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Research Council



Department
for Environment
Food & Rural Affairs



Natural Capital
and Ecosystem
Assessment





**Coast-R
Network**



UNIVERSITY
of HULL

Energy &
Environment Institute

Sharing and building on climate adaptation solutions using DAFNI

Tom Kirkham, DAFNI Science Lead

Kyle Stevenson, DAFNI User Liaison Lead

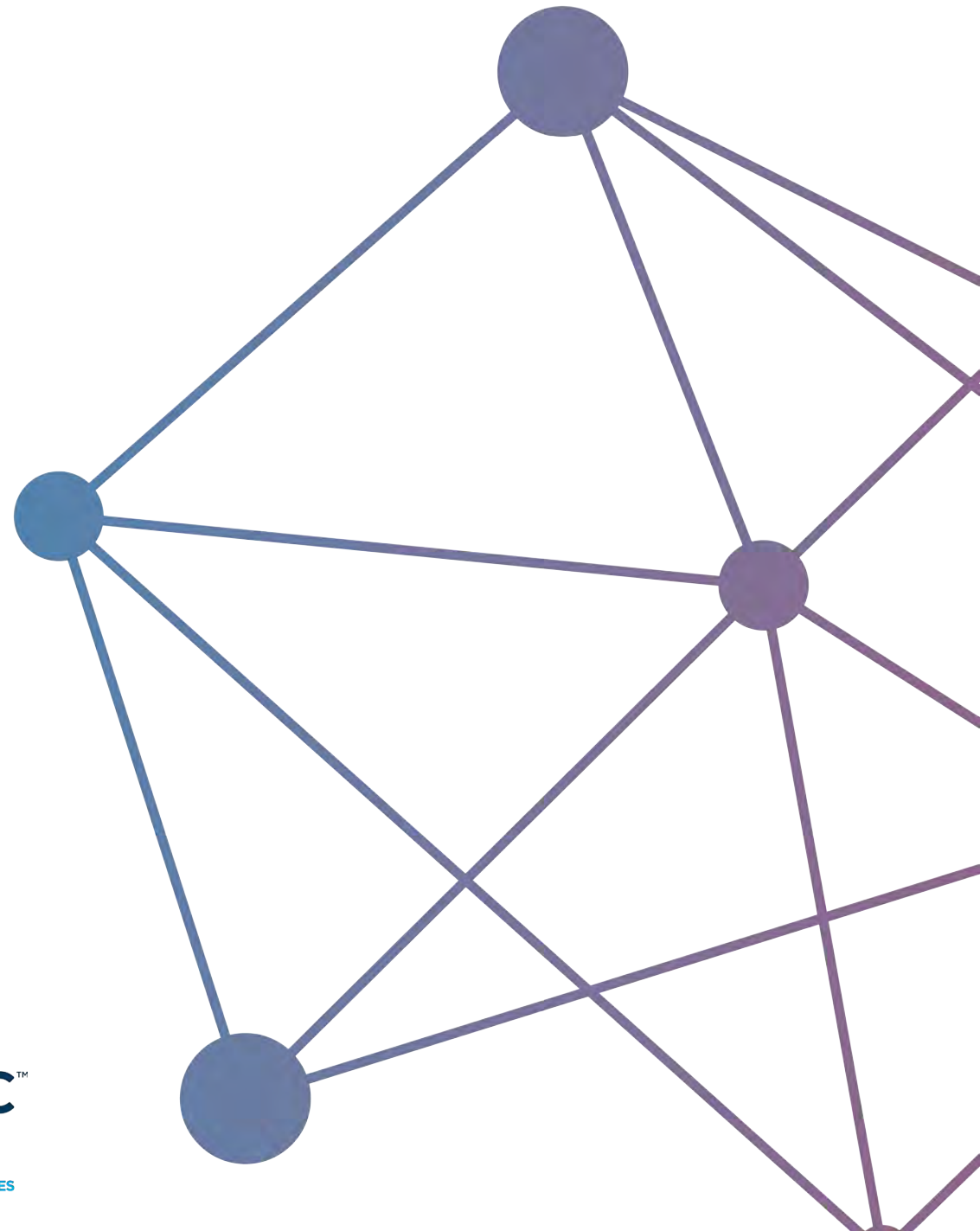


#CoastRNetwork



Data and Analytics Facility for National Infrastructure

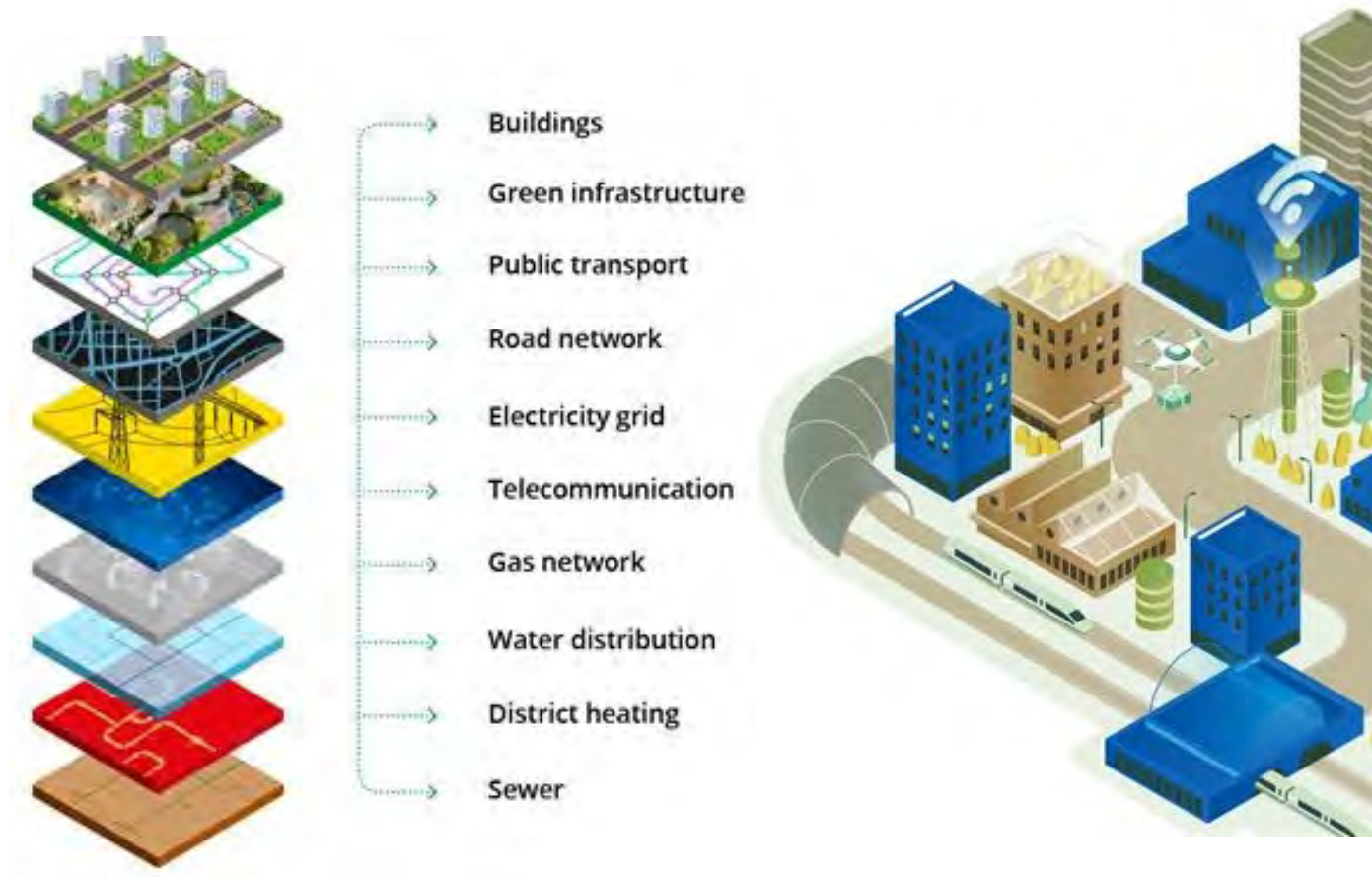
Tom Kirkham & Kyle Stevenson



What is DAFNI?

The Data & Analytics Facility for National Infrastructure

- £8m investment in 2017-2021 under UK Collaboratorium for Research on Infrastructure and Cities (**UKCRIC**)
- Computer platform for research into decision making for national infrastructure.
- Wider programme of work engaging Government, Industry and Academia.



The DAFNI Platform is:

- A secure repository for heterogeneous national infrastructure data and models
- A collaborative platform to bring researchers and facilitate the development of modelling frameworks
- A high-throughput computing platform
- A place to make data and models available for long-term accessibility



Who are we?

DAFNI Team

Dr. Brian Matthews



DAFNI Programme
Lead

Sarah Byrne



Senior Software Engineer
/ Product Owner

Elizabeth Mamtsits



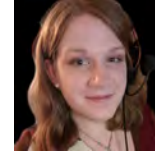
Research Software
Engineer & Liaison

Dr. Bethan Perkins



DAFNI Group Lead

Rose Dickinson



Senior Software Engineer/
Technical Lead

Lizzie Salmon



Scientific Computing
Graduate

Katie Cartmell



Delivery Manager

Dr. Lewis Sampson



Research
Software Engineer

Mathew Sims



Senior Software
Engineer

Catherine Dhanjal



Media Manager

Akhil Dubakunta



Software Engineer

Teagan Zoldoske



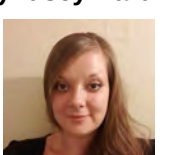
Data Curator

Dr. Kyle Stevenson



User Liaison

Lyndsey Harding



Programme Support
Officer

Dr. Server Kasap



DevOps Engineer

Jack Haydock



Software Developer

Alison Oliver



Community Research
Manager

Dr. Saiful Khan



Senior Data
Scientist

Aaron Larkins



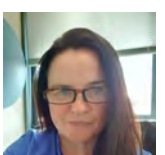
Software Engineer

Lilith Cole



Senior Software
Engineer

Marion Samler



Business Development
Manager

Dr. Jens Jensen



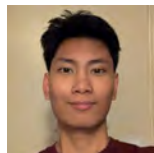
Data Scientist

Abhishek Mazumdar



Senior Software Engineer

Earl Talavera



Scientific Computing
Graduate

Tom Kirkham



Science Lead

James Acris



Senior Software Engineer

Karen VanHaltren



Data Curator

Archit Mantry



Project Co-Ordinator

DAFNI at STFC



Rutherford Appleton Laboratory



Daresbury Laboratory



UK ATC

The DAFNI platform



Science and
Technology
Facilities Council



Engineering and
Physical Sciences
Research Council



UKCRICTM

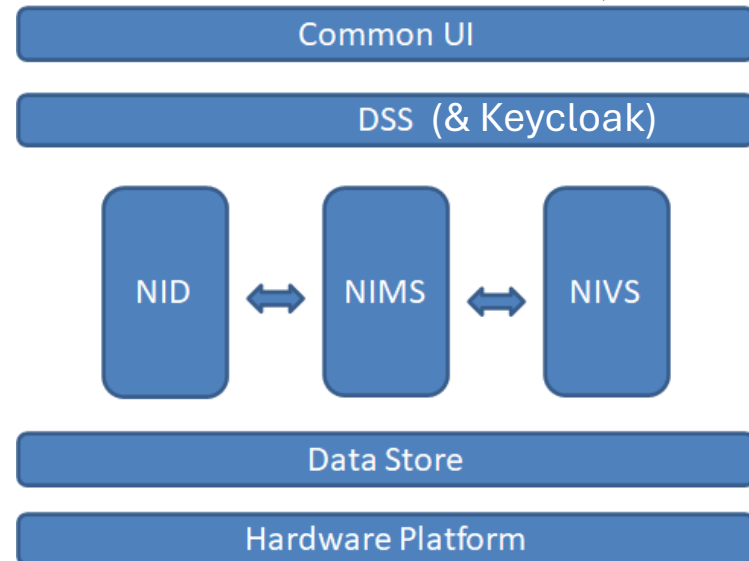
UK COLLABORATORIUM
FOR RESEARCH ON
INFRASTRUCTURE & CITIES



DAFNI

Data & Analytics Facility
for National Infrastructure

DAFNI Architecture



kubernetes

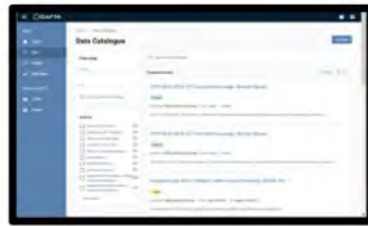
Is used for managing the DAFNI cluster, handling the deployment of Docker containers, and the allocation of computing resources.



docker

Docker is a container technology that allows DAFNI to deploy and run software packages.

DAFNI Architecture : Overview



User Login
Access control
under the DSS and
group membership

User can explore
data uploaded into
DAFNI to find
suitable data

User can upload data
into DAFNI
with suitable
metadata and
permissions

User can upload
models containerised
using DOCKER to the
Model Repository

User can construct
and execute
workflows combining
models

User can construct
and generate
visualisations of data
and outputs of
workflows



DAFNI Security Service
DSS



National Infrastructure
Database
NID



kubernetes



NIMS



docker



National Infrastructure
Modelling Services
NIMS



National
Infrastructure
Visualisation Suite
(NIVS)

National Infrastructure db



The National Infrastructure Database (or NID) provides DAFNI with the capability to handle a large searchable catalogue of data. This data can be either public or private in DAFNI, and can be shared within groups as needed.

Users are given the ability to upload, publish and use all DAFNI data available to them in models and workflows.

The NID also handles the associated metadata, used in searches.

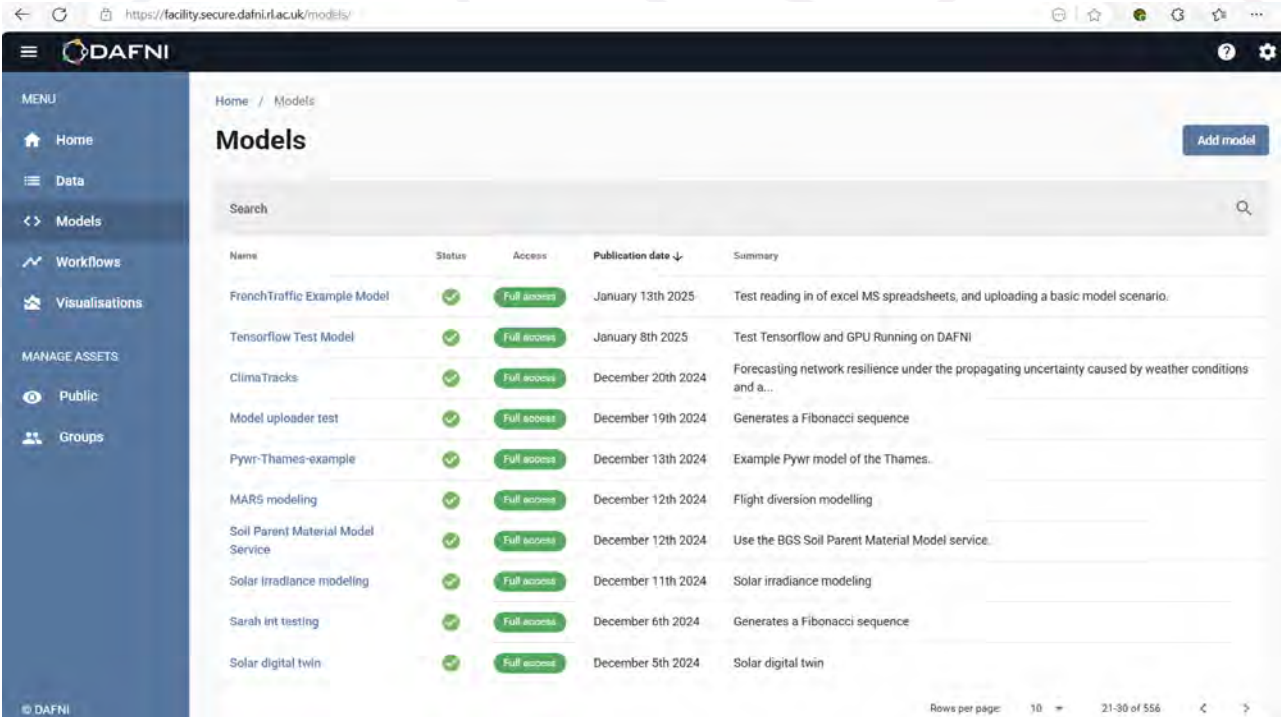
The screenshot shows the DAFNI Data Catalogue web application. The interface includes a dark blue sidebar menu with options like Home, Data, Models, Workflows, Visualisations, and Manage Assets. The main content area is titled "Data Catalogue" and features a search bar, a date range filter, and a list of datasets. Two datasets are highlighted: "CGFI-GRI Gridfinder (Paraguay)" and "CGFI-GRI WRI Global Power Plant Database (Chile)". A detailed view of the "CGFI-SFI Global Steel Database July 2021" is shown at the bottom, including contact information, creation details, project details, and a description. A world map is visible at the bottom right of the detailed view.

NIMS : Supporting User Models



Models – which could be written in a variety of computing languages - can easily be uploaded into the National Infrastructure Model Service (or NIMS). Like the data (NID) stored in DAFNI, models are also indexed with metadata for searchability.

Models can be run on the DAFNI kubernetes cluster, taking full advantage of model dockerisation, and can access the data stored on DAFNI, in a straightforward manner.

A screenshot of the DAFNI web application's 'Models' page. The page has a dark blue sidebar menu on the left with options: Home, Data, Models (selected), Workflows, and Visualisations. Below these are 'MANAGE ASSETS' options: Public and Groups. The main content area is titled 'Models' and includes a search bar. It displays a table of models with columns: Name, Status, Access, Publication date, and Summary. The table lists ten models, all with a status of 'checked' and 'Full access'. The models include 'FrenchTraffic Example Model', 'Tensorflow Test Model', 'ClimaTracks', 'Model uploader test', 'Pywr-Thames-example', 'MARS modeling', 'Soil Parent Material Model Service', 'Solar irradiance modeling', 'Sarah int testing', and 'Solar digital twin'. At the bottom right, there is a pagination control showing 'Rows per page: 10' and '21-30 of 556'.

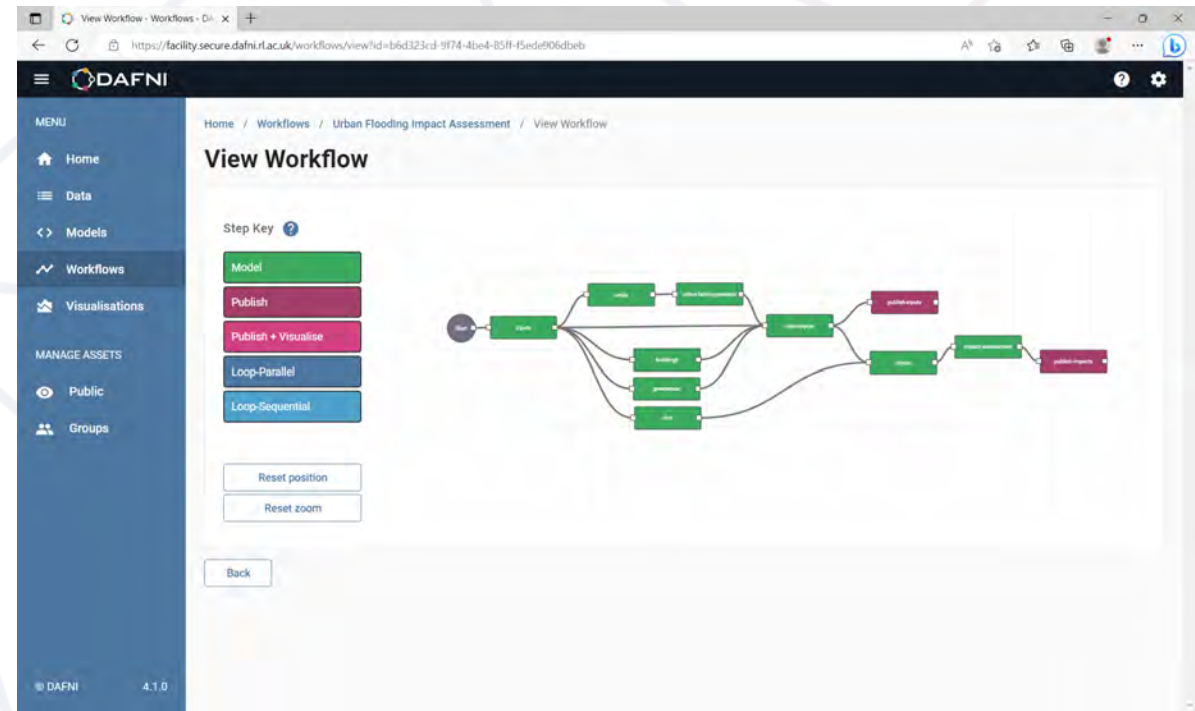
Name	Status	Access	Publication date	Summary
FrenchTraffic Example Model	✓	Full access	January 13th 2025	Test reading in of excel MS spreadsheets, and uploading a basic model scenario.
Tensorflow Test Model	✓	Full access	January 8th 2025	Test Tensorflow and GPU Running on DAFNI
ClimaTracks	✓	Full access	December 20th 2024	Forecasting network resilience under the propagating uncertainty caused by weather conditions and a...
Model uploader test	✓	Full access	December 19th 2024	Generates a Fibonacci sequence
Pywr-Thames-example	✓	Full access	December 13th 2024	Example Pywr model of the Thames.
MARS modeling	✓	Full access	December 12th 2024	Flight diversion modelling
Soil Parent Material Model Service	✓	Full access	December 12th 2024	Use the BGS Soil Parent Material Model service.
Solar irradiance modeling	✓	Full access	December 11th 2024	Solar irradiance modeling
Sarah int testing	✓	Full access	December 6th 2024	Generates a Fibonacci sequence
Solar digital twin	✓	Full access	December 5th 2024	Solar digital twin

NIMS : Workflows

Models in DAFNI can be joined together to form workflows in a flexible manner. Workflows can also contain loop elements, and models in general can run in series or in parallel.

The drag and drop interface allows workflows to be easily constructed and edited later.

Models can be shared between workflows, within access limits (which are controlled by the model, and data owners).

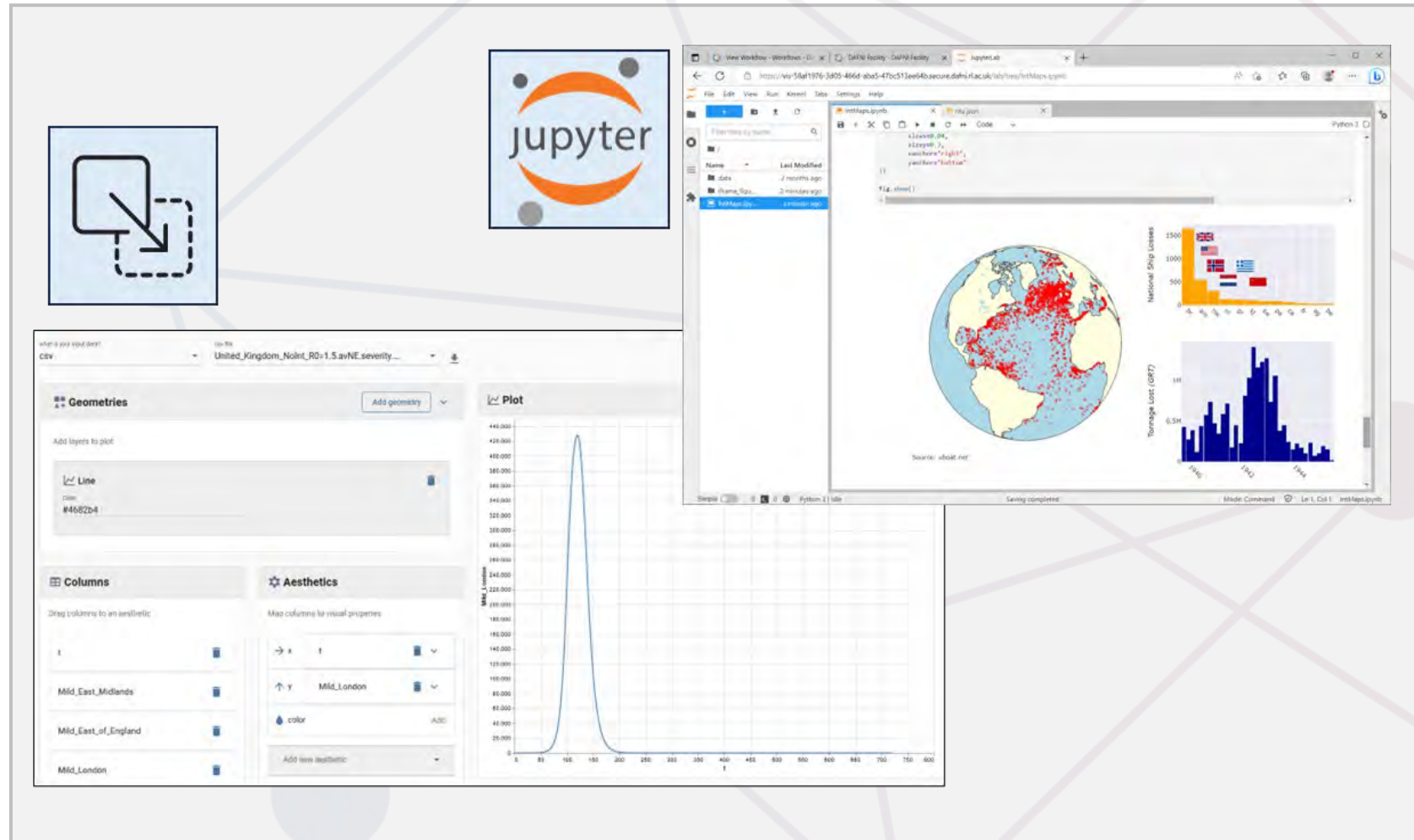


NIVS : Building Visualisations



The National Infrastructure Visualisation Service (or NIVS) allows us to visualise, understand and further analyse data from workflow outputs.

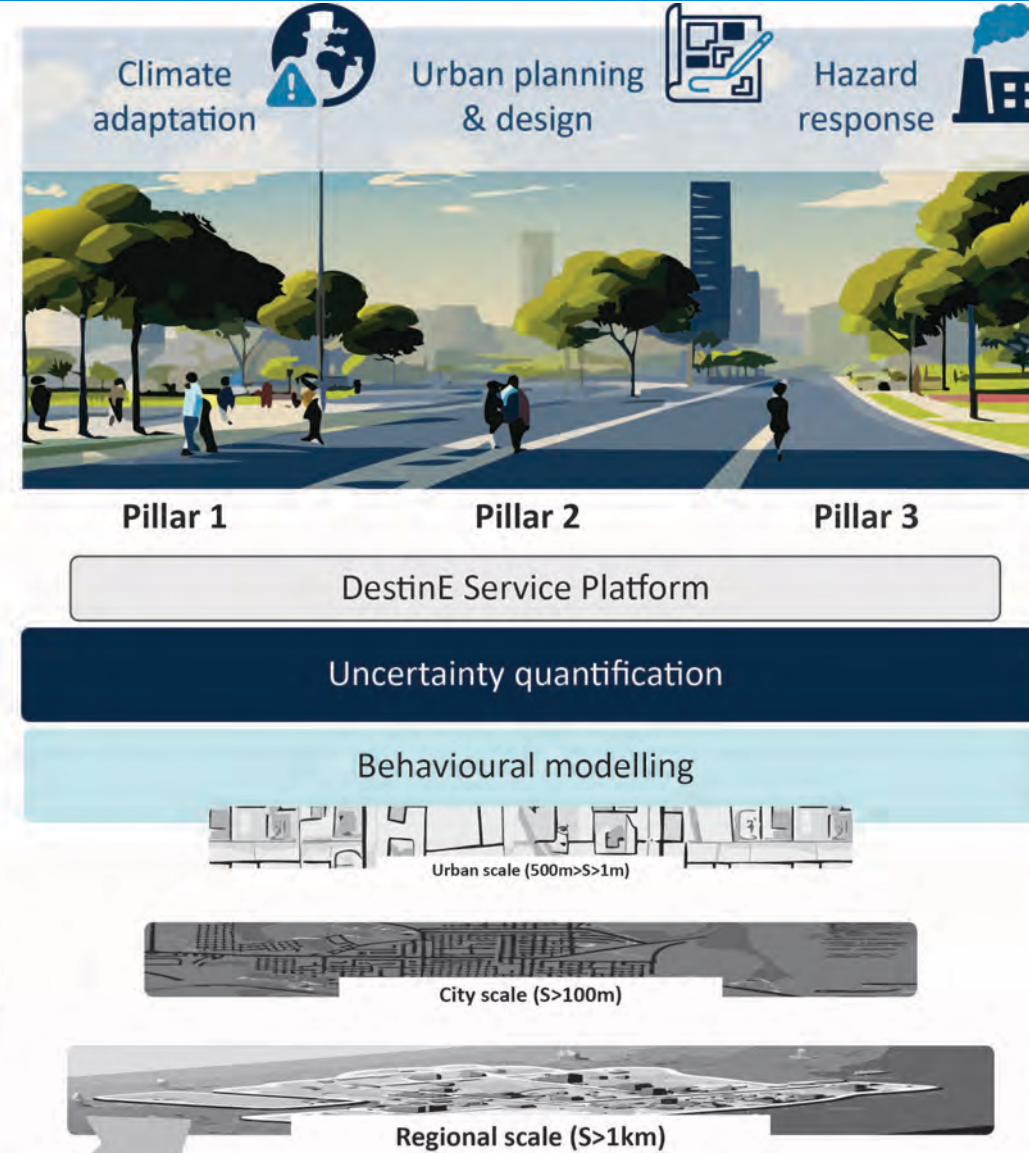
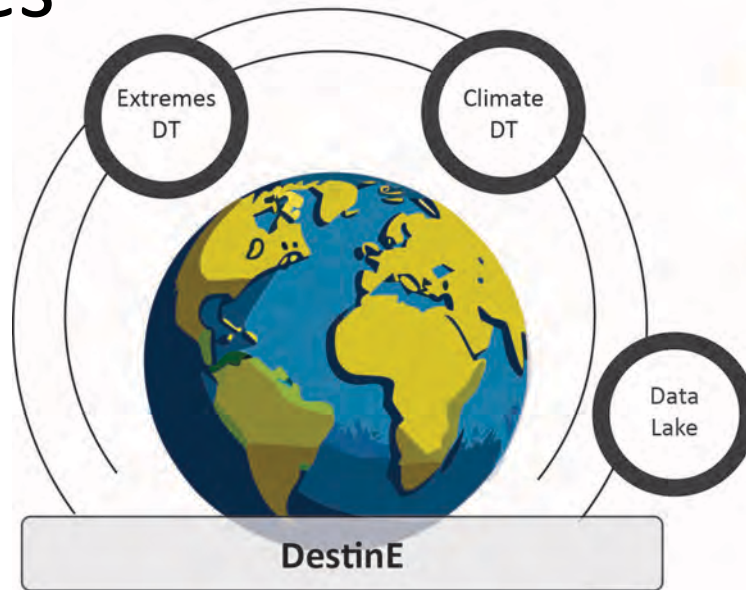
In DAFNI we currently support two different classes of visualisation. A straightforward drag & drop tool, and Jupyter notebooks (python & R scripting).



A network diagram with 10 nodes (circles) of varying sizes connected by lines. The nodes are arranged in a complex, interconnected pattern. The text "How DAFNI is being used" is overlaid in the center.

How DAFNI is being used

UrbanAIR Urban Simulation for Air Quality and Heat Resilience Strategies



Pilot Study

Traffic Digital Twin in Sheffield

Christian Genes, Daniel Coca



Traffic data from the Sheffield Urban Observatory

- 640 sensors that report traffic flow (number of cars per minute)
- Time resolution: 5 minutes

Build AI-based model

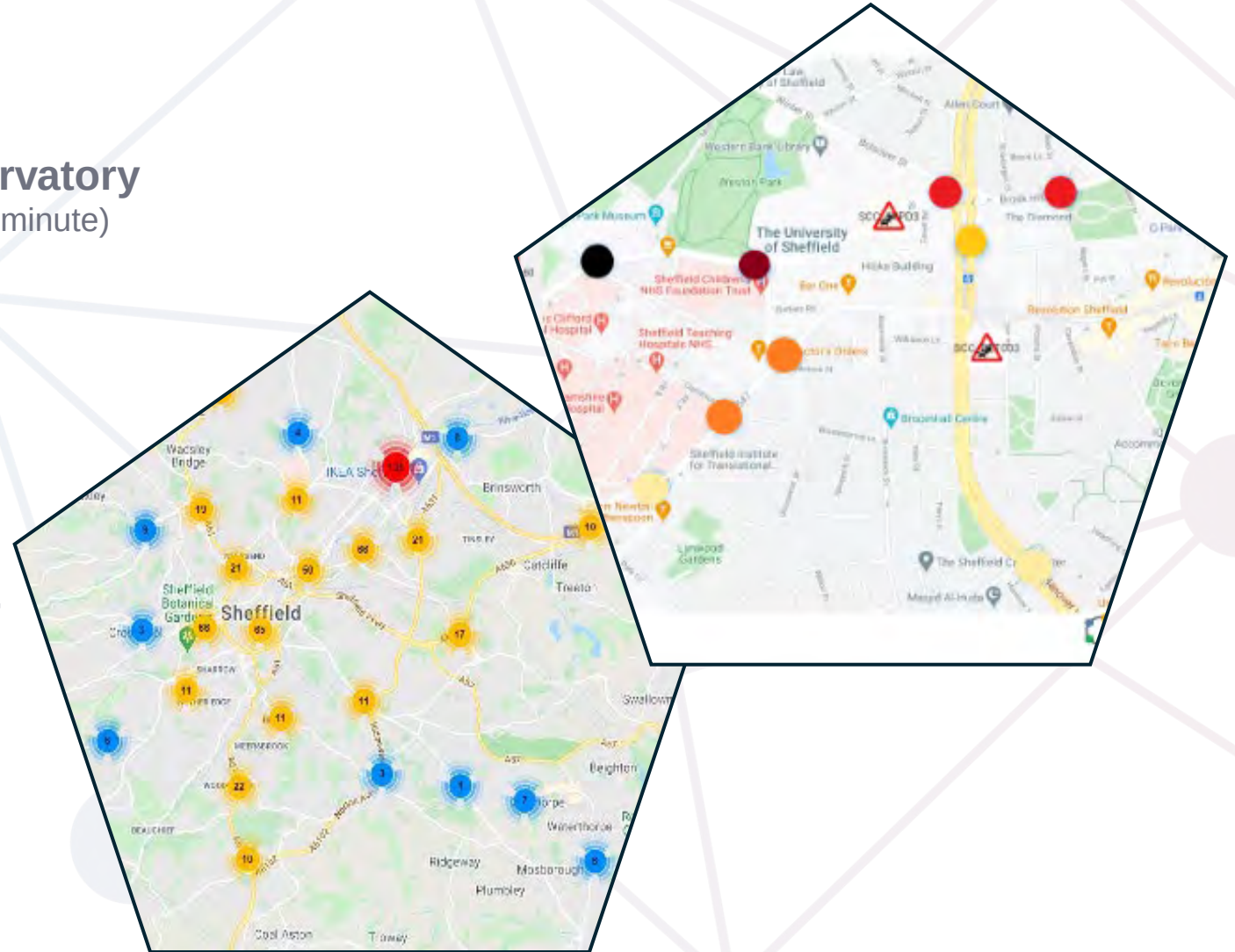
- Updates in real-time for each sensor
- Predicts evolution of traffic (ex: 30 minutes ahead)

Digital replica of Sheffield traffic

Identify areas where congestion will occur

Use cases:

- Traffic monitoring system to predict congested areas
- Real-time traffic flow optimisation



OpenCLIM



Topic Areas

1. Biodiversity/land cover
2. Urban development
3. Agriculture
4. Heat stress
5. Inland flooding
6. Drought and water supply

Fluvial Flooding

A) Climate-related flood hazard

- How might climate change impact flood risk and damages in the future across the UK and the devolved administrations?
- What is the most important 'gap' you see in existing climate flood risk assessments?
- What areas of uncertainty that may influence future flood risk concern you most?

B) Adaptation to flood risk

- How might changes in development affect flood risk?
- How can we reduce flood risk through carefully designed land use change?
- What is the most important sectoral influence on flooding for OpenClim to consider?

Models

- **HEAT:** sWGBT, VP
- **ARCADIA:** mortality risk, residential discomfort, labor productivity
- **HBV & SHERTRAN:** streamflow, runoff depth, reservoir flow, soil moisture, g'water
- **CityCAT:** fine scale surface water floods
- **Future Flood Explorer:** flood risk and damages
- **National Water Simulation:** reservoir storage, water restrictions, abstraction shortfalls
- **CropNET & EcoCROP:** potential/actual crop yield, crop suitability
- **Urban Development Model (UDM):** spatial development, land use
- **Wallace Initiative:** species richness, climate change refugia for biodiversity



CReDo Climate Resilience Demonstrator

Investigate impact of flooding

- Impact on communications infrastructure, water/sewerage, power
- Infrastructure failures cascade – e.g loss of power impacts comms networks
- Asset owners: BT, Anglian Water, UK Power Networks

DAFNI's role is:

- Provide the secure data platform trusted by all participants to support Digital Twins
- Enable collaboration while enforcing the security requirements imposed by asset owners
- Run the flood simulations on DAFNI
- Help modellers containerise their models

Collaboration with: BT, Anglian Water, UK Power Networks, STFC's Hartree Centre

A place to make data and models available for long-term accessibility

BSRW Projects

Developing a Resilience Framework

USARIS Dr Francesca Pianosi, University of Bristol	Uncertainty quantification and sensitivity analysis for resilient infrastructure systems
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Supporting Key Models

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

Exploring Resilience Scenarios

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

BSRW “Sandpit” Projects

Transport	
ClimaTracks Solutions (Rail) Giuliano Punzo, University of Sheffield; Ji-Eun Byun, University of Glasgow; Qian Fu, University of Birmingham; Tohid Erfani, UCL; Iryna Yevseyeva, De Montfort University; Kostas Nikolopoulos, Durham University	Forecasting resilience of railway network under propagating uncertainty
IMPACT (Road) Dr. Qiuchen Lu, UCL; Prof. Tao Cheng, Mr. Xuhui Lin, Dr Tohid Erfani, Dr Trung Hieu Tran	Improving flood disrupted road networks resilience with dynamic people-centric digital twins
MARS (Airports) Fabian Steinmann, Cranfield University	Flight Diversion Modelling for the UK Aviation System

Energy	
D-RES Desen Kirli, University of Edinburgh; Laiz Souto, University of Bristol	Provision of distributed grid resilience using EVs during extreme weather events
ForNET Kostas Nikolopoulos, Durham University; Lu Yang, York St John University; Haoran Zhang, University College London	DAFNI Forecasting Services for Energy Networks resilience using EVs during extreme weather events
BRINES Hannah Bloomfield, Newcastle University; Sean Wilkinson, Newcastle University; Ji-Eun Byun, University of Glasgow	Building risk-informed redundancy in energy systems transitioning to net-zero

Summary

- DAFNI enables different parties to **collaborate** around models and data and to create workflows
 - Providing a point at which other parties can discover and (with owner permission) reuse the resources
- DAFNI is home to **100s of models and data sets**
 - Created by academia
 - Used by policy makers and industry for applied research
- DAFNI is **free to use**
 - Providing an exploitation route to projects
 - Extending the life of research beyond initial funding



QUESTIONS?



Tom Kirkham
DAFNI Science Lead



Kyle Stevenson
DAFNI User Liaison Lead



**Coast-R
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Thank you for joining us

Have you joined the Network?

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