Catchment behaviour, carbon storage and climate change

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Future climate scenarios for the UK typically include higher magnitude and more frequent storms and these scenarios have implications for the management of river catchments. The EU Water Framework Directive (2000) and the Water Environment and Water Services (Scotland) Act 2003 include the promotion of sustainable flood management strategies. In Scotland, one aspect of this river basin management includes altering hydrological pathways and providing wetland storage sites to reduce flood peaks at downstream sites. It is unclear how changing hydrological pathways will impact current stores of carbon, particularly in peatland areas. A potential outcome of increased flooding and duration of ground saturation is increased diffusion of dissolved organic carbon into surface water, as well as increased erosion mobilising particulate carbon; both of these changes could impact water colour and quality and result in partial loss of short-medium term terrestrial carbon reservoirs with resulting effects on concentrations of greenhouse gases (methane and CO_2). The aims of this project link expertise in SAGES Themes 1 and 2 to monitor current carbon cycling within a dynamic landscape context in two Scottish catchments (Devon and Tummel) and to provide predictive models of how carbon storage sites, carbon uptake/release (and water quality) will be impacted by changing hydrological pathways. The Devon catchment is chosen as it is currently a test site for sustainable flood management techniques, including wetlands development and altering hydrological pathways, by the Callander-based hydrological consultants Mountain Environments. The Tummel catchment contians extensive peatlands and is a major tribuatiry of the River Tay, a future potential UNESCO site of focussed hydrological research.

Components of the aims of the project include:

1. Detailed geomorphological mapping of catchments
2. Seasonal measurement of dissolved, particulate and gaseous carbon in non-flooding and flooding areas within each catchment
3. Develop seasonal model of carbon transport for each geomorpholgical/hydrological zone in the catchment
3. Model present day known flood events to calibrate HEC-RAS flow model
4. Model hypothetical scenarios of flooding using HEC-RAS and Mike21 in order to predict flood duration and erosion in floodplain sites
5. Estimate impact on net carbon storage for each zone in the catchment under hypothetical flooding scenarios

Specific methodologies include *in situ* gas analysis (rate of CO_2 release), sampling soil pore water and surface waters for laboratory measurement of DOC, nitrogen and methane, sampling of soils and peats for laboratory measurement of POC and nitrogen, geomorphological mapping, and flow and erosion modelling. Specific areas of expertise and supervision are covered by Robinson, Rowan and Singer (fluvial geomorphology and modeling) and Tey and Waldron (measurement and modelling of carbon storage/release in DOC, POC and gaseous phases CO_2 and methane). Training in surveying, mapping, and sampling techniques, flow and sediment transport modelling and laboratory methods will be provided. All necessary equipment and laboratories are available at the Universities of St Andrews and Glasgow. The University of St Andrews will contribute £5K/year to the project (fees and research) costs.

Facilities and equipment

The University of St Andrews has a Facility of Earth and Environmental Analysis (FEEA) which includes all surveying equipment, a VISALA gas analyser, gas chromatography, a clean laboratory, a Delta-Plus mass spectrometer and sediment/soil analysis (LS-230, XRF/XRD, LA-ICP-MS, and JEOL electron microprobes with SEM). The University of Glasgow has a clean laboratory and a DOC analyser.

Project summary for advertisement (in 40 words or less):
This project will measure the storage and release of carbon in two Scottish catchments in order to predict how future increases in the magnitude and frequency of storms might impact hydrological pathways and the rate of carbon release to the atmosphere.

SAGES Themes and evidence of Cross-disciplinary research:
This research links issues central to Theme 1, such as landscape response to some external forcing (climate change) and includes flow and erosion modelling. It also addresses central research areas in Theme 2 by addressing how carbon cycling will alter under climate change scenarios in Scottish catchments. Since Scotland has Europe's largest store of peatlands, this research has both regional and international significance and is a novel integration of quantitative geomorphology, sedimentology and organic geochemistry.