

Research Environment (REF5)

UoA 7: Earth Systems and Environmental Sciences

Research environment in the Environmental Sciences Research Institute

Overview

Research in Earth systems and environmental sciences at Ulster is conducted within the Environmental Sciences Research Institute (ESRI). All staff in ESRI are also members of the School of Environmental Sciences which delivers undergraduate courses in environmental science, marine science, and geography. The breadth of this delivery naturally requires staff with a wide range of expertise and this is reflected in the diversity of our research activities, which range from geophysics to human interaction with the environment and also includes work in coastal systems, maritime archaeology, freshwater sciences, benthic and terrestrial ecology, and Quaternary environmental change. Research within ESRI is structured in a number of small research groups in these areas although there is substantial collaboration between the groups.

Our overarching aim is to conduct and disseminate excellent research in areas that are relevant to society. In the current REF period, our main strategic objectives have been to:

1. Increase our overall level of internationalisation in terms of staff, students, and collaborations with leading researchers worldwide.
2. Increase the number and quality of proposals to highly competitive funders, particularly Research Councils.

The data in the table below demonstrate the success of key elements of the research strategy.

Metric	RAE 2008	REF 2014
Staff returned	24	18.4
Research Council spend in period	£480k	£2,768k
Research Council spend per annum	£80k	£553.6k
Total spend per annum	£932k	£1,267k
Outputs with non-UK authors	39.6%	47.9%
International research students	15.4%	27.8%
International research staff	12.5%	36.4%
International staff in submission	16.7%	30%

Infrastructure and facilities

ESRI is housed in a £1m research building constructed in 2004 and in an immediately adjoining block refurbished in 2005. The facility contains 2 conference/seminar rooms (one equipped for Skype meetings), 4 specialist (analytical chemistry, ecology, marine geophysics, and sediments) and 2 general laboratories, a coffee room, and office space for all staff and postgraduate students. Additionally, ESRI has an outdoor storage area for vehicles, boats, and trailers and 3 large garages housing marine and coastal survey equipment, freshwater and ecology survey equipment, and a dive store. There is also a dedicated cold store in a separate building.

The marine geophysics lab is equipped with in excess of £500k of high-resolution marine and terrestrial geophysical and dive equipment including chirp and boomer sub-bottom profilers, side-scan sonar, echosounders, magnetometers, multiple-antennae GPR, resistivity profiling and seismic refraction. The processing

and spatial analysis suite comprises high-end computing facilities with esri ArcGIS, IVS Fledermaus, CARIS Hips&Sips and Kingdom Suite.

Freshwater and ecology research is supported by field equipment and 2 specialized laboratories – analytic chemistry and ecology. The terrestrial ecology lab is divided into a ‘preparation lab’ where plant and soil material are prepared for chemical analyses and a ‘wet lab’ where the initial processing of plant and soil samples usually start. The two areas are equipped with in excess of £60k of new equipment. Field work in these areas is supported by equipment to discreetly sample vegetation and animals, soil, sediment, and water. In addition, we have an instrumentation suite for high resolution freshwater monitoring which includes phosphorus and nitrate analyzers and multi-parameter water quality sondes.

Our coastal survey equipment is specifically designed to monitor wind blown sediment flux in beach and sand dune environments and represents one of the largest collections of its kind internationally. The field rig consists of 2 x 17m masts, 4 x 6 m masts, 18 load cell sediment traps (sampling at 25 Hz), 16 audio impact sensors (safires) listening to grain impacts (at 25 Hz), as well as 24 ultrasonic anemometers which are interfaced simultaneously. The combined equipment in this setup, funded by a recent NERC grant, has an approximate value of £240k.

The scientific diving facility is equipped with a full suite of SCUBA equipment for up to four divers, serviced and maintained to ensure compliance with the relevant legislation. The facility operates a 6.5 m coded research vessel (£50k) which is licensed to operate in Category 4 waters. Diving equipment includes four full sets for drysuit diving in temperate waters. Underwater imagery can be collected using an inspection camera, topside display with digital recording facility. There is also a range of digital terrestrial cameras in underwater housings, and an amphibious NIKONOS camera.

ESRI maintains a fleet of vehicles and boats to support fieldwork. At present we have 4 vehicles (including three 4x4s) suitable for this as well as 2 cars for general transportation. We also have 3 boats for use on rivers, lakes, and offshore. Additionally, we are equipped with a 6*2.5m refrigerated container operating at 4°C which is used to store and preserve over 200 m of deep and shallow water marine sediment cores for paleoenvironmental research, as well as 100 m of lake sediment cores and thousands of water samples from Irish lakes.

In addition to the lab/field equipment, we have made significant investments in high performance computing in the past few years (> £100k from ESRI funds and external grants). As a result, we now have a dedicated high performance computing system which consists of 300 interconnected cores across the system.

Research collaborations

Every research group in ESRI is returning co-authored papers with international collaborators and this is also true for 75% of staff included in the submission. Additionally, the majority of our grant applications to highly competitive funders have national/international investigators or partners. We are currently involved in several large collaborative projects including GLANAM on glaciated ice sheet margins (FP7: Benetti, Dunlop), Britice-Chrono on ice sheet forecasting (NERC: Benetti), one on climate change and landslide/tsunami risk in the UK (NERC: McCloskey, Dunlop, Nalbant), REAKT on earthquake risk reduction (FP7: Steacy), and we lead one on late glacial sea level minima (NERC: Cooper, Jackson, Quinn).

In addition to the large scale projects described above, significant collaborations involving both joint grants and publications include:

- British Antarctic Survey: Sedimentological processes in Antarctica and subglacial sediment processes (Benetti, Dunlop)
- Cambridge University: Sudan archaeology (Breen, Forsythe)
- Griffith University, Australia: Coastal adaptation (Cooper)
- GFZ Potsdam: Earthquake hazard (Steacy)
- GNS Science, New Zealand: Earthquake forecasting and hazard (Steacy)
- INGV Rome: Earthquake hazard (McCloskey, Nalbant, Steacy)
- Marine Institute Ireland: Archaeology applications of the JIBS data (Forsythe, Quinn)
- NUI Galway: Aeolian transport (Jackson)
- Universities of Aberdeen and Dundee: Barrier island geomorphology (Cooper)
- University of Edinburgh: Earthquake hazard and mitigation (McCloskey, Nalbant)
- University of KwaZulu-Natal: stratigraphic record of sea level rise (Cooper)

- University of Maine: Sea level research (Jackson)
- University of Minnesota: Agricultural, biodiversity, and CO₂ sequestration (Fornara)
- University of Sheffield: Subglacial bedform production (Dunlop)
- University of Wisconsin: Transient modeling of the last deglaciation (Clark)
- Woods Hole Oceanographic Institute: West Antarctic ice sheet deglaciation (Clark)

Interdisciplinary research

The majority of our research is interdisciplinary and this is indicated by the collaborative nature of our grants and publications both internally and externally. Some examples of note are:

- Linking earthquake science to community vulnerability to increase resilience to earthquake and tsunami hazard (McCloskey)
- Understanding past ice sheet behaviour through integrated geological, geomorphological, and sedimentological studies (Benetti, Dunlop)
- Combining archaeological studies with environmental and community sustainability (Breen, Forsythe, Westley)
- Global climate modelling and model-data comparison through the last glacial cycle (Clark)
- Understanding terrestrial ecosystems through plant ecology, soil ecology, and soil microbiology (Fornara)
- Investigating aeolian transport of sand through observation and computation fluid dynamics modelling (Jackson)

Collaborations with research users

Interactions with research users have guided our research strategy in a number of areas. In coastal science, collaborations with the Canadian companies RWDI consulting engineering and Klimaat Consulting and Innovation have brought state-of-the-art computational fluid dynamic modelling to our NERC funded work on coastal dune processes. The techniques developed in that work are now being applied to research on Martian dune systems in collaboration with the Planetary Science Institute (Arizona) and the Carl Sagan Centre (California). In Quaternary science, data from national initiatives such as the Irish National Seabed Survey and the Joint Irish Bathymetric Survey are enabling us to undertake research on the glacial history and sediment transport of the entire Irish Shelf. Additionally, high resolution geochemistry data collected by the Geological Survey of NI as part of the Tellus project is enabling a new approach to Quaternary glaciation research in Ireland.

Collaborations with the humanitarian organisations Kogami (Sumatra) and Concern Worldwide have led to the development of a social science thread to our geophysical research. Specifically, one PhD student has completed work on understanding how community based initiatives can improve earthquake awareness in a developing country whereas another is working with Concern to understand and improve their approach to working in earthquake prone area. In archaeology, collaborations with industrial archaeologists through the Ecosal Atlantis initiative has led to new AHRC funded research on the salt producing areas of Ireland.

Leadership in the academic community

The research excellence of several ESRI members was recognized internationally during the assessment period. Professor Andrew Cooper was appointed a Fellow of the Geological Society of America in 2009 and a Fellow of the Royal Society of South Africa in 2013, Professor Peter Clark was appointed a Fellow of the American Geophysical Union in 2010, and Professor John McCloskey was made a Member (equivalent to 'Fellow') of the Royal Irish Academy in 2012. (Professor Marshall McCabe was appointed to the RIA in 2005.) Additionally, Dr. Colin Breen and Dr. Wes Forsythe jointly received an award of merit from the US Society for Historical Archaeology.

Three ESRI academics (Jackson, Jordan, Nalbant) are currently members of the NERC peer review college and Steacy was a member from 2007-2011 (deputy chair on 4 of the 7 panels in which she participated). Additionally, McCloskey chaired the Geophysical Equipment Pool funding committee from 2006 – 2010, Benetti was an expert evaluator on a Marie Curie Panel in 2011 and was vice chair of a subsequent one in 2013 and she is also an expert evaluator for the FP7 programme on renewable energy, and Steacy was a member of an FP7 funding panel for tsunami hazard (2012). Clark was joint coordinating lead author of Chapter 13 (Sea Level Change) of the Fifth Assessment Report of the Intergovernmental Panel on Climate

Change (2013) and Steacy was a member of an expert elicitation panel on future seismic hazard in the Christchurch NZ region (2011).

Seven ESRI members are or have been editors or associate editors of international journals during the assessment period – Breen (Journal of the North Atlantic, Underwater Archaeology Proceedings), Clark (Journal of Climate, Atmosphere-Ocean), Forsythe (Underwater Archaeology Proceedings), Jackson (Journal of Coastal Research, Journal of Engineering Technology), Jordan (Environmental Science and Policy), Quinn (Journal of the North Atlantic), Steacy (Journal of Geophysical Research).

Additionally, five academics have convened academic conferences or acted as program chairs – Breen (Society for Historical Archaeology, Leicester, 2013), Cooper (International Coastal Symposium, Durban, 2014), Jackson (Adapting to Coastal Change, the Hague, 2011), Jordan (Catchment Science, Dublin, 2011), Steacy (ESF conferences on challenges in earthquake dynamics, Obergurgl, 2008, 2011).