



Environmental Risks to Infrastructure Innovation Programme



NERC invites proposals for innovation projects as part of the [Environmental Risks to Infrastructure Innovation Programme](#) (ERIIP). The Environmental Risks to Infrastructure Innovation Programme (ERIIP) will fund a balanced portfolio of projects which cover the range of environmental hazards and sectors of interest to ERIIP members, across all three themes of the programme.

For this call NERC and ERIIP members are encouraging proposals that fill gaps in the portfolio of themes, hazards and sectors within the scope of the programme, as well as proposals that address the challenges of ERIIP partners.

All projects must specify and address a real industry, policy or regulator issue that arises from managing environmental risks. The proposals should clearly indicate how the project will develop tangible outputs in terms of knowledge, data, models tools, approaches, how these will be utilised by project partner(s) (e.g. for planning, operational or strategic decisions) and what outcomes (benefits) this will have on the project partner(s).

ERIIP Industry Members

A key part of this innovation programme is that it is industry-led (this includes industry, policy or regulatory). Members of the programme have been invited to define the challenges that they are interested in addressing.

The following pages contain information on research priorities and environmental risk challenges which the partners would be interested in seeing projects addressing. It is anticipated that project partners will be willing to provide their time and expertise 'in kind' to shape the proposal, steer the project (in conjunction with the academic) and report on how the project's outcomes have been incorporated into their organisation.

ERIIP Partners (Jan 2017)

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| <ul style="list-style-type: none">• Arup• Atkins• EDF Energy• Environment Agency• HR Wallingford• HS2• National Grid | <ul style="list-style-type: none">• Network Rail• Scottish & Southern Energy• Scottish Water• Translink• Transport Scotland• Temple Group• UKWIR |
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This list is not exhaustive and proposals outside these areas will also be considered. Project partners are not restricted to ERIIP Members, although this is encouraged and the following research priorities and challenge areas are intended to provide further information on areas for potential collaborative work.

Project partnering support service

NERC has contracted the [Construction Industry Research and Information Association](#) (CIRIA) to support the Innovation Programme. For this call, CIRIA will be organising the following activities to support new academic – partner collaborations and the development of proposal ideas.

[A brokerage workshop](#) will be held in London on 15th March 2015. This event will provide an opportunity for ERIIP members to present the environmental risks they face and for the infrastructure sector and academics to initiate collaborations and discuss and develop project ideas. Also, there will be opportunities for one-to-one meetings at the event.

CIRIA are offering a project partnering support service to facilitate introductions between the academic community and the infrastructure sector. So, if you are an academic looking for a project partner or an infrastructure sector organisation looking for an academic with appropriate expertise, please get in touch.

Unless contact details of ERIIP members are provided within this document, it is advised that you contact CIRIA in the first instance who can put you in contact with the appropriate contact within each member organisation.

For more information on all of the above, or to discuss your idea informally, please contact CIRIA:

Sirio D’Aleo, 020 7549 3300, sirio.daleo@ciria.org

Owen Jenkins, 020 7549 3300, owen.jenkins@ciria.org

[Arup Website](#)

We are an independent firm of designers, planners, engineers, consultants and technical specialists offering a broad range of professional services across the built environment and infrastructure sectors. We aim to help our clients meet their business needs by adding value through technical excellence, efficient organisation and personal service.

Our Markets

- Cities
- Water
- Energy
- Transport and mobility.
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Areas for Innovation

We are interested in working with researchers to develop research and projects across the infrastructure spectrum. Particular areas of interest include:

- Developing methods to integrate data sources (e.g. point measurements, remote sensing, real-time sensing) to improve the design and/or operation of infrastructure
- Tools to support the development and optimisation of adaptation strategies for infrastructure
- Quantifying environmental risks at procurement stage to influence financing and procurement methodologies for infrastructure assets
- Preparing for and managing the impacts of severe weather and related uncertainties
- Understanding and mitigating environmental risks to complex infrastructure assets with multiple ownerships.

If you wish to be put in contact with Arup, please get in touch with CIRIA.

[Atkins Website](#)

Atkins is a global infrastructure consultancy providing design and advisory services to a range of infrastructure owners and operators.

We have a long-standing interest in environmental risks to infrastructure in relation to design and operation.

We are looking for academic collaborators in the following areas:

- Infrastructure vulnerability to space weather
- Reviewing existing methods (including application of statistics and dynamical methods) for flood prediction and frequency analysis
- Dynamic decision making for infrastructure in response to extreme events
- Managing future uncertainty (including climate uncertainty) in long-term infrastructure investment decisions
- Understanding value contributions of infrastructure projects to customers in long-term infrastructure investment decisions
- Future climate extremes in developing countries
- Potential use of big data in identifying and responding to environmental risks to infrastructure (including decision support)
- Understanding how integrated infrastructure design can deliver local and regional economic resilience and recovery in environmental crises.

Please contact Dr Geoff Darch (geoff.darch@atkinsglobal.com) to discuss further.

[EDF Energy Website](#)

EDF Energy is an integrated energy company in the United Kingdom, with operations spanning electricity generation.

For the purpose of this Innovation Programme and call EDF Energy are interested in proposals addressing environmental risks for the following sectors:

- Nuclear
- Renewables and Offshore wind.

EDF energy are keen to support proposals addressing the following environmental hazards and cross cutting issues.

Hazards:

- Extreme weather
- Coastal flooding
- Marine environment hazards (storms, wave, wind, current)
- Space weather
- Marine Biology survey (biofouling, marine ingress)
- Sea water temperature (low and high)
- Lightning intensity.

Cross cutting areas:

- Climate change
- Hazard Combinations
- Remote sensing Satellite and drones monitoring of environmental variables and infrastructures
- Uncertainties
- Black swan (including storms and surges)
- Cascade effects.

If you wish to be put in contact with EDF Energy, please get in touch with CIRIA.

[Environment Agency Website](#)

The Environmental Risk to Infrastructure Innovation Programme (ERIIP) is important to the work we do to:

- increase the resilience of society and its enabling infrastructure from the risks of flooding and coastal erosion;
- provide advice and support to businesses, the public sector and other organisations to help them adapt to changes in climate; and to,
- protect and manage water quality and resources, ensure land is managed in an integrated way and to enhance biodiversity.

Topic areas for innovation

- We are interested in working closely with researchers to develop innovative solutions and projects which help us to:
- develop tools and data to support the analysis of the propagation of flood impacts through networks of infrastructure assets - methods need to address both high level strategic assessments (e.g., at a regional or UK scale) and detailed local site appraisal.
- take a more collaborative approach during the development of the evidence to support future investment in flood and coastal risk management allowing more open exploration and analysis of investment needs.
- develop and pilot methods which integrate data sources (e.g. remote, geophysical, real-time sensing) to enhance our inspection and investigation of flood risk asset thus closing the gap between expected performance and actual performance.
- bring forward methods which help us quantify the risks and uncertainties of morphological change and extreme flooding to critical infrastructure at the coast over the very long-term (e.g. 100 – 1000 years).
- develop methods to set tolerable limits of wave overtopping for the range of our flood risk management assets (built and natural) which are proportional to the people, property and infrastructure they protect.
- improve our understanding of the temporal and spatial patterns of extreme rainfall in cost effective and resource efficient way; allowing infrastructure operators to understand the resilience of their networks.

Audience

We are interested in research proposals that will help:

- risk management authorities in the UK manage their flood and erosion risk infrastructure assets. Risk management authorities include the Environment Agency, lead local flood authorities, district councils, highways authorities and water and sewerage companies.
- other infrastructure owners become more resilient to the future risks associated with climate change.
- businesses become more resilient to potential future disruption to the infrastructure that they rely on.

Outcomes

We would be keen to see research that is synthesised into evidence to inform the development of industry guidance, published advice, practical tools, open spatial databases and GIS.

For further information, please contact ask_evidence@environment-agency.gov.uk

[HR Wallingford Website](#)

HR Wallingford is an independent Research and consultancy organisation offering state-of-the-art analysis, advice and support in engineering and environmental hydraulics, and in the management of water and the water environment.

Our interest in this programme relates to our desire to offer our clients world leading advice relating to:

- Likelihood, uncertainty and impact of extreme water related natural hazards on their infrastructure
- Understanding of how climate change can influence these natural hazards
- How adaptation and mitigation measures can be implemented to reduce the increased risks from natural hazards.

Areas of innovation

We are interested in collaboration with regard to:

- Increasing understanding of how we define, characterise and simulate extreme events relating to flooding from multiple sources and how climate change can influence these events.
- How the innovative use of dredged material from the sea bed can help mitigate the impacts of coastal
- Erosion
- Uncertainties associated with coastal flood risk analysis and the influence of sea level rise
- Impact of climate change on the effectiveness of defence systems' performance in protecting critical infrastructure
- Impacts of droughts on thermal and nuclear power stations
- Impacts of droughts on hydropower in the UK, including on the effectiveness of existing and future microhydropower schemes.

Our clients

This research will help us provide support and advice to our clients who include, Government departments and agencies and private sector infrastructure and utility owners. We welcome collaboration with industry and academic partners.

If you wish to be put in contact with HR Wallingford, please get in touch with CIRIA.

[HS2 Website](#)

High Speed Two (HS2) Ltd is seeking academic collaborators for NERC funding call: Environmental Risks to Infrastructure.

Throughout the design phase, HS2 Ltd is working on understanding and reducing environmental risks to its assets, and where possible, to interdependent infrastructure. Increasing the resilience of the Proposed Scheme to extreme weather and climatic events, particularly under changed future climates, is a key aspect of this work.

HS2 Ltd is particularly interested in proposals which relate to:

1. Research into the effects of climate change on soil moisture deficit leading to slope failure in combination with cumulative effects of rainfall events in wetter winters.
2. The effect on SMD of the zone of desiccation of trees, to support the nominally greater tree standoff zone that has been proposed for HS2.
3. Remote assessment methods for building the resilience of slopes to the impacts of soil moisture deficit under future climates.
4. Methods for building resilience of structures and power distribution masts and cantilevers to the effects of extreme winds and storms (particularly increased gust loading and “jet stings”) despite limited underlying climate change information. Structures of particular interest include boundary security fencing, OLE, power supply of all kinds.
5. Methods for quantifying and prioritising climate change vulnerabilities to interdependent infrastructure and cascade impacts that affect HS2 infrastructure. Special consideration given to disruption to classic services, highway network availability, power supply of all kinds and telecommunications.
6. Selection of vegetation that supports (superficial) soil stability on slopes and is climate resilience through a smart, proactive, approach rather than reactive changes to planting as the climate changes.
7. Developing and applying information on the impacts of climate change on lightning events. This improved information would be taken into account in climate change design impact assessments of HS2 and associated technical requirements (see ‘shared research interests – lightning impacts on UK infrastructure’ for more information).
8. Developing resilience of the railway network to space weather events (see ‘shared research interests – space weather impacts on UK infrastructure’ for more information).

If you are interested in discussing a collaborative proposal, please get in touch with Alison Walker (Alison.Walker@hs2.org.uk) and Chris Harris (Chris.Harris@hs2.org.uk).

[National Grid Website](#)

National Grid are seeking to collaborate on projects which will improve and deliver a strategic framework to address fuller understanding and preparedness of challenges in respect of hazard and resilient risk on National Grid Infrastructure, both medium and long term.

- Medium term - provides direction in determining the pathways in a more structured way.
- Long term - improvement in qualitative and quantitative data aiding production of a robust response plan and capability to undertake fast response and further risk reduction through partnership/collaborative working.

For the purpose of this call, National Grid define resilience as the ability of assets, networks and systems to anticipate, absorb, adapt to and / or rapidly recover from a disruptive event.

This can be secured through a combination of activities or components principally Resistance, Reliability, Reduction and Response & Recovery.

Risks and Challenges

- New types of event – arising under climate change; solar gain on urban assets.
- Low probability high impact events - more interruptions to networks.
- Extreme events impact upon the electricity transmission network and security of supply.
- Resilience of specific infrastructure - vulnerability to major flood incidents.
- Urban heat risks – solar heat faults future fault distribution from solar heat faults their rare occurrence makes it difficult determine a relationship between fault numbers and weather events.
- Offshore transmission network - threat that climate change poses to infrastructure (e.g. interconnectors) and its operation.
- Spatial distribution of risks - any spatial variations in the sectors' climate change risks.
- Repair and service restoration times.
- Combination of one or more events above.

Specific interest in proposals which address:

- Smart analytics for the prediction of faults on the electricity network under extreme weather events/scenarios (eg storms, flooding...)
- Methods to improve the resilience of electricity network assets during storm events.
- Consider 'One-Stop Shop' for hazard information storage
- Methods to improve the resilience of electricity network assets (including substations) in areas of flooding. (Currently exists under ETR138 but requires review and release of updated version)
- Asset monitoring possibly electronic/wireless of the stability of tower and cable assets. Could also be a solution which also acts as miniature weather stations and system dynamic rating / monitoring all these exist in isolation but could they be brought together?
 - Install hazard monitoring on towers and cables
 - Bring together potential dynamic rating technologies / studies (Weather station)

- Ground movement monitoring BGS studies Proactive Infrastructure Monitoring and Evaluation (PRIME)
- Impact of changes in legislation through the water framework directive on the operation of existing hydro-electric generation assets.

(Whilst National Grid is possibly not directly impacted, we should be very interested in the outputs from a system development point of view we also need to understand risks associated with the operation of Dinorwig during either high river levels downstream or period when extreme drought may have an impact).

Informing industry-led guidance or regulatory frameworks related to risk assessment and building resilient infrastructure:

- Visualising and communicating risk to enable decision-making; and
- Improving assessments of the vulnerability of infrastructure networks, enabling infrastructure operators to focus upon the most 'at risk' zones.

As with ETR138 industry led guidance and targets are the way we should be driving resilient but all parties must be signed on (and apply it) for example while transmission and distribution apply a standard for flooding generation do not (apart from Nuclear).

We can use data we have on previous events and apply the analysis outcomes to different locations to understand realistic potential could happen events – what would happen if we have storm surges similar to 2013/14 occurring with the very high river discharge levels we have now.

Note: National Grid have to be careful with visualisation of risk as this can sometimes send a confusing message if interpreted incorrectly (because a site is in a flood zone does not mean it is at risk of flooding) however we do need to understand interconnectivity risks and a visualisation of this is often the best demonstration of this.

National Grid would like to hear both from academics and energy companies willing to develop new collaborations in this area.

If you wish to be put in contact with National Grid, please get in touch with CIRIA.

Network Rail

[Network Rail Website](#)

In 2002 Network Rail took over as owner and operator of Britain's railway infrastructure. Our mandate from government was to improve safety, reliability, efficiency and punctuality on the network.

- Each weekday we carry 4m passengers on our network - last year there were 1.27bn separate journeys and 100 million tonnes of freight was transported by rail between ports, factories and shops
- We spend £1.84m every day operating, maintaining and renewing the railway
- We are one of the country's largest property owners with 8,200 commercial properties generating £1.3bn between 2009-14, all of which goes to improve the railway
- Over the past 20 years passenger numbers have doubled. This is why Network Rail is now carrying out the biggest railway investment programme since the Victorian era.

Why is the Environmental Risk to Infrastructure Innovation Programme important to us?

As infrastructure manager of the national railway:

- We know what impact the environment has on the safety and reliability of the infrastructure and punctuality of journeys
- We want to share and develop knowledge with industry and academia to improve infrastructure resilience
- We need to champion innovation so that we can effectively respond to the challenge of climate change.

Priority hazards

- Flooding of the infrastructure
- Wind damage due to vegetation around the railway
- Landslips due to extreme rainfall and freeze thaw
- Coastal erosion and scour of structures
- Effect of drought on track bed stability
- Electrical failure due to heat, rain and flood.

Research questions

- How can we adapt the legacy railway so that it is resilient to long-term flooding?
- What innovative low maintenance drainage solutions are available to manage water around the railway?
- Visions for an integrated transport system that is resilient to long-term flood and continues to serve rural and coastal communities
- Can we develop a national flood risk assessment tool so that infrastructure managers can collaborate and develop joined up flood resilience schemes?
- Can we improve how we build earthworks and the track bed so these are more stable to extreme rainfall and heat that we expect to see in the future?
- A modular building design for electrical equipment that performs in extreme weather.

If you wish to be put in contact with Network Rail, please get in touch with CIRIA.

[SSE Website](#)

Submarine electricity cables

Scottish Hydro Electric Power Distribution (SHEPD) is the distribution network owner in the north of Scotland. We have recently been consulting on the holistic impacts (health and safety, socio-economic, environmental and economic and engineering) of installing [electricity submarine cables](#). As part of this consultation we asked stakeholder to identify the material impacts in the 4 categories that should be quantified so that we can therefore take them forward into our cost benefit analysis.

Although the main environmental impacts are covered as part of our detailed environmental assessment we are keen to work with academics and institutions to identify the future environmental impacts. SHEPD are keen to understand how to predict how the changing environment could affect the reliability of supply and thus economic life (up to 50 years) of our cables.

Examples from the existing literature which have illustrated how environmental impacts or climate change implications affect the wider marine environment would be of interest. However, projects which illustrate how this research could be adapted to serve as justification to update our current methods of design, inspection, survey, monitoring, installation and decommissioning now for future electricity submarine cables installations would be beneficial.

SHEPD are keen to support proposals addressing the following environmental impacts and cross cutting issues but not limited to these specific tasks:

- New types of seabed event – arising under climate change
- Low probability high impact events - more interruptions to our submarine electricity cables.
- Aggressive marine growth or invasive species degrade cable protection
- Changes in marine mammal behaviour and their reaction to permeant seabed features
- How changes in sea level effect tidal behaviour
- Expected rates and levels of costal erosion as a result of climate change
- Changing wind patterns and effect of salt dispersal from the sea
- Forecasting and monitoring sea acidity level
- Accurately mapping and monitoring of tidal patterns and how these are evolving
- What is the implication of changes in the gulf stream for coastal water temperature
- The ability to predicting sediment movements as a way to optimise cable protection or decommission activities
- How does future environmental changes effect cable protection method
- As a result of the changing marine environment, what is the risk that protected species in proximity to a cable would be adversely effected from future decommissioning

If you wish to be put in contact with SSE, please get in touch with CIRIA.

[Scottish Water Website](#)

Scottish Water's corporate vision is to be trusted to care for the water on which Scotland depends. In order to achieve this, our purpose in managing our assets is to plan and deliver an affordable, resilient, and reliable water and wastewater service to our customers and for Scotland.

The Environmental Risk to Infrastructure Innovation Programme (ERIIP) is important to Scottish Water as it is the natural environment which presents our asset systems with many of their key challenges.

In particular, we are interested in working with researchers to develop projects which will help us to:

Understand how climate change may affect raw water quality.

- A key area of concern is understanding how much DOC is likely to increase over the next 10 to 50 years, and in particular changes to the fraction of hydrophilic DOC which is more challenging to remove.
- We also would be interested in understanding the effect of short lived extremes of weather on the raw water envelope, for example to what extent more extreme rainfall might lead to high peaks in organics loading; and whether more extreme storms may increase salinity in coastal freshwater lochs, impacting on the formation of disinfection by-products (e.g. bromides).

Prepare for environmental hazards that can provide an external shock to our asset systems, for example:

- Temperature extremes, their effects on water networks, and how smart technologies could be used to reduce and manage the impacts.
- Innovative low-cost tools and technologies to identify areas at elevated risk from ground movement / landslips, and provide for their ongoing monitoring.
- Changes in the nature and frequency of lightning strikes and the adequacy of existing protection measures.

Construct key hazard scenarios for use in resilience plans:

- Hazard datasets provide a bewildering volume of information: can current research be distilled down to something that allows a consistent narrative to be played through business scenario planning?

To discuss Scottish Water research priorities and interests, or other partnering opportunities, please contact:

Will Carroll, Technical Lead, Water Strategy will.carroll@scottishwater.co.uk .

[Temple Group Website](#)

Temple Group is an environment, planning and sustainability consultancy, responsible for significant contributions in terms of policy, strategy, programmes and delivery. We have been actively engaged with some of the UK's largest and most challenging programmes and projects from inception through to completion. Temple's core business focuses on the planning and delivery of major linear infrastructure projects and site developments. [The Ecology Consultancy](#) is part of Temple Group and the [Green Infrastructure Consultancy](#) is a sister company.

Temple is interested in collaborating on projects across three themes.

1. The role of green infrastructure in mitigating the effects of severe weather

Areas of interest include the following:

- Trialling of GI solutions in hotspot locations (identified based on historical patterns of severe weather, for example) and where there have been specific adverse effects on infrastructure. GI solutions can include tree and vegetation planting, living snow fences, shelterbelts, living coasts and catchment-wide programmes
- Development of and testing of guidance for GI solutions for use by design engineers in road, rail and other major UK infrastructure
- Approaches to the planning and maintenance of the 'soft estate' of major infrastructure which recognises its multi-functionality, particularly its role in climate change adaptation
- Cost benefit analyses on GI solutions
- Review and potentially trial the application of SuRe, a new international standard for Sustainable and Resilient Infrastructure, on UK infrastructure
- The effectiveness of catchment scale approaches to GI for flood protection which affect more than one infrastructure owner/ asset manager (see interdependencies)

2. Interdependencies among infrastructure providers

Building on the work undertaken by ITRC and others, to investigate the interdependencies associated with two or more infrastructure schemes at specific example locations which would generate cost savings for infrastructure stakeholders concerned and share the burden of managing the effects of climate change. Examples could include historic flood or landslide sites affecting more than one piece of infrastructure. The work could involve identifying hotspots of critical infrastructure which would benefit from strengthened resilience or solutions to reduce their 'hotspot' status. It could involve identifying common investment appraisal techniques or cost benefit analyses agreed by multiple stakeholders for specific hotspot locations. The vulnerability of different stakeholders' operations and knock-on effects (e.g. for emergency vehicle routes or for patients or customers) should be considered as part of the appraisal process. A multi-stakeholder approach would assist consideration of joint funding for improving the resilience of the infrastructure concerned.

3. Identification and consideration of environmental risks under the new Environmental Impact Assessment (EIA) Directive

Implementation of European Directive 2014/52/EU into UK legislation* is the subject of consultation by the UK government until 31st January 2017. Article 3(2) of the Directive specifies assessment of the expected effects deriving from “the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project concerned”. The Directive (Article 8a(4)) also requires the determination of procedures for “monitoring of significant adverse effects on the environment.” where appropriate.

Our principal areas of interest are in:

- identifying those disasters which comprise or arise from environmental risks to proposed or planned infrastructure projects which will be subject to new EIA regulation and approaches to assessing these as part of EIA;
- defining how the monitoring of significant adverse effects on the environment (by an infrastructure project) should be undertaken in a way which also takes account of the environmental risks (or risk of major disasters) to that infrastructure.

* The government will continue to negotiate, implement and apply EU legislation until EU exit negotiations are concluded as all rights and obligations of the UK’s membership of the EU remain in force until then.

If you wish to be put in contact with Temple Group, please get in touch with CIRIA.

[Transport Scotland Website](#)

The aim of ERIP is to provide sound evidence for the identification and assessment of environmental risks and their impacts on infrastructure, translating the latest research into industry-relevant outputs.

Of the three themes identified by ERIP, theme number 1 is perhaps of most interest to Transport Scotland:

1. **Identifying, understanding and quantifying environmental risks to the infrastructure system.**
2. Likelihood, effect and impact of multi-hazard combinations on the infrastructure system.
3. Dealing with uncertainty in design, operational and investment decisions.

Transport Scotland has identified a number of environmental risks to transport networks in Scotland within the [Scottish Climate Change Adaptation Programme](#). The hazards that are of interest to Transport Scotland are as follows:

| Hazards | Strategic research questions and 'grand challenges' |
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| Inland Flooding and surface water flooding | <ul style="list-style-type: none"> • Research into the development of a surface water flooding model for strategic road and rail corridors, using existing flood forecast data from national metrological service. • Assessing SUDS systems post instillation, to determine if SUDS designs are able to manage current and future water across road infrastructure schemes (particularly during extreme weather events). • Improving assessments of the vulnerability of road and rail infrastructure networks to flooding, enabling infrastructure operators to focus on the most 'at risk' zones. • Understanding relationships between landscape and localised flooding events including consequences of similar rainfall events due to different ground conditions e.g. saturated ground, frozen ground, parched ground etc. |
| Geological hazards and landslides | <ul style="list-style-type: none"> • Identifying of the greatest risk from individual or combinations of rock types, sub-soils and soils relating to landslide events. |
| Storms and gales / Wind | <ul style="list-style-type: none"> • Determine if wetter weather will contribute to a change in traffic and congestion patterns in urban areas • Assessing the influence of wind direction relating to the impact of high winds on rail and road networks. |
| Low temp risks (and unintended impacts) | <ul style="list-style-type: none"> • Examine how passenger infrastructure and the access to it (such as railway or bus stations, ports and event smaller structures such as bus shelters) should be designed to cope with more severe weather • Examine how level of winter preparedness might be affected by modelled reductions in environmental risk (e.g. likelihood of reduced incidents of snowfall). |
| Scour and debris impact on bridges | <ul style="list-style-type: none"> • Perhaps around methods to improve the resilience of bridges in areas at risk of flooding (within potential vulnerable areas in Scotland). • Techniques or technology to assess underwater scour impacts on civil engineer structures (rather than just replying on river-bank visual |

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| | assessments) . |
| Fog | <ul style="list-style-type: none"> • Assess fog projections to determine the significance of fog events for road networks. |
| Other (all hazards together; under theme 3) | <ul style="list-style-type: none"> • Examining how road infrastructure design and procurement contracts mitigate environmental risk (through 'sustainability tests' during procurement). • Examining the combined impact of severe weather on the road and rail network. For example is high wind and some rain better or worse than some wind and high rainfall. |

If you wish to be put in contact with Transport Scotland, please get in touch with CIRIA.

[UKWIR Website](#)

Who we are

UKWIR was set up by the UK Water Industry in 1993 to provide a framework for the procurement of a common research programme for UK water operators on 'one voice' issues. UKWIR's members are water and sewerage undertakers in England, Wales, Scotland, Northern Ireland and the Republic of Ireland.

How we work

Our work is often carried out in collaboration with government departments, industry regulators and other key industry stakeholders. Some work is done in collaboration with research organisations internationally.

Our research is delivered by a wide range of contractors, academic institutions and other organisations in the UK and overseas. Project management is undertaken by both the water industry's staff and by experienced individuals employed by UKWIR.

Our Research

Delivery of a successful research programme which addresses the key challenges the industry faces is key. In particular we have developed a number of 'Big Questions' with the industry. It is crucial that those involved with water research know about, understand and support our Big Questions, and want to help us answer them.

They are:-

1. How do we **halve our abstractions** by 2050?
2. How will we achieve **zero leakage** in a sustainable way by 2050?
3. How do we achieve **zero interruptions** to water supplies by 2050?
4. How do we achieve **100% compliance with drinking water standards** (at point of use) by 2050?
5. How will we deliver an **environmentally sustainable wastewater service** that meets customer and regulator expectations by 2050?
6. How do we achieve **zero uncontrolled discharges from sewers** by 2050?
7. How do we achieve **zero customers in water poverty** by 2030?
8. How do we ensure that the regulatory framework incentivises efficient delivery of the **right outcomes for customers and the environment**?
9. How do we become **carbon neutral** by 2050?
10. How do we turn all **wastes** we receive and generate **into products** by 2030?
11. What is the **true cost of maintaining assets** and how do we get this better reflected in the regulatory decision making process?

Whilst we welcome research that will help us to answer any of our Big Questions, we hope the ERIIP programme will help us to make progress in answering some of the following aspects:-

How do we halve our water abstractions by 2050? By eliminating water wastage; by understanding the socio, environmental and economic issues associated with maximising the use of potential new sources of drinking water (eg. desalination, final effluent re-use, rainwater harvesting) how can we minimise abstractions and the impact of water supply on the environment, and at the same time maximise the benefits of such action and investment on society, customers and the environment?

Topics in the ERIIP remit include:

- Investigating ways of making water resource systems resilient to environmental risks
- Understanding how best to use the variety of historic records available to us to supplement rain gauge data to improve our understanding of climatic variation
- Understanding the impact of drought on water infrastructure and abstractions
- Develop better methods for monitoring and modelling of aquifer salinisation
- Developing tools, and approaches for the cost effective harvesting rainwater or re-using wastewater

How will we achieve zero leakage in a sustainable way by 2050? The environment surrounding water infrastructure (e.g. underground pipes) is a major driver of leakages and bursts, yet we do not understand the basic mechanisms that control these processes e.g. ground heave/movements, traffic vibration etc. How can we better understand and model such environmental impacts on infrastructure.

Topics in the ERIIP remit include:

- Better understanding of how the environment (in particularly temperature, soil type, soil wetness) interact with pipes to cause bursts & leakage
- Better leak detection and location techniques (acoustic and non-acoustic)
- Novel leak repair methods
- Developing leak free new networks, which can withstand environmental impacts

How do we achieve 100% compliance with drinking water standards (at point of use) by 2050? The environment and land use are major controllers of raw water quality which has a significant impact on the level of treatment required to ensure it meets drinking water standards. As well as improving how water is treated, water companies also want to help customers to understand the risks to water quality arising in their homes and helping them to safeguard water in their homes

Topic in the ERIIP remit include:

- Develop new systems, tools, techniques to maximise and secure the benefits to water quality & quantity via catchment management
- Developing sustainable treatment technologies, which are resilient to environmental risks
- Identifying routes to minimise disinfection by products from the reaction between chlorine and dissolved organic carbon in raw water, and or finding better options for disinfection such as catalysis

How will we deliver an environmentally sustainable wastewater service that meets customer and regulator expectations by 2050? The wastewater treatment process uses a combination of physical, chemical and biological processes, which are affected by the environment, particularly temperature and rainfall / snowmelt, saline infiltration etc

Topics in the ERIIP remit include:

- Maximising benefits to the water system and environment via integrated catchment management (ref water quality)
- Developing sustainable treatment technologies which are resilient in wide range of environmental conditions
- Maintaining and protecting biosolids recycling routes to land
- Undertaking relevant research to define what a 21st Century Drainage network should be

How do we achieve zero uncontrolled discharges from sewers by 2050? Excess run-off of surface water from impermeable surfaces and infiltration from soil into sewerage pipes contributes to overflows and uncontrolled

discharges which can impact on the environment and public health. They can also cause flooding of urban areas.

Topics in the ERIP remit include:

- Understanding hydrological processes which govern movement of water from soil into sewers
- Methods to better monitor and reduce sewer blockages
- Reducing overflows (escapes) at rising mains and pumping stations
- Achieving integrated sewerage catchment management (ref water quantity)
- Addressing sewer infiltration due to excess surface water flows, including flows from developments
- Undertaking relevant research to define what a 21st Century Drainage network is

Please contact Hans Jensen (hjensen@ukwir.org.uk) or Mandy Fletton (mfletton@ukwir.org.uk) if you think you can help and would like to discuss further.

Additional research priorities

The following pages contain information on shared research interests and environmental risk challenges which the industry partners would be interested in seeing projects addressing.

Space weather impacts on UK infrastructure

The following space weather events are potentially harmful to infrastructure:

- Coronal Mass Ejections. These produce a high intensity effect, with high magnetic fields leading to geomagnetically induced currents.
- Solar Radio Bursts, leading to broadband radio interference.
- Solar Radiation Storms resulting in Single Event Effects, which may cause disruption to digital electronics.

The low frequency/likelihood but high impact nature of space weather events means that understanding possible impacts is important.

GAPS/POSSIBLE AREAS FOR FURTHER STUDY

Many of the threats posed by space weather events are similar in nature to other environmental events. However strategies for dealing with space weather and detailed plans are generally not available. This is because space weather events are expected to occur very infrequently.

Nevertheless, research is needed and areas of interest include:

- How might the risk and impact of space weather events vary both spatially and temporally?
- What interdependencies exist with other systems for example energy, telecoms and infrastructure? What are the alternatives if these systems fail?
- Refinement of impacts to be characterised geographically, consider length of disruption, risk to passengers and an estimate of the cost range.
- Are existing networks robust to multiple points of failure?
- Studies into the impacts of space weather at a sub-system and component level. There is a need for further research to identify the impact on the types of electronic components used in rail infrastructure; this would have to involve equipment manufacturers.
- Development of contingency plans in the event of a severe space weather event occurring;
- Developing a range of scenarios of future space weather events ;these could provide input into business planning/continuity exercises;
- How to promote better coordination between relevant stakeholders including National Grid, MetOffice and the Department for Business, Energy and Industrial Strategy.
- Can historical network disruption or failures of railway assets correlate with space weather events?

Lightning impacts on UK infrastructure

Over recent years, total train delay due to lightning strikes has steadily increased. Compared to other weather-related delay incidents there are a relatively small number of delay incidents due to lightning, but when these occur finding and fixing the affected equipment can result in lengthy train delays.

GAPS/POSSIBLE AREAS FOR FURTHER STUDY

The data available raises a number of key questions:

- Is data about lightning strike available for the UK and for which period?
- Does spatial variability of the phenomenon suggest locations that are particularly vulnerable?
- Can we clearly correlate records of the number of historic lightning events with the increased number of strikes on our asset?
- Does this indicate whether rail assets are becoming increasingly vulnerable or whether there is simply more lightning events?
- Nationally what specific asset types are most vulnerable and have greatest impact on performance?
- Do our current asset policies support increased asset resilience taking into account the likely increased lightning events due to climate change?
- If asset policies do not currently promote resilience of the effected assets, what options exist to protect the asset?
- How can we find and fix affected assets rapidly to reduce the duration of train service disruption?

Scour of structures in rivers and estuaries

- The application of tools and data at a catchment/sub-catchment level that can help asset owners identify the likelihood of risk to particular assets from scour / deposition (as opposed to the inspection of individual assets)
- Novel inspection techniques for assessing the condition of submerged elements of bridges and other structures prone to scour

CURRENT GAPS IN TERMS OF KNOWLEDGE, GUIDANCE, TOOLS, APPROACHES

Environment Agency

- How can we better predict the likelihood of erosion and deposition around flood plain structures?
- How do we define critical thresholds for intervention / mitigating actions
- What effect is CC and consequent river regime in terms of flow volumes (and sequencing) and sediment load going to have on critical structures
- How can we define which structures / localities will present the most risk as a consequence of changing sedimentary regime. (it is the likelihood info rather than impact necessary here)
- Are there unintended consequences from reducing / increasing sediment supply through changes to catchment management? Effect on structures and conveyance capacity
- Are there monitoring technologies available to indicate where and when action is required?
- Are there better means of understanding susceptibility of failure of structures – what are the threshold loadings vs likelihood that these exceeded?
- Whether there are opportunities for field monitoring to support engineering judgement in resolving such issues.

Network Rail

- Enhanced measures for automatic monitoring of parameters such as water level, flow rate, bed level (i.e. direct measure of scour) and structure movement.
- The determination of if/when infrastructure can be re-opened following closure (i.e. confirmation that no scour has occurred without using divers or waiting for flood waters to subside).

- Are there any known techniques for accurately establishing foundation depths without coring?

Highways England

A risk based approach is currently adopted and appears appropriate. However this relies on knowledge of inspectors and those managing the structures. For a general inspection guidance on what should be looked at so that any evidence or vulnerability of scour can be noted at an early stage would be useful. Guidance on techniques for monitoring of more high risk structures may be useful.

PRELIMINARY LIST OF CHALLENGES AND RESEARCH QUESTIONS

Research challenges can broadly cover four levels:

- 1. At the catchment level – these relate to understanding holistically where scour and deposition may occur now and in the future**
 - A. Continued R&D to deliver cheaper, more robust and precise hydro-morphological monitoring and assessment systems at the level of an individual reach or asset
 - i. To support and strengthen industry practice scour risk management procedures
 - ii. To inform channel maintenance planning and operations
- 2. At the river reach or asset system level – the behaviours and interactions of the river and structures**
 - A. Development of integrated whole-system hydro-morphological analysis
 - i. To understand influences of up/downstream land and river channel management (e.g. NFM, river restoration) on infrastructure risk
 - ii. To understand, model and map sources of sediment and larger "debris", its recruitment, conveyance and impacts (e.g. blockage or damage from trees)
- 3. For specific, especially extreme events, understanding the effects and interactions in greater detail and gathering information from field monitoring**
 - A. Capturing system dynamics
 - i. Temporal evolution of scour or erosion risk within an event
 - ii. Behaviour of systems associated with sequences of hazard events
- 4. The availability and role of models to predict the effects of the above**
 - A. Probabilistic analysis
 - i. Hazard events
 - a) models and assessments than can account for spatial patterns, temporal effects, sequences
 - b) models for combined hydrological and geomorphological sources of hazard
 - B. Vulnerability and pathways
 - i. Development of fragility functions
 - ii. Assessment, quantification and constraining of uncertainty in models.

The whole system view of infrastructure should consider both the operational risk to individual assets and the risk associated with a more strategic view of system resilience in the face of extreme ("black swan") type events. There may be different arguments for investing in mitigation measures across these two types of risk.

If you wish to be put in contact with the ERIIP members interested in this topic, please get in touch with CIRIA.