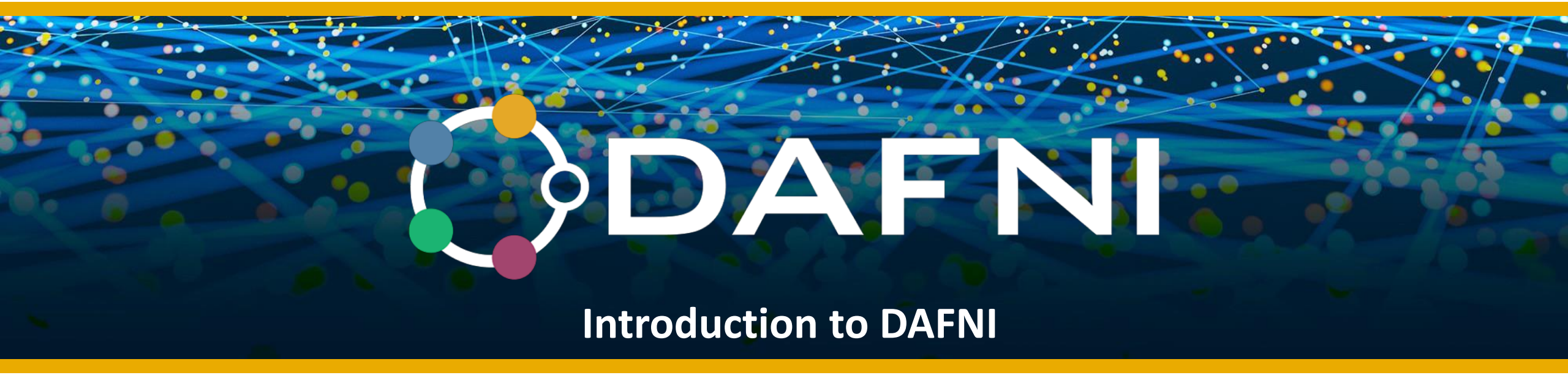

Introduction to DAFNI

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

Science and Technology Facilities Council

Engineering and Physical Sciences Research Council

UKCRIC

DAFNI

Why DAFNI ?

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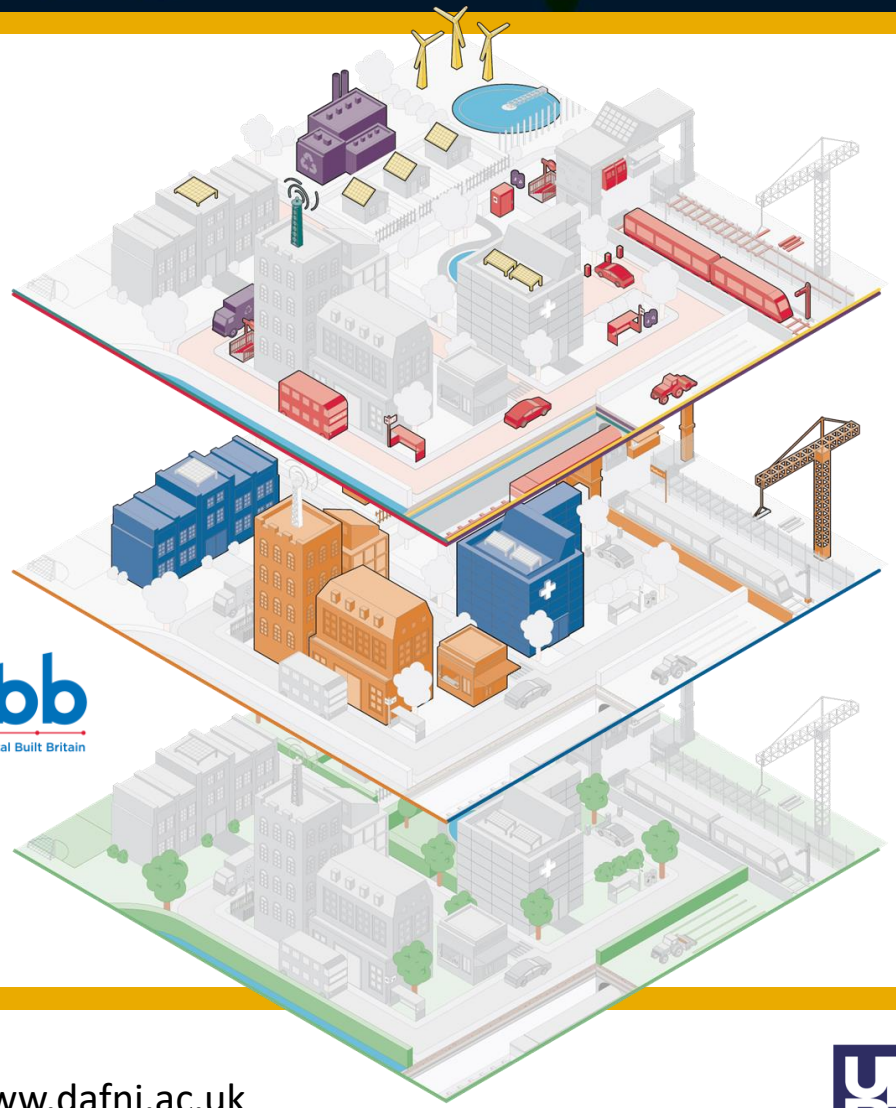
Supporting Modelling of the built environment

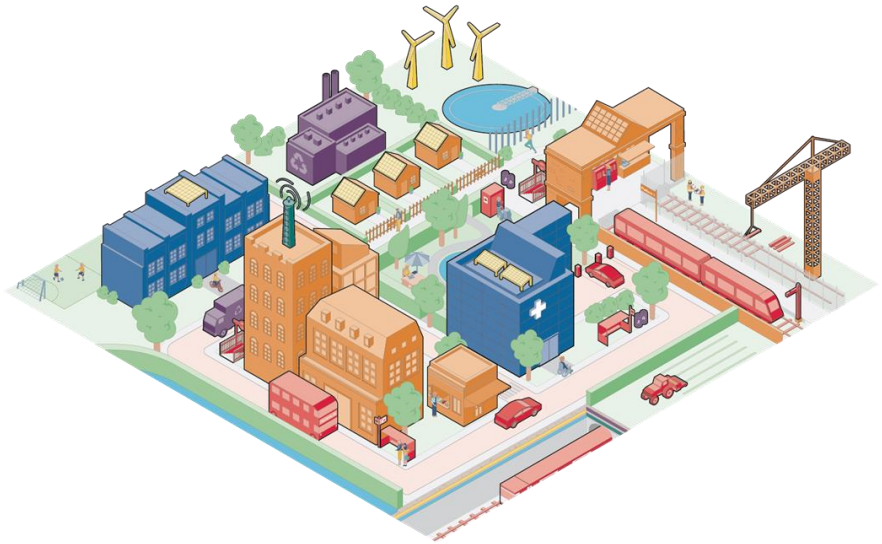


Economic infrastructure

Social infrastructure

Natural environment

Plan → Build → Operate → Evolve



Built environment

cdbb
Centre for Digital Built Britain

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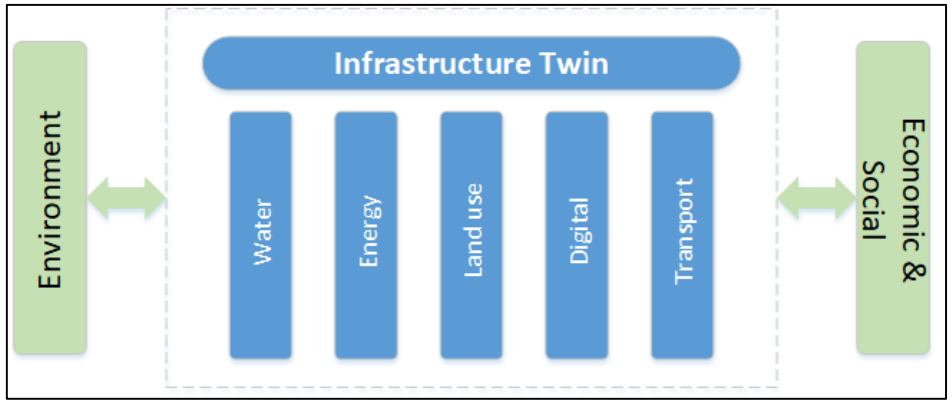
Technical Challenges of Infrastructure Research

- Scaling up
  - More data
  - Higher resolution
  - More compute resources
- Integration between models
  - Capture the interdependencies
  - Integration across scales - Nation to Item
  - Integration across sectors
- Data integration and exchange.
  - Share data between infrastructure models
  - Security respected
  - Common standards for interchange and interoperation
  - Common Metadata standards
- Supporting an ecosystem of Digital Twins
  - Integrated data infrastructure
  - Connections to sensors and “real-time” I/O
  - Analysing large-scale historic data to propose decisions

Integration across scales



Integration across sectors

DAFNI as a Community Hub

- A Place for sharing and combining data and models
- A Place to support collaborations
- A Place to deploy applications
- A Place as a legacy

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DAFNI provides to the Infrastructure Research Community

- A hybrid high-performance computing platform
- A secure repository for heterogeneous national infrastructure data and models.
- A collaborative platform to research and develop *multi-system models* of infrastructure assets and systems in *a managed environment*
- A place to make data and models available for long-term accessibility

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What DAFNI can offer

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DAFNI

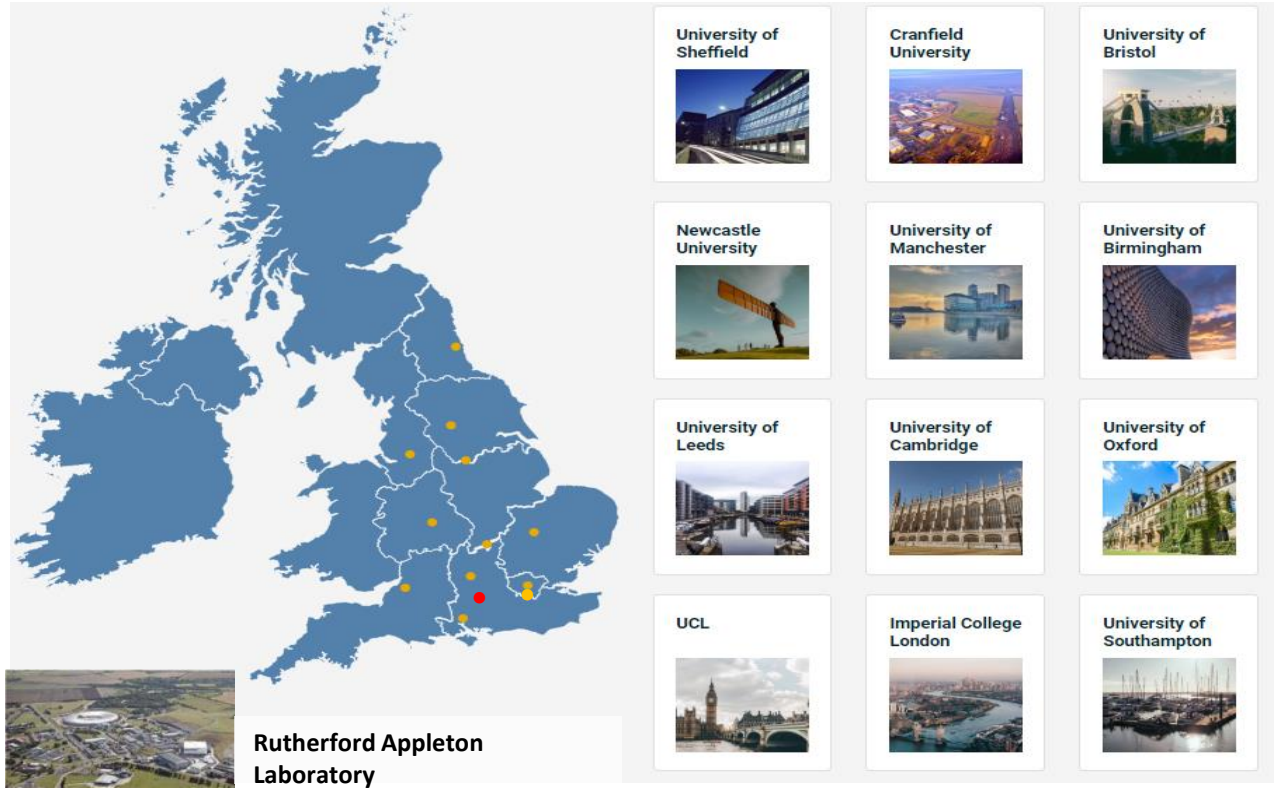
Data & Analytics Facility for National Infrastructure

Providing a computing platform to improve decision making for national infrastructure

UK's next generation platform to support research into infrastructure decisions: planning, investment, design and operation.

- £8M investment 2017-2021 under the UKCRIC programme
- A Partnership of 12 partner universities
  + STFC as development and hosting partner

Leading to Partnerships between Academia, Government, Industry



Rutherford Appleton Laboratory
Harwell Didcot, Oxfordshire

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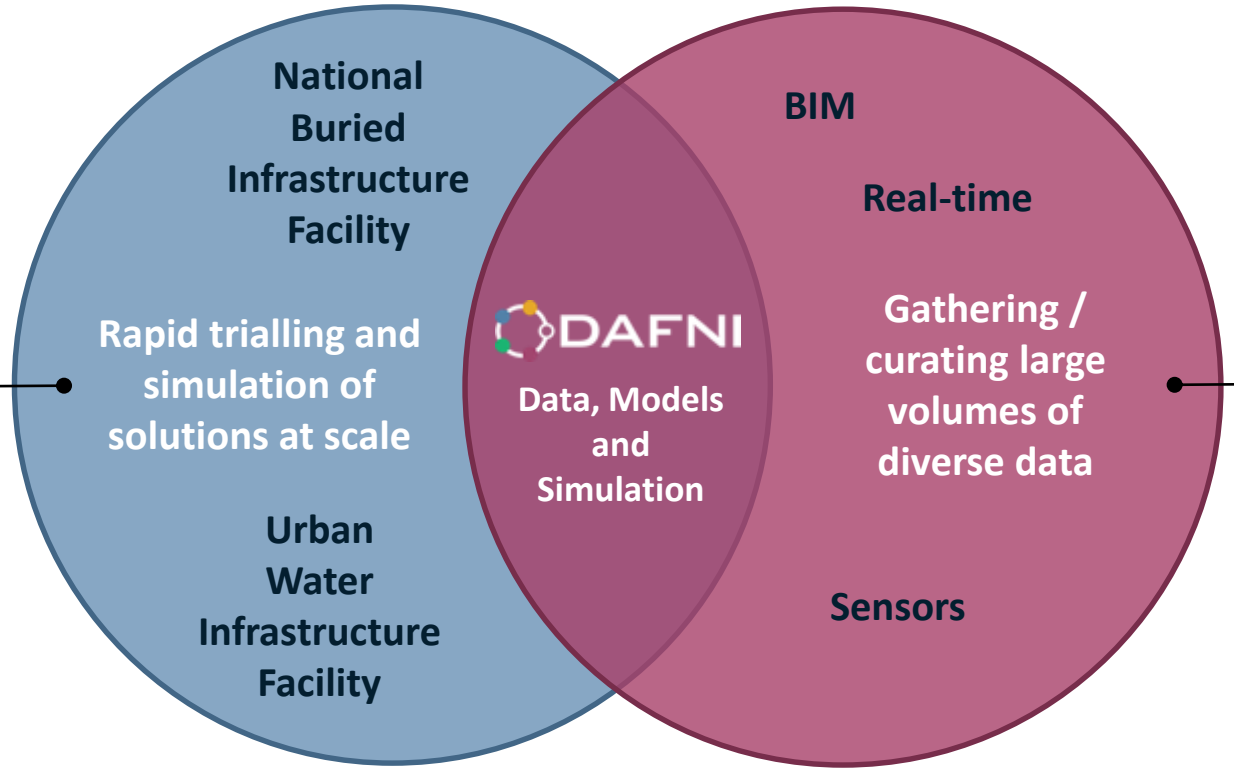
DAFNI in UKCRIC

National Infrastructure Labs



Urban Observatories

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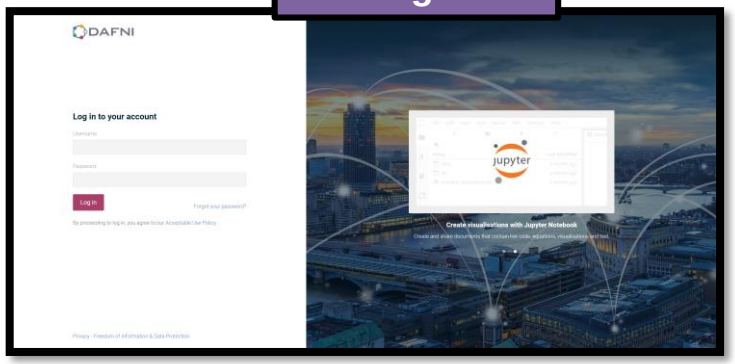
DAFNI: A HTC Hardware Platform

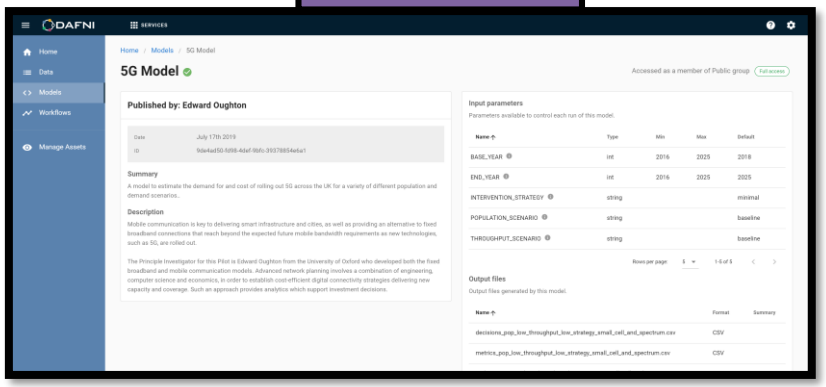
- DAFNI provides a dedicated HTC cluster
    - 27 server nodes
        - 792 CPUs, 16.8TB RAM, 10×Nvidia V100 GPUs (paired)
    - 2PB storage total:
        - Including 127 TB of “fast” storage (e.g for databases)
        - 20TB very high-throughput SSD/Flash storage pool
- Maintained in the STFC Machine Room at RAL
- Set up as a Kubernetes Cluster
- Can give more computing power to applications
    - faster
    - scale up

DAFNI Functionality

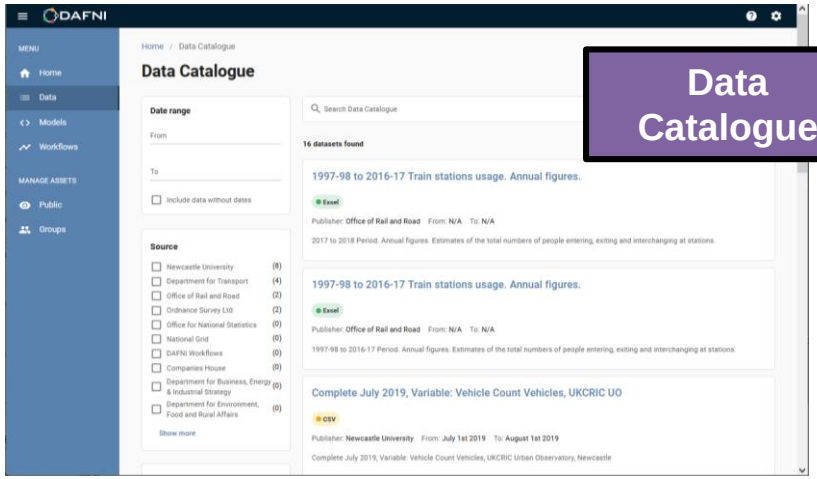
Login



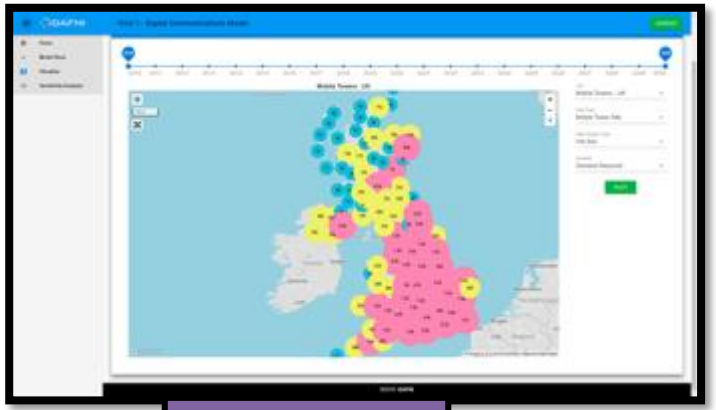
Data



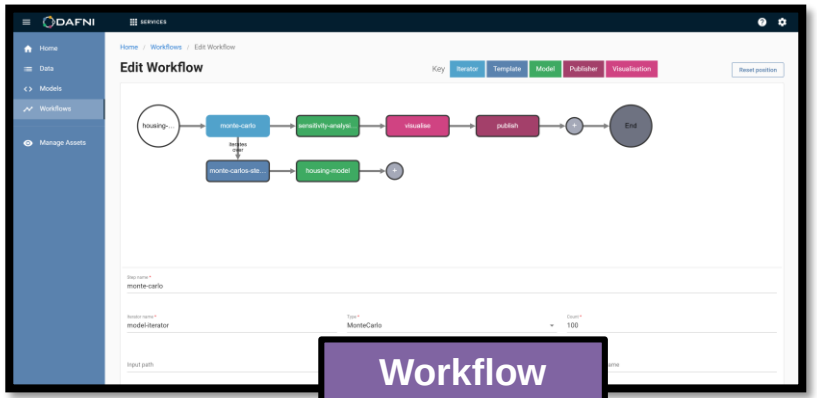
Data Catalogue



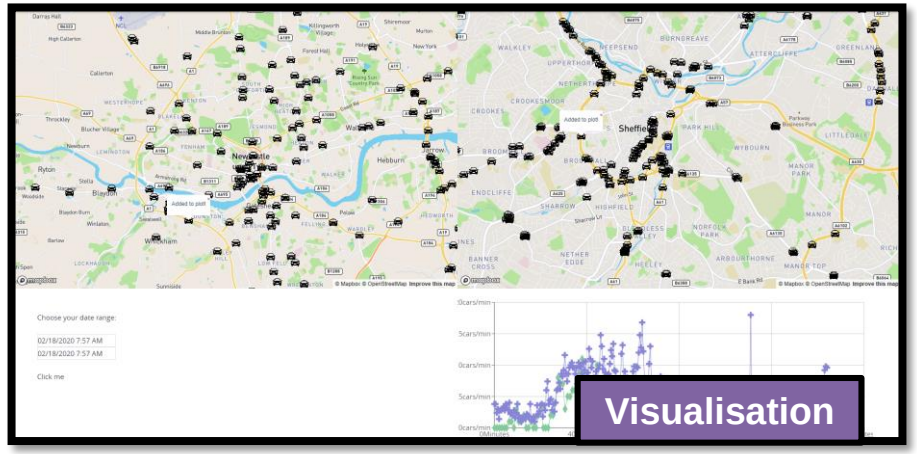
Models



Workflow Management



Visualisation



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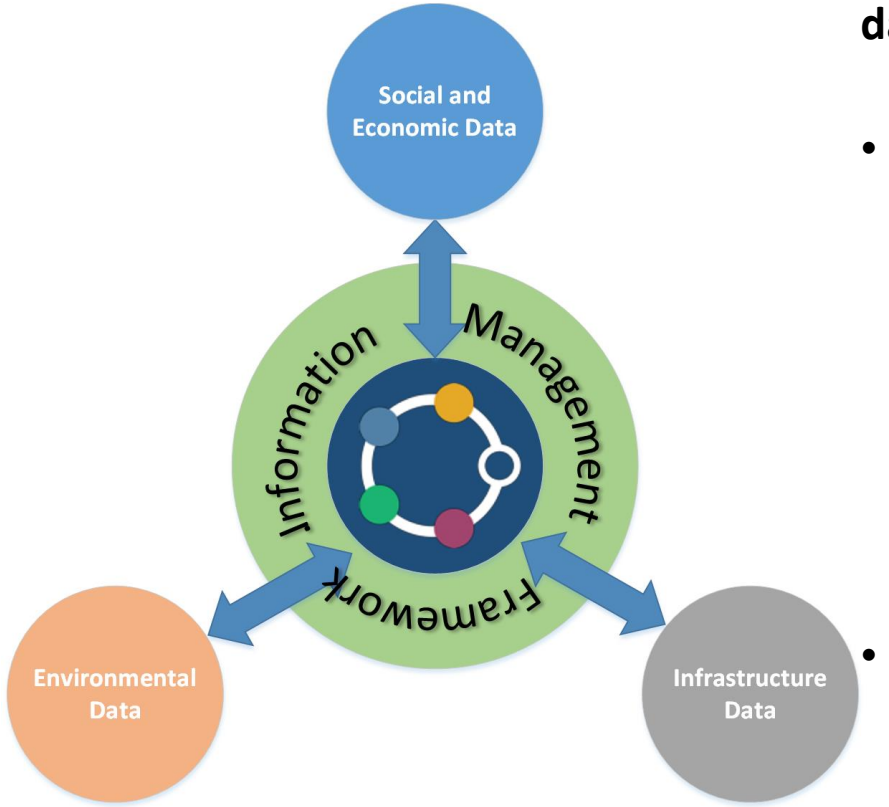
DAFNI as a Information Infrastructure

- 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
  - DCAT 2.0
  - Common search and access



A platform for integrating and combining data

- DAFNI's NID provides basis for representing data from different sources
  - Extensible to sectors: water, energy, transport …
  - Support an Ontological framework for data
- A data store – but not all data needs to be held centrally

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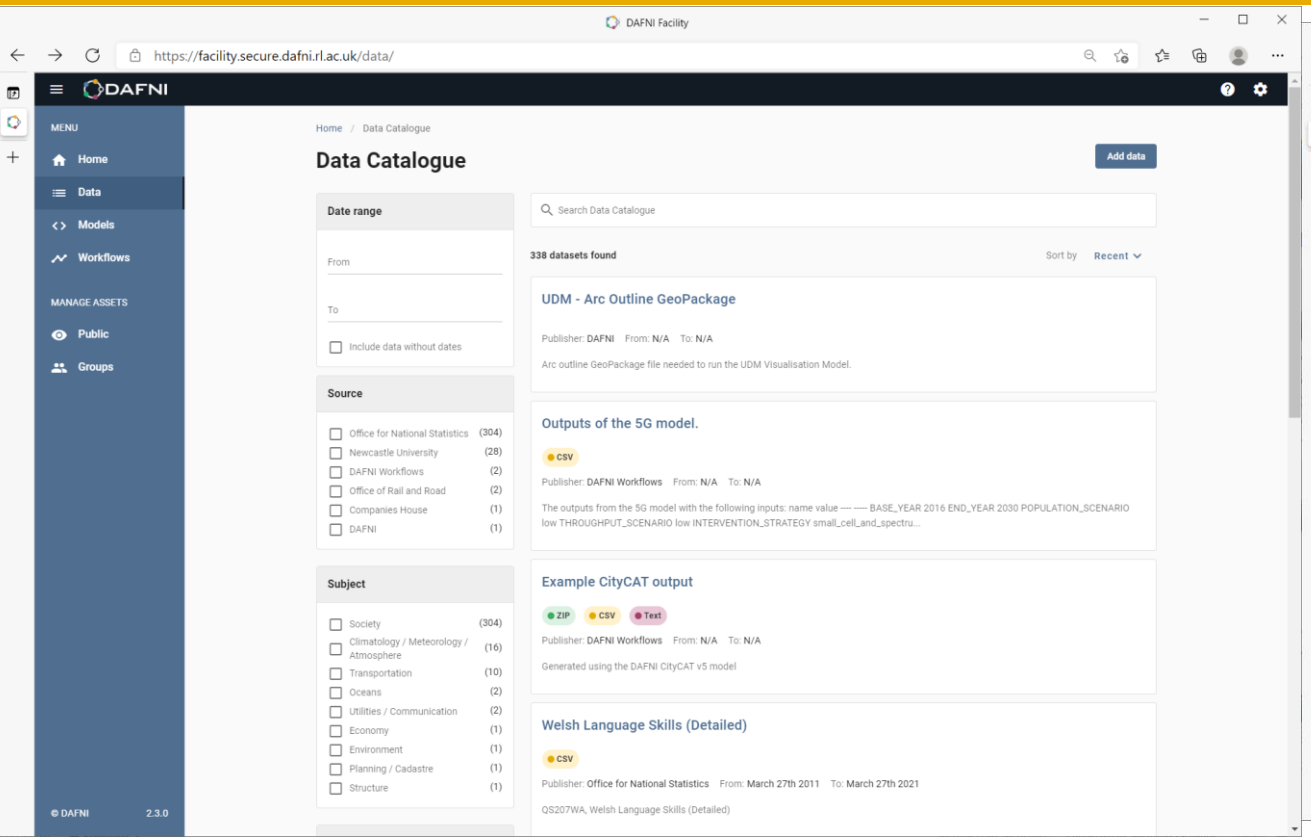
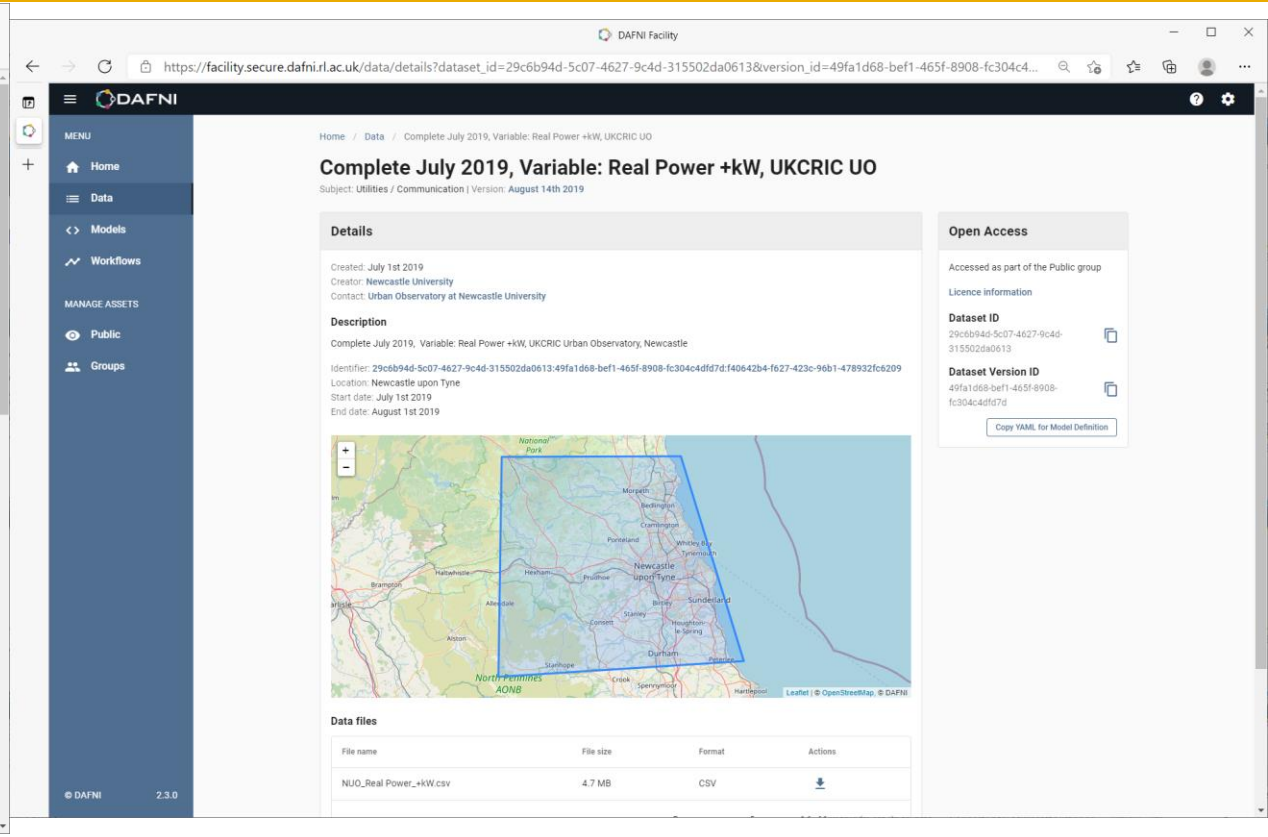
NID





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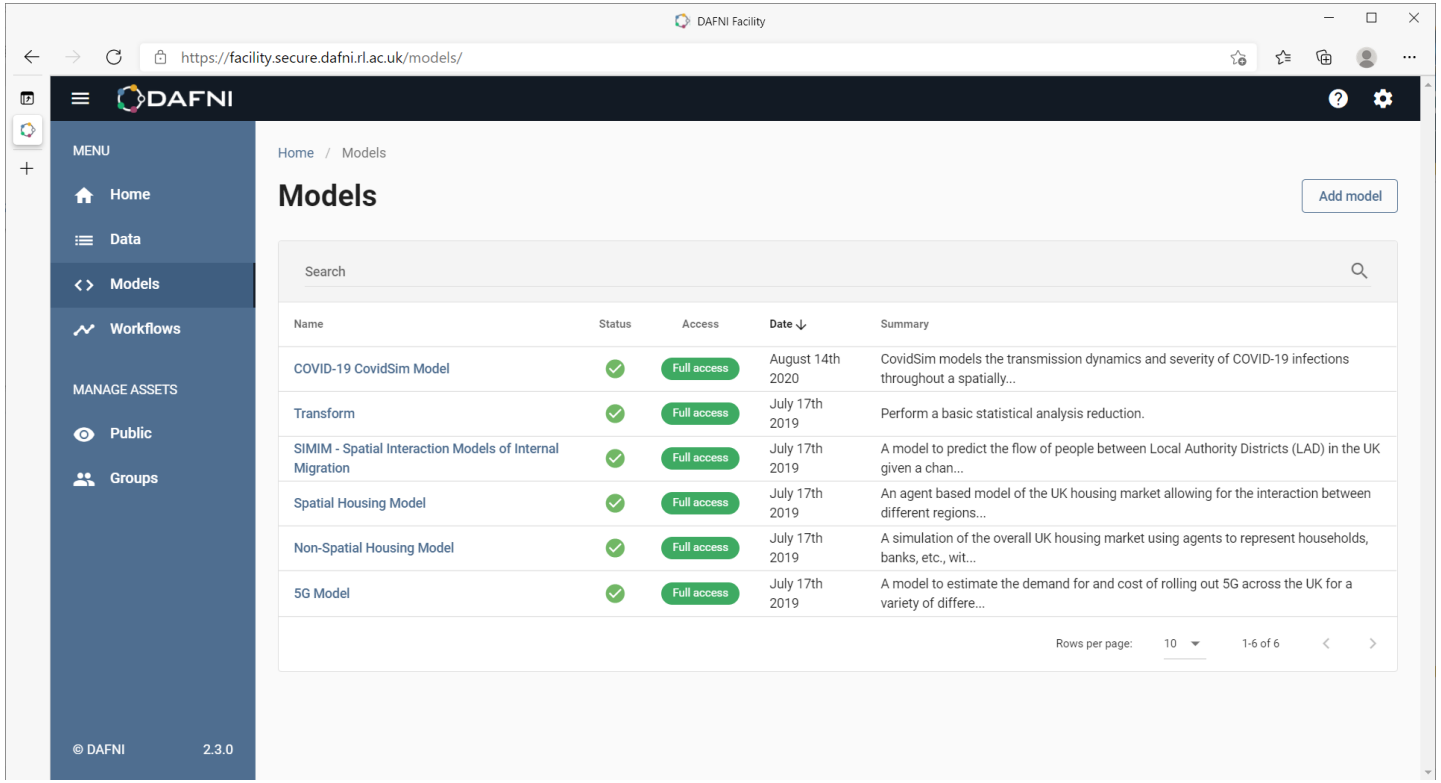
NIMS: Uploading models

- Upload models from anywhere
  - Models “containerised” using Docker
  - Independent of code and operating systems
- 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
- A repository of models
  - Harbor - a repository of Docker containers.
  - Sharing models
  - Within the same security framework



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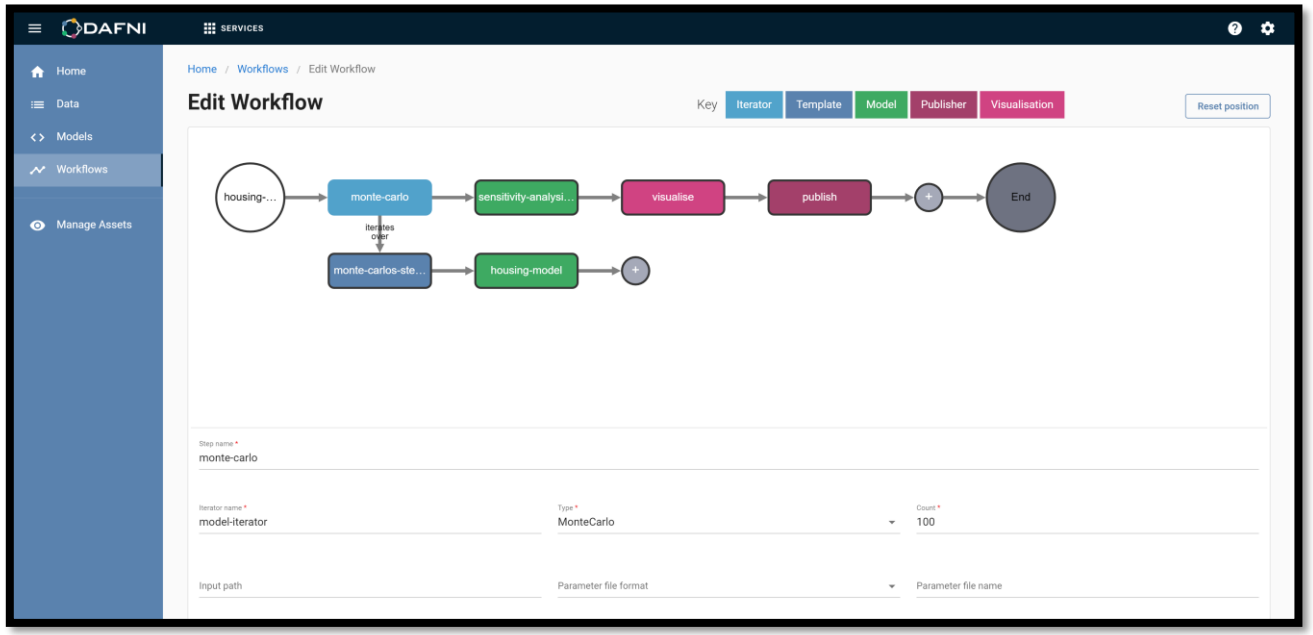
NIMS: Supporting user models

- The NIMS allows workflows to be constructed
  - Chaining models together
  - Coupling models together
- Add iterators
  - E.g. Monte-Carlo
- Add Visualisations
  - Jupyter Notebooks
- Key feature of providing an Infrastructure Ecosystem
  - Coupling different sectors
  - Coupling different scales



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How is DAFNI being used?

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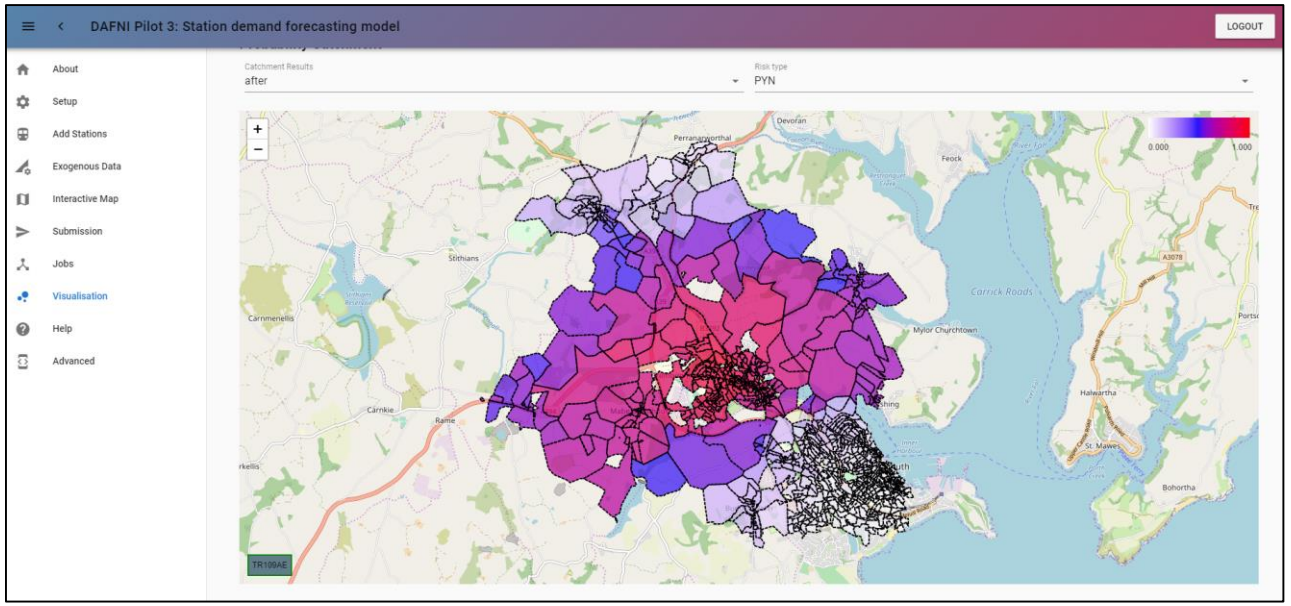
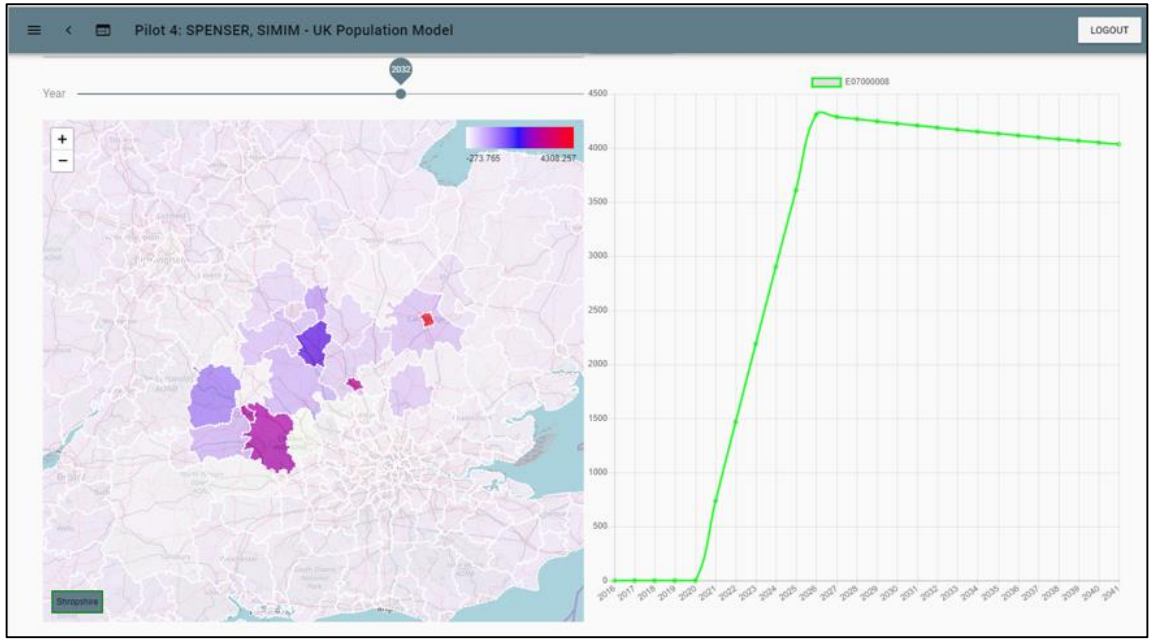
Projects on DAFNI: Supporting and extending models



A map showing the probability catchments of Penryn station after adding a new station in Helston
Station demand model, University of Southampton

Map showing the CAMCOX corridor and the movement of people given a change in households, jobs and GVA
SIMIM model, University of Leeds



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UK Infrastructure Transitions Research Consortium (ITRC)

From 2011 the UK Infrastructure Transitions Research Consortium (ITRC) has developed:

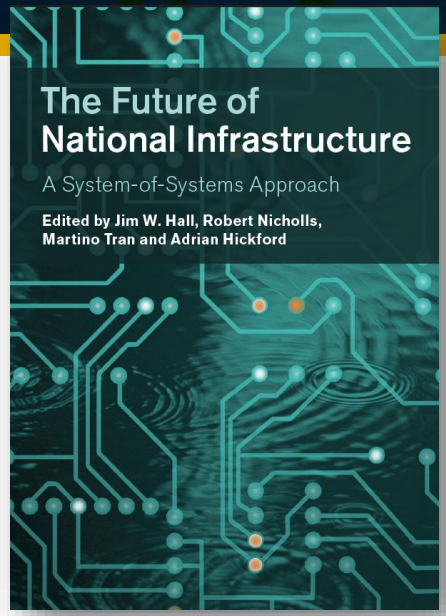
The NISMOD national system-of-systems model (energy-transport-digital-water-waste) for infrastructure **planning** in Britain

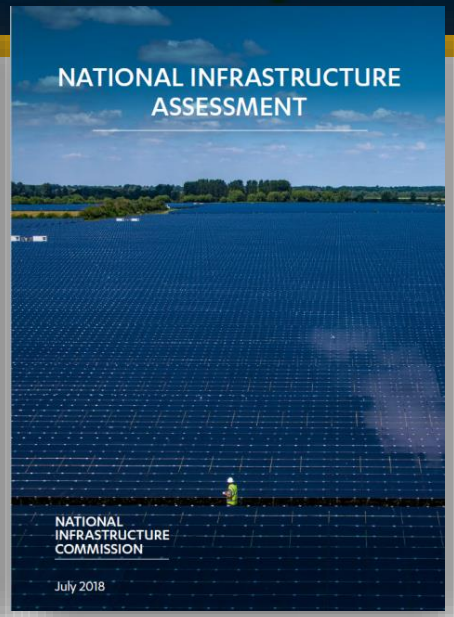
- NISMOD was used in the UK's first National Infrastructure Assessment

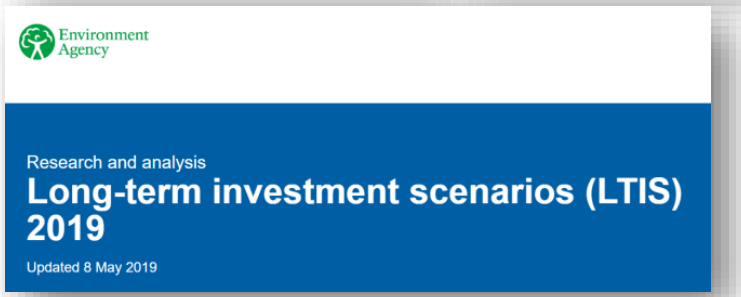
National modelling of climate **risks** to infrastructure networks

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

NISMOD is being migrated to a new £8million **facility** DAFNI: the Data and Analytics Facility for National infrastructure







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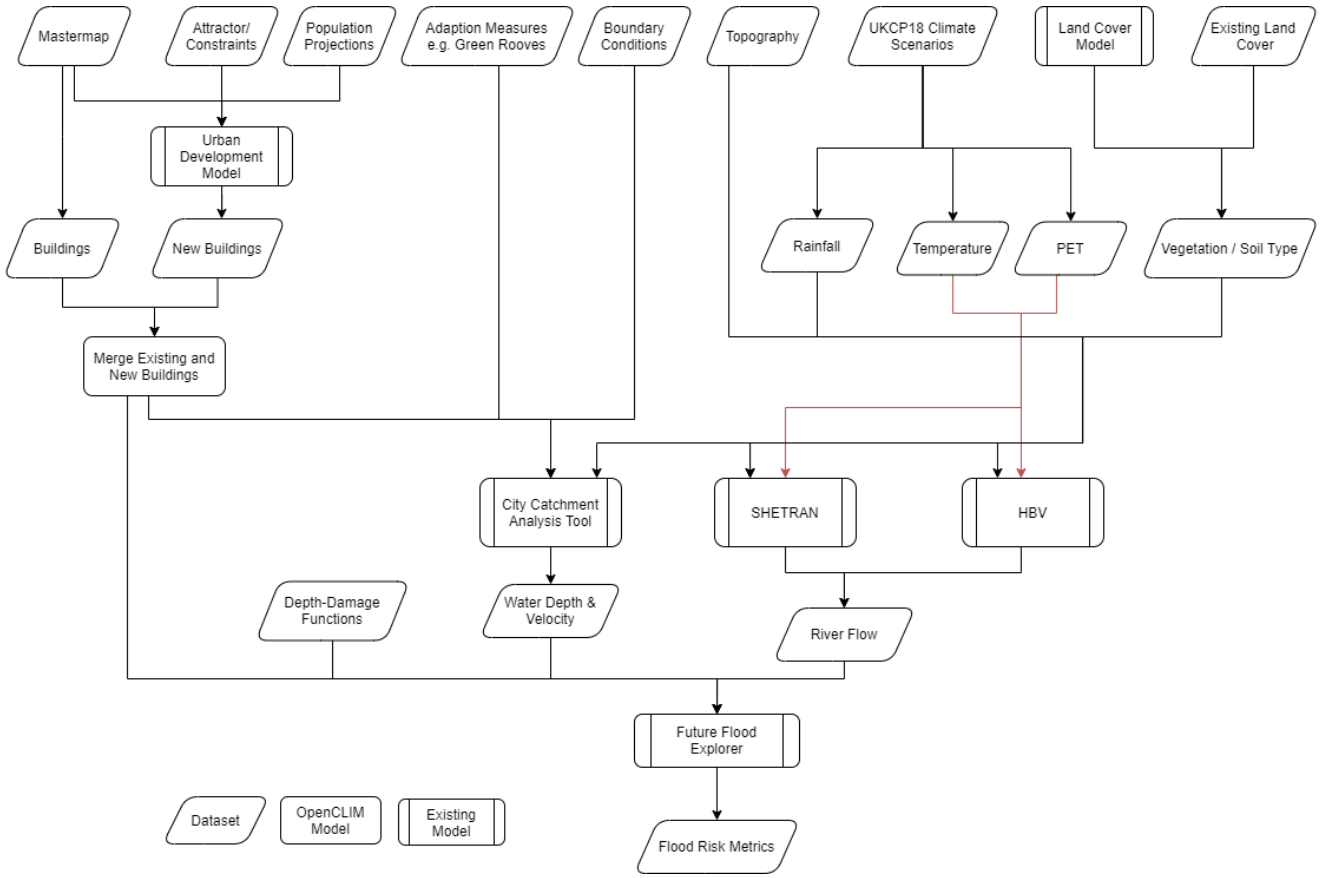
OpenCLIM

- New project – led by University of East Anglia

- Assess the risk of climate change
  - Flooding
  - Health risk from extreme heat
  - Agriculture and biodiversity
- Affect of approaches to 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



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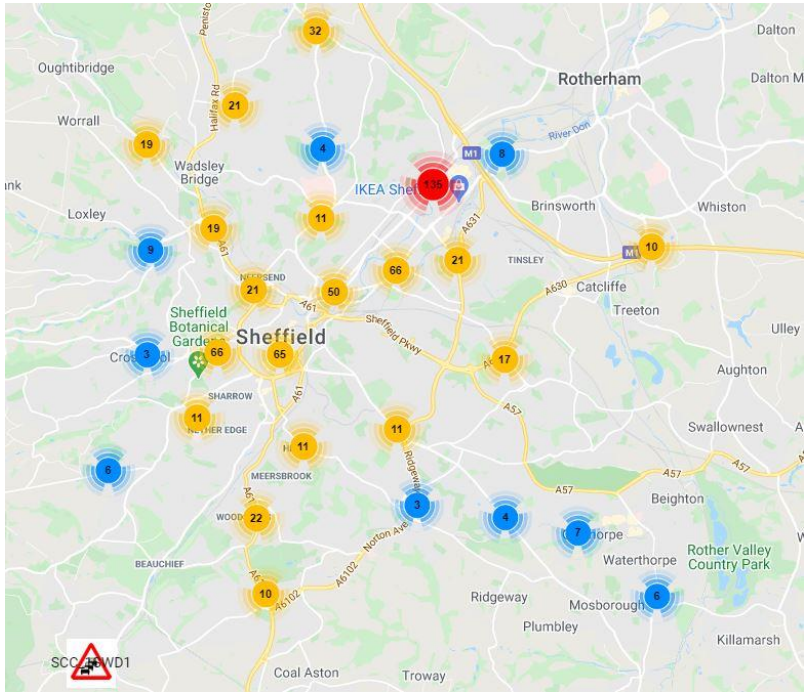
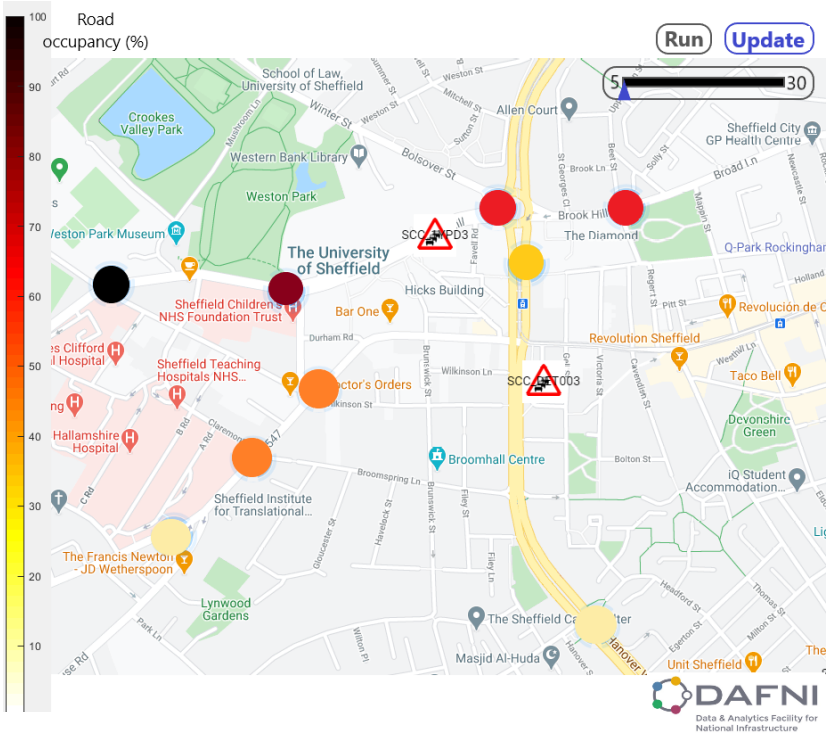
08/06/2021 University of Sheffield

Pilot study - Traffic Digital Twin in Sheffield



- Use 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)
- Create 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

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Summary

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DAFNI is Open for Business!!!

DAFNI Phase 1: 2017-21: 4 year development programme

- Requirements gathering, design, implementation
- Now in an intense development phase

Getting pilot users onto the platform

- Pilot programme
- Champions programme
- Webinars
- Hackathons – particularly with the Urban Observatory programme
- Final event – July 2021

Please talk to us! info@dafni.ac.uk

DAFNI Phase 2

- Long-term sustainability for production beyond September 2021
- Seeking to establish a hybrid model: platform support and contributions from projects.

A production platform

- Setting up a service management environment
- Operating the platform
- User support, operations, help desk
- Getting more users on the platform

Looking towards further development:

- Digital Twins: running long-running models with real-time input and outputs
- Support for Machine Learning models
- Richer data infrastructure
- An extended framework for integrating models.

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Summary

An environment for research collaboration

For researchers, government and industry exploring new ideas in modelling

DAFNI Platform offers:

- A HTC platform supporting research and technology transfer
- Data sharing within a common information infrastructure
- Scaling and coupling models
- A long-term legacy for keeping such models accessible

Still work to be done:

- Digital Twin Pilots
- Experimenting with a more dynamic data management framework
- Data Ontology Support

Supporting sustainable development of infrastructure for our regions, cities, rural areas and down to the household level.

Thank You

Dr Brian Matthews

Brian.Matthews@stfc.ac.uk

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Questions?

- Data needed for the project flagships
  - Data sets you have?
  - Data sets you use? E.g. UKCP18, MasterMap …

- Models
  - What models do you have in mind ?
  - Code? Python, R, C++, …. MatLab? ExCel ? Proprietary?
  - Linux? Windows?

- Licencing and access conditions ?
  - Open preferred.

- Who are your users?
  - Who will be using the platform?
    - Researchers? Analysts? Policy makers?
  - How would users anticipate interacting with the platform.

Thank You

Dr Brian Matthews
Brian.Matthews@stfc.ac.uk
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