Acoustic Quality and Health in Urban Environments – The SALVE Project

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Background & Aim

- In health research, urban sound is often reduced to the risk factor noise measured in a-weighted decibel[1,2]
- However, the whole sprectrum of urban sound can also be understood as resource for a healthy urban environment
- Research is missing to analyze urban sound in respect to the built environement and human health
- Soundscape ecology (SE) is an approach to consider the whole time-frequency spectrum of sound including a widened array of noise and soundscape indices[3]
- Since traffic is a main component of urban sound, the SARS-CoV-2 lockdown provides an unique opportunity to investigate the urban sound distribution with drastically reduced traffic in the entire urban environment
- Aim here is to describe the effects of the SARS-CoV-2 lockdown in a German city on noise levels as well as on the development of anthrophonic and biophonic soundscapes (Fig. 1)

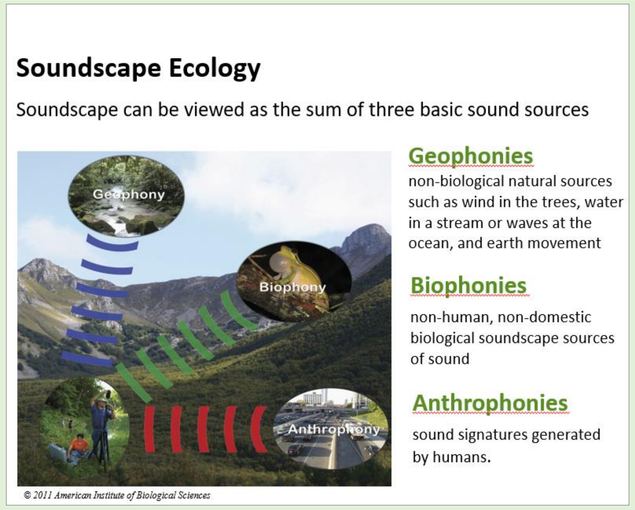

Fig. 1: The three basic sound sources studied in Soundscape Ecology.

Methods

- 22 Wildlife Acoustics SM4 Devices in different land use types in the city of Bochum, Germany in metropolitan Ruhr Area (Fig. 2)
- Automatic recording of 3-minute samples every 26 minutes (part of SALVE project[5])
- Calculation of sound indices L_{Aeq}, NDSI, using Wildlife Acoustics Kaleidoscope software and R, where the NDSI indicates the proportion of biophonic to anthrophonic sounds
- Calculation of power spectrum using Welch's Method[6] with hamming window, 1025 frequency points and 50 % overlap
- Observation period: 5 weeks before and after 2020-03-16, the start of the lockdown
- Data stratified by land use type (Fig. 3)

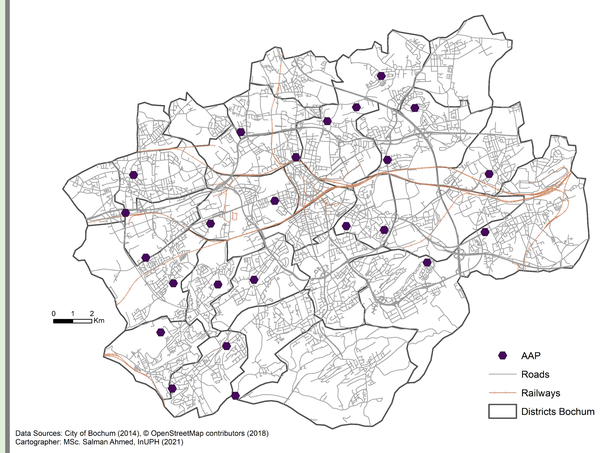

Fig. 2: Map of Bochum and location of recording devices.

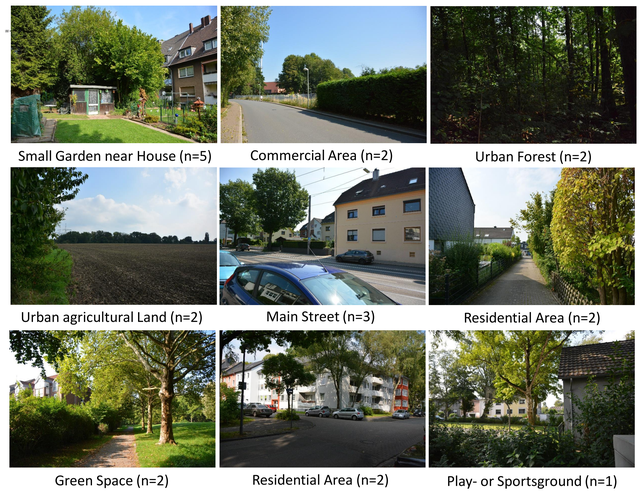

Fig. 3: Exemplary photos of recording sites and number (n) of devices per land use type.

Results

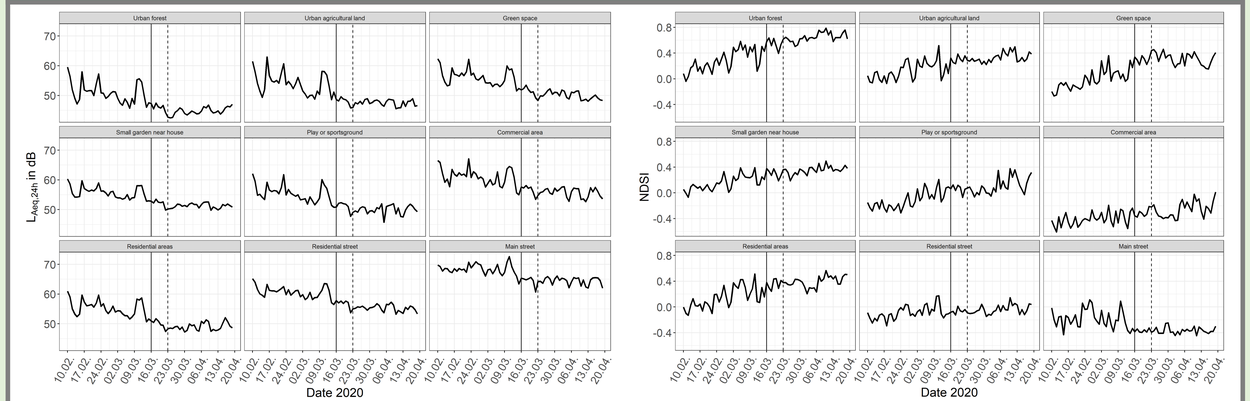

Fig. 4: L_{Aeq} and NDSI, averaged by date. Vertical lines represent start of first restrictions on 16th of March (solid line) and strict contact restrictions starting on 22th of March (dashed line).

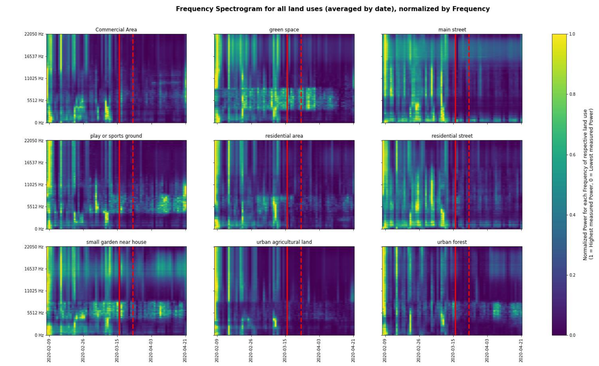

Fig. 5: Frequency Spectrogram for all land uses (averaged by date), normalized by Frequency. Vertical lines represent start of first restrictions on 16th of March (solid line) and strict contact restrictions starting on 22th of March (dashed line).

- Mean overall noise level reduced by 5.1 dB(A) after lockdown, with clear reductions in all land uses (Fig. 4)
- Mean overall NDSI increased by 0.15. Only in "Main street", a clear reduction was observed, indicating an absence of biophonic sound sources (Fig. 4)
- Frequency range from approx. 4 to 8 kHz less affected by lockdown in most places, indicating a non-anthrophonic frequency range. E.g., green spaces and small gardens show a dynamic in these ranges that is seemingly unaffected from lockdown (Fig. 5)
- Sharp decrease in power in most other frequency ranges after lockdown (Fig. 5)
- Comparing the normalized frequencies by row, we can see that low frequency ranges (< 4 kHz) show similar dynamics as frequencies > 8 kHz. (Fig. 5)

Conclusion

- Reduced anthrophonic sound sources changed the urban acoustic environment in terms of noise and frequency composition
- Noise levels as well as biophonic and anthrophonic frequency ranges vary in different land uses
- Metrics of sound ecology can complement traditional noise measures to characterize urban sound
- SE metrics can help to understand the acoustic environment to facilitate future research on urban design and health promotion

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