Centre for Landscape and Climate Research

In January 2012, Professor Heiko Balzter was appointed as Director of this new centre at the University of Leicester. He is a full research professor and will build up this exciting new research centre over the coming years. The aim of the centre is to understand interactions of the water cycle with ecosystems across multiple spatial and temporal scales. It will undertake fundamental research that helps solve the problems of global biodiversity loss, water scarcity and flooding, and threats to food security, which are arising from complex interactions between anthropogenic climate change and land use change.

In its first phase, the centre will develop the new research field of *Spatial Ecohydrology*, which analyses the effects of spatial patterns and processes upon biological populations in the bio-hydro-geochemical systems of evolving three-dimensional landscapes. This new research field draws together Geography, Ecology, Hydrology, Physics and Chemistry with Social Sciences to understand changing landscapes and the ecosystem services they provide. Three developments have created a unique opportunity for research in Spatial Ecohydrology:

> (i) the availability of increasingly high-resolution satellite images and derived biophysical parameters such as leaf area index, biomass, soil moisture etc. (30 m to 50 km),
> (ii) the increasing spatial resolution of climate models (8-50 km) and
> (iii) decreasing cost of high-performance computing power.

The narrowing gap between observational and modelled data provides an opportunity to exploit their synergies. The centre focuses on methodological aspects of spatial and temporal analysis of ecohydrological systems. It will analyse the significance of spatial location, scale, patchiness and structure for coupled hydro-ecological systems. Geostatistical analysis techniques such as variogram analysis, kriging, spatial point pattern analysis, space-time auto-regressive integrated moving average (STARIMA) models and wavelet analysis will lead to deeper understanding of the impacts of spatial scale and structure on biological population dynamics and water resource availability.

The centre will advance our understanding of a range of ecosystem services, a concept adopted by the Millennium Ecosystem Assessment (Table 1). Newly available satellite data from the European GMES programme and the Global Earth Observation System of Systems (GEOSS) can be utilised in a rigorous way to quantify and economically value these ecosystem services.

Table 1: Categories and examples of ecosystem services.

Category	Examples
provisioning	food, biofuels, fibre, timber, wool, biochemicals, natural medicines
regulating	air-quality maintenance, climate regulation through land cover, greenhouse gas sequestration, erosion control by vegetation, water purification, natural hazard protection from storms, floods and landslides, bioremediation
cultural	cognitive development, recreation, spiritual and religious value, social relations affected by ecosystems, aesthetic value, cultural heritage
supporting	soil formation, nutrient cycling, primary production of vegetation, water cycling, production of atmospheric oxygen, provision of habitat for biodiversity

Activities of the centre

The centre is participating and/or leading a range of research projects. Most of these are in close collaboration with one or more University Departments.

Research grants and projects

Start date	End date	Project name and funder	Total grant	Grant to Leicester
Feb-10	Feb-12	ESA Earth Explorer BIOMASS mission, Phase A study "Development of Algorithms for Biomass Retrieval", Coordinator K. Papathanassiou	£ 260,808	£ 21,592
Apr-09	Mar-12	G-STEP (GMES Space Technology Exchange Programme), East Midlands Development Agency, Director P.Monks	£ 863,000	£ 258,900
Aug-07	Jul-12	European Space Agency (ESA) contract "Generic Environment for Cal/Val Analysis"	£ 312,500	£ 27,442
Sep-08	Aug-12	GEOLAND2, Towards an operational GMES Land Monitoring Core Service, FP7 GMES project	£ 22,400,000	£ 150,000
Apr-10	Mar-13	LiDAR:net - Establishment of a Terrestrial LiDAR Knowledge Exchange (KE) Network, NERC Earth Observation Technology Cluster	£ 3,500	£ 3,500
Sep-11	Aug-14	ESA Sentinel Convoy Study: Synergetic Observations with Satellites Flying in Formation with European Operational Missions; Land Study with SSTL	£ 200,000	£ 6,500
Oct-11	Sep-14	DEFRA Greenhouse gas emissions from lowland peatlands	£ 1,745,567	£ 472,971
Dec-11	Nov-14	EAGLE (Development and Demonstration of a Renewable Energy Rating Platform), EU-FP7-SME-BSG	£ 1,880,000	£ 228,923
Jan-11	Sep-14	Methane fluxes in East Anglian Fenland, College studentship	£ 53,000	£ 53,000
Jan-11	Dec-15	GIONET (GMES Initial Operations – Network for Earth Observation Research Training), EU-FP7-ITN	£ 2,692,308	£ 538,462

ESA Earth Explorer BIOMASS mission, Phase A study "Development of Algorithms for Biomass Retrieval"

In this ESA funded study, we have investigated radiative transfer model simulations of Synthetic Aperture Radar (SAR) images over a virtual forest. This work tested the ability of P-band SAR to monitor temporal changes in forest biomass (forest growth and deforestation / degradation). The project informs the proposed BIOMASS mission concept that is under consideration in ESA.

G-STEP (GMES Space Technology Exchange Programme), East Midlands Development Agency and European Regional Development Fund

The mission for G-STEP is to promote the use of satellite, aerial and ground monitoring Earth Observation data in order to improve regional competitiveness. It facilitates knowledge transfer and collaborations between businesses and academic researchers.

European Space Agency (ESA) contract "Generic Environment for Cal/Val Analysis"

In this ESA study we have contributed to the development and implementation of a toolbox for calibration and validation of remote sensing data, using correlative data products from airborne campaigns and field data to assess the quality of the satellite data. The tools will be implemented at ESA and made available for use.

GEOLAND-2, Towards an operational GMES Land Monitoring Core Service, FP7 GMES project

GEOLAND-2 is the Land Monitoring Core Service precursor in the European GMES programme (Global Monitoring for Environment and Security). In the work package on Natural Resource Monitoring in ACP Countries, we have developed a method to regularly feed new satellite data into an environmental indicator framework. Africa has been recognised as one of the continents that is both worst affected by, and most vulnerable to climate variability and change. Changes in the distribution and magnitude of extreme rainfall events observed in many parts of the African continent are associated with both climate change and climate variability. We analysed spatial and temporal changes in rainfall and vegetation patterns in sub-Saharan Africa over 9 years. The outcome of the analysis, which is foreseen to be updated annually, is a set of maps and country environmental profiles. They identify areas that are thought to have received anomalously low/high rainfall, have suffered a decrease in vegetation cover or have greened up more than usual. This environmental indicator set is being implemented in the Joint Research Centre of the European Commission.

LiDAR:net - Establishment of a Terrestrial LiDAR Knowledge Exchange (KE) Network, NERC Earth Observation Technology Cluster

In this knowledge exchange project, we are working towards a code of practice for terrestrial LIDAR, together with industry and University partners. A series of workshops and meetings are being organised.

DEFRA Greenhouse gas emissions from lowland peatlands

The East Anglian Fens represent the largest, and most intensively modified area of lowland peat in the UK. This research project will quantify greenhouse gas fluxes from fenland under different land use to derive recommendations for land management and climate mitigation policies. It uses data collected by two eddy covariance flux towers and field measurements. The large areas under drainage and cultivation are undergoing severe and continuing peat carbon loss, leading to peat wastage across large areas. Small areas of 'natural' fen vegetation remain, while other areas have undergone re-wetting and (partial) restoration from intensive to extensive agricultural use. As part of a long-term collaborative research programme with the NERC Centre for Ecology and Hydrology (CEH), called FENFLUX, we are monitoring carbon, energy and water exchanges between the land and the atmosphere at Wicken Fen Nature Reserve. It is the largest of only four surviving fragments of the Great Fen Basin of East Anglia remaining under natural tall fen vegetation. The fen has an exceptionally rich flora and fauna, is a SSSI and conserves habitat and rare species. The sedge is harvested regularly in a rotational cropping scheme every 3-4 years continuing the traditional low impact use. The site is under high water table management, although water table drops significantly in summer. Recently water supply has been improved with lode water to maintain the mineral water

supply and soil chemistry. Bakers Fen, also in the Wicken Fen Nature Reserve, is located close to the natural Sedge Fen. It was converted from intensive arable agriculture in 1998, by raising water tables during winter, and introducing extensive conservation grazing by Konics and Scottish Highland cattle. The site has a small elevation gradient supporting flooding of a larger area until late spring which creates a more naturally varied landscape. The vegetation is dominated by pasture grasses, with some patches of *Juncus effusus*. The monitoring station also records soil moisture and temperature at multiple locations as well as soil heat flux. Water level is regularly recorded at several dipwells, and monitoring continuously by four continuous water level recorders.

EAGLE (Development and Demonstration of a Renewable Energy Rating Platform), EU-FP7-SME-BSG

In order for the European Commission to achieve ambitious renewable energy targets there is a strong need to accelerate market penetration of Renewable Energy Systems (RES) in both industrial and domestic sectors.

The domestic sector is of major significance, as it will reduce reliance on large centralized energy plants. There are several domestic options including solar thermal, solar electric, heat pump and biomass systems. Of these, solar and heat pump technologies have the widest potential application as they require no physical feedstock.

However, despite steady market growth, these technologies still make up only a small fraction of total household energy supply. One of the main reasons for this is the initial investment required, coupled with uncertainty over return on investment. This is compounded by the huge range of available products and a lack of objective information relating to system performance.

As a result, consumers are often confused and unable to make informed decisions. In addition, installation companies often experience difficulties when advising customers on the various options and their respective benefits. Hence, despite considerable technological advancements in terms of system performance and efficiency, there exists a significant knowledge and confidence barrier that restricts increased market acceptance.

In order to address this problem, we propose to develop a system that can automatically provide accurate and objective information about the suitability of a renewable energy technology for a given user scenario. The system will be intuitive and easy to use employing a unique dynamic grading technology. This will enable consumers to make better informed decisions and will allow our membership to provide better service.

This will help to significantly increase market penetration and revenues for our pan-European membership involved in the design, manufacture and installation of domestic renewable energy technologies.

GIONET (GMES Initial Operations – Network for Earth Observation Research Training), EU-FP7-ITN

The University of Leicester is home to one of the world's leading centres for space research and satellite monitoring, and is the lead institution of GIONET. GIONET is a European Centre of Excellence for Earth Observation Research Training, supported by the European Commission Marie Curie Programme. It has 7 full partners and 4 associated partners from a range of European

countries, with participation from Universities, research institutes and companies. GIONET is training 14 early-stage researchers (PhD level) who are developing better methods for observing and controlling deforestation, using satellite monitoring for disaster relief after landslides and floods, monitoring climate change, measuring lake water quality and coastal erosion. The European GMES programme (Global Monitoring for Environment and Security) is in the GMES Initial Operations (GIO) period (2011-2013). GIONET will satisfy the strong demand for highly skilled researchers with satellite remote sensing expertise, both in the private sector and in Universities. The monitoring methods developed in GIONET will also benefit the economy, and the project is designed to have a strong collaboration between academics and private companies to achieve a lasting research impact. Four open international summer schools will be held, which are open to external participants (see www.gionet.eu). GIONET addresses the research themes of Land cover and change, Geohazards and Emergency Response, Forest monitoring, Climate adaptation and Coastal Zone and Freshwater Monitoring.

New research proposals

The centre is pursuing funding opportunities and welcomes collaborative proposals in the field of landscape and climate research. Some proposal initiatives are originating from the research centre, but equally, new initiatives can be brought to the centre by academic and research staff and research students. Just contact the centre director by email to hb91@le.ac.uk.

Postgraduate research

The research centre has a large group of research students contributing to its research culture. Many of them are pursuing a three-year PhD programme, but some come here for an MRes (Master by Research), which allows the student to concentrate on a supervised research project over one year.

Any available bursaries and studentships will be advertised on the University web site. The international office maintains a web site with financing advice. If you wish to undertake an MRes or PhD in the research areas covered by the research centre, you are advised to contact the centre in the first instance to discuss topics.

Incoming visiting fellowship programme

The Visiting Fellowship scheme enables academics and researchers to spend a period of time conducting research in the Centre for Landscape and Climate Research at the University of Leicester. The aim of this recently established Research Centre is to understand the interactions of the water cycle with ecosystems across multiple spatial and temporal scales. It carries out fundamental research addressing biodiversity loss, water scarcity and flooding, and threats to food security, which arise from complex interactions between anthropogenic climate change and land use change. Prospective applicants should note that the Centre for Landscape and Climate Research only accepts applicants who can demonstrate an established research record or an outstanding potential for research excellence. Applicants should describe how their visit will complement our research environment and enhance the Centre's research profile, provide a clear explanation for the proposed duration and timing of their visit, and describe quantifiable research objectives for their visit.

Outgoing Visiting Researcher Scheme

The Centre for Landscape and Climate Research scheme to support outgoing research visits aims to enable researchers affiliated to the Centre to undertake research visits to other Universities, Research Institutes or R&D departments in Industry. The visit should serve the purpose to establish or enhance research collaboration, further the Centre's reputation and lead to a tangible output. The scheme is open to all academics, researchers and postgraduate research students at the University of Leicester affiliated to the Centre. Prospective applicants should note that Centre for Landscape and Climate Research only accepts applications that clearly demonstrate a collaborative research activity with the host organisation and that make a compelling case how this award would contribute to the Centre's objectives.

Poster competition

The centre is holding a poster competition that is open to all staff and postgraduate students. The competition aims to attract posters of high quality in the field of landscape and climate research. To enter into this competition, you will have to use the A0 portrait template provided by the research centre for this purpose, and present your original research, including an abstract, rationale, methods description, main results and conclusions. Deadline for submission of posters is 30 September 2012. The best poster will attract an i-pad as its prize. The next best four posters selected by the jury will receive a certificate of attainment and a small prize. Winners will be notified by 31 October 2012.

Open Forum

The research centre is holding monthly Open Forum meetings, to which all interested researchers (staff and students) are most welcome. In the Open Forum meetings, we will discuss the centre's activities and future strategy, new funding opportunities, conferences and publication plans, as well as recent research outcomes and new projects.

Annual conference

The research centre will hold a research conference every year, which will be openly advertised. It is envisaged to invite an external keynote speaker, followed by Leicester research talks. A poster session and an evening social event will also be held.

Research methods seminar series

Researchers in the centre contribute to a range of related seminar series and research group meetings in the participating departments. The centre will hold a research methods seminar series to provide discussions of a topic introduced by a presenter. The focus of this seminar series is the methodological aspect of research. We will discuss how climate models, satellite data and field surveys can be analysed in a common approach to advance the field of landscape and climate research and address the centre's research questions.