with stagnated economic activities, such as decreasing transportations and closing buildings or factories.

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