

CMEE MRes Project Proposal:

Using N-Dimensional Hypervolumes to Assess the Stability of Ecosystems Under Land-Use Change

Keywords:

N-Dimensional Hypervolumes;
Ecosystem Stability;
Land-Use Change

Student:

David Bridgwood
dmb2417@ic.ac.uk
MRes - Computational Methods in Ecology and Evolution

Supervisor:

Professor Robert Ewers
r.ewers@imperial.ac.uk
Faculty of Natural Sciences, Department of Life Sciences (Silwood Park)

1 **Introduction**

2 The stability of an ecosystem is its ability to self-regulate and return to an equilibria state after
3 an environmental perturbation. Ecosystems are facing escalating pressures from climate and
4 land-use change, these environmental perturbations are expected to cause ecosystems to move
5 away from stability and towards new ecosystem states (Standish et al. 2014). The forests of Borneo
6 are an example of an incredibly biodiverse ecosystem (De Bruyn et al. 2014), under severe
7 pressures from land-use change due to timber harvest and expansion of commercial crops (Tsujino
8 et al. 2016). It is therefore important to understand the impact that these stresses are having on the
9 stability of Borneo's forests.

10 N-dimensional hypervolumes have historically been used to quantify ecological species niches
11 with axis representing those things which make up a species' ideal environment (e.g. temperature
12 and food-size) (Blonder et al. 2014), the subset of the n-dimensional space that the given shape
13 occupies is that species' niche. The concept of multi-dimensional shapes has since been used in a
14 variety of applications within ecology, from functional and community ecology to addressing
15 phylogenetic and evolutionary questions (Blonder 2017). Barros et al. (2016) demonstrated that it is
16 possible to use these hypervolumes to investigate the impact that perturbations on an environment
17 have on an ecosystem. They were able to use n-dimensional hypervolumes to define the state of
18 an ecosystem using ecosystem components from species abundances, to functional traits and
19 ecosystem services. They applied several models with different levels of climate and land use
20 change and compared their n-dimensional hypervolumes once at equilibria. This allowed them to
21 determine if ecosystems settled at different states and so assess the possible impacts of
22 environmental perturbations on the stability of ecosystems.

23 This project will use a similar approach to Barros et al. (2016) to determine how the state of
24 ecosystems in Borneo's rainforests are being impacted by land-use changes.

25 **Aims and Objectives**

- 26 • Building of n-dimensional hypervolumes to characterise the state of ecosystems in Borneo's
27 rainforest under varying degrees of land-use change pressures.
- 28 • Comparison of these hypervolumes to determine the trajectory of ecosystem-states under
29 land-use change.

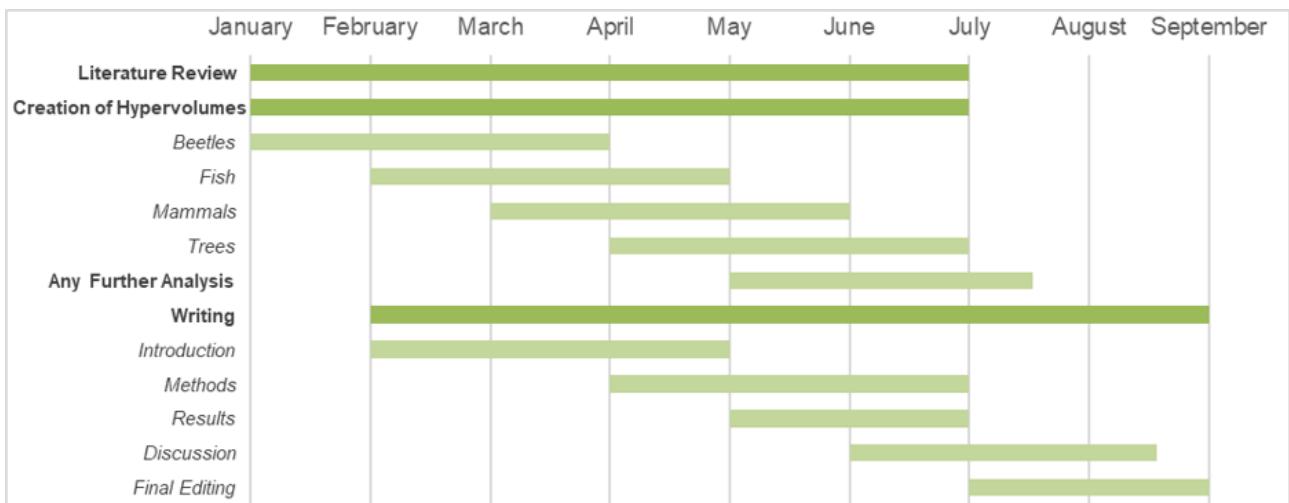
30 **Methods**

31 Hypervolumes for ecosystems under different land-use changes and at different time-points
32 will be constructed using the R package "hypervolume" (Blonder & Harris 2017), with relevant
33 ecosystem components acting as the axis. Once constructed these hypervolumes can be compared
34 using a number of different metrics to determine the impacts of perturbation on the state of the
35 ecosystems. Firstly changes in hypervolume size will be used to measure the magnitude of changes

36 to the ecosystem components. The amount of overlap between hypervolumes will then be used as
37 an indicator of similarity in ecosystem states with more similar ecosystems having a higher
38 proportion of overlap. Finally, the change in distance between the central points of hypervolumes
39 (the centroid) will indicate how the mean values for ecosystem components have shifted (Barros
40 et al. 2016).

41 Data for the construction of the hypervolumes will come from the SAFE project (Ewers et al.
42 2011), a large scale ecological experiment looking at the impacts of forest-fragmentation in Borneo.
43 Data from this project is readily available for taxa including; beetles, fish, mammals and trees.

44 **Project Feasability (Timeline)**



45

46 **Budget**

Expense	Amount
Something	£-
Something else	£-
Total	£500

47

48 **References**

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