Achieving Net Zero: Understanding the Potential Hydrological Impacts of Changing Climate and Land Cover in the UK

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Understanding the Potential Hydrological Impacts of Changing Climate and Land Cover in the UK

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1. Broad Background and Achieving Net Zero
2. Questions and Outline
3. Methodology
4. Initial Results
5. Conclusions

JULES
Joint UK Land Environment Simulator

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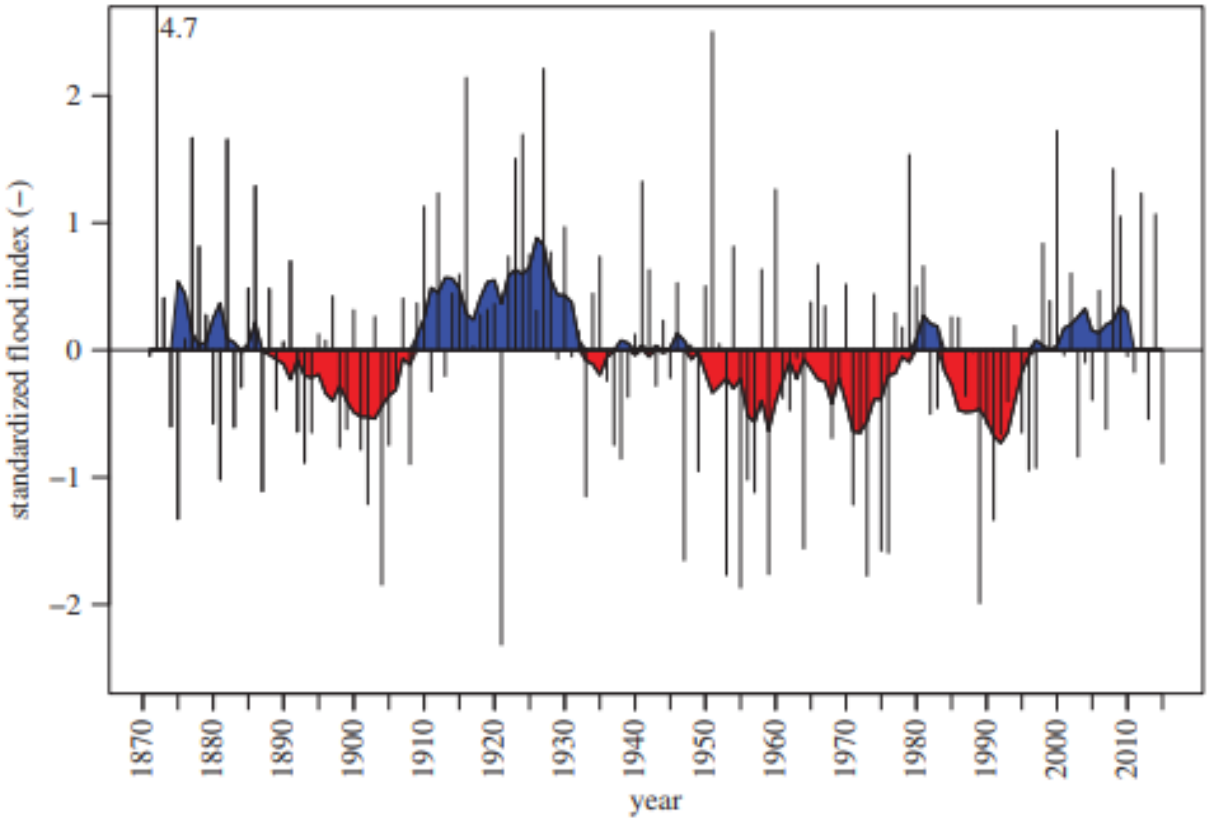
1. Background: A changing world

- Flood **magnitude** and **frequency** have risen in many regions across the globe (Winsemius et al., 2016)
- Climate change is set to **increase rainfall intensity and flooding** (IPCC, 2019)
- Land use and land cover are **changing**
- How can we predict **future streamflow** in a **nonstationary climate and landscape**?



Flood rich (blue) and poor (red) periods in England and Wales (Dadson et al., 2017)

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1. Background: A changing world

https://www.bbc.co.uk/news/uk-england-40548635

http://news.bbc.co.uk/local/york/hi/people_and_places/newsid_9153000/9153477.stm

https://www.bbc.co.uk/news/av/uk-25908866/uk-floods-aerial-view-of-somerset-levels

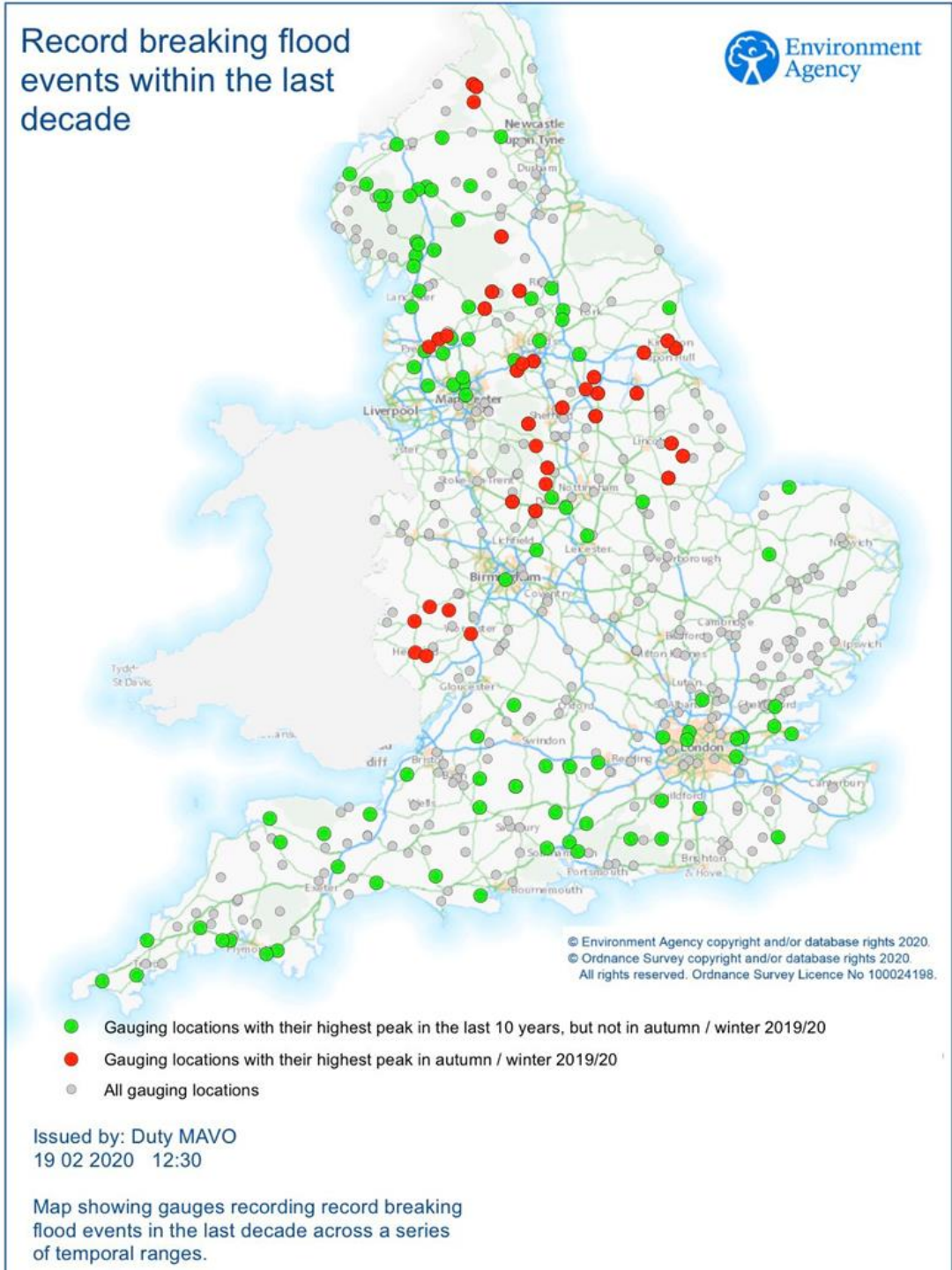
https://www.theguardian.com/uk-news/2019/nov/15/uk-floods-warnings-in-place-across-britain-after-further-rainfall#img-1

1. Background: A changing world

2020

https://inews.co.uk/news/flooding-uk-river-severn-ironbridge-shrewsbury-worcester-floods-shropshire-warnings-weather-forecast-2000434

https://metro.co.uk/2020/02/28/storm-jorge-raging-towards-britain-bringing-even-flooding-12318975/



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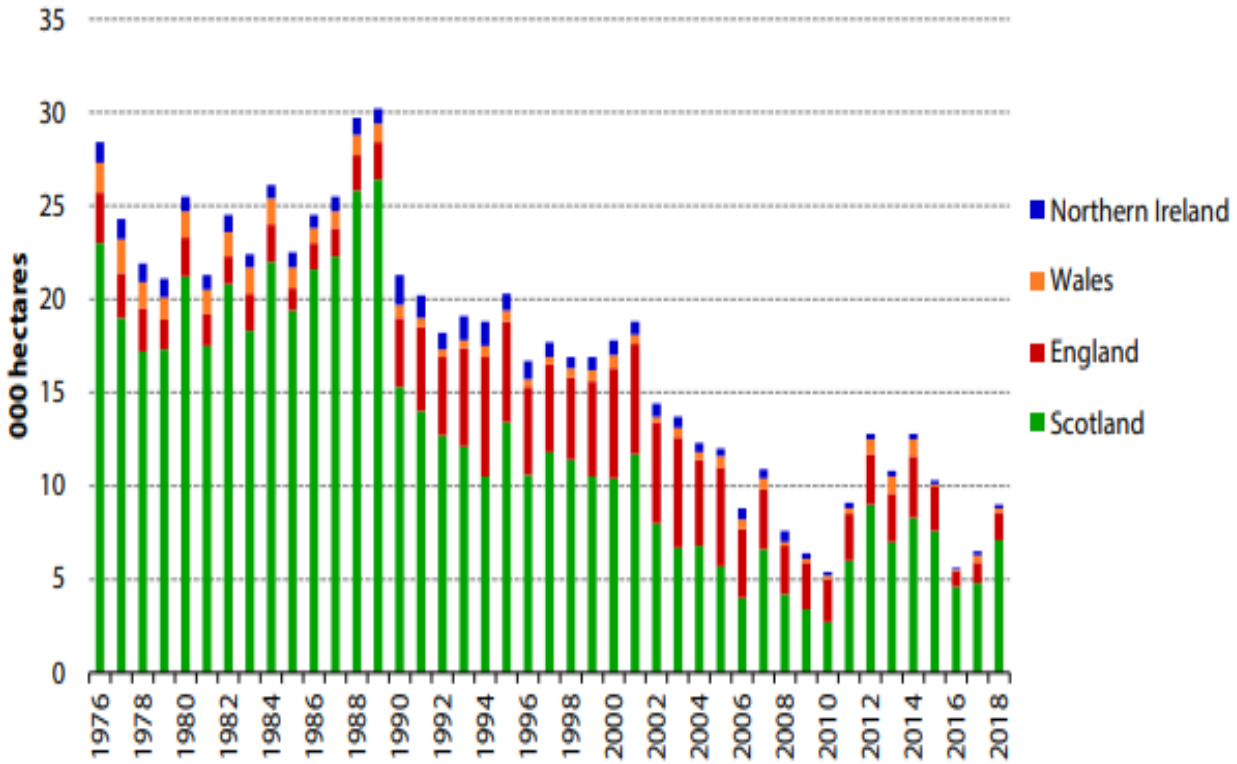
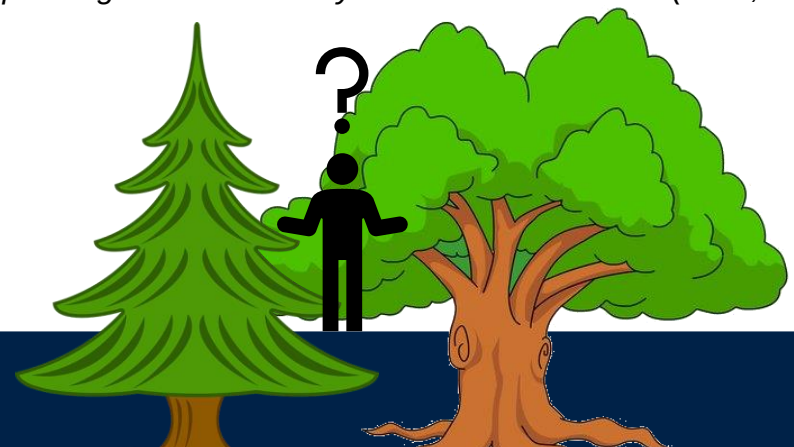
1. Achieving Net Zero

- Climate models suggest limiting CO_2 can **reduce** the amount of **negative effects** on communities across the world (CCC, 2019a, IPCC, 2018)
- One of the ways that the UK government proposes to reach **Net Zero** by **2050** is to **increase** the amount of **afforestation** (CCC, 2019b)
- Potential for Natural Flood Management?



Area of new tree planting for each country in the UK: 1976-2018 (CCC, 2018)



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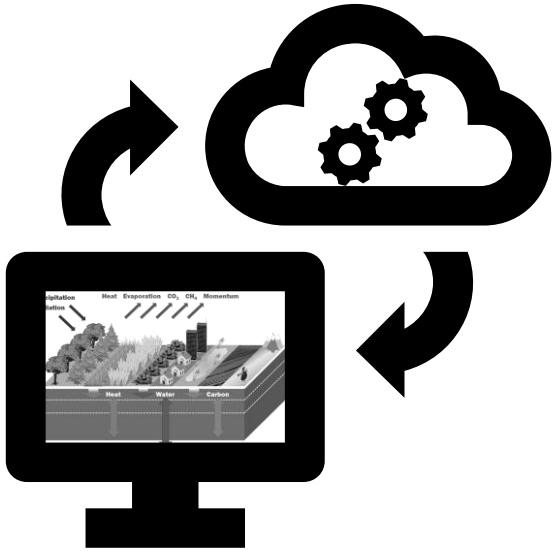
2. Outline and Aims

1. **To what extent does afforestation influence UK streamflow?**
2. **How does afforestation location influence catchment streamflow dynamics?**
3. ***Where can afforestation locations reduce high flows?***

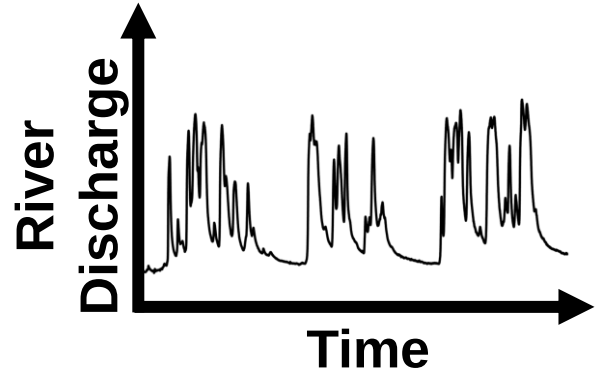
Theoretical Landcover Scenarios

CHESS-met 2000-2010



JULES: Land Surface Model

UK Assessment of Potential Landscape Changes Catchment Hydrology



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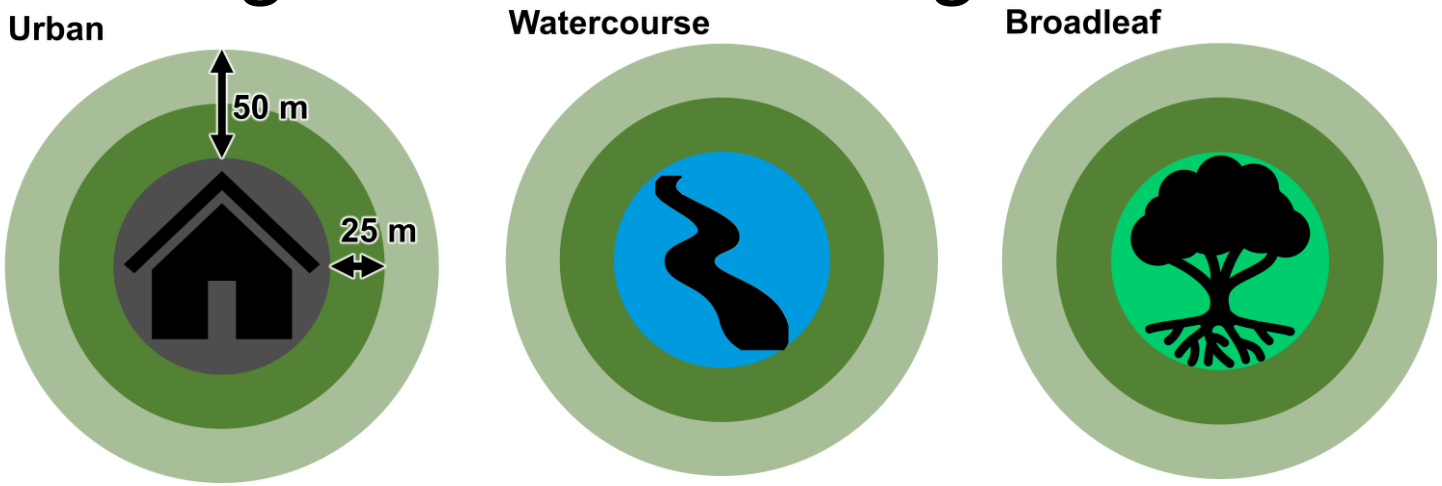
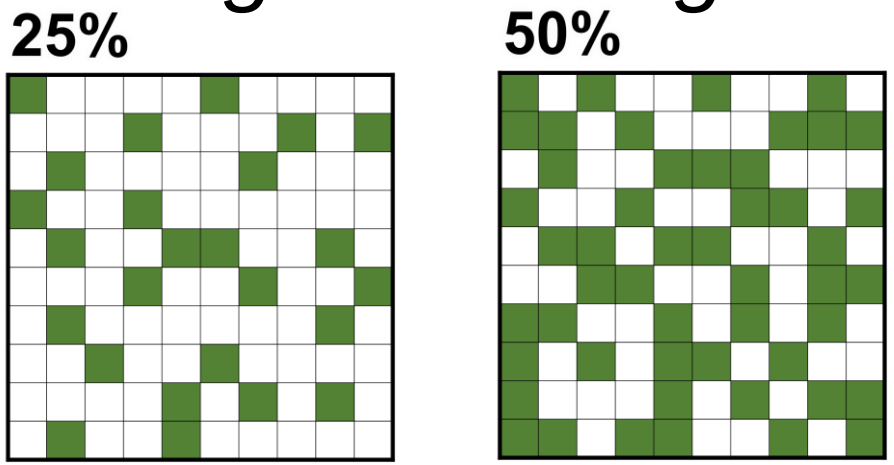
3. Methodology: Land Cover Generation

*Planting **around** existing land cover*



*Planting **in** drainage area*



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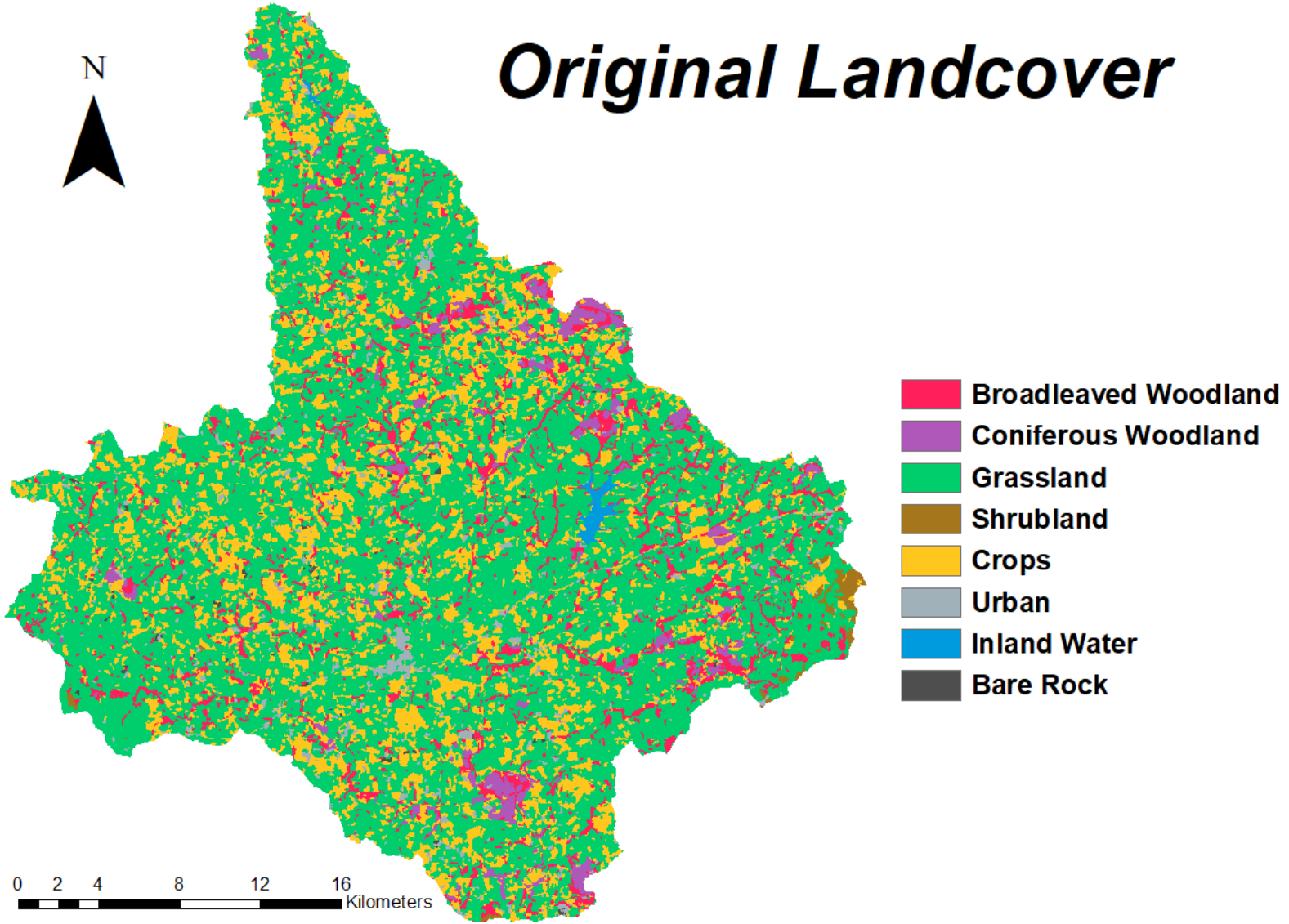

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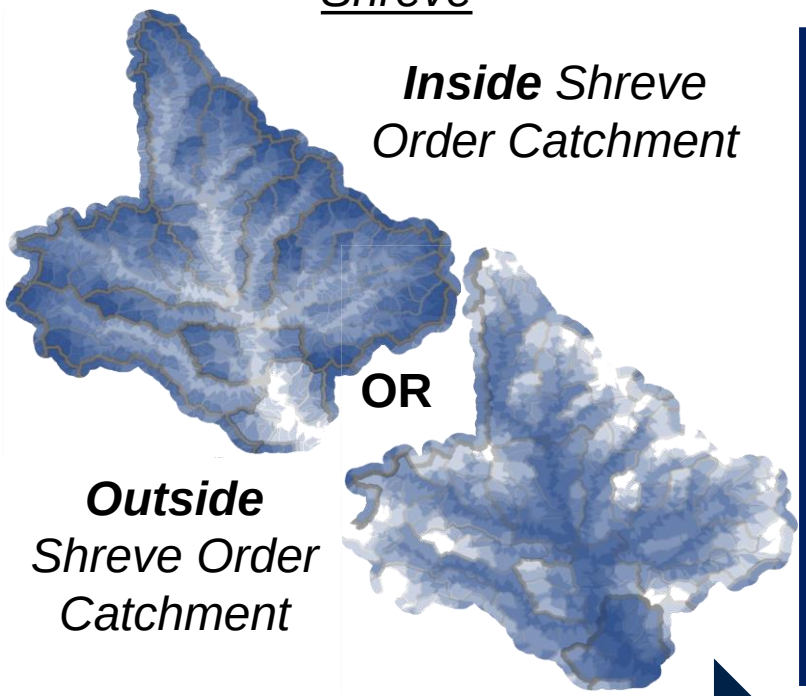
3. Methodology: Land Cover Generation

Drainage Basin Planting Location

Shreve

***Inside** Shreve Order Catchment*



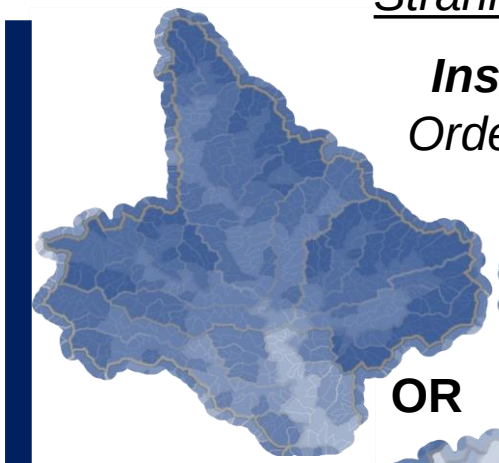
OR

***Outside** Shreve Order Catchment*

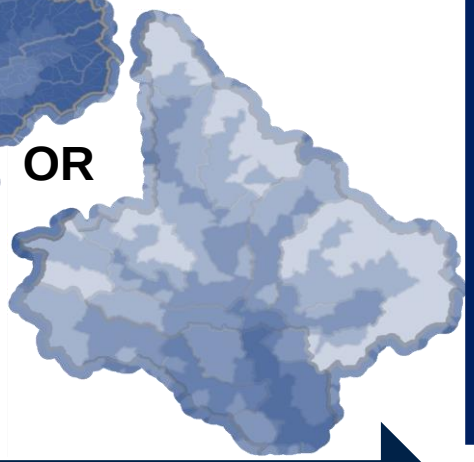
1 **7 Orders Based on Shreve Number** **7**

Strahler

***Inside** Strahler Order Catchment*



OR

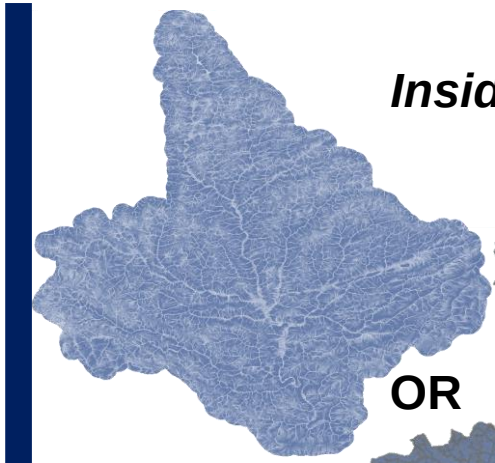


***Outside** Strahler Order Catchment*

1 **7 Orders Based on Strahler Number** **7**

Topographic Wetness Index

***Inside** TWI Area*



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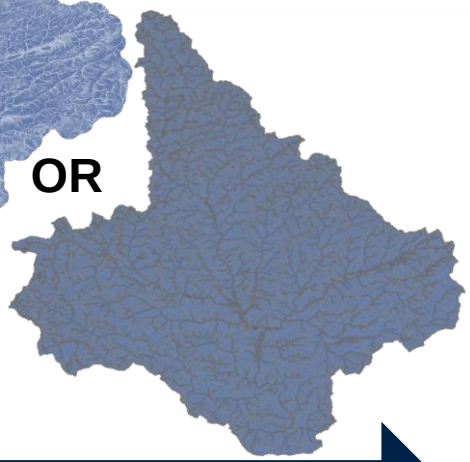

***Outside** TWI Area*

1 **5 Orders Based on TWI** **5**

3. Methodology: Land Cover Generation

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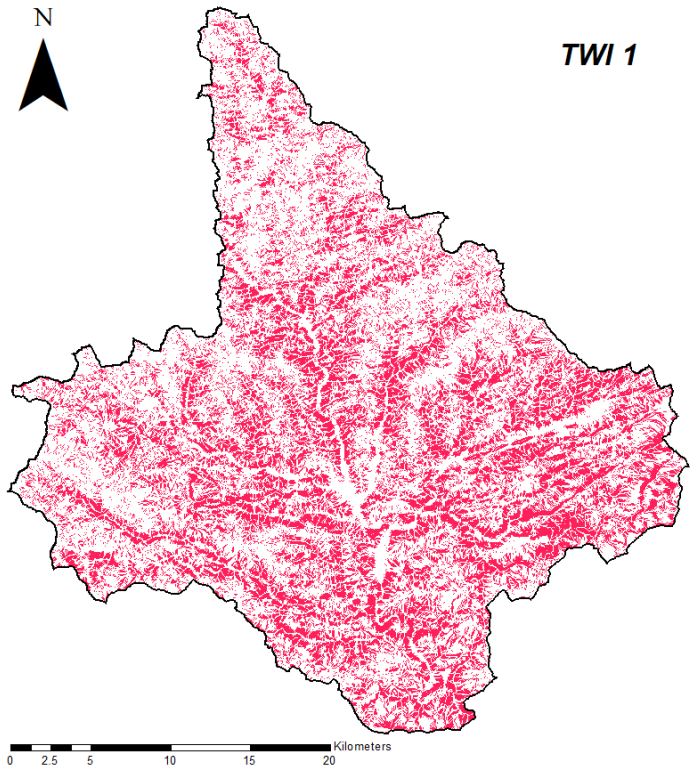
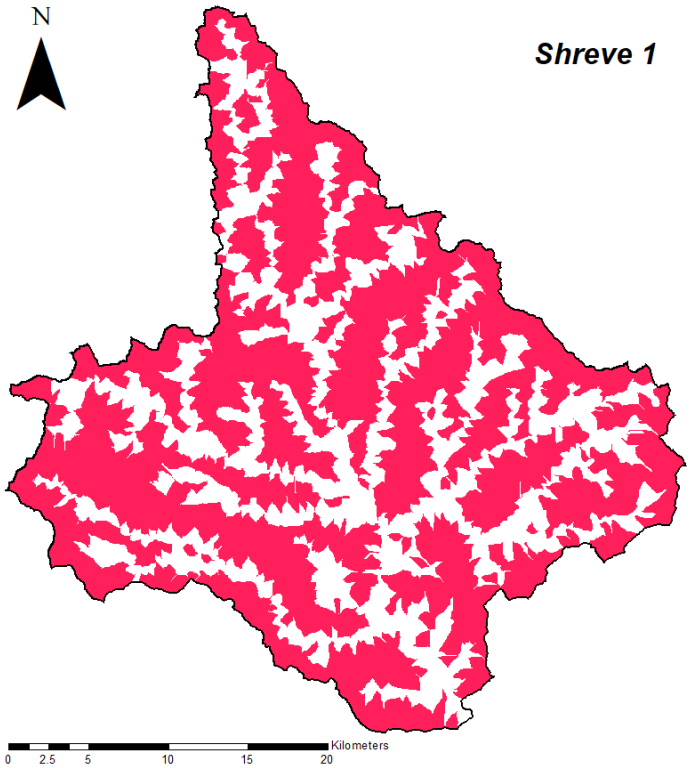
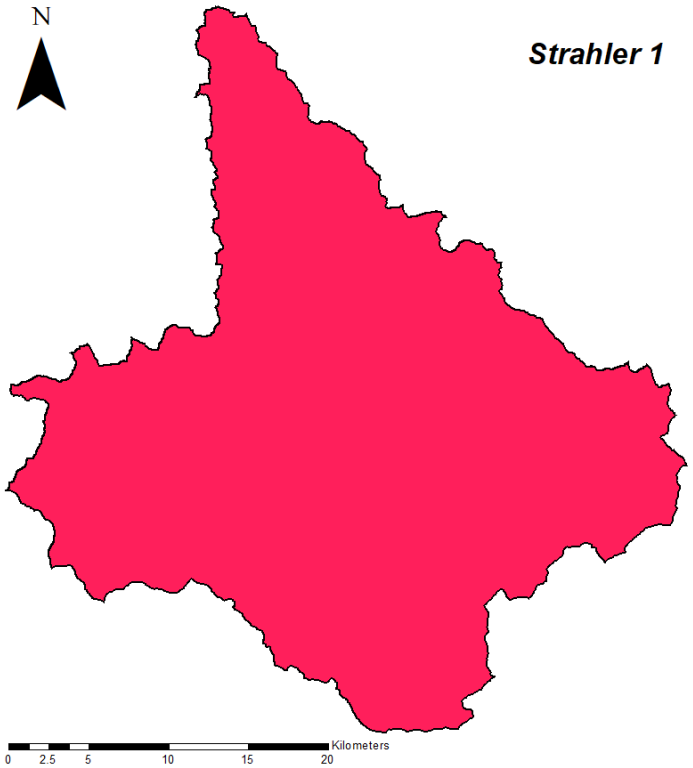
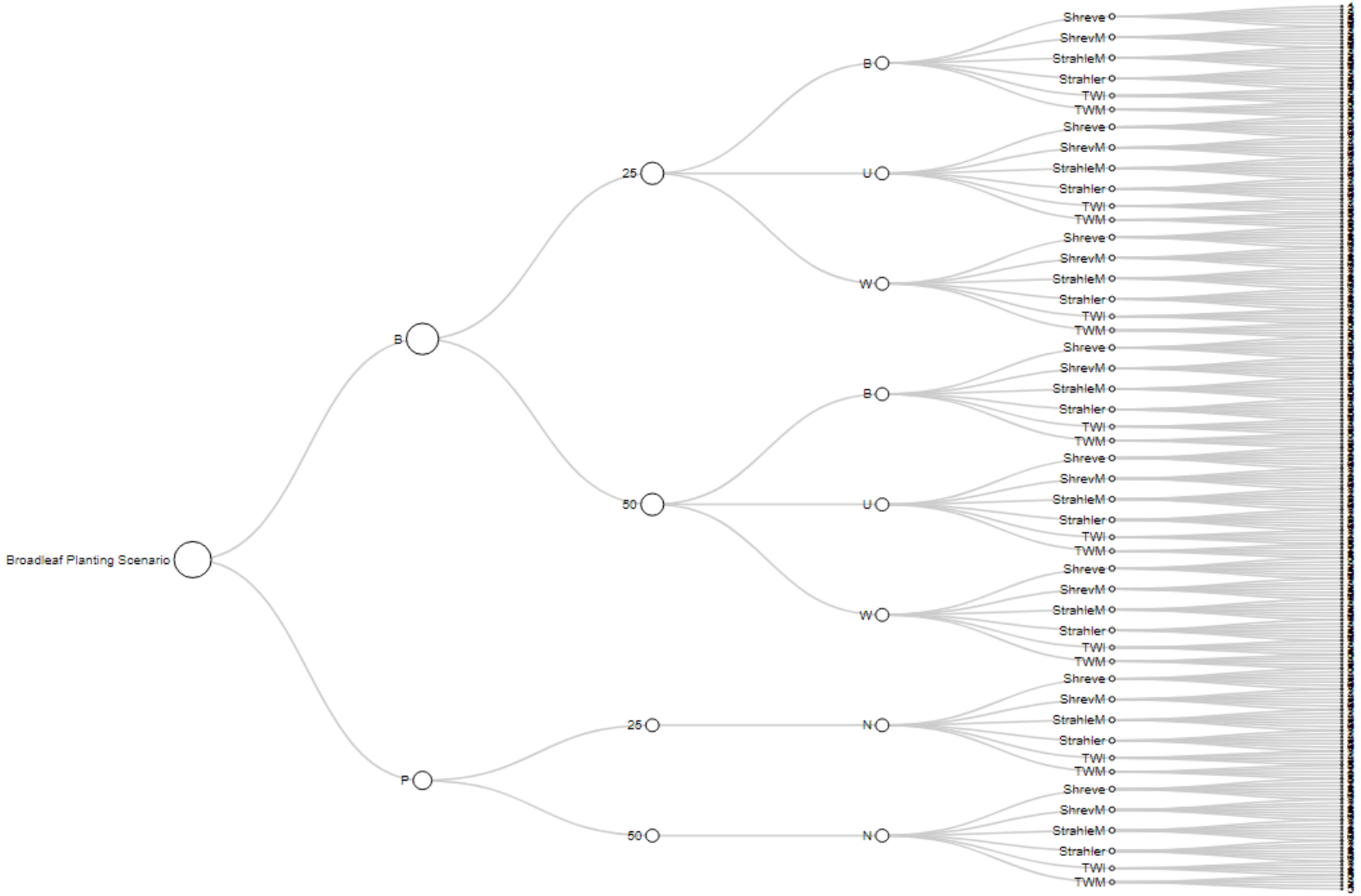






River Tamar Planting Locations

3. Methodology: Land Cover Generation



4. Initial Results: High and Low Flows

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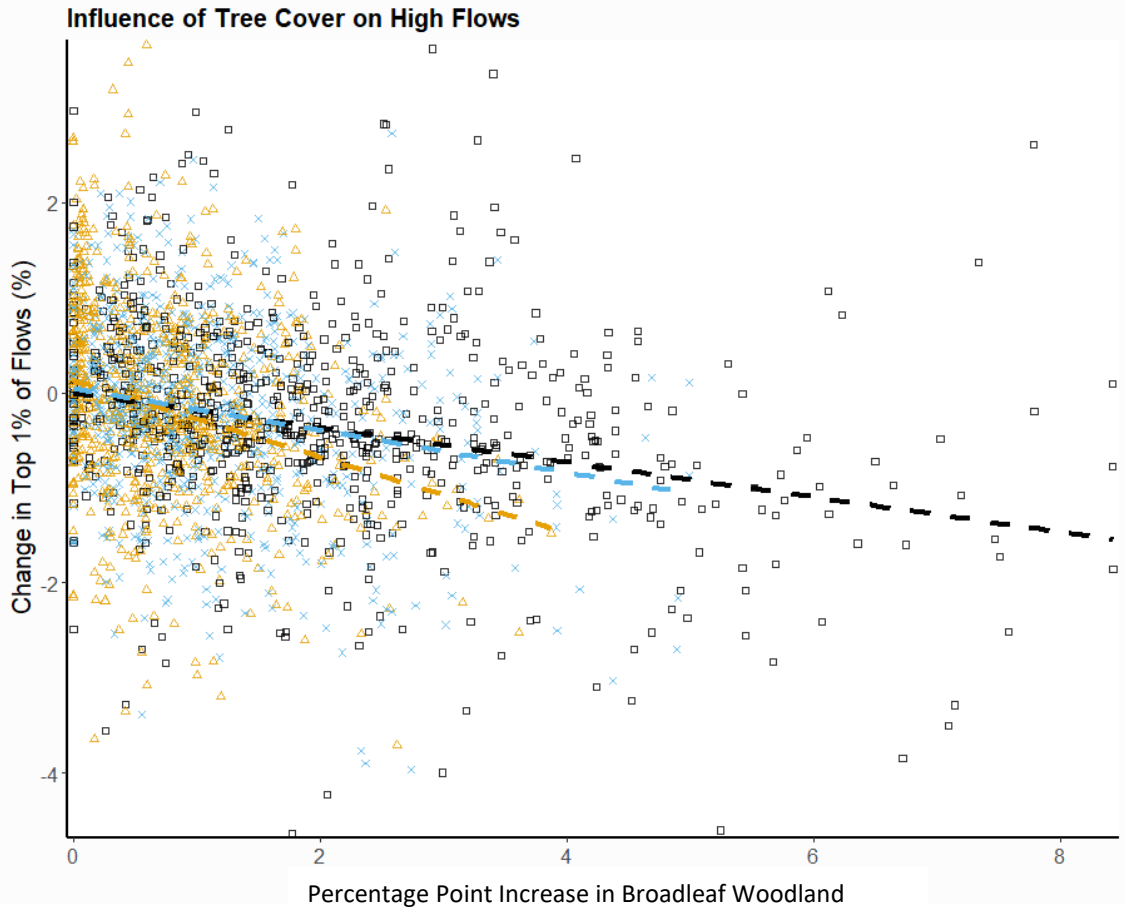

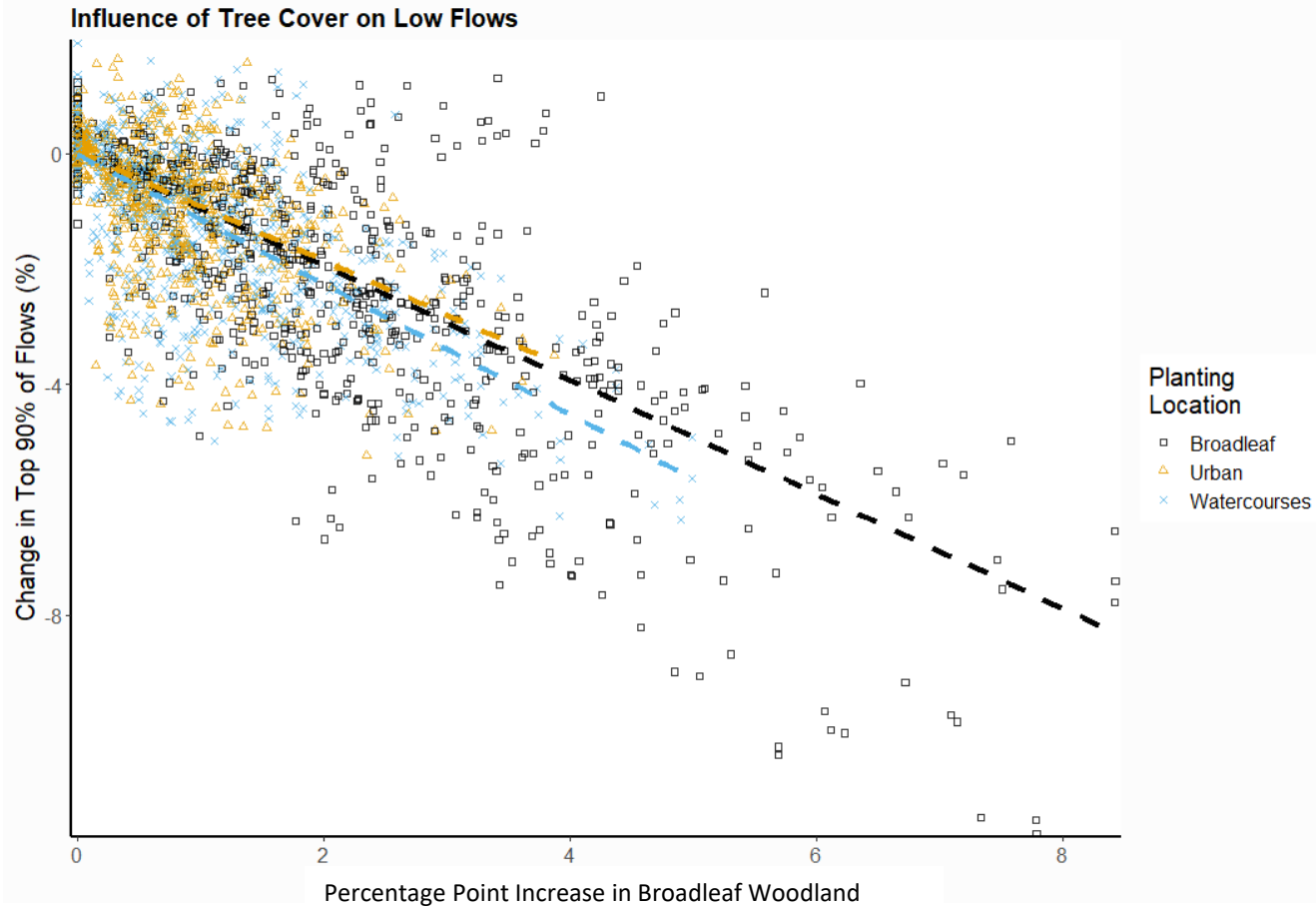

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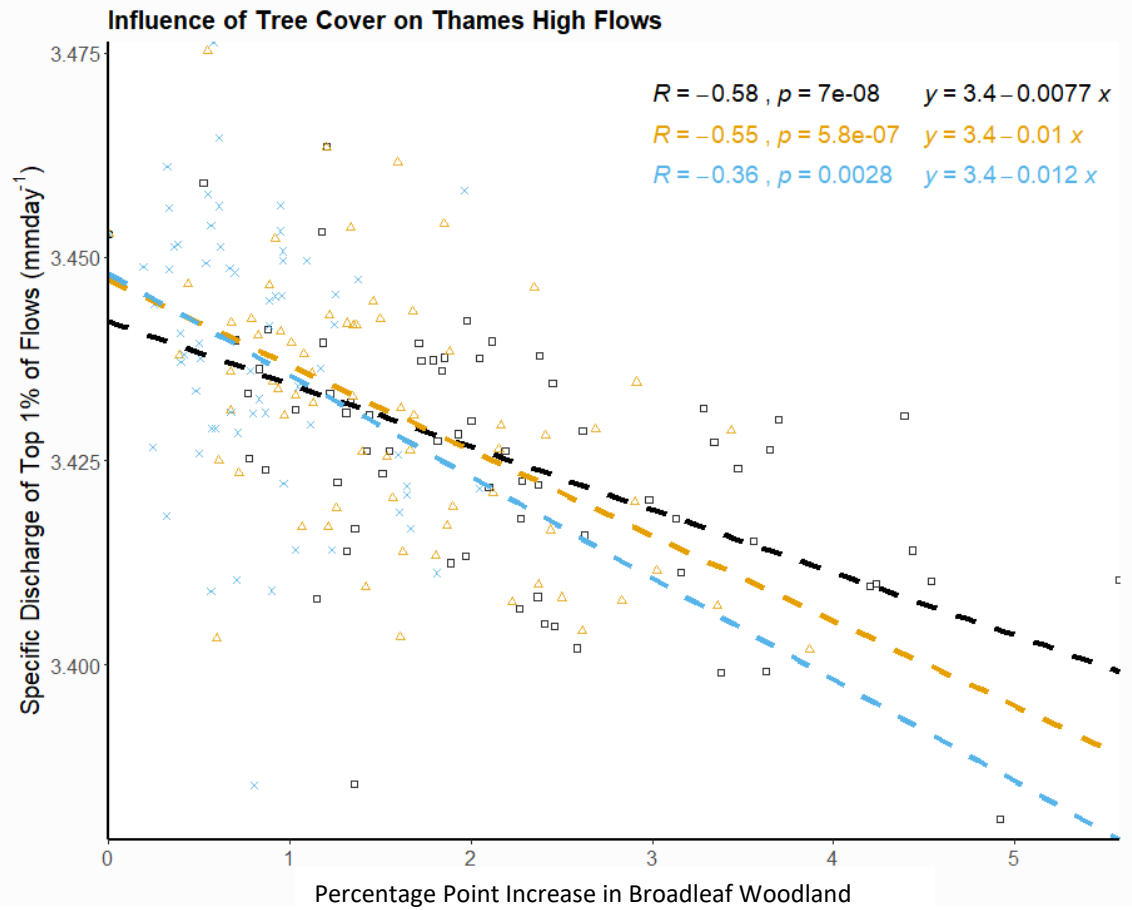
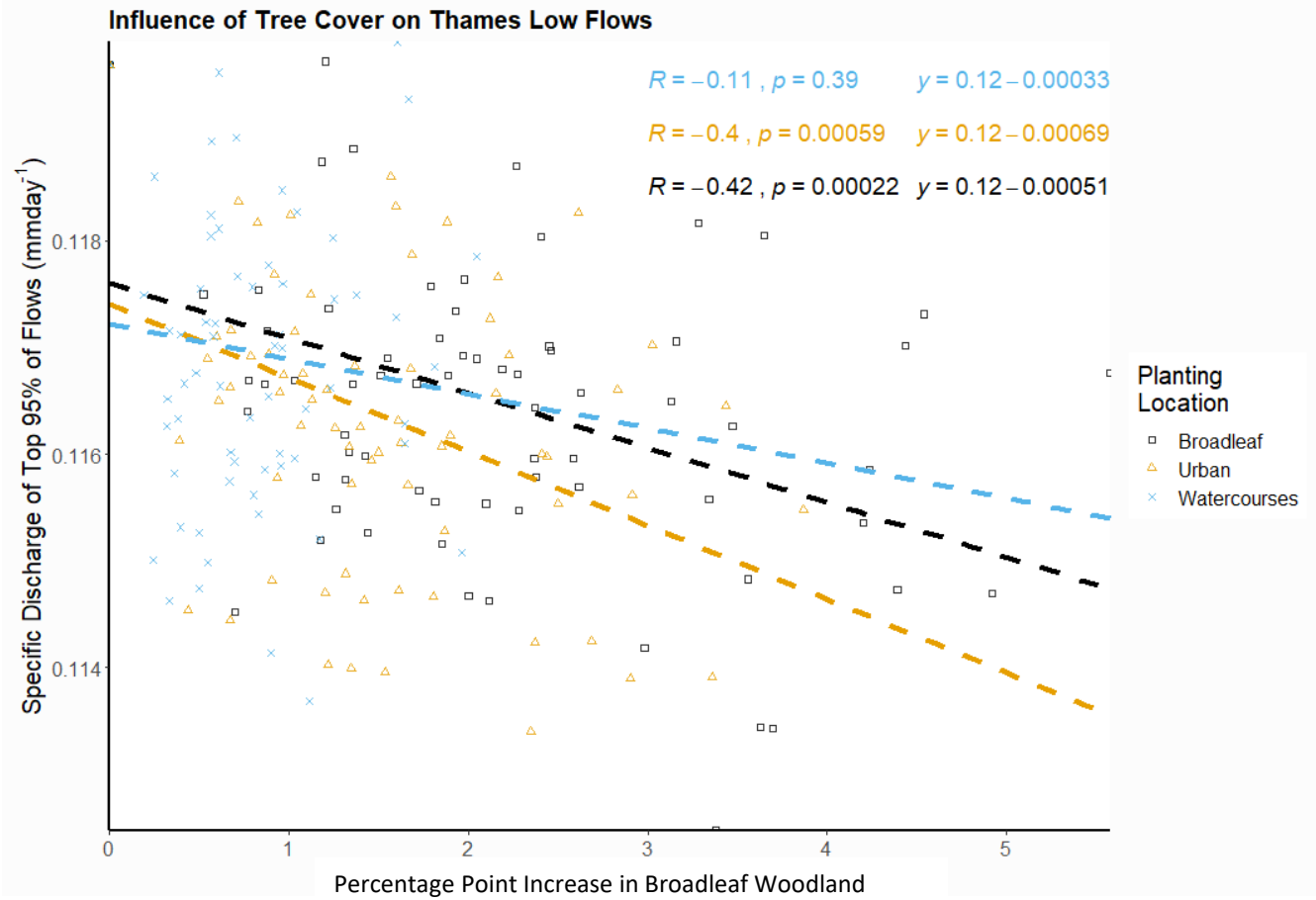
5. Initial Results: River Thames





4. Initial Results: River Dynamics

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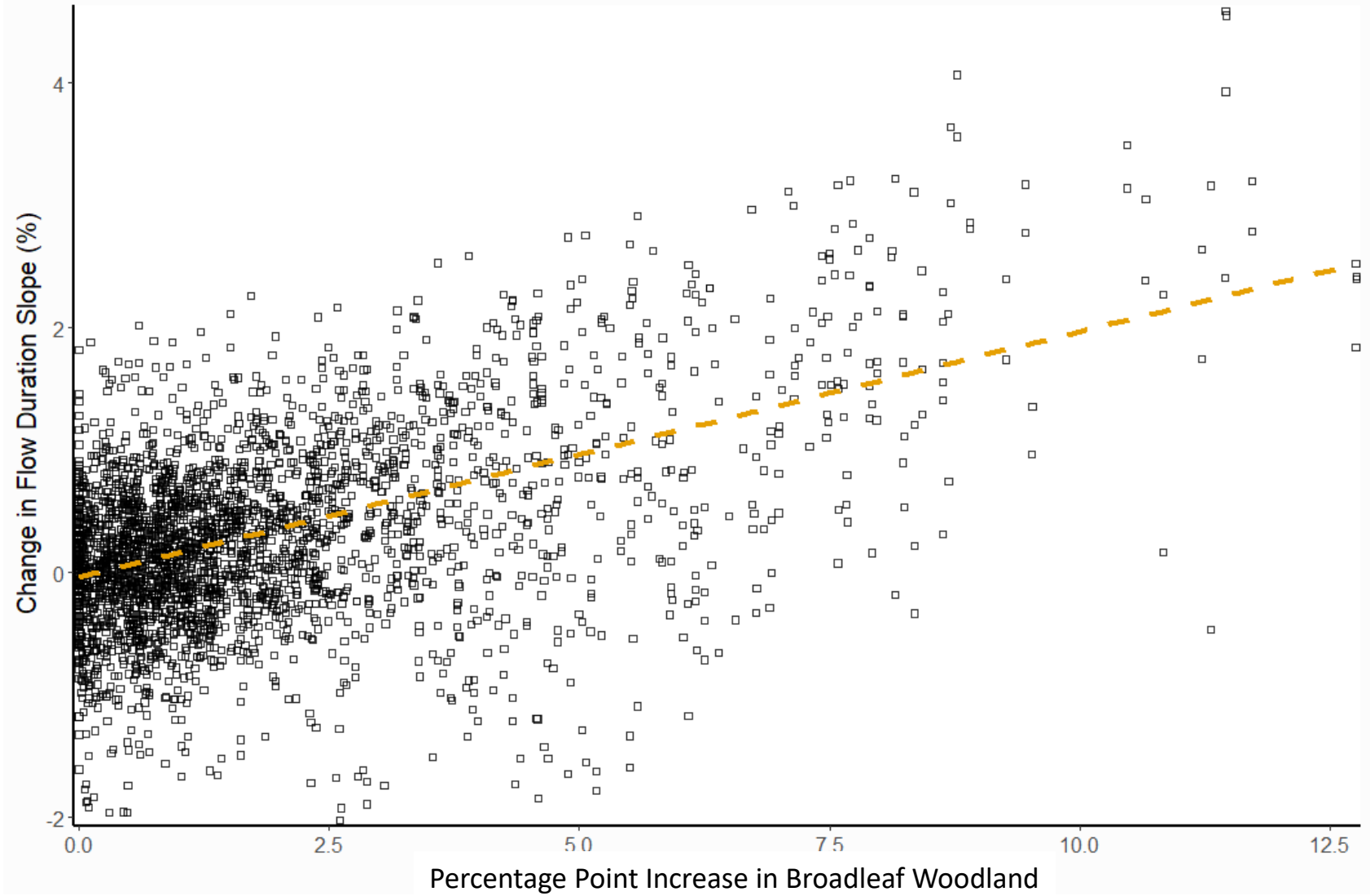

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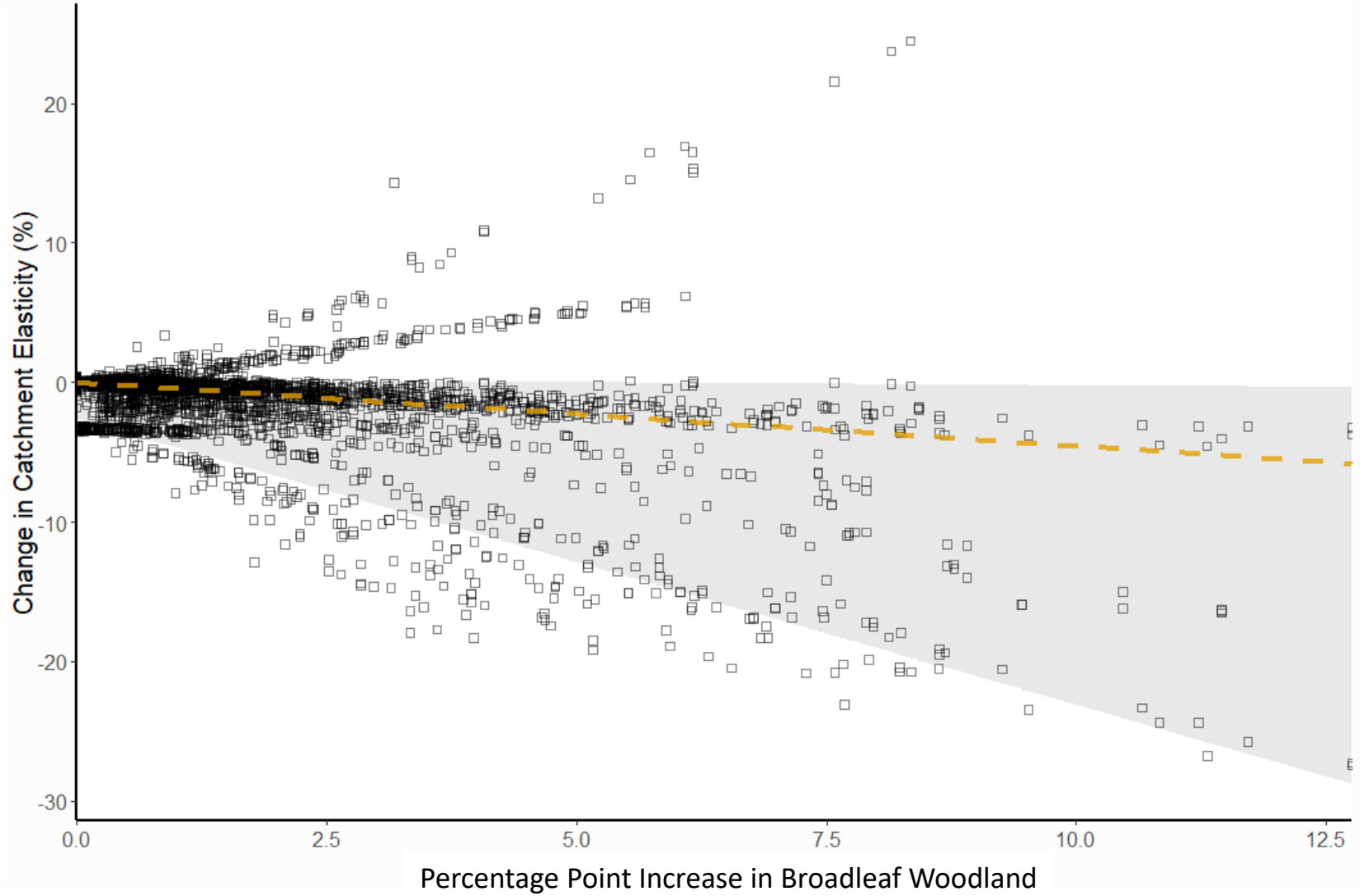

4. Initial Results: Planting Location

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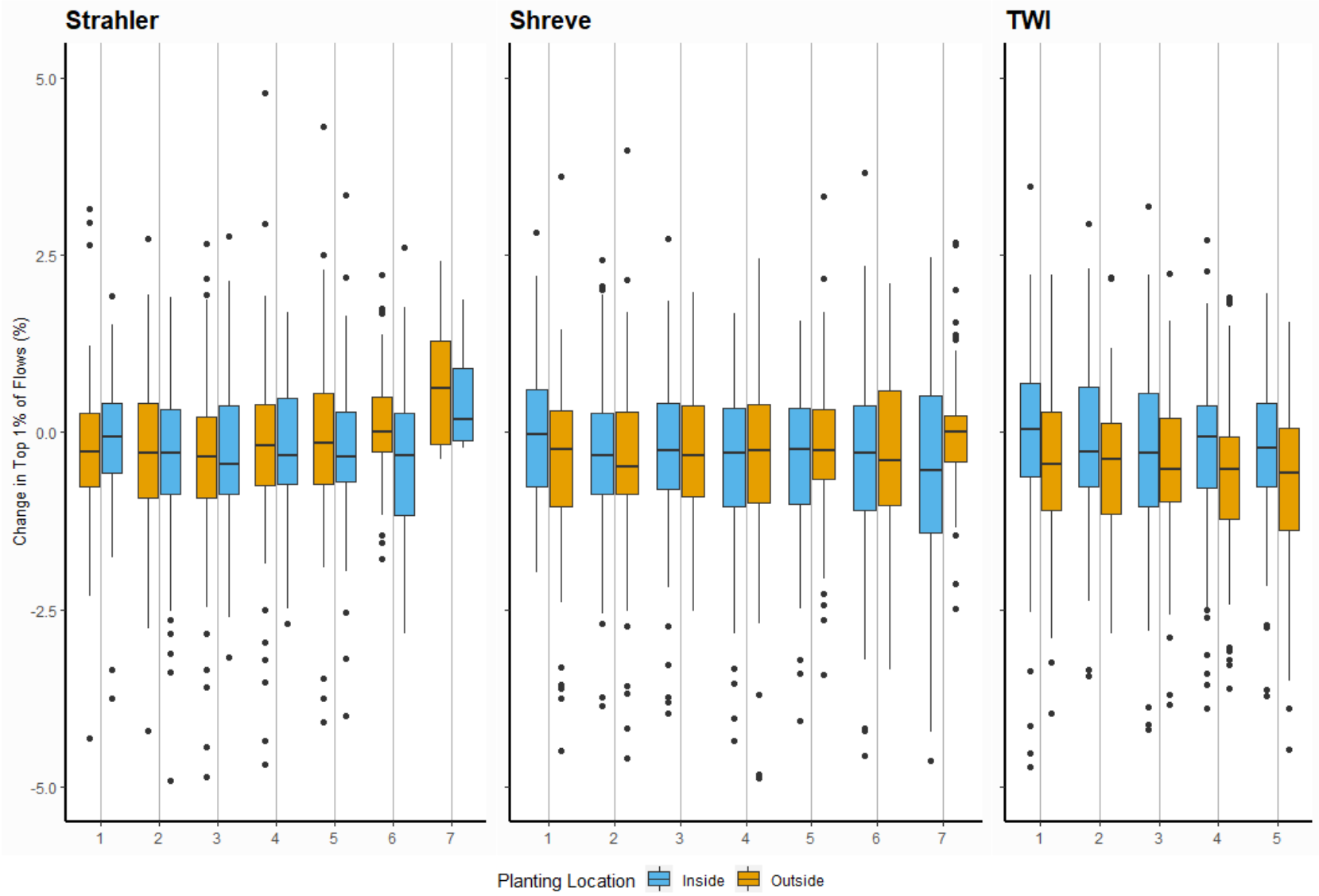

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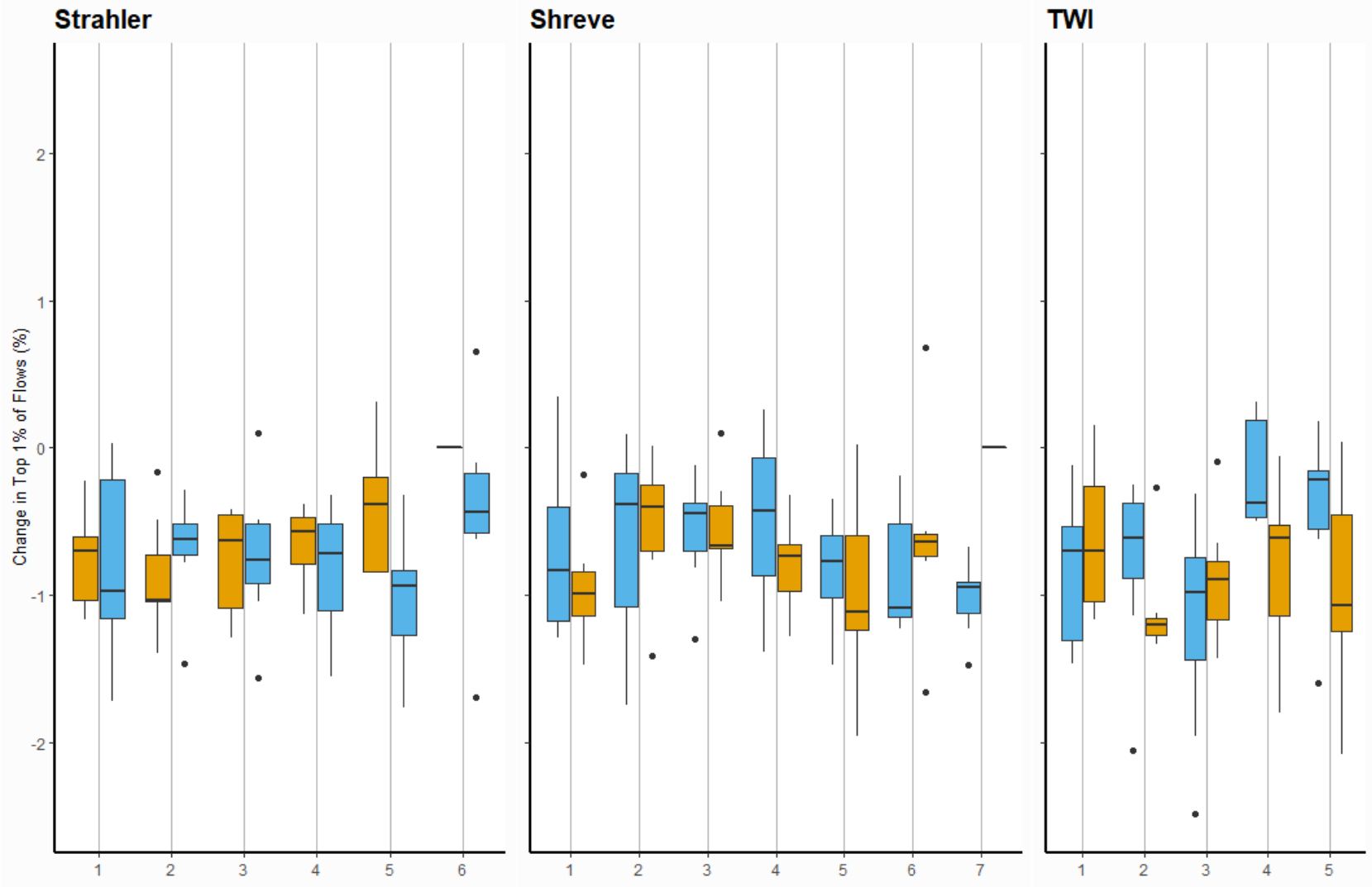

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5. Conclusions

- Afforestation location has a significant impact on catchment hydrology increasing flow regime variability and dampening catchment response to rainfall.
- Care must be taken on afforestation location as it can lead to unintended changes in streamflow e.g. increase extremes.
- Plan to use ensemble weather forecasts to test future climate impacts on streamflow.

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Questions?

River Culm Flooding on 28th December 1979. Environment Agency