



Introducing the UK Climate Resilience Programme

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Abstract

- Research and policy relating to climate change risks and adaptation have been developing in the UK since the 1990s.

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- The 2008 Climate Change Act established much of the framework for UK climate risk assessment and adaptation management.
- The UK Climate Resilience Programme was funded from 2018–2023 to address research gaps in characterising and quantifying climate risks, managing climate related risks through adaptation, and co-producing climate services.
- From the outset, the programme prioritised co-production, innovation, trans-disciplinary research, and working with stakeholders to ensure outputs were useful and usable.

Keywords Climate risks · Adaptation · Resilience · Policy

1 INTRODUCTION

Global and UK climate is changing at an unprecedented rate. New weather and climate records are being set, and there is growing evidence that human activity is influencing the probability of dangerous climate extremes [5]. Further climate change is now inevitable, but the amount and pace of change will be shaped by the effectiveness of international climate mitigation policies. Recent past and projected future change mean that adaptation is critical in reducing climate risk and vulnerability in human and natural systems. The concepts of adaptation, vulnerability, resilience and risk provide overlapping, alternative entry points for the climate change challenge (see box of key terms).

Key terms [7]

Mitigation (of climate change): A human intervention to reduce emissions or enhance the sinks of greenhouse gases.

Adaptation: In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.

Risk: The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change. In the context of climate change impacts, risks result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards.

Hazard: The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.

Exposure: The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected.

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Impacts: The consequences of realised risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather/climate events), exposure, and vulnerability.

Resilience: The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation.

Projection: A potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Unlike predictions, projections are conditional on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realised.

Scenario: A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces and relationships.

In the UK, the decade 2012–2021 was 1°C warmer than the 1961–1990 average, compared with 0.8°C for global surface temperature [10]. In July 2022, the UK experienced unprecedented high temperatures above 40°C and there is growing evidence that the intensity of heavy rainfall events has increased in recent years [4]. Changes in UK climatic impact-drivers—the climate conditions that affect the things we care about in nature and society [15]—have led to a multitude of climate impacts, such as infrastructure damage and heat-related deaths. There is some evidence of adaptation action in the UK [8], which could offset some of the increased risk due to climate change, but the UK’s Climate Change Committee states that the gap between the level of risk and the level of adaptation has widened recently for many sectors [3].

The UK research base in climate risk and resilience is world leading but fragmented. Climate scientists at the Met Office and in UK universities have been at the forefront of climate science and climate services, exemplified by the UK Climate Projections 2018 (UKCP18) and the development of high-resolution global climate modelling. Engineering and other sciences have translated climate hazard knowledge into impact and risk metrics (for example, in infrastructure and urban adaptation), creating a national infrastructure system-of-systems model. Social science research has focused on areas such as barriers to adaptation, economic costs and benefits, risk perception, behaviour and communication, and the science-policy interface. The arts and humanities have achieved contributions in the philosophy of climate science, the history, heritage, ethics and culture of climate change, climate adaptation and resilience, and artistic interventions focusing on living with change and loss. The UK was also world leading in setting up a ‘boundary organisation’ to act as a bridge between scientific research, policymaking and adaptation practice through the UK Climate Impacts Programme (UKCIP) in 1997. The next section briefly reviews key developments in UK climate adaptation research and policy.

2 A BRIEF HISTORY OF UK CLIMATE RESEARCH AND POLICY ON ADAPTATION

In the 1990s, the UK government founded the Met Office Hadley Centre (1990) [12], published the first national assessment of the possible impacts of climate change (1991) [4] and established the pioneering UK Climate Impacts Programme (UKCIP) to bring together scientific research, policymaking and adaptation practice (1997) [13]. While UKCIP's overarching aim was to help the UK adapt to the unavoidable impacts of climate change, its remit shifted over time—from engaging organisations on initial impact assessment, to occupying the boundary space between climate projections and research, supporting policy development (including the legislative requirements of the Climate Change Act 2008) and helping organisations develop and implement adaptation strategies and actions. As well as developing a portfolio of tools, UKCIP published the first national climate change scenarios in 1998 and was influential in framing climate adaptation as a problem of risk management [19].

During the 2000s, more national climate change scenarios were published by the Met Office (2001 and 2009) and the UK developed a regional, multi-sectoral and integrated assessment of the impacts of climate and socioeconomic change in the UK [9]. The Climate Change Act 2008 created a framework for adaptation to climate change, by establishing:

- the five-yearly, UK-wide Climate Change Risk Assessment (CCRA);
- that a National Adaptation Programme (NAP), must be put in place to address climate change risks and be reviewed following each CCRA;
- the 'Adaptation Reporting Power' (ARP), giving the government discretionary power to require relevant bodies to report on climate preparedness; and
- the Adaptation Sub-Committee (now the Adaptation Committee) of the independent climate change committee (CCC), to advise government and evaluate adaptation progress.

The UK government has since published three CCRA (2012, 2017 and 2022), three NAPs for England (2013, 2018 and 2023) and there have been three rounds of ARP reporting. Responsibility for climate change adaptation is split between the four countries of the UK. The UK government is responsible for climate change adaptation in England and for reserved matters, with national governments in Northern Ireland, Wales and Scotland being responsible for adaptation in all devolved policy areas. The Adaptation Committee of the CCC has assessed progress of the UK and devolved governments in preparing for and adapting to the impacts of climate change. Between 2008 and 2010, local authorities reported against a process-based framework to help their preparations for a changing climate (known as National Indicator 188).

The early 2010s saw the development of regional climate change partnerships under the umbrella ‘Climate UK’ (for example, the London Climate Change Partnership and Climate Northern Ireland) and the transfer of many of UKCIP’s functions to the Environment Agency’s Climate Ready Programme in 2012. Financial austerity in the public sector led to the closure of most of the regional climate change partnerships and in March 2016, the Climate Ready Programme also ended, leaving England largely devoid of a boundary organisation focused on climate impacts and adaptation (with the exception of the Marine Climate Change Impacts Partnership).¹ However, since 2019 more than ten city and regional Climate Commissions have been established under the Place-based Climate Action Network (PCAN), working as independent advisory groups bringing together the public, private and civic sectors. During this period, research continued including the following programmes: the Programme of Research on Preparedness, Adaptation and Risk (PREPARE; 2012–2013); the Living With Environmental Change (LWEC) Programme (which included ‘climate change impact’ report cards and Engineering and Physical Sciences Research Council’s (EPSRC) ‘Adaptation and Resilience to a Changing Climate’ (ARCC), amongst others); the Met Office Hadley Centre Climate Programme and the UK Climate Projections 2018 [11]; CCRA2 [1], and some decision support tools (for example, the Climate Just tool).

While undertaking the delivery of the CCRA2 evidence report, the then-named Adaptation Sub-Committee collated over 200 evidence gaps

¹ Boundary organisations continue to exist in Scotland (Adaptation Scotland) and Northern Ireland (Climate Northern Ireland).

which were discussed and supplemented at a research needs conference in late 2016. The committee concluded that to progress understanding of climate risks in future CCRAAs, the following cross-cutting evidence gaps needed to be addressed:

- UK spatial modelling capability;
- Socioeconomic scenarios for the UK;
- Decision support frameworks;
- Monitoring;
- Behaviour change;
- Adaptation options.

In 2017, the chair of the Adaptation Committee wrote to Research Council Chief Executives stating that a concerted multidisciplinary effort was required to support future CCRAAs. In mid-2018, with support from Department for Environment, Food and Rural Affairs (Defra)'s Chief Scientist, the Natural Environment Research Council (NERC) and the Met Office jointly submitted a proposal for a programme on Climate Resilience to UK Research and Innovation (UKRI)'s Wave 1 Strategic Priorities Fund (SPF). The SPF UK Climate Resilience (UKCR) programme was approved in the autumn of 2018 at a total cost of £18.65 million over the period 2018–2023, as a partnership between UKRI and the Met Office.

3 THE SCIENCE PLAN AND ITS IMPLEMENTATION

The Strategic Priorities Fund (SPF) offered an opportunity to improve climate risk assessment and enhance UK resilience by encouraging and funding high-quality multi- and interdisciplinary research and innovation using integrative approaches that cross traditional disciplinary boundaries. It provided space for pioneering research, laying the foundation for future capability, and aimed to link effectively with government departments' research priorities and opportunities. The UKCR programme is an example of SPF's ability to respond with agility to strategic priorities and opportunities, and ensure the UK remains at the cutting edge of research.

The vision for the UKCR programme was:

To enhance the UK's resilience to climate variability and change through frontier interdisciplinary research and innovation on climate risk, adaptation and climate services, working with stakeholders and end users to ensure the research is useful and usable.

The programme's three main objectives were:

- Characterising and quantifying climate-related risks;
- Managing climate-related risks through adaptation;
- Co-producing climate services.

The science plan recognised that single disciplinary approaches will not be able to 'solve' this complex challenge and that multi- and interdisciplinary research efforts that include the natural sciences, social sciences, engineering, the arts and humanities are needed. It also recognised that the engagement and involvement of a wider range of stakeholders, such as practitioners and policymakers, are essential in addressing this challenge.

A programme board was established to oversee UKCR investment, with representation from the following funding bodies: the Met Office, NERC, AHRC (Arts and Humanities Research Council), ESRC (Economic and Social Research Council) and EPSRC. An independent steering committee was also established, to provide strategic input on the shape and delivery of the initiative, policy, alignment with other initiatives and opportunities for programme coordination and coherence. Following a networking workshop in September 2018, NERC/UKRI issued an interdisciplinary call to supplement ongoing UKRI Research Council awards/activities in climate resilience,² and a further call for the role of UKCR champion. During this first round of funding, 19 projects were funded by NERC/UKRI, and Professor Suraje Dessai and Dr Kate Lonsdale, based at the University of Leeds, were appointed as champions to act as thought leaders, flag bearers and strategy owners for UKCR. The

² Funding projects up to £250k for up to 12 months with a total budget up to £3.5m.

champions worked closely with the Met Office to ensure integration of the programme and development of strategy.

The champions and the Met Office led the development of a joint science plan [16], in consultation with UKRI and Met Office communities and climate resilience stakeholders from public, private and third sectors, while also taking into consideration government departments' research priorities, the evolving UK climate resilience research landscape and the state-of-the-art in relevant disciplines. The science plan identified opportunities to significantly improve capabilities and address the challenges of quantifying risk and enhancing resilience. It was delivered through four main activities: frontier research, building research capability, developing and testing climate services, and coordination and networking activities. A central aspiration of the programme was to grow the community of interacting researchers, practitioners and policymakers in climate resilience. This underpinned all activities, but was particularly important in climate services, networking activities and the embedded researcher scheme. Guided by the science plan, UKRI issued seven open calls³ and the Met Office commissioned 13 external projects⁴ and 16 internal projects,⁵ resulting in more than 60 projects funded across the whole programme. The science plan envisioned a series of legacies for the programme, as shown in Fig. 1:

Building on the science plan, the programme developed a high-level narrative to link the outlined 'legacy items' with UKCR's vision and objectives, articulating the activities needed to achieve the agreed legacy items, which would ultimately contribute to the programme goal of "enhancing the UK's resilience to climate variability and change". This narrative underpinned the monitoring, evaluation and learning plan for the programme. Programme activities were designed with consideration of the spectrum of knowledge brokering approaches, from 'linear

³ UK Climate resilience first call; Champion; Enhancing climate change risk assessment capability; Governing Adaptation; AHRC Living with climate uncertainty; Present and future climate hazard; Embedded researchers.

⁴ E.g. Development and provision of UK socioeconomic scenarios for climate vulnerability, impact, adaptation and services research and policy; Enabling the use and producing improved understanding of EuroCORDEX data over the UK; Climate services standards monitoring and valuing.

⁵ Within four work packages: Improving climate hazard information; From climate hazard to risk; Climate services pilot; Operational climate services.



Fig. 1 Envisioned programme legacies identified in the UKCR science plan

dissemination of knowledge’ to ‘co-production’. Given the goal of the programme, traditional evaluation criteria, such as academic publications and citations, were expanded to include knowledge utilisation, knowledge exchange processes, and benefit of research to society. Thus, in addition to research excellence, the programme has assessed partnership and co-production, research relevance for target users, positioning of research outputs for use, and progress towards building a coherent climate resilience research community [11].

4 BOOK ROADMAP

This book synthesises research conducted throughout the programme, through a series of chapters authored by UKCR researchers (usually a pairing from the Met Office and academia). At the time of writing in late 2022, several UKCR-funded projects were still ongoing, so some outputs have not been captured. Chapter 2 considers the key interpretations of climate resilience and its implications for practice. The rest of the chapters are organised in four parts.

In ‘Part 1: Undertaking Resilience Research’, we explore two means used in the programme to deliver context-specific, multi-stakeholder resilience research and achieve outputs suitable for practice and policy. Both co-production and embedding highlight the importance of more integrative approaches to climate resilience research, and this section provides guidance on how to deliver these approaches.

In ‘Part 2: Managing Climate Risks’, we focus on the place-based and context-specific nature of climate resilience research. Chapter 5 draws on projects that worked at specific geographical scales, to consider how connection to ‘place’ adds motivation and meaning to building climate resilience. Chapter 6 synthesises projects which directly interacted with *people* in particular places, using creative means to increase local engagement in discussions on climate risks. Both chapters emphasise the need for a ‘context first’ approach to climate resilience research and decision-making.

In ‘Part 3: Tools for Resilience Building’, we discuss climate services in Chapter 7 and decision support tools in Chapter 8. As well as summarising the contributions of the programme and highlighting research priorities going forward, both chapters consider what has been learned about the wider policy and practice context needed for the development and upscaling of climate services and decision-support tools.

Finally, in ‘Part 4: Understanding and Characterising Risk’, we summarise and signpost the programme’s contributions to this area, including new methods, data sets and tools. Chapter 9 outlines how the programme used new tools to improve the projection of hazards and discusses how they can be used to inform decision-making. Chapter 10 summarises how projects used UKCP18 datasets to calculate how climate change is likely to affect climate-related hazards and resources in the UK. Chapter 11 considers how UKCR projects have contributed to developing hazard information into risk information, while also highlighting the need for improved exposure and vulnerability data and better understanding of compound, cascading and systemic risks.

In the Afterword, the editors summarise and reflect on the research undertaken by the UKCR programme and conclude with a series of key learnings and priorities for future research.

NB: In all chapters, the authors refer to UKCR-funded projects by their abbreviated titles. Please turn to the List of Projects section at the back of the book for a brief description of each project and the research team, plus website links. More information about the programme, its objectives, legacy items and funded research can be found at <https://www.ukclimateresilience.org/>.

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