GeoNetZero Centre for Doctoral Training (CDT): Geoscience and its Role in the Low Carbon Energy Transition

(2022 start)

Project Title: The quantification of carbon credits: An example from Peatland Restoration of upland areas of the UK and the application of the Peatland Code

Host institution: University of Nottingham (UoN)
Supervisor 1: Sean Rigby
Supervisor 2: David Large (UoN), Joseph Wood (U. of Birm.), Matt Clark (UoN)

Project description (250 words max.):

This project aims to provide technical rigor to the satellite assessment of the value assigned to carbon credits associated with peatland restoration projects.

Peatland carbon will soon increase substantially in value for investors (including windfarm owners) operating under the IUCN Peatland Code. We have a new innovative method (published and supported by Nature Scot) that provides a means of precisely quantifying peatland condition using satellite measures of peatland surface motion. This is currently the only effective and economic means of large area monitoring for peatlands. However, the reasons for differences in observed surface motion (e.g. the bimodal behaviour of natural systems, response to restoration, role of gases) are not understood and the better they are understood the greater confidence will be in applying surface motion monitoring to quantifying peat condition and carbon value.

Porosimetry of peat is key to understanding this relationship. This work will involve studies of percolation effects in the migration of water within peat, to test a percolation-based theory for the hysteresis behaviour of peat surface motion with rainfall and water content.

There is a current debate regarding the monetary value associated with carbon credits in general, and, in particular, in the subsequent labelling of deliveries of oil and LNG as "green". Given that depleted peatlands actually emit greenhouse gases until they have been restored sufficiently the values assigned to these particular credits are likely to come under review at some stage in the future. This study would provide fundamental understanding that could inform this review.

Stated link to the overarching theme of the CDT i.e. The Role of Geoscience in the Energy Transition and the challenge to meet the net zero emission targets (NOTE: In order to qualify for NEO Energy CDT funding, there must be an explicit link to the Energy Transition with a clear application to the UK's Continental Shelf (UKCS). For projects supported by 100% matched funding from your University, links to the broader Energy Transition remit are sufficient):

Peatland restoration is a low carbon methodology used to offset emissions from other technologies, and the success of that methodology depends on confidence in monitoring, reporting and verification. This project will allow better determination of the value for emitters of carbon credits associated with peatland restoration. The project thus considers environmental impacts and dependencies resulting from peatland restoration and critically evaluates the use of peatland restoration as part of emitter industry's social licence to operate.

Details of mapping/fieldwork locations/data to be used by the project and confirmation of access to key data being secured (please attach map as an appendix if relevant):

The project will involve field visits to peatland to obtain samples for laboratory analysis and to situate field monitoring equipment. Field sites will be chosen within a 1300 km^2 area of the Flow Country, Northern Scotland. A wide range of sites are possible in this area for which we have extensive data (Bradley et al 2021) including those in a variety of near natural states and at various stages of restoration. We also have good working relationships with RSPB, Plantlife, Nature Scot, Peatland Action and Forestry and Land Scotland who own and/or manage many of the sites in this area. Potential well characterised target sites are forest to bog restoration sites on the RSPB Forsinard Reserve, the Plant Life, Munsary Peatlands and Knockfin Heights. All are well characterised but exact site selection will depend on time of year and status of breeding birds. Key data on the condition of these sites was gathered during previous research (Bradley et al 2021, Marshall et al 2021) and we have characterised the entire area using surface motion (Bradley et al 2021).

Bradley et al 2021 https://esurf.copernicus.org/preprints/esurf-2021-58/
Marshall et al 2021 https://www.nature.scot/satellites-track-bog-breathing-help-monitor-peatlands

Outline of planned work schedule for the 4-year research period:

Year 1:
Introduction to, and training in, porosimetry experimental techniques.
Introduction to key theoretical concepts, such as percolation theory.
Develop field monitoring devices to simultaneously measure surface motion and pore pressure.
Finalise site selection
Install field monitoring devices
Collect peat samples for laboratory analysis.

Year 2:
Undertake laboratory experiments on peat samples
Collect additional samples to address uncertainties and knowledge gaps as necessary
Collect field monitoring data
Compare field monitoring data to satellite measures of surface motion and the ecohydrological condition of the peatland
Collate or estimate available carbon emission factors for the peatland sites

Year 3: Analysis and modelling of field data.
The physical understanding of the relationship between surface motion and peat properties will be achieved by:
Analyse the shape and nature of the hysteresis on a plot of pore pressure vs. surface motion. This hysteresis is a function of pore properties of the peat.
Analyse the results of various experimental porosimetry techniques available at Nottingham on peat to understand the pore structure and aid interpretation of the hysteresis curves.
Interpretation of the pore structure and hysteresis will then be used to propose the physical mechanism linking surface motion with peat properties and propose mechanisms that explain the global range. This can also be considered in the context of current PhD research at Nottingham developing a fully coupled poroelasticity-ecology-hydrology peatland growth model.
Finally, possible transfer functions will be proposed that relate surface motion properties to carbon emission factors.

Year 4: Finish data analysis. Write-up

Any Additional Research Costs (NOTE: Each CDT studentship includes an individual Research Training and Support Grant (RTSG) budget of £20k for the full 4-year study period)

None, the 20k should be sufficient to cover fieldwork costs, consumables and travel to meetings and conferences.

Supervisory arrangements and involvement of external partners (NOTE: Please indicate the area(s) of expertise covered by each supervisor. External collaboration is encouraged, but if proposed partner is not currently providing support to the CDT, please outline the extent of the partner's involvement with the project.)

The student will be based at the University of Nottingham and jointly supervised there by Profs Sean Rigby and David Large, with input from Prof. Joseph Wood of the University of Birmingham. Prof. Rigby and Prof. Wood are experts in pore structure characterisation and the structure-transport relationships for multiphase flow in porous solids, such as rocks and soils. They will supervisor the porosimetry aspect of the project. Prof. Large is an expert in peatlands who led the development of satellite monitoring of peatland surface motion. This research was undertaken using sites in the Flow Country and was funded by NERC and Peatland Action (Nature Scot) and he collaborates widely with peat scientists across the UK. Matt Clark will supervise the field equipment development and installation.

An external partner in this Research is Professor Roxane Andersen at the Environmental Research Institute, University of the Highlands and Islands. They have been collaborators on all previous projects in this area and hold a vast amount of knowledge and data on restoration activities and sites in the Flow Country. Co-location of monitoring equipment where possible would also enable them to keep an eye on the equipment.

Likely graduate career routes:
The graduate would gain knowledge and skills in porosimetry and fluid flow that are of general applicability in a range of environment-related areas, such as oil and gas production and geothermal, as well as soil science. Working for monitoring, reporting and verification authorities, with respect to peatland carbon credits.