EEES Project Proposal Form – 2022 entry

Project Title	**OU15 - Hyperspectral signals of change in grassland ecosystems**
Key words	Earth observation, calcareous grassland, species-rich, long-term experiment
Supervisory team (including email address	**PI:** Dr. Kadmiel Maseyk (kadmiel.maseyk@open.ac.uk) **Co-I:** Dr. Clare Lawson (clare.lawson@open.ac.uk); Dr. Holly Croft (U. Sheffield, h.croft@sheffield.ac.uk)
Is the PhD suitable for part time study?	Yes ☒ No ☐

Project Highlights:

- Using long-term field experiments to develop change metrics for grassland ecosystems
- Field work at a climate change experiments across the UK
- Integrating ecophysiology, biodiversity, and field spectroscopy

Overview (including 1 high quality image or figure):

The driving forces of climate change and land management affect ecosystem natural capital through their impacts on ecosystem structure and function. Calcareous grasslands are ecosystems of high conservation importance due to their high biodiversity but are becoming increasingly rare due to conversion to arable land. Understanding the impact of global change processes on these ecosystems is therefore key to their conservation. To understand ecosystem responses to climate change we use long-term experiments (LTEs): field-based manipulation of specific climate factors or nutrient levels in a controlled manner to simulate future conditions. When run over the long term (i.e. multi-year to decadal), they provide valuable insight into the nature and direction of shifts in ecosystem processes (Grime et al 2007, Sayer and Silvertown 2019). We can also use these experiments to identify the signals associated with ecosystem change and apply this knowledge to understanding contemporary change dynamics. Changes in leaf and canopy traits, physiology, and species composition change the magnitude and spectral composition of vegetation reflectance (Peng et al. 2018, Punalekar et al. 2016) which is being measured through systems on canopy, drone, airborne and satellite platforms. Therefore, knowing the relationship between spectral signals and vegetation climate change responses can help us identify and quantify rates of contemporary change.

This project will investigate ecosystem responses to environmental change and the associated reflectance spectra in grassland ecosystems. It will focus on the impacts of hydrological change (drier and wetter) on calcareous grassland at the RainDrop LTE, located in a Natural England SSSI at Wytham, Oxfordshire (Fig. 1). Field spectroscopy will be combined with measurements of plant and ecosystem structure and function and species diversity to identify the signals associated with climate change impacts. Measurements will also be made at other grassland experimental sites in the Ecological Continuity Trust register across the UK to identify general and specific responses to change. Data and results will be integrated into a process-based canopy radiative transfer model and compared with remote sensing data.

Figure 1: The rain shelters and irrigation system in operation at the RainDrop experimental site at Wytham, near Oxford.

Alt-text: A sloping grassland with a sprinkler system in the foreground and two rain shelters behind. The rain shelters are 1-2 m high, and have gutter roofing that covers half of the shelter area.

Methodology:

The RainDrop LTE was established in 2016 and will be entering its 7th year of treatment at the start of this project. Rain shelters are used to intercept 50% of incident rainfall over 25 m^2 treatment plots, to impose a drought treatment, and this is simultaneously distributed by irrigation on an adjacent plot, for a wetting treatment. High-resolution spectroscopy using a dual-field-of-view spectrometer system will be used to measure reflectance indices and solar induced fluorescence in the field across the treatments and sites. Leaf and ecosystem properties that underpin canopy reflectance and radiation transfer models will be quantified, including leaf chlorophyll content, fluorescence, optical properties and leaf area index. Depending on the interests of the student, there are options to further explore the links with plant physiology and species diversity, incorporate this information into a modelling framework or contextualise remote sensing data.

Training and skills:

You will gain experience in field spectroscopy and plant ecophysiological and measurements, data handling and analysis. You will receive the necessary training in all analytical techniques and instrument use. You will also be supported in the development of your skills in field planning and project management, including liaising with external organisations and sites. A rich and varied training programme is available to OU PG students which includes sessions on academic writing, research design and data management, career development communicating your research, as well as opportunities to get involved in public engagement, media and remote digital teaching.

Partners and collaboration:

The possibility of a CASE partnership with Natural England will be explored once projects are confirmed. You will also have the opportunity to collaborate and with other students and researchers

at RainDrop and other ECT network sites. RainDrop is also part of the international DroughtNet network.

Possible timeline:

Year 1: Literature review, instrument and technique training, first season fieldwork and analyses.

Year 2: Second season of fieldwork, including extension to other sites. Attend BES Annual Meeting.

Year 3: Final measurements and data analysis. Attend EGU conference.

Year 4: Complete writing up

The student will be encouraged to participate in local and international meetings and develop their own networks through the course the PhD.

Further reading:

Grime J.P., et al. (2008) 'Long-term resistance to simulated climate change in an infertile grassland'**.** PNAS 105, 10028-10032. doi: 10.1073/pnas.0711567105

Sayer E.J., and Silvertown J. (2019) 'Long-term ecological experiments forever! - Unique challenges and opportunities.' BES Virtual Issue. Available at https://besjournals.onlinelibrary.wiley.com/hub/long-termexperiment.

Peng Y., et al (2018) 'Assessment of plant species diversity based on hyperspectral indices at a fine scale'. Scientific Reports 8, 4776 doi: 10.1038/s41598-018-23136-5

Punalekar, S., et al (2016) 'Characterization of a Highly Biodiverse Floodplain Meadow Using Hyperspectral Remote Sensing within a Plant Functional Trait Framework.' Remote Sensing, 8(2), 112. doi: 10.3390/rs8020112

Further details:

We invite applications from students with a strong background in plant, ecosystem ecology or grassland ecology, physiology or remote sensing, an interest in global change processes and an enthusiasm for field work and independent research. Clean driving licence for accessing UK field sites is desirable.

If you're not sure whether your academic background is suitable, please contact Kadmiel Maseyk (kadmiel.maseyk@open.ac.uk) or Olivia Acquah at STEM-EEES-PhD@open.ac.uk. We'd be happy to hear from you.

The successful student will join well-established teams researching environmental and ecosystem processes and a vibrant postgraduate community at the Open University.

Applications should include:

- An OU STEM application form, downloadable from: OU STEM application
- A CV with the names of at least two referees (preferably three and who can comment on your academic abilities)
- And an Open University application form, downloadable from: Home OU application form (if you are resident in the UK) or an Overseas OU application form (if you are an international applicant).

Applications should be sent to STEM-EEES-PhD@open.ac.uk by **12 noon** on **Friday, 7th January 2022**.