

Introduction to DAFNI

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



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Engineering and Physical Sciences Research Council



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Why DAFNI?

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DAFNI The Challenge of Data in Developing Infrastructure

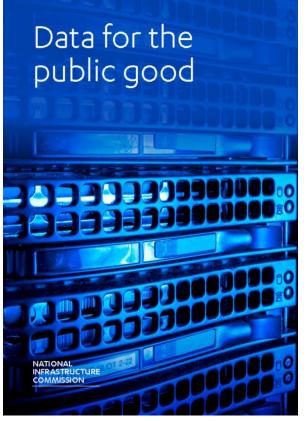


"Data is now as important to UK Infrastructure as concrete or steel"

Launch of DAFNI at The Royal Society in London 1st June 2019

Sir John Armitt, Chair, National Infrastructure Commission Infrastructure Commission Mational infrastructure between infrastructure dovelopment within the

... 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 datadriven economy.



https://nic.org.uk/app/uploads/Data-forthe-Public-Good-NIC-Report.pdf

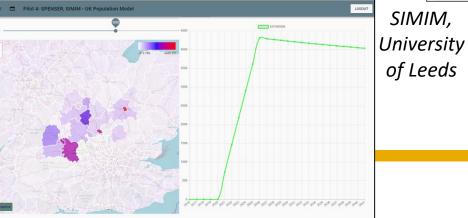
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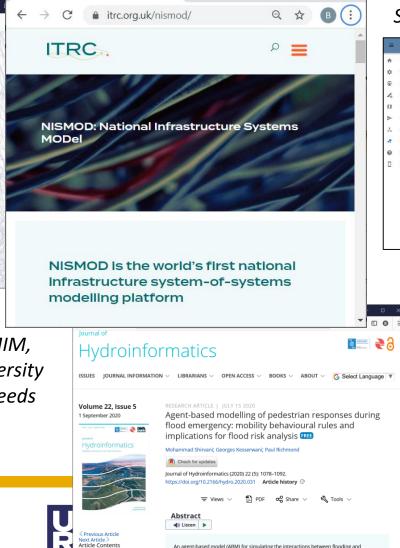


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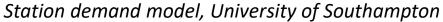


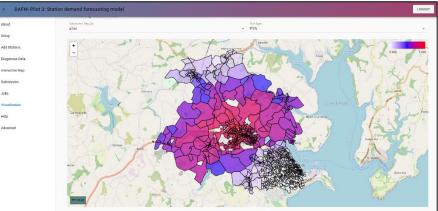
NISMOD | ITRC

HIGHLIGHTS

An agent-based model (ABM) for simulating the interactions between flooding and pedestrians is augmented to more realistic model responses of evacuees during floodwater flow. In this version of the ABM, the crowd of pedestrians have different body heights and weight, and extra behavioural rules are added to incorporate pedestrians'

World-leading research in the UK







Newcastle University > School of Engineering > Our Research > Civil and Geospatial Engineering > Water > Flood Risk Manager

Increasing flood risk

Kesearen counen

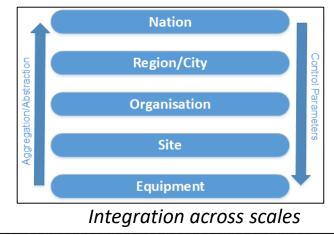
Floods are the most frequent, economically damaging and socially disruptive of natural disasters. The frequency of river and tidal flood events is increasing more rapidly than other natural disasters. This is a result of climate change, urbanisation and environmental

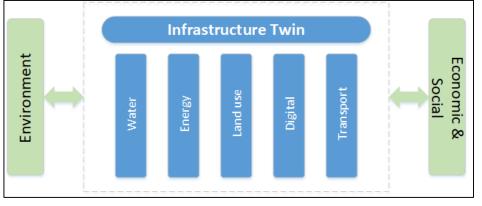


DAFNI Technical Challenges of Infrastructure Research

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

Infrastructure Systems Research is Multi-disciplinary by its very nature





Integration across sectors



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The DAFNI Programme

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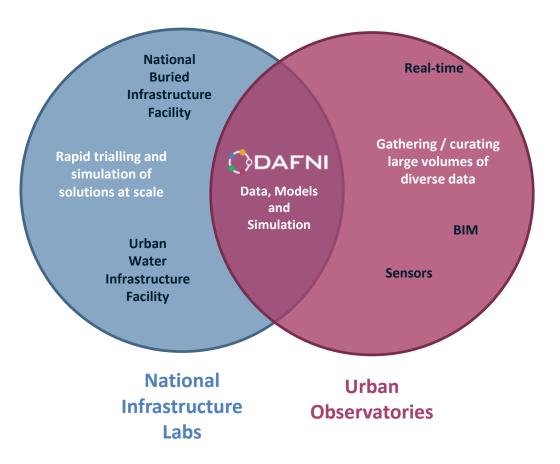




Providing a computing platform for research into decision making for national infrastructure

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

Towards Partnerships between Academia, Government, Industry



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UKCRIC

The DAFNI Partnership



Prof. Jim Hall Uni. of Oxford



Prof. Stephen HallettDr. Theo TryfonasCranfield Uni.Uni. of Bristol.





Dr. Nik Lomax Uni. of Leeds



Prof. Liz Varga UCL



Prof. Julien Harou Uni. of Manchester











Prof. Nigel Cassidy Uni. of Birmingham

Dr. Aruna Sivakumar I Imperial College

Prof. Daniel Coca Uni. of Sheffield

Dr. Peter Oliver STFC









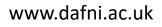
Dr. Simon Blainey Uni. of Southampton

Dr. Luke Smith F 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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DAFNI as a Community Hub

- A Place for sharing and combining data and models
 - $\,\circ\,$ A hybrid high-performance computing platform
 - $\,\circ\,$ 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
 - $\,\circ\,$ A place to make data and models available for the long-term



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The DAFNI Platform

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DAFNI: A HTC Hardware 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



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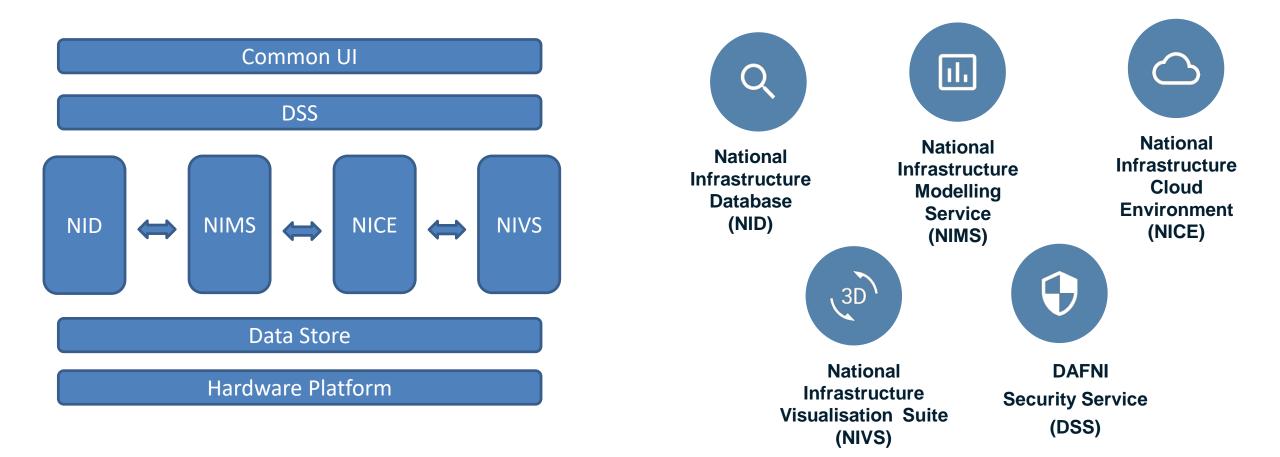


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DAFNI Components



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NID: DAFNI as a Data Hub

- DAFNI provides a Data Hub
 - Data sharing
 - Data integration
 - Data curation
- The DAFNI NID provides
 - A trusted secure space to hold and access data

Public

🚉 Groups

- Importing from and linking to other data sources
- A metadata framework for the data catalogue
 - Common search and access

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A platform for combining data

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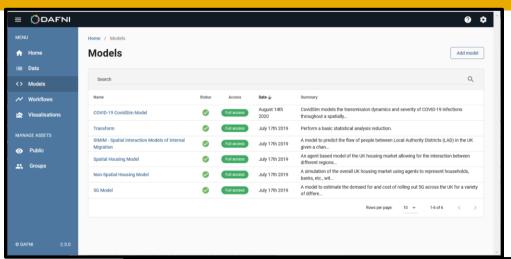
- DAFNI's NID provides basis for holdin data from different sources
- A data store but not all data needs to be held centrally

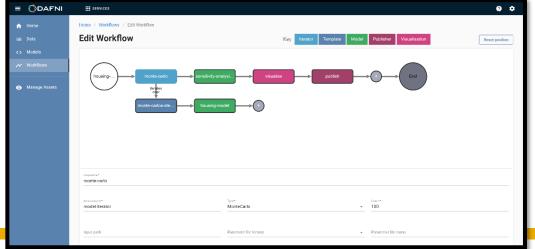
UKCRIC

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NIMS: Supporting user models

- 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
 - o Kubernetes orchestration of containers
 - Scale up models for more compute
 - o Access to data in the NID
 - o Access to visualisations
- The NIMS allows workflows to be constructed
 - Coupling models together
- Key feature of providing an Infrastructure Ecosystem
 - o Across different sectors
 - o Across different scales
- A repository of models and workflow
 - Sharing models
 - Within the same security framework





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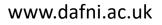


NIVS: Building Visualisations

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



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How is DAFNI being used?

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DAFNI UK Infrastructure Transitions Research Consortium (ITRC)

- 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

NISMOD now supported on DAFNI

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

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Environment Agency

Research and analysis Long-term investment scenarios (LTIS) 2019 Updated 8 May 2019



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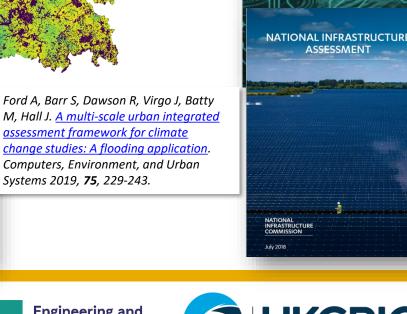
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The Future of

Edited by Jim W. Hall, Robert Nicholls Martino Tran and Adrian Hickford

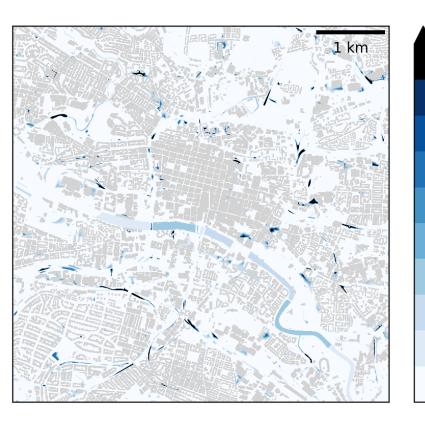
National Infrastructure A System-of-Systems Approach



OpenCLIM

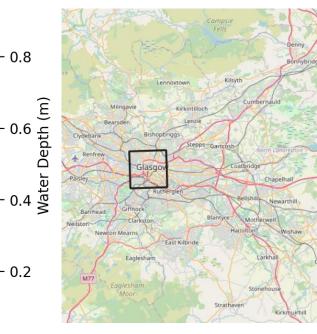
OPEN CLIMATE IMPACT FRAMEWORK

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



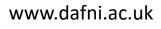


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https://www.tyndall.ac.uk/OpenCLIM

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









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B/ME/DMMersity of Sheffield

DAFNI Pilot study - Traffic Digital Twin in Sheffield

Traffic data from the Sheffield Urban

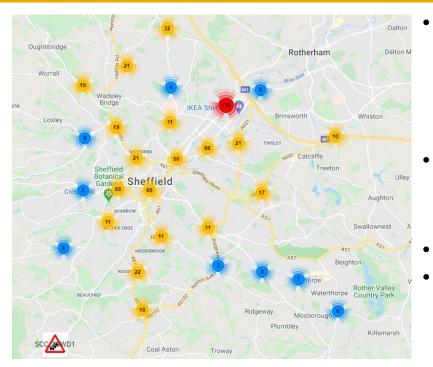
updates in real-time for each sensor

A digital replica of the Sheffield traffic

Identify areas where congestion will occur

predicts evolution of traffic (ex: 30 min ahead)

640 sensors that report traffic flow (no. of



Use cases:

• Traffic monitoring system that predicts congested areas

Observatory

cars/min)

Build AI-based model

Time resolution: 5 min

- Real-time traffic flow optimization

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Christian Genes, Daniel Coca

Road Update occupancy (%) Run) Crookes Valley Pa estern Bank Libra The University of Sheffield ng 🖨 40 Hallamshi . 0 O The Sheffield C Masjid Al-Huda 🕑

DAFNI UK Centre for Greening Finance and Investment



https://ukcgfi.org/

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

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What next for DAFNI?

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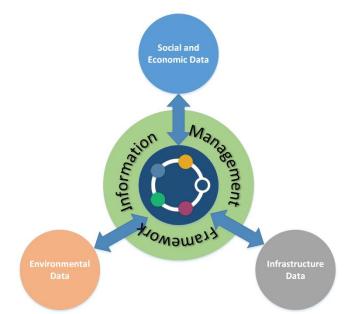


DAFNI-ROSE

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



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Working With DAFNI

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





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The DAFNI Team



Brian Matthews



David Macaree



Marion Samler



Tom Gowland



Bethan Perkins



Noel Vizcaino





Dhiwagaran Thangavelu

info@dafni.ac.uk www.dafni.ac.uk



James Hannah



Rose Dickinson



Alex Kemp



Matt Jones





Mat Wilcoxson









DAFN

Thank You

Dr Brian Matthews Brian.Matthews@stfc.ac.uk <u>www.dafni.ac.uk</u> <u>info@dafni.ac.uk</u>



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