

DAFN

DAFNI: a computational platform to support infrastructure systems research.

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



www.dafni.ac.uk



Science and Technology Facilities Council







Why DAFNI?

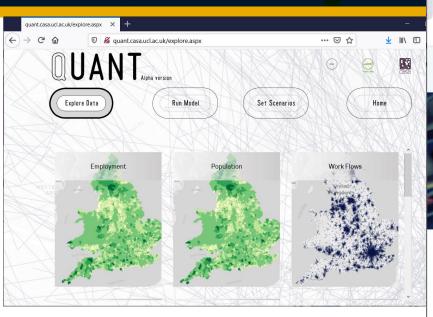
www.dafni.ac.uk

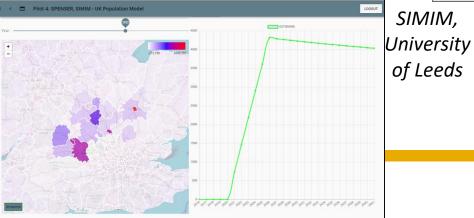


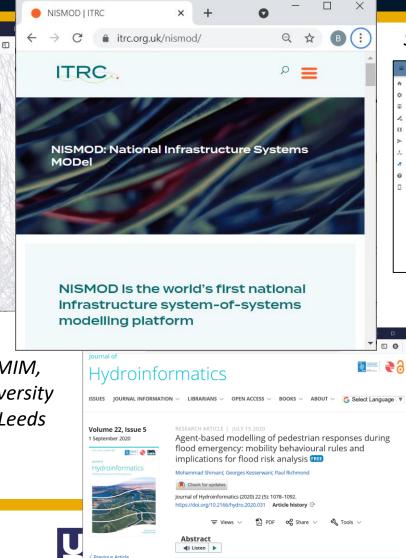
Science and Technology Facilities Council









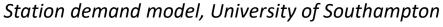


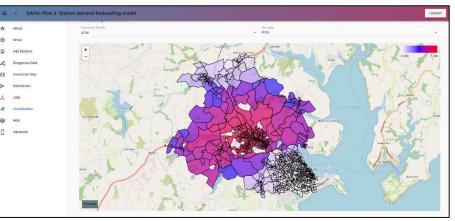
Next Article > Article Contents

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







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

Increasing flood risk

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



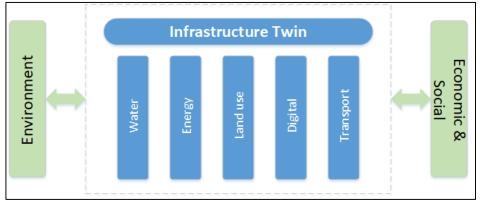
Kesearen counen

DAFNI Technical Challenges of Infrastructure Research

- Scaling up
 - More data, Higher resolution
 - Performant computing hard to access
- 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 sectors



Science and Technology Facilities Council





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



Science and Technology Facilities Council



Engineering and Physical Sciences Research Council

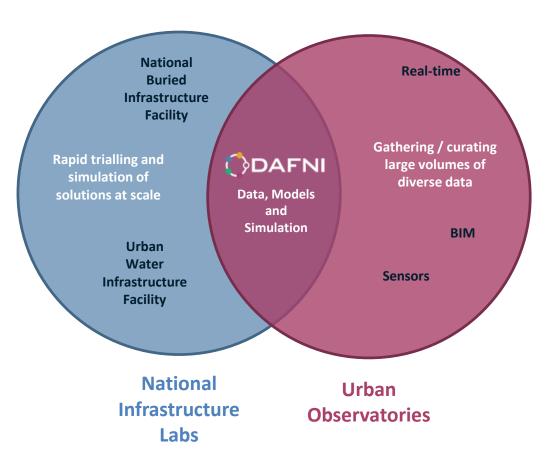


Data and Analytics Facilities for National Infrastructure

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

Towards Partnerships between Academia, Government, Industry



www.dafni.ac.uk



Science and Technology Facilities Council



Engineering and Physical Sciences Research Council



UKCRIC

The DAFNI Partnership



Prof. Jim Hall Uni. of Oxford



Prof. Stephen Hallett Di Cranfield Uni.



Dr. Theo Tryfonas Uni. of Bristol.



Dr. Nik Lomax Uni. of Leeds



Prof. Liz Varga UCL

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











Prof. Nigel Cassidy Uni. of Birmingham

Dr. Aruna Sivakumar Imperial College

Prof. Daniel Coca Uni. of Sheffield

Dr. Peter Oliver STFC









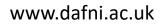
Dr. Simon Blainey Uni. of Southampton

Dr. Luke Smith P Uni. of Newcastle

Prof. Mike Batty Dr. I UCL Un

Dr. Ruchi Choudhary Uni. of Cambridge

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





Science and Technology Facilities Council







The DAFNI Platform

www.dafni.ac.uk

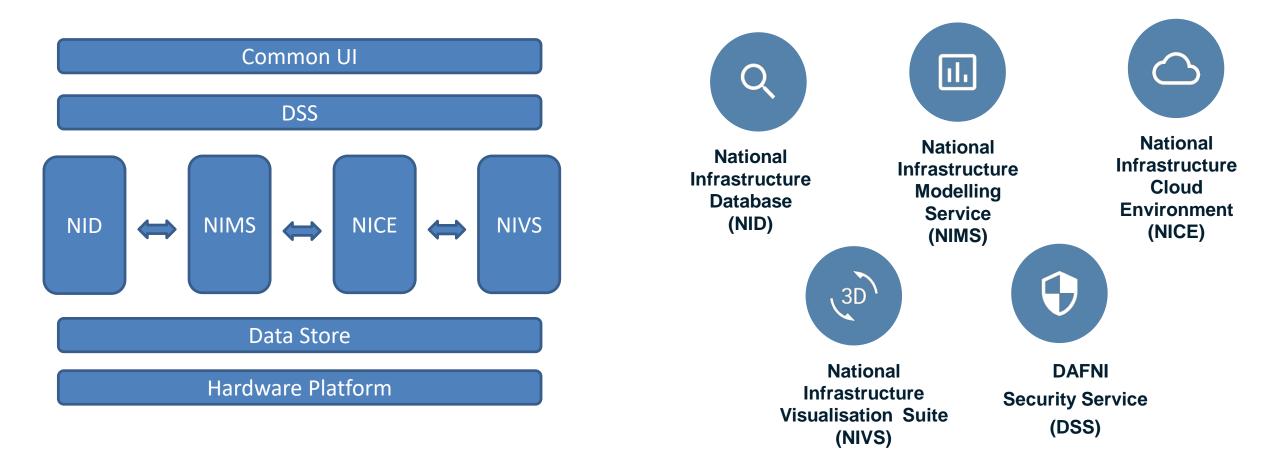


Science and Technology Facilities Council





DAFNI Components



www.dafni.ac.uk



Science and Technology Facilities Council





			DAFNI Facility	- 🗆 ×										
←	→ C 🗇 https:	://facility.secure.dafni.rl.ac.uk/data/	Q (2)	¢ @ 🔹 …					🔘 DAFNI Fac					×
		··· · ·	· · · ·	0 ¢ ^	~		s://facility.secure.dafni.rl	.ac.uk/data/details?dataset_id=29c6b94	4d-5c07-4627-9c4d	-315502da0613&ve	rsion_id=49fa1d68-bef1-4	165f-8908-fc304c4 ල	-	
					ø								0	ث
<u> </u>	MENU	Home / Data Catalogue	_		0	MENU	н	iome / Data / Complete July 2019, Variable: Real	Power +kW, UKCRIC UO					
+	↑ Home	Data Catalogue	Add deta		+	🔒 Home		Complete July 2019, Var	iable: Real F	ower +kW, l	JKCRIC UO			
	≔ Data	Date range	Q. Search Data Catalogue			😑 Data		ubject: Utilities / Communication Version: August 14						
	<> Models	Date range	a ocure para carangae			<> Models		Details				Open Access		
	🛹 Workflows	From	338 datasets found Sort by Recent V			≁ Workflows		Created: July 1st 2019				Accessed as part of the Public gr	up.	- 1
	MANAGE ASSETS		UDM - Arc Outline GeoPackage					Creator: Newcastle University Contact: Urban Observatory at Newcastle University				Licence information	ais	
		To				MANAGE ASSETS		Description				Dataset ID		
		Include data without dates	Publisher: DAFNI From: N/A To: N/A			O Public		Complete July 2019, Variable: Real Power +kW, UKCR	RC Urban Observatory, New	castle		29c6b94d-5c07·4627·9c4d- 315502da0613	ē	
	Sroups	Source	Arc outline GeoPackage file needed to run the UDM Visualisation Model.			🚉 Groups		Identifier: 29c6b94d-5c07-4627-9c4d-315502da0613 Location: Newcastle upon Tyne	1:49fa1d68-bef1-465f-8908	fc304c4dfd7d:f40642b4-fe	627-423c-96b1-478932fc6209	Dataset Version ID 49fa1d68-bef1-465f-8908-	6	
		Source	Outputs of the 5G model.					Start date: July 1st 2019 End date: August 1st 2019				fc304c4dfd7d	-u	
		Office for National Statistics (304) Newcastle University (28)						National	- MANA			Copy YAML for Model Def	nition	- 1
		DAFNI Workflows (2)	e CSV Publisher: DAFNI Workflows From: N/A To: N/A					- And the	The later					- 1
		Office of Rall and Road (2) Companies House (1)	The outputs from the 5G model with the following inputs: name value BASE_YEAR 2016 END_YEAR 2030 POPULATION_SCENARIO					m / 35 /	Morpeth					
		DAFNI (1)	low THROUGHPUT_SCENARIO low INTERVENTION_STRATEGY small_cell_and_spectru					Part of the	Cramiter	aton	\backslash			
								A BAR	Newcas	Whitey Bly Tynemouth tie				
		Subject	Example CityCAT output					Bramoton	Prudhoe upon Ti	me Sundarius				
		Society (304)	• ZIP • CSV • Text					A CONTRACT	Consett Stanley	Houghton				
		Climatology / Meteorology / (16) Atmosphere	Publisher: DAFNI Workflows From: N/A To: N/A Generated using the DAFNI CityCAT v5 model					Aston	Dur					- 1
		Transportation (10) Oceans (2)	Generated using the UAPNI CityCAL VS model					North Pennines AONB	enhope Crijok Spenrym	A A Martinepool	Leafiet (@ OpenStreetMap, @ DAFNI			
		Utilities / Communication (2)	Welsh Language Skills (Detailed)					Data files			contraction of the second seco			
		Economy (1) Environment (1)						File name	File size	Format	Actions			
		Planning / Cadastre (1)	CSV Publisher: Office for National Statistics From: March 27th 2011 To: March 27th 2021					NUO_Real Power_+kW.csv	4.7 MB	CSV	•			
	©DAFNI 2.3.0	Structure (1)	QS207WA, Welsh Language Skills (Detailed)			© DAFNI 2.3.0		HUU_Real POWEL+KW.CSV	4.7 MD	CSV	¥			
				-						· ·				

www.dafni.ac.uk



Science and Technology Facilities Council



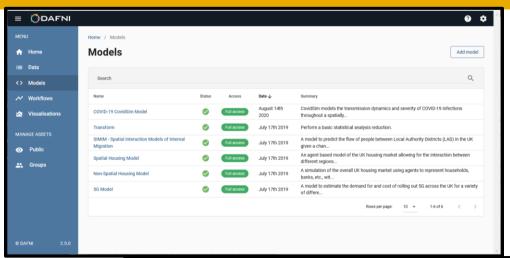
Engineering and Physical Sciences Research Council

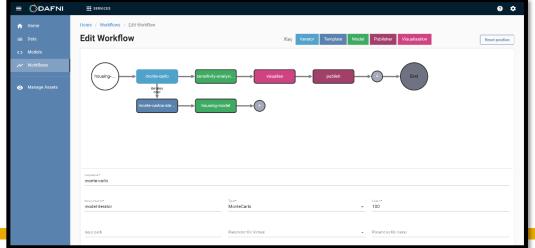


NID

NIMS: Supporting user models

- Upload models from anywhere into a model repository
 - Models "containerised" using Docker 0
 - Independent of code and operating systems 0
 - Sharing models 0
 - Within the same security framework 0
- Models can then be run on the HTC cluster
 - Kubernetes orchestration of containers 0
 - Scale up models for more compute 0
 - Access to data in the NID 0
 - Access to visualisations 0
- The NIMS allows workflows to be constructed
 - Coupling models together 0
- Key feature of providing an Infrastructure Ecosystem
 - Across different sectors 0
 - Across different scales Ο
- A repository of models and workflow
 - Sharing models 0
 - Within the same security framework 0





www.dafni.ac.uk



Science and Technology **Facilities Council**



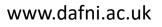


NIVS: Building Visualisations

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



sv – Unit	d_Kingdom_NoInt_R0=1.5.avNE.severity 👻 🛓	
Geometries	Add geometry V Plot	
Add layers to plot	440.000-	
<mark>l∼ Line</mark> ^{Color} #4682b4	380 000	
Columns	x Aesthetics	
Drag columns to an aesthetic	Map columns to visual properies 180.000-	
t	→ x t ■ ✓ 160.000- 140.000- 120.000-	
Mild_East_Midlands	↑ y Mild_London	
Mild_East_of_England	color Add 40.000 20.000	
Mild_London	Add new aesthetic • 0 0 50 100 150	200 250 300 350 400 450 500 550 500 650 700 750 t





Science and Technology Facilities Council







How is DAFNI being used?

www.dafni.ac.uk

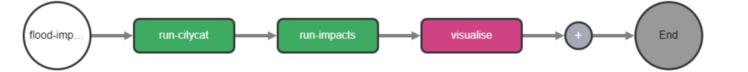


Science and Technology Facilities Council





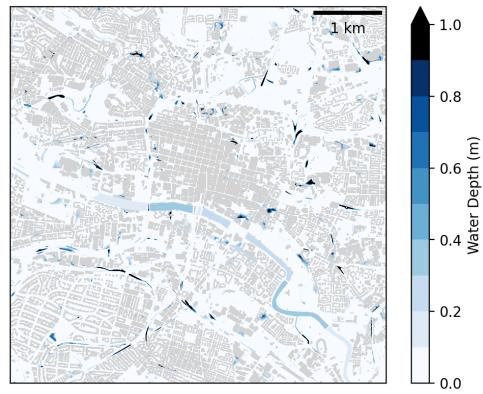
OpenCLIM



- 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
 - o 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

ΟΡΕΝ

MATE

P A C T

FRAMEWORK

www.dafni.ac.uk



Natural Environment Research Council

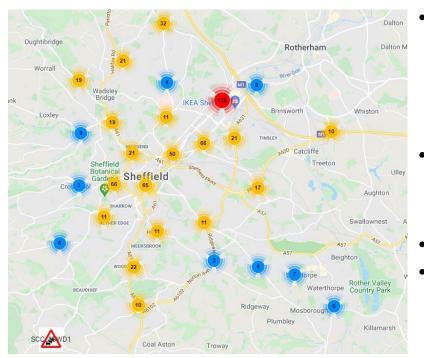


Science and Technology Facilities Council





Pilot study - Traffic Digital Twin in Sheffield DAFNI



Use cases:

- Traffic monitoring system that predicts congested areas ۲
- Real-time traffic flow optimization ۲

Science and Technology **Facilities Council**



Engineering and Physical Sciences Research Counci

Of

Sheffield.

Road

occupancy (%)



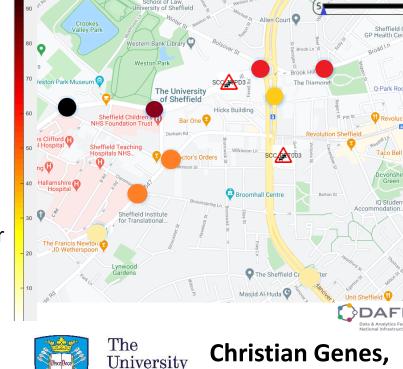


Update

Run)

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





What next for DAFNI?

www.dafni.ac.uk



Science and Technology Facilities Council





DAFNI-ROSE: Building a Community

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

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

www.dafni.ac.uk



Science and Technology Facilities Council





DAFN

Thank You

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



Science and Technology Facilities Council



Engineering and Physical Sciences Research Council



www.dafni.ac.uk



Science and Technology Facilities Council



