MOT4Rivers:

Monitoring, modelling and mitigating pollution impacts in a changing world: science and tools for tomorrow's rivers

Better Water Quality for Wales Conference
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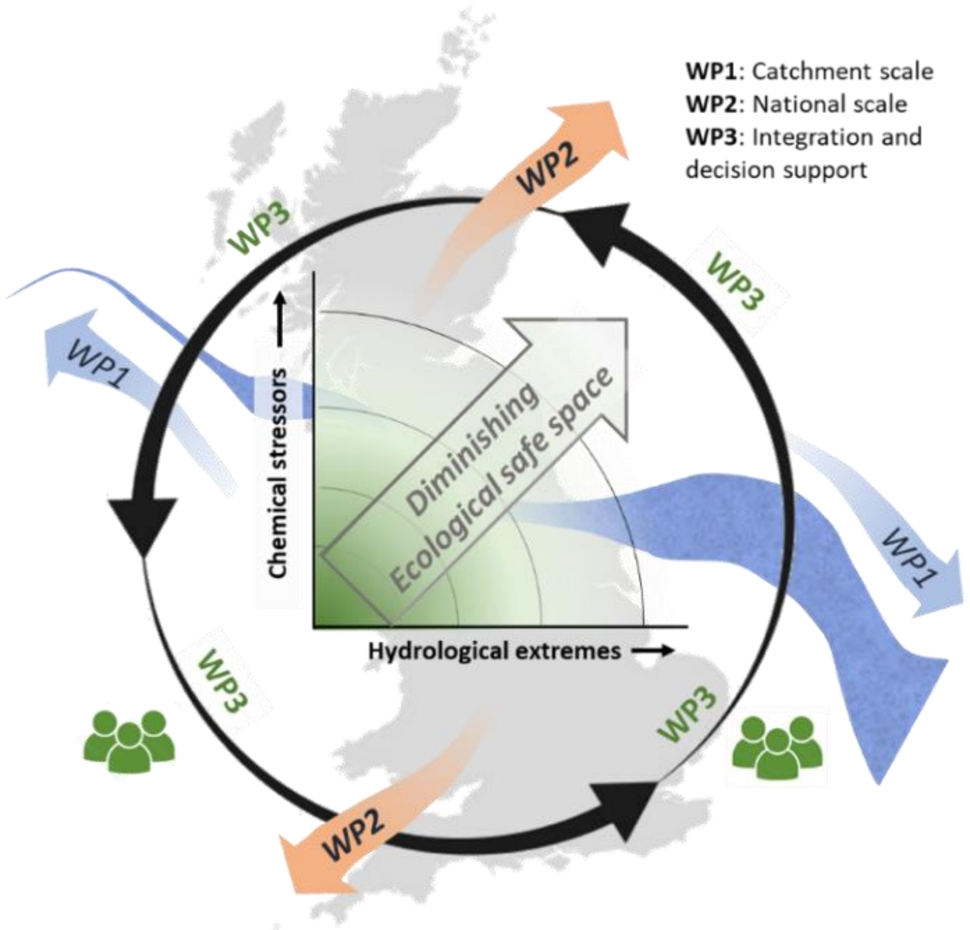
MOT4Rivers Research Vision

Explore the *Ecological Safe Space* within which ecosystems can thrive, as delimited by changing hydrological, chemical and biological stressors.



Combining *state-of-the-art* science and *next generation* technology from the catchment to the national scale to deliver:

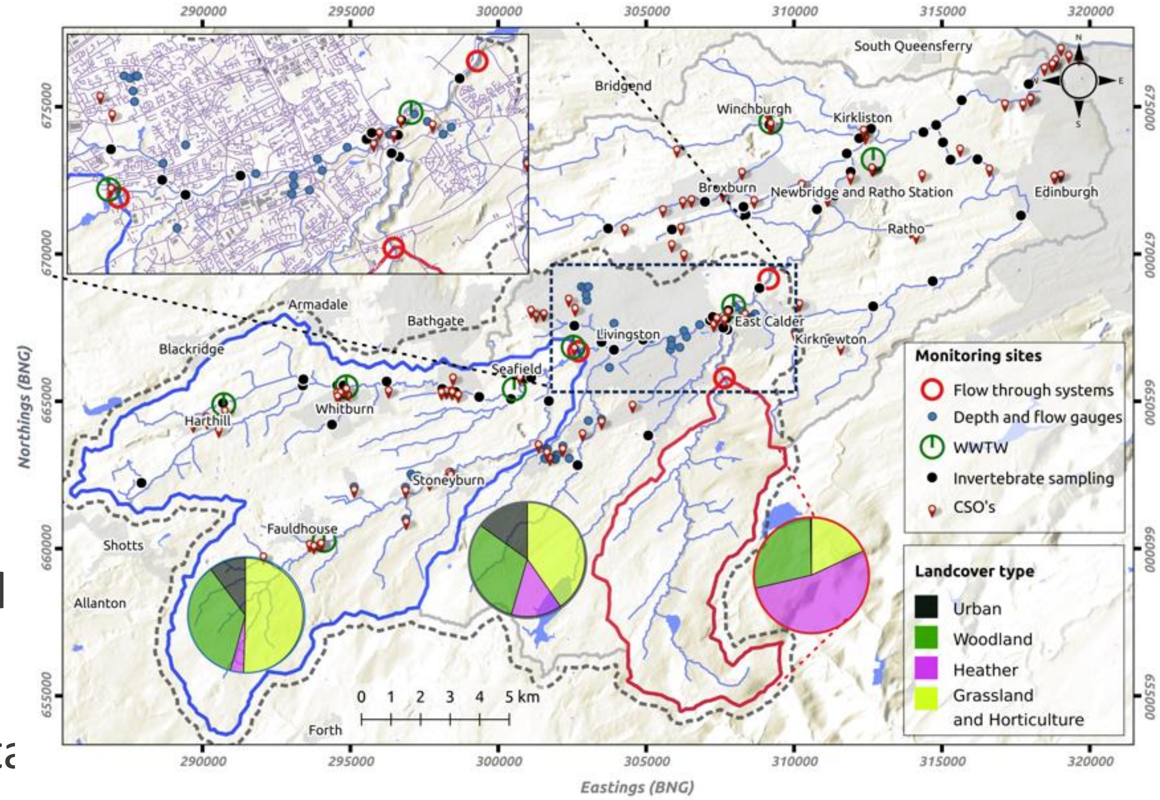
1) Intelligence on the hydro-climatic controls on the fate and impact of pollutant cocktails
2) Understanding on the differential sensitivity of ecological communities and their structure and function
3) Decision Support Tools for testing interventions for mitigation and adaptation

Theme 1: Hydro-climatic controls on pollutants

Assessing pollutants at catchment and national scale by bringing together data from across the *water sector* and transforming our understanding through state-of-the-art science and technology:

Almond catchment – event based up to seasonal catchment scale controls on fate of individual and contaminant combinations through the latest in digital innovation and modelling

National scale using data science (AI, data mining and ML) to assess how spatial climatic and hydrological gradients influence environmental impacts



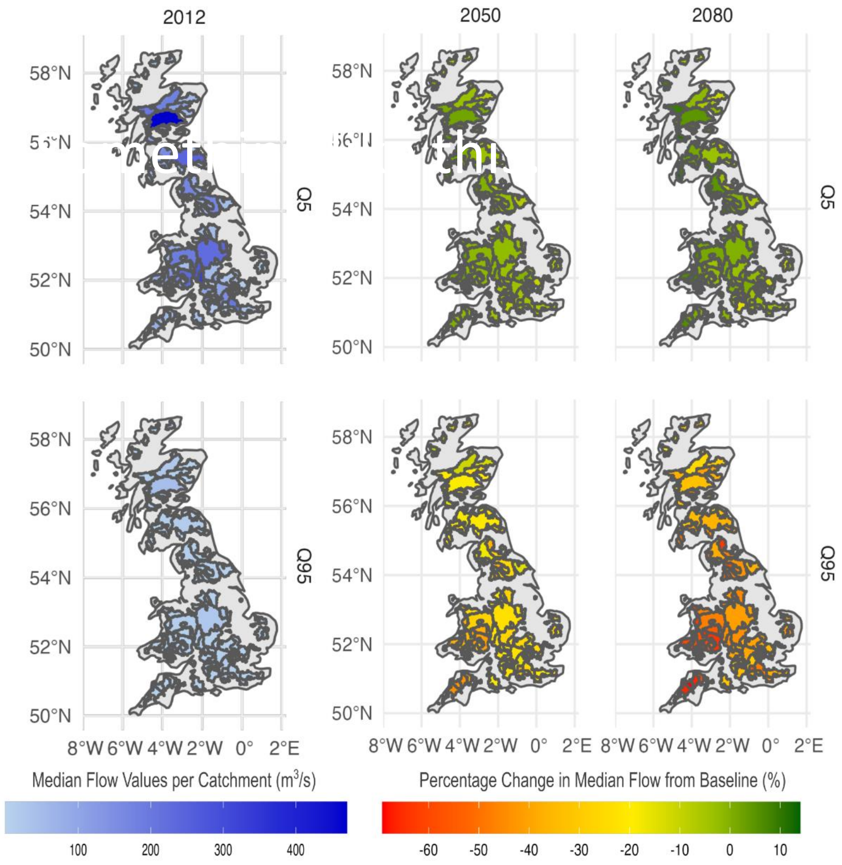
Theme 2: Impact of pollutant mixtures & exposure regimes on freshwater ecosystems

Using transformative data science and analytic techniques to quantify the *sensitivity* of ecological receptors to our indicators of catchment and national chemical ‘*exposure*’

We will include a suite of geospatial artificial intelligence methods to create an analytics pipeline to:

- fuse, assimilate and impute the diverse national data sets,
- develop and classify chemical exposures and ecological sensitivity
- use deep learning and other methods to explore relationships

We will sense check the findings for ecological meaning



eFLaG: High Flow Q5/Low Flow Q95 metric 2012 & percentage change for 2050s & 2080s

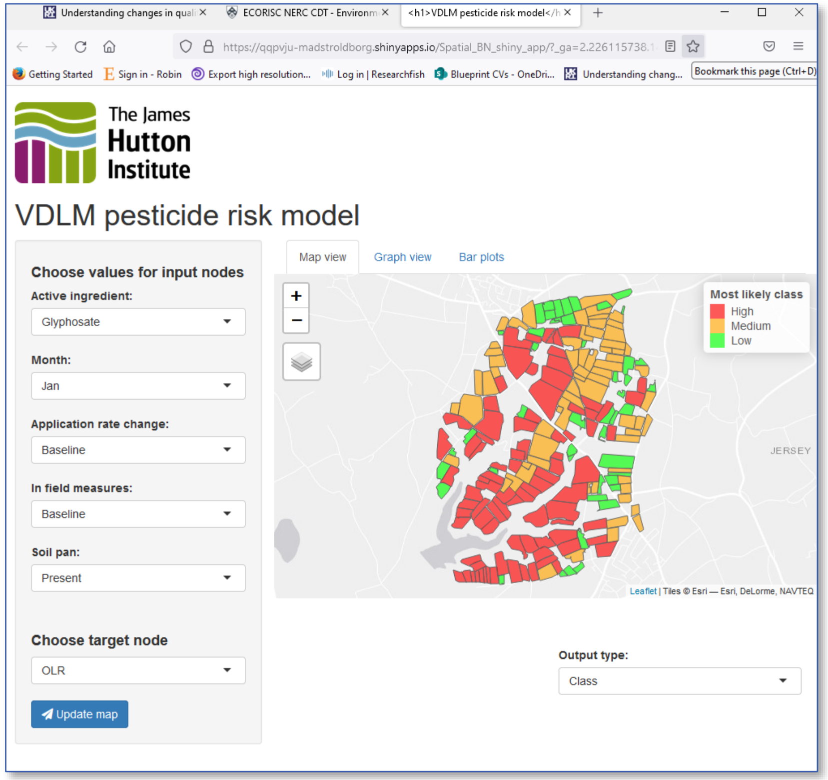
Hannaford et al, 2022 (pre-print), *Earth Syst. Sci. Data*

Theme 3: Informing adaptation, mitigation & detection of risks with current & future river quality

Bayesian networks are **probabilistic models** that incorporate uncertainty and improve environmental risk assessments.

We will develop a probabilistic **Decision Support Tool** with:

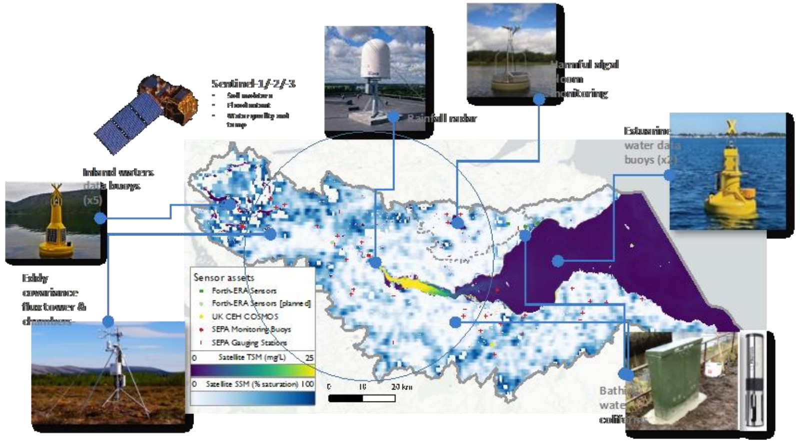
- Landscape-scale understanding of pollutant mixture sources, mobilisation, delivery and ecological risk
- Under co-developed mitigation scenarios and policy options
- Current and future conditions
- Behavioural change (eg pharmaceutical eco-prescribing)



Example Decision Support Tool for catchment scale pesticide risk model

Troldborg et al. 2022 HESS, Moe et al. 2020 J. Integrated Env. Assessment & Management

MOT4Rivers - Transformational science enabled by:

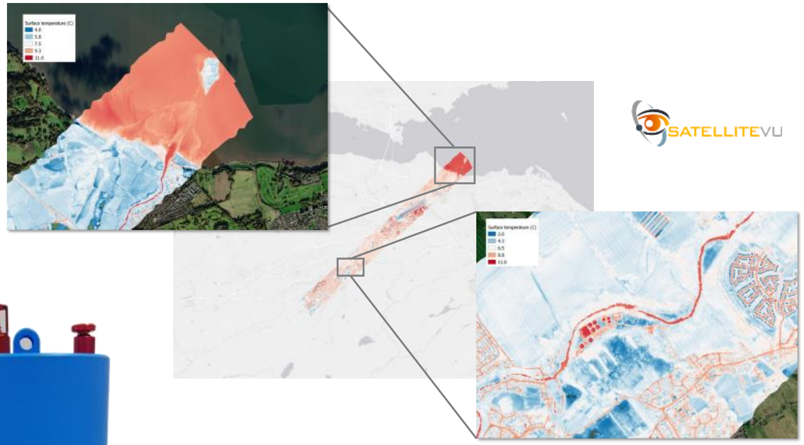


Forth-ERA: Digital observatory of the water continuum – support the Green Recovery

Hydro Nation Chair: R&I programme funded by Scottish Water to support the Net Zero ambition

Attracting next generation sensing:

- Satellite-based thermal imaging:

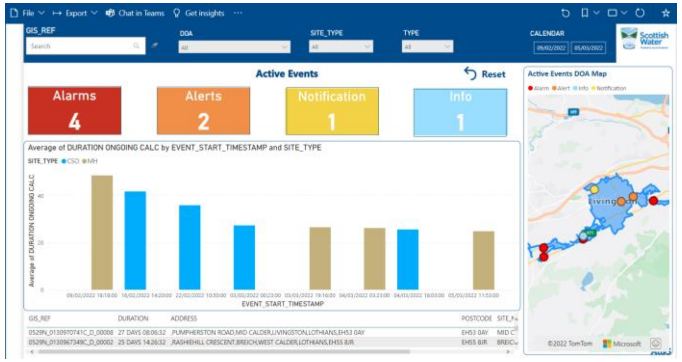


- Lab on a chip sensors high temporal resolution monitoring, novel analytes:
  - Caffeine, Ibuprofen
  - NO_2 & NO_3, PO_4 & NH_4

Scottish Water's Wastewater Intelligent network:

60 flow and depth sensors and hydraulic modelling

Active Alerts Dashboard



The Team Including Partners & Support

Hydro Nation Programme
- Scottish Government / Riaghaltas na h-Alba / gov.scot
- Hydro Nation Chair – Net Zero - Scottish Water Sector
- CREW
- Hydro Nation International Centre
- UNESCO
- University of Dundee

Policy Partners
- Department for Environment Food & Rural Affairs
- The Scottish Government / Riaghaltas na h-Alba

Local/Catchment Partners
- West Lothian Council
- Forth Rivers Trust

Health Partners
- NHS Highland
- OHBP – One Health Breakthrough Partnership

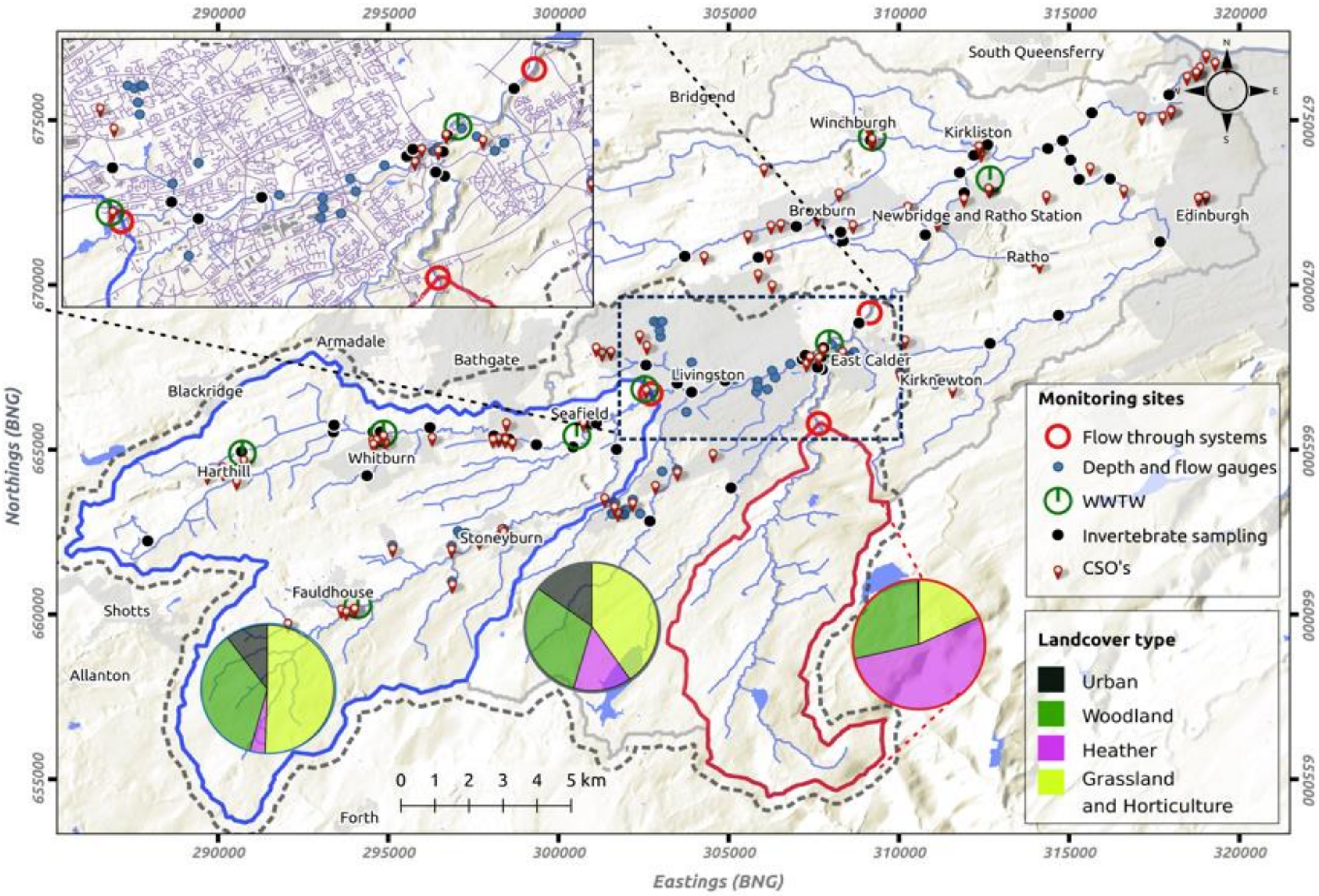
International Partners
- Danube4All
- DANUBIUS-RI
- Water - ForCE
- MERLIN
- UN environment
- WWQA – World Water Quality Alliance
- GEO AQUA WATCH

UK Water Industry Partners
- Scottish Water – Trusted to serve Scotland
- British Water
- UKWIR
- SPRING
- The UK Water Partnership

Digital Partners
- The Alan Turing Institute
- SWS
- 3DEO
- lightwater sensors
- SatelliteVu

Regulatory/Statutory Partners
- SEPA – Scottish Environment Protection Agency
- Environment Agency
- NatureScot – Scotland's Nature Agency / Buidheann Nàdair na h-Alba
- JNCC – Joint Nature Conservation Committee

Almond catchment monitoring



Almond catchment monitoring

Table 1: Proposed sampling strategy, spatial/temporal resolution and associated parameters

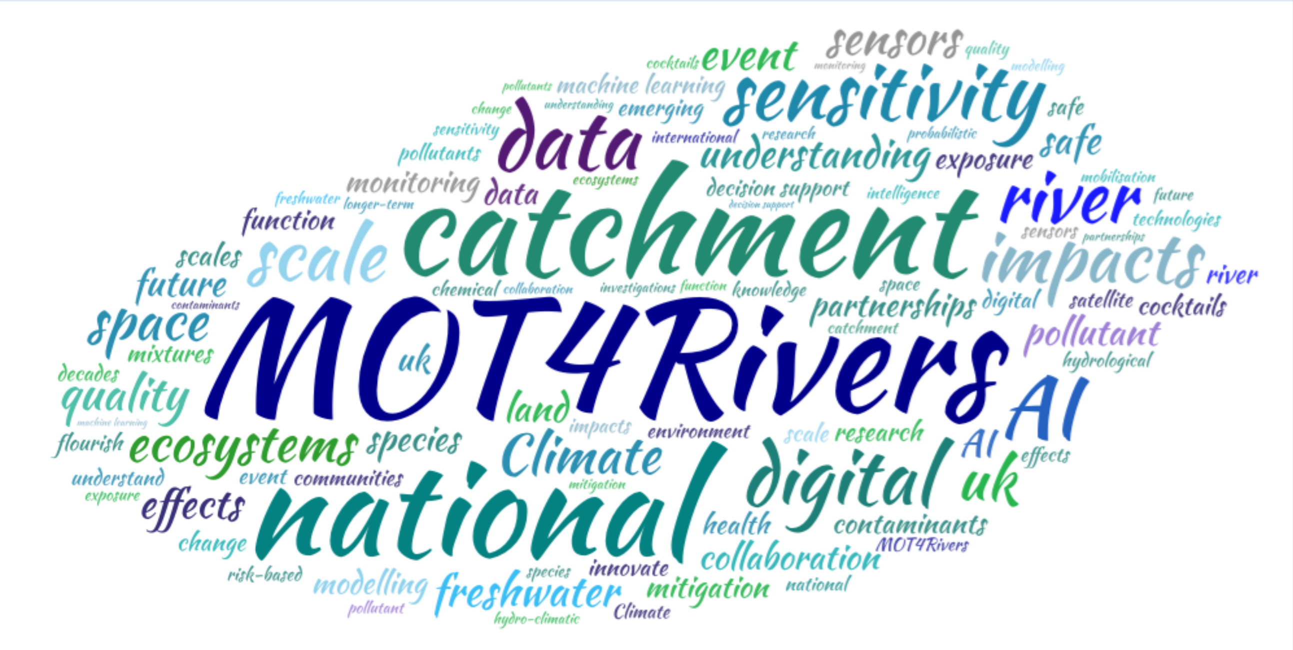
No of Sites	Frequency	Parameters Measured
60	15-min	East Calder: water depth and flow sensors
3 sentinel	15-min	Flow Through Systems: Coliforms (faecal, *E. coli*, total), T, CDOM, Chl a, DO, BOD, COD, Turb. Additional sondes for pH, EC, DOC, TOC, TSS and trialling novel sensors for Optical Chemical Sensing Caffeine, Pharmaceuticals (Lightwater Sensors), and Microfluidics for dissolved NO_2, NO_3, NH_4 and PO_4 (SouthWestSensor Ltd)
15-25	Monthly	Spatially distributed sampling for the above plus, DON, TON, pharmaceuticals, pesticides, pCO_2, pCH_4, CO_2/CH_4 fluxes, eDNA
6-8	6-monthly	As above plus macro-invertebrate surveys
3 sentinel	Quarterly*	Time-integrated suspended sediment sampling, bed sediment sampling and passive sampling for pesticides/pharmaceuticals
3 sentinel	Event	All parameters, target 30 high flow events across 3 sites
		* indicates sampling to cover 18-month period, all others 30-36



Almond catchment monitoring – key steps

1. Finalise monitoring sites in catchment using past data from SEPA & FRT to ensure we span pollutant gradients of interest ☑
2. Catchment recce sampling in May ☑
3. Install monitoring equipment including high resolution flow through systems
4. Commence sampling in early autumn (likely September)
5. Collect data over 36 months to 2026

Engage with local stakeholders to optimise outputs for all



Thank you

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