PhD studentship opportunities in Agriculture and the Environment: an exciting new initiative of our developing partnership

Sustainable intensification of agriculture:
The role of EO in quantifying the agricultural landscape

Supervisors: Dr Clare Rowland (CEH Lancaster), Dr Dan Morton (CEH Lancaster), Dr Alan Blackburn (University of Lancaster) and Dr Mikhail Semenov (Rothamsted Research)

Why is this project important?

Global food demand is expected to double within the next 50 years, increasing the pressure on agricultural land (Tilman et al., 2002). The FAO suggest that, with traditional agricultural practice, an additional 120 million ha (an area twice the size of France) will be needed by 2030 (Harrison et al., 2002). Meeting land requirements might be possible through the conversion of natural areas, but this risks accelerating climate change and biodiversity loss (UNEP 2009). Sustainable intensification has been suggested as a strategy to manage the demands of increasing yields, whilst keeping environmental degradation at sustainable levels (Tilman et al 2011). However, this raises many challenges. For example, how do we monitor the landscape to determine whether agricultural intensification is sustainable? In agricultural systems where environmental degradation has occurred yield reduction can be catastrophic and irreversible (Schubert et al. 2004), such rapid decreases in yield are easily detected by current systems. However, degradation often begins slowly and the warning signs may be subtle and difficult to detect. An enhanced ability to monitor these ecosystems to support understanding, prediction and mitigation is therefore imperative, as is understanding the role that EO should play in such a monitoring system.

This exciting project will determine the potential for using Earth Observation (EO) to quantify both the intensity of agriculture and the environmental quality of the surrounding landscape, using new EO satellites (Sentinel-1 (radar) and Sentinel-2 (optical)). Such methods are essential for understanding the potential role of EO in monitoring sustainable agricultural intensification. Techniques will be developed in the UK but will be globally applicable. The project will also use unmanned aerial vehicles, NERC ground sensor networks, BBSRC fields sites and AgSpace farmer networks.

Objectives will include:

1. Estimate biophysical variables from Earth Observation data (Sentinel-1 and -2 data). To quantify the quantity of agriculture (i.e. yield) and the quality of the surrounding non-crop vegetation it is important to estimate some form of index or biophysical variables for the vegetation and soil components of the ecosystem.
   a. Vegetation: A range of EO-derived vegetation products will be produced to drive a crop yield model and also to provide metrics of environmental quality. The EO-derived products will include crop Leaf Area Index, woody cover, vegetation productivity and vegetation stress indices.
   b. Soil: The research will explore the potential for mapping soil properties from bare-field images to quantify soil colour, texture, and moisture, as well as mapping bare-soil duration.
2. **Quantifying the intensity of agriculture (yield modelling)**
EO indices from objective 1a will be integrated into the Sirius wheat yield model (Semenov et al., 2014) to predict crop yield within the growing season. The potential for incorporating the EO-derived soil properties to improve the yield predictions and make the model more widely applicable will be explored.

3. **Assess the environmental quality of the landscape**
The vegetation and soil parameters estimated in objective 1 will be assessed to identify landscape-scale variations in the environmental quality of the farmed and non-farmed aspects of the landscape.

4. **Assess the sustainability of intensification**
The data on crop productivity from objective 2 and on environmental quality from objective 3 will be assessed to determine the level of sustainable intensification across the study region.

5. **Develop recommendations for the role of EO in monitoring Sustainable Agriculture**
The research will be used as a basis upon which to derive recommendations for developing a system to monitor the sustainable intensification of agriculture, using EO.

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**Objective 1: Estimate biophysical properties**

**Objective 2: Quantify the intensity of agriculture**

**Objective 3: Assess the environmental quality of the landscape**

**Objective 4: Assess the sustainability of intensification**

**Objective 5: Develop recommendations for the role of EO in monitoring Sustainable Agriculture**

Work will be conducted at a mix of field and landscape-scales, using existing infrastructure for field based validation/calibration of both regional and farm scale assessments.

**What’s in it for you?**
This PhD provides an excellent training opportunity for you to become a highly skilled, inter-disciplinary environmental scientist in a rapidly expanding area. You will gain an understanding of agricultural issues, as well as developing the technical skills to effectively exploit new satellite data sets, and to develop validated, EO-based methods for monitoring agro-ecosystems. These skills will be in high demand for many years. You will be trained and supported to develop new research methods and transferable skills which will stand you in good stead for a career within or beyond academia.

PhD supervision is split between three institutions: CEH Lancaster, Lancaster Environment Centre (LEC) and Rothamsted Research. This will enable you to access the facilities provided by all three of these organisations, including the wealth of knowledge and facilities available. You will be based primarily at Lancaster, within CEH Lancaster and LEC, but will have visits to Rothamsted Research to work with the
researchers there. At Lancaster you will join an exciting and interdisciplinary research environment and you will have access to the research training programmes offered by both the Faculty of Science and Technology and the Faculty of Arts and Social Sciences at Lancaster University. Joining the Environment Centre will also connect you to the work of a large and vibrant community of researchers interested in developing novel perspectives on environmental and social issues.

The PhD is inter-disciplinary and so as well as a number of project supervisors, also has an advisory panel, who will be able to advise on specific aspects of the work. The advisory panel currently consists of: Prof Pete Atkinson (LEC), Prof Richard Pywell (CEH Wallingford), Dr Aidan Keith (CEH Lancaster) and Dr Vincent Gillingham (AgSpace).

Who should apply?
This PhD is interdisciplinary in nature and as such would suit applicants from a wide range of numerate, scientific backgrounds, including (but not limited to) candidates with degrees in Physics, Engineering, Environmental Science, Geography or Ecology. MSc’s in a relevant subject such as Remote Sensing, Environmental Modelling or Data Science would be an advantage, but an MSc whilst desirable is not essential.

The small print
**Studentship funding:** Full studentships (UK/EU tuition fees and stipend (£14,057 2015/16 [tax free])) for UK/EU students for 3.5 years. Unfortunately studentships are not available to non-UK/EU applicants.

**Academic Requirements:** First-class or 2.1 (Hons) degree, or Masters degree (or equivalent) in an appropriate subject.

**Deadline for applications:** Midnight 31 March 2016

**Provisional Interview Date:** To Be Confirmed

**Start Date:** October 2016

For further information or informal discussion about the position, please contact Dr Clare Rowland (clro@ceh.ac.uk).

**Application process:** Please upload a completed application form (download from http://www.lancaster.ac.uk/media/lancaster-university/content-assets/documents/lec/pg/LEC_Funded_PhD_Application-Form.docx) outlining your background and suitability for this project and a CV at LEC Postgraduate Research Applications, http://www.lec.lancs.ac.uk/postgraduate/pgresearch/apply-online.

You also require two references, please send the reference form (download from http://www.lancaster.ac.uk/media/lancaster-university/content-assets/documents/lec/pg/LEC_Funded_PhD_Reference_Form.docx) to your two referees and ask them to email it to Andy Harrod (lec.pg@lancaster.ac.uk), Postgraduate Research (PGR) Co-ordinator, Lancaster Environment Centre by the deadline.

Due to the limited time between the closing date and the interview date, it is essential that you ensure references are submitted by the closing date or as soon as possible.

**Further reading**


