NatureSensing: An IoT approach to characterising biodiversity of green spaces

Background

Despite the promise around greenspace to improve health, robust evidence on the characteristics of greenspace that yield the best health outcomes is lacking, as highlighted by Barton and Rogerson[1]:

If greenspace were considered in the same way as a drug for mental health and well-being would be, more detailed understanding of its mechanisms would lead to optimal dosage, and knowledge of when and for whom it might work best. Optimal doses need to account for a wide range of mediators (Shanahan, Fuller, Bush, Lin, & Gaston, 2015)*, including:*

- *Environmental factors, both qualitative (e.g. biodiversity, air quality, noise) and quantitative (e.g. tree canopy cover), as well as weather*
- *Personal factors, such as age, gender, beliefs about the value of nature, nature relatedness, prior experiences and childhood memories, as well as perceptions of risk*
- *Social and community factors, including social interaction, trust, ethnic, cultural and social norms, and accessibility of green spaces.*

Biodiversity of greenspaces

One of the key characteristics of greenspaces that could impact health is biodiversity, i.e. species richness and abundance. Capturing information on biodiversity, however, is complicated and highly resource intensive, and little research exist to date on how local governments could incorporate biodiversity into planning and design of green spaces to assess its potential health and environmental impacts.

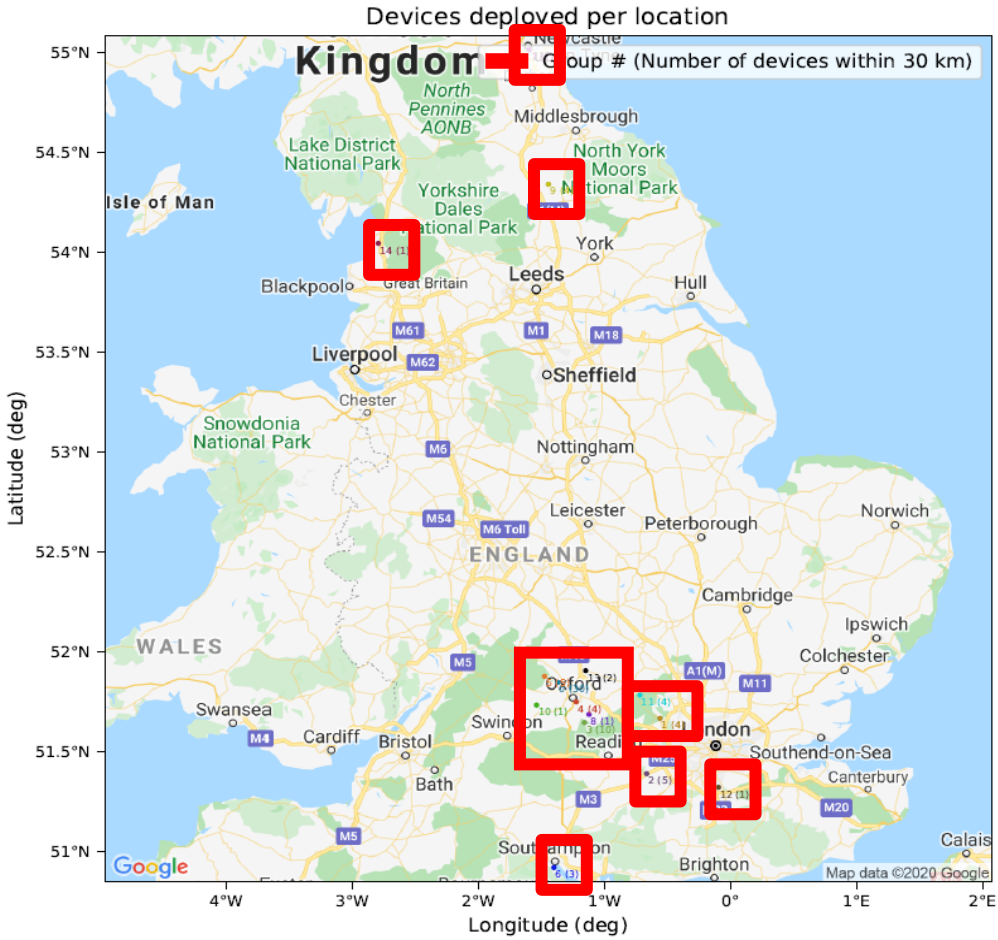
In this project, partners from the University of Oxford, Oxfordshire County Council, Newcastle University and Open Acoustic devices came together to explore whether a citizen-science approach utilising Internet of Things (IoT) sensors could efficiently and effectively capture information on biodiversity in greenspaces.

We used AudioMoth, a validated low-cost, full-spectrum acoustic logger,[2] developed by Professor Alex Rogers at the University of Oxford's Computer Science Department, in our citizen-science approach to capture soundscape information of greenspaces in Oxfordshire and beyond (https://www.openacousticdevices.info/audiomoth). We then explored how this information could be used to extrapolate biodiversity information based on the 'biotic' or natural characteristics of the soundscape information captured by AudioMoth using an analytical method called Normalised Difference Soundscape Index (NDSI).

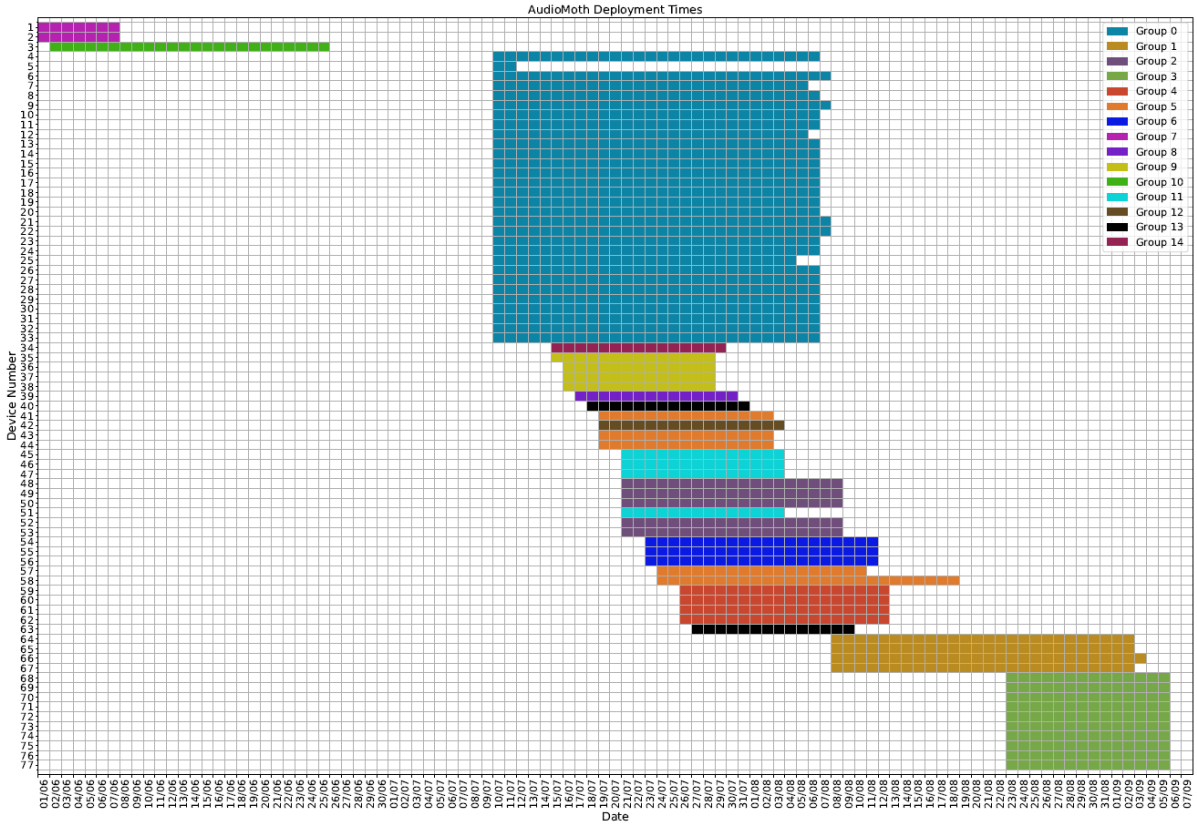
We partnered with the Oxfordshire County Council, Newcastle University and Blenheim Palace Estates to recruit volunteers through an active engagement campaign through their networks: https://www.greenspacehack.com/project/nature_sensing.html. Volunteer information was captured through an online survey form. Despite the difficulties with the COVID-19 restrictions, 22 individuals volunteered to deploy the Audiomoth devices in compliance with COVID-19 social distancing regulations and following instructions posted on our Greenspace Hack website: https://www.greenspacehack.com/sensing/. In addition to community volunteers, the Innovation team at Blenheim Palace Estates also agreed to deploy sensors across their 1,000 acres of greenspace.

Deployment locations

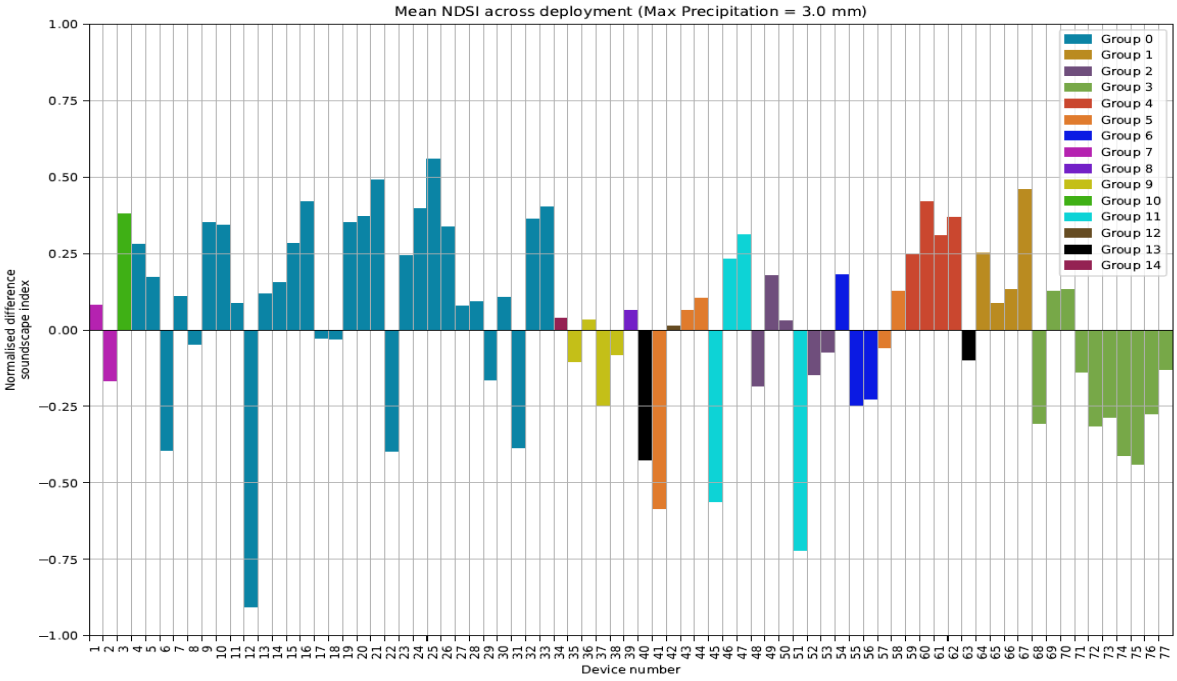
Data was organised into 14 geographical groups, with comparable environments, defined by deployed devices within 3 km of each other, which are highlighted in the red boxes on the map below.



Soundscape information was captured for approximately the same length of time across different groups as highlighted in the graph below:



To analyse the soundscape information, we used the NDSI, which produces values between -1.0 and +1.0 and represents a ratio of biotic to anthropogenic (i.e. human-derived) sound and uses frequency bands to define each. A number closer to +1.0 indicates a greenspace with greater biotic sound, and thus biodiversity, compared to -1.0, which indicates a greenspace with more human-derived sounds. Across our sites we found the NDSI values as indicated in the graph below:



Implications of our findings

Overall, the soundscape information captured using AudioMoth and then analysed using NDSI seems to be a good method for defining the "naturalness" of a site and, thus, the biodiversity levels. From the analyses of all of our sites, ranking by NDSI demonstrated that sensors deployed near Blenheim Palace were the "most natural". One caveat is that it is difficult to judge the overall effectiveness of the NDSI metric due to lack of diversity in sites, which we will hopefully be able to overcome in future studies by exploring a greater variety of sites.

Having established a method to extrapolate an IoT-informed measure of 'naturalness', we would now like to explore what this score actually means in practice. We plan on deploying to a greater variety of sites to ensure the NDSI can be used across a range of settings. We also plan on applying for future funding to explore stakeholder engagement to link the 'naturalness' score and what we have learned from our scoping review to experiences of citizens of greenspaces. Our goal would then be to help use this score to inform policy planning around health and environmental impact of greenspaces by the Oxfordshire County Council and local governments more generally.

For any questions or more information, please email anant.r.jani@gmail.com

References

1. Barton, J., & Rogerson, M. (2017). The importance of greenspace for mental health. *BJPsych. International*, *14*(4), 79–81. https://doi.org/10.1192/S2056474000002051
2. Hill, A. P., Prince, P., Snaddon, J. L., Doncaster, C. P., & Rogers, A. (2019). AudioMoth: A low-cost acoustic device for monitoring biodiversity and the environment. HardwareX, 6, e00073. https://doi.org/10.1016/j.ohx.2019.e00073