SPITFIRE

NERC SCIENCE OF THE ENVIRONMENT

SPITFIRE Doctoral Training Partnership (DTP)

Research Experience Placement Project 2018

Lead Supervisor:	Prof Justin Sheffield (Geography and Environment) With Dr. Sarvapali Ramchurn (ECS)
Email:	Justin.sheffield@soton.ac.uk
University/Research Organisation:	University of Southampton
Department:	Geography and Environment
Project Title:	Machine learning approaches to hydrological and agricultural forecasting for water and food security in Africa.

Total Student Support Costs: £	£2500 (£200 for 10 weeks plus £500 research and training support grant), plus we will seek departmental support from ECS and Geography to extend the project to 14 weeks
Based on a minimum of £200/week full time for a minimum of 8 weeks and maximum of 10 weeks and a £500 Research and Training Support Grant.	

Proposed Start Date: 18 June 2018	Proposed End Date: 21 September 2018
Projects should run over the summer vacation and we recommend that projects will have terminated by 21 September 2018.	

Brief Summary – please provide a brief summary (maximum 300 words) of the project.

This should include:

- *Project outline;*
- *Links to staff/School/Centre activity as appropriate;*
- *Supervisory arrangement;*
- *How space/equipment/supporting resource demands will be met;*
- *Elements of the project that will incorporate elements other than computer/modelling e.g. fieldwork and data collection;*
- *How the project will enhance the skills of the appointed student;*
- *Any intellectual property rights concerns that may arise from the work.*

Project Outline: Livelihoods across sub-Saharan Africa are often dependent on subsistence agriculture, which is susceptible to floods and droughts. There is potential to improve livelihoods through early-warning of hazards so that farmers can, for example, choose to plant more drought tolerant crops. Our current ability to forecast hazards is based on statistical regressions that link ocean temperatures to rainfall forecasts or dynamical climate models that forecast rainfall and other climate variables. Whilst these approaches are quite different, their skill is generally low across Africa, and not specific enough to be useful. This project will explore an alternative approach of using machine learning (ML) to forecast rainfall and flood/drought risk based on a range of predictors and do this at the scale of farmer decision making. The project will look at gathering relevant datasets, structuring and combining them within machine learning models that learn correlations across multiple dimensions. The work will also involve benchmarking multiple inference techniques to determine the most appropriate solution. If time permits, a visualisation tool will be developed for end-users.

Links to staff activity: The project links to the GCRF funded BRECcIA project, led by Prof Justin Sheffield, which is focused on water and food security in sub-Saharan Africa.

Supervisory arrangement: The project will be co-supervised by Prof. Sheffield (Geography) and Dr. Ramchurn (ECS) and mentored by one of the BRECcIA PhDs/Postdocs.

Space/equipment/supporting resources: The student will spend time in Geography ad ECS and be provided with a desktop computer and access to departmental resources.

Project elements: The student will interact with BRECcIA project African partners to collect data, and to identify essential decision making variables, and with PhDs/Postdocs working on the project.

Enhancement of skills: The student will work within an inter-disciplinary project focused on global development challenges, and will develop skills in: environmental data analysis/prediction; understanding environmental problems/contexts; collaboration, especially with international early-career researchers.

Please give an indicative timescale for the student's work over the length of the project: (maximum 150 words).

This should include:

- *The broad tasks the student will undertake;*
- *An indicative timescale for these tasks.*

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1) Review of hydrological forecasting for farmer decision making (Week 1)
To focus the work, a case study will be chosen via discussions with African partners, and will likely be in West Africa, working with the AGRHYMET regional climate centre.

2) Data collection (Week 2-3)
Potential predictor variables are ocean temperatures, and atmospheric variables, and forecast variables are rainfall, streamflow, flood/drought indices. Historic data will be collected from existing databases and from case study partners.

3) Development/testing of machine learning tools (Week 4-7)
Potential ML approaches (GPs, SVMs, Deep Learning) will be reviewed based on the collected data and required forecast variables. The selected approach will be developed and tested on the historic data.

4) Application to a real-world context (Week 8-10)
The ML approach will be applied to a real-world context (e.g. planting date). The results will be presented to African partners and a report written on the findings.

Proposed procedure for appointing students, including selection criteria:

Please identify specific criteria that should be considered for the selection of placement students e.g. specific quantitative skills that may be required, subject knowledge etc. If a student has been pre-selected, or the research area has been led by the student, please provide the student's contact details, and a summary of their suitability for the SPITFIRE DTP REP programme.

Essential criteria: Knowledge and experience in using different ML methods is essential, as is the ability to work with large datasets. Interest in developing world challenges is also essential.

Desirable criteria: Some knowledge of the following is desirable but not essential: hydrology or water resources; climate forecasting; decision making; subsistence agriculture.