

Supplementary information - Understanding Research Priorities in Natural Catastrophe Insurance

Research Proposals

1. Principled use of catastrophe models under uncertainty

This project proposes a structured framework to interrogate catastrophe model assumptions, quantify uncertainty across the loss exceedance curve, and help underwriters, actuaries and reinsurance buyers move from blind reliance on point estimates to informed, uncertainty-aware decisions.

2. Translating key European/North American perils to African markets

This research would assess how major perils such as flood, wind and wildfire—commonly modelled in Europe and North America—apply to African markets in the near term and by 2050, using Earth observation and locally sourced data to overcome sparse observations and build a more robust basis for writing business in Africa.

3. Social science on drivers and barriers to insurance uptake in emerging markets

This proposal calls for social-science-led research into why insurance uptake remains low in emerging markets (for example, wildfire in southern Europe or multi-peril risk in Africa), exploring whether the main constraints lie in pricing, risk understanding, regulation, cultural attitudes or public awareness.

4. Drivers of European windstorm variability and future change

This project aims to disentangle the relative roles of the NAO, aerosols, AMOC, global warming and other circulation patterns in driving European windstorm variability on annual to decadal timescales, including changes in storm severity indices and clustering, using climate and high-resolution models.

5. Calibration standards and practices in insurance flood catastrophe models

This research would investigate how UK flood catastrophe models are calibrated, why different vendors converge on similar national-scale risk estimates, and whether this reflects overfitting to historical losses, with the goal of improving the justification and transparency of risk estimates used for pricing and solvency.

6. Near-term understanding of U.S. tornado risk and clustering

This proposal focuses on improving near-term predictability of U.S. tornado losses, particularly the representation of clustering, which is seen as a key driver of the gap between occurrence exceedance and aggregate exceedance perspectives in severe convective storm portfolios.

7. Uncertainty quantification across the flood modelling chain

This project proposes an open-source framework to quantify uncertainty along the entire flood modelling chain—from climate inputs and large ensembles, through DEM choice and model version, to post-processing—so that vendors and users can identify where uncertainty reduction would be most impactful.

8. Global hail hazard and vulnerability under climate change

A two-part project is proposed: first, to use convection-permitting models to build a present-day global baseline of hail size and damage potential and project future changes; second, to develop vulnerability functions for both severe and subsevere hail for property and crops outside the U.S., where current models rely heavily on U.S.-derived assumptions.

9. Sensitivity to limitations of reanalysis datasets in weather and climate applications

This proposal highlights the need to understand how sensitive catastrophe-relevant analyses are to limitations in reanalysis products such as ERA5, especially as new generations (e.g. ERA6) and AI-based weather datasets emerge, given how many downstream decisions and models depend on these data.

10. Automated global sensitivity analysis for OASIS LMF models

This project would develop an automated tool to perform global sensitivity analysis (e.g. PAWN, Sobol methods) on OASIS LMF models, turning well-established GSA theory into practical workflows that show which input uncertainties most strongly influence loss outputs and where to focus model improvement.

11. Dynamic sensitivity analysis framework for catastrophe models

This proposal suggests building a model execution framework that allows users to dynamically adjust key parameters and see corresponding changes in losses, replacing today's manual, project-based sensitivity studies with a more transparent, flexible and user-driven approach.

12. Interactions between perils under climate change in catastrophe models

This research would explore how multiple perils interact within catastrophe models under climate-change forcing, addressing the current disconnect between advanced Earth system modelling and cat model implementation, and seeking new academic–industry partnerships despite vendor IP constraints.

13. Contract uncertainty and its impact on catastrophe model loss estimates

This project would examine how policy terms and conditions—such as wordings, sub-limits and deductibles—introduce uncertainty into catastrophe model loss estimates, an area seen as under-researched despite its importance for understanding risk, pricing and the protection gap.

14. Policyholder behaviour and loss amplification

This proposal focuses on how policyholder behaviour around insurance and claims can amplify losses, a mechanism largely absent from current catastrophe models, and considers how better representation of such behaviour could influence pricing, contract design and assessments of protection gaps.

15. Vendor transparency and a grading system for catastrophe model methodology

This research would review major and boutique catastrophe model vendors and develop a grading system for transparency in methodology and results, aiming to give users clearer insight into model changes, limitations and suitability for different decisions.

16. Qualitative research on policyholders and terms and conditions

This proposal suggests qualitative research into how policyholders understand and interact with different insurance terms and conditions, addressing a perceived lack of R&D focused on the individuals being insured and how this shapes risk, claims and product design.

17. UK wildfire risk from present day to 2050

This project would characterise UK wildfire risk over the next 25 years to 2050, using satellite imagery, historical data, case studies and European wildfire models to understand where fires occur, the role of arson, emerging exposure, and implications for which properties should be insured and under what regulatory framework.

18. Compound wind and flood events in Europe

This proposal aims to extend existing work on compound wind–flood events beyond the UK to a European scale, using reanalysis and climate models to better understand bulk versus tail risks and to ensure that pricing and reinsurance structures reflect compound tail behaviour rather than focusing only on single-peril views.

19. AMOC/SPG tipping points and their impact on hazard

This research would investigate how potential tipping points in the Atlantic Meridional Overturning Circulation and subpolar gyre translate into changes in natural hazards relevant to insurance, bridging the gap between a large scientific literature and the practical need to inform customers about abrupt shifts in risk.

20. Wind-driven wildfire processes and urban conflagration

This project proposes improving the representation of wind-driven wildfire processes, especially for tail events and urban conflagrations, where current models diverge significantly and confidence is low, using kilometre-scale or convection-permitting models to better capture the most impactful scenarios.

21. Wildfire model uncertainty for present day and 5–10-year horizons

This proposal focuses on understanding uncertainty in second-generation wildfire catastrophe models for peak regions, examining how parameterisation and modelling choices collapse underlying uncertainty, and how hazard data can be more credibly linked to insurance loss metrics over the next 5–10 years.

22. Market-level impact of catastrophe models on decision-making

This research asks whether and how catastrophe models improve decision-making at the market level, for example in portfolio composition and pricing, using data such as NFIP and mortgage records alongside vendor models to help both practitioners and regulators understand the systemic effects of widespread model use.

23. Improved detection and inference of severe hail events

This project aims to develop better methods for detecting and inferring severe hail, addressing biases in reanalysis-based approaches and limitations of current gridded methods, by leveraging radar networks (e.g. NEXRAD/WSR-88D) and high-resolution convection-permitting models.

24. U.S. severe convective storms: severity, modelling and natural variability

This proposal examines present-day severity and natural variability of U.S. severe convective storms, questioning the suitability of current model updates, and exploring medium-term forecasts and model evaluation to understand whether models adequately capture trends and variability in a peril causing increasing impacts.

25. Representation of the climate change signal in catastrophe models

This research would investigate how climate change signals are incorporated into catastrophe models, with particular attention to separating physical hazard changes from behavioural and socioeconomic drivers, and to the implications of uninsured losses for the stability of the financial system.

26. Drivers and barriers to insurance uptake in emerging markets (systemic perspective)

Complementing earlier social-science proposals, this project would look at drivers and barriers to insurance uptake in emerging markets from a systemic and policy perspective, asking whether the key levers lie in better risk understanding, improved service provision, regulation, or broader financial inclusion.

27. Spatial variability of hail intensity and model suitability

This proposal seeks to understand trends in the spatial variability of hail intensity, addressing the disconnect between spatial and intensity patterns and biases in observations under current elliptical-on-grid approaches, with the goal of improving model suitability and understanding of risk concentration.

Summary of UK Academic Nat-Cat relevant research groups

****this is an incomplete summary. However, hopefully provides some useful information**

IRIS (Imperial College)

Assessing tropical cyclone risk on a global scale given the infrequency of landfalling tropical cyclones (TC) and the short period of reliable observations remains a challenge. Synthetic tropical cyclone datasets can help overcome these problems. Here we present a new global dataset created by IRIS, the ImpeRIal college Storm model.

Franziska Arnold-Dwyer (UCL Laws)

My project seeks to reposition insurance at the heart of the resilience debate, showing how insurance law and regulation can drive a shift from an almost exclusively compensatory model of insurance (loss occurs, insurance pays) to one that systematically embeds loss prevention (insurance pays upfront for loss prevention). This paradigm shift would address pressing societal issues in both developed and developing countries: widening insurance protection gaps and associated financial exclusion.

I am looking for project partners with experience in risk modelling, resilience theory and practice, behavioural economics, and from the insurance industry.

High-Resolution Climate Modelling (Reading)

HRCM is a long-standing collaboration between the National Centre for Atmospheric Science, University of Reading, and the Met Office Hadley Centre. HRCM scientists use weather-resolving global models to understand weather and climate risk in a changing climate. Current projects include Huracán (on North Atlantic tropical cyclone risk across midlatitude regions), nextGEMS and DYAMOND (on state-of-the-art kilometre-scale global climate modelling), and EERIE (on high-resolution ocean modelling and the ocean mesoscale's role in shaping climate). HRCM led CMIP6-HighResMIP and develops tools, methods and datasets for high-impact weather research, supported by an international network of collaborators across academia and industry.

Serge Guillas (UCL Stats)

- FITTER project, on future Indonesian tsunamis
- Interactions between climate change and quake
- Collaborations with RIKEN-CCS on end-to-end quantification of uncertainties in TC risk.

Hydrology Research Group, University of Bristol

Interests in flood (Paul Bates, Jeff Neal), drought (Gemma Coxon), uncertainty and decision making (Francesca Pianosi) and hydrological processes (Ross Woods). Part of the NERC-funded FLOOD-CDT Centre for Doctoral Training.

Gregor Leckebusch (University of Birmingham)

Research on physical processes in weather and climate systems, with emphasis on extreme extra-tropical and tropical cyclones, their drivers, and related uncertainties. Further research includes work towards extreme precipitation from synoptic-scale systems and to the drought-heat nexus under non-stationary conditions. Gregor works closely with various actors in the insurance sector, from CAT modellers to brokers and reinsurers. Current highlight interests lay in new tools and methods of hazard estimates for parametric insurance, the design and suitable application of (physically consistent) event sets, their non-stationarity characteristics, the evaluation of independencies of hazards (e.g., Atl TC vs EUWS), the intra-seasonal variability of clustering of severe storms, and how to incorporate the impact of anthropogenic climate change in suitable hazard assessments.

Storm Risk (Exeter)

- windstorms/extratropical cyclones
- hurricanes and typhoons
- extreme rainfall
- floods

Our interdisciplinary approach is based on concepts and techniques from dynamical systems theory, extreme value theory, climate science, and spatial statistics. The aim of our research activity is to help improve fundamental understanding and prediction of severe weather and its interaction with society. We focus a lot on the impacts for the insurance sector, with a long-standing partnership with the Willis Research Network.

UCL Risk and Disaster Reduction

The RDR conducts research in disaster risk reduction and resilience, around the themes: What causes risk and disaster? What are the consequences of risk and disasters? and Catalysing change. Our research foci are: Climate change and adaptation; Conflict and migration; Educating leaders; Health and social risks; Inclusion and politics; Natural hazards and risks; and Warning, resilience and finance. The RDR has received substantial research funding (£10 million+) in areas such as gender responsive resilience, hazard and risk uncertainty modelling, digital health, climate and environment, urban resilience, warning, and migration crises.

OpenVulnerability, a worldwide unique web database of 240'000+ multi-hazard fragility, vulnerability, and consequence models for buildings, infrastructure, and lifelines subjected to earthquakes, floods, wind, landslide, or tsunamis.

Environmental Change Institute (Oxford)

Our interdisciplinary research focuses on the complex processes of global environmental change, the exploration of sustainable solutions and motivating change for the better through partnerships and education.

Erica Thompson etc. (UCL STEaPP)

We work on the appropriate use of mathematical modelling to support real-world decisions, from mathematical and statistical questions about methodologies of inference from models to psycho-social questions about the formation of confidence and the role of expert judgement. Within insurance we work on understanding the values which drive information development and decision making across the insurance industry, alongside model evaluation and uncertainty.

Konstantinos Chalkias (Birkbeck)

Management studies of the insurance sector

I-Risk (Newcastle)

i-Risk is a NERC funded Doctoral Focal Award training 41+ PhD researchers to become the next generation of global leaders in transformative, interdisciplinary informatics for disaster risk reduction (DRR), which can exploit these nascent technologies to increase understanding of evolving, and multiple, natural hazards under climate change and urbanisation – and their escalating impacts on society and infrastructure – to enhance resilience.

Meteorology relevant CDT/DTP/DLAs

Name and research council	Universities or Lead University	Number of students (Where it's stated on the website)	Last cohort (start)
Living Well with Water DFA in the Arts and Humanities (AHRC and NERC)	University of Hull (with RGS as a partner)	~ 40 total?	2029
EPSRC CDT in Aerosol Science	University of Bristol	~ 19 per year	2028
Aura CDT in offshore wind energy sustainability and resilience	University of Durham	~65 total	2028
Future Fluid Dynamics CDT (they have a cloud on their home page!)	University of Leeds		2028
Net Zero Aviation CDT	Cranfield		2028
Water infrastructure and Resilience II (WIRe II) CDT	Cranfield		2028

Mathematics for our Future Climate (MFC): Theory, data and simulation	Imperial College		2028
Resilient Flood Futures (NERC)	Southampton		2026
UNRISK: Understanding Uncertainty to Reduce Climate Risks (NERC)	Leeds		2027
Interdisciplinary Life and Environmental Science Landscape Award (and previous DTP) BBSRC and NERC	University of Oxford		2024 for DTP 2 2030 for DLA
QUARTILES (BBSRC and NERC)	University of Aberdeen and Queen's University Belfast		2029
Addressing the Challenges of Changing Environments (ACCE+)	Liverpool		2029
Advanced Research and Innovation in Environmental Sciences (ARIES) DTP2 and DLA	UEA		2024 for DTP 2029 for DLA
Cambridge Research Experience and Advance Training for Environmental Scientists (CREATES)	Cambridge		2029
Central England NERC Training Alliance CENTA2 DTP, CENTA3 DLA	Birmingham		2024 for DTP 2029 for DLA
CROCUS: Climate System and Biodiversity Science	University of Reading		2029
E4 and E5 Edinburgh Earth and Environment doctoral training	Edinburgh		2024 for DTP 2029 for DLA

ExaGeo-Exascale Computing for Earth, Environmental and Sustainability Solutions	Glasgow		2029
GE4+	Bristol		2024 for DTP 2029 for DLA
IAPETUS(2)	Durham		2024 for DTP 2029 for DLA
IGNITE	Southampton		2029
TREES (Training Research and Equity in Environmental Sciences)	UCL		2029
YES DTN (Yorkshire Environmental Sciences)	Leeds		2029
I-Risk	Newcastle		