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Seismic Noise Lowering Caused Due To Covid 19

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ABSTRACT: *Human activities causes fluctuation which propagate into ground as high frequency seismic waves. We evaluated seismic background noise at national network in India. The analyses were performed to understand characteristics of noise wave-field in such unprecedented situation and its effect on site response at the station. This quiet period provides an opportunity to detect subtle signals from subsurface seismic sources that would have been concealed in noisier times and to benchmark sources of anthropogenic noise. Although social activity was not reduced significantly at this juncture, local reduction of seismic wave excitation in the high-frequency band, 20–40 Hz, was recorded at some places. A strong correlation between seismic noise and independent measurements of human mobility suggests that seismology provides an absolute, real-time estimate of human activities.*

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I. INTRODUCTION

Seismic noise with frequencies above 1 Hz is often called cultural noise. Seismometers record signals from more than just earthquakes. Around the world, seismometers don't just pick up loud echoes of earthquakes rumbling through the subsurface. The instruments also detect many subtle reverberations. Seismometers can even detect ground vibrations generated by everyday human activities, such as traffic, construction and parades or football games. . Seismometers in urban environments are important to maximize the spatial coverage of seismic networks and to warn of local geologic hazards, even though anthropogenic seismic noise degrades their capability to detect transient signals associated with earthquakes and volcanic eruptions. Hence, it is important to accumulate observations in various cities to understand the characteristics of cultural seismic noise in urban environments.

II. DATA ANALYSIS AND METHODOLOGY

The seismological data from the entire national network, including those operated by other agencies funded by the Ministry of Earth Sciences (MoES), are compiled, processed, analysed and archived systematically in DC of the NCS in standard SEED format, which could be retrieved successfully as and when required. The DC is equipped with data acquisition modules, SEEDLINK server for real-time data exchange, data storage, networking and data access infrastructure with regional centres, offline data exchange and information management. All the data collected at New Delhi data Hub is mirrored at Hyderabad data Hub to ensure the data availability in case something goes wrong at either of the locations. All the seismic stations of the national network of India, equipped with tri-axial broadband velocity sensors with 120 s period coupled with 24 bit DM-24 digitiser, are operating at sampling intervals of either 40 or 100 samples per second (sps). As the sampling rates at some stations are 40 sps, we analysed data up to 20 Hz. The longest periods recorded in waveform data found limited to about 100 s. Data from the seismic stations received to Central Receiving Station (CRS) through very small aperture terminal (VSAT). At seismic stations located in loose soil areas, the upper top soil cover removed up to 1.5–4.5 m and a concrete pier constructed for placing the sensor and hence minimized the soil effect. More broadly, the seismic lockdown will help us to differentiate between human and natural causes of seismic noise. The gradual easing of restrictions will allow us to monitor the effect of different human activities on seismic noise and lead to a better understanding of anthropogenic noise sources.

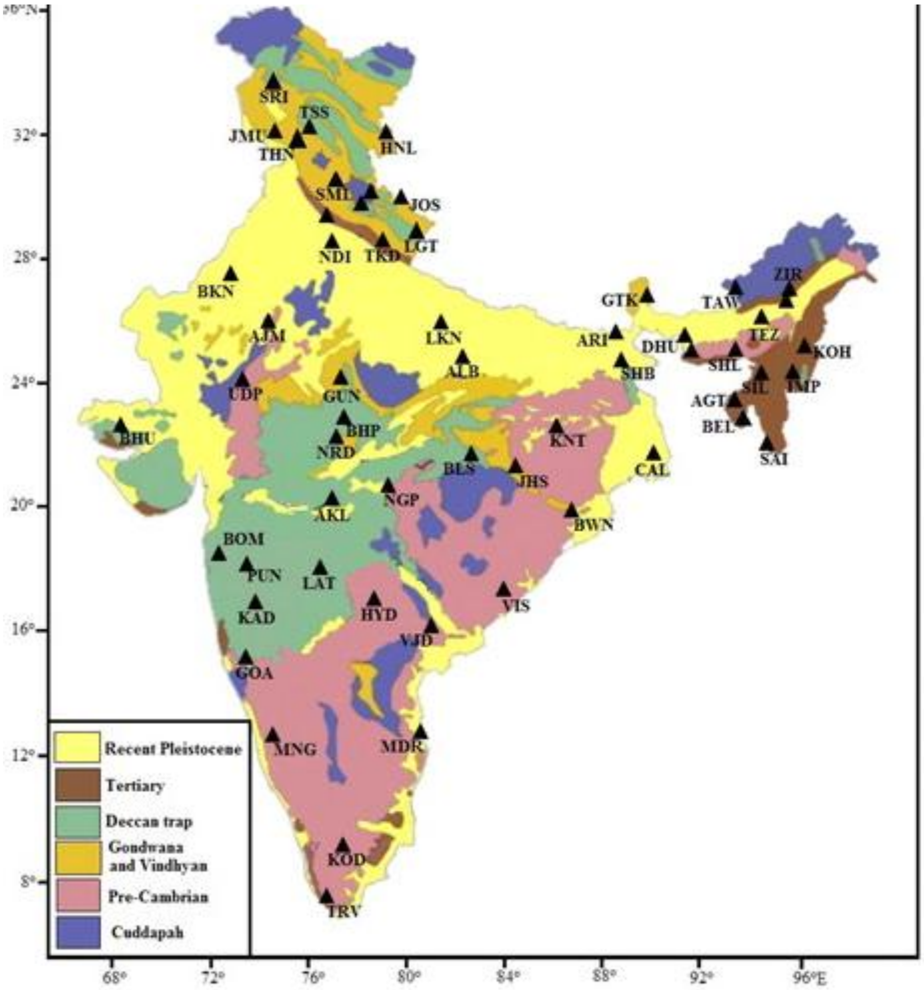

FIGURE 1

POWER SPECTRAL DENSITY

The power spectral density (PSD) approach employed for quantitative assessment of seismic background noise as power (energy) distribution with frequency. PSD is measure of signal strength as a function of frequency which is used to understand the variations of SBN in short and long period spectrum at different time intervals. It is typically used to characterize broadband random variables. We adopted the formulation proposed by McNamara and Buland (2004) for PSD analysis of SBN at 115 BBS stations across the country, before and during lockdown situations. However, we presented the results for representative 20 BBS stations, considering different geological formations as well as urban and remote areas. Power Spectral density of the vertical component for the broadband stations of the NCS seismic network before (Left Panel) and during (Right Panel) lockdown. PSDs from the vertical component are shown in decibels (dB) relative to the ground acceleration. Reduction of ambient noise < 1 s is obvious in PSDs; which is higher before the lockdown. Consequently, in the present study, we considered vertical component of ambient noise wave-field in the analysis to understand the influence of COVID-19 lockdown situation. A 30 minutes time window used for cutting noise samples from homogeneous sections of the ambient noise wave-fields. About 200 samples from each segment of 7 days period (i.e., before and during lockdown) analysed for estimating a single average noise spectrum at each site. We also analysed the waveforms recorded in different time periods such as a week and two weeks separately for PSD and compared. The results are depicted identical in terms of values and patterns. Estimated PSD contains a set of standard reference curves of new Low Noise Model (LNM) and High Noise Model (HNM), which indicate the upper and lower limits of a cumulative compilation of ground acceleration power spectral density.

Figure 2 Illustrates this.

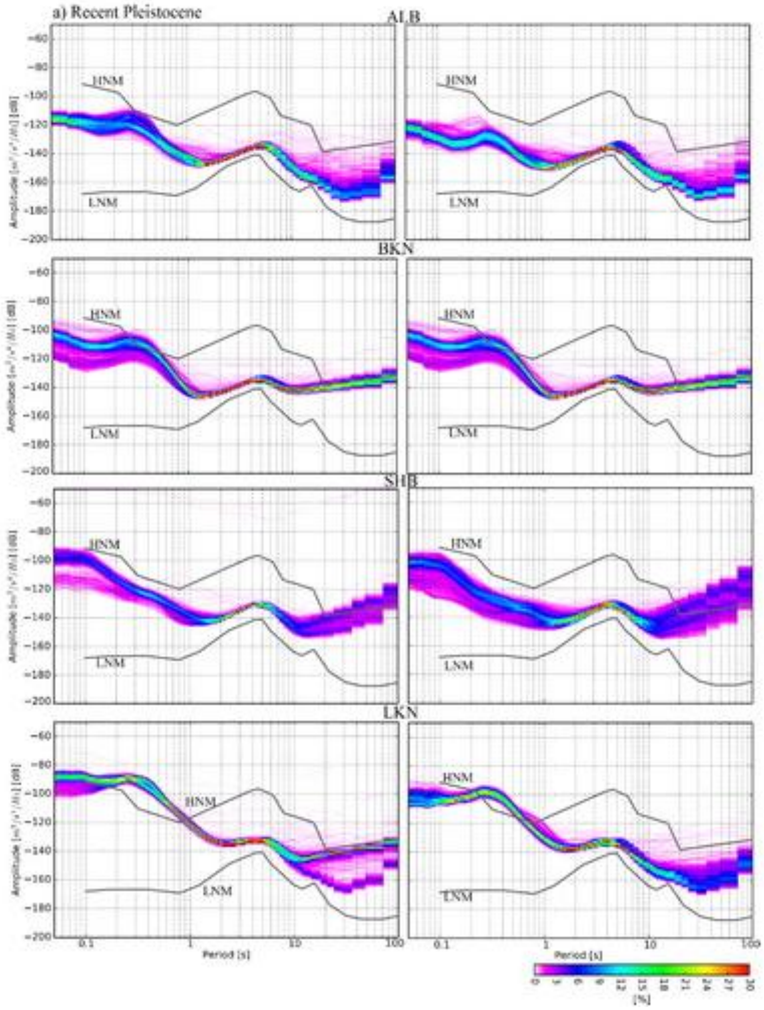

FIGURE 2

WHAT IS SEISMIC NOISE? WHAT WAS THE IMPACT OF PANDEMIC ON SEISMIC NOISE LEVEL?

Seismic noise refers to vibrations within the Earth, which are triggered by natural and man-made phenomena like earthquakes, volcanoes and bombs. Seismometers, specialised devices that record ground motions, also capture seismic noise.Everyday human activity such as road traffic, manufacturing in factories, the sound produced by planes roaring overhead, or simply people walking down the street also generate seismic noise, which is recorded as a near-continuous signal on seismometers. The sound signals created by human beings is often referred to as anthropogenic seismic noise.Soon after the COVID-19 pandemic was declared a global health emergency earlier this year, countries across the world responded by imposing stringent lockdown measures and enforcing social distancing norms. As a result of this, offices were shut, manufacturing slowed down drastically, and air and road travel was stalled almost completely.Many scientists have noticed favourable changes in the environment such as reductions in nitrous oxide emissions and improved air quality due to the pandemic. But the team of seismologists from around the world has found that the coronavirus outbreak also resulted in unparalleled noise reduction globally.

What were the regional variations in noise levels?

The level of anthropogenic seismic noise recorded varies based on a number of factors. Highly-populated urban areas will generate more vibrations from human activity than less densely populated regions. Timing too, plays an important role. The degree of seismic noise is found to be much lower during public holidays.

The study found that global median high-frequency anthropogenic seismic noise (hiFSAN) dropped by as much as 50 per cent in the beginning of the year. The most drastic reduction of hiFSAN since the lockdown began was observed in Sri Lanka, where it went down by half.Apart from data collected from surface stations, the researchers also assessed the effect of the pandemic on seismic levels underground. They did this using seismometers installed in boreholes. The researchers found that vibrations from human activity are felt even deep below the surface of the Earth.

III. AVERAGE NOISE LEVEL

The daily power spectral density for the three components of seismic data recorded at Shillong (25.567°N 91.856°E) is monitored continuously at a rate of 100 samples per second since its installation in the late 2007. The instrument is Nanometrics Trillium make, whose response is flat down to 240 s. The ambient noise spectral power at six different widely separated frequencies (0.01 Hz, 0.032 Hz, 0.1 Hz, 0.154 Hz, 1.037 Hz and 9.87 Hz) is shown for all three components starting from 1 March 2020 till the first week of April 2020. The spectral power at 9.87 Hz has taken a sharp dip on the 22 March 2020 in EW, NS and vertical direction. This was the day the Prime Minister of India announced what he termed as “Janata Curfew”, self-imposed lockdown of people for a day. On this day, people were asked to remain indoors all day. Incidentally, it was also a Sunday. However, the dip by 10–15 dB on the Janata Curfew Sunday is not the typical of other weekends. On 23 March, power levels appear to be catching up with those of background noise levels. However, the complete lockdown of India started on the 25 March 2020 and is still ongoing. Ever since the 25 March, the background seismic noise levels

THE SEISMIC LOCKDOWN WAVE

By analysing months- to years-long datasets from over 300 seismic stations around the world, our study was able to show that seismic noise was reduced in many countries. This made it possible to visualise the resulting ‘seismic lockdown wave’ moving through China at the end of January to Italy in March, and then around the rest of the world. While 2020 has not seen a reduction in earthquakes, this seismic noise quiet period is the longest and most There was a strong match between how much seismic noise fell in a particular area and the change in the amount of human movement recorded there, as measured using mobile phone data made publicly available by Google and Apple). This correlation means open seismic data can act as a broad proxy for tracking human activity almost as it happens – as people reduce their movements, seismic noise quickly decreases. We can also use the seismic data to understand the effects of pandemic lockdowns and recoveries without impinging on people’s privacy because we don’t rely on the movements of individuals.

More broadly, the seismic lockdown will help us to differentiate between human and natural causes of seismic noise. The gradual easing of restrictions will allow us to monitor the effect of different human activities on seismic noise and lead to a better understanding of anthropogenic noise sources.

RESEARCH CHALLENGES:

Analysis of SBN record is an established robust technique for checking the noise characteristics of a particular seismic station, and compares the level in respect of the global standards. It is originated by numerous transient and permanent sources in different specified time periods. The quantification of such noise makes it possible to appraise the performance of seismic network. Significant variations in PSD for both the situations, before and during lockdown, found mainly at short period < 1 s, which may be generated due to local wind and man-made activities. We observed a clear peak at about 5 s (0.2 Hz) , which originates globally on the Earth due to interaction between oceanic waves and coastal region (Longuet-Higgins Friedrich et al.)

IV. CONCLUSION:

Ambient vibration has reduced across the world due to the lockdown, which is different from country to country. Apart from helping in quantifying the noise power of a site and providing ground vibration records in the event of an earthquake, seismic data of broadband sensors can also help in identifying the human contribution to background seismic noise during rare disasters like COVID-19 that lead to lockdown. Anthropogenic noise in Shillong, India, is found to be anywhere from 5–10 dB at 10 Hz. Similar analysis can be conducted for other countries of the world, if they had announced lockdown, in figuring out the human contribution to ground vibrations.

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