vision

World-leading

discovery science

Natural Environment Research Council

helps solve

UK water issues

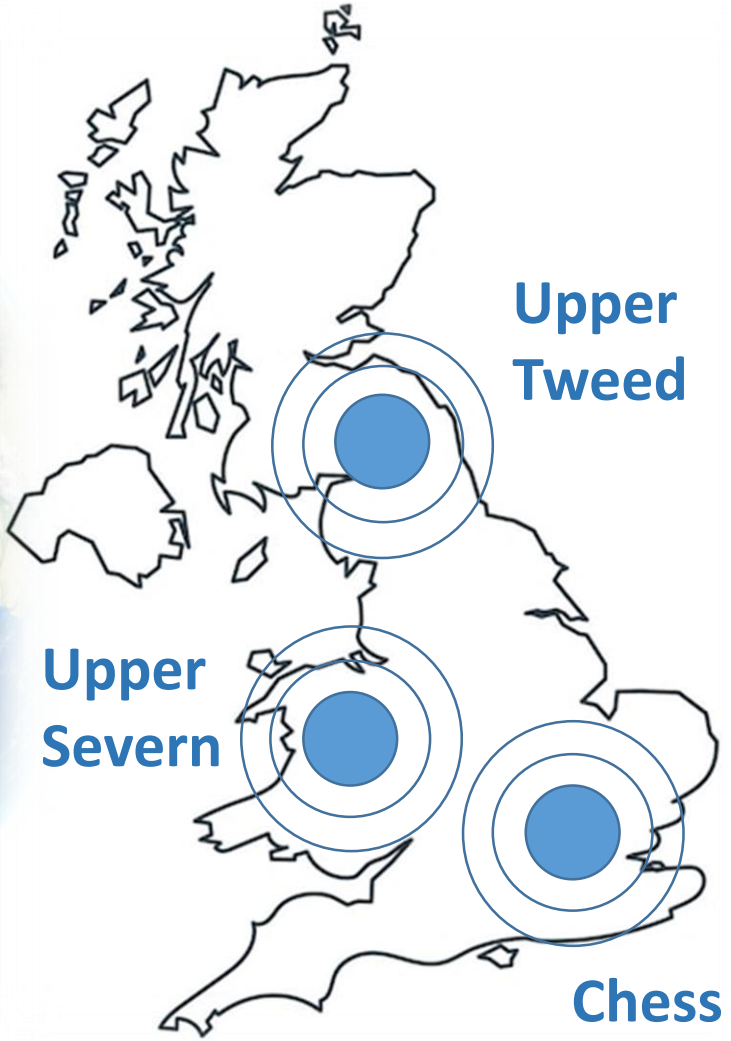
Infrastructure captures

UK variability in hydrological phenomena

range of challenging UK water issues

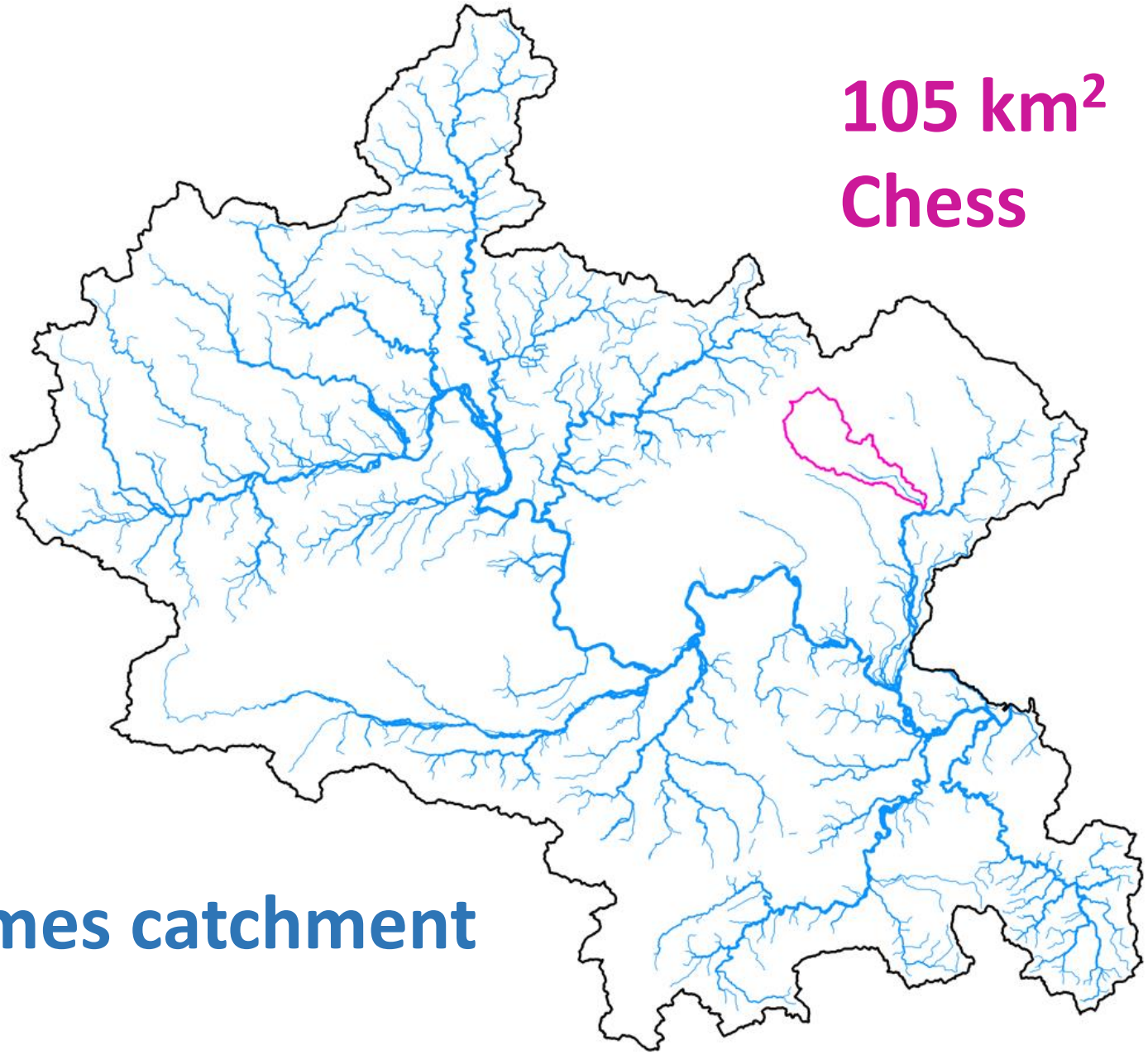
Natural Environment Research Council

UK water research infrastructure



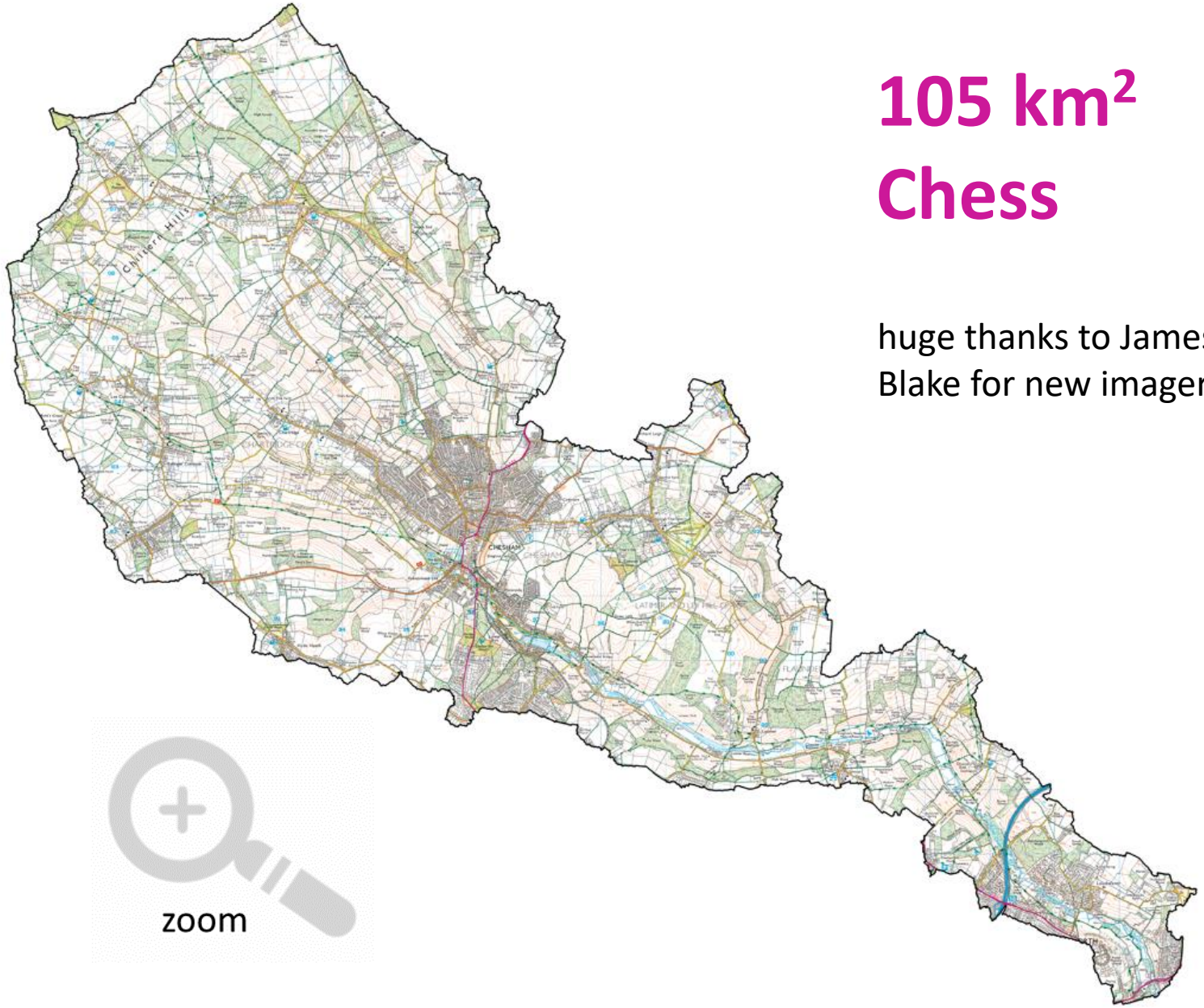
Integrated network of smart catchments

139 – 174 – 105 km^2



105 km^2
Chess

Thames catchment

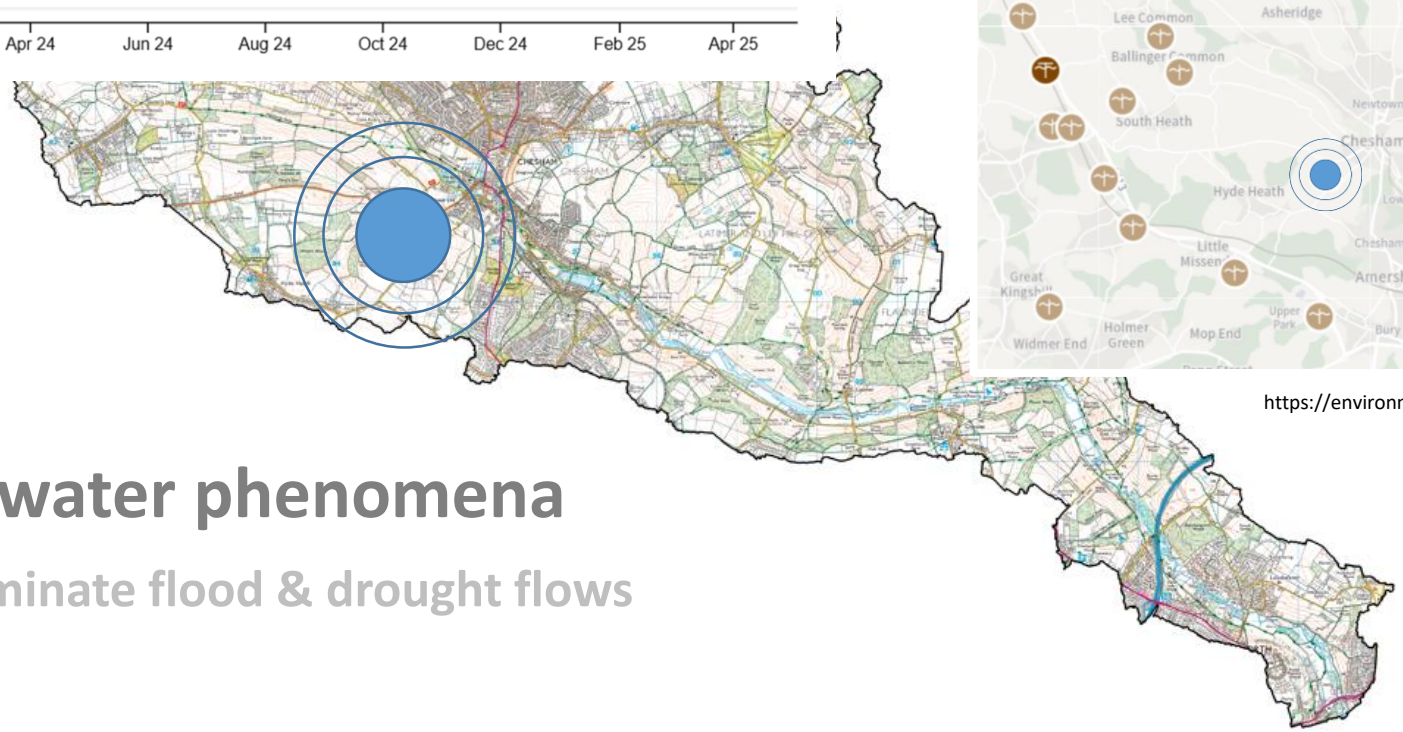


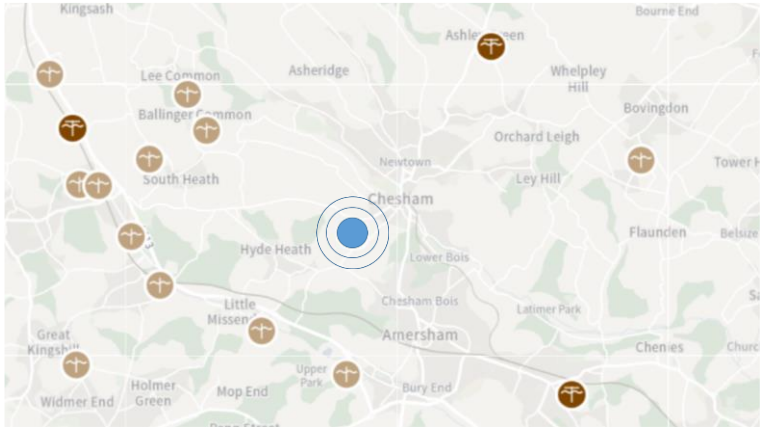
105 km^2 Chess

huge thanks to James Blake for new imagery

live EA borehole data

105 km²
Chess





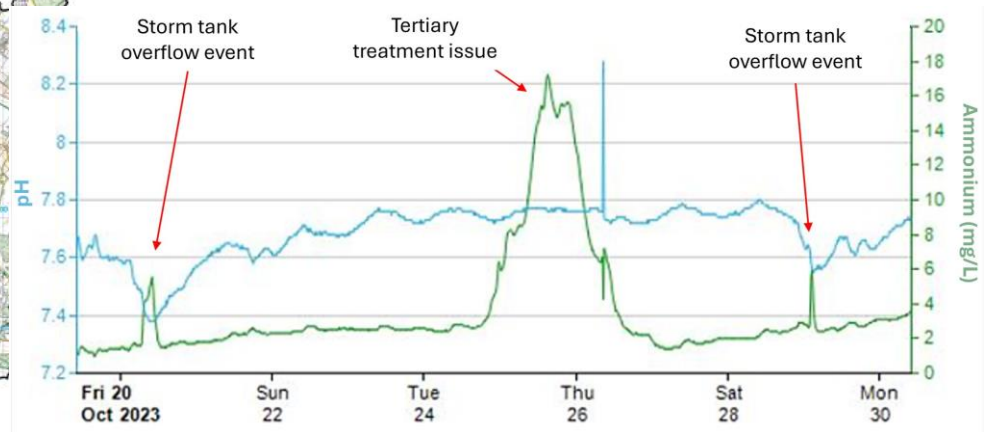
https://environment.data.gov.uk/hydrology/explore

deep groundwater phenomena

dominate flood & drought flows

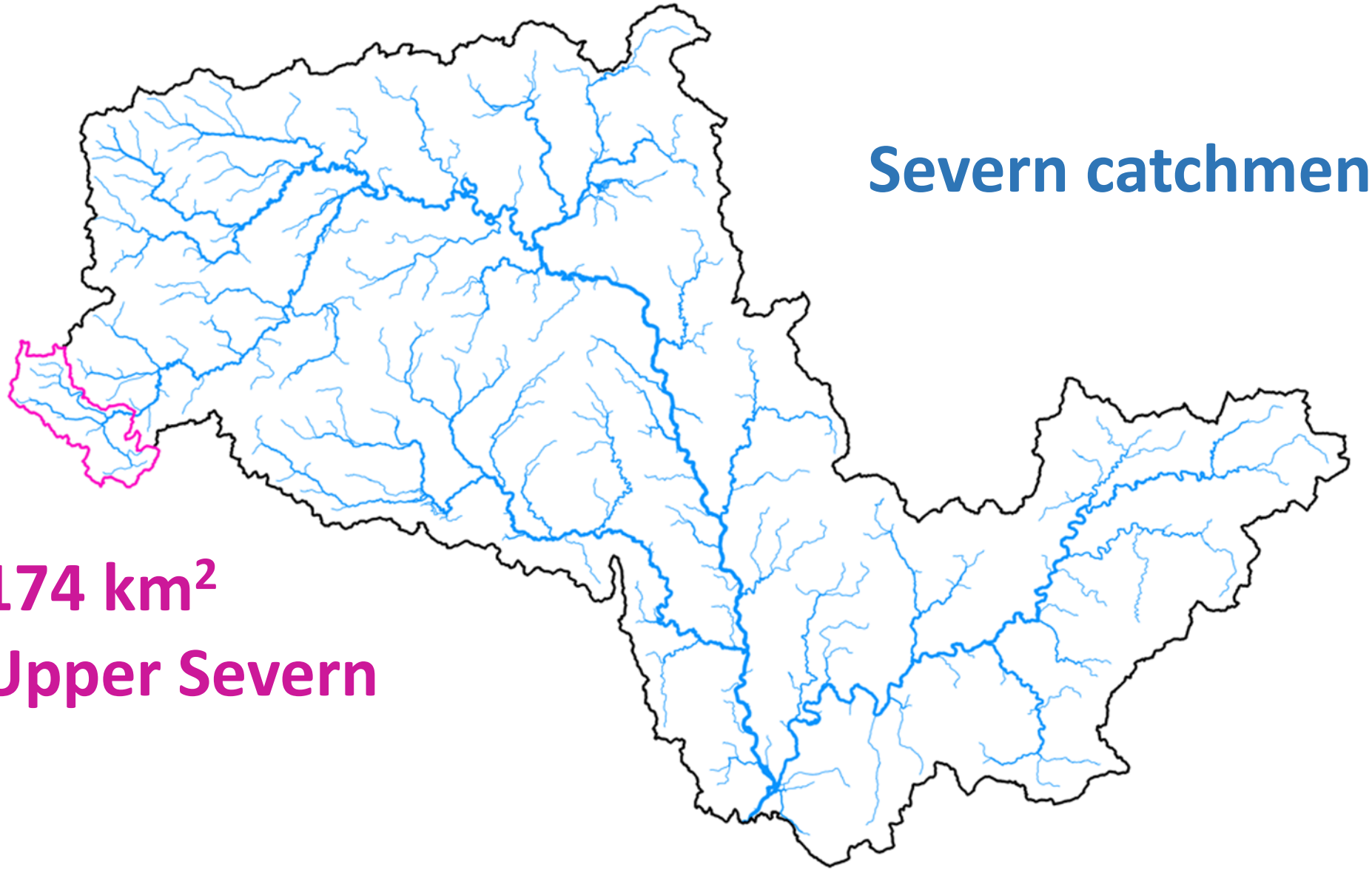
105 km^2 Chess

WwTW issues



https://www.fba.org.uk/articles/integrating-citizen-science-into-catchment-management-lessons-learnt-from-the-river-chess

on drought flows



Severn catchment

174 km^2

Upper Severn

174 km²

Upper Severn

till/head-based surficial geology

generating flood flows

174 km²

Upper Severn

http://www.es.lancs.ac.uk/people/nickc/Hankin_etal2018.pdf

pastoral & forestry pollutants

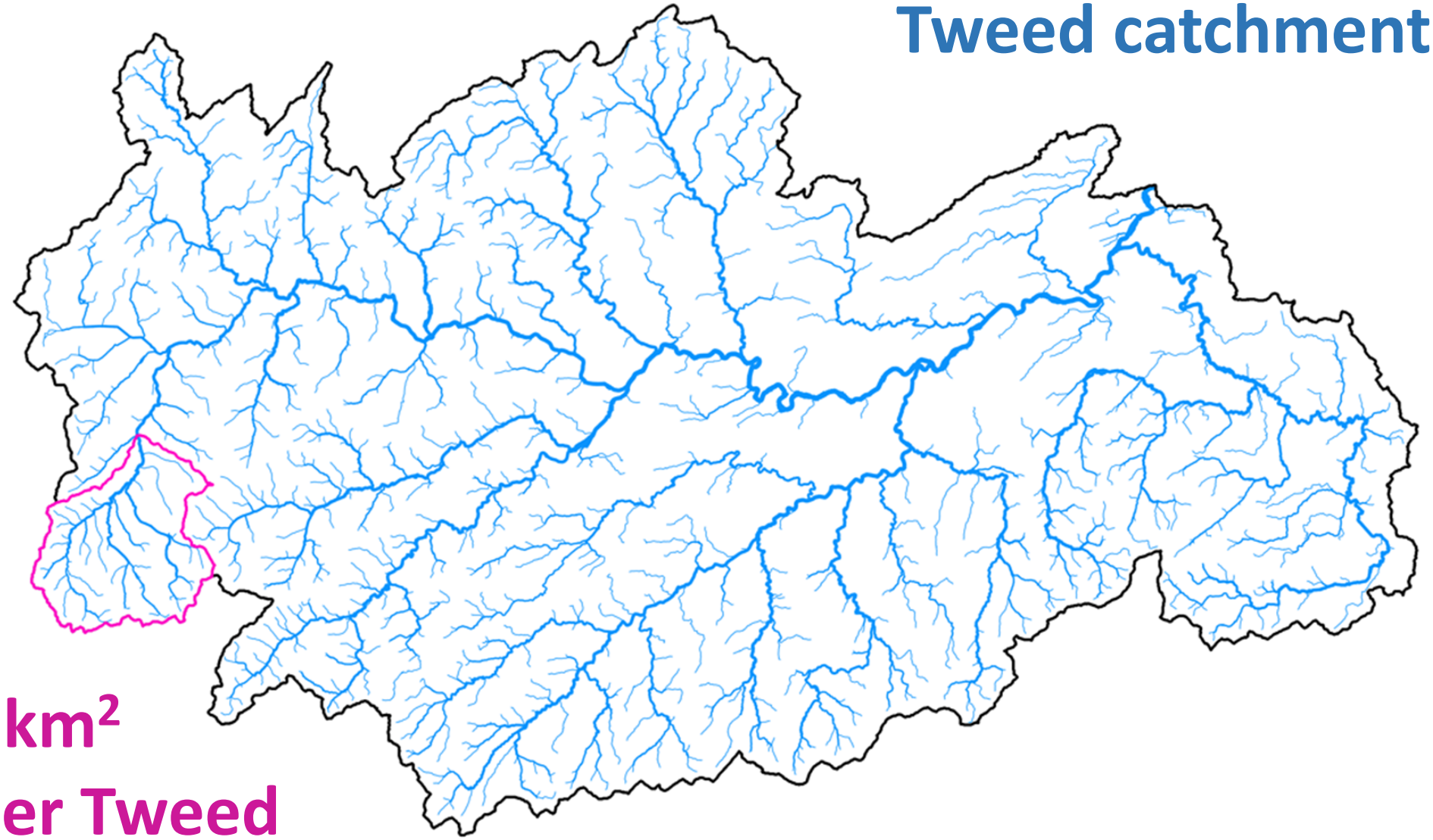
in flood & drought flows

https://www.bbc.co.uk/news/uk-wales-43389895

174 km^2

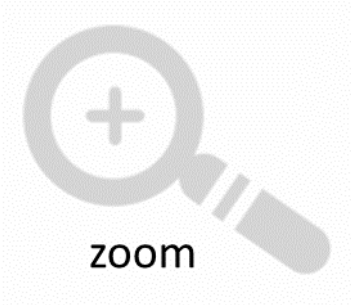
Upper Severn

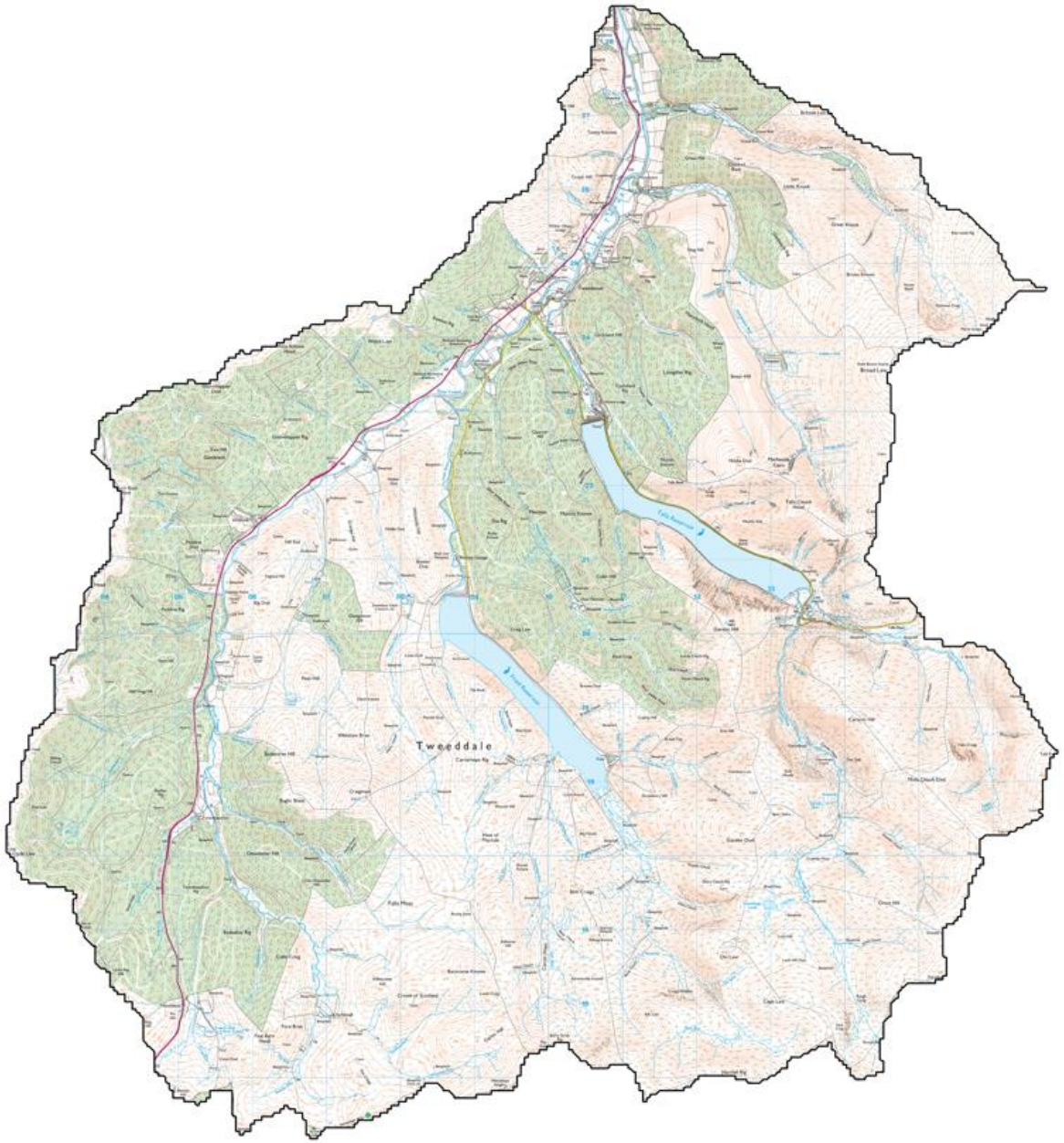
Tweed catchment



139 km²

Upper Tweed





139 km²

Upper Tweed

Snow melt phenomena

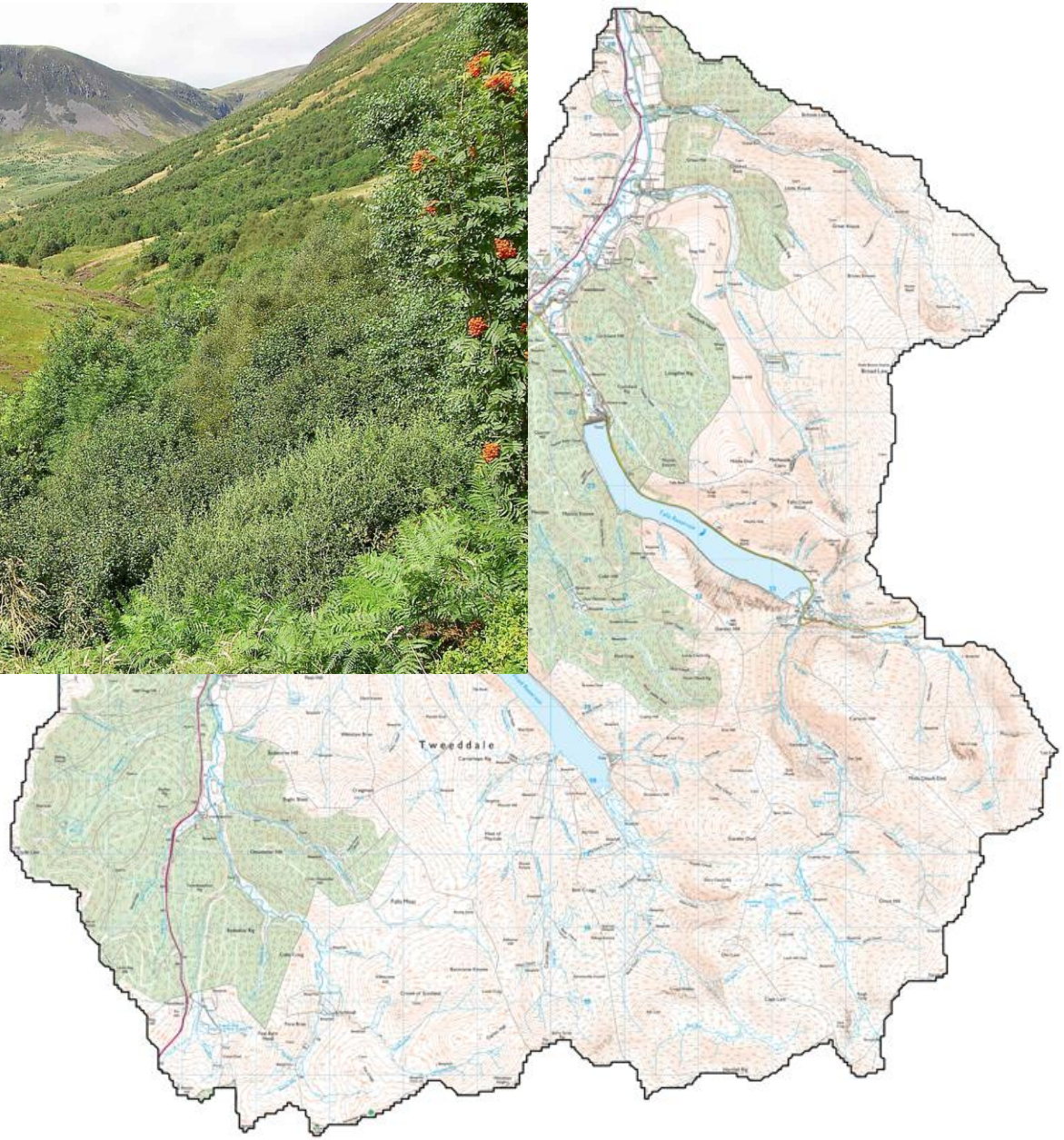
generating flood flows

https://floodforecastingservice.net/2021/02/16/snow-melt-and-hydrometric-observations-perspectives-for-flood-forecasting/

139 km²

Upper Tweed

https://bordersforesttrust.org/search?t=Tree%20planting

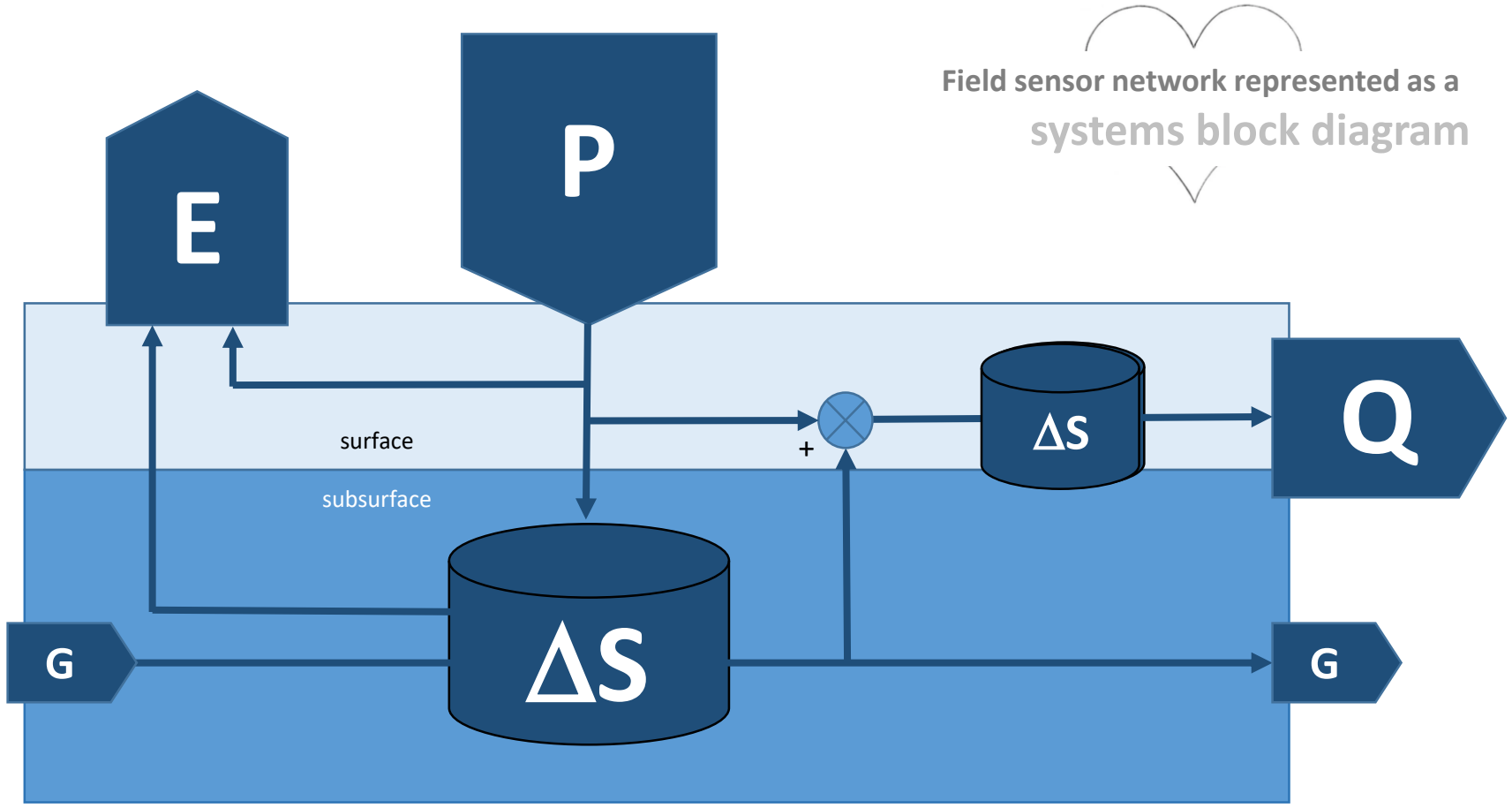


139 km^2
Upper Tweed

Nature-based Solution

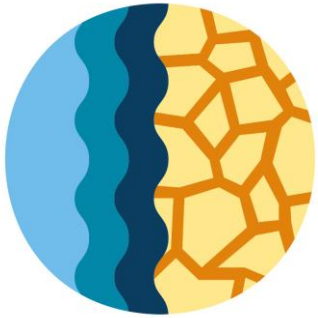
effects on flood & drought flows

Integrated, real-time sensor-processing network



delivering

high-fidelity temporal observations



FDRI
FLOODS &
DROUGHTS
RESEARCH
INFRASTRUCTURE

delivering

high-fidelity temporal observations

Accurate, complete (high freq + linked + analysed) & precise

Prejudice against high-fidelity temporal observations

Perceived irrelevance

don’t see the value for decision making

Overemphasis on precision

folk like simple, qualitative data

Cognitive overload

overwhelming amount of data

Resource constraints

perceive high cost (collection and analysis)

Difficulty in interpretation

don’t have the skills to interpret

Technological barriers

lack technical expertise of tools

Historical context

institutional / cultural resistance as apparently not needed before

Published examples of use

high-fidelity temporal observations

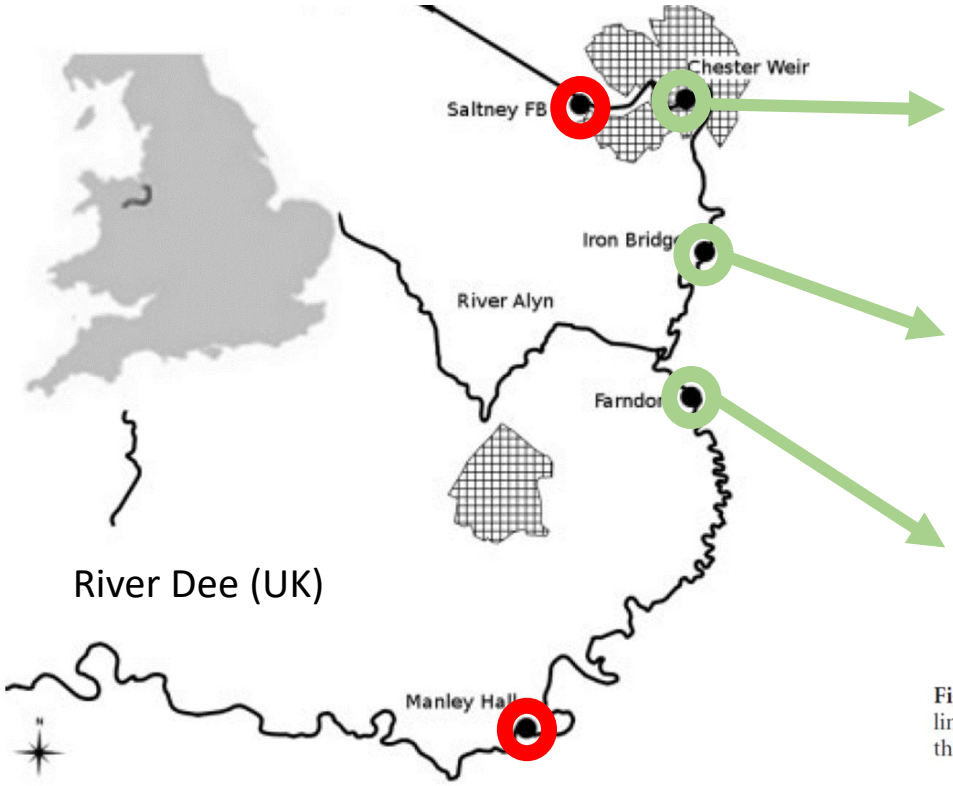
MISO-models

Multiple-Input-Single-Output

Simple example: real-time monitoring of +2 phenomena to explain/attribute dynamics in one variable

forecast 3 river levels (independently)

tide level



upstream river level

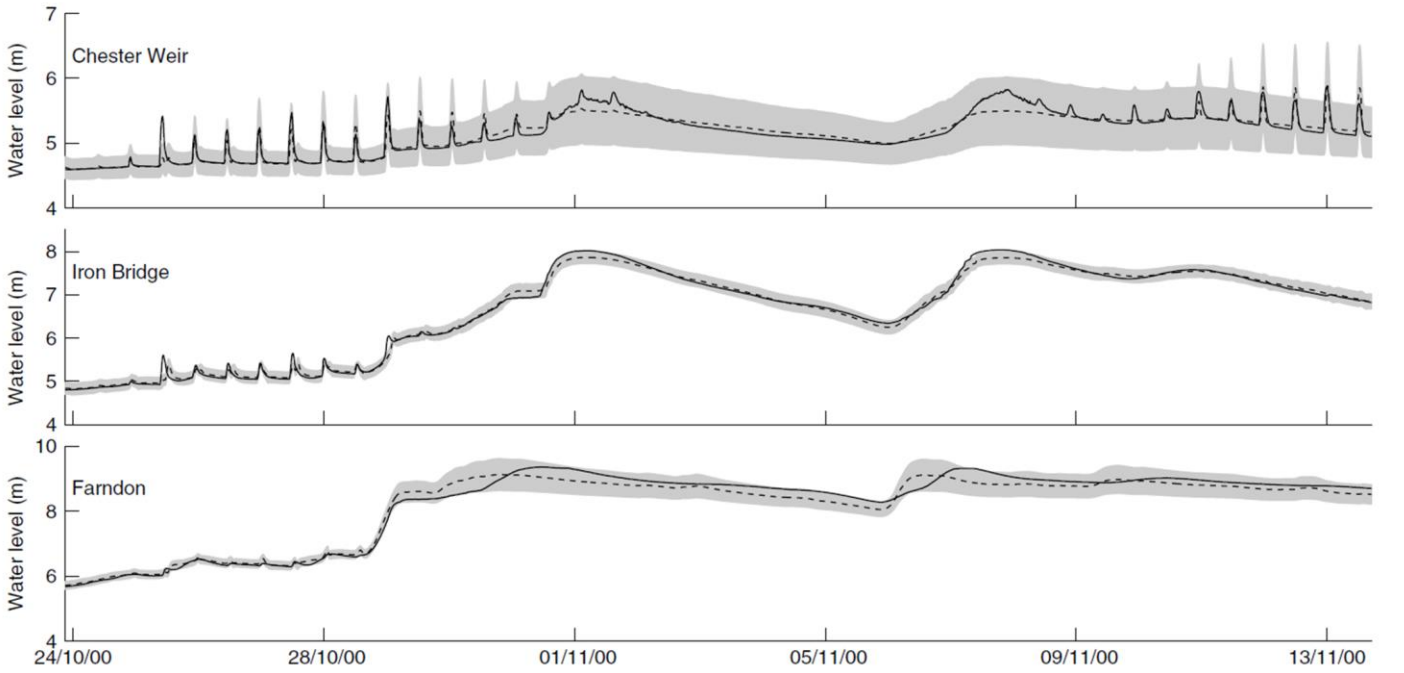


Figure 5. Predictions at the maximum available lead time for the three river water level gauges for a flood event during the calibration period. The solid line represents the observed water level, the dashed line the expected value of the predictions and the grey area encloses ±2 × the standard deviation of the prediction.

Smith, Beven & Horsburgh (2013) QJR Meteorol Soc 139: 340-349

Stream temperature

from

Solar radiation

Soil temperature

Majerska, Osuch and Wawrzyniak (2014) Science of The Total Environment 923: 171298

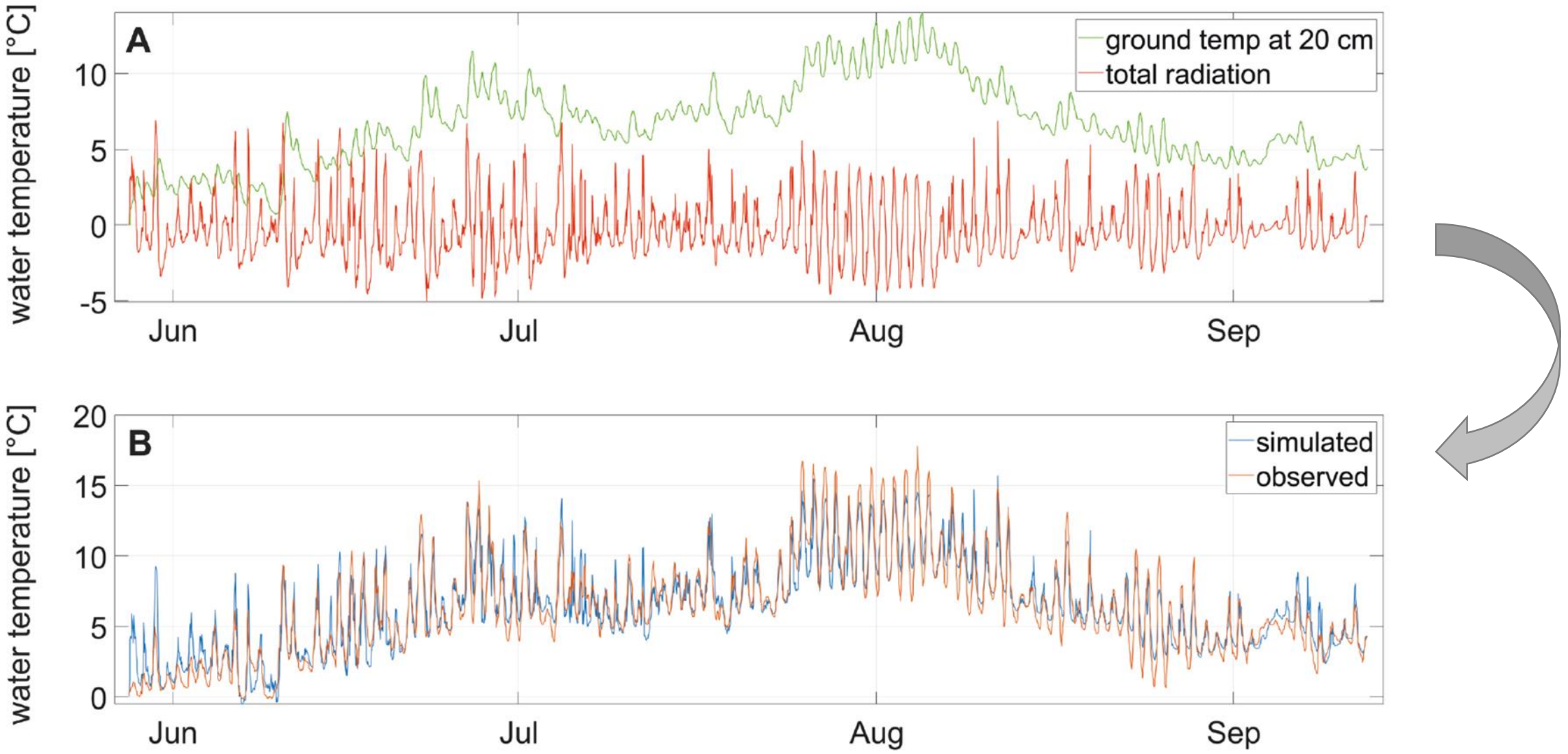
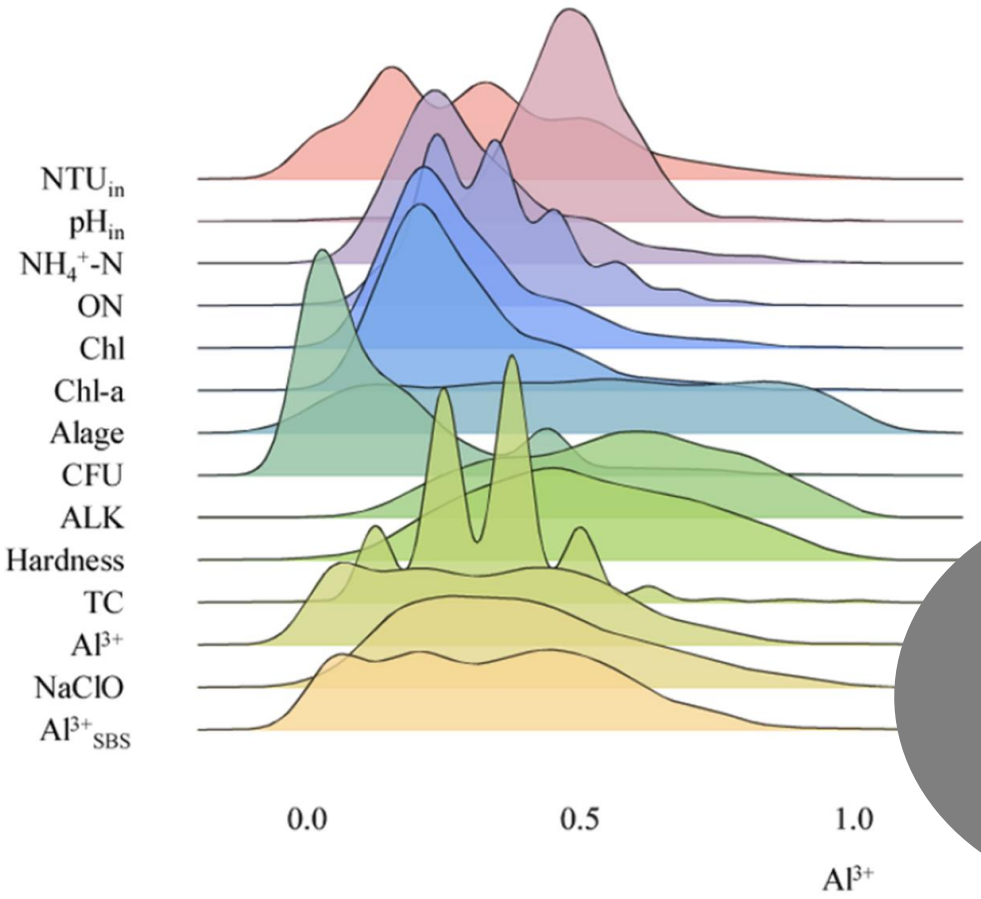
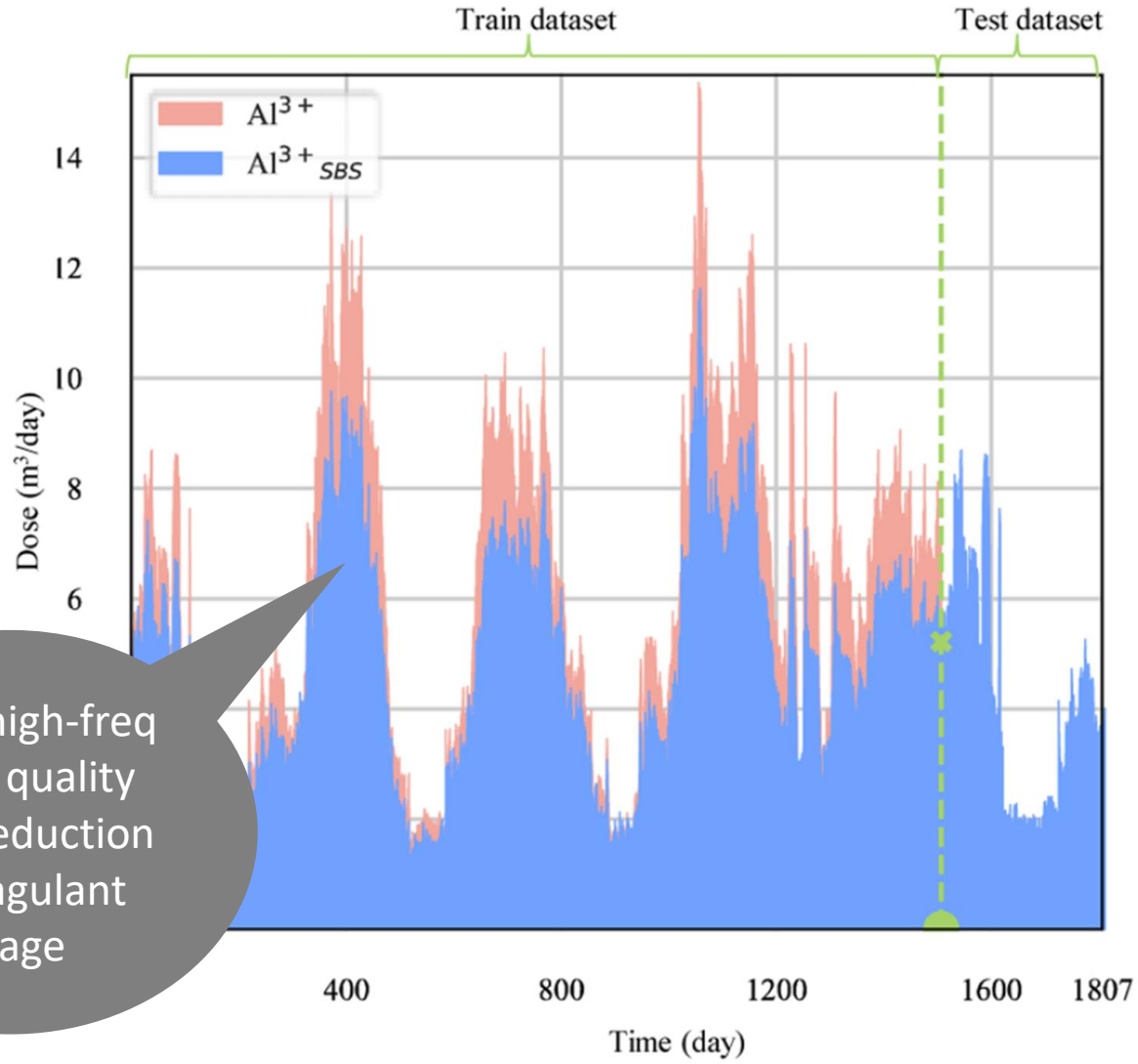


Fig. 3. Time series of a) outputs from the MISO model in the form of water temperature explained by ground temperature and total radiation and b) observed and simulated water temperature in the 2020 summer season with MISO.

real-time raw water treatment control



ML of high-freq water quality gives reduction in coagulant usage



INPUT: water quality variables (normalised)

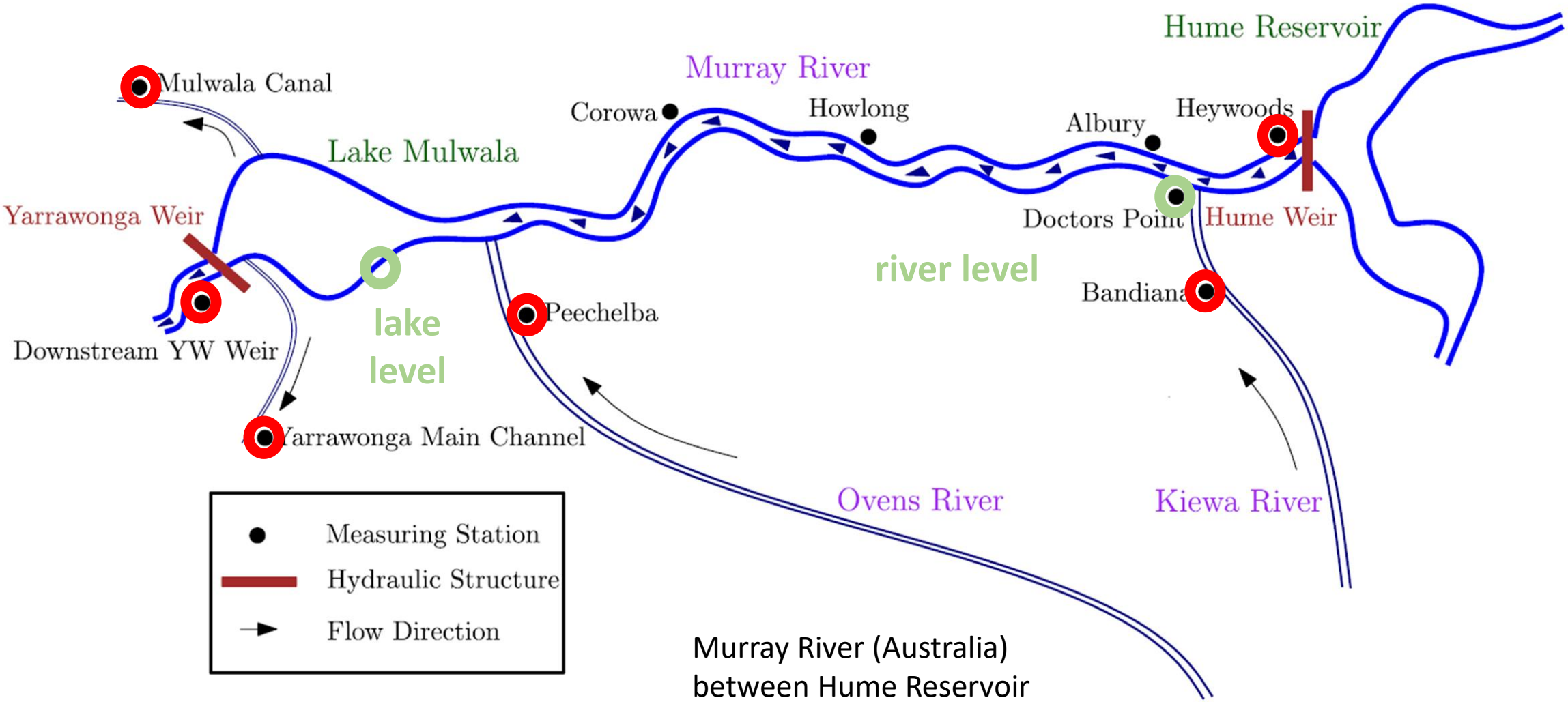
Shenzhen treatment works, China

Wang et al. (2025) Water Research 280: 123541

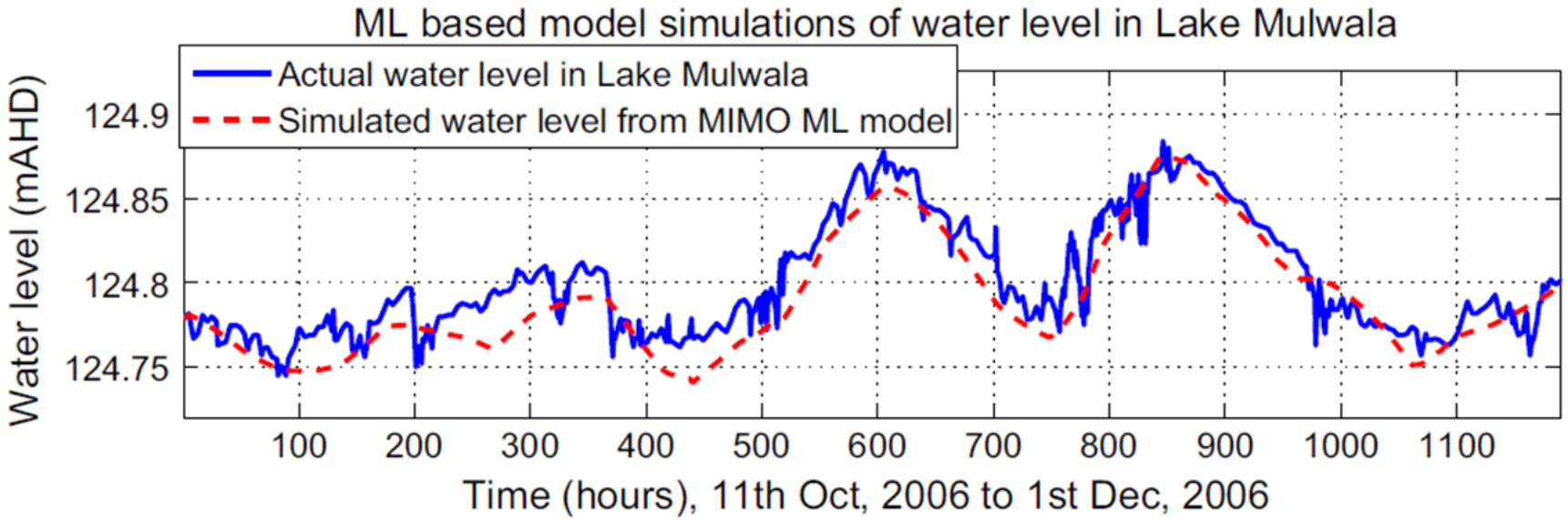
MIMO-models

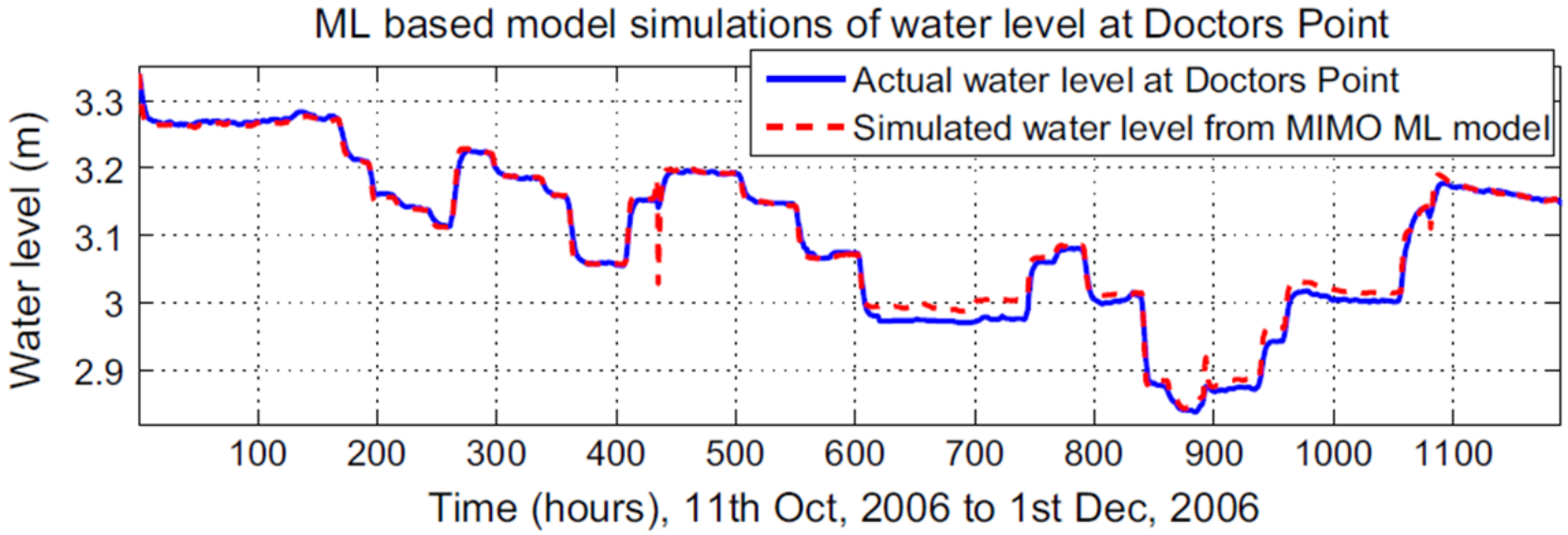
Multiple-Input-Multiple-Output

complex example: real-time monitoring of +2 phenomena
to explain/attribute dynamics in +2 variables



Murray River (Australia) between Hume Reservoir and Lake Mulwala





Nasir & Weyer (2016) Control Engineering Practice 52: 70-92

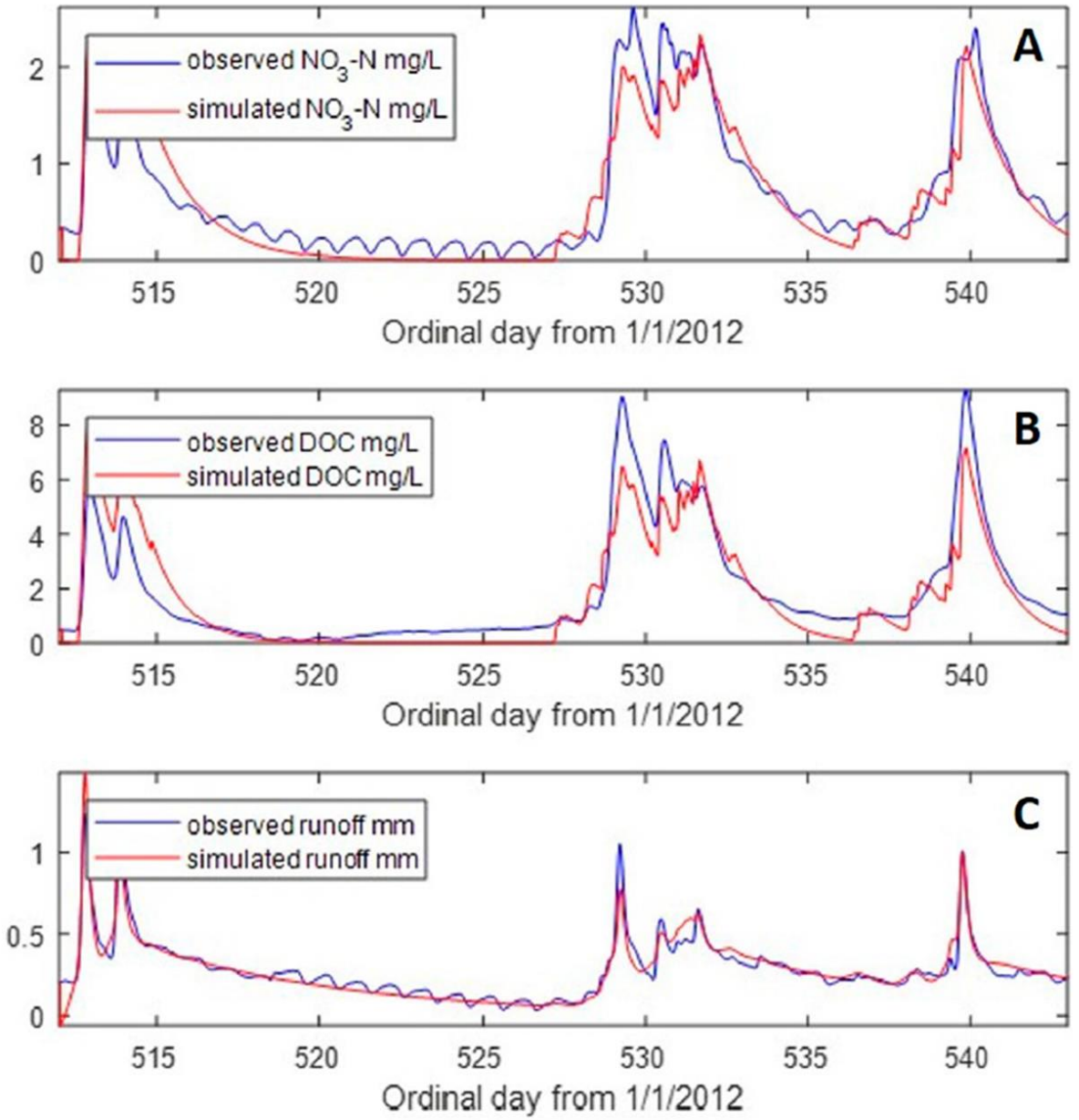
SIMO-models

Single-Input-Multiple-Output

simple example: compare dynamics of +2 variables
partly controlled by the same phenomenon

NO_3-N dynamics interpretation with reference to rain-runoff & rain-DOC dynamics

NERC Brianne micro-basins (mid-Wales)



Chappell 2024. Frontiers in Environmental Science, 12: 1473726

Many more opportunities enabled…

scientist training
in AI formulation

bridging divide between modellers and field scientists

greater appreciation of field monitoring in problem solving

Solutions to mitigate effects of climate change on flooding & water shortage

Identifying behaviour of water pollutants & effective mitigation measures

Flood & drought forecasts better informed by state of catchment

help solve

UK water issues

Building evidence base on efficacy of Blue-Green Infrastructure

Harnessing digital innovation for smarter water management

Optimising water solutions for food production, energy systems and nature recovery

depends on your personal commitment

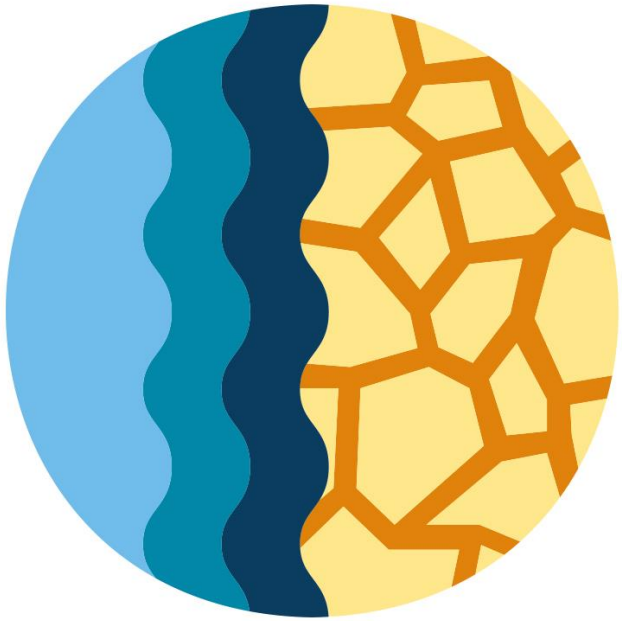
to an aspect of

designing

deploying

testing

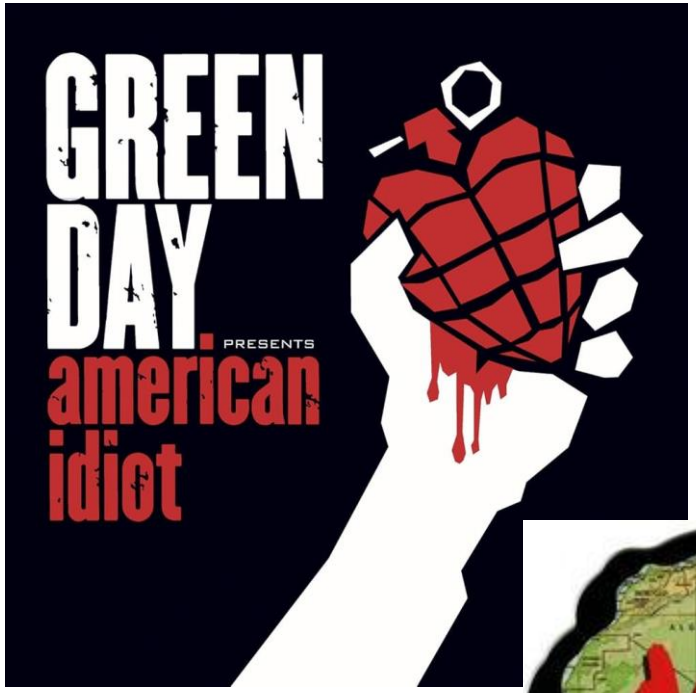
maintaining



FDRI

FLOODS & DROUGHTS RESEARCH INFRASTRUCTURE

If you don't have high-fidelity temporal observations



[American idiot]

Aliasing

songs where only every other beat missing

[Africa]

thank you

chiefscienceadvisor-fdri@lancaster.ac.uk