Assessing flood impacts using a multi-scale geospatial database model

Newcastle University

University of Nottingham
UK | CHINA | MALAYSIA

UKRI Engineering and Physical Sciences Research Council

Presenters

Professor of Earth Systems Engineering

PhD student, EPSRC Centre for Doctoral Training in Geospatial Systems

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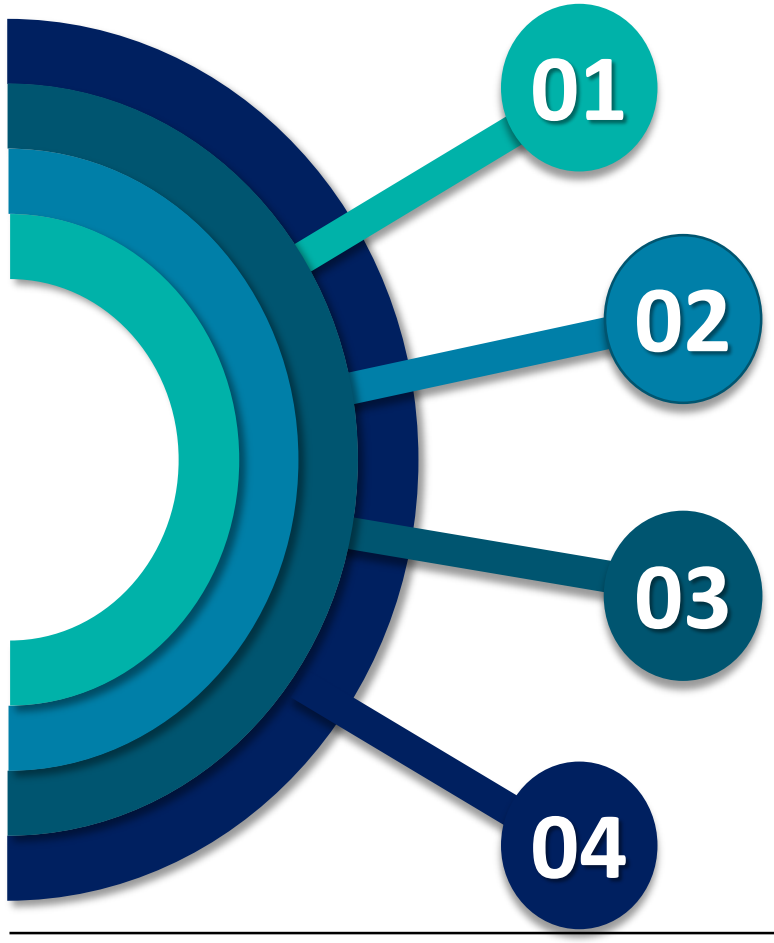
Agenda



Flooding in the UK

Need for geospatial framework for managing impact of flooding

Esri technology stack in use

Benefits of integrated model

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Flooding in the UK

Flash flooding, river flooding, coastal flooding, surface water flooding…

2.4 million buildings are at risk of flooding from rivers or the sea

2.8 million buildings are at risk of flooding by surface water

2.6 billion

£

Costs for flood damage in the UK since 2011

Environment Agency (2009); Thorne (2014); UK Government (2020a)

Newcastle upon Tyne (UK)

Flooding: Toon Monsoon (June 2012)

Summers, M., 2012, The Northern Echo: Roads turn to rivers in a flash as thunderstorms hit region,
Url = https://www.thenorthernecho.co.uk/sport/9788748.roads-turn-rivers-flash-thunderstorms-hit-region/, Visited: June 2020.
Hardisty, A., 2012 Newcastle Floods 28/06/2012, Url = https://www.youtube.com/watch?v=Afm3_WUIqIc, Visited: June 2020.

Complexity of urban environment
Buildings
Infrastructure
Roads

Flood management

Providing data, responsible for tasks during different stages of flooding, dealing with flood impacts

Department for Environment Food & Rural Affairs

Office for National Statistics

Ordnance Survey

Environment Agency

Newcastle City Council

urban observatory

fhrc Flood Hazard Research Centre

CEH Centre for Ecology & Hydrology NATURAL ENVIRONMENT RESEARCH COUNCIL

Geomni

ITRC mistral multi-scale infrastructure systems analytics

Tyne & Wear Urban Traffic Management & Control

NORTHUMBRIAN WATER living water

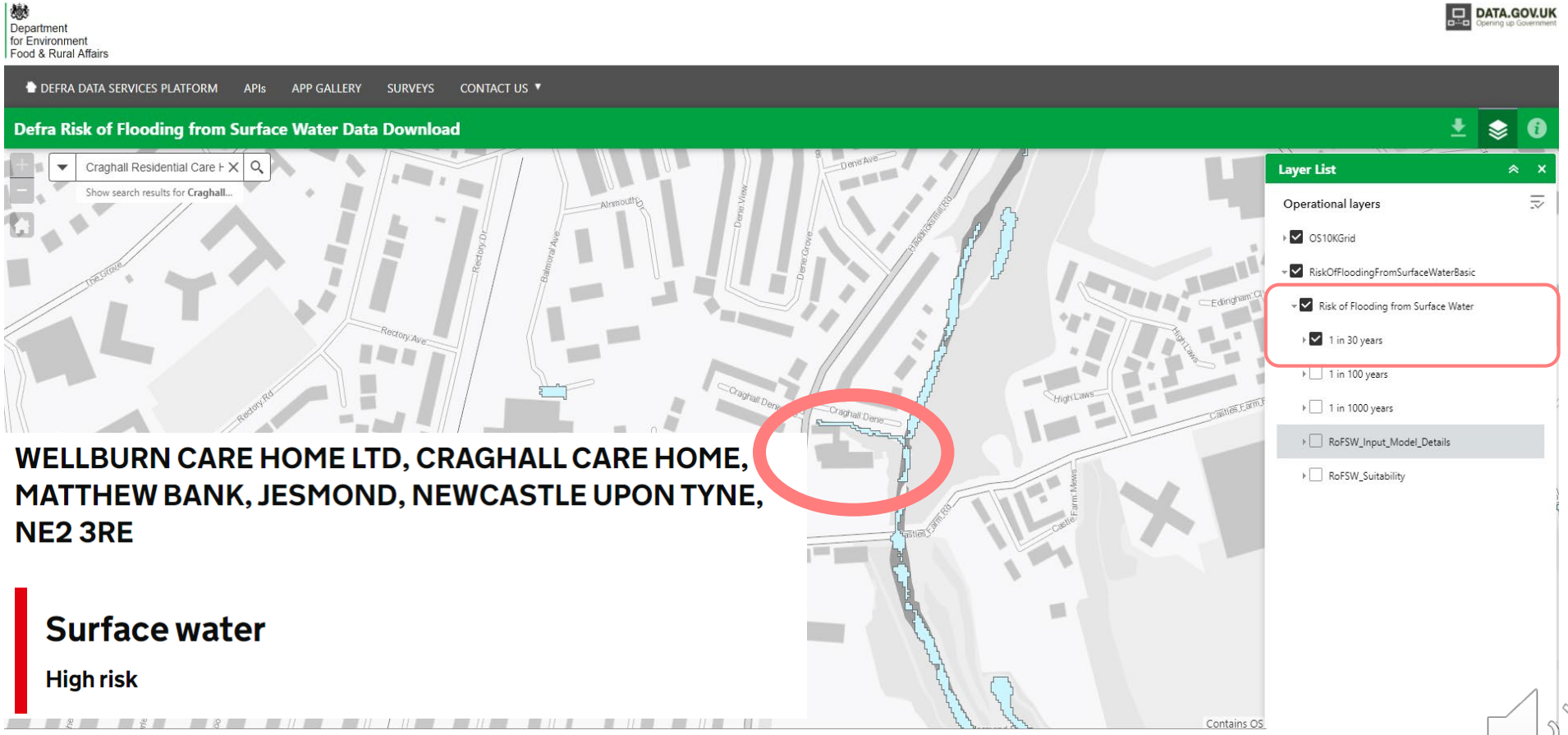
Hazard maps to indicate areas at risk

Example: Risk of surface water flooding

Flood extent

Flood velocity

Flood depth



Environment Agency 2020 Risk of Flooding from Surface Water Extent: 3.3 percent annual chance [Raster], Tiles: NZ16, NZ17, NZ26, NZ27, Environment Agency (UK).
Using EDINA Digimap Ordnance Survey Service, Url = *https://environment.data.gov.uk/DefraDataDownload/?Mode=rofsw*, Visited: May 2020.

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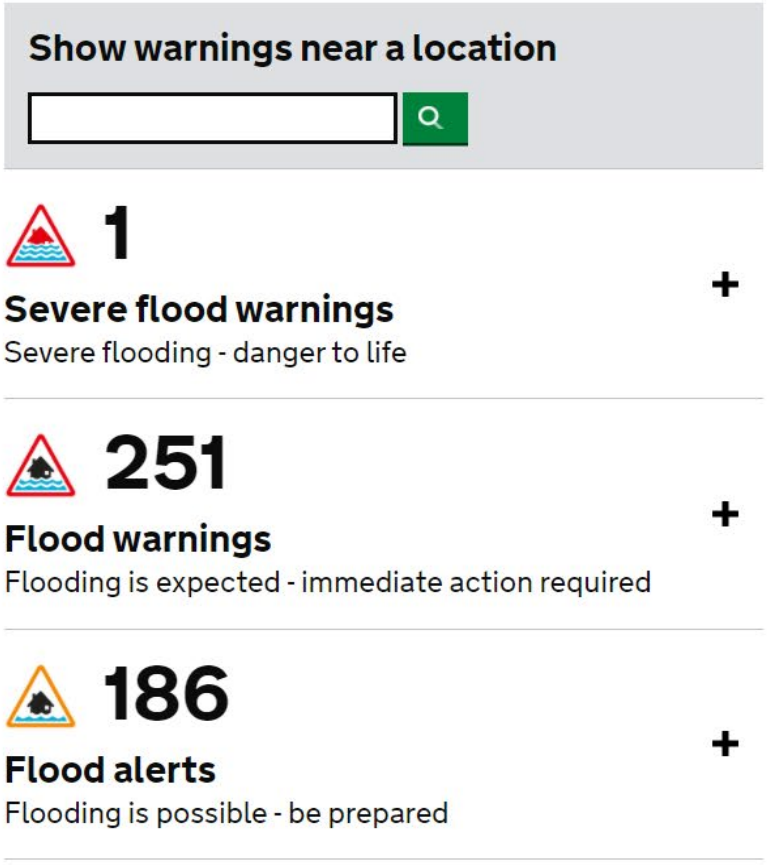
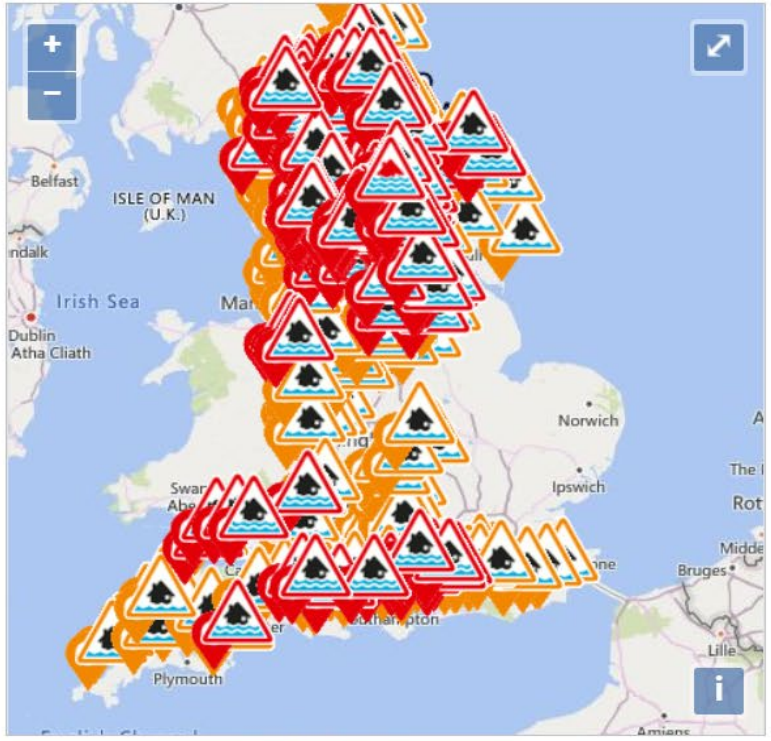
Hazard maps to indicate areas at risk

Example: Flood warnings for England





UK Government 2020b Flood warnings for England, Url = *https://flood-warning-information.service.gov.uk/warnings*, Visited: July 2020.

Current hazard maps

Enable to answer the following questions:

Is my house within the flood zone?

Are flood alerts issued for my area?

Enhance to answer the following questions:

How many vulnerable neighbours require special assistance?

Which roads are blocked due to flooding?

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Aim

Develop a **flood geospatial database** model for heterogeneous data from different sources to assess the **impact** of **flooding** on the **environment**, **society** and **infrastructure**.

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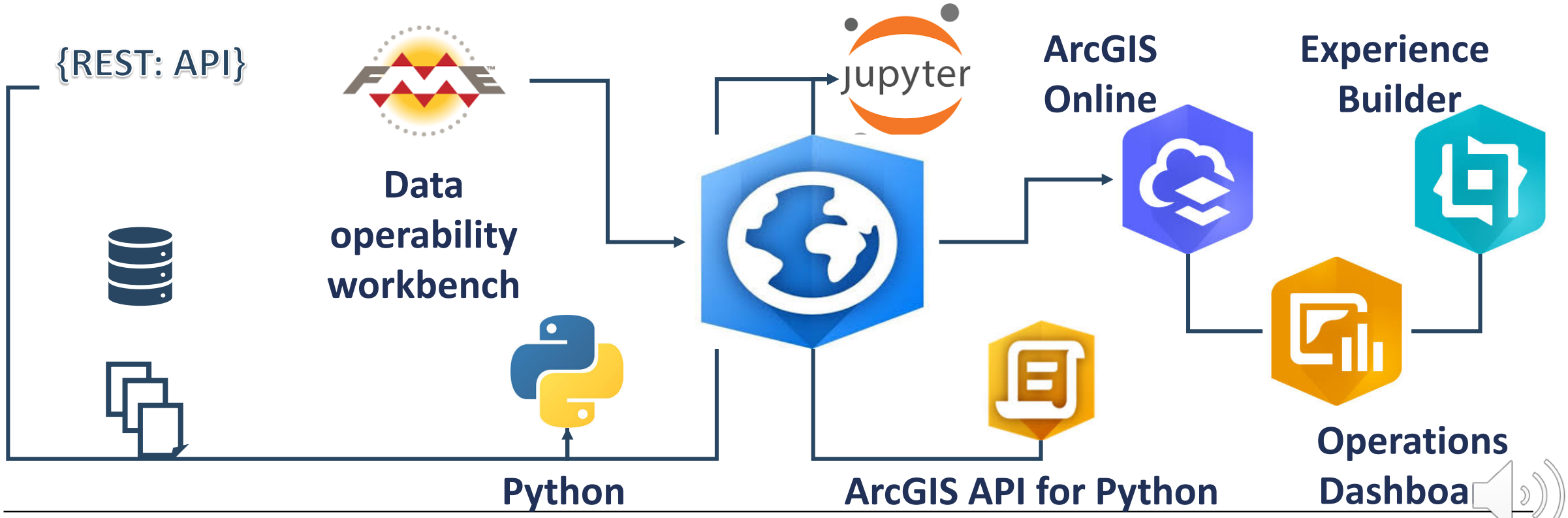
Conceptual and technical workflow

Extract	Transform	Design	Analyse and visualise	Share
datasets	data	data model	flood impact	results



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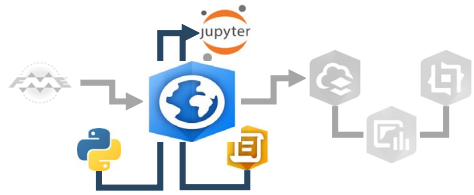
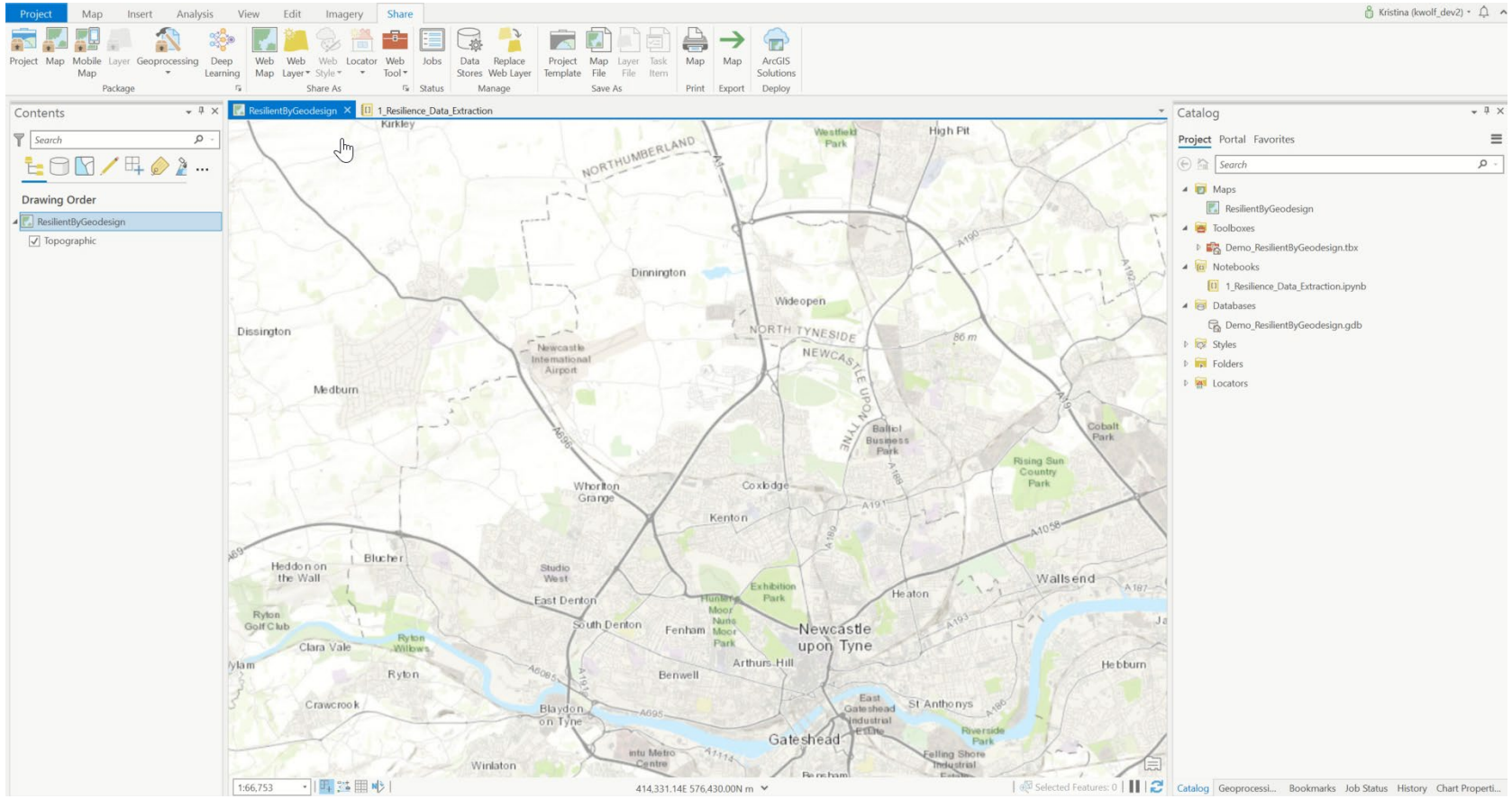
Extracting data

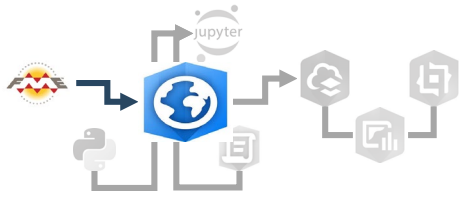
Using Jupyter Notebook to extract data and enrich with administrative hierarchical information

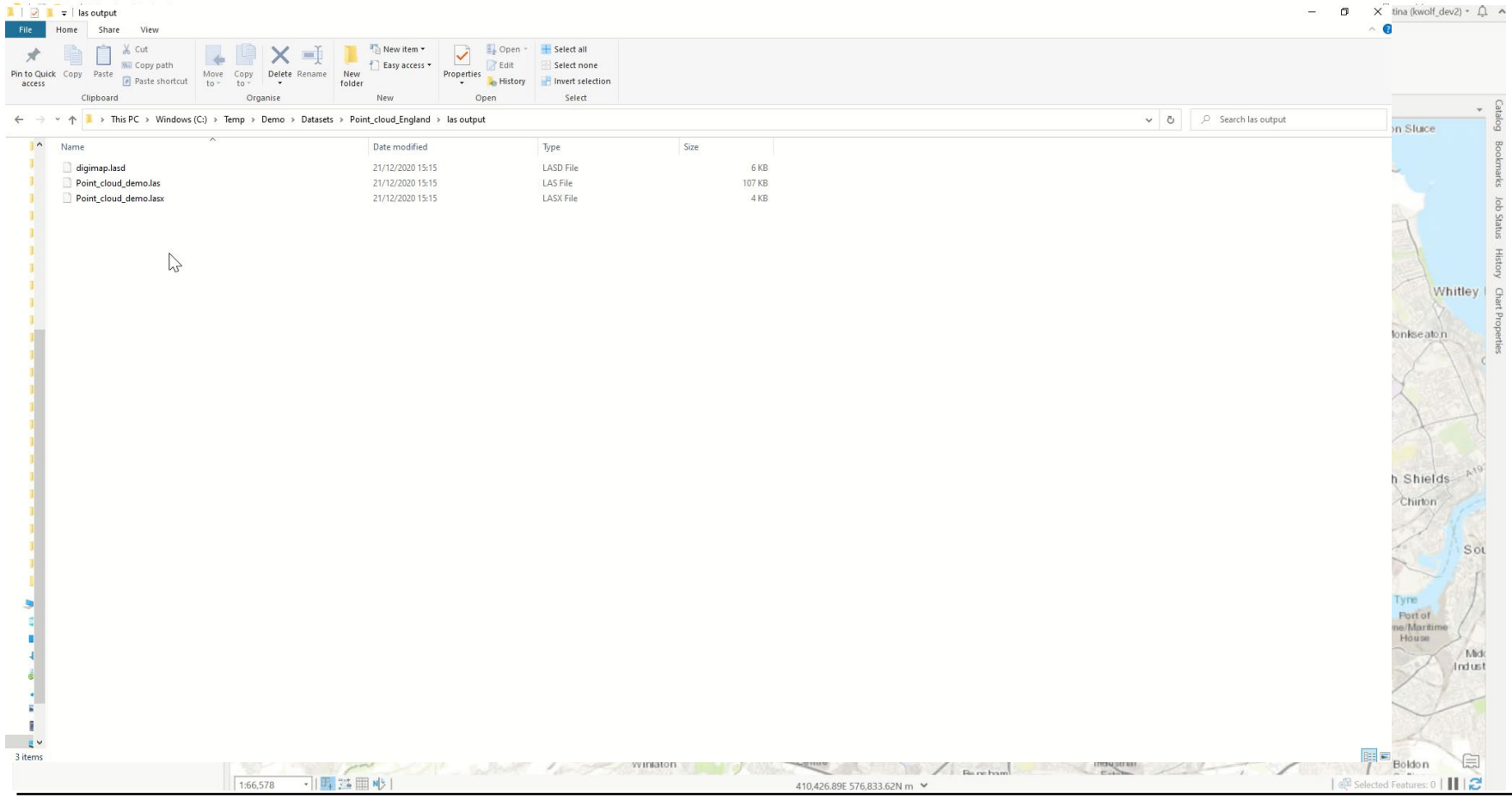




Transforming data

Using FME to convert between different data formats in an automated way





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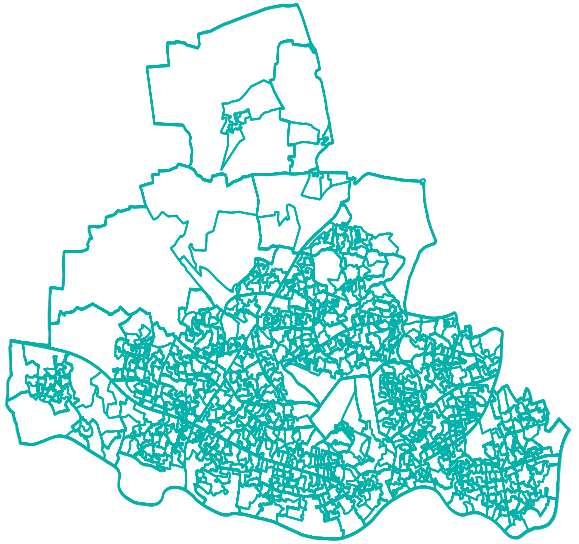
Designing a data model for Newcastle

Integrating static and dynamic real-time data

- Environment
- Rainfall
- Society
- River level
- Infrastructure
- Incidents



Newcastle

MSOA

LSOA

OA

… for **improved flood impact assessment** at different scales.

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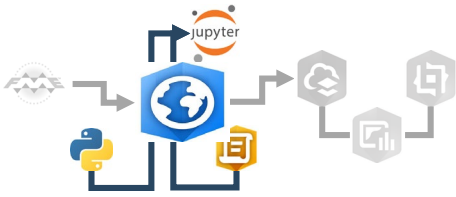
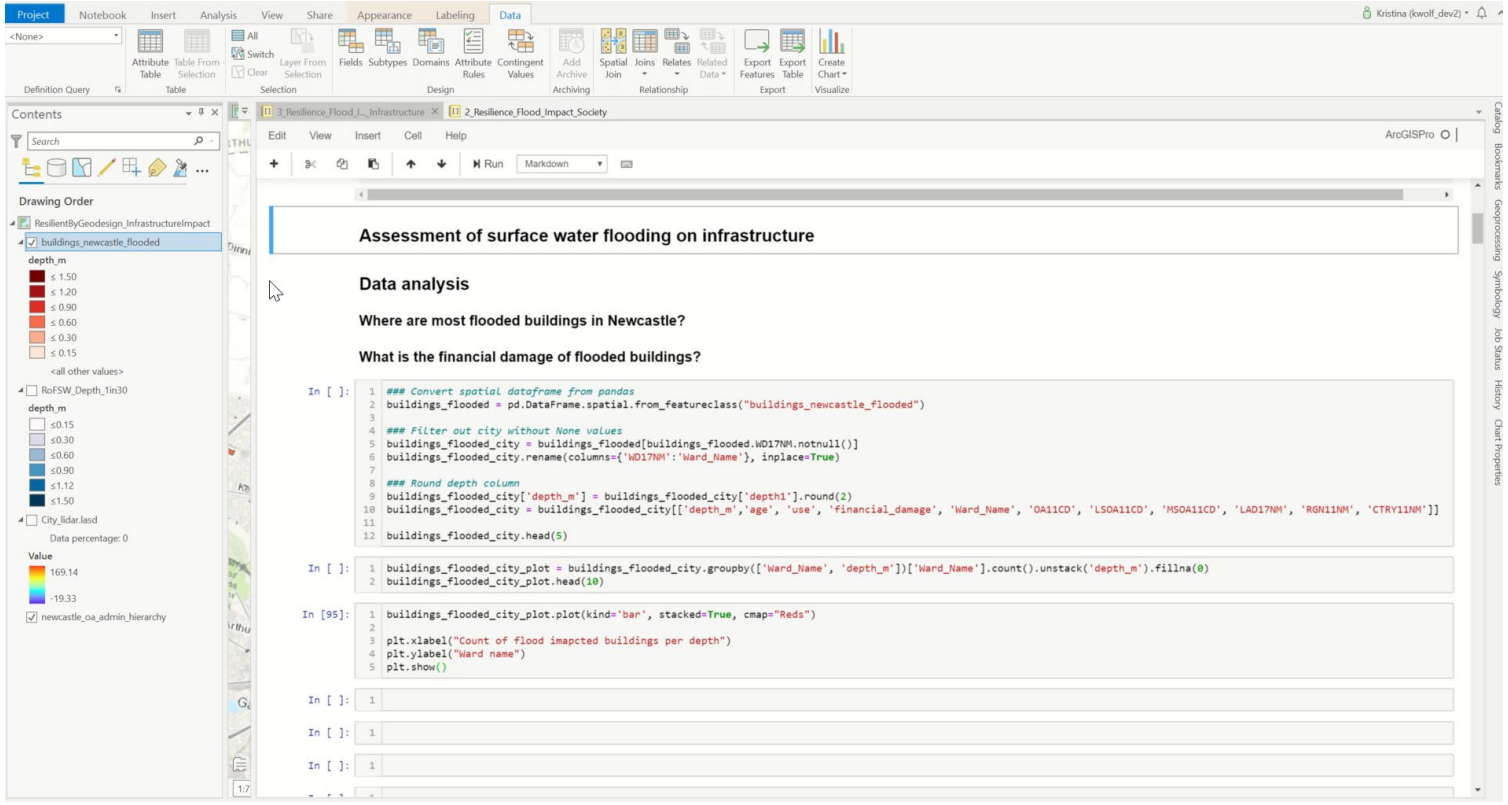
Analysing and visualising data

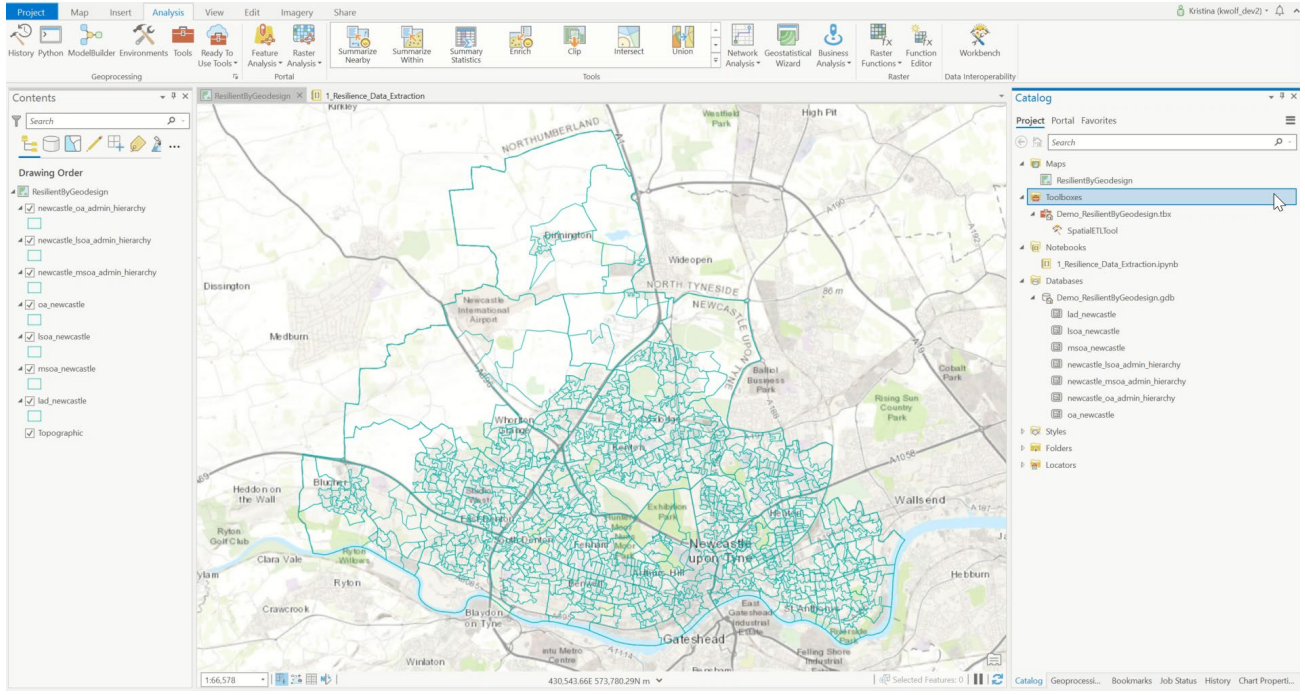


Using spatial queries to analyse flood impact



Updating data

Update (online) data through scheduled script



- River level
- Daily accumulated rainfall
- Temperature
- CCTV images
- Incidents
- Accidents

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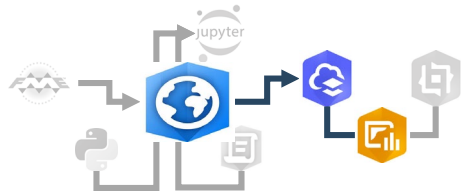
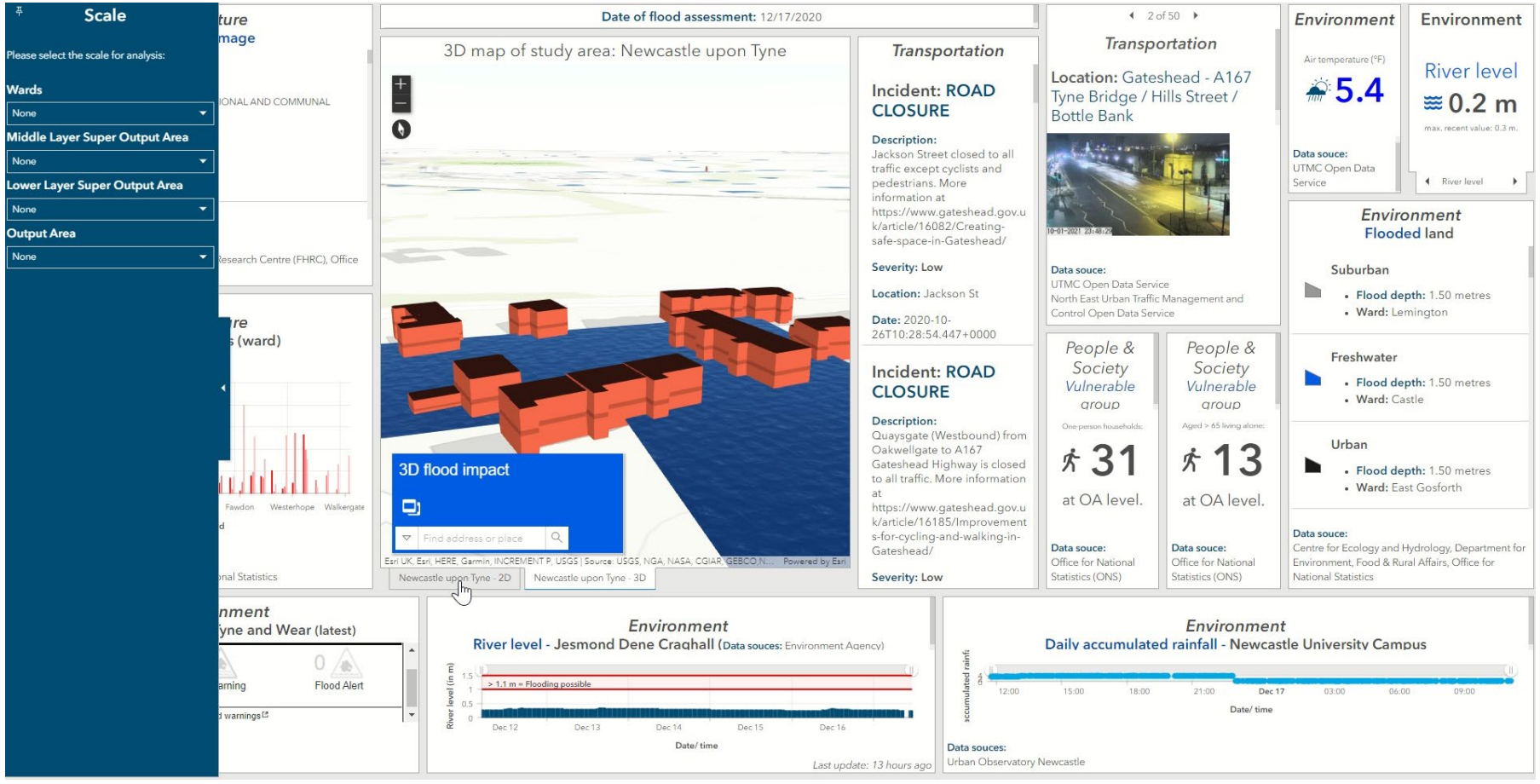
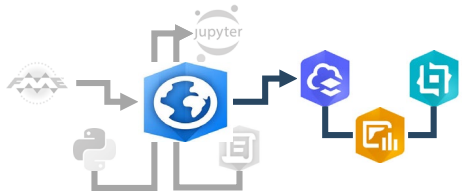
Visualising data

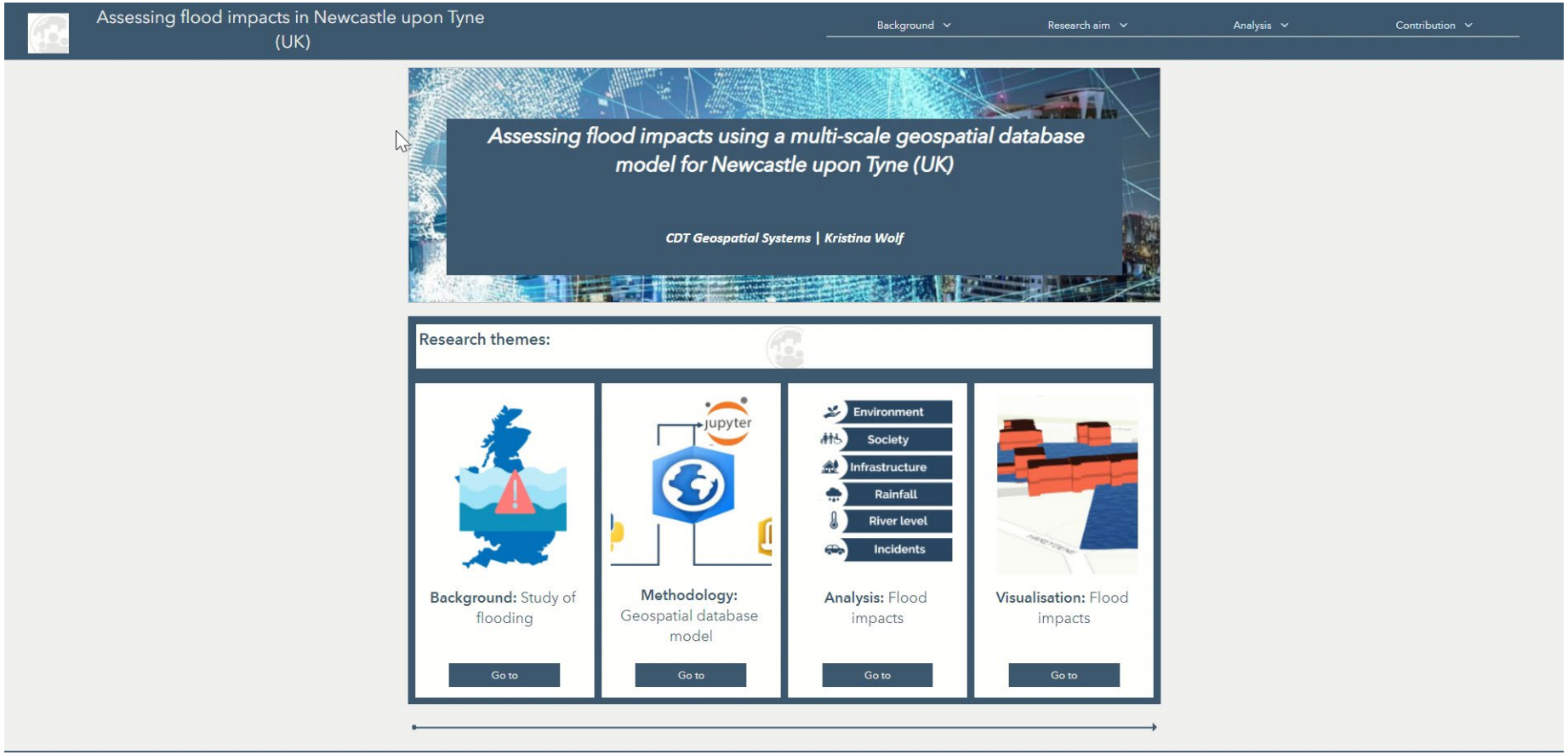
Using Operations Dashboard to visualise assessment of flooding on environment, society and infrastructure





Using Experience Builder to share project story





The integrated flood database model enables

Integration of **heterogenous data** for improved flood risk assessment and **decision support** (multiple organisations)

Quick location **overview** of different city conditions through **shared analysis** of **common data**

Standardised, automated data extraction and transformation using Python, allowing research **reproducibility and scalability**

Improving overall resilience.

Thanks and acknowledgments

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Ordnance Survey

Newcastle University

Thank you for your attention.

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References

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CEH 2018 Land Cover plus: Crops (2018) [FileGeoDatabase geospatial data], Scale 1:2500, Tiles: GB, Updated: 26 May 2017, UK Centre for Ecology and Hydrology, Using: EDINA LIDAR Digimap Service. Url = *https://digimap.edina.ac.uk*, Downloaded: May 2020.

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Esri 2020 ArcGIS Pro: Release 2.5.0. Redlands, CA: Environmental Systems Research Institute.