

# Uncertainty Quantification and Sensitivity Analysis for Resilient Infrastructure Systems (USARIS)

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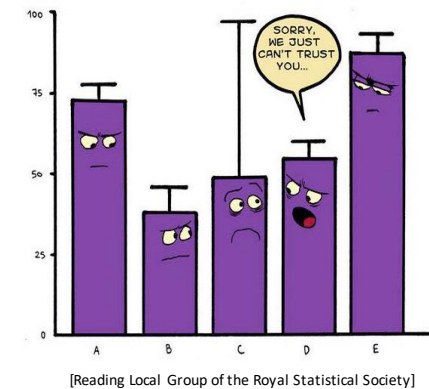
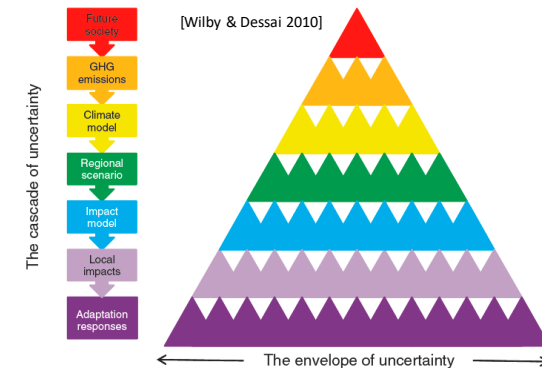
# Computational models have become an essential source of information to support infrastructure decisions, but...

Model outputs are conditional on many **uncertain assumptions**

- about the system's properties and drivers
- how drivers will evolve in the **future**

For models to be **trustworthy** and **effective** for infrastructure resilience we must:

- avoid **spurious precision**
- identify **key sources of uncertainty**
  - when does the model stop being valid?*
  - where to start to improve the model?*
- identify **robust designs**
  - which designs perform "well enough" across a range of futures?*



# Uncertainty quantification (UQ) and sensitivity analysis (SA) provide a generic methodology to address these challenges

Step 1 **propagate** input uncertainties

Step 2 **analyse** the input-output dataset

Monte Carlo simulations

quantifying uncertainty

quantifying sensitivity

stress-testing

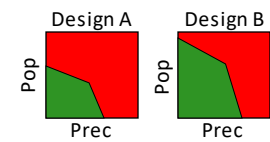
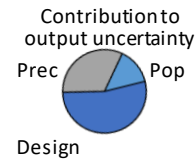
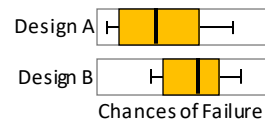
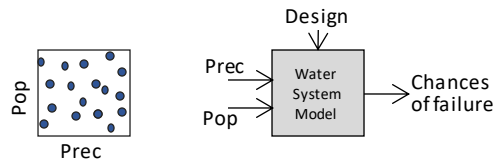
*How uncertain are model output(s) given uncertainty in inputs?*

*Which inputs mostly contribute to the output uncertainty?*

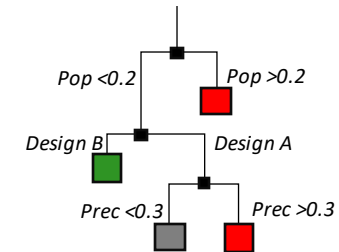
*What designs perform **well enough** across a large range of inputs?*

*What are **threshold** values in the inputs that lead to "good enough" outputs?*

*What is the **precision** and **scope of validity** of the model?*



chances of failure:  
■ below critical threshold  
■ above critical threshold  
■ unclear



# USARIS will set the foundations to include UQ&SA into DAFNI and demonstrate their value to the DAFNI users' community

DAFNI already enables Monte Carlo simulations so we will focus on step 2 (quantifying and attributing output uncertainty)

- We will rely on existing UQ&SA packages (e.g. <https://safetoolbox.github.io/>)
- The integration into DAFNI will be conducted by developing **two pilot applications (DAFNI workflows)** in **water** and **energy**
- The workflows will be used for **training and dissemination** during the project (e.g. online trainings for EPSRC-CDT early-career researchers, 2024 annual workshop of the “*Next Generation Challenges in Energy and Climate Modelling Group*”) and beyond
- We will investigate scalability and provide **recommendations** for future developments of DAFNI



**Pianosi**  
UQ&SA  
water systems



**Salwey**  
UQ&SA  
water systems

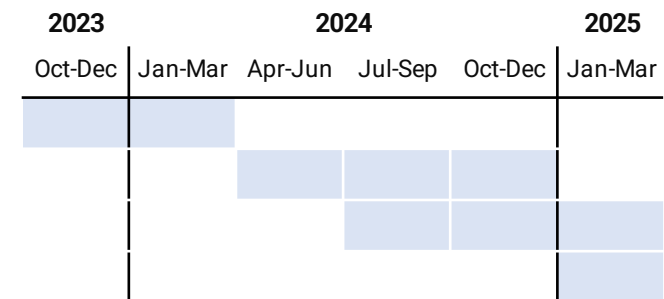


**Bloomfield**  
energy systems



**Coxon**  
water systems

- WP1: defining pilot applications
- WP2: developing pilot apps
- WP3: training and dissemination
- WP4: wrap up & recommendations



# Long-term vision and community engagement

Ultimately USARIS will contribute to enable and promote best practices for responsible modelling in the DAFNI users community

## Get in touch if you want to:

- learn more about UQ&SA
- brainstorm ideas on how UQ&SA can help in your sector
- discuss training opportunities
- provide pilot applications

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**nature**

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## Five ways to ensure that models serve society: a manifesto

**Pandemic politics highlight how predictions need to be transparent and humble to invite insight, not blame.**

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