# DAFNI CONFERENCE 2024

## WORKING TOGETHER FOR RESILIENT INFRASTRUCTURE

ASTON UNIVERSITY . BIRMINGHAM . 10 SEPTEMBER 2024


DAFNI Data & Analytics Facility for National Infrastructure


# Join us at our 2024 roadshows

https://www.dafni.ac.uk/roadshow-series-2024/

- 16-17 September 2024
  DAFNI Roadshow Wales / Sioe Deithiol Cymru
  Swansea University / Prifysgol Abertawe

- 22-23 October 2024
  DAFNI Roadshow Scotland
  University of Glasgow

- 28-29 October 2024
  DAFNI Roadshow Ireland & Northern Ireland
  Queen's University Belfast

# Contents



Audience participation is welcomed throughout various points in the programme.

**Version date 3 September 2024**

# Welcome

Welcome to the DAFNI Conference 2024
I am pleased to welcome you all to this year's conference venue located in Aston University, a particularly apt venue as they have just joined UK Collaboratorium for Research in Infrastructure Cities (UKCRIC) and Aston is now part of the same UKCRIC theme as DAFNI: 'data driven solutions'.

I am particularly pleased to welcome our three keynote speakers, who have a great breadth of expertise across our key theme of resilient infrastructure, and the conference sub-themes. Martine Wauben, Head of Data for London and Helen Huemer-Markides, Infrastructure Data & Innovation Lead from the Greater London Authority are a great addition to the conference and will give an insight into how academics and industry can work together to inform policy. Asaad Faramarzi, Professor of Geotechnical Engineering and a DAFNI Strategy board member, will be giving a keynote talk on the University of Birmingham's campus digital twin (DT), which is a great demonstration of how the University are using data from the DT to inform key decisions linked to decarbonisation of heat and transport.

At last year's conference, we introduced our new work theme 'Building a Secure and Resilient World' (BSRW), which enabled us to showcase the fantastic research that had begun within the DAFNI community. We were able to demonstrate the DAFNI platform developments and roadmap priorities, and this year we are looking forward to giving you an update on our progress.

In our 2024 conference, we focus on our research priorities and projects. Our theme this year is 'Working Together for Resilient Infrastructure', specifically looking at modelling for resilient infrastructure, plus challenges and opportunities in data sharing, and the impact of digital twins.
With the DAFNI programme and community growing, I am pleased to introduce our agenda today, including three fantastic keynotes, 14 project speakers, an exhibition, DAFNI demonstrations, and an industry panel.

We will be highlighting our Centre of Excellence projects through a series of presentations, sharing progress on our eight BSRW projects as well as introducing six transport and energy projects. We have lots to catch up on this year, including our most recent funding from the Department of Science, Innovation and Technology, who funded our project 'DAFNI-Data Infrastructure for National Infrastructure', which is focused on the 'Challenges and Opportunities of Data Sharing' across Energy, Transport and Water.
I am pleased that we can give you all an update on progress and look forward to our inspiring data sharing industry panel later this afternoon.

I hope that you have an enjoyable and informative day.

Brian.

**Dr Brian Matthews leads the DAFNI programme at Rutherford Appleton Laboratory (RAL)**

Dr Brian Matthews has over 30 years of experience in R&D development in computing, with a focus on tools, methods and standards for managing accessing research data from scientific experiments.

He took a leading role in the development of the data management infrastructure that supports the ISIS Neutron and Diamond Light Sources, and has worked extensively on European programmes on data infrastructures.

He leads the DAFNI team, developing data and modelling infrastructure to support research into national infrastructure, and is Co-Investigator on projects extending its use including #OpenCLIM and the UK UK Centre for Greening Finance and Investment initiative.

He is Co-Investigator and Technical Lead on the Physical Sciences Data Infrastructure (PSDI) Service, one of EPSRC's National Research Facilities.

# DAFNI Strategy Board

**Professor Michael Batty**
University College London

**Professor Julien Harou**
University of Manchester

**Dr Simon Blainey**
University of Southampton

**Professor Phil James**
Newcastle University

**Dr Juan Bicarregui**
STFC

**Dr Nik Lomax**
University of Leeds

**Dr Ruchi Choudhary**
University of Cambridge

**Dr Giuliano Punzo**
University of Sheffield

**Professor Daniel Coca**
Newcastle University

**Professor Stephen Hallett**
University of Cranfield

**Dr Asaad Faramarzi**
University of Birmingham

**Professor Theo Tryfonas**
University of Bristol

**Professor Jim Hall**
Oxford University

**Professor Liz Varga**
University College London

# DAFNI Team

**Dr Brian Matthews**
DAFNI Programme Lead

**Sarah Byrne**
Software Engineer

**Katie Cartmell**
Delivery Manager

**Catherine Dhanjal**
Media Manager

**Rose Dickinson**
Senior Software Engineer / Technical Lead

**Akhil Dubakunta**
Software Engineer

**Caroline Haigh**
Research Software Engineer

**Lyndsey Harding**
Administrator

**Jack Haydock**
Software Developer

**Dr Jens Jensen**
Data Scientist

**Dr Server Kasap**
DevOps Engineer

**Aaron Larkins**
Scientific Computing Graduate

**Archit Mantry**
Project Co-Ordinator

**Elizabeth Mamtsits**
Research Software Engineer

**Dr Bethan Perkins**
DAFNI Team Lead

**Letizia Protopapa**
Research Software Engineer

**Marion Samler**
Business Development Manager

**Lewis Sampson**
Research Software Engineer

**Kyle Stevenson**
User Liaison

**Esther Turner**
Senior Research Software Engineer / User Liaison

# Conference Programme

# Morning Programme

**Chair:** **Tom Kirkham, DAFNI science lead**

**09:00** — **Arrival and breakfast networking**

**09:20** — **Welcome and housekeeping**

**09:30** — **Keynote presentation from the Greater London Authority**
Martine Wauben, Head of Data for London, and Helen Huemer-Markides, Infrastructure Data & Innovation Lead

**10:10** — **DAFNI – technical update**

**10:45** — **Break, demos, networking**

**11:15** — **Project updates**

## Room 1

| | |
|---|---|
| **STORMS** | Dr Xilin Xia, University of Birmingham |
| **D-RES** | Dr Desen Kirli, University of Edinburgh |
| **FIRM** | Professor Richard Dawson, Newcastle University |
| **Clima Tracks** | Dr Giuliano Punzo, University of Sheffield |

## Room 2

| | |
|---|---|
| **SCQUAIR** | Dr Richard Milton, UCL |
| **SOFRAMODE** | Dr Vassilis Glenis, Newcastle University |
| **BRINES** | Dr Hannah Bloomfield, Newcastle University |
| **Pywr-WREW** | Dr Anna Murgatroyd, Newcastle University |

**12:20** — **Networking lunch**

# Afternoon Programme

**Chair:** **Professor Theo Tryfonas, School of Civil, Aerospace and Design Engineering at the University of Bristol**

**13:20** **Exhibition/demos/posters**

**13:50** **Keynote - University of Birmingham's Digital Twin**
Professor Asaad Faramarzi, Professor of Geotechnical Engineering, University of Birmingham

**14:30** **Industry panel discussion**

**15:20** **Break, demos, networking**

**15:50** **Project updates**

## Room 1

| | |
|---|---|
| **RIWS** | Dr Ana Mijic, Imperial College London |
| **ForNet** | Professor Konstantinos Nikolopoulos, Durham University |
| **NIRD** | Dr Raghav Pant, University of Oxford |

## Room 2

| | |
|---|---|
| **USARIS** | Saskia Salwey, University of Bristol |
| **IMPACT** | Dr Qiuchen Lu, UCL |
| **MARS** | Dr Fabian Steinmann, Cranfield University |

**16:40** **Conference closing remarks from Dr Brian Matthews**

**16:45** **Conference close**

# Keynote Speakers

## Martine Wauben

Head of Data for London at the Greater London Authority

Martine Wauben is Head of Data for London at the Greater London Authority, realising the Mayor of London's vision to make it simpler for people to share and use data held across London to improve the city and benefit Londoners.

Previously, she was a government data scientist and statistician at Number 10 Downing Street, the Department for Health and Social Care, and the Ministry of Justice, and has done work internationally in Rwanda and Nepal. She also seeks out opportunities for collaboration and sharing of best practice across Europe and globally.

## Helen Huemer-Markides

Infrastructure Data & Innovation lead at the Greater London Authority

Helen is Infrastructure Data & Innovation lead at the Greater London Authority (GLA). In her role she engages with local authorities and across the infrastructure sector (including telcos, gas, water, power, and transport providers), to use geospatial data and digital tools to meet common outcomes and drive collaborative working for London's infrastructure. Projects include leading the Infrastructure Mapping Application (IMA) and delivering the National Underground Asset Register (NUAR) in London. Prior to the GLA, she worked across central government and consultancy, always focused on using data and digital solutions to improve outcomes for people and places.

## Digital Twin for University of Birmingham

## Professor Asaad Faramarzi

Professor of Geotechnical Engineering
at the University of Birmingham.

Professor Asaad Faramarzi is a professor of civil and geotechnical engineering and Head of the Civil Engineering Department at the University of Birmingham. He completed his PhD in computational mechanics in 2011 at the University of Exeter followed by a 2-year postdoctoral research fellow before joining Birmingham in 2014. He has over 15-year experience in leading several research projects in the field of computational mechanics and numerical modelling applied to civil and geotechnical infrastructure problems. His other research interests include developing numerical procedures to infer data from novel sensing technologies for locating and condition assessment of underground features.

# Invited Speakers

## CHAIR
## Tom Kirkham
Science Lead - DAFNI

My background is in distributed computing having worked in academic and industry roles since completing my PhD in 2008. My interests are in widening access to advanced computing infrastructure with an interest in data and model security, standardisation and reuse.

I have recently joined the DAFNI team rejoining STFC from Innovate UK where I was the Innovation Lead for Future Telecoms working with Industry and academia to deliver a 70m GBP UKRI investment funded by DSIT. I am keen to use my skills and experience to support the current and future development of the DAFNI community.

## CHAIR
## Professor Theo Tryfonas
School of Civil, Aerospace and Design Engineering at the University of Bristol

Theo Tryfonas is Professor of Infrastructure Systems and Urban Innovation with the School of Civil, Aerospace and Design Engineering at the University of Bristol. He is broadly interested in Urban Data, IoT applications for infrastructure and Digital Twins. He led the delivery of UKCRIC's Bristol Urban Observatory and sits on the Strategy Board of DAFNI. He is currently leading Bristol's contribution to several large H2020 and Horizon Europe grants including projects TwinERGY (957736), TwinAIR (101057779) and ELABORATOR (101103772).
He recently served as a member of DSIT's Secure Connected Places EAG and now sits on BSI's Technical Committee SDS/2 (Smart and Sustainable Cities and Communities). He is also on the editorial boards of Ad Hoc Networks and IET Smart Cities journals.


## Data Security Architect for DAFNI

## Dr Jens Jensen

DAFNI, Rutherford Appleton Laboratory, Harwell, Oxford

Dr Jens Jensen is a mad scientist in STFC's Scientific Computing Department and acting leader of DAFNI. His research interests include managing hundreds of petabytes of data to enable global scientific collaborations, architecting data security for research, and defining best practices for trustworthy identity management and scalable authorisation to enable researchers to collaboratively share and analyse this data. He manages and/or contributes to projects that range in scale from IoT to international research infrastructures. With a background in mathematics, he also likes to promote scientific software engineering and mathematical methods for data analysis and statistics.

# Industry Panellists

## Caro Ames

Data Science Strategy Leader at
**Arup**

Caro is Arup's Data Science Strategy Leader. She is passionate about the use of data and AI to solve critical infrastructure challenges and has experience spanning the delivery of data and ai strategies, products, and capability building programs for organisations across the built and natural environments. As part of her role, Caro is a member of the core team that has been critical in enabling the energy sector's data sharing infrastructure through the Digital Spine Feasibility Study (DESNEZ), and ESO's VirtualEnergySystem program.

Previously, Caro was the delivery lead for the built environment practice at Faculty, a leading applied AI company. She holds a MEng from the University of Oxford specialising in energy systems modelling.

## Ben Fitzsimons

Technical Director
**Water Resources East**

Ben is the Technical Director at Water Resources East (WRE), overseeing and steering the technical work programme associated with the development of the regional water resources plan. Ben joined WRE in 2021 and is committed to helping to develop a multi-sector, integrated water management approach with WRE's members and partners across the East of England.

## Holger Kessler

Senior Stakeholder Manager, Assets & Technology - Infrastructure UK & Ireland at
**AtkinsRéalis**

Holger is an experienced professional with over 25 years of working in geoscience, environment and infrastructure. He has a strong background in research and government programs, emphasising collaboration, digital transformation and data sharing. Notably, he contributed to the National Underground Asset Register at the Geospatial Commission. His expertise spans project management, team leadership, policy development and strategic stakeholder engagement, both in the UK and internationally.

As a trained geographer, soil scientist, and chartered geologist, Holger is known for his dynamic approach to forming inclusive teams and communities focused on innovation and change. He advocates for the use of geospatial data and digital transformation to address societal issues and the effects of climate change. Holger's career includes significant time at the British Geological Survey and a leadership role in The Future of the Subsurface Foresight Project at the Government Office for Science before moving to AtkinsRealis in 2024.

## Yiu-Shing Pang

Open Data Manager at
**UK Power Networks**

Yiu-Shing Pang manages the Open Data programme at UK Power Networks " the electricity distribution system operator for London and the south-east of England. He chairs the Energy Networks Association's Open Data working group, driving best practice and standardisation across the energy sector. Previously, Yiu-Shing worked in UK Power Networks' strategy and regulatory affairs, and prior to that, he trained as a patent attorney in London. Yiu-Shing holds a MSci in Physics from University College London, and a PGCert in Intellectual Property Law from Queen Mary University of London.

## Olly Tones

Head of Data Sharing and Technology at
**Department for Science, Innovation and Technology (DSIT)**

Olly Tones is Head of Data Sharing and Technology in the Department for Science, Innovation and Technology, where he is responsible for policy areas covering Public Sector Asset Management, Researcher access to data and Interoperability. A civil servant with nearly two decades experience, his focus has always been on improving public services whether through Digital Trade, Frontier Technologies, Justice Services, or Data Access policy. He has a keen interest in ensuring public services deliver efficiently and effectively for citizens and this zeal is now focused on leading teams who are developing UK policy that improves public sector data access for the benefit of the economy and wider society, harnessing the opportunities and tackling the challenges which increased data access can bring to science, innovation and the UK.

## Martine Wauben

Head of Data for London at the
**Greater London Authority**

Martine Wauben is Head of Data for London at the Greater London Authority, realising the Mayor of London's vision to make it simpler for people to share and use data held across London to improve the city and benefit Londoners.

Previously, she was a government data scientist and statistician at Number 10 Downing Street, the Department for Health and Social Care, and the Ministry of Justice, and has done work internationally in Rwanda and Nepal. She also seeks out opportunities for collaboration and sharing of best practice across Europe and globally.

# Project Speakers

## BRINES

**Dr Hannah Bloomfield** is a Newcastle Academic Track fellow in climate resilient energy systems. She gained her PhD in 2017 and has since worked on climate services projects in the energy, transport and finance sectors, and held a science engagement fellowship with the Royal Meteorological Society. Hannah specialises in modelling UK and European electricity demand and renewable generation, as well as developing tools for Mexico, India and African regions. Her work improves the accessibility of large meteorological datasets to energy system modellers and policy makers.

## ClimaTracks

**Dr Giuliano Punzo** obtained an MEng in Aerospace Engineering at the University of Naples before getting his PhD in swarm engineering at the University of Strathclyde, Glasgow. With a core focus on distributed systems, Giuliano moved from aerospace to infrastructure and socio-technical systems, using modelling techniques in the areas of network science, control theory and game theory. Dr Punzo is a Lecturer at the University of Sheffield, director of the Sheffield Urban Flows Observatory, where he also leads the transport theme, and member of the DAFNI Strategy Board.

## D-RES

**Dr Desen Kirli** is a sustainable energy engineer and an Elizabeth Georgeson Research Fellow in "Data and Digitalisation for Net Zero" at the University of Edinburgh. She aims to bridge the gap between academic research and implementation in the industry for accelerated decarbonisation of energy systems. She researches the use of data-driven and digital smart grid solutions including digital twin modelling, smart contracting, and AI. Her industry-relevant research on smart local energy systems and operation of energy storage systems is used in Scottish and UK pilot sites.

## FIRM

**Professor Richard Dawson** is Professor of Earth Systems Engineering and Director of Research & Innovation in the School of Engineering at Newcastle University. Richard's research focuses on infrastructure resilience to extreme weather and climate change. He is a member of the UK's Committee on Climate Change, Lead Author of the Cities, Settlements and Infrastructure Chapter of the Intergovernmental Panel on Climate Change 6th Assessment Report, and a Fellow of the Royal Academy of Engineering and of the Institution of Civil Engineers.

## ForNet

**Professor Konstantinos (Kostas) Nikolopoulos** is the Professor and Chair in Business Information Systems and Analytics at Durham University Business School and Management Board Member in the Institute of Hazard, Risk and Resilience. His research interests are Forecasting, Analytics, Information Systems, and Operations. He founded and directed the forecasting laboratory (forLAB) at Prifysgol Bangor University in Wales where he was Professor of Business Analytics/Decision Sciences at Bangor University for a full decade, and Associate Dean for Research & Impact for the College of Business, Law, Education, and Social Sciences.

## IMPACT

**Dr. Qiuchen Lu** is an associate professor in Digital Built Asset and Facility Management at The Bartlett School of Sustainable Construction, University College London. Her research is at the forefront of digital twins for improved built environment resilience to address climate challenges whilst promoting social equity, including the multi-layer digital twins in the built environment (creating digital twins and exploring new values of digital twins from assets, buildings to cities levels). She leads projects within the field of informatics for Smart, Sustainable and reSilient (3S) built environments.

## MARS

**Dr Fabian Steinmann** is a Lecturer in Organisational Resilience and Change at the Cranfield School of Management. Fabian holds a degree in Aerospace Engineering from the University of Stuttgart (Germany), and completed his PhD in Air Transportation Resilience at the Safety and Accident Investigation Centre of Cranfield University where he developed a novel framework encompassing both proactive and reactive elements of resilience in air transportation. Currently, Fabian's research centres on organisational and network resilience and change, primarily within the aviation and maritime industry.

## NIRD

**Dr. Raghav Pant, PhD**, is a Senior Research Associate at the Environmental Change Institute, University of Oxford. Raghav works with the Oxford Programme for Sustainable Infrastructure Systems (OPSIS), and has led risk and resilience analysis research teams as part of the EPSRC-funded Infrastructure Transitions Research Consortium. His analysis of failure criticality of Great Britain's national infrastructure networks, undertaken in collaboration with Infrastructure UK in HM Treasury was instrumental in moving the policy thinking from silo-sectored to a multi-sector and cross-sector one. He led the first evidence-based systems analysis of interdependent network vulnerabilities of UK's interconnected networks to support the National Infrastructure Commission's recommendations of a new resilience framework in UK.

## Pywr-WREW

**Dr Anna Murgatroyd** is a Lecturer in Hydrology at Newcastle University, working in the Environment Agency/Ofwat National System Simulation Modelling project, the GCRF Water Security and Sustainable Development Hub, and the Food and Climate systems Transformations Alliance. Anna pioneers risk-based approaches to defining and managing water security in the UK, exploring key trade-offs between competing goals of water resource systems like ecosystem resilience and public water supply reliability. Anna led the technical development of new climate simulations and the Water Resources model for England and Wales (WREW) for the NSSM project, and works with the EA exploring the impact of climate change on water resources.

## RIWS

**Dr Ana Mijic** is a Reader in Water Systems Integration and Director of the Centre for Systems Engineering and Innovation at Imperial College London. Her research focuses on advanced systems modelling and water systems analysis. She leads the development of novel simulation tools focused on quantifying interactions between the water cycle and sustainable development, to inform policy, regulatory bodies, and the water industry. Prominent areas of research include developing frameworks for a systems approach to catchment and urban water management, including applications to irrigation water use in India, Blue-Green infrastructure and water infrastructure planning under deep uncertainty and urban water-energy nexus.

## SCQUAIR

**Dr Richard Milton** is a senior researcher at UCL's Bartlett Centre for Advanced Spatial Analysis. On secondment to the Alan Turing Institute for AI and Data Science, Richard developed the current evolution of the "QUANT" spatial interaction model with an emphasis on AI for building new transport infrastructure scenarios for carbon net zero. He worked on different versions of the QUANT spatial interaction model, initially funded by Future Cities Catapult in 2014. His QUANT expertise underpins the Royal Society's pandemic response project (RAMP), gaining a RAMP Early Career Investigator Award in 2021.

## SOFRAMODE

**Dr Vassilis Glenis** is Senior Lecturer in Hydroinformatics in the School of Engineering at Newcastle University. In his research in hydrodynamic modelling, he has developed advanced shock-capturing finite volume methods and applied them using cloud computing. Originator and main developer of the CityCAT hydrodynamic simulation software, Vassilis has focussed on flood modelling in urban environments, coupling the surface and pipe networks and incorporating blue-green interventions. He has also developed and applied stochastic weather generators for climate change impact assessments, notably for the UKCP09 national climate projections.

## STORMS

**Dr Xilin Xia** is an Assistant Professor in Resilience Engineering within the School of Engineering at the University of Birmingham. His research focuses on computational modelling of natural hazards, such as floods, landslides and debris/mud flows, and their impacts. He has developed numerical methods and open-source code that have been used worldwide. He is also leading projects to develop national-scale risk assessment and forecasting tools for extreme weather impacts in the UK and India. He is a Turing Fellow and a recipient of 2024 Prince Sultan bin Abdulaziz International Prize for Water.

## USARIS

**Saskia Salwey** is a research associate at the University of Bristol in the School of Civil, Aerospace and Design Engineering. She is currently working on the DAFNI-USARIS project which aims to integrate uncertainty quantification and sensitivity analysis (UQ&SA) into the DAFNI platform via two model applications presented as DAFNI workflows. This work aims to promote best practises for responsible modelling and robust decision-making under uncertainty. Outside of this project Saskia's background is in computational hydrology where her previous research has mainly focused on understanding and modelling the impacts of reservoirs on national-scale hydrology across Great Britain.

# Project Summaries

## Room 1 (11:15-12:20)

# STORMS

**STORMS: Strategies and Tools for Resilience of Buried Infrastructure to Meteorological Shocks**

Principal Investigator: Dr Xilin Xia, Assistant Professor in Resilience Engineering, University of Birmingham
Co-Investigator: Professor Nicole Metje, University of Birmingham
Co-I: Professor David Hannah, University of Birmingham
Co-I: Dr Asaad Faramarzi, University of Birmingham
Co-I: Dr Soroosh Sharifi, University of Birmingham
Postdoctoral Research Fellow, Dr Nikolas Reppas, University of Birmingham
Co-I, Dr Steven Cole, UK Centre of Ecology and Hydrology
Co-I, Mr Robert Moore, UK Centre of Ecology and Hydrology
Co-I, Dr Adam Griffin, UK Centre of Ecology and Hydrology
Co-I, Dr Alison Kay, UK Centre of Ecology and Hydrology
Co-I, Dr Andrew Hughes, British Geological Survey

Buried infrastructure systems are vulnerable to meteorological shocks or extreme weather events, such as floods and droughts due to extreme precipitation, as well as extreme temperatures. Such events can lead to soil movement, thermal contraction and expansion, and sinkholes, among other problems. Despite the urgency, our society is not well prepared for the impacts of these shocks on buried infrastructure. Our understanding of where the risk is and how much it is remains poor, because existing risk assessment tools do not comprehensively consider impacts from both flood water and subsurface moisture/temperature variations. The extent to which the UK's buried infrastructure can cope with a significant weather event, or 'shock', is unclear. Such understanding is crucial for developing effective resilience strategies. This project aims to develop a comprehensive weather-related risk assessment framework for buried infrastructure, which include cables and pipes vital to cities and urban lives.

The project is expected to deliver significant societal and economic impacts. By enhancing decision-making capabilities among infrastructure operators and utility companies, the research can lead to fewer service disruptions, potential cost savings, and increased resilience of infrastructure systems in the face of meteorological shocks and climate change.

# D-RES

**D-RES: Provision of distributed grid resilience using EV's during extreme weather events**

Principal Investigator: Dr Desen Kirli, Elizabeth Georgeson Research Fellow, University of Edinburgh
Co-Investigator: Dr Laiz Souto, University of Bristol

Project D-RES, with a focus on digital twin modelling, aims to ensure optimal use of existing assets, leveraging their flexibility to ensure energy security and inter-operability as volume of renewables increase.

Existing research shows the value of flexibility, however, the potential of smaller distributed assets is often overlooked. There are millions of flexible end-user assets that can help increase energy security and avoid procurement of expensive balancing actions by the National Grid. This would help with grid stability and energy costs.

One barrier in this field is the access to and handling of vast amounts of data from different assets. This project will overcome this limitation by using data from ongoing EPSRC Projects and data provided on the DAFNI platform. In terms of handling the large datasets and ensuring interoperability of energy system assets, the DAFNI network and the sandpit team's expertise in energy data and energy system modelling will devise solutions to these and publish these openly For the DAFNI stakeholders and beyond.

The main objective is to simulate the impact of distributed flexibility on energy security and resilience. It will focus on optimisation of EV smart charging and Vehicle-to-Grid services from EVs in response to storm events.

# FIRM

**FIRM: Flood resilience simulation on DAFNI**

Principal Investigator: Professor Richard Dawson, Professor of Earth System Engineering and Director of Research in the School of Engineering, Newcastle University

Actions taken before, during and after the shock of flood infrastructure failure can lead to radically different outcomes. Poor warnings, slow evacuation, or failure to erect temporary flood defence infrastructure all reduce resilience, increase damages and threaten lives.

The Flood Infrastructure Resilience Model (FIRM) is a coupled agent-based and hydrodynamic flood model built on a geospatial data architecture that is used to explore the impact of the flood infrastructure failure on flood resilience, and to test strategies to mitigate the impact of these shocks.

FIRM integrates remotely sensed information on topography, buildings and road networks with empirical survey data to fit characteristics of specific communities. Simulation of individuals has been coupled with a hydrodynamic model to assess their response and their resilience in the event of flooding. The aim of this project is to re-code FIRM into Python for greater inter-operability, integrate FIRM onto DAFNI to make it more accessible to the community, to enhance FIRM by adding new functionality to test a wider set of flood resilience actions, and to provide virtual and in-person training to support the wider uptake of the model and DAFNI.

# ClimaTracks

**ClimaTracks: Forecasting resilience of railway networks under propagating uncertainty**

Principal Investigator: Dr Giuliano Punzo, Lecturer, University of Sheffield & Director of the Sheffield Urban Flows Observatory

Co-Principal Investigator: Ji-Eun Byun University of Glasgow

Co-Investigator: Tohid Erfani University College London

Co-I: Iryna Yevseyeva De Montfort University

Co-I: Konstantinos Nikolopoulos Durham University

Researcher Co-I:Qian Fu University of Birmingham

ClimaTracks aims to compute risks of weather-related disruptions and asset failures in a railway network. To properly take into account the inevitable effects of uncertainty in railway services, the project focuses on occurrence of uncertainty from weather conditions and asset failures and propagation of uncertainty through interdependent components in a network. To this end, this project will collate relevant datasets, develop a computational model to perform probabilistic analysis on network performance, and make those outcomes available to the public using DAFNI platform. The project's objectives are summarised in the following:

1. To identify and collate available datasets for forecasting weather-related disruptions. This project will harness FAIR-guided data collaboration to enhance infrastructure resilience against climate variability, focusing on developing reliable and adaptable transport networks through the strategic integration of diverse data sources.

2. To formulate a set of informative decision metrics (with potentially conflicting objectives) for operators and users, which provide comprehensive information on disruption risks and help them to make decisions on route selection.

3. To create a model and its software implementation to map the uncertainty about weather and asset-specific robustness to the uncertainty about loss of services between given Origins and Destinations in the railway network.

# Project Summaries

## Room 2 (11:15-12:20)

# SCQUAIR

**SCQUAIR: Simulating the Resilience of Transport Infrastructures using QUANT**

Principal Investigator: Dr Richard Milton, Senior Researcher, Centre for Advanced Spatial Analysis, UCL

Co-Investigator: Professor Michael Batty, UCL

We have developed a model that simulates the pattern of land use and transportation for Great Britain which is configured in terms of thousands of small zones and three modes of transport which bind together employment at place of work and population at place of residence. The model is called QUANT and runs very rapidly in a web-based environment. It is optimised to deliver results to the user in a matter of minutes so that users can derive and test future scenarios for land use and transport, on-the-fly so-to-speak.

We will adapt the 'what-if' scenario capability of QUANT to the DAFNI platform so that users can run thousands of scenarios whose data can be used to train various optimisation models that show how future plans for the location of land uses and transport can be massively improved. We will demonstrate how models such as these can be used effectively to predict the impacts of such scenarios and generate the impacts of shocks to the land use transport system such as those posed by new infrastructure projects such as HS2 which are continually being evolved.

# SOFRAMODE

**SOFRAMODE: Sewer Overflow Flood Risk Analysis MOdel DAFNI Enabled**

Principal Investigator: Dr Vassilis Glenis, Newcastle University

Co-Investigator: Dr Claire Walsh, Newcastle University

Co-I: Professor Chris Kilsby, Newcastle University

SOFRAMODE aims to develop and demonstrate a state-of-the-art platform on DAFNI to understandand simulate urban drainage related to surface water flooding and high-profile storm overflow events, for any UK town or city.

Scenarios will encompass current and future rainfall event magnitudes, and provide functionality for consultants and industry, as well as researchers, to design and test a range of strategies to mitigate Storm Overflow spills and surface water flooding. The platform will be underpinned by the CityCat model. We will make the model more widely available and useful to non-academic and non-expert users through addressing:

1. Extend functionality of the existing workflow on DAFNI to allow users to assess the effectiveness of blue-green mitigation features.

2. Optimise BGI (Blue Green Infrastructure) design using a Genetic Algorithm tool to optimise the location of BGI to allow more users, including communities and local authorities, to rapidly assess flood and Storm Overflow risk and test a range of scenario-based affordable management portfolios.

3. Develop a tool to better visualise and use the (surface and pipe) drainage network for model set up and analysis of results.

4. Resilience scenarios framework: develop a methodology to flexibly explore a wide range of rainfall events and design constraints

# BRINES

**BRINES: Building Risk-Informed redundancy Net-zero Energy Systems**

Principal Investigator: Hannah Bloomfield, Newcastle University School of Engineering

Co-Investigator: Ji-Eun Byun, University of Glasgow Infrastructure & Environment

Co-Investigator: Sean Wilkinson, Newcastle University School of Engineering

Colin Manning, Newcastle University School of Engineering

BRINES will explore the use of weather and climate data to highlight future resilience challenges to the UK power network from both an operational perspective (maintaining the balance of supply and demand) and from an asset management perspective (making sure assets are not damaged by extreme weather). The project identifies two primary challenges, higher variability from increasing weather-dependence and compounded consequences owing to weather-dependency of both demand and supply.

To address the challenges, the project will harness the collated meteorological data for probabilistic modelling. Thereby, the project will assess optimal design of system redundancy (i.e. construction of generation assets more than required to be armoured against high consequence events) from a risk-based perspective. Detailed objectives include:

- Prepare existing hourly timeseries of demand, wind, and solar power generation from historical observations and the UKCP18 climate model for use and visualisation on the DAFNI platform.
- Prepare existing timeseries of weather variables that can be used as proxies for asset damage
- Assess the 'most challenging periods' from a system resilience perspective from a combined operations and asset management perspective.
- Develop a risk assessment tool of national energy system on the DAFNI platform

# Pywr-WREW

**Pywr-WREW: Water Resources model for England and Wales built in Python water resources simulation system**

Principal Investigator: Anna Murgatroyd, Lecturer in Hydrology, School of Engineering, Newcastle University

Co-Investigator: Professor Jim Hall, University of Oxford

There is increasing concern about the resilience of England's water supplies, because of the effects of population growth, climate change and the need to ensure enough water for natural ecosystems. The 2014 Water Act introduced a duty "to secure the long-term resilience of water supply systems". There is evidence of the increasing pressures on water supplies, and a case for a new framework for management of water resources, taking a largescale systems perspective. It is no longer tenable to just manage water resources at a company scale and response will require large-scale infrastructure and policy interventions.

Pywr-WREW will re-build the national Water Resources model for England and Wales (WREW) using the open-source generic dynamic python library Pywr. This will enable the model to be widely used by researchers and practitioners. Development of this will build on recent and ongoing research by the University of Oxford as part of the National System Simulation Modelling (NSSM) project. Hosting the Pywr-WREW simulation model on the DAFNI Platform will allow us to collaborate with our partners (e.g., the EA and water industry stakeholders) much more easily to conduct model runs and explore results together. In addition, DAFNI's state of the art computational infrastructure will improve the efficiency of our model and analysis considerably.

# Project Summaries

## Room 1 (15:50-16:40)

## RIWS

**RIWS: Resilience scenarios for integrated water systems**

Principal Investigator: Dr Ana Mijic, Reader in Water Systems Integration and Director of the Centre for Systems Engineering and Innovation, Imperial College London

The resilience of water systems in the context of climate change, weather extremes, planning and operational decisions is crucial for water infrastructure service delivery and environmental management.

There is a need to develop resilience assessments to address interlinked challenges of water systems and the environment. This project addresses a critical knowledge gap: What are resilience scenarios for integrated water systems (RIWS) that can be used to evaluate resilience metrics for various stressors, across system components and to inform adaptive planning? The development of RIWS will be supported by the novel Water System Integration Modelling Framework (WSIMOD) developed at the Imperial College London that will be integrated with the DAFNI platform.

Novel resilience metrics that combine concepts of a critical threshold in performance data with performance metrics evaluation will be informed by Greater London Authority, Thames and Affinity Water and Environment Agency's engagement through participatory workshops. The RIWS project aims to develop scenarios that can provide evidence for water companies, planning authorities and environmental regulators on the feasibility of water systems adaptive planning when assessed by resilience metrics, such as structural options (e.g., wastewater treatment plant upgrade) or coordinated operational decisions (e.g. water supply and wastewater systems information exchange to manage river water quality).

## ForNet

**ForNet: DAFNI FORecasting Services for Energy NETworks**

Principal Investigator: Professor Konstantinos Nikolopoulos, Professor in Business Information Systems & Analytics, Durham University

Co-Investigator: Dr Yang Lu, York St John University School of Science

Co-I: Dr Haoran Zhang, University College London

ForNet identifies a critical gap in current energy demand forecasting models: the lack of consideration for human behaviour and cognitive biases. By integrating insights from behavioural science into quantitative and judgmental forecasting methods, the project aims to develop more nuanced and accurate models that reflect real-world energy use patterns. This involves a multi-faceted methodology that includes collecting and analysing data on energy consumption, renewable energy adoption, and weather conditions, alongside behavioural data from UK surveys and studies. The project will leverage collaborative efforts, drawing on expertise from various fields to identify, quantify, and adjust for cognitive biases in energy demand models.

Objectives include:

1. Refine Energy Models with Behavioural Data: Enhance existing energy demand models by incorporating data on consumer behaviours and cognitive biases, thereby increasing the models' accuracy and relevance to actual energy use patterns.

2. Assess the Impact of Cognitive Biases: Systematically analyse how various cognitive biases—such as the optimism bias, status quo bias, and others—affect energy consumption and forecasting. This includes identifying the most significant biases and quantifying their impacts on demand predictions.

3. Foster Collaboration and Innovation: Share methodologies, data, and findings on the DAFNI platform to encourage collaboration and spur innovation in energy forecasting and policy development.

# NIRD

**NIRD: Building systemic resilience of interdependent infrastructure networks at the national scale**

Principal Investigator: Dr Raghav Pant, Senior Research Associate, University of Oxford

Co-Investigator: Professor Jim Hall, University of Oxford

Building resilience of national infrastructure networks to flood and storm events remains a significant challenge in the UK. In recent years extreme flood and storm events across the UK have affected large numbers of infrastructure networks and their customers, resulting in economic damages and losses of the order of tens of millions of pounds. Government agencies and infrastructure operators have noted that the lack of coherent datasets of interconnected networks and cross-sectoral resilience metrics makes it challenging to plan for and respond to extreme large-scale weather events. NIRD aims to address the above challenges by delivering an open-source modelling framework on the DAFNI platform for stress-testing interdependent network resilience against flood and storm events. This framework will be demonstrated through a novel national-scale database of interdependent electricity, transport, water supply, and telecoms networks connected to buildings and population concentrations in the UK. The project will create a novel network risk analysis methodology and implement it in an accessible, reusable and scalable way on the DAFNI platform. The proposed outcomes of the project will include quantifying the impacts of shocks through damages to infrastructure assets and disruptions to people and the economy dependent on infrastructure services

# Project Summaries

## Room 2 (15:50-16:40)

# USARIS

**USARIS – Uncertainty quantification and sensitivity analysis for resilient infrastructure systems**

Principal Investigator: Dr Francesca Pianosi, Associate Professor in Water and Environmental Engineering based in the School of Civil, Aerospace and Design Engineering University of Bristol

Co-Investigator: Dr Gemma Coxon, University of Bristol

Co-I: Dr Hannah Bloomfield, University of Reading

Researcher: Saskia Salwey, Research Associate, University of Bristol

Computational modelling provides a vital tool to support infrastructure decisions, allowing evaluation of risks and benefits of different infrastructure options on a virtual system (or digital twin) before committing to a particular design. Model outputs, though, are conditional on a range of uncertain assumptions and input data, due to our incomplete or imperfect knowledge of the drivers and the properties of the system being modelled. When models are used for long-term planning, the uncertainty about the current properties and drivers of the system is compounded with further uncertainty about how these will evolve in the future.

Overconfidence in model results and insufficient consideration of the breath of possible futures is a key obstacle to infrastructure resilience. If models are used to inform large investment decisions, they must be trustworthy and defensible.

Uncertainty Quantification and Sensitivity Analysis (UQ&SA) is a set of generic methods that can be used to analyse the propagation of uncertainties in model and thus improve the model's construction, validation, and use for decision-making under uncertainty. They are applicable to any mathematical model regardless of the specific application domain. The goal of this project is to set the foundations for integrating UQ&SA functionalities in the DAFNI platform.

# IMPACT

**IMPACT: IMproving flood-disruPted road networks resilience with dynAmic people-Centric digital Twins**

Principal Investigator (lead): Dr Qiuchen Lu, Bartlett School of Sustainable Construction, University College London

Co-Investigator: Prof Tao Cheng, Dept of Civil, Environ & Geomatic Eng, University College London; Director of SpaceTimeLab for Big Data Analytics

Team members:

Dr Tohid Erfani, Dept of Civil, Environ & Geomatic Eng, University College London

Dr Trung Hieu Tran, Cranfield University

Mr Xuhui Lin (Research Assistant), Bartlett School of Sustainable Construction, University College London

IMPACT aims to improve the resilience of road networks in fast-changing floods through the dynamic people-centric digital twin. This project will design 'user-road-flood' cross-domain systems (the datahub, data engine and resilient enabler) for the proposed digital twin, and build data-sharing strategies to integrate and share multimodal transportation datasets (including car, bus, and bicycle flows etc.), to assess dynamic congestion risks with a high level of precision.

We aim to create user-road-flood digital twins which will be the three main modules of the proposed digital twin. This will be achieved through objectives including:

Creating a layered dataset (user-road-flood datahub) to provide essential datasets and data-sharing strategies to integrate and share multimodal transportation data, for understanding flood impacts on road networks and traffic.

Assessing time-variant congestion risks through developing a novel dual assessment (user-road-flood data engine) based on the propagation of flooding, topological measurements of road networks, and population activities: a). generating a time-variant vulnerability index series and b). evaluating the time-variant congestion risk map on the transportation system under flooding.

Proposing the dynamic people-centric resilient strategies for road/traffic recovery, integrating the dynamic importance of roads and the propagation of flooding (user-roadflood resilience enabler).

Integrating the proposed dynamic people-centric digital twin and data-sharing strategies with DAFNI systems.

# MARS

## MARS – Flight Diversion Modelling for the UK Aviation System

Principal Investigator: Dr Fabian Steinmann, Lecturer in Organizational Resilience and Change & Deputy Aviation Safety & Compliance Manager, Cranfield University

Co-Investigator: Dr Irene Moulitsas Cranfield University

Researcher: Dr Desmond Bisandu Cranfield University

The proposed project aims to assist the Operations Directors Liaison Group (ODLG) by providing additional resources and expertise for the development of the next iteration of the mass diversion protocol. The initial phase of the project involves data collection. The dataset will be made available to the DAFNI community and uploaded into the National Infrastructure database. After the data is pre-processed, a computational model of the UK airport network can be developed. This model enables the research team to simulate airport closures and the subsequent diversion of aircraft to alternate airports. The project will investigate the diversion process, highlighting potential bottlenecks in the system and providing crucial information for the ODLG for the next iteration of the protocol. Project outputs will identify airports, where additional pre-approved slots would stabilize the system during mass diversion events.

Furthermore, the developed model and documentation will be uploaded into the Modelling catalogue. The team is a strong advocate of open-source software and the data and software will be available to the community with the MIT license.

# User Case Studies

## Mini case study of DAFNI platform user

### Professor Robert Nicholls, University of East Anglia and The Tyndall Centre for Climate Change Research

The DAFNI platform is a central part of the OpenCLIM project which was designed to support UK-level Climate Change Risk Assessment (CCRA) mandated by the Climate Change Act of 2008. OpenCLIM conducted an integrated assessment of climate risks across five different sectors: heat stress, flooding, drought, agriculture, and biodiversity. They made the results available to policymakers, and the legacy and workflows available to researchers through the DAFNI platform.

DAFNI is funded for the long term as a recognised critical national infrastructure. It will be there long beyond individual projects and the OpenCLIM results we've lodged in DAFNI will be there and available to researchers and policymakers for a decade or more beyond the project's lifespan.

## Mini case study of DAFNI platform user

### Dr Evangelia Manola, Research Fellow in the UCL Department of Civil, Environmental & Geomatic Engineering

We aim to look at the Circular Economy in Construction - during the design phase, to consider what positive impact can this have at the end of the life of the infrastructure now, rather than only considering this at the end of the infrastructure or project lifetime. We're also researching where and which materials can be reused, how much waste will be generated at the end of the project.

Our research also highlights the benefits of increased use of digital technology such as the DAFNI platform for the implementation of Digital Twins and as a platform for interdisciplinary research, and how the DAFNI platform can facilitate stakeholder collaboration for improved transparency and efficiency.

## Mini case study of DAFNI platform user

### Dr André Neto-Bradley, Research Associate, University of Cambridge

EnergyFlex is a microsimulation model that uses public data to synthetise a representative housing stock for any local authority, and allows users to estimate energy efficiency and characteristics of the housing stock in the area. The model has been run using DAFNI and the outputs can be used to locally tailor and target energy efficiency and decarbonisation efforts. EnergyFlex was developed through a collaboration between the University of Cambridge, University of Leeds, the Alan Turing Institute and DAFNI.

DAFNI shares data and models in a way that's easy for other people to access. On DAFNI models can be put out into the open so that you can integrate these with other outputs and inputs feeding into a variety of models, not just your own. DAFNI also allows researchers to help avoid duplication and to build on the work of others

## Introduction DAFNI

DAFNI is a computing platform which aims to support advanced research into national infrastructure, including transport, water, and energy and city scale modelling. The DAFNI platform supports research that aims to provide the UK with a world-leading infrastructure system that is more integrated, efficient, powerful, reliable, resilient and affordable. It is enabling the community to conduct research that is able to generate new insights at a higher level of detail and accuracy than ever before.

DAFNI was originally funded by an £8 million EPSRC investment in the UK Collaboratorium for Research in Infrastructure and Cities (UKCRIC) and a £1.2m grant under EPSRC's Resource Only Strategic Equipment. Its aim has been to become the national platform to satisfy the computational needs in support of data analysis, infrastructure modelling and visualisation, and encourage whole-system thinking for the UK's infrastructure research needs.

In March 2023 UKRI awarded £4m to STFC Scientific Computing to establish a national Centre of Excellence for Resilient Infrastructure Analysis, and move the Data & Analytics Facility for National Infrastructure (DAFNI) into its new phase.

DAFNI **Data & Analytics Facility for National Infrastructure**

If you would like to get involved in DAFNI, please contact
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Keep up to date with latest news and sign up for our DAFNI Mailing list at:

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