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Understanding the hydrological dynamics of acid herbicides in river catchments using high-resolution data

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afbini.gov.uk

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www.daera-ni.gov.uk

Interreg
EUROPEAN UNION
Northern Ireland - Ireland - Scotland
European Regional Development Fund

An Roinn Tithíochta, Pleanála agus Rialtais Áitiúil
Department of Housing, Planning and Local Government

Project Partners

northern ireland water
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EAST BORDER REGION

Ulster University

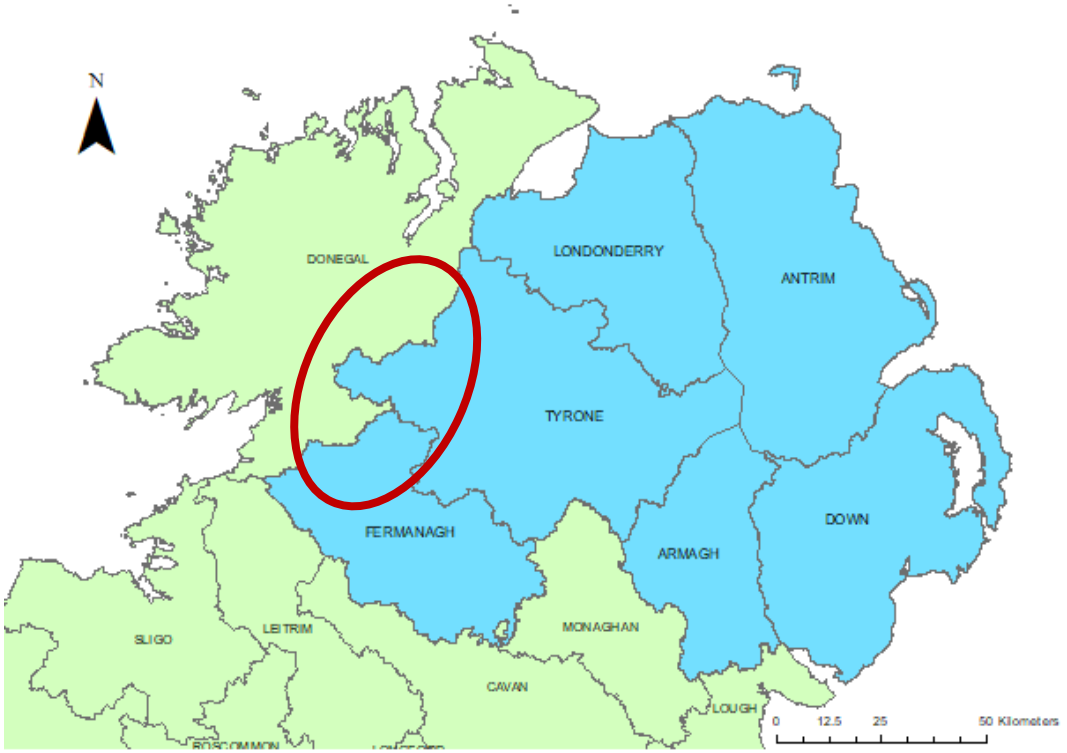
The Rivers Trust

The 'Source to Tap' project is supported by the European Union's INTERREG VA Programme, managed by the Special EU Programmes Body (SEUPB).

Source to Tap – project background

An innovative project to protect and improve the rivers and lakes within cross-border catchments in Ireland/Northern Ireland.

- Two cross-border catchments:
  - Catchment 1 = 384 km^2
  - Catchment 2 = 386 km^2
- Pesticide concs >>DWD limit of 0.1 µg L^{-1} in **surface** water abstracted for drinking water treatment before supply.



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Which pesticides?

MCPA – main concern

- Most used herbicide on marginal and upland agricultural land in Ireland/Northern Ireland
- Suppress rushes (*Juncus* spp.)
- Highly soluble

Other acid herbicides in the catchments include:

- **Mecoprop**
- **Fluroxypyr**
- **Triclopyr**

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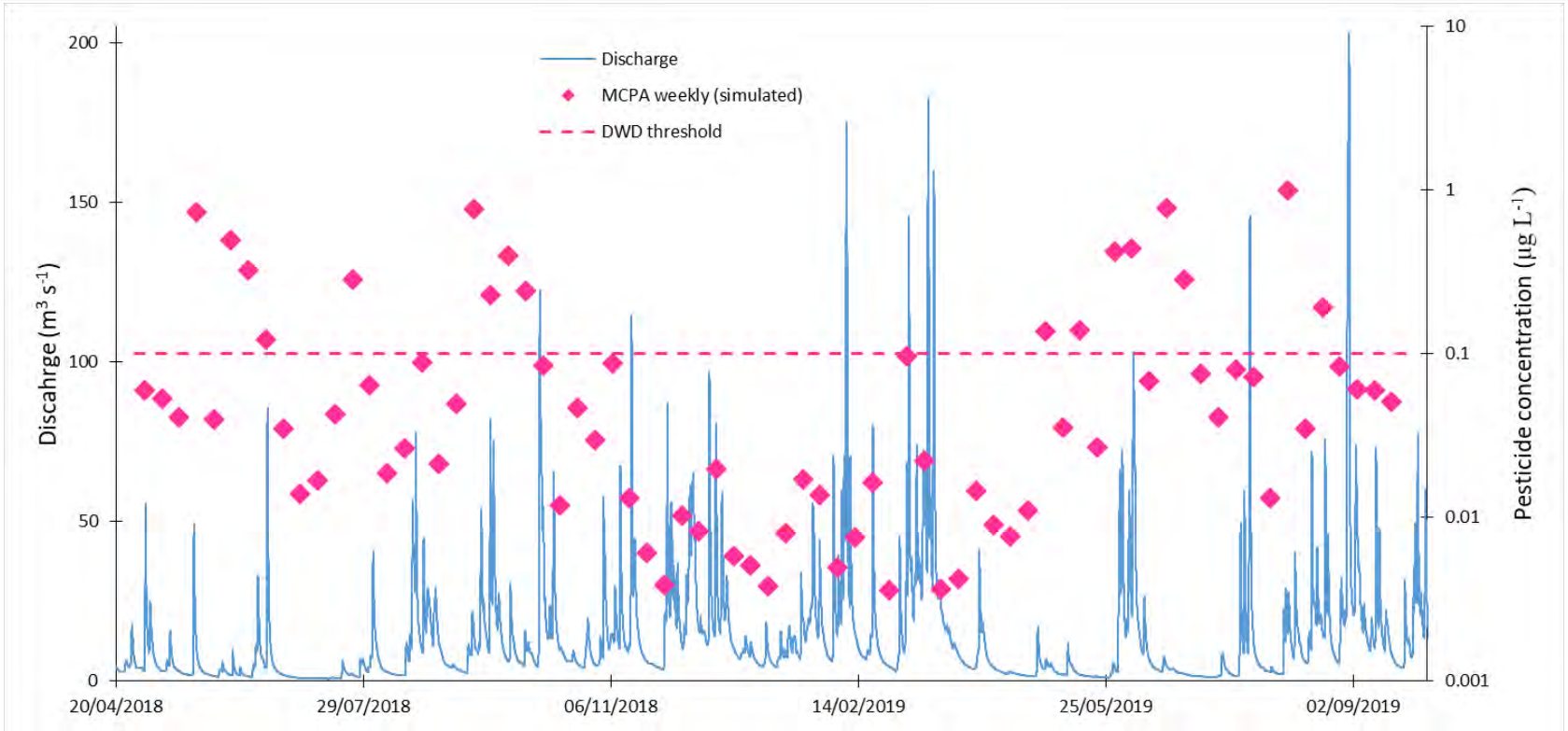
Impact of sampling frequency
(simulated from high resolution data)



- Sampling typically weekly across EU water companies – e.g. NI Water sample every 6-10 days
- Higher frequency needed to identify sources and for development of mitigation options

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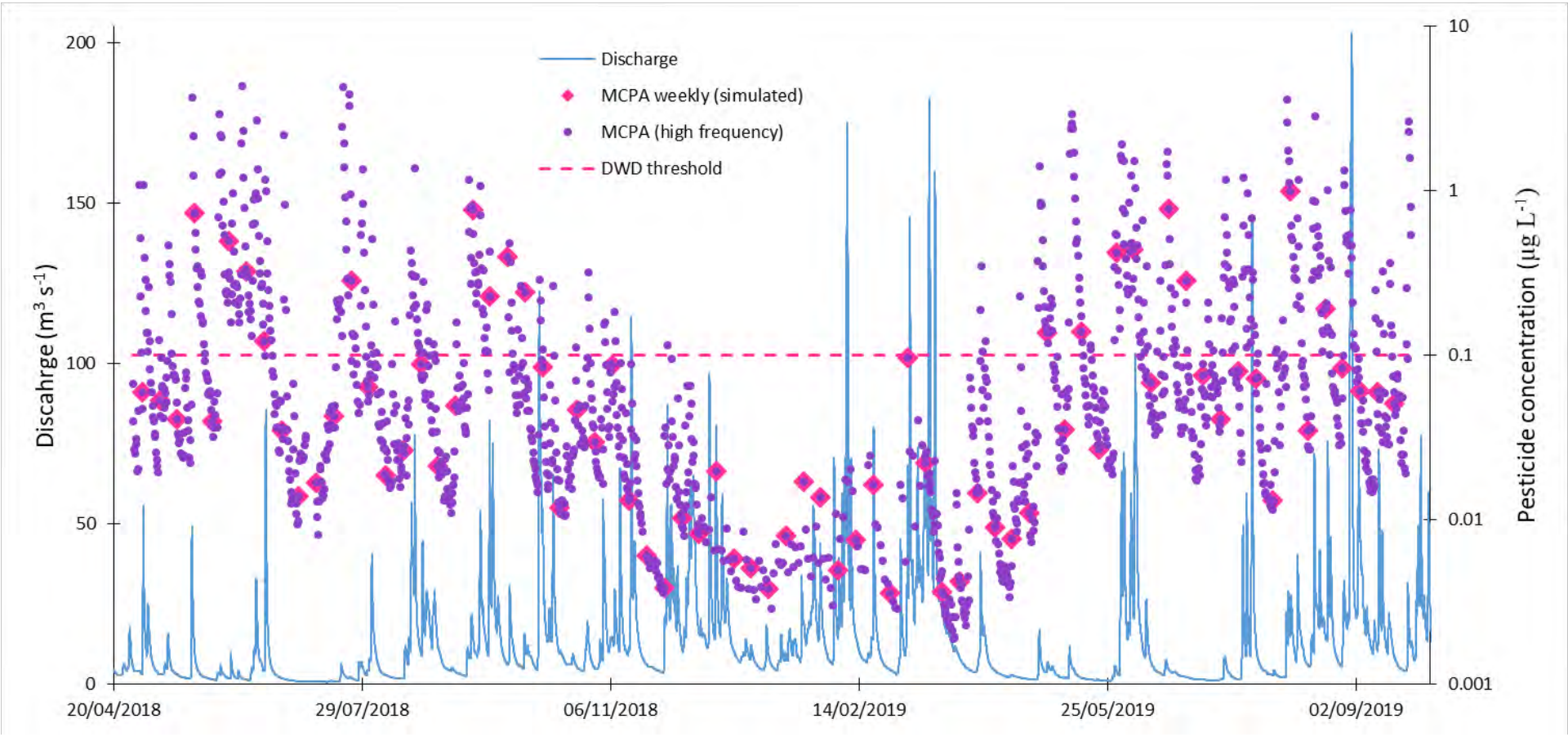
High resolution monitoring



- Weekly sampling misses peaks and troughs.

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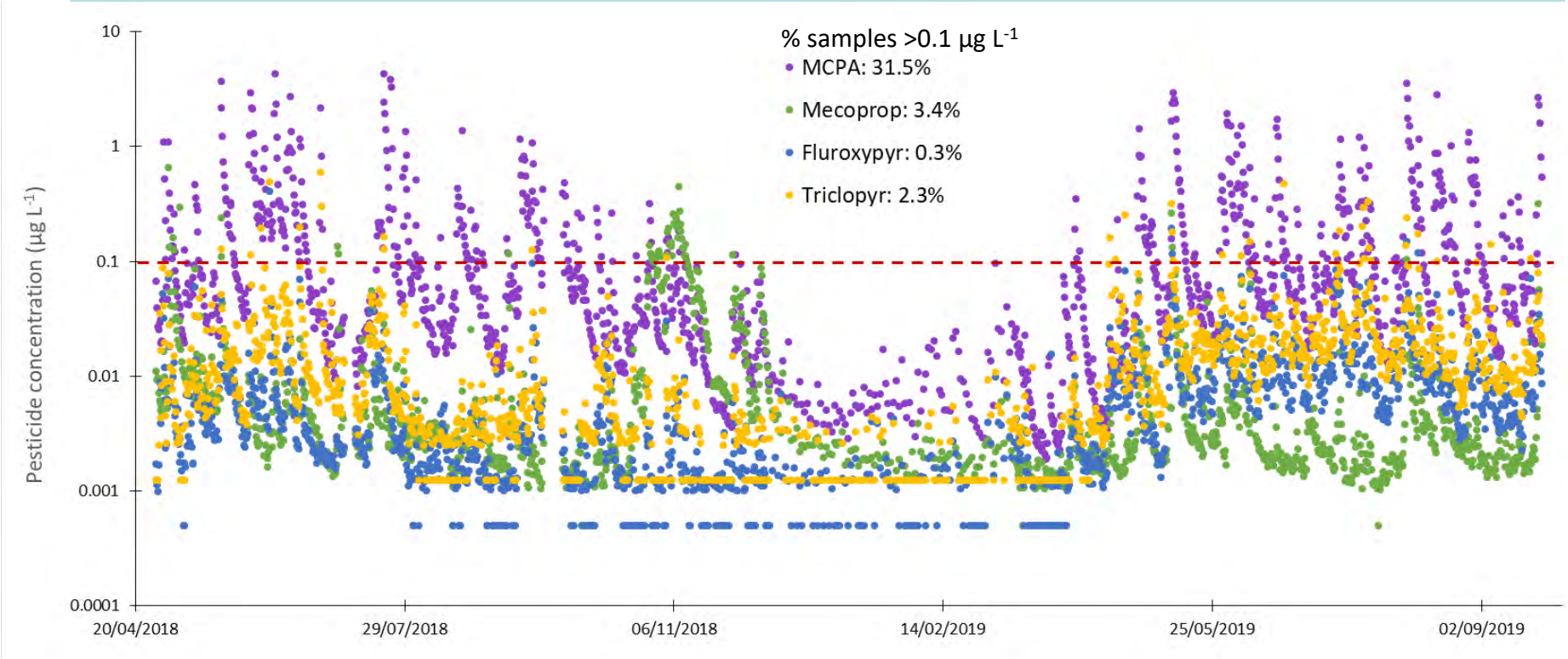
High resolution monitoring – Catchment 1



- Very little high resolution pesticide data for the island of Ireland
- Shows problem greater than expected
- Pesticide removal requires additional treatment = increased costs

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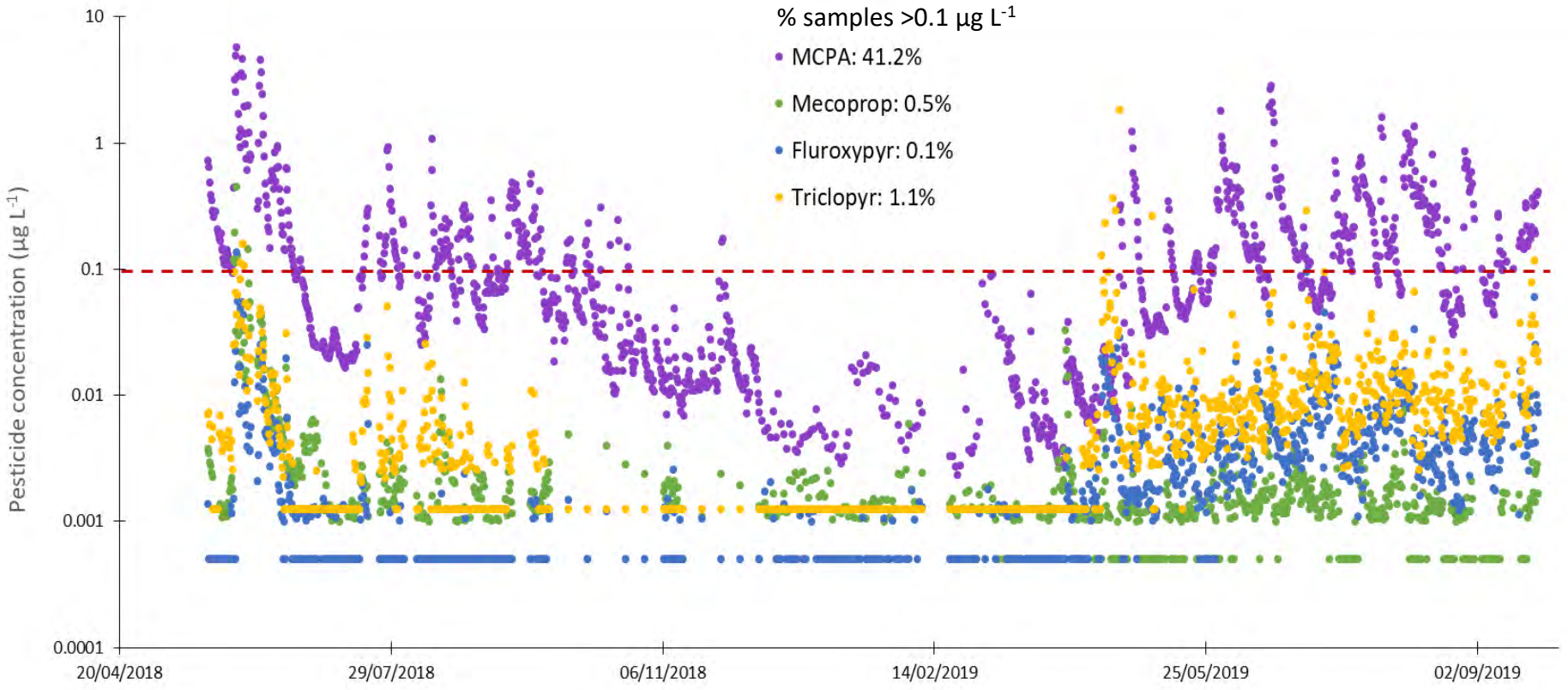
High resolution monitoring –Catchment 2



- Enables analysis to understand sources and pathways
  - Focus on Catchment 1

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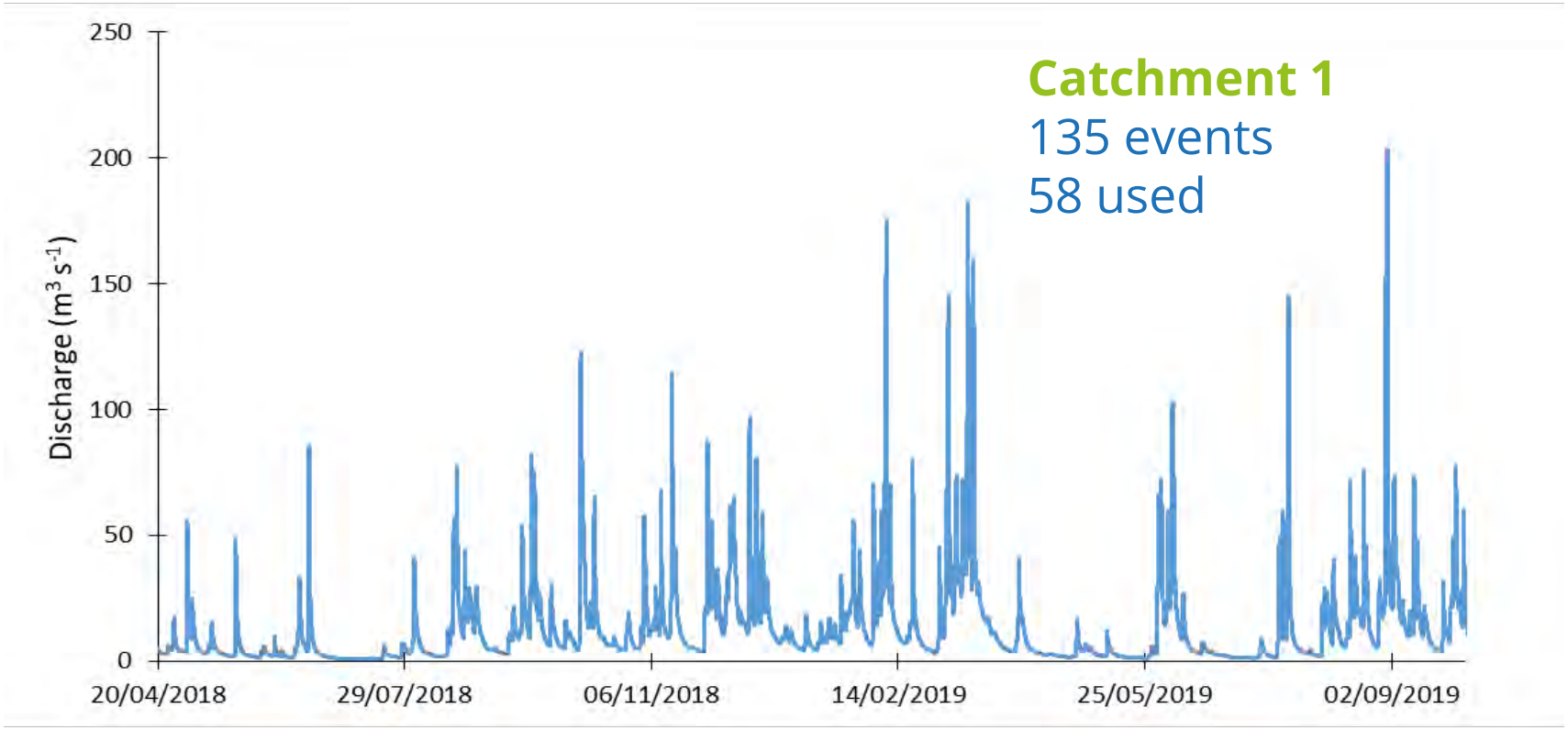
Storm event selection



- Storm events identified by discharge peaks
- Discharge and concentration standardised 0-1 for each event with 7 or more pesticide samples

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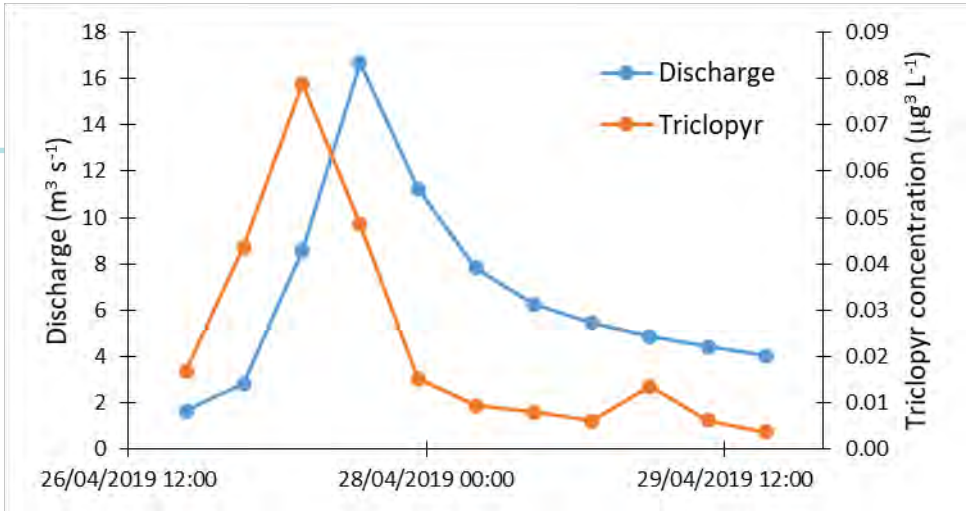
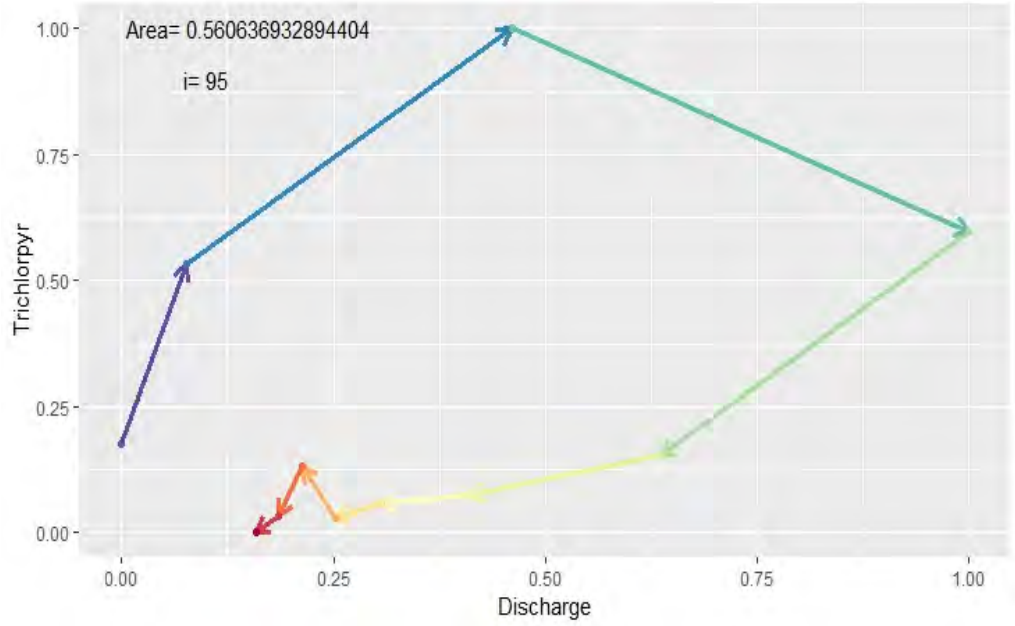
What is hysteresis?

Predict and understand sources and pathways of solutes during rainfall events

- Clockwise
  - Pesticide concentration peaks before flow
  - Transport limited
  - Closer source





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What is hysteresis?

Predict and understand sources and pathways of solutes during rainfall events

- Clockwise
  - Pesticide concentration peaks before flow
  - Transport limited
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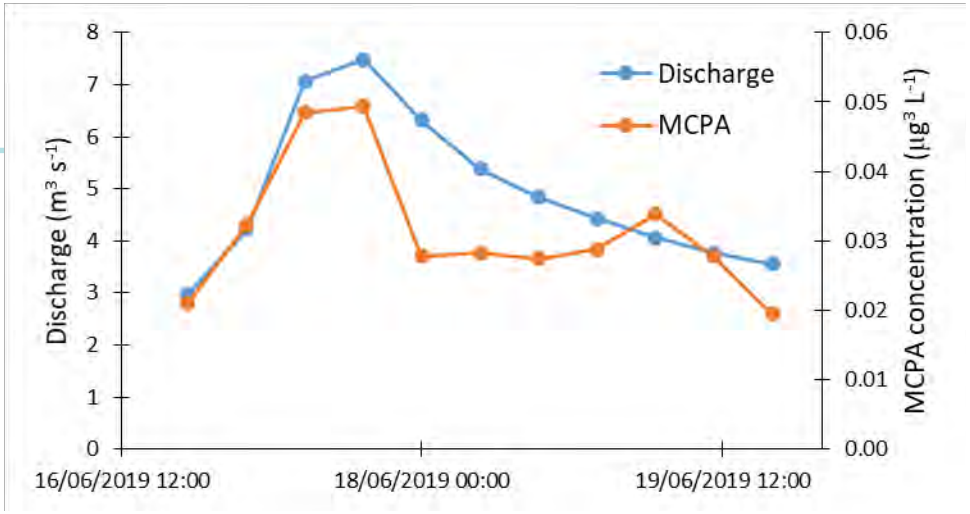
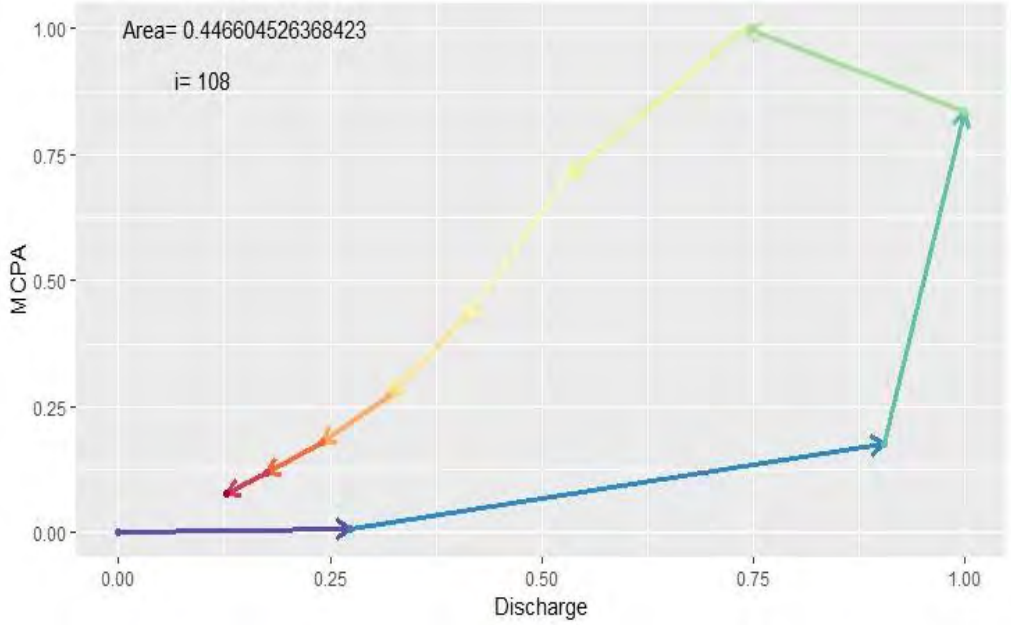
- Anti-clockwise
  - Flow peaks before pesticide concentration
  - Supply limited
  - Further source





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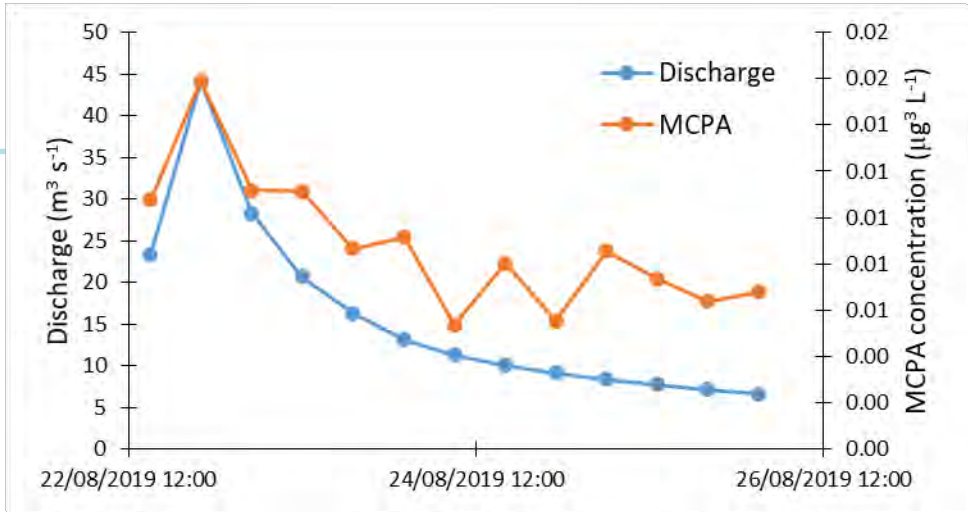
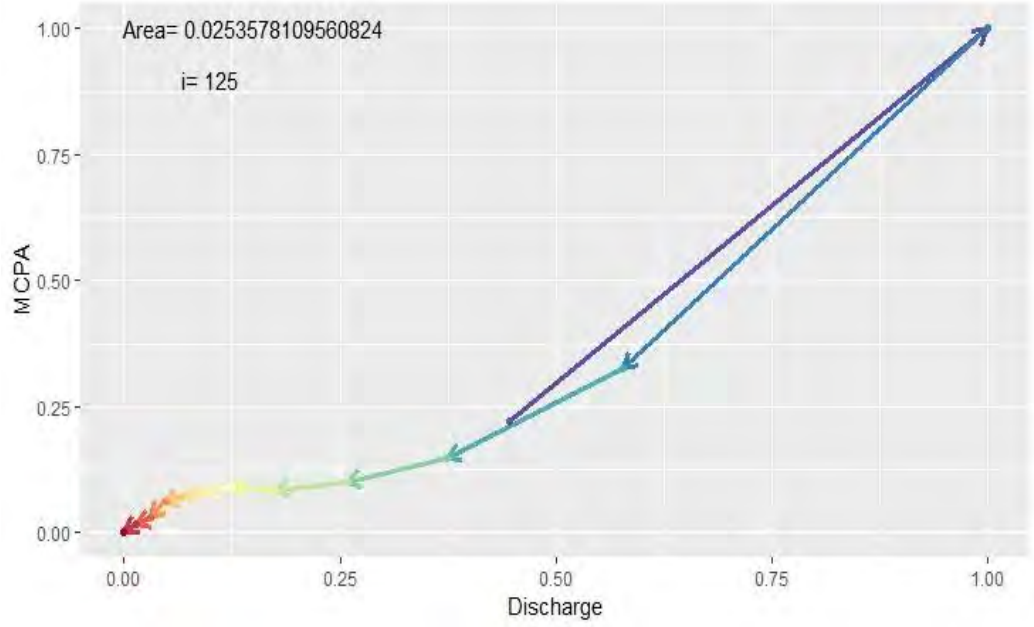
- No hysteresis
  - Pesticide concentration and flow peak together





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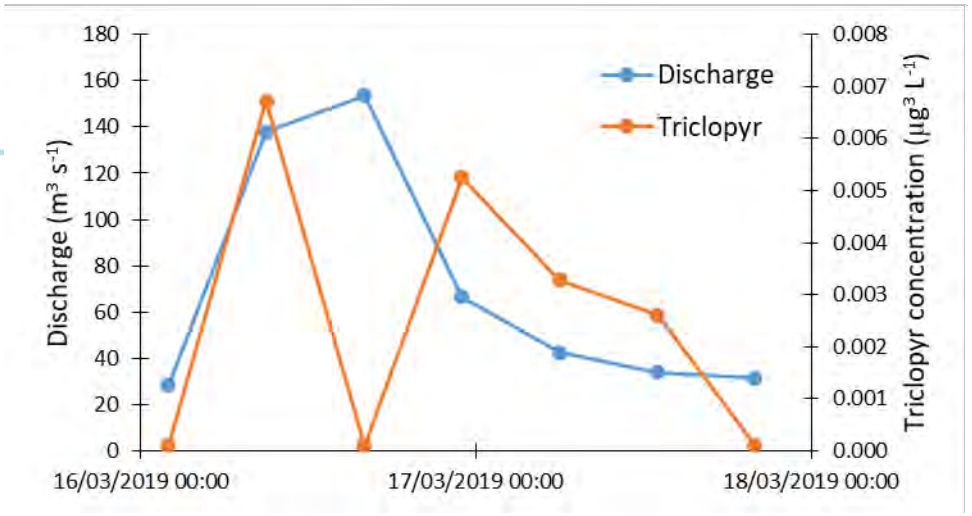
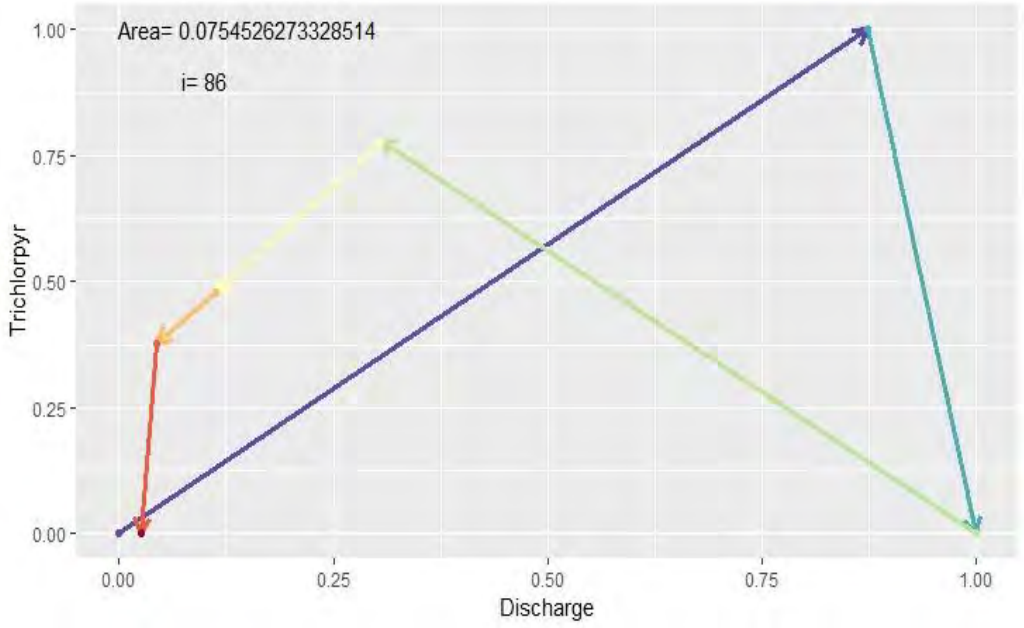
- Figure-of-8





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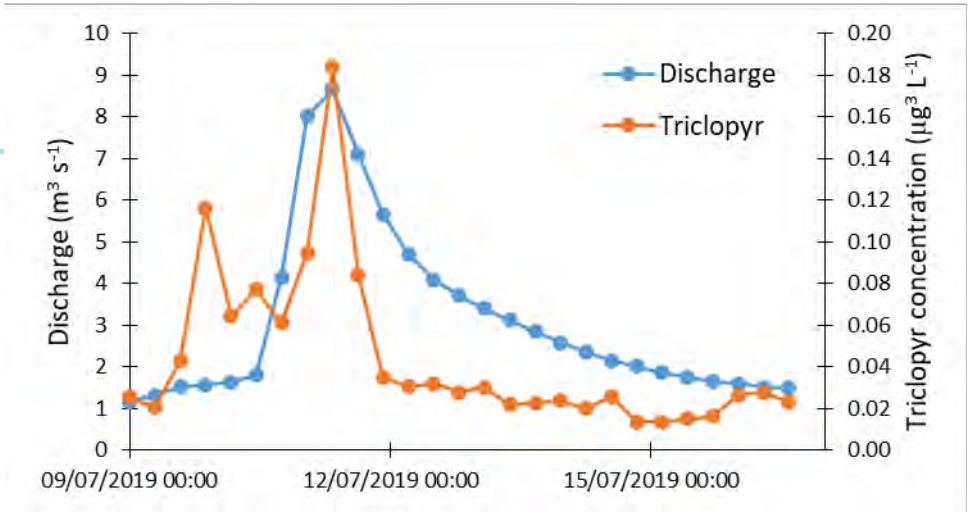
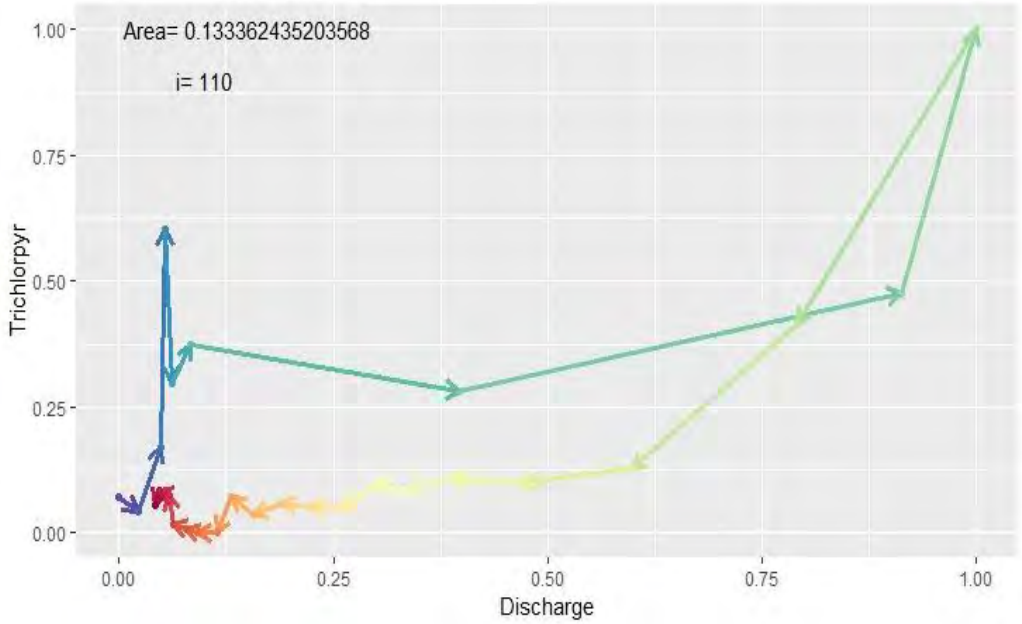
- Complex dynamics





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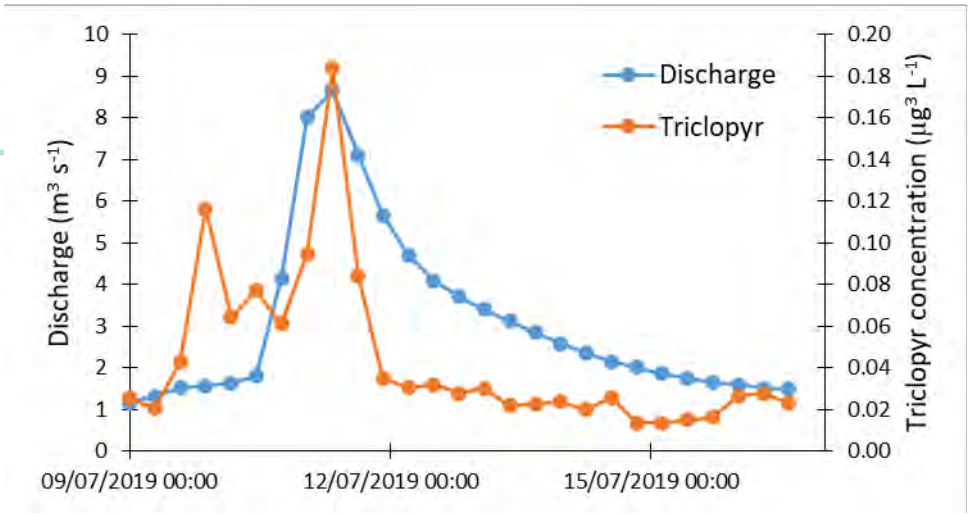

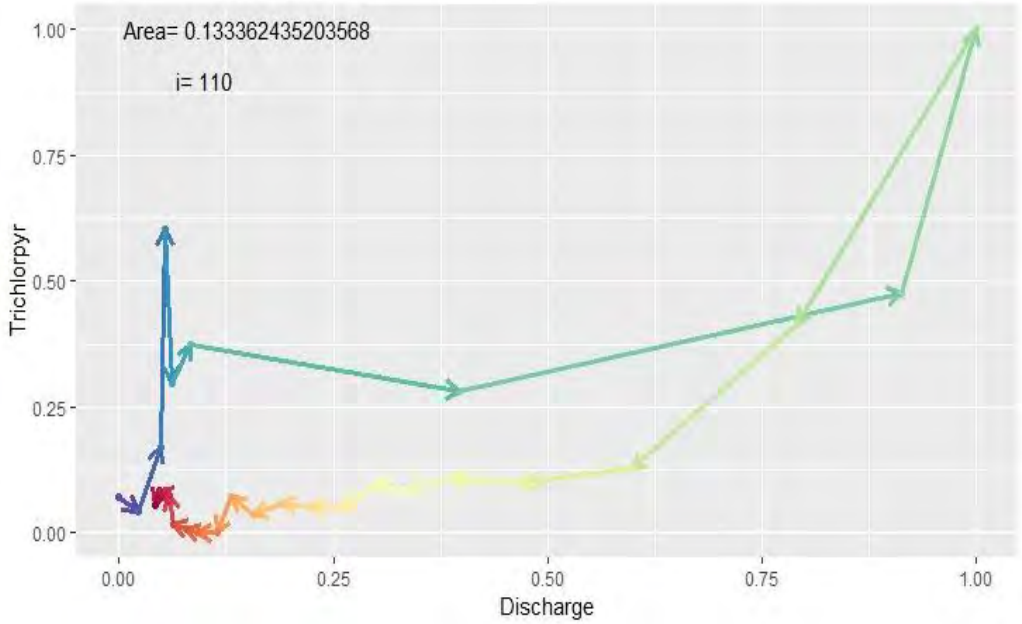

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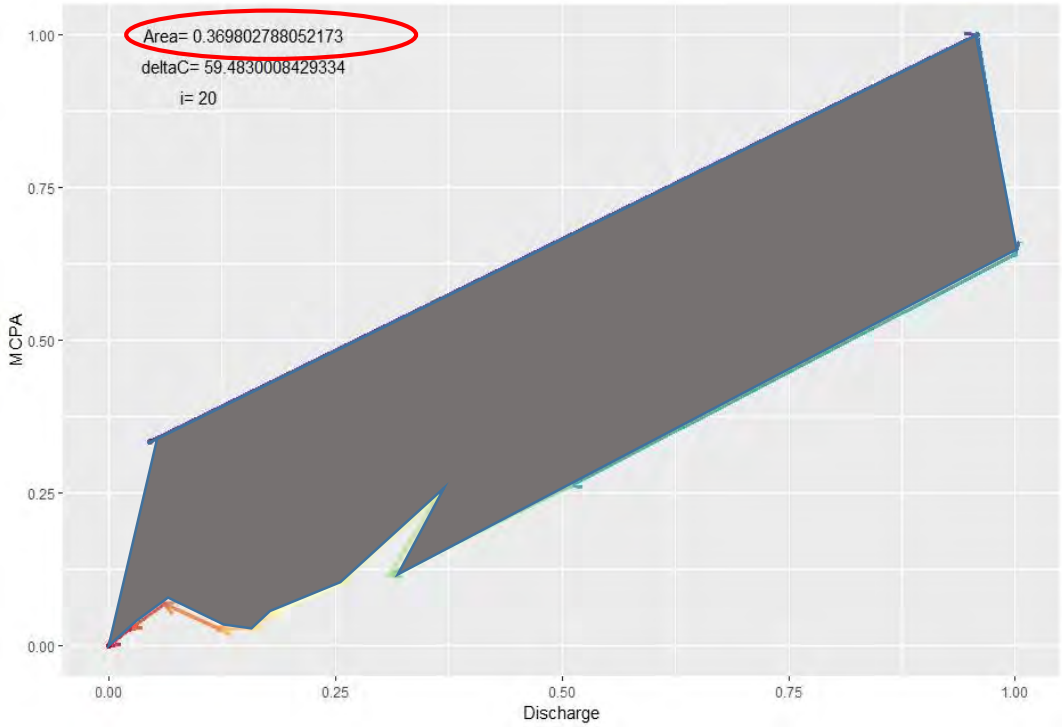
What is hysteresis?

ΔR and ΔC

Equations used are from Butturini et al. (2006) Biogeochemistry, 77: 327-349. DOI 10.1007/s10533-005-0711-7

ΔR = R*Ah*100

- Clockwise = 1
- Anti-clockwise = -1
- No hysteresis = 0
- Figure-of-8 = 0
- Complex = 0



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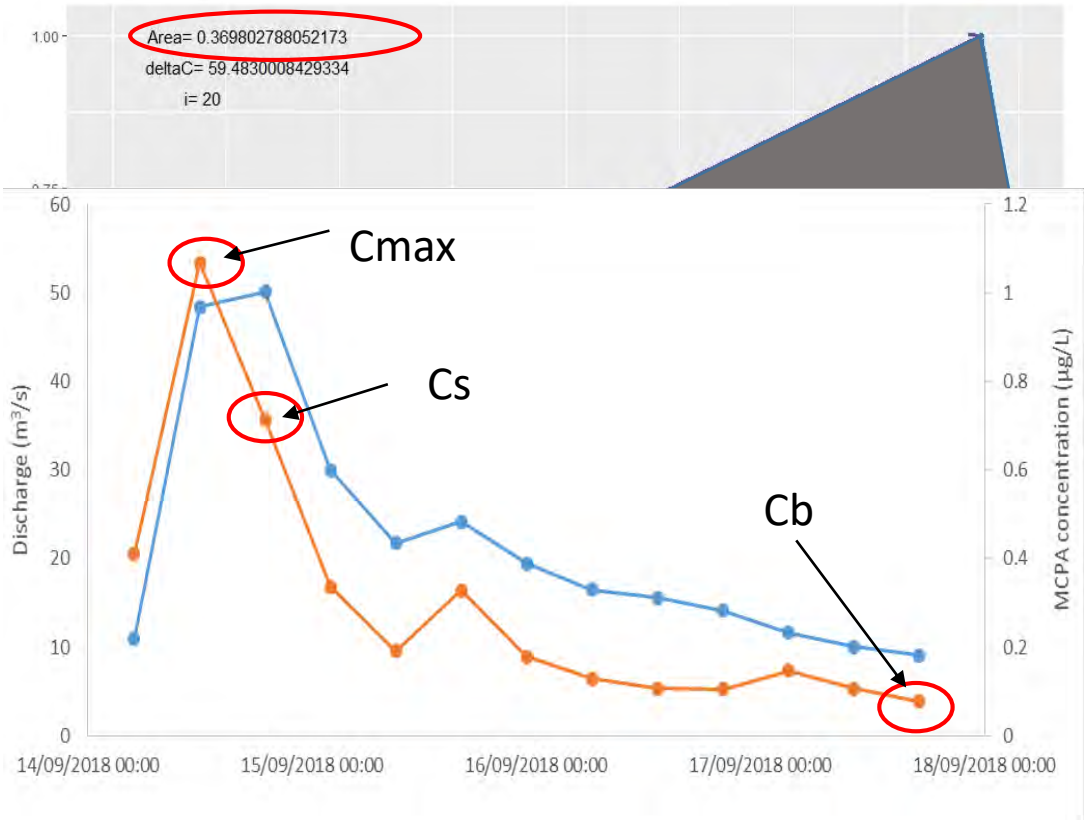

ΔC = ((Cs – Cb)/Cmax)*100

Proportional concentration change over event

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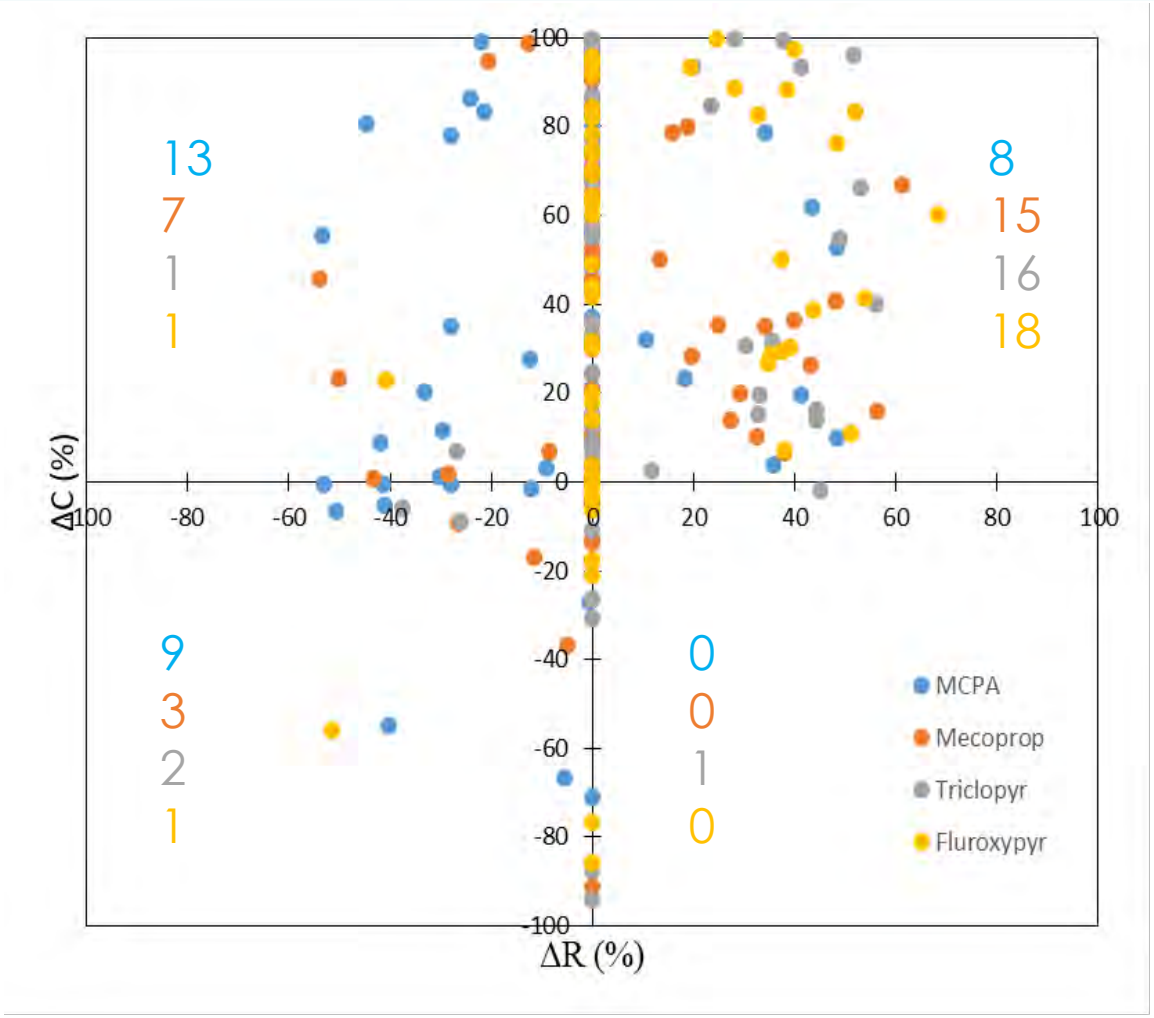
ΔR vs ΔC – Catchment 1

Anti-clockwise Flushing

Clockwise Flushing



Anti-clockwise Dilution

Clockwise Dilution

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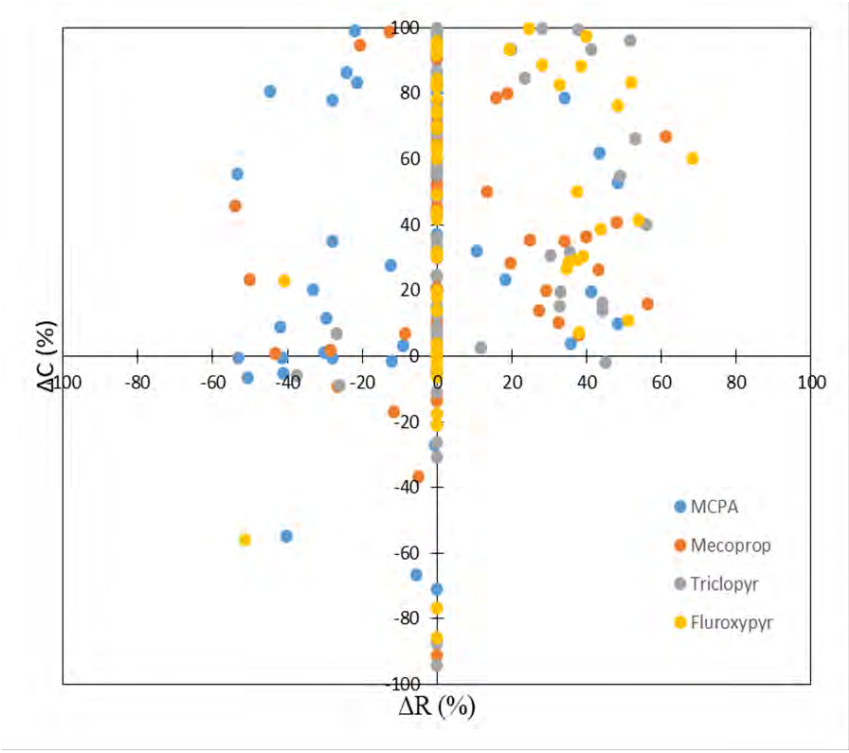
How is hysteresis useful?

- Different movement of MCPA to other herbicides – MCPA has a higher K_{OC} so runs off slower? MCPA from more distant sources?
- Little dilution of any herbicide – each event distinct.
- Many events have ΔR of 0
  - No distinct hysteresis
  - Different locations contribute to same events



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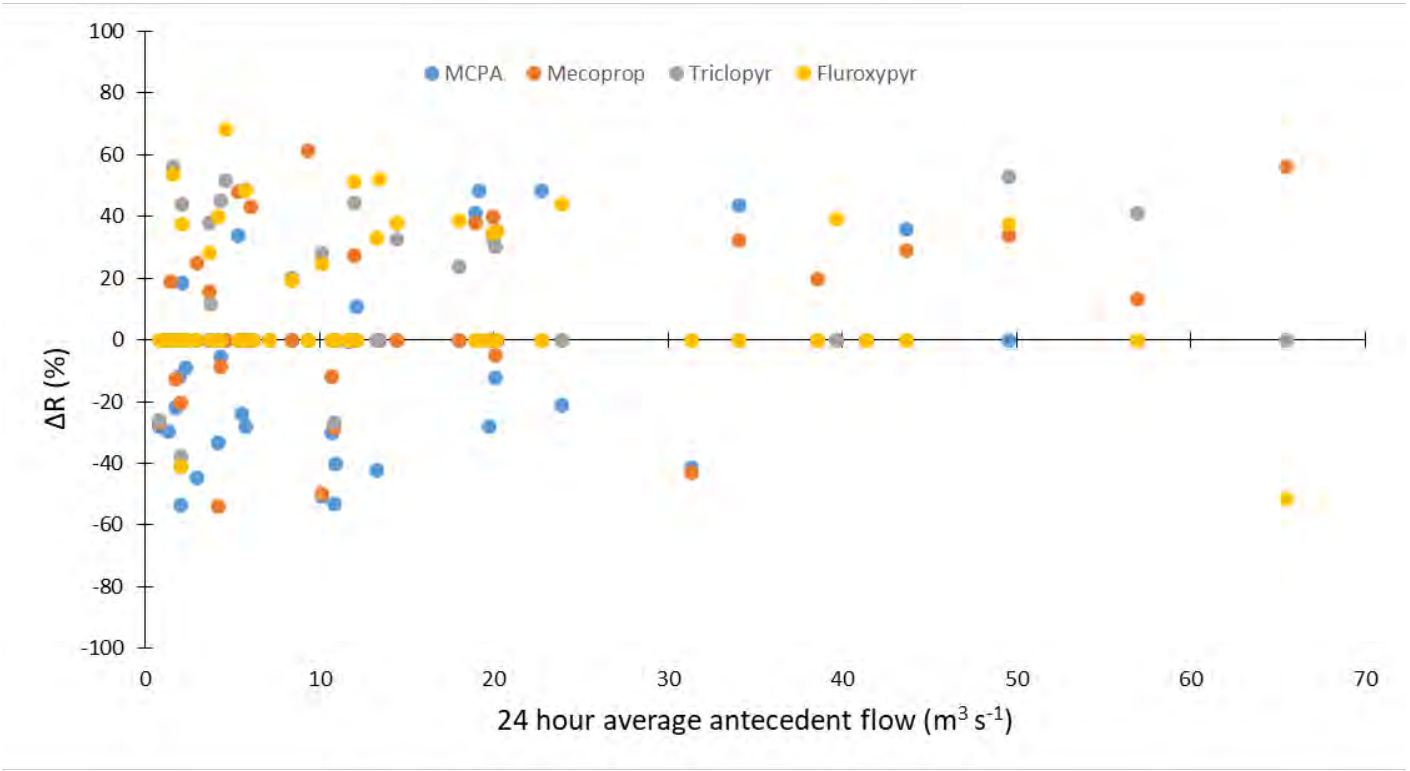
How is hysteresis useful?



Whilst ΔC appears to have no relationship to antecedent flow…

Further data could enable prediction of the timing of pesticide concentration peaks based on antecedent flow – benefit water companies

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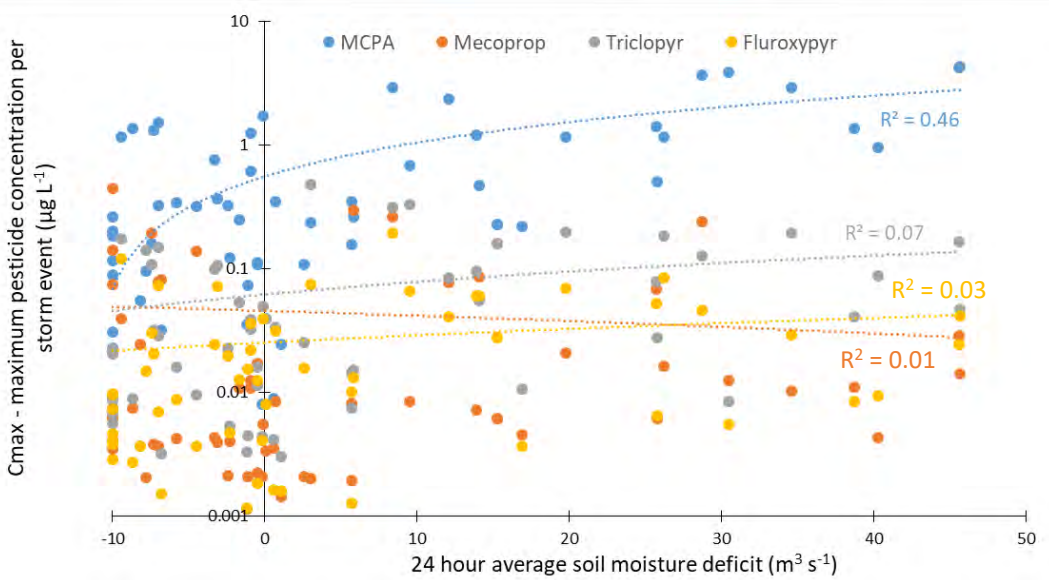
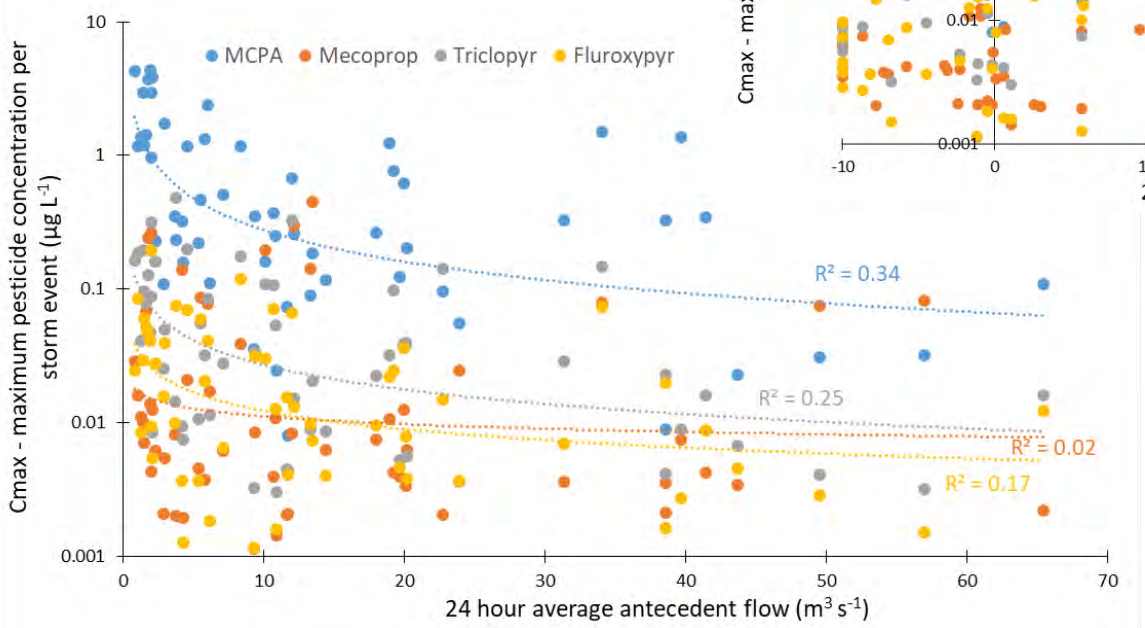
How else are the data useful?

Prediction of the magnitude of pesticide concentration peaks based on antecedent flow or soil moisture deficit





Different pesticides correlate differently

- Future modelling studies
- More data!

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Summary

Pesticide monitoring

- Long term high resolution data for island of Ireland
- Issue is greater than initially thought – problem for water companies

Acid herbicide dynamics in relation to flow

- Help inform on locations of sources in catchments
- Help inform on flow pathways of different herbicides
- Possibly can predict timing and magnitude of pesticide concentration peaks based on antecedent flow and SMD – benefit water companies

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