Dr Brian Matthews
DAFNI Project Lead, Scientific Computing Department,
Science and Technology Facilities Council

DAFNI

4th July 2022

UKRI Science and Technology Facilities Council
UKRI Engineering and Physical Sciences Research Council
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DAFNI CONFERENCE 2023

BUILDING A SECURE AND RESILIENT WORLD

IMPERIAL COLLEGE, LONDON. 12 SEPTEMBER 2023

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Where has DAFNI come from?

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UKRI Engineering and Physical Sciences Research Council
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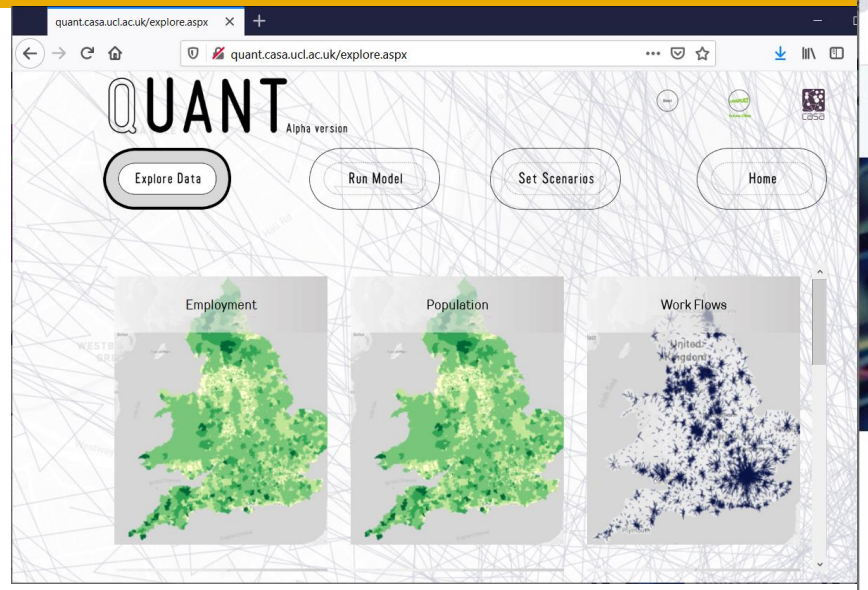
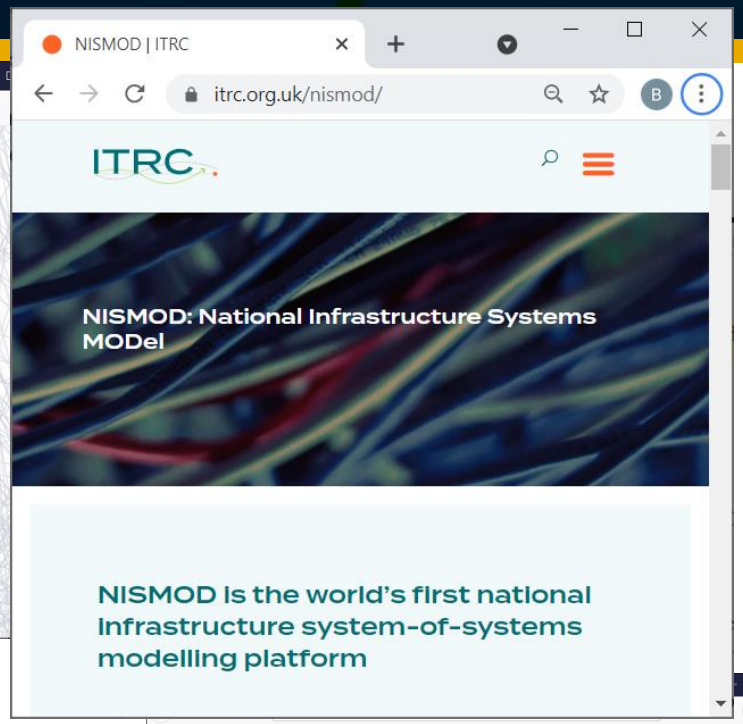
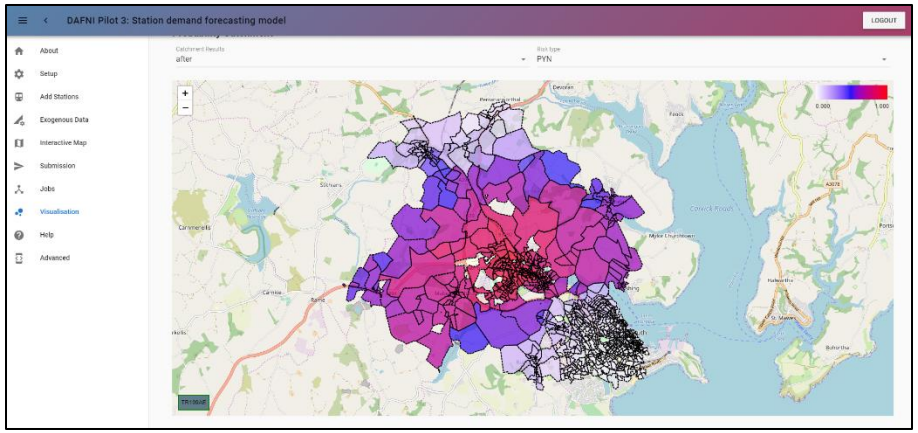
DAFNI

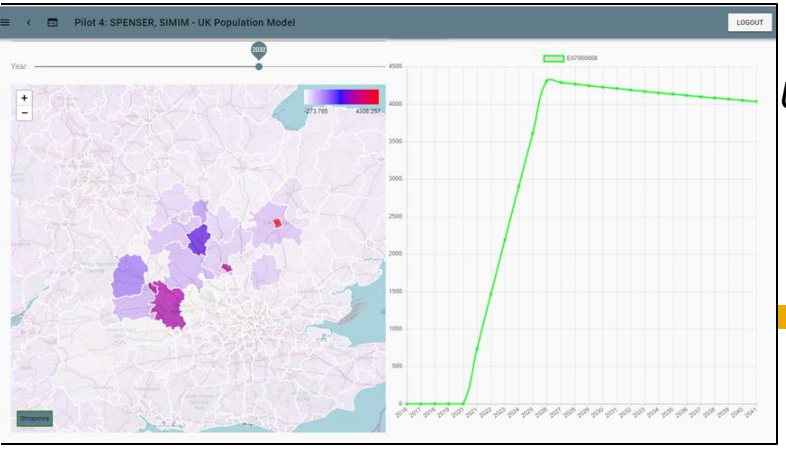
World-leading research



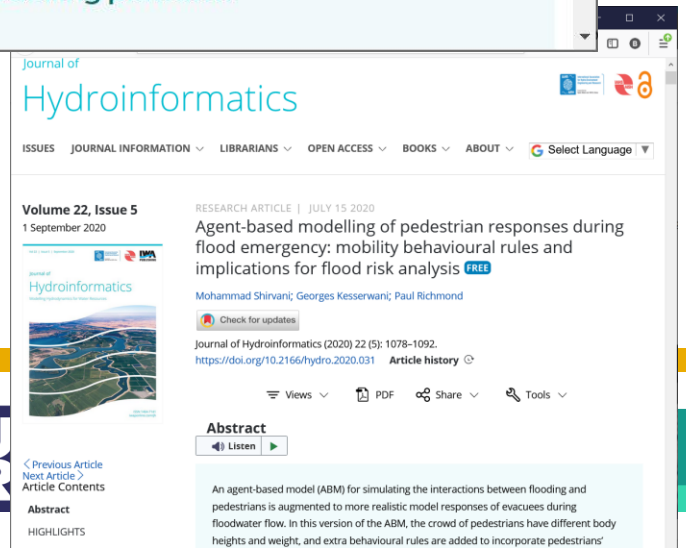


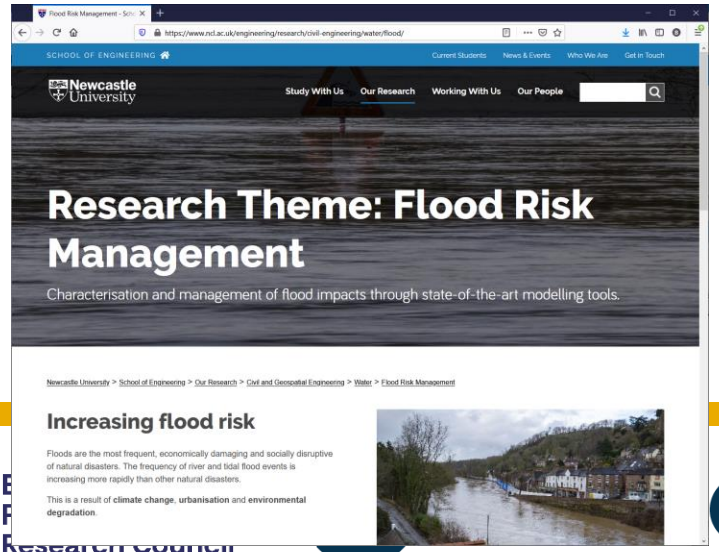
Station demand model, University of Southampton





SIMIM, University of Leeds





Phillip-James.jpg

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The DAFNI Partnership

Data and Analytics Facilities for National Infrastructure

Providing a computing platform for research into decision making for national infrastructure

£8M investment 2017-2021 under the UK Collaboratorium for Research on Infrastructure and Cities

Prof. Jim Hall
Uni. of Oxford

Prof. Stephen Hallett
Cranfield Uni.

Dr. Theo Tryfonas
Uni. of Bristol.

Dr Assad Faramarzi
Uni. of Birmingham

Dr. Aruna Sivakumar
Imperial College

Prof. Giuliano Punzo
Uni. of Sheffield

Dr Juan Bicarregui
STFC

Dr. Nik Lomax
Uni. of Leeds

Prof. Liz Varga
UCL

Prof. Julien Harou
Uni. of Manchester

Dr. Simon Blainey
Uni. of Southampton

Prof. Phil James
Uni. of Newcastle

Prof. Mike Batty
UCL

Dr. Ruchi Choudhary
Uni. of Cambridge

A Partnership of 12 universities and + STFC as development and hosting partner

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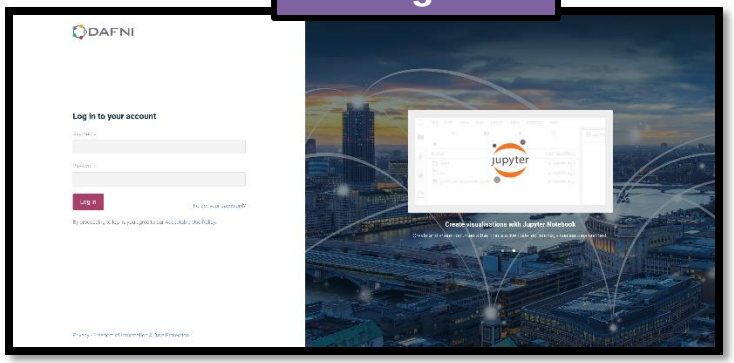
A Collaborative Platform

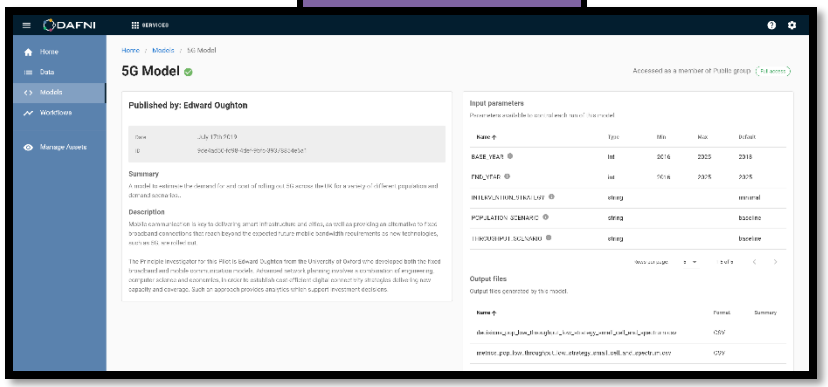
- To support scientific modellers in their technical collaborations
- To foster new connections and collaborations in research
- To spearhead new levels of transparency and reproducibility in model-based research
- To facilitate communication of scientific results to non-technical decision makers

DAFNI Functionality

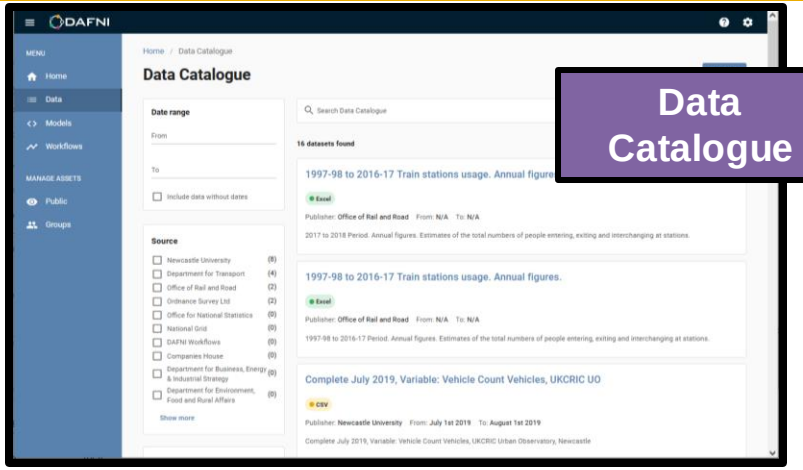
Login



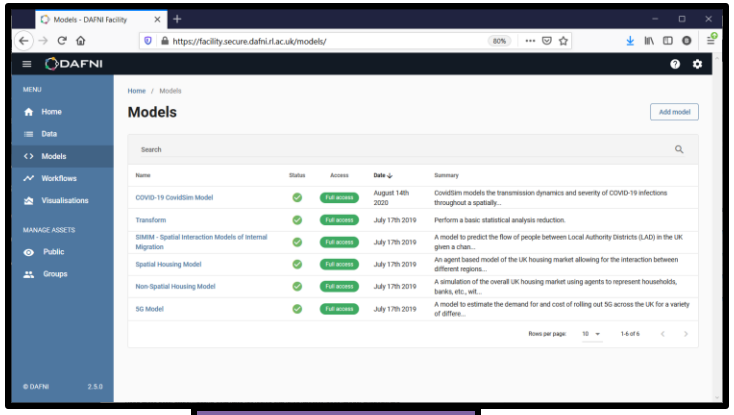
Data



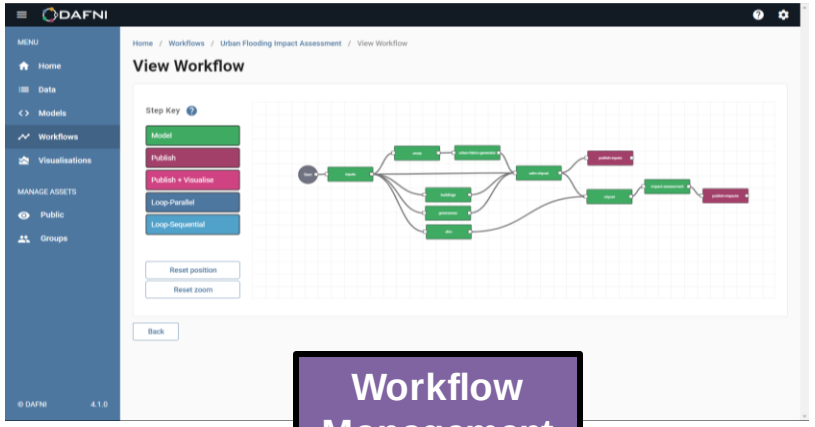
Data Catalogue



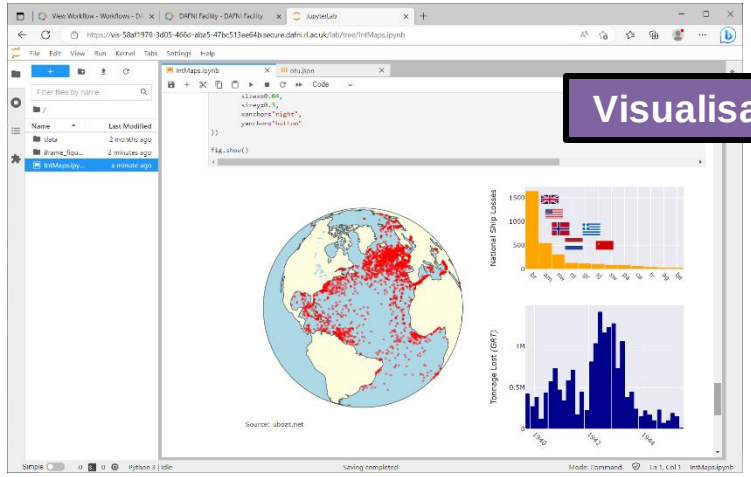
Model Catalogue



Workflow Management



Visualisation



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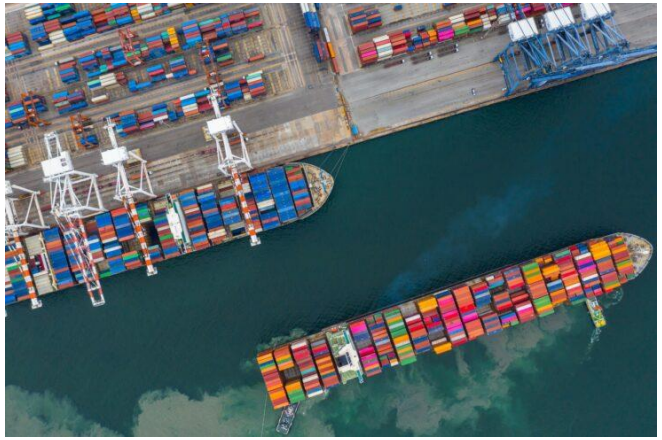
University College, London: A Shipping Model



Global shipping is currently responsible for 2-3 % of CO2 emissions, and with a business as usual scenario extrapolated into the future we could expect emissions from shipping to increase anywhere from 50-250 % in the next three decades.

Liz Varga,
Evangelia Manola

Cargo shipping has adopted a practice know in SFTW (steam fast, then wait) which has been encouraged by maritime law. Unfortunately this often results in shipping burning more fuel than is necessary to reach their destination in time.

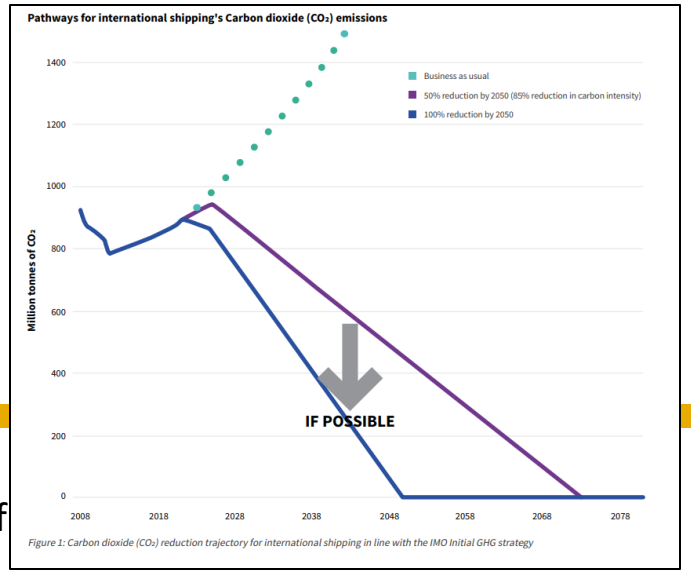


Figure 1: Carbon dioxide (CO_2) reduction trajectory for international shipping in line with the IMO Initial GHG strategy

The UCL pilot shipping project tracks the movements of selected ships and evaluates the potential fuel that can be saved (recorded as anywhere between 20-60 %). Information can then be relayed through the INMARSAT communications system to the ship.

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The DAFNI Centre of Excellence for Resilient Infrastructure Analysis

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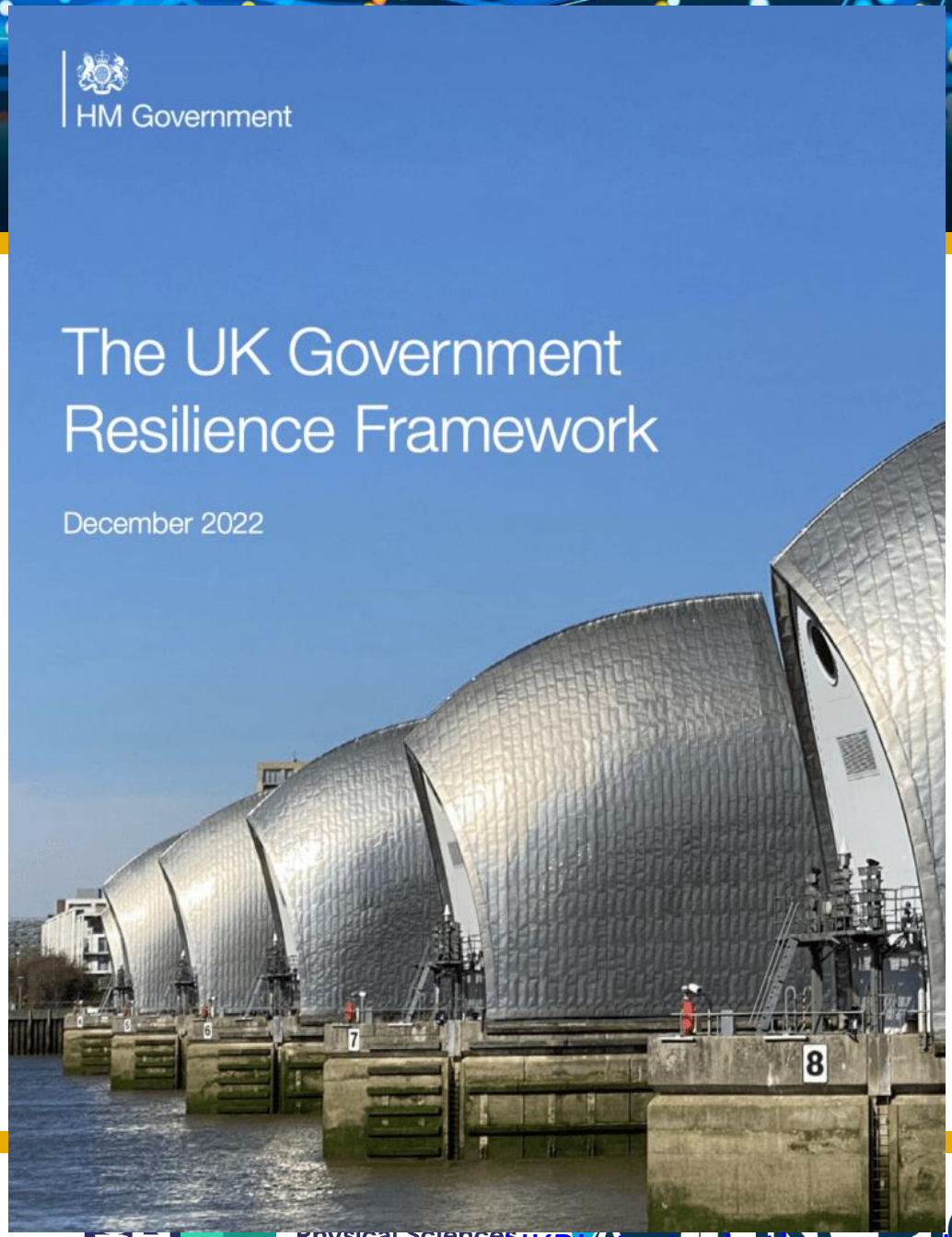
Building and Secure and Resilient world

UKRI Strategic Theme

This funding aims to strengthen social and economic resilience, and enhance national security across virtual and physical spaces, by improving awareness of risks and threats; preparedness, decision making and response; and allowing change to be understood as a force for good



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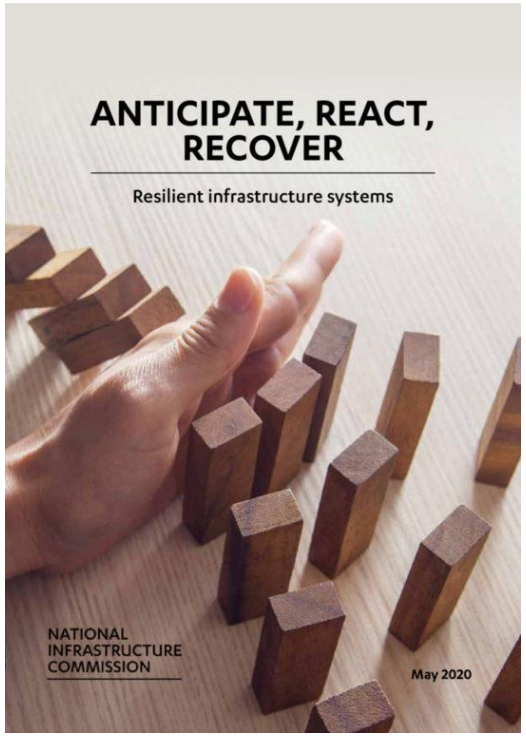
UKRI strategic themes – UKRI



https://nic.org.uk/studies-reports/resilience/

www.dafni.ac.uk

A PROACTIVE APPROACH IS NEEDED TO MAKE THE UK'S INFRASTRUCTURE RESILIENT TO FUTURE CHALLENGES

The UK's water, energy, digital, road and rail infrastructure has, for the most part, proved resilient to shocks and stresses over recent years. But there may be different or harder challenges in the future.

RECENT EVENTS HAVE EXPOSED VULNERABILITIES

The 'Beast from the East' in 2018 left **200,000** people without water for 4 hours and **60,000** people without water for 12 hours across the UK

A power outage in August 2019 led to **1.1 million** customers being disconnected from the grid

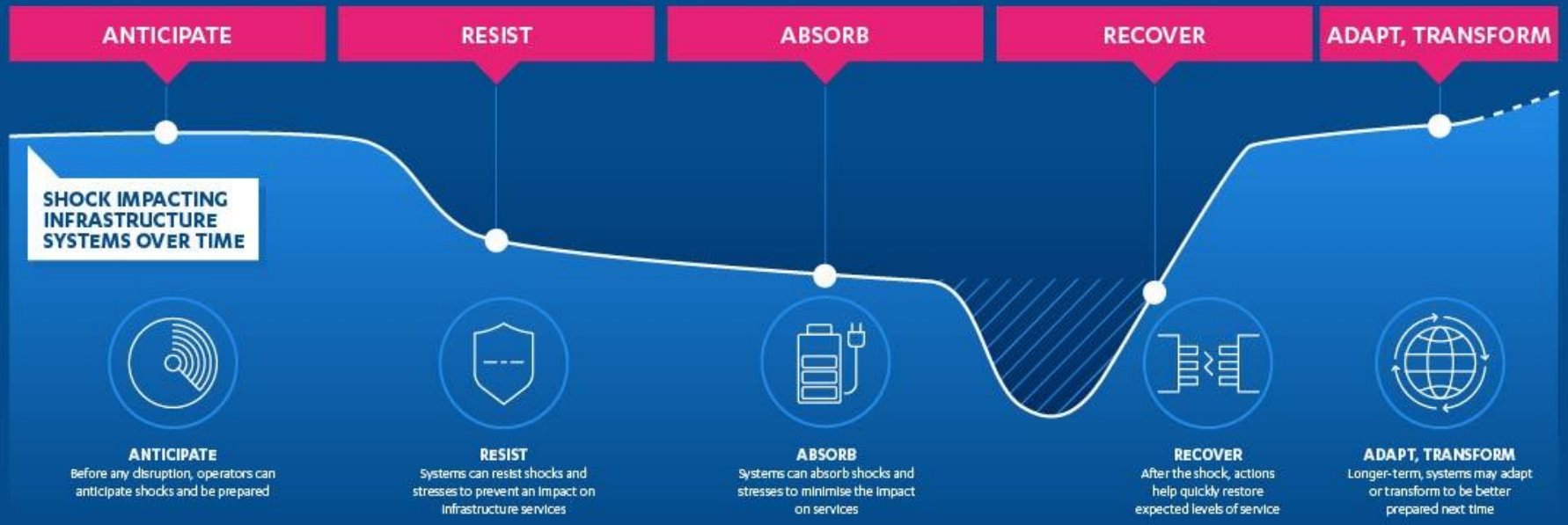
In December 2018, over **30 million** of O2's mobile network users were unable to get online for almost a whole day

In May 2018, rail timetabling changes disrupted Northern Rail and Govia Thameslink passengers' travel plans for **several weeks**

THE COMMISSION RECOMMENDS:

	ANTICIPATE	RESIST, ABSORB, RECOVER	ADAPT, TRANSFORM
The system architecture needs to...	Face uncomfortable truths	Test for and address vulnerabilities	Drive adaptation and value resilience properly
The Commission recommends that...	Government sets resilience standards	Regulators oversee regular stress testing Infrastructure operators address vulnerabilities	Infrastructure operators produce long term resilience strategies Regulators value resilience in decisions to support investment

THE COMMISSION HAS DEVELOPED A NEW FRAMEWORK FOR RESILIENCE



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The DAFNI Centre of Excellence for Resilient Infrastructure Analysis:

Strengthening resilience in the natural and built environment in response to short-term and long-term threats via computational modelling

Short term shocks – e.g. flooding, heat events, emergency response

Long term shocks – e.g. effects and adaptations to climate change, demographic change

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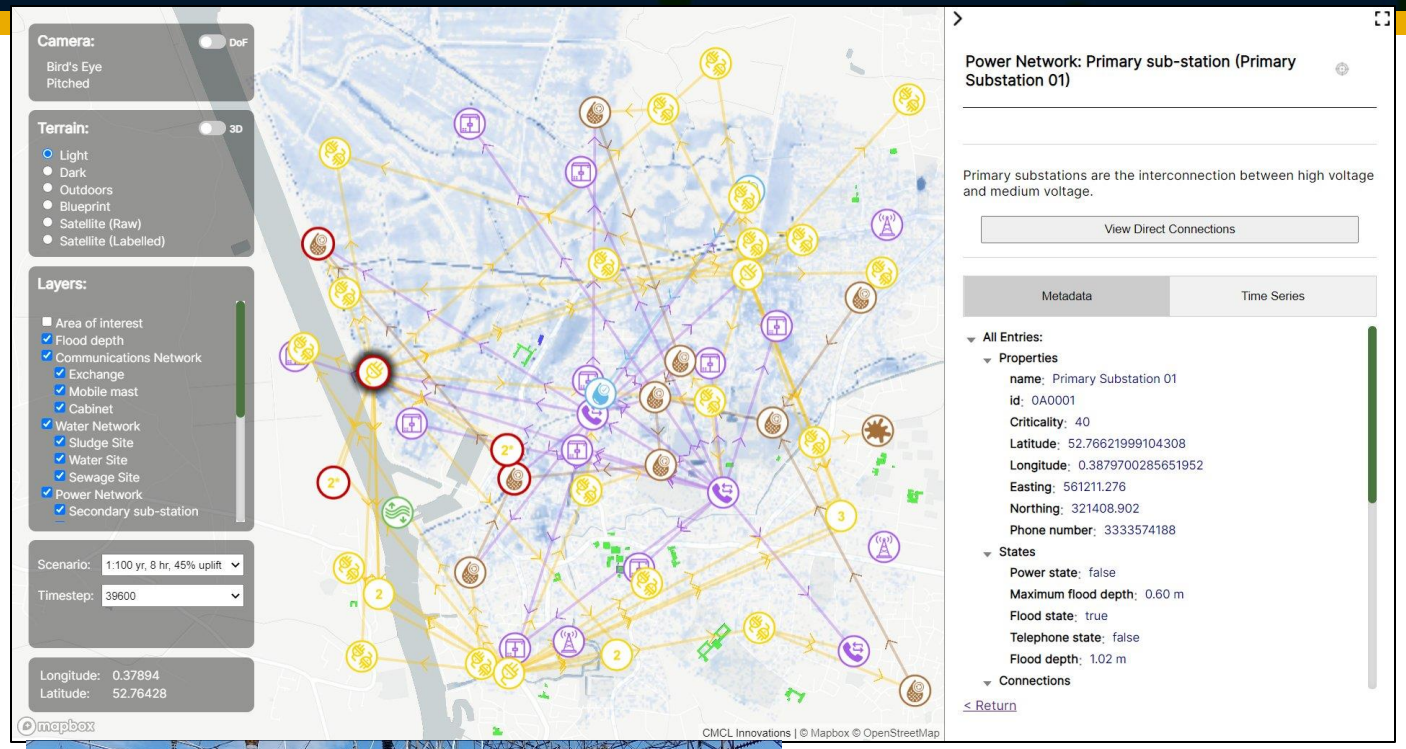
CReDo – Climate Resilience Demonstrator



The CReDo project aims to investigate the impact of climate change on infrastructrure networks, and how we can mitigate the potential economic and social damage caused.

CReDo is currently focussed on the impact of flooding on infrastructure networks, possibility of interrelated sites going down. Evidence based decision support for flood mitigation was also provided.

DAFNI also facilitates secure data holding for BT, Anglian Water, and UKPN.

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Why a Centre of Excellence in Computational Modelling?

- Resilience assessment and stress testing of infrastructure
  - Applying the best research in infrastructure modelling to analyse computationally the impact of shocks
  - Provide measures on the resilience
  - Assess impact of mitigations and adaptations to the model

- Look at the knock-on effects of co-dependency
  - Systems of systems modelling rather than each system in isolation
  - Data sharing and integration – data sharing agreements.

- Consider the impact of change in other domains to the resilience of the system
  - Changes in the built environment
  - Changes in demographics and economics
  - Changes in environmental conditions – especially climate change

- Make tools available for use and re-use in new scenarios

Objectives

Build on current DAFNI to form a Centre of Excellence in Modelling Resilience

- Provide a centre of expertise and capacity to support computational modelling of resilience challenges for the BSRW programme
- Provide a collection of compute and data resources to enable research in Resilience
- Provide demonstrators to explore resilience to shocks via computational modelling on the DAFNI platform
- To engage with the wider stakeholder community to exploit research into resilience

We need the engagement of the Research Community across all these objectives

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Research Programme

Three funding streams:

1. **Supporting Key Models**
   Providing key resources to explore resilience

2. **Developing a Resilience Framework**
   Providing tools to describe and measure resilience

3. **Exploring Resilience Scenarios**
   Providing research demonstrators of resilience in practise

A total fund of £1.4M is available overall for projects, for up to 18 months.

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A Programme of Research

Developing a Resilience Framework

- **USARIS: Uncertainty quantification and sensitivity analysis for resilient infrastructure systems**
  - Dr Francesca Pianosi, University of Bristol

Supporting Key Models

- **Pywr-WREW: A Water Resources model for England and Wales built in Python water resources simulation system**
  - **Dr Anna Murgatroyd, University of Oxford**
- **FIRM: An agent-based model of flood infrastructure resilience – FIRM**
  - Prof. Richard Dawson, University of Newcastle
- **SCQUAIR: Small Changes and Computer-Generated Spatial Interaction Modelling with QUANT**
  - **Dr Richard Milton, University College, London**

Exploring Resilience Scenarios

- **STORMS: Strategies and Tools for Resilience of Buried Infrastructure to Meteorological Shocks**
  - **Dr Xilian Xia, University of Birmingham**
- **RIWS: Resilience Scenarios for Integrated Water Systems**
  - Dr Ana Mijic, Imperial College London
- **SOFRAMODE: Sewer overflow flood risk analysis model DAFNI enabled**
  - **Dr Vassilis Glenis, University of Newcastle**
- **NIRD: systemic resilience of interdependent infrastructure networks at the national scale**
  - Dr Raghav Pant University of Oxford

Developing the CoE

- Projects will get underway from October onwards
  - DAFNI will be supporting them and helping them work together.
- Will also be working with other projects in the programme
  - Especially the Research and Coordination Hub
- Planning events
  - Including next year's DAFNI Conference!
- **Extending the coverage**
  - **Workshops and Sandpits**
  - **Transport, Energy, Telecommunications**
  - **Funding small exploratory studies**

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Accessing DAFNI

Access to DAFNI is **FREE** to UK Researchers

Also as a facility in JeS

Trial accounts for others on application

Also inclusion on Research Grants

Talk to us

info@dafni.ac.uk

www.dafni.ac.uk

Sign up to the Newsletter

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Thank You
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