



UNIVERSITY OF
OXFORD

Climate services

Impacts, risks, and adaptation

A summary of relevant research at the University of Oxford

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There is growing recognition of the need for **climate information services** to help decision makers at all levels cope with climate variability and change. Successful climate services depend on highly **interdisciplinary research**, and end-to-end capability from climate data and modelling, to climate impacts assessment, to decision-making.

Researchers at the **University of Oxford** are working on a huge number of projects relevant to climate services, including **climate science** which is designed to support climate impacts and adaptation, analysis of **climate impacts** on ecosystems, water, food, energy, and infrastructure, **risk and decision analysis**, and research to better understand **stakeholders' perspectives and decisions**. An increasing number of Oxford's researchers are also working directly with users and providers to develop and deliver climate services.

This document is intended to provide a summary of Oxford's existing research into climate impacts, risks, and adaptation, as a resource to promote further collaboration within Oxford and with external partners. The ultimate aim is to generate more interdisciplinary research which might support **climate services for resilience and adaptation**. The summary can by no means capture the wealth of important climate-related research activity across the university, in particular the extensive capacity in fundamental climate science and climate change mitigation. More information on these areas is available through the [Climate](#) and [Energy](#) networks.

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Climate science for climate impacts and adaptation

There is a wealth of climate science research at the University of Oxford, contributing to the development and evaluation of datasets which are fundamental to climate information services, including from large scale field campaigns, and analysis of remote sensing data and reanalyses. There is also a great deal of work which contributes to the development of state of the art climate models.

Here the focus is on research to improve information from seasonal forecasting and long term projections. Details about the variety of climate research across the university can be found through the [Oxford Climate Research Network](#).

Analysis of existing datasets

- Analysis of climate model output, led by [Richard Washington](#), provides a vital assessment of the suitability of models for applications, with a focus on South East Asia and Africa. Richard Washington also leads the metrics and model evaluation theme for [IMPALA](#), a new project led by the Met Office seeking to improve future climate projections over Africa.
- The [Climate Processes Group](#) in the Department of Physics leads the development of the [Community Intercomparison Suite](#) (STFC/NERC funded), a software tool facilitating the easy access, co-location, aggregation, analysis and plotting of heterogeneous observational datasets (ungridded/gridded satellite imager/profiler products, aircraft measurements, data, aircraft measurements, surface measurement networks) and models ([Philip Stier](#), [Nick Schutgens](#)).
- Oxford researchers, in consultation with the CLIVAR VACS panel, have developed the [African Climate Atlas](#), a web interface to make observed and model datasets, including CMIP3 and CMIP5, available in a point-and-click format ([Richard Washington](#), [Sebastian Engelstaedter](#)).
- A [new technique](#) to tackle model location biases and improve projections is being tested, using brain registration tools to map simulations onto observed data ([Myles Allen](#), [William Ingram](#)).

Model development and experiments

- Large ensembles of climate model experiments generated by [climateprediction.net](#) (CPDN) and [weather@home](#) (WAH) ([Myles Allen](#), [Neil Massey](#), [Friederike Otto](#), [Richard Jones](#)) constitute an important tool for applied climate research, with unique capacity for attributing causes of and generating robust statistics of projected changes in extreme weather. This includes new higher resolution simulations (25km grid-spacing) for Europe and Africa.
- A new set of future projections are being developed using the WAH infrastructure, designed to generate more comprehensive event sets for risk assessment and decision-making ([Neil Massey](#)).
- The feasibility of near real-time attribution studies for extreme weather events is being trialled in a [new collaborative project](#) with Climate Central ([Friederike Otto](#)).

- The potential to use cloud computing is also being investigated, with support from Google Enterprise, Microsoft Research, and Amazon Cloud Services, which could speed up analysis and allow stakeholders questions to be answered more quickly ([Juan A. Añel](#)).
- Fundamental research into the development of seasonal forecasts is ongoing, including uncertainty assessment, which has generated metrics about the adequacy of seasonal forecasts in different regions ([Tim Palmer](#), [Antje Weisheimer](#)).
- Recent studies have shown that the stratosphere can influence regional weather, particularly over Northern Europe in some winters when the stratospheric vortex is disturbed. Oxford researchers are investigating solar cycle influences via the stratosphere on seasonal and decadal timescales ([Lesley Gray](#), [Dann Mitchell](#)).

Links to climate impacts

- The ECI is seeking to further integrate its climate programme with climate impacts and adaptation, and has recently appointed a Research Fellow in Climate Modelling for Climate Services ([Rachel James](#)).
- Extreme event attribution projects are increasingly exploring the potential to extend research into the drivers of change in weather risk towards attribution of impact risk, including for Europe ([EUCLEIA](#); [Myles Allen](#), [Antje Weisheimer](#)) and Africa ([ACE-Africa](#); [Myles Allen](#), [Simon Dadson](#), [Richard Jones](#)).

Climate impacts research

Ecosystems

- Research into the feedbacks between biomes (especially tropical forests) and global atmospheric change, e.g. carbon cycle feedbacks. This involves direct field studies (e.g. drought experiment in Brazil and monitoring impacts of actual droughts), satellite monitoring and development of the JULES vegetation model ([Yadvinder Malhi](#)). Field data are frequently used to inform and test model development.
- Research into impacts of tropical climate variability and extreme events on the ecology of tropical biomes, including productivity, mortality and species range distributions ([Yadvinder Malhi](#)).
- A [collaborative project](#) with the Oregon State University and other US institutes involving [Myles Allen](#) and [Richards Jones](#) is looking at modelling of and climate change impacts on forests in west coast USA, in part through generation of large parameter perturbation ensemble regional downscaling experiments using the CPDN/WAH infrastructure.
- Expertise in the impacts of climate change on biodiversity and nature conservation is applied through bioclimatic envelope modelling ([Pam Berry](#)).
- Research is also being conducted into climate change impacts on birds ([Ben Sheldon](#)) and cold ecosystems ([Marc Macias-Fauria](#)), alongside extensive work into longer term environmental change, macroecology, and ecosystem sensitivity to climate forcing ([Kathy Willis](#)).

- Expertise in ecosystem services ([Pam Berry](#), [Kathy Willis](#)) allows for analysis of the interactions between climate change impacts, ecosystem functioning, and society.
- The [Biodiversity Institute](#) connects experts in biodiversity across social and natural science departments.

Water

- Model development underpins research into hydrological impacts. [Paul Whitehead](#) has expertise in water quality and nutrient modelling. [Simon Dadson](#) has developed inundation schemes and a river flow model, which he is working to incorporate into the Met Office Unified Model via JULES.
- Research into climate change impacts on water resource systems, the interaction with non-climate drivers, and the effectiveness of management options includes global projects, and work on the Thames Basin ([Simon Dadson](#), [Paul Whitehead](#), [Jim Hall](#)) and the Ganges-Brahmaputra-Meghna delta ([Paul Whitehead](#)).
- Flood risk assessment and management is a specific area of expertise (led by [Jim Hall](#)). This incorporates coastal/tidal risk analysis, formerly as part of the Tyndall Centre Coastal Simulator and [Thames Estuary 2100](#) projects, and latterly as part of the NERC [iCOASST](#) programme ([Andres Payo](#)). Fluvial and urban flood risk analysis has extended the use of spatial-temporal model outputs and stochastic simulation methodology.
- Oxford is involved in two new interdisciplinary projects funded under the NERC UK Droughts and Water Security call, focusing on drought risk on monthly to decadal ([IMPETUS](#): [Tim Woolings](#), [Antje Weisheimer](#)), and longer ([MaRIUS](#): [Jim Hall](#), [Richard Jones](#)) timescales.
- Research is also underway as part of the [GWP/OECD](#) Task Force, which aims to illustrate and compare alternate strategies and pathways for achieving water security ([Jim Hall](#), [Simon Dadson](#)).
- Experts in water economics and development ([Rob Hope](#)) and water and sanitation ([Katrina Charles](#)) are also considering the role of climate change.
- The [Oxford Water Network](#) brings together many of these researchers to address the challenge of managing water in a complex and uncertain world.

Food

- The impacts of climate change on agriculture ([Richard Washington](#)) and the adaptive capacity of small-holder systems ([Ariella Helfgott](#)) is being investigated in Africa and South-East Asia.
- The relationship between droughts, agricultural production, and food security is also being examined on a global level, with a focus on the probability of [multiple breadbasket failure](#) ([Jim Hall](#), [Simon Dadson](#)).
- [Food systems](#) research being developed by [John Ingram](#) incorporates climate impacts on all aspects of the food system, including productivity but also transport, storage, and consumption patterns.
- [Joost Vervoort](#) leads a global project on scenario-guided policy development for climate-smart agriculture and food systems with 30 governments across East and West Africa, South and Southeast Asia and Latin America. Combined socio-economic and climate

scenarios are used to test and develop policies, action plans, and investment plans at national and regional levels.

- The [Oxford Martin Programme on the Future of Food](#) brings together research across Oxford on food production and consumption, waste, economics and governance.

Energy

- The impact of climate change and extreme weather on the future of energy production is being investigated in collaboration with utilities companies, with a focus on hydropower, wind, nuclear, and thermal power ([Juan A. Añel](#)).
- The [Oxford Energy Network](#) brings together over 180 senior researchers whose work is wholly or partly related to energy.

Infrastructure and the built environment

- The UK [Infrastructure Transitions Research Consortium](#), led by [Jim Hall](#), addresses challenges to energy, transport, water, waste and ICT, including management of climate-related risks. Recent analysis of 'hotspots' of infrastructure vulnerability provides the potential to link with analysis of extreme climatic events. The impact of severe flooding is already being investigated in the case of rail and electricity networks.
- The Adaptation and Resilience in the Context of Change ([ARCC](#)) network, managed by [UKCIP](#), brings together research on adapting to challenges such as climate change that threaten our built environment and infrastructure. The ARCC network supports co-operative working among the related policy, practice and academic communities, and enables the sharing of information and knowledge to support decision and policy making and thereby deliver benefits to society, the economy and the environment.
- As part of the [ARCADIA](#) project ([Jim Hall](#)), on adaptation and resilience in cities, Oxford researchers have expanded the urban integrated assessment framework to allow system-scale understanding of the inter-relationships between climate impacts, the urban economy, land use, transport, and the built environment, providing information to help design cities that are more resilient and adaptable ([Jim Hall](#), [Katie Jenkins](#)).
- [Heritage conservation](#) work includes assessment of climate change impacts ([Heather Viles](#)), and a new ES/SRC funded Centre for Doctoral Training in Science and Engineering in Arts, Heritage and Archaeology ([SEAHA](#)) provides opportunities for future PhD projects.

Cross-sectoral impacts

- Cross-sectoral interactions between biodiversity, agriculture, water, forests, coastal and urban environments are also fundamental for understanding climate change impacts. ECI researchers were involved in the development and application of the [CLIMSAVE](#) Integrated Assessment Platform, designed to allow stakeholders to explore future scenarios (CLIMSAVE; [Pam Berry](#), [Robert Dunford](#), [Paula Harrison](#)).
- Currently other impact models (including agent-based models) are being developed for Lyme disease, urban growth, and agricultural land use change, and applied for analysis for high-end scenarios ([IMPRESSIONS](#); [Paula Harrison](#)).

Risk and decision analysis

- There is an increasing focus on risk analysis and decision making under uncertainty, led by [Jim Hall](#), including applicability of risk-based decision making for urban adaptation planning, management of UK drought risk, and water resources planning in Thames Basin.
- As part of the [CREDIBLE](#) consortium, ECI researchers are exploring the application of decision analysis methodologies to natural hazards ([Jim Hall](#)).
- The ECI has recently created a Research Fellowship in Climate Decisions (reporting to [Jim Hall](#)) and is seeking to grow links with economists in Oxford and deepen analysis of the economics of climate adaptation.
- [Patrick McSharry](#), at the [Smith School of Enterprise and the Environment](#), is investigating the quantification and financing of risk associated with natural catastrophes.
- The ECI is a partner in the [ENHANCE](#) project looking to develop new ways to enhance societies' resilience to catastrophic impacts of natural hazards, including a probabilistic analysis of surface water flood risk in London, and development of an agent-based model to assess the potential role of Insurance and other mechanisms to enhance resilience today and in the future ([Jim Hall](#), [Katie Jenkins](#)).

Understanding user needs and perspectives

- Many climate impacts projects include stakeholder engagement to inform research questions, and this is promoted by the Climate network's Knowledge Exchange Research Fellow, [Pete Walton](#). Information about user needs and perspectives is highly valuable and there is potential to use this learning to orientate more climate change research towards decision makers.
- [Extreme event attribution](#) research also increasingly includes interaction with a range of stakeholders, including local governments and the UNFCCC: to investigate the meaning of attribution, and the potential for attribution services ([Pete Walton](#)). Oxford, alongside Reading, the Met Office, and the Red Cross, has developed a participatory game to promote science-policy dialogue, as part of the [ACE-Africa](#) project led by [Myles Allen](#).
- The Oxford Martin School Programme on Resource Stewardship ([OMPRS](#)) includes a research project on The Usability of Forecasts, to examine why scientific information is – or is not – used in decision making for the management of natural hazards and resources ([Steve Rayner](#), [Tim Palmer](#)).
- Social science expertise in the relationship between science and democracy has been applied to better understand perceptions of flood risk through “competency groups”, which bring together scientists and local people to apply hydrological models for risk management ([Sarah Whatmore](#), [Catharina Landström](#)).
- There is potential to draw on understanding of risk, resilience, decision-making, and scenario planning in business and enterprise, through collaboration with the [Said Business School](#), as well as the [Smith School of Enterprise and Environment](#). [Mick Blowfield](#) conducts empirical research on climate change transformation with companies around the world.

- An understanding of the policy context is also important in the delivery of climate services for adaptation. [Steve Rayner](#) has published extensively on the role of adaptation within international climate policy.

Climate Services

- Many Oxford research projects include generating products for stakeholders. For example, analysis of European wind storms is used to produce event sets for the insurance industry ([Neil Massey](#)).
- Oxford researchers provide scientific consultation for public policy on adaptation. As well as playing an important role in successive assessments of the Intergovernmental Panel on Climate Change (including [Myles Allen](#), [Tim Palmer](#), [Yadvinder Malhi](#)), two Oxford academics are members of the UK government's [Adaptation Sub Committee](#) ([Lord Krebs](#), [Jim Hall](#)), Lord Krebs being the chair. [Jim Hall](#) and [Paul Sayers](#) are also working with the Environment Agency to support long term investment decisions for flooding and coastal risk.
- Oxford researchers also work with companies on climate services. [Mick Blowfield](#) works with individual companies such as Mars and Accenture, and with business forums, to build a two-way process of communication between academics and the business community.
- [UKCIP](#), led by [Roger Street](#), helps organisations, sectors and governments adapt to the changing climate. UKCIP's work is focussed on supporting effective adaptation decision-making and enabling the exchange of knowledge and information between scientists, policymakers and adaptation practitioners. Recent work includes input into understanding and enhancing adaptation services as provided by the European and member states' adaptation platforms; working within [JPI-Climate](#) on identifying users' needs for, and mapping providers of, climate services within Europe; supporting adaptation planning in the West Balkans; adaptation and climate services support in China, and work on monitoring and evaluating adaptation progress in the coffee sector.

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Acronyms

ACE-Africa: Attributing impacts of external climate drivers on extreme weather
ARCADIA: Adaptation and Resilience in Cities: Analysis and Decision making using Integrated Assessment
CLIMSAVE: Climate Change Integrated Assessment Methodology for Cross-Sectoral Adaptation and Vulnerability in Europe
CLIVAR VACS: World Climate Research Programme panel on Climate Variability and Predictability
CMIP: Coupled Model Intercomparison Project
CPDN: climateprediction.net
CREDIBLE: Consortium on Risk in the Environment: Diagnostics, Integration, Benchmarking, Learning, and Elicitation
ECI: Environmental Change Institute, University of Oxford
ENHANCE: Enhancing risk management partnerships for catastrophic natural hazards in Europe
EUCLEIA: European Climate and weather events: interpretation and attribution
GWP/OECD: Global Water Partnership/Organisation for Economic Co-operation and Development
iCOASST: integrating COASTal Sediment Systems
IMPALA: Improving Model Processes for African cLimAte
IMPETUS: Improving Predictions of Drought for User Decision-Making
IMPRESSIONS: Impacts and Risks from High-End Scenarios: Strategies for Innovative Solutions
JPI-Climate: Joint Programming Initiative on Climate
JULES: Joint UK Land Environment Simulator
MaRIUS: Managing the Risks, Impacts and Uncertainties of drought and water Scarcity
NERC: Natural Environment Research Council
OMPRS: Oxford Martin School Programme on Resource Stewardship
OPENNESS: Operationalisation of Natural Capital and Ecosystem Services
SEAHA: Centre for Doctoral Training in Science and Engineering in Arts, Heritage and Archaeology
STFC: Science & Technology Facilities Council
UNFCCC: United Nations Framework Convention on Climate Change
WAH: weather@home