Imperial College London

Natural Environment Research Council

2021_30: Assessing ecosystem resilience through the use of ecoacoustics

Supervisors: Lorenzo Picinali (l.picinali@imperial.ac.uk); Rob Ewers, Department of Life Sciences

Department: Dyson School of Design Engineering

Tropical rainforests are globally important ecosystems that exert strong influence on global biodiversity, global carbon budgets and global livelihoods. The desirable – and arguably essential – state for a tropical rainforest ecosystem is one that is stable, resilient and sustainable, but there are no methods available to unambiguously quantify these concepts in real-world ecosystems. There are, however, concepts such as critical slowing down (Clements and Ozgul, 2018) that have been demonstrated in laboratory systems (Dai et al., 2012, Drake and Griffen, 2010). Should it be feasible to detect field ecosystem analogues of the metrics recorded in these laboratory, microcosm studies, there is opportunity to develop a robust, early warning system capable of detecting the loss of ecosystem resilience in near real-time.

EcoAcoustics - the sound of the environment - is probably the best available option to do this. Acoustics amalgamates all of the noise from all of the species within an ecosystem, and we have demonstrated its ability to quantify ecosystem properties including habitat quality and biodiversity (Sethi et al., 2020). In this project, you will extend this work to examine acoustic data for the temporal signals associated with critical slowing down (Dai et al., 2012): an increase in the size and duration of fluctuations in the acoustic signal. The thesis will have two components. First, you will collect and analyse temporal variability in long-term, continuous acoustic records collected across a primary forest to oil palm plantation habitat gradient in Sabah, Malaysia. Second, you will develop and implement novel field experiments that introduce acoustic disturbances to investigate acoustic variation across a habitat gradient to a standardised disturbance, with a view to experimentally quantifying ecosystem resilience.

For both research components, acoustic monitoring will be carried out using devices developed in our lab (Sethi, 2018), which will be further extended by adding multi-microphone arrays. 3D sound analysis and localisation techniques (e.g. beamforming – Van Veen, 1988) will be employed in the time/frequency domain in order to determine the directivity and diffuseness of the various elements of the recorded soundscape (Pulkki, 2007). This information will then be integrated with the other acoustic data and facilitate the measurement of the temporal variability and the quantification of ecosystem resilience. Furthermore, the 3D audio recording will allow to re-create the acoustic field of the original environment in the lab through loudspeaker arrays, and to use these for further soundfield analyses in a controlled and replicable environment.