# Nuclear Hazards and Risks

## Theme Leads

**Professor David Richards, University of Bristol**
**Contact:** david.richards@bristol.ac.uk
David's research interests are climate change, landscape evolution, geochronology, isotope geochemistry and environmental radioactivity. His work is focused on developing novel mass-spectrometric protocols to explore environmental pathways of radionuclides, particularly caesium, plutonium, and uranium.

**Professor Andy Cundy, University of Southampton**
**Contact:** a.cundy@soton.ac.uk
Andy's research interests are environmental geology, environmental radioactivity, contaminated land management, geohazards, and coastal processes and change. His work is focused on understanding the environmental cycling and behaviour of aquatic and terrestrial contaminants (radioactive, metal, organic, and plastic contaminants); sedimentary and geomorphic responses to geohazards, sea-level rise, and anthropogenic disturbance; environmental geology; radiometric dating; and contaminated land, wastes and water management.

## Theme Summary

To reassure regulators, operators, and the public, safety assessment of nuclear power generation and waste management is paramount. Detailed knowledge of the source, form, pathways of nuclear material and legacy contamination in terrestrial and ocean settings is neccessary to quantify and model potential radiological risks. In addition, environmental hazards and climate change present important foci of attention for a wide range of stakeholders.

Research in this area seeks to directly influence decision-making in the nuclear industry and other sectors on matters of:

- External hazards to nuclear installations and infrastructure – including seismic and volcanic activity at a wide range of temporal and spatial scales.
- Climate change – impact of riverine floods, sea level change, extreme events.
- Radiological hazards, risk reduction and management of contaminated land.
- Atmospheric dispersal of radioactivity.
- Nuclear materials forensics and provenance.
- Radionuclide source detection and analysis.

# Research capabilities

## Radiological Hazards

*Key academics: Prof. Awadhesh Jha (University of Plymouth); Prof. Neil Willey (UWE, Bristol); Prof. Phil Warwick, Prof. Andy Cundy (University of Southampton)*

Radiological assessment is key to safety assessments, decommissioning and decontamination of nuclear facilities, and transportation. The Hub offers expertise in direct assessment and modelling of radiological hazards in terrestrial and marine ecosystems. Monitoring undertaken in the field is supplemented by novel laboratory methods applied to plant and faunal specimens. Radiation presents an environmental stressor that requires modelling and researchers have been involved in projects at Chernobyl, Fukushima and UK settings.


### Case Study

**Radioactivity and the Environment (RATE) (£8m NERC, 2014-18):** An integrated, multi-disciplinary programme assessing and reducing uncertainty associated with radiological risk assessment to protect human health and the environment.

UWE Bristol and the University of Plymouth played a major role in the work-package TREE (TRansfer-Exposure-Effects) focused upon reducing uncertainty in estimating radiation exposure, dose effects and environmental transfer of radioactivity in non-human biota, which are required for safety. TREE was awarded the Times Higher Education 'Research Project of the Year 2016' for the impact of its "ground-breaking" science. UWE investigated plant uptake of iodine, technetium and selenium radioisotopes under controlled conditions in current and possible future flora of the British Isles, to generate comprehensive datasets. These have been used to explore behaviour in relation to plant phylogeny. The University of Plymouth focussed on bioaccumulation and dose effects in marine and freshwater bivalves.

## Infrastructure risks

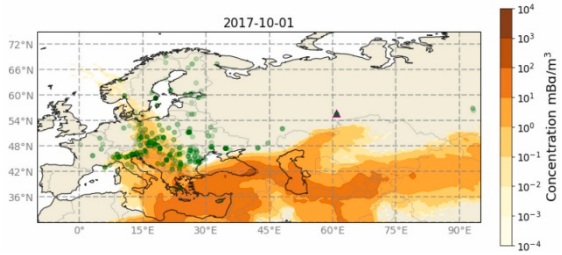
Key academics: *Prof. David Richards, Prof. Tom Scott, Prof. Adam Crewe (University of Bristol); Prof. Andy Cundy (University of Southampton)*

Extreme events pose a threat to infrastructure associated with nuclear power generation and decommissioning efforts. These can range from tsunamis to space weather, earthquakes and volcanic activity. The South West Nuclear Hub can draw upon an extensive range of expertise across engineering, sciences, and social sciences to consider the multiple, and often cascading, risks that might develop.

Contact: enquiries@southwestnuclearhub.ac.uk

## Atmospheric dispersal

*Key academics: Dr Peter Martin, Dr Luke Western, Prof. Tom Scott (University of Bristol)*



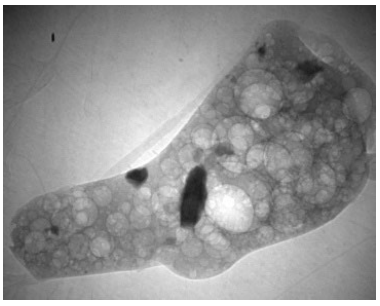

Whilst robust nuclear regulation and safety culture have been extremely successful in controlling nuclear materials, unexpected events, such as the Chernobyl and Fukushima accidents, can cause radiological incidents and release of radioactivity into the environment.

Increasingly frequent wildfires in the Chernobyl Exclusion Zone, for example, are causing radioactive releases from fuel sources present in the environment. Bristol researchers are working with the UK Met Office and Ukrainian authorities to enhance modelling capabilities to predict radioactive aerosol formation, release, and dispersal. Similar tools have been used to explore the source estimation of an unexpected release of ruthenium-106 in 2017 from Russia (see figure above).

The *Met Office Academic Partnership (MOAP)* brings together research excellence at the Met Office, University of Bristol, and other institutions. It offers an unparalleled opportunity for collaboration in many facets of risk that affect the nuclear industry, including atmospheric dispersal, extreme climate risks and sea level change.

**Case Study**

**Analysing Fukushima Daiichi fuel debris –** A small radioactive particle (450µm x 280µm x 250µm) was brought to the UK from within the Fukushima restricted zone. Experimental analysis using X-ray imaging and fluorescence measurements revealed the particulate's internal structure and 3D elemental distribution. Researchers were able to attribute the material to a specific source on the power plant and provide crucial information to explain the events that occurred during the 2011 accident.



## Facilities

A wide range of well-equipped facilities for isotopic characterisation and radiometric assay are available across South West Nuclear Hub academic members, including the following:

### Bristol Isotope Group – University of Bristol

The *Bristol Isotope Group* uses isotope measurements to investigate natural processes, providing a high-precision and accurate means to date objects, determine the rates of geochemical processes and trace the origin of material. The facility has a reputation for the novel isotope methods that take advantage of a suite of five magnetic-sector mass spectrometers, two Excimer laser-ablation systems and a HEPA filtered clean laboratory.

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SOUTH WEST NUCLEAR HUB

## GAU-Radioanalytical Laboratories – University of Southampton

A long-established UKAS-accredited laboratory with facilities focused on:

- waste characterisation and analytical techniques
- remediation technologies
- nuclear forensics
- environmental studies

Radioanalytical services include alpha and gamma spectrometry, liquid scintillation analysis, $^{3}H$, $^{14}C$, $^{36}Cl$ and $^{129}I$ extraction, radiometric dating ($^{210}Pb$ and $^{137}Cs$), and mass spectrometry, all of which are available to external clients.

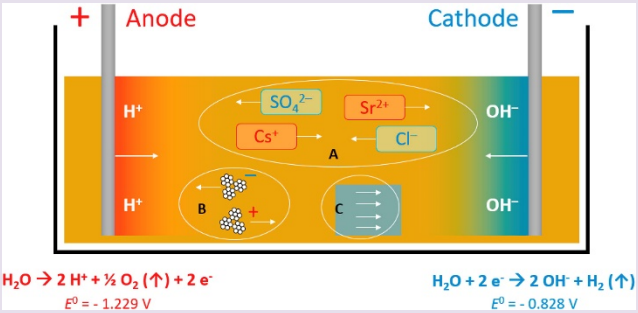
### National Nuclear User Facility: EXACT - Next Generation Accelerated Characterisation Technologies

An easily accessible state-of-the-art test-bed facility, with supporting infrastructure for research and technology development and validation. It provides training in in-situ, on-site and off-site characterisation and remediation methods and access to supporting facilities the University of Southampton, University of Bristol and National Physical Laboratories.

The facility provides a flexible space for the development and testing of new methodologies and technologies with low level active reference materials and radiotracers. The laboratory features fume cupboards, bench and floor space with a customisable aqueous test rig to permit active testing of in-line and on-line sensors. The facility contains a portable gamma detector, an automated gamma spectrometer, a benchtop liquid scintillation counter and an SBET analyser.

### Case Study

**Electrokinetic remediation of contaminated land. GAU, University of Southampton**. The large amounts of soil and other radiated materials needed to be remediated in locations such as Fukushima. Electrokinetic Remediation is a less labour-intensive and more cost-effective in-situ method for dealing with contaminated materials and reducing risk. Researchers at GAU have demonstrated a method that is effective in mobilising caesium and strontium in organic-rich clay soil used to simulate material found in the Fukushima Exclusion Zone in Japan. They are also working on decision-support tools to enable stakeholders to consider options for site-scale operation.

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