SWP5: Land Use Management and Flood Risk

Uplands

Lowlands

Presenter: Enda O'Connell

EPSRC Grant: EP/FP202511/1

Research Teams

- Imperial College London

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Three Key Science Questions

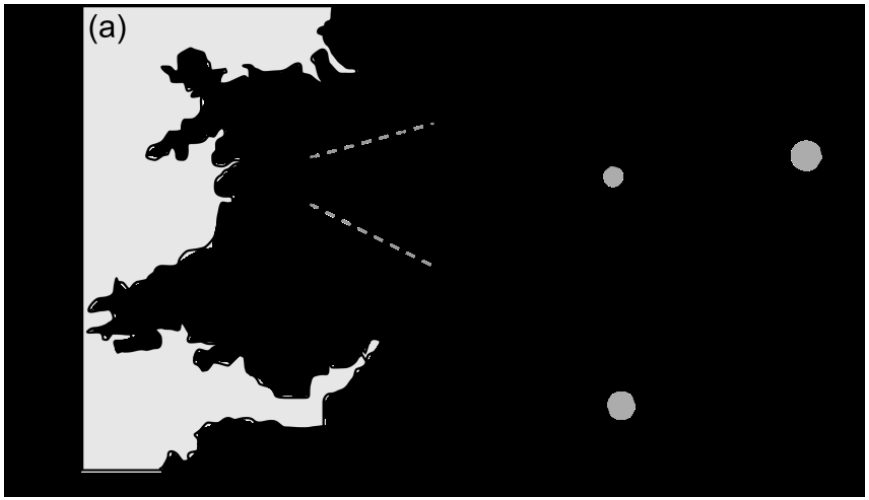
1. How do upland land use management changes affect local scale (<10km2) runoff generation ?

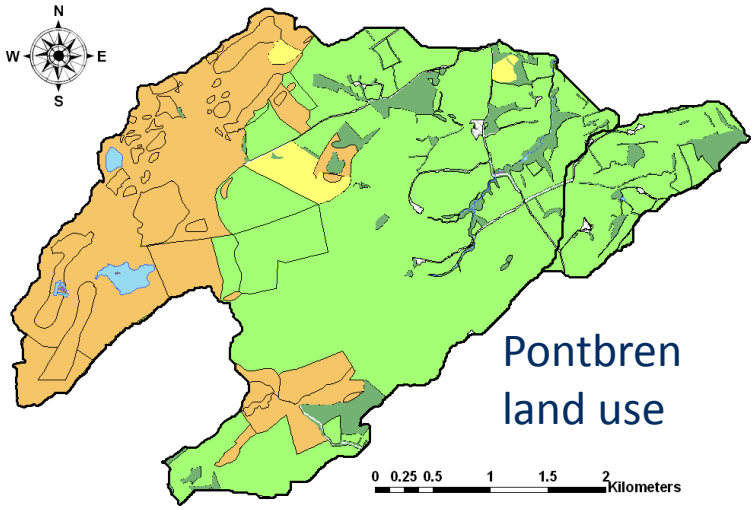
2. How do upland local scale changes in runoff generation propagate through the river channel network to affect catchment flood response ?

3. How does lowland wetland land use management affect catchment scale flood response?

The Pontbren Experiment

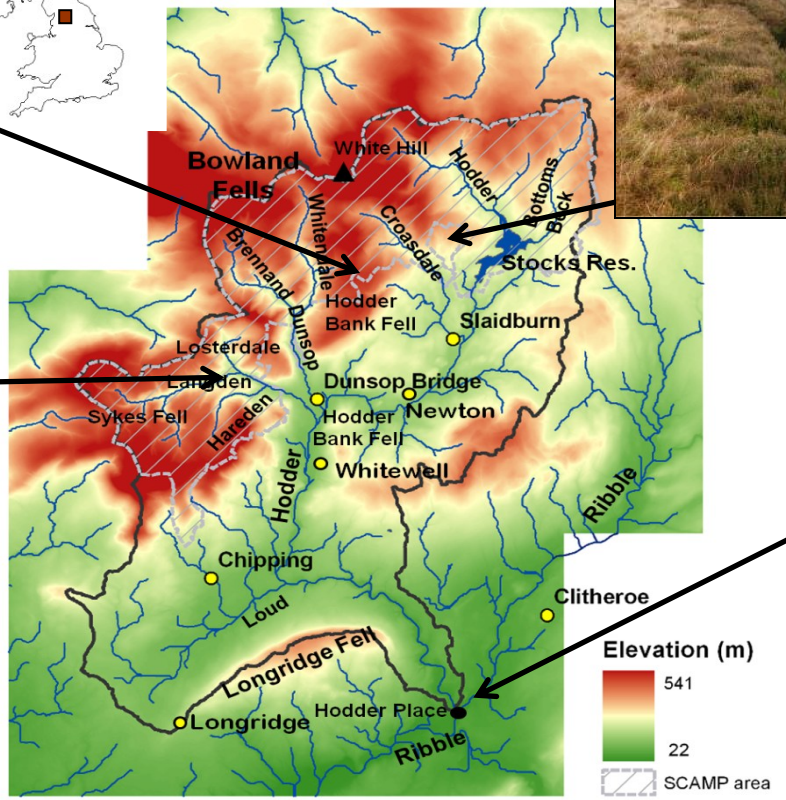
- A unique multi-scale experiment: process-hillslope-small catchment (12.5km2)
- Major investment in data by FRMRC
- Strong stakeholder involvement: local farmers committed to surface runoff mitigation
- New modelling developments



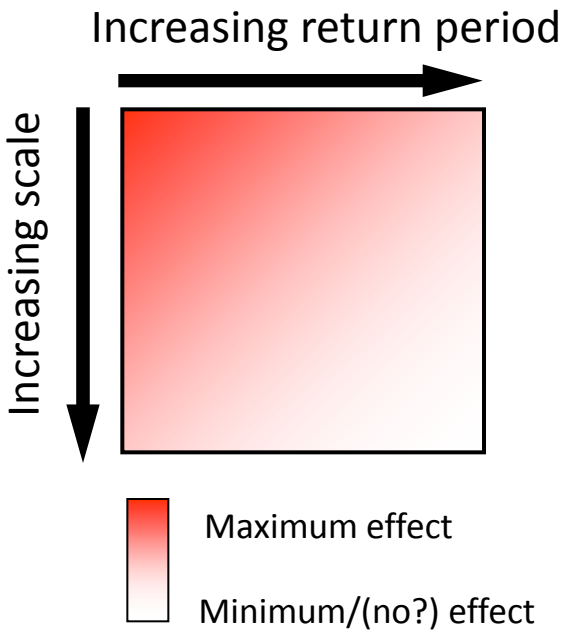


The Hodder Multi-scale Experiment (SCaMP)

Area 260 km2



Outcomes



Direction of Effects:

- \- Tree planting
- \- Stock exclusion
- \+ Peatland drainage
- -/+ Peatland drain blocking

Long term experiments are essential to isolate land management effects

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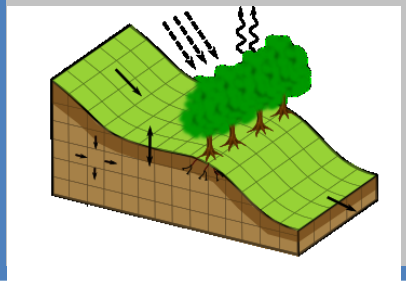
FRMRC flood risk management research consortium

SPR Modelling Framework

Information about local response

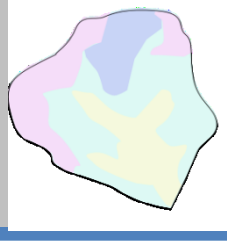
either small scale parameters included in a physics based model, or regionalised indices (IC)

Hillslope model (1d,2d,3d)



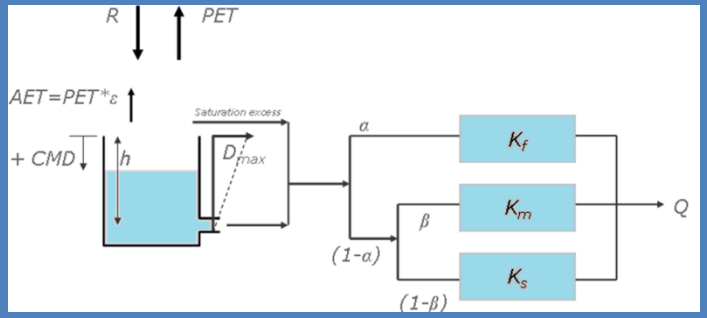
Regionalised Data

i.e. HOST, Curve no.



Metamodels

reproduce the responses produced by the small-scale model and/or the regionalised indices (IC)

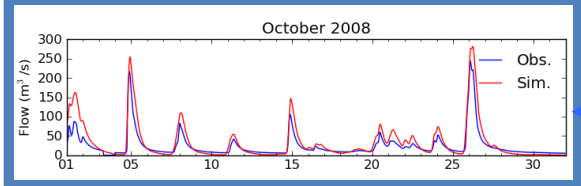


Catchment Discretisation

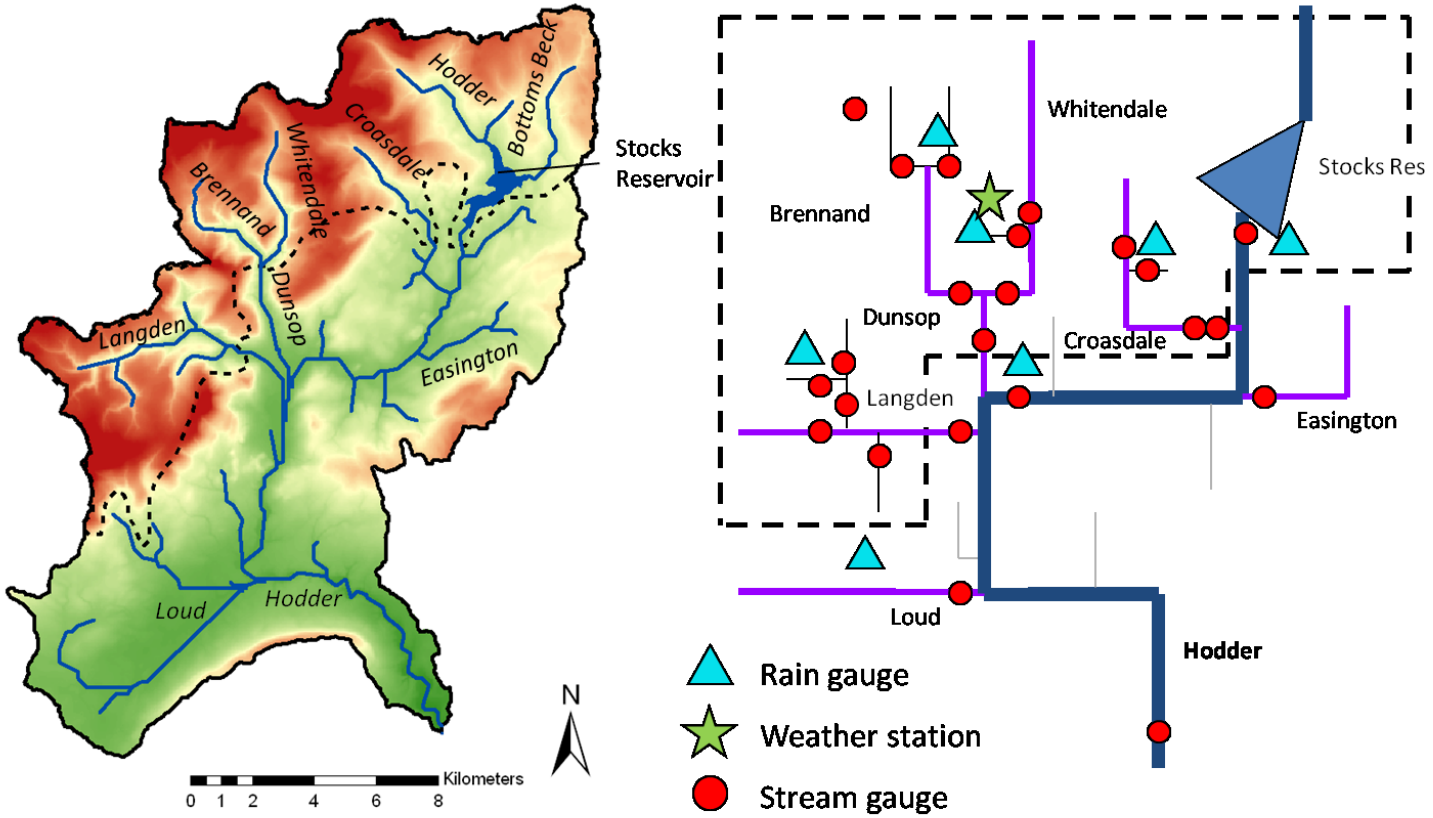
use metamodels and parameters to generate runoff from hydrologically similar areas (IC)

Hydraulic routing

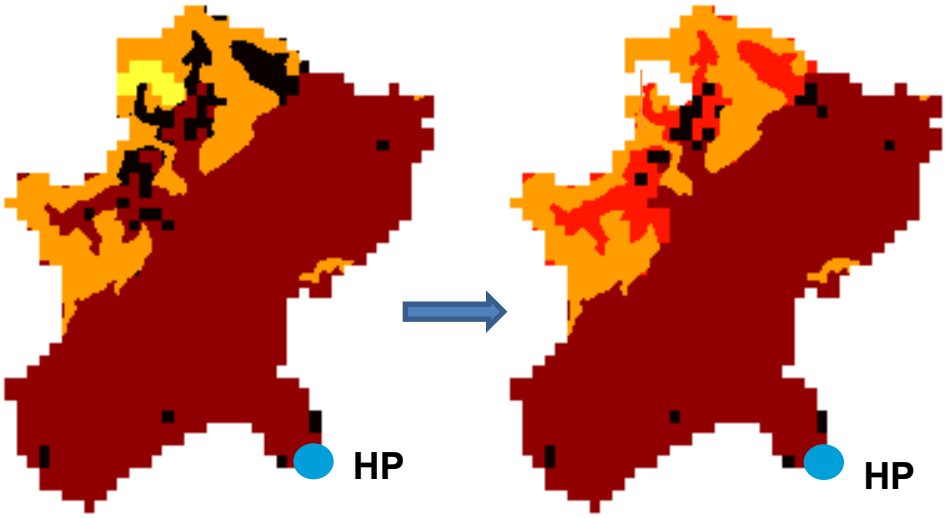
through dense channel network based on accurate St Venant equation solver (NU)



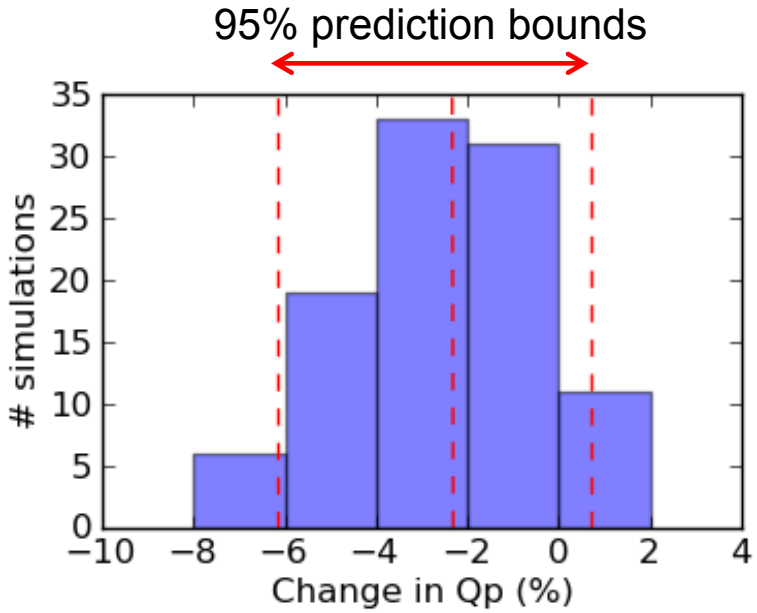
Hodder Multi-scale Experimental

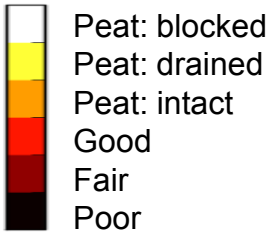


Hodder: SCaMP Impacts



Pre-change Post-change





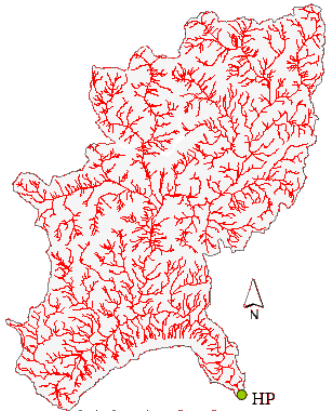
Impact on peak is small, only a few percent, but considerable uncertainty

Controls on Impacts at Catchment Scale

- Geomorphological Dispersion: configuration of network controls arrival times of impacts at Receptor
- Hydrodynamic Dispersion: channel friction attenuates impacts

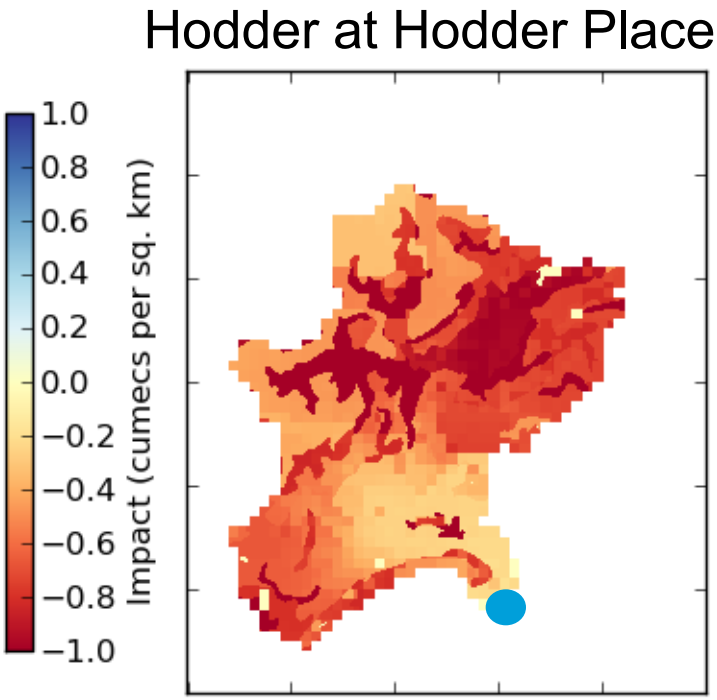
Dual Science Question...

How can downstream flood impacts at the **Receptor** be tracked back through the river channel network (the **Pathway**) to the local **Source** areas that created the impact?



SOURCE **PATHWAY** **RECEPTOR**

Impact Decomposition Mapping Tool



Analysing spatial contributions to impact gives answers to questions such as:

- Which areas are most sensitive to change?
- Is stocking density reduction effective?
- What is the importance of soil type?
- How does impact change with the rainfall pattern?

Outcomes

1. SPR Modelling Framework for predicting flood impacts for various configurations and mixes of land use management (LUM) changes
2. Understanding of controls on LUM flood impacts at catchment scale: roles of geomorphological and hydrodynamic dispersion
3. Decomposition Mapping Tool for use by catchment managers in assessing impacts and the effectiveness of mitigation measures

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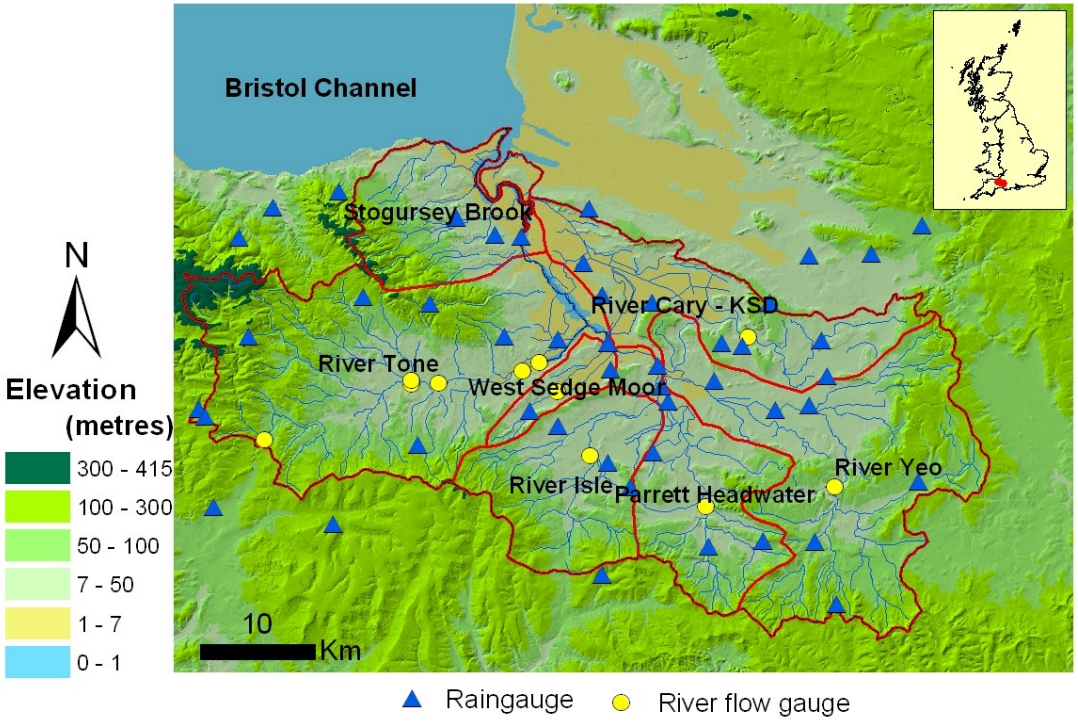
Wetland Land Use Management:

Whole Catchment Scale Impacts

The Parrett (750km2) and Tone (200km2) catchments – Large floods in 1999 and 2002

DHI MIKE SHE Model



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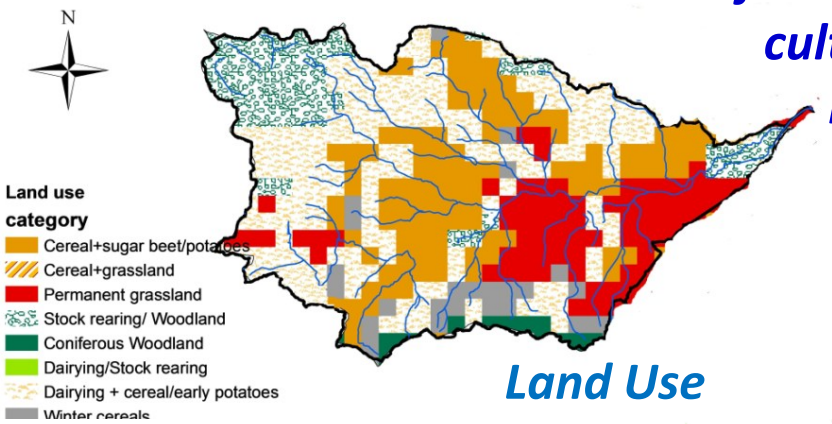
Human Activities and Soil

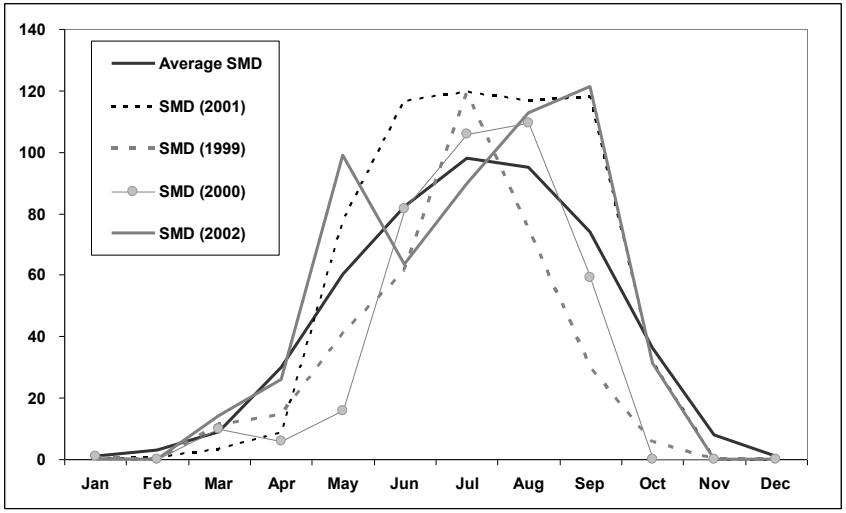
- *Soil degradation increased by heavy machinery or soils worked in wet conditions*
- *Cultivated land, winter cereal crops, more degraded than permanent grass, but it varies with the degree of slope*

If soil moisture is at optimum levels during the soil cultivation periods of the autumn and spring the risk of soil degradation occurring is limited



Land Use

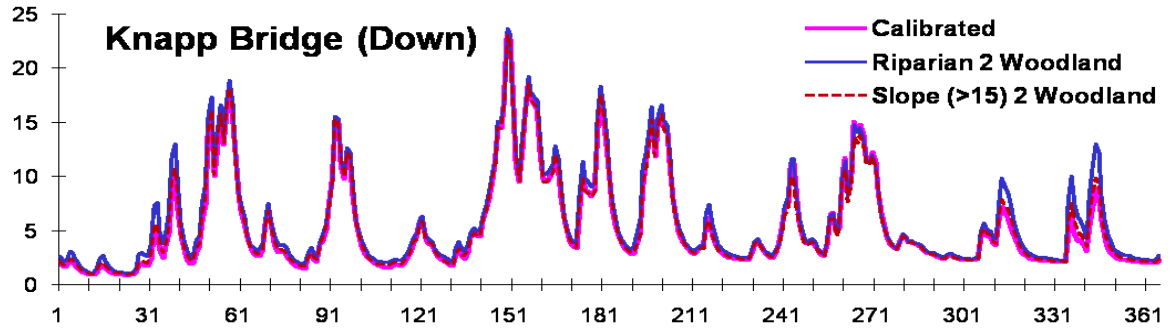
Bare soil: harvest ~ before seeding

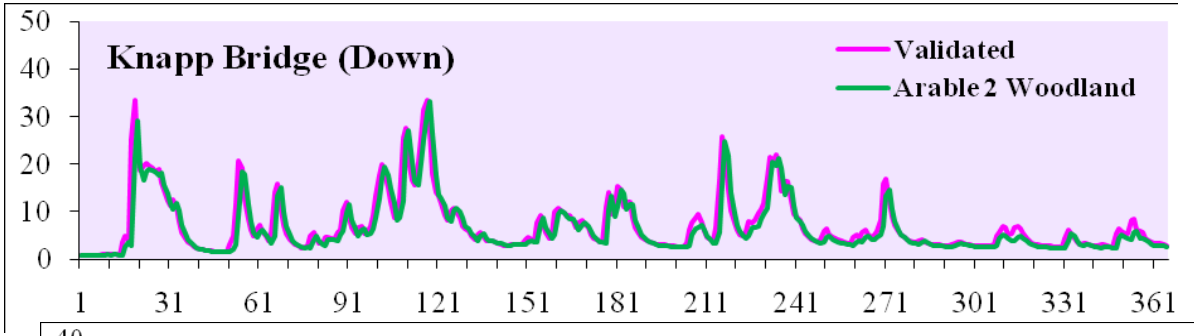


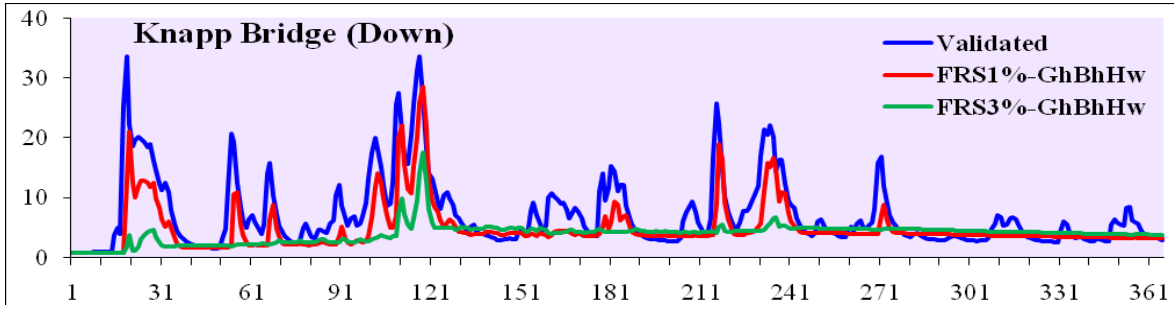
Average Soil Moisture Deficit (1961 ~ 2000)

Outcomes

- *LAND USE Change had relatively LITTLE impact at Whole Catchment Scale*
- *FLOOD retention STORAGE MORE EFFFECTIVE at decreasing flood volume and peak, but varied by sub-catchment*
- *Large Catchment Response dominated by CHANNEL NETWORK*







*Land Use Change had **greater** impact on **Sediment, Bio-Diversity, Water Quality and Landscape** rather than flood peak or volume*

Thank you for your attention.

Questions?