



## Introduction to DAFNI

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# Why DAFNI?



**Sir John Armitt,  
Chair, National  
Infrastructure Commission**

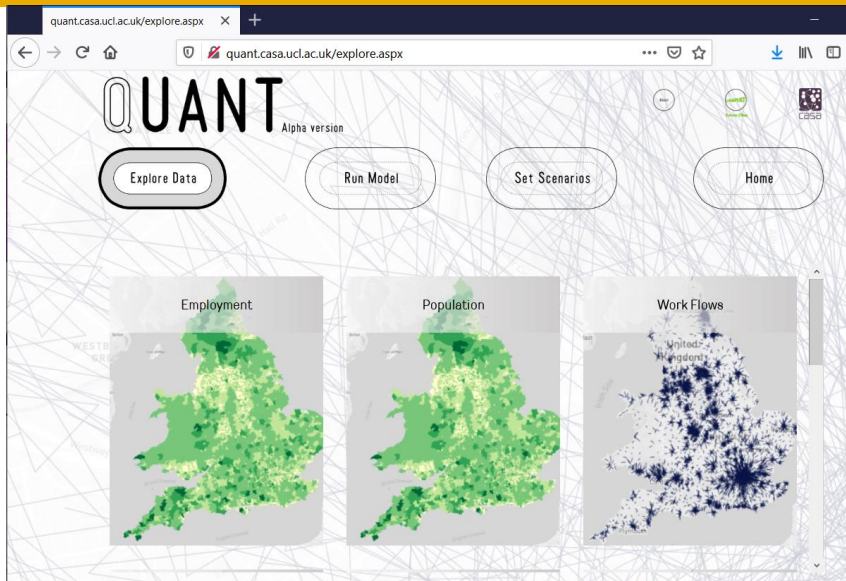
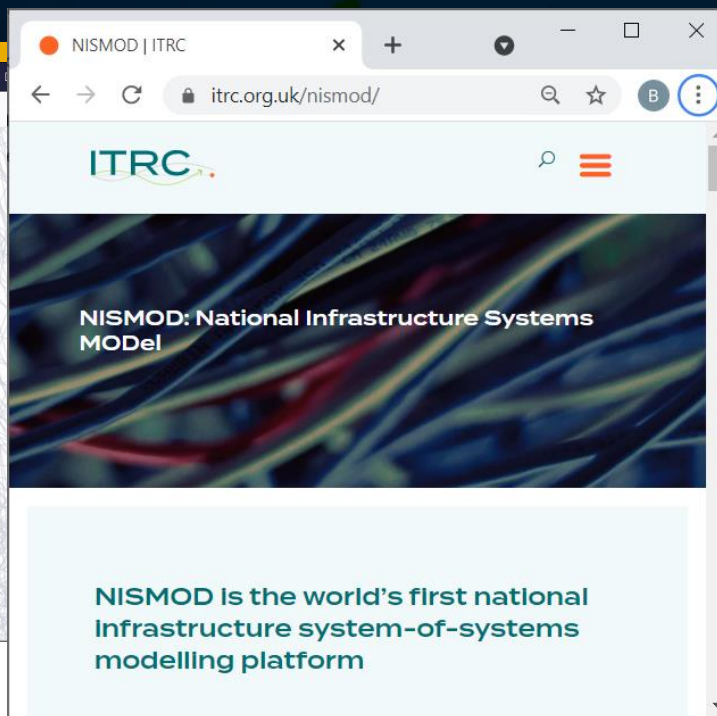
## ***“Data is now as important to UK Infrastructure as concrete or steel”***

*Launch of DAFNI at The Royal Society in London 1<sup>st</sup> June 2019*

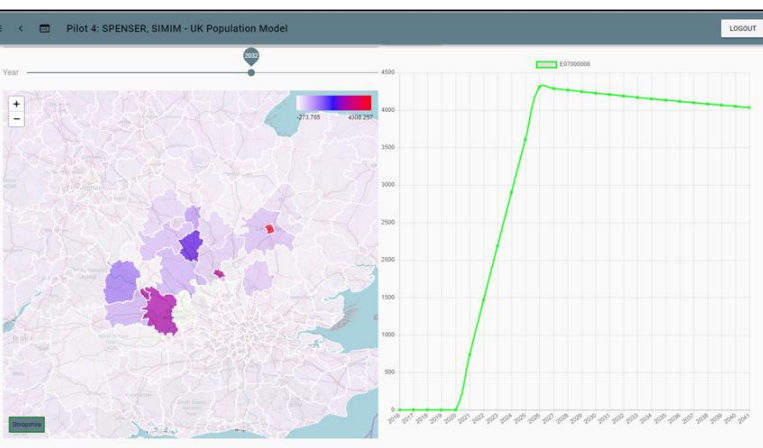
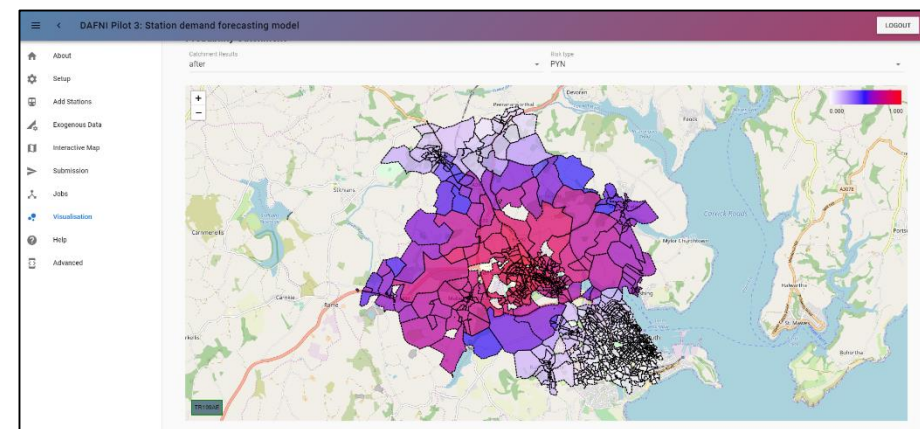
... a [National] digital twin would **bring together individual infrastructure models capturing data on national infrastructure and the interdependencies between infrastructure systems**, supporting the development within the infrastructure sector of a data-driven economy.



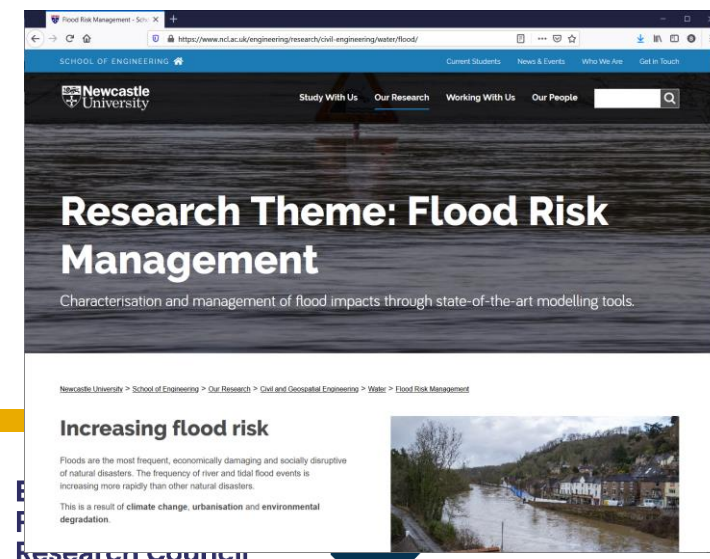
<https://nic.org.uk/app/uploads/Data-for-the-Public-Good-NIC-Report.pdf>

## Station demand model, University of Southampton



## SIMIM, University of Leeds

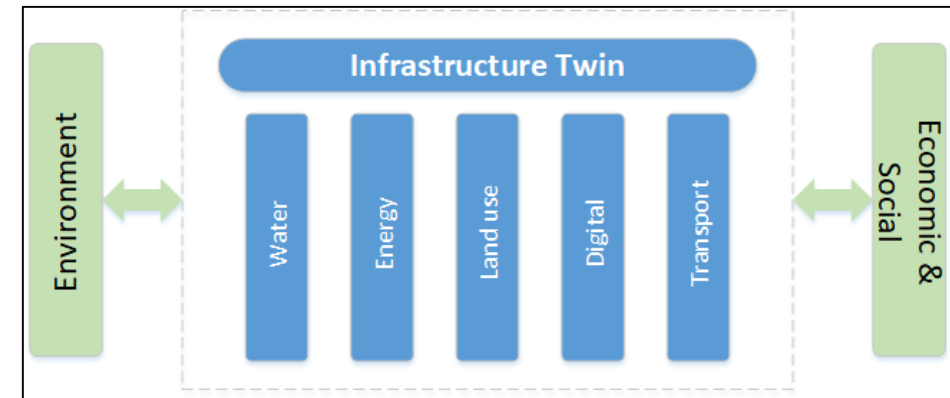



- Scaling up
  - More data, Higher resolution
- Integration between models
  - Across scales
  - Across sectors
- Data integration and exchange.
  - Share data between infrastructure models
  - Security respected
  - Common standards for interchange and interoperation

**Infrastructure Systems Research is Multi-disciplinary by its very nature**



*Integration across scales*



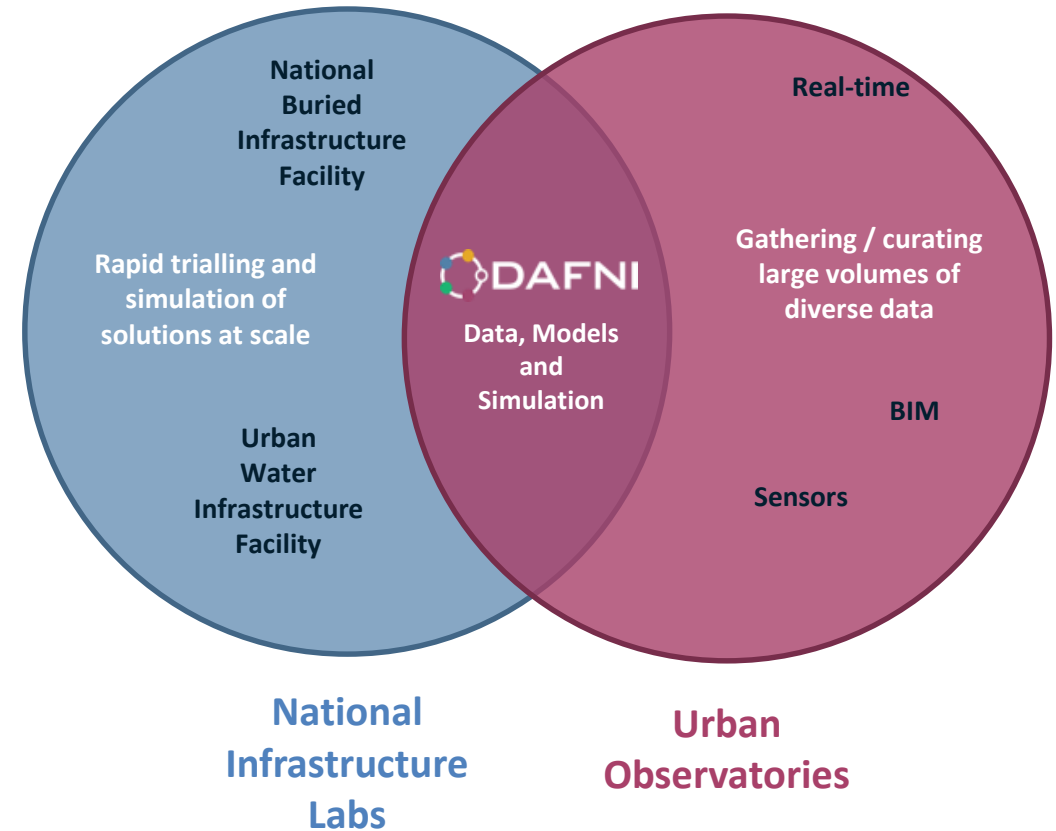
*Integration across sectors*

# The DAFNI Programme

## 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**

**Towards Partnerships between Academia, Government, Industry**





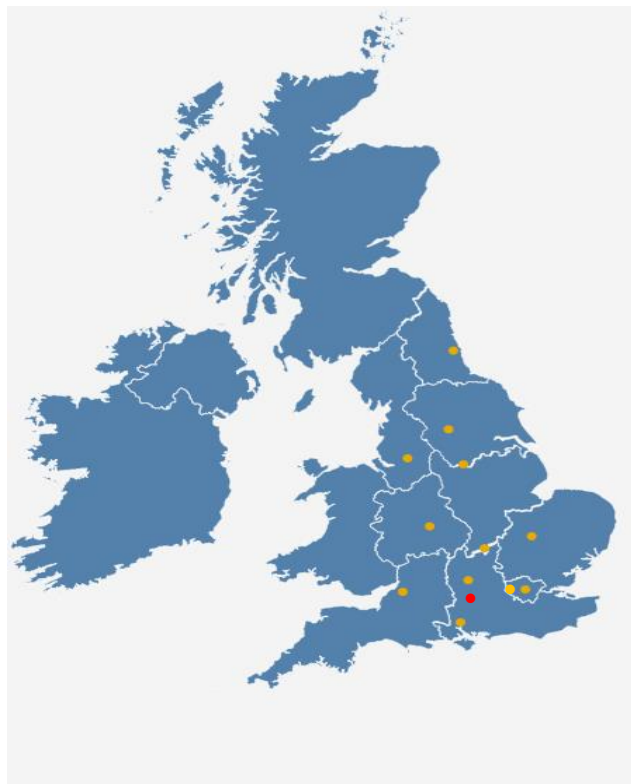
**Prof. Jim Hall**  
Uni. of Oxford



**Prof. Stephen Hallett**  
Cranfield Uni.



**Dr. Theo Tryfonas**  
Uni. of Bristol.



**Prof. Nigel Cassidy**  
Uni. of Birmingham



**Dr. Aruna Sivakumar**  
Imperial College



**Prof. Daniel Coca**  
Uni. of Sheffield



**Dr. Peter Oliver**  
STFC



**Dr. Nik Lomax**  
Uni. of Leeds



**Prof. Liz Varga**  
UCL



**Prof. Julien Harou**  
Uni. of Manchester



**Dr. Simon Blainey**  
Uni. of Southampton



**Dr. Luke Smith**  
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**



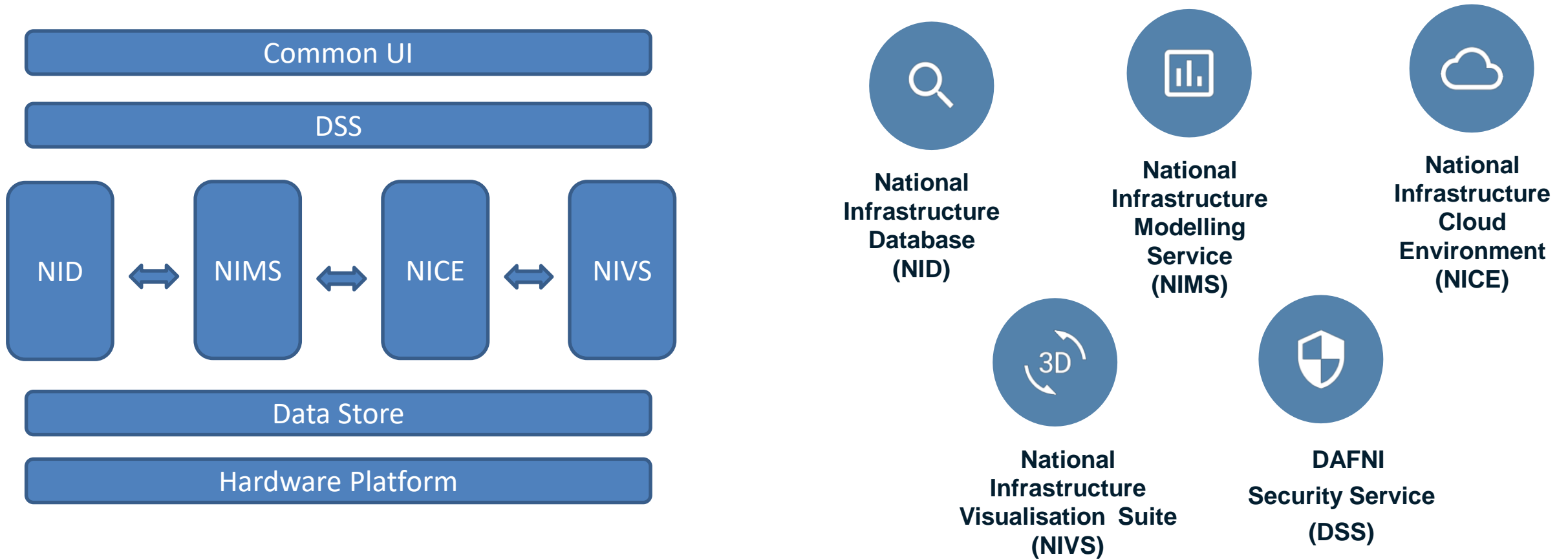
- **A Place for sharing and combining data and models**
  - A hybrid high-performance computing platform
  - A secure repository for national infrastructure data and models
- **A Place to support collaborations and deploy applications**
  - A collaborative platform to research multi-system models of infrastructure
- **A Place as a legacy**
  - A place to make data and models available for the long-term

# The DAFNI Platform

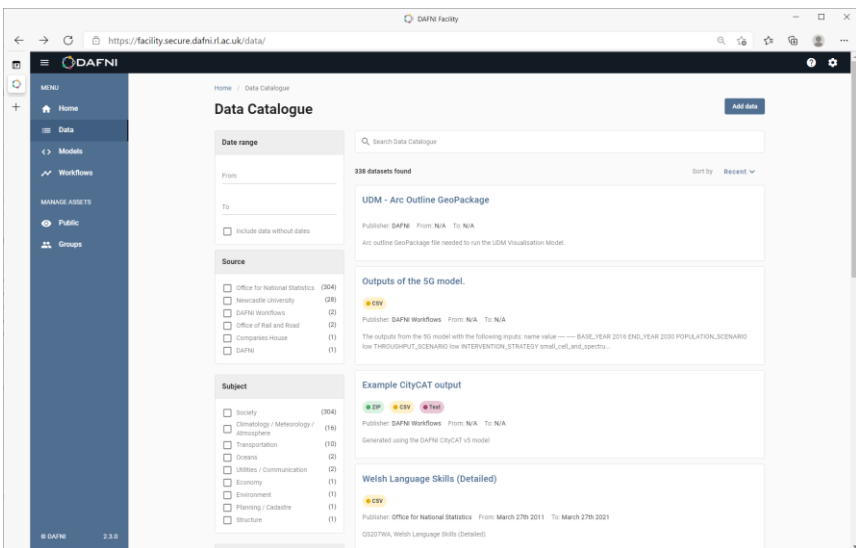
- DAFNI provides a dedicated HTC cluster
  - 27 server nodes, 792 CPUs, 16.8TB, 10 GPUs
  - 2PB hybrid storage
- Set up as a Kubernetes Cluster
- Can give more computing power to applications

*Complemented by hardware investments in universities*



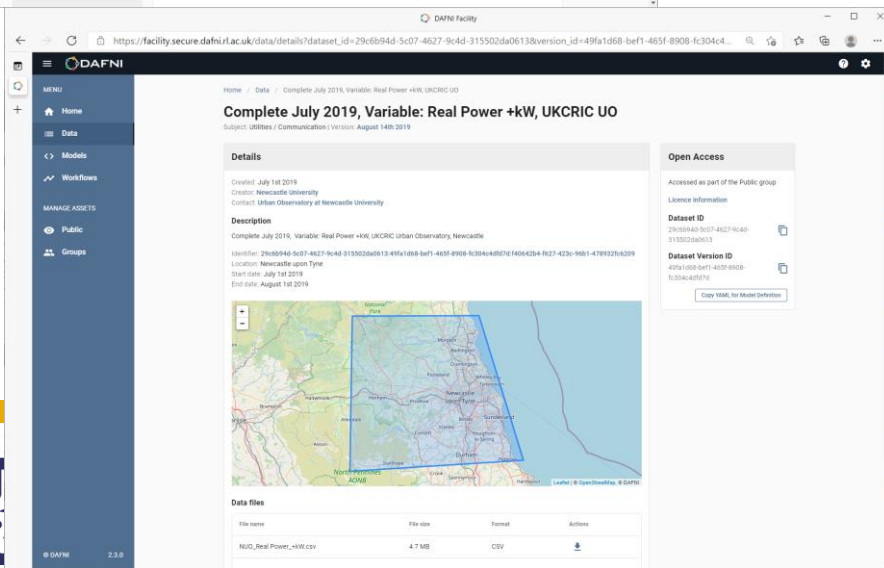


- DAFNI provides a Data Hub
  - Data sharing
  - Data integration
  - Data curation
- The DAFNI NID provides
  - A trusted secure space to hold and access data
  - Importing from and linking to other data sources
- A metadata framework for the data catalogue
  - Common search and access

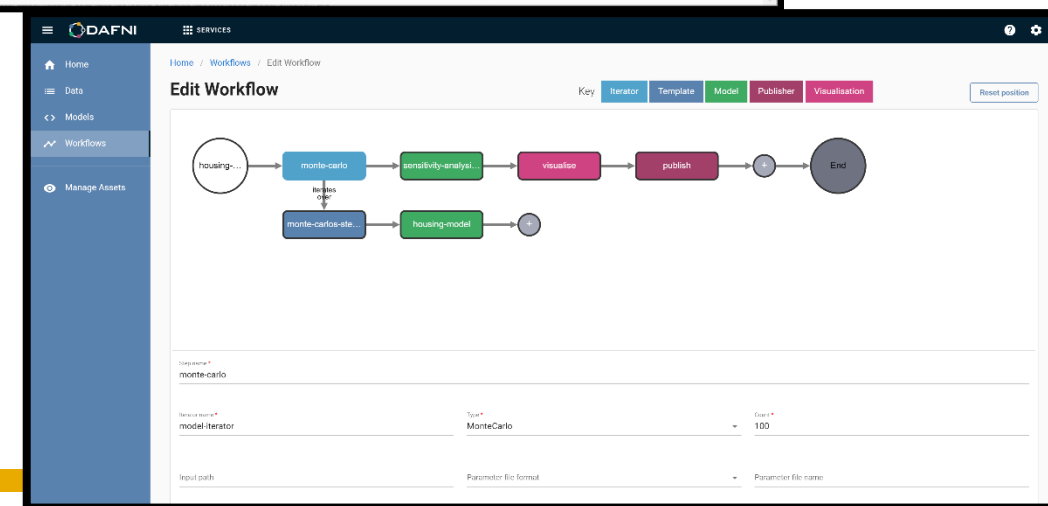
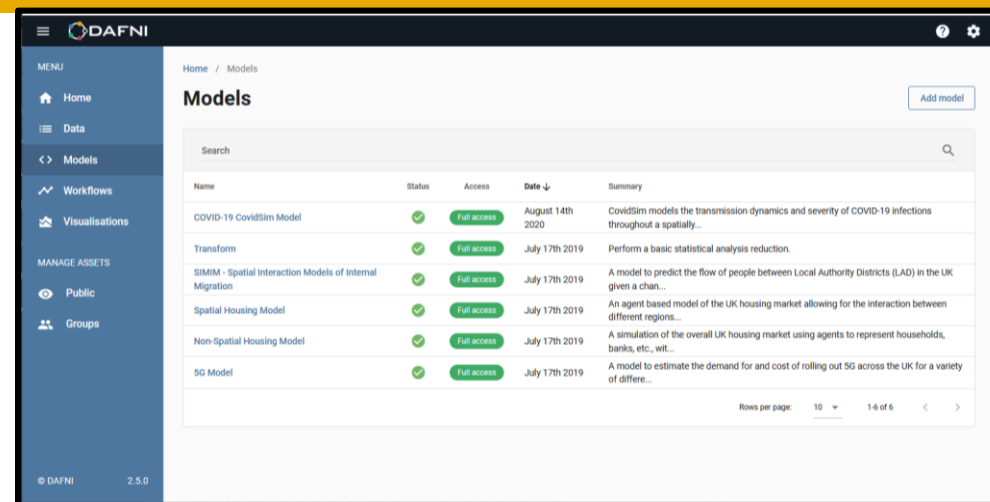


## A platform for combining data

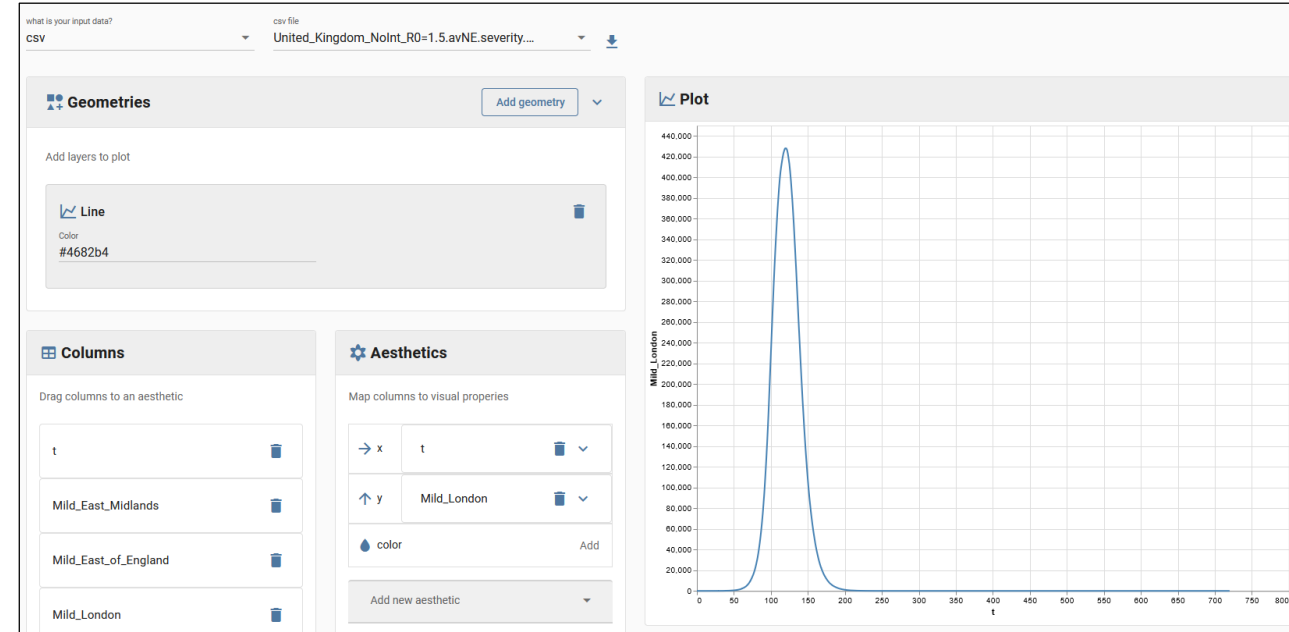
- DAFNI's NID provides basis for holding data from different sources
- A data store – but not all data needs to be held centrally



- Upload models from anywhere into a model repository
  - Models “containerised” using Docker
  - Independent of code and operating systems
  - Sharing models
  - Within the same security framework
- Models can then be run on the HTC cluster
  - Kubernetes orchestration of containers
  - Scale up models for more compute
  - Access to data in the NID
  - Access to visualisations
- The NIMS allows workflows to be constructed
  - Coupling models together
- Key feature of providing an Infrastructure Ecosystem
  - Across different sectors
  - Across different scales
- A repository of models and workflow
  - Sharing models
  - Within the same security framework



- The National Infrastructure Visualisation Service
  - Build visualisations from workflow output
- Two ways
  - Drag and drop tool
  - Jupyter Notebooks



# How is DAFNI being used?



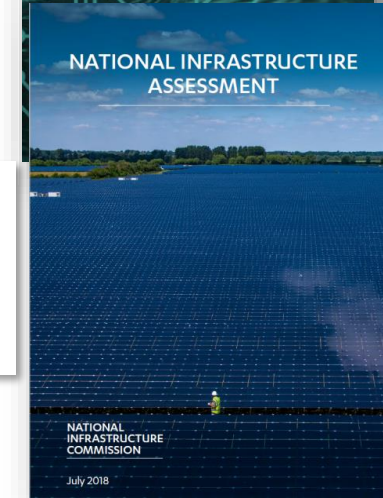
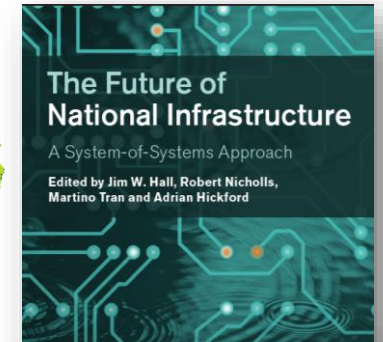
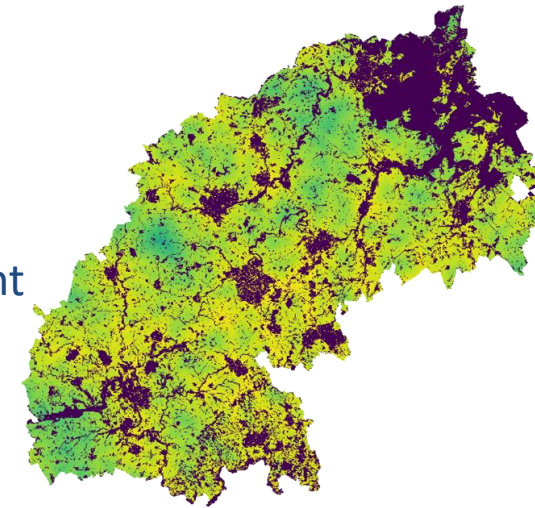
The UK Infrastructure Transitions Research Consortium developed:

The NISMOD national system-of-systems model for **infrastructure planning** in Britain

- energy-transport-digital-water-waste
- NISMOD was used in the UK's first National Infrastructure Assessment

National modelling of climate **risks** to infrastructure networks

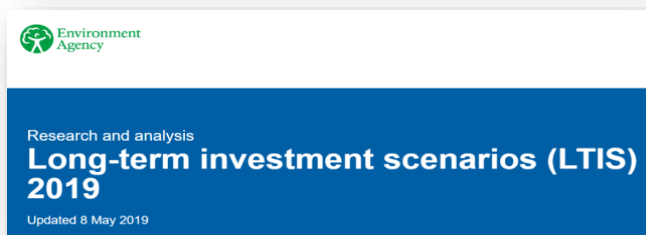
- Used to inform the Environment Agency's long term investment strategy for flood defences
- Analysis for the National Infrastructure Commission's resilience study



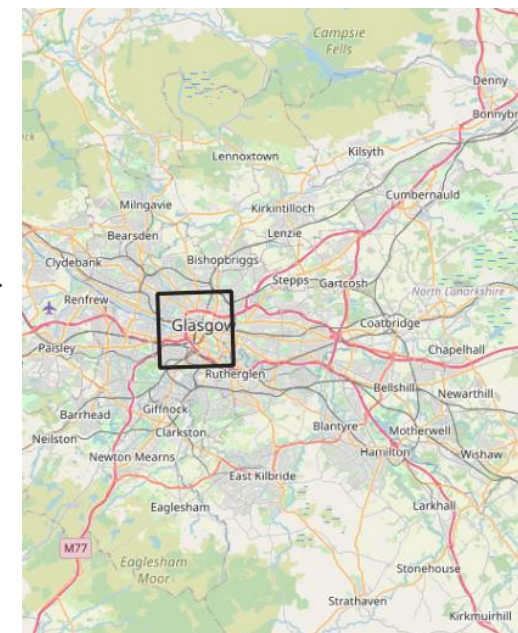
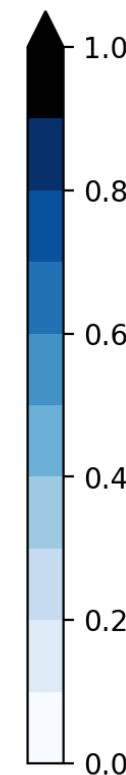
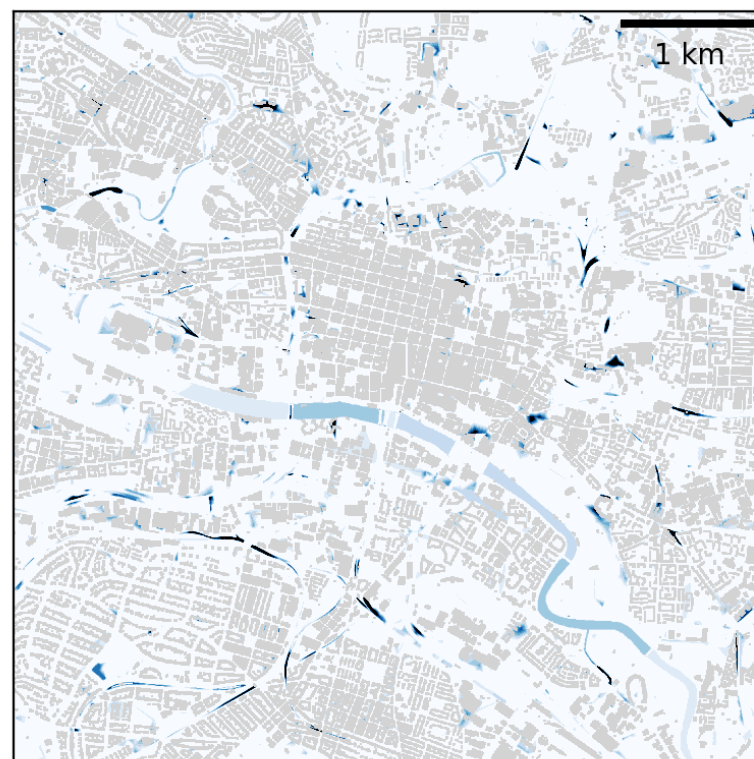
Ford A, Barr S, Dawson R, Virgo J, Batty M, Hall J. [A multi-scale urban integrated assessment framework for climate change studies: A flooding application](#). *Computers, Environment, and Urban Systems* 2019, **75**, 229-243.

**NISMOD now supported on DAFNI**

<https://www.itrc.org.uk/>



- NERC project
  - led by University of East Anglia
  - Aug 20 – Nov 22
- Assess the risk of climate change
  - Flooding
  - Health risk from extreme heat
  - Agriculture and biodiversity
- Affect of approaches to adaptation
  - Bio-adaptation
  - Case studies in the Clyde Catchment, Norfolk Broads
  - Towards CCRA4
- Multi-systems modelling approach
- Working with DAFNI to provide
  - A framework for combining models together
  - A place where users can go to access and run workflows
  - A legacy where models can be accessed for the long-term

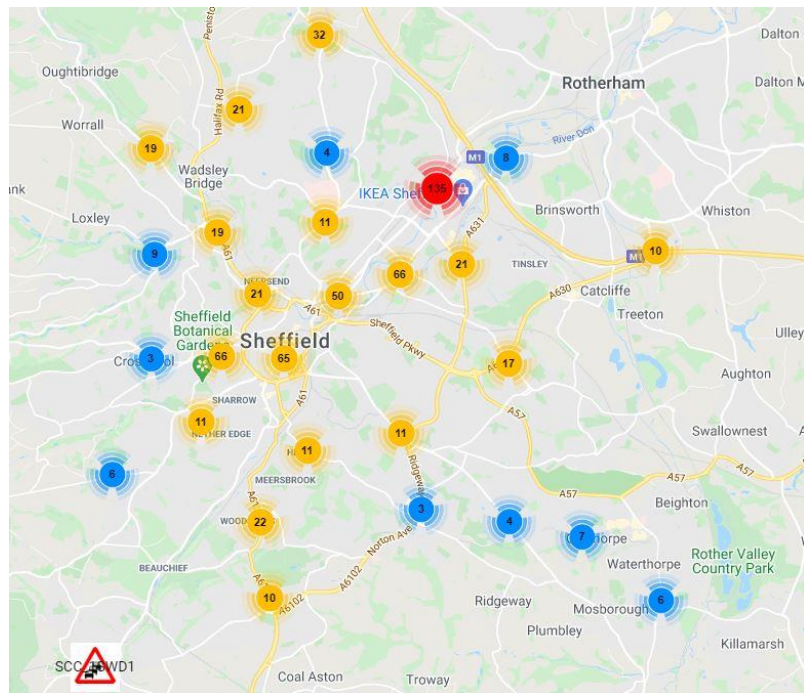


<https://www.tyndall.ac.uk/OpenCLIM>

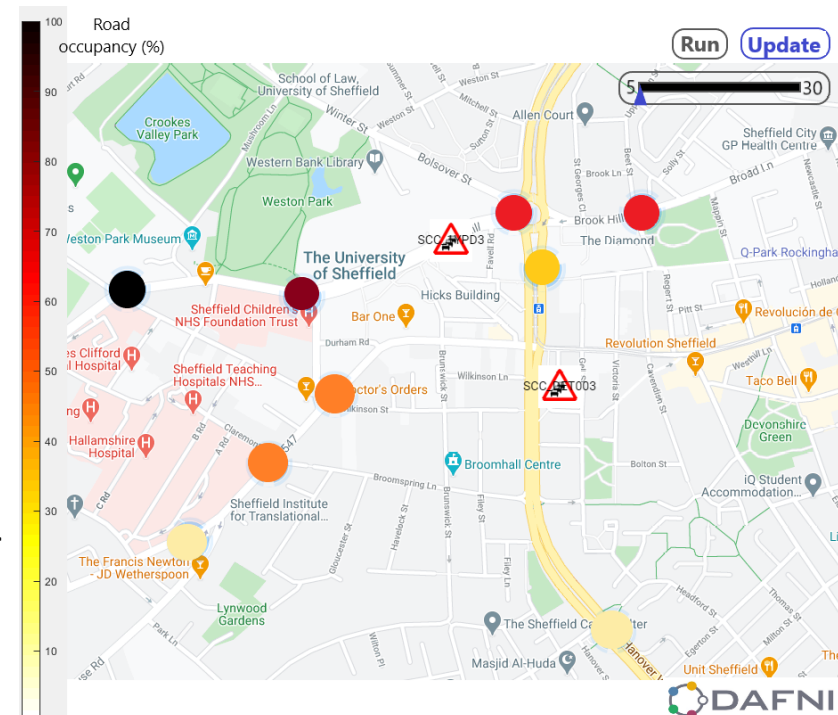
*Flood event impact on Central Glasgow, CityCat model, University of Newcastle*



# Pilot study - Traffic Digital Twin in Sheffield



- Traffic data from the Sheffield Urban Observatory
  - 640 sensors that report traffic flow (no. of cars/min)
  - Time resolution: 5 min
- Build AI-based model
  - updates in real-time for each sensor
  - predicts evolution of traffic (ex: 30 min ahead)
- A digital replica of the Sheffield traffic
- Identify areas where congestion will occur



### Use cases:

- Traffic monitoring system that predicts congested areas
- Real-time traffic flow optimization



The University Of Sheffield.

**Christian Genes,  
Daniel Coca**



Science and Technology Facilities Council



Engineering and Physical Sciences Research Council



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A national centre to accelerate use of climate and environmental data by financial institutions

- unlock opportunities for the UK to lead in greening finance and financing green

DAFNI provides an open, e-infrastructure

- Easy-to-use for practitioners to use climate and environmental data and analytics
- To make green investment decisions

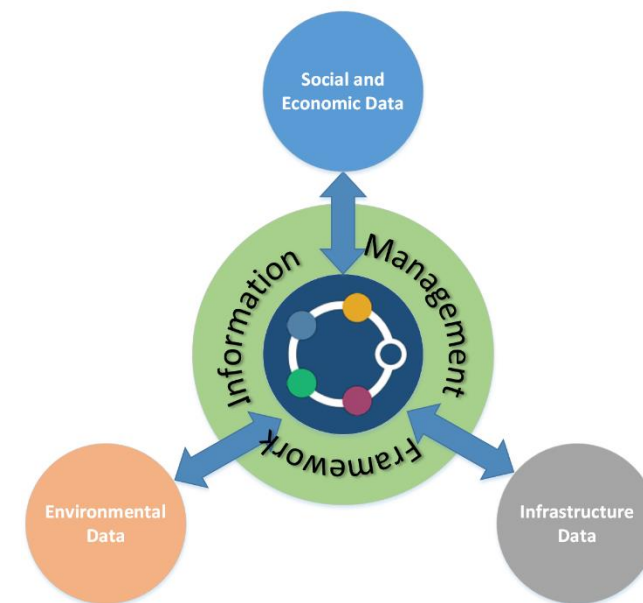
<https://ukcgfi.org/>

# What next for DAFNI?

## DAFNI-ROSE

A grant under EPSRC's Resource-Only Strategic Equipment programme  
July 2021-June 2023

- A production platform
  - With an enriched collection of data and models
- Developing the User Base
  - Research users
  - Working with CDTs for early careers researchers
- Looking towards further development:
  - Digital Twins:
  - Information Integration infrastructure
- Forming Multi-disciplinary partnerships
  - With academia, government and Industry



**Towards Long-term sustainability within the UKRI programme**

## DAFNI will be available for use by UK Researchers

- Available for researchers in relevant research areas
  - EPSRC's Priority Research Areas: Infrastructure and Urban Systems, Built Environment, Energy Networks, Whole Energy Systems, Structural Engineering, Control Engineering, Water Engineering, Coastal and Waterway Engineering, and Operational Research.
  - EPSRC Themes: Digital Economy, Energy, Global Uncertainties, ICT, and Living with Environmental Change (LWEC)
  - Multidisciplinary projects across research councils, and with government and industry
- Setting up an application process
  - Oversight by our Governing Board
- Large-scale use requiring RSE effort
  - DAFNI can participate in Research Projects as a partner
- For use outside these areas (e.g. government, commercial)
  - Cost model based on resource usage, scale of use

**Please talk to us!**

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David Macaree



Marion Samler



Tom Gowland



Bethan Perkins



Noel Vizcaino



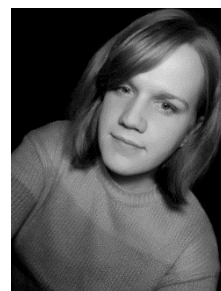
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James Hannah



Rose Dickinson



Alex Kemp



Matt Jones



Rocio Garavito-Ramirez



Mat Wilcoxson





**Thank You**

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