

# *Eddleston Water - maximizing benefits for local communities*

*Professor Chris Spray – University of Dundee*



- 1) ***Land Use Strategy – Ecosystem services approach*** and ***maximising policy deliverables*** – Borders pilot study (Tweed Forum)
- 2) ***Past and present*** are not the same (let alone the future!) – a historical perspective on changing societal demands and service provision (Skhue Ncube)
- 3) ***Modelling interactions*** between services (Katya Perez and Ruth Dittrich)
- 4) ***Can we measure this on the ground*** (the Eddleston partnership)
- 5) ***Incentives and working with farmers*** (Heriot Watt, SAC Consulting)

# Land Use Strategy – Scottish Borders national pilot

LUS focused on a new “*approach to land use in terms of delivering multiple benefits, working in partnership with nature and linking people more closely with the land*”.

## Challenge:

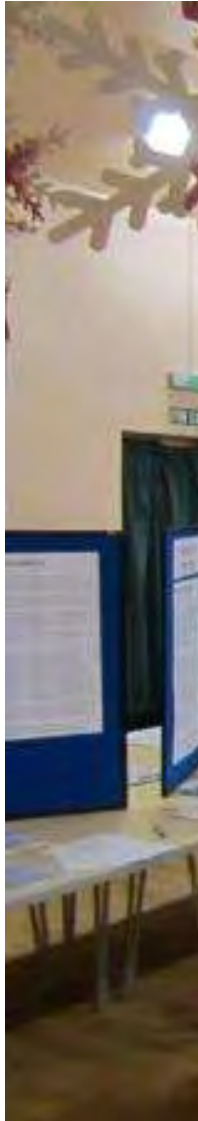
To *test the delivery* of Scottish Land Use Strategy using an Ecosystem Approach and *ecosystem service mapping at a regional scale*.

Work with **Stakeholder partnerships** to explore delivery of multiple benefits under different current and future *policy scenarios* related to climate change





# Case study sub-catchments - key issues

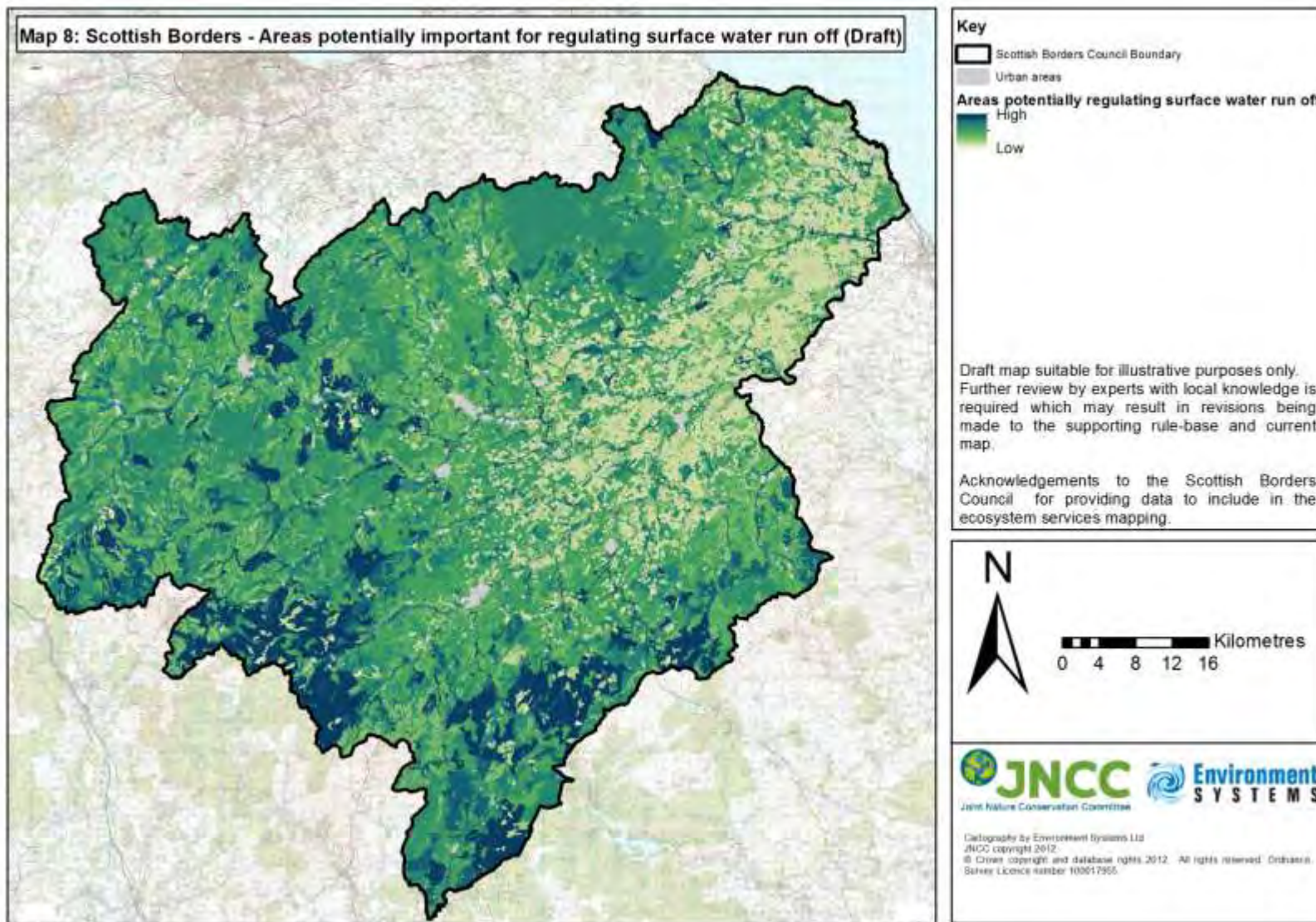


**Following massive series of stakeholder consultations at sub-catchment level (Eddleston) → Produced maps of the important goods and services as seen and validated by local communities**

- **Provisioning - (4)** Crops, Livestock, Renewable energy, Timber
- **Regulating - (6)** Water quality, Flood risk, Soil erosion, Sediment risk for watercourses, Soil carbon resource, Vegetation carbon resource
- **Supporting - (2)** Biodiversity, Pollination
- **Cultural - (4)** Sense of place, Game & Sporting, Historic sites, Landscape designations.

**Data collected from existing sources – 107 data sets, 74 utilised to create 16 main maps above**

# Mapped the main ecosystem services and validated with communities - *Water regulation*





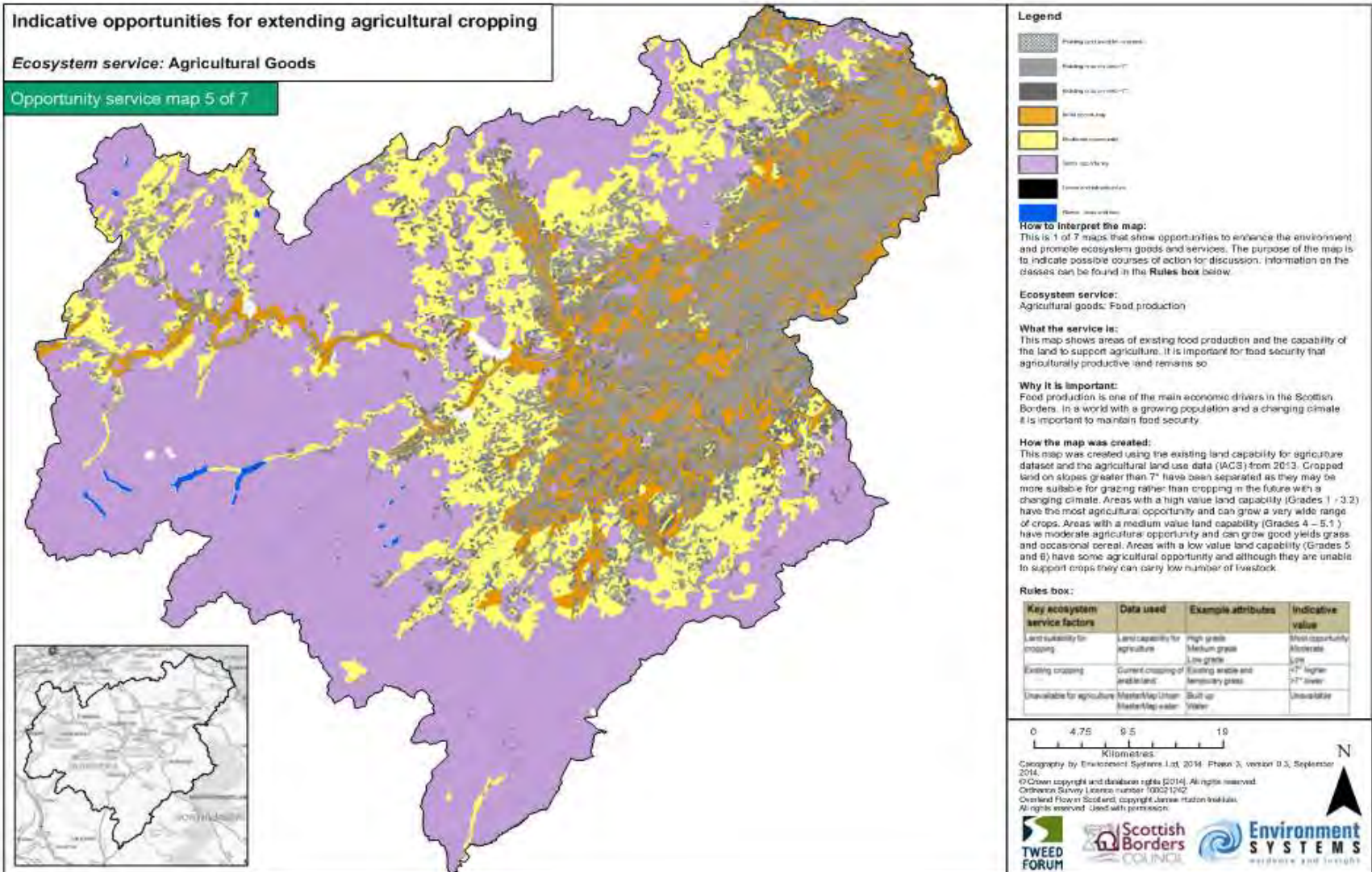
## How to look at integrating and maximizing benefits?

- **in terms of the 7 policy drivers** expected to have an influence on land use choices.

Represented these as a series of *Ecosystem services Opportunity Maps and Multiple benefit and Interaction maps*

1. Mitigation of flood risk
2. Expand Timber provision
3. Native Woodland expansion
4. Biodiversity enhancement
5. Improve Agricultural production & goods
6. Water quality enhancement
7. Enhance Soil carbon storage

# If policy was to maximise Food Security, where are the potential areas for expansion of Agricultural Cropping – provisioning service





# Identified key interactions between the different land uses and ecosystem services - Stakeholder consultation - Interaction/multiple benefits matrix

Existing ecosystem services

		Existing Land Use								
		Food production - livestock and crops	Timber and Woodland	Renewable Energy (wind farms)	Natural flood management	Diffuse pollution control	Carbon storage (soil & vegetation)	Recreation	Development sites	Biodiversity
Possible New Land Use	Food production - livestock and crops		1	+	--	---	-	- +	-	---
	Timber and Woodland	--		0	- +	++ --	+(+)	+ -	-	-
	Renewable Energy (wind farms)	0	-		-	-	--	--	+	-
	Natural flood management	---	+	+		++	+++	+	---	++
	Diffuse pollution control	-	+	+	+		+	+ -	- +	+++
	Carbon storage (soil & vegetation)	- (+)	0	+ - -	+	++		+	---	++
	Recreation	-	++++	--	+	-	+ -		- +	-
	Development sites	---	---	- +	---	---	---	-		- - +
	Biodiversity	-	+	+	++	++	+	+	+	

### Proposed expansion of service

**Yellow** - interaction maps [9] incl. softwood conifer plantation

**Blue** - Multi-benefit maps [15] incl. native woodland expansion

The matrix was designed by considering mainstream, land use scenarios within the Scottish Borders rather than specialist features. For the existing land use 'Recreation' would include specialist playing fields and footpaths etc. Biodiversity refers to sites being managed to enhance biodiversity either through designation or individual farming practices. Natural flood management are where an existing scheme is present. To read the interactions, for example, at<sup>1</sup> the negative effects would be from a situation such as the felling of farm woodland to grow crops, rather than agro-forestry (which could produce a neutral effect), as this is currently not a common or likely land use in the SBC area. Renewable energy in SBC at present concentrates on wind energy and therefore only wind energy has been considered. Development here refers to standard planning development, rather than environmentally sensitive development.

## Trying to understand and 'map' integration and maximisation of ecosystem services / multiple benefit provision

### Maps for multiple benefit produced so far in the Borders are:

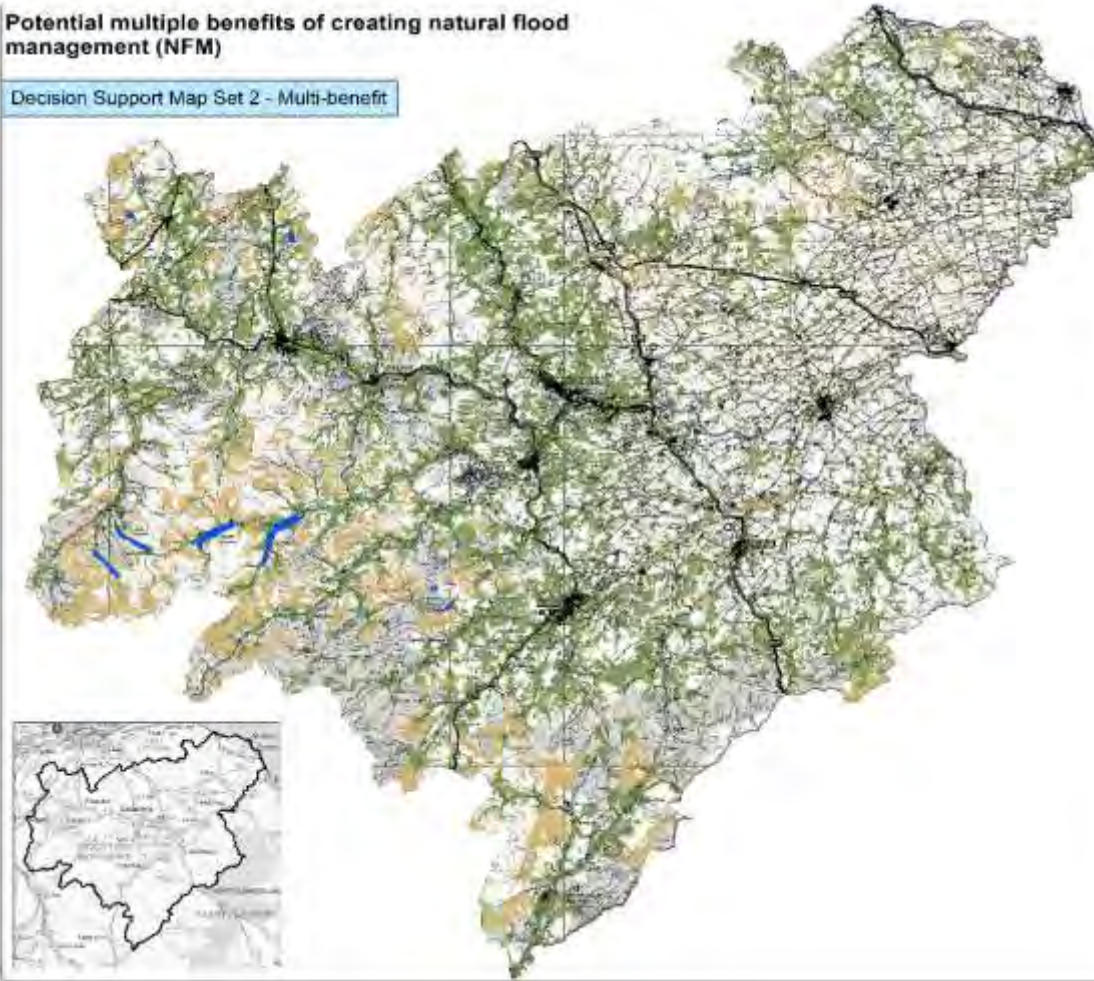
- **Planting native and mixed woodland** + Natural flood management, biodiversity, water quality, soil carbon storage
- **Creating areas for natural flood management** + biodiversity, water quality, soil carbon storage
- **Improving water quality** + natural flood management, biodiversity, soil carbon storage
- **Planting conifer plantations** + natural flood management, soil carbon storage
- **Re-placing softwoods with native/mixed woodland** to promote biodiversity + water quality, soil carbon storage
- **Enhancing soil carbon retention** + biodiversity, water quality
- **Enhancing biodiversity** + water quality, native woodlands, soil carbon storage



# If policy was to maximise Reduction of the risk of flooding, where would subsequent changes in land use lead to delivery of other ecosystem services?

## Potential multiple benefits of creating natural flood management (NFM)

### Decision Support Map Set 2 - Multi-benefit



#### Legend

- NFM opportunities only
- NFM opportunities multi-benefit with 1 other opportunity
- NFM opportunities multi-benefit with 2 other opportunities
- NFM opportunities multi-benefit with 3 other opportunities
- Urban and infrastructure
- Rivers, lochs and lakes

**Themes to consider:**  
It is probable that climate change may be adding to the frequency of extreme storm events. Natural flood management techniques help the river and surrounding countryside by reducing the speed at which rainfall reaches the rivers. Implementing natural flood management measures in the catchment builds resilience in the environment to better absorb the effects of climate change.

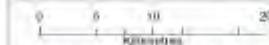
**What the map shows:**  
This map shows areas where a land use change to aid natural flood management may provide multiple benefits for other ecosystem services. These include enhanced biodiversity, improved water quality and enhancement of soil carbon.

**How the map has been created:**  
The map has been created by looking at where opportunities to enhance natural flood management overlap with opportunities to enhance biodiversity, water quality and soil carbon.

The map is one of a series of maps that explore the current and potential use of land in the Scottish Borders. It is not intended to prescribe a course of action, but rather to act as a decision support tool. This map highlights the other ecosystem services that could be enhanced with a change of land use in these areas.

#### Notes box:

Key ecosystem service factors	Data used
Location of flood risk	Opportunities map 1 of 7 Flood risk opportunities to remove the ability of the land to absorb water, leading to increased flooding
Enhance multi-benefit (biodiversity, soil)	Opportunities map 4 of 7 Biodiversity opportunities (potential) across habitats and river catchments Opportunities map 6 of 7 Soil carbon opportunities (improving water quality) Opportunities map 7 of 7 Water quality opportunities to enhance soil carbon storage



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**Potential areas for delivery of multiple benefits from NFM**



# *But what about **changing ecosystem service priorities over time?** - and maximizing benefits for local communities*

## MAPPING AND ASSESSMENT OF CHANGES IN ECOSYSTEM SERVICES DELIVERY – A HISTORIC PERSPECTIVE ON EDDLESTON AND ALE CATCHMENTS

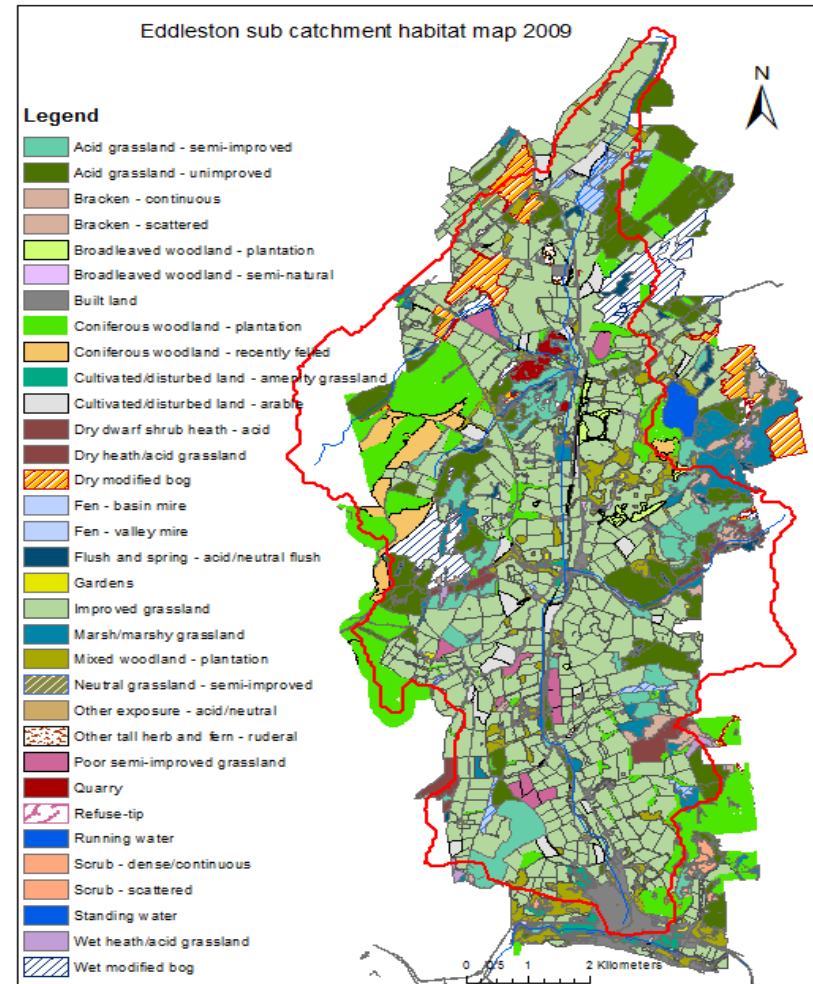
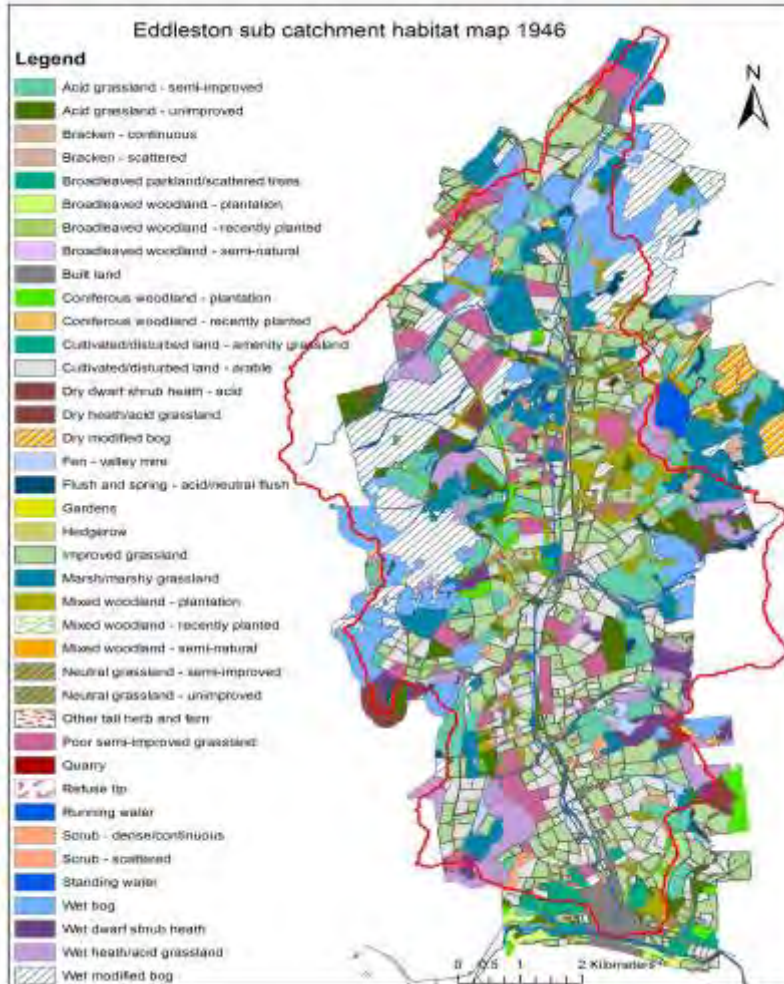


The Scottish  
Government  
Riaghaltas na h-Alba



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# Eddleston Water – comparing *land use and derived ecosystem services* from 1946 and 2009



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Land use maps 1946 and 2009



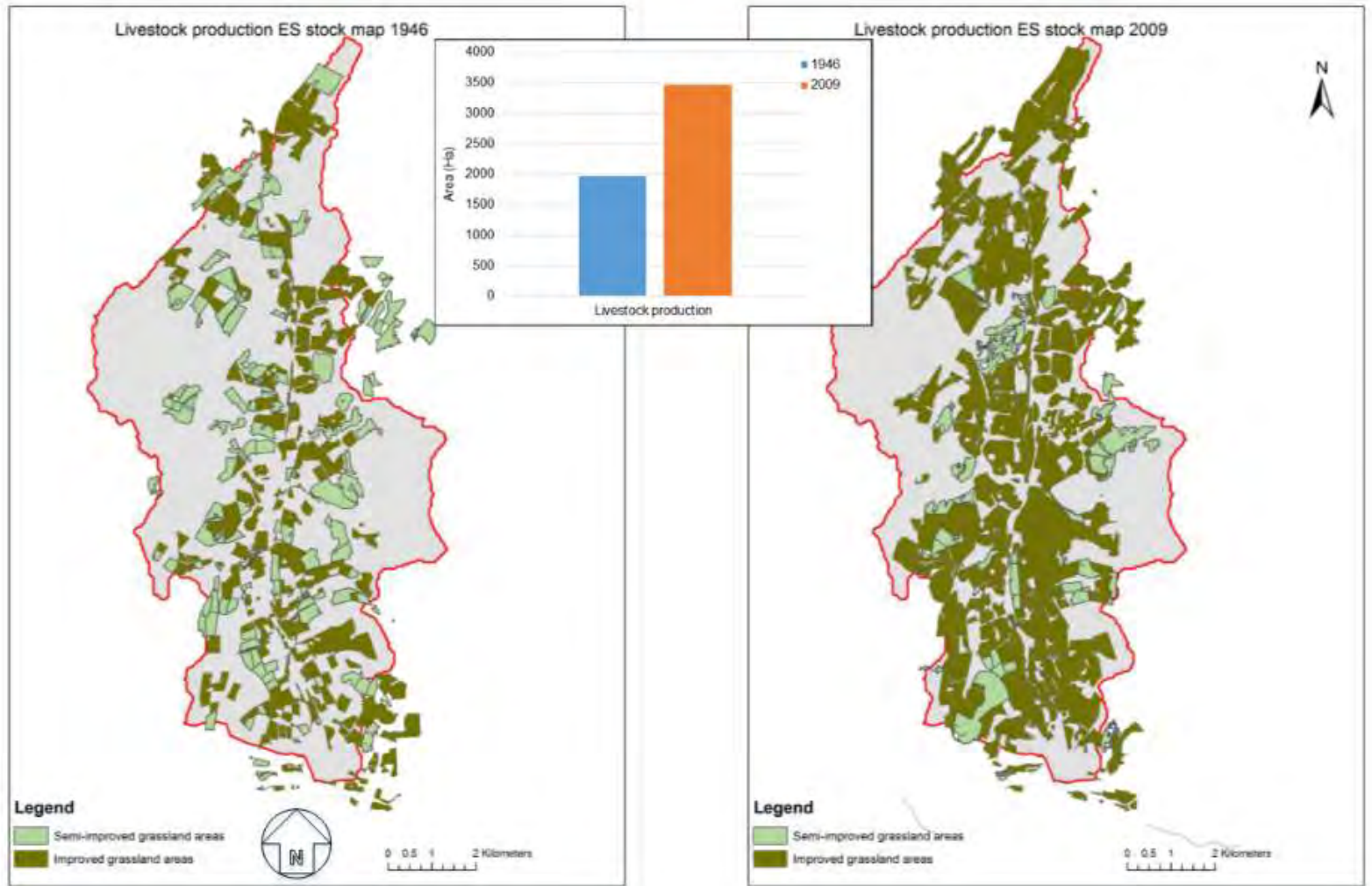
The Scottish Government  
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SEPA  
Scottish Environment  
Protection Agency

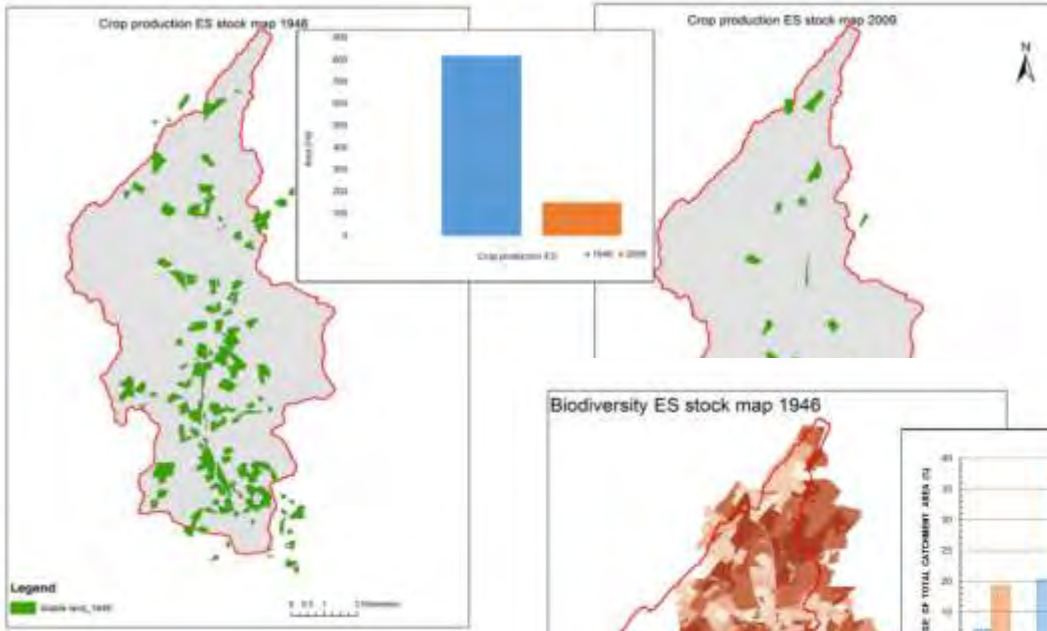


# Eddleston Water – some major *increases* in Ecosystem Service delivery - 1946 and 2009

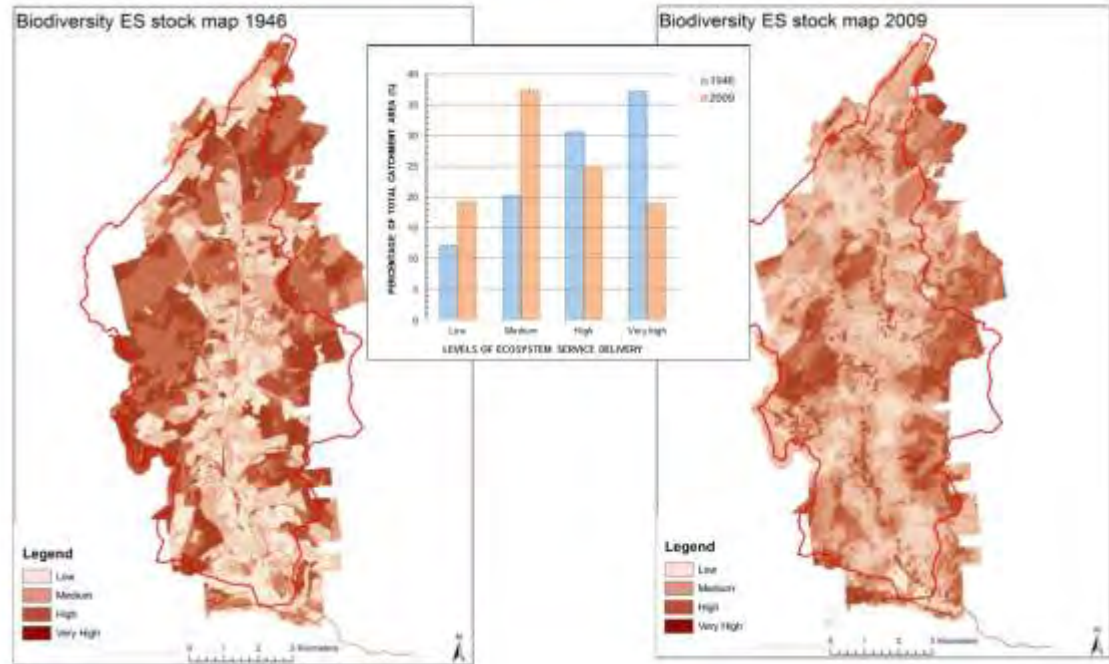




# Eddleston Water – some major *losses* in Ecosystem Service delivery - 1946 and 2009

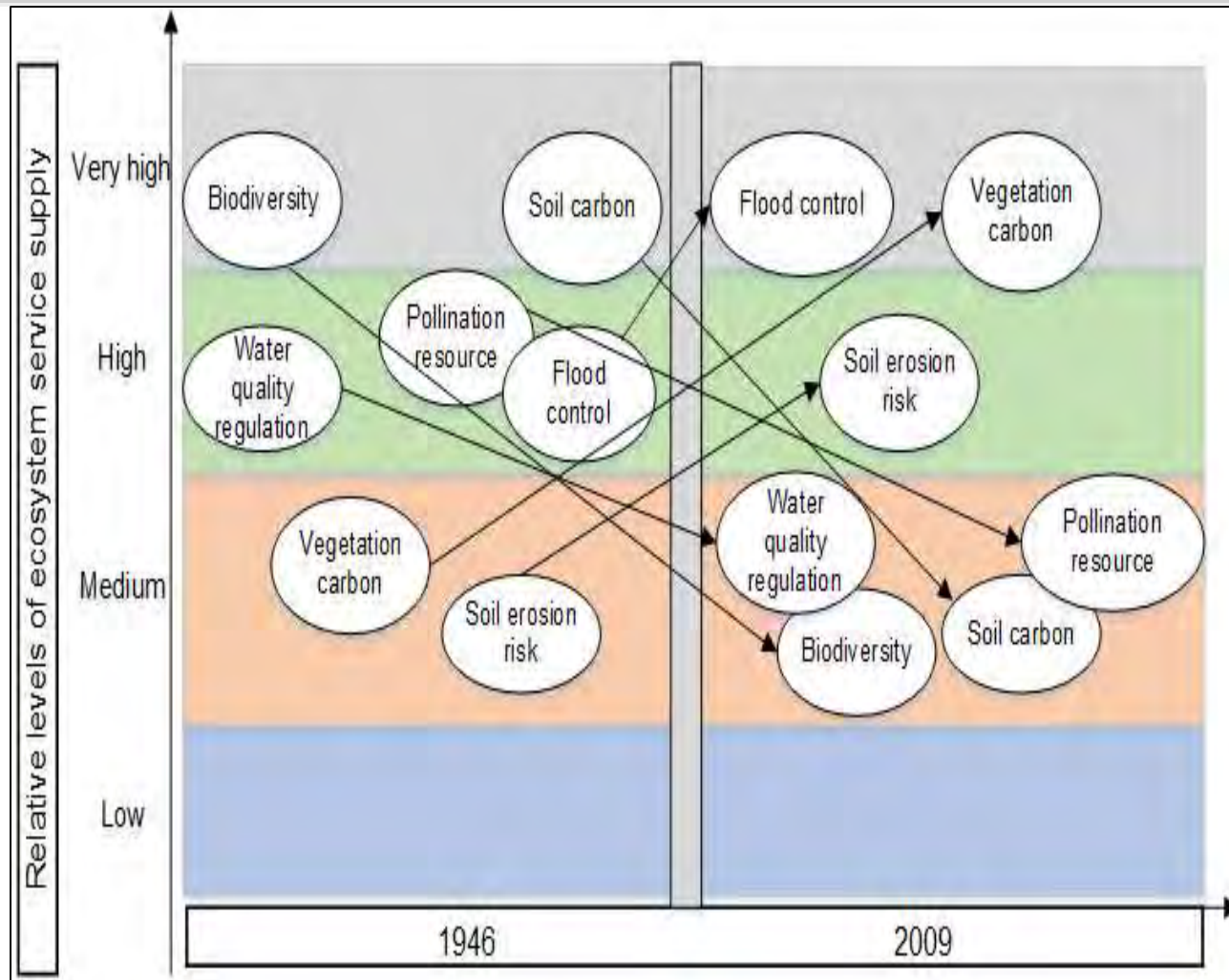


Crop production service



Biodiversity - ecosystem service

# Eddleston Water – relative changes in levels of Ecosystem Service delivery: 1946 and 2009



# The Eddleston Water project - maximizing benefits from land use change for the local community

## Answering policy questions concerning the costs and benefits of 'restoring' river catchments for people and for wildlife

- **Can we reduce the risks of flooding** to local communities by changing the way we manage our land and rivers? and by how much?
- **Can we improve habitats** and meet the requirements for 'good ecological status' under the Water Framework Directive?
- What techniques and ideas **work** best? – and where?
- **How do we maximise the potential benefits that could be delivered alongside these** – for landscape, water quality, climate change resilience, recreation, fishing, tourism, etc?
- What are the **costs** of restoration?
- **How do we reduce flood risk whilst also maintaining a prosperous and sustainable farming community and local businesses?**



# Eddleston Water - monitored catchment for 'proving' the value, costs and benefits of *restoring ecosystem function and services* at a catchment scale

## Scientific Measurements include:

River flow and flood gauges

Ground water surveys and boreholes

Rainfall and weather stations

River habitats and hydro-morphology

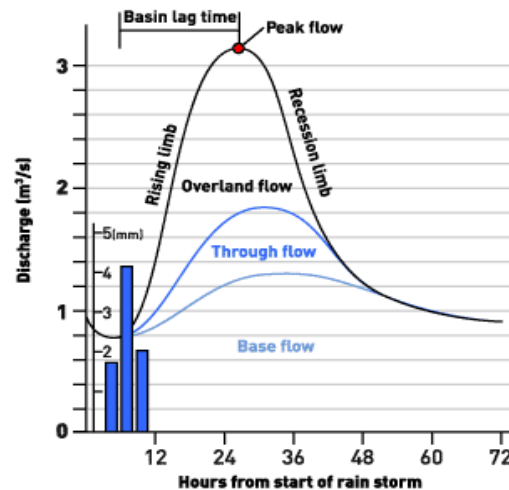
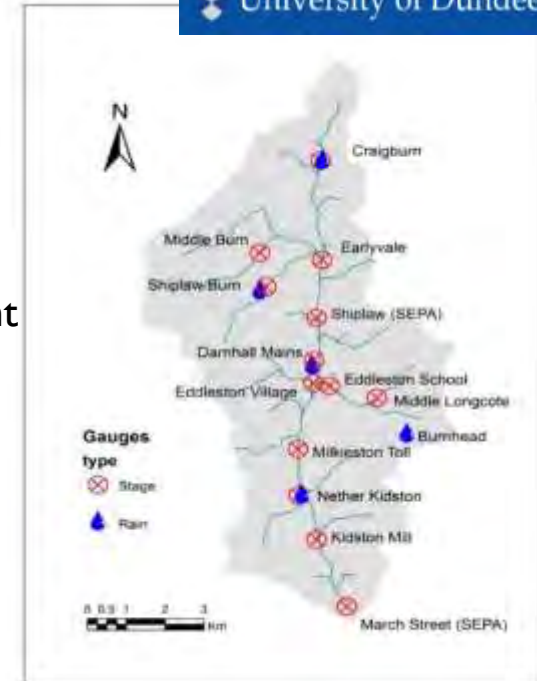
River biology – fish, plants, invertebrates

Land-owner & community engagement

Ecosystem services – past, present & future

- Long-term partnership project
- Scottish Government funding
- Empirical study
- 69 sq km

University of Dundee



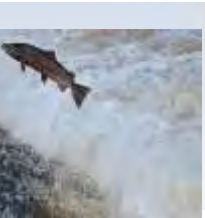
TWEED FORUM



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SEPA  
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Protection Agency



Interreg  
North Sea Region  
Building with Nature

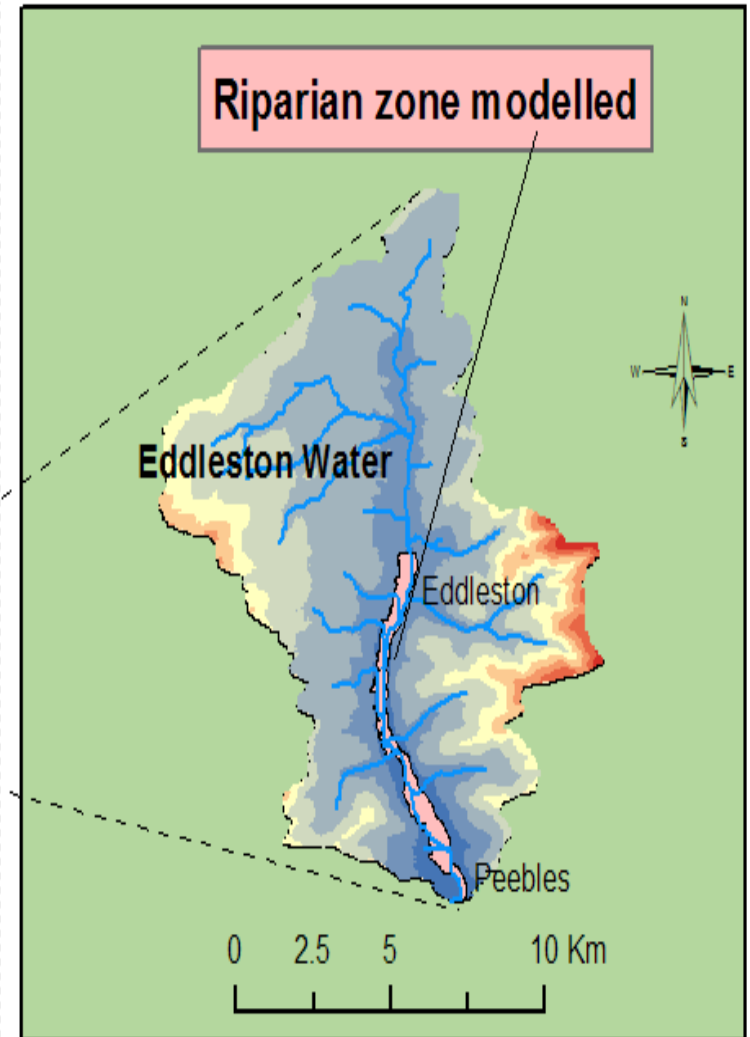
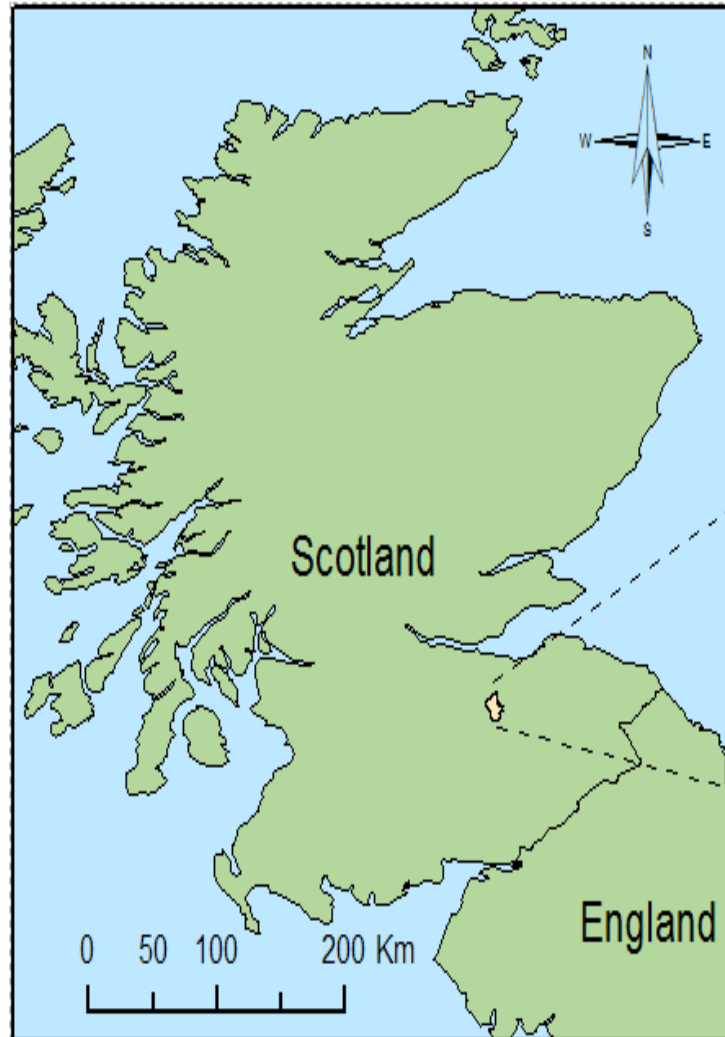
# Modelling Flood risk reduction impacts on other Ecosystem services

**Floodplain  
modelling  
work -  
Katya Perez**

*Dundee and  
Newcastle  
Universities*

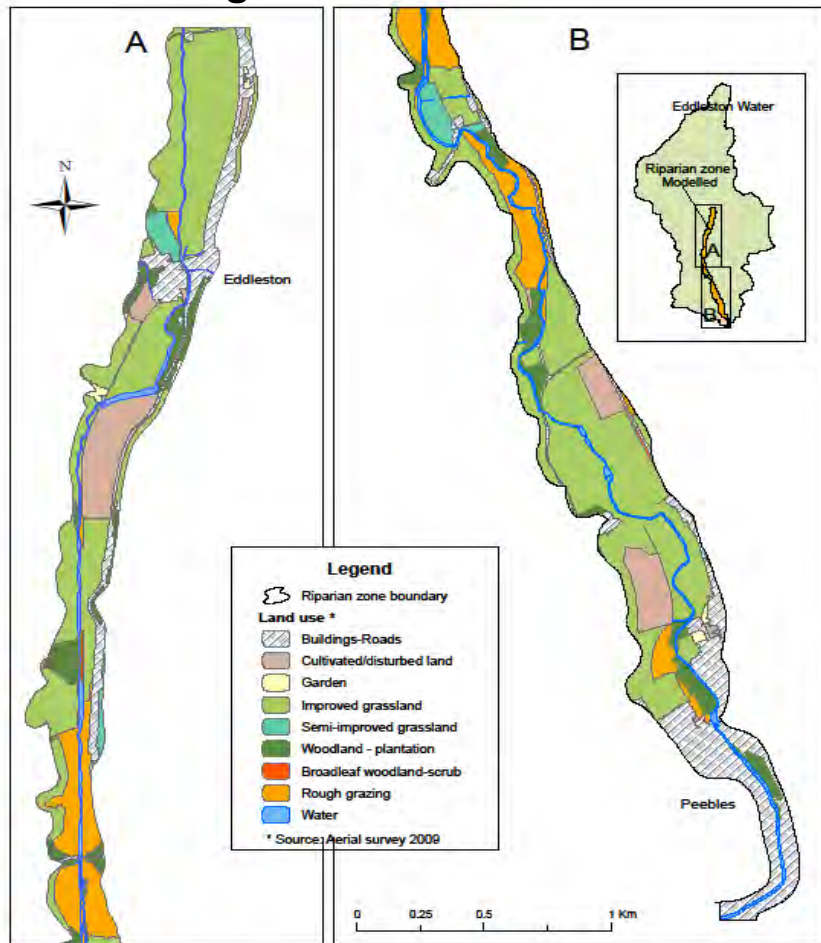
**Economic  
valuation of  
NFM forest  
planting on  
ecosystem  
services**

**Ruth  
Dittrich  
Edinburgh**

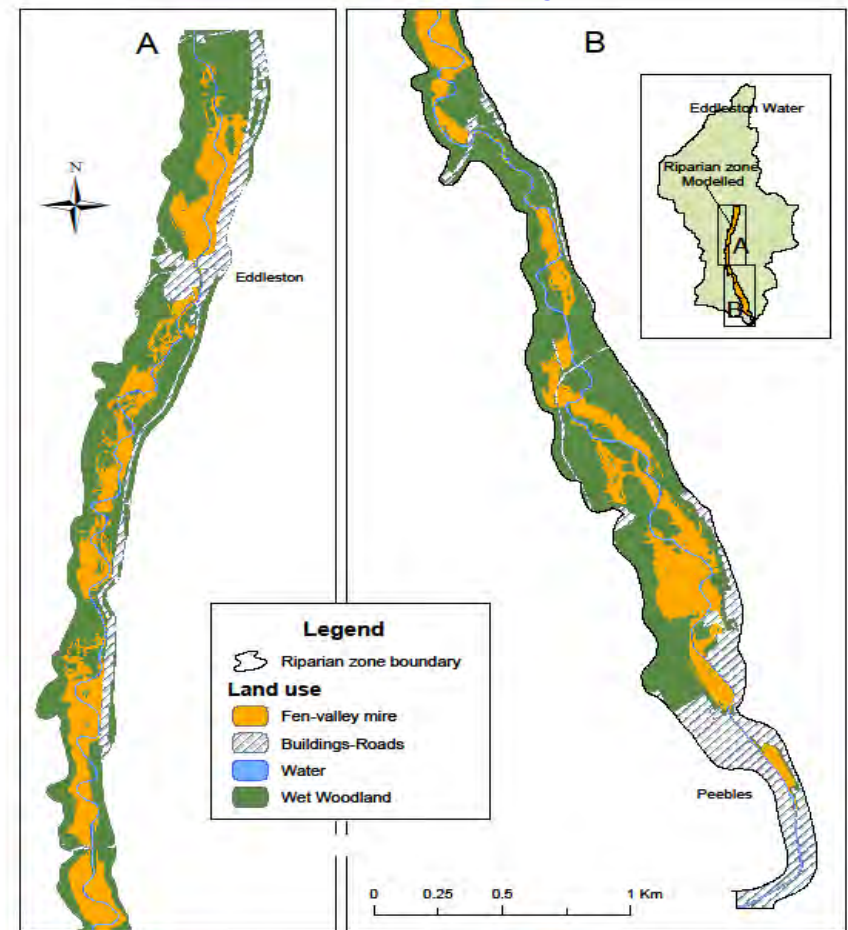


# Eddleston Water: ecosystem services under an NFM flood reduction scenario – Katya Perez

## Current straightened river course & agricultural land uses



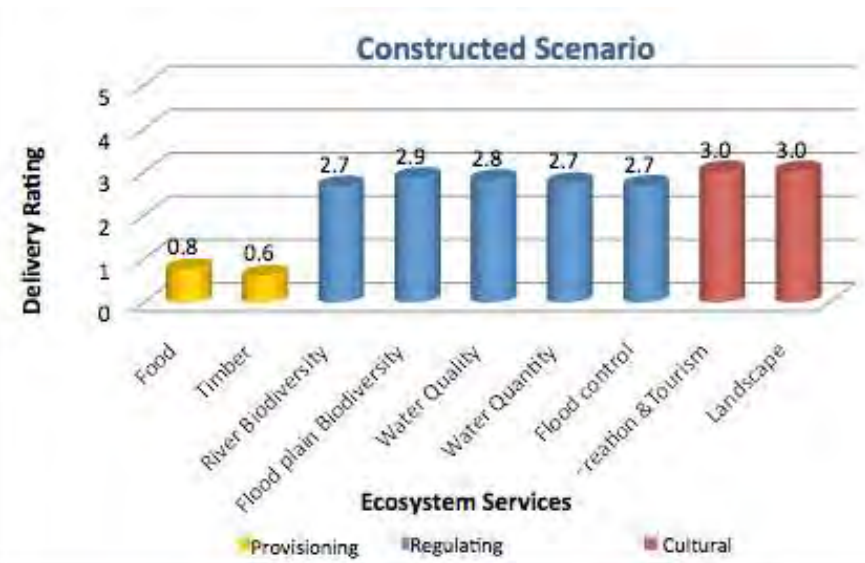
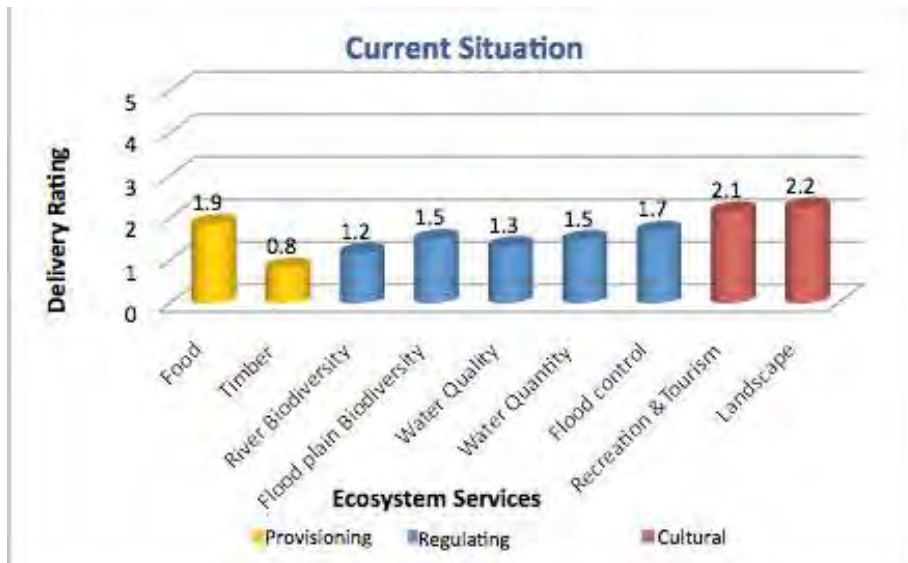
## Created 'NFM max' scenario - re-meandered river course & wet valley woodland





# Eddleston Water: maximizing ecosystem services ?

Clear **Trade offs** between modelled and current land use for ecosystem services –

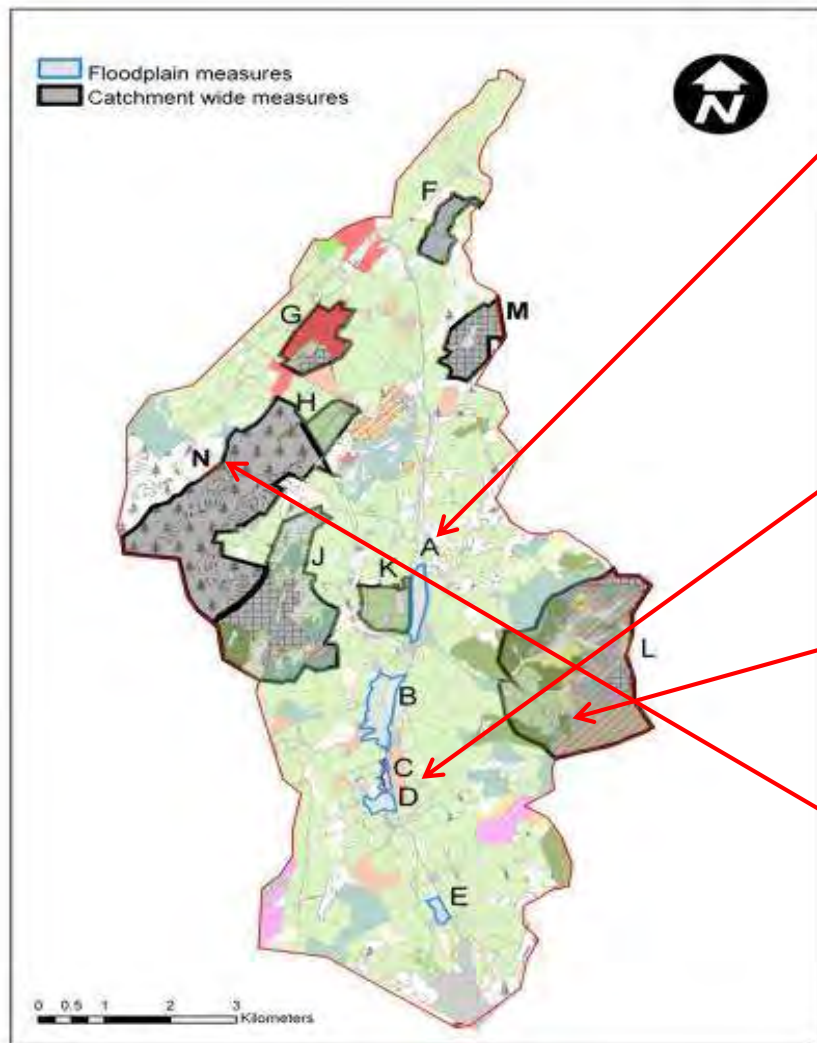


Change in Ecosystem service scores shows **multiple benefits from scenario that favours flood regulation as dominant ecosystem service in the floodplain**

**Cost benefit (££) of NFM woodland planting very positive if include multiple ecosystem services – Ruth Dittrich**

# Can we measure differences in ecosystem service delivery on the ground?

## Eddleston Scoping study **identified NFM options to reduce flood risk**



### Potential options/measures:

**A:** breach/set back embankments, **new fence margins, riparian woodland, wet woodland,**

**C:** **re-meander channel - Cringeltie**

**L:** Reduced stocking density, **tributary woodland, floodplain forest – Longcote burn**

**N:** create ponds, wetlands, riparian woodland block ditches, **engineered log jams – Middle burn**

## *Large number of landscape NFM measures introduced*

*To date*, Tweed Forum and the partners have worked with 20 farmers to:

- *Re-meander over 2 km of river*, and reconnect with the floodplain
- *Planted 200,000 native trees in 70 hectares* (with a further 45ha in progress)
- *1 km contour planting* of hedges
- *Created 22 upstream off-line ponds*
- *Created one floodplain pond*
- *Constructed 101 high-flow log structures* to restrict flow and to recreate a basin mire

*Have improved the river from 'Bad to 'Moderate' Ecological Status*, and on target for 'Good' (Water Framework Directive)

With the award of an EU North Sea Region Interreg grant in 2016, it has core support for *further work up to 2020*



## Impact of re-meandering previously straightened channels – to reduce flooding in low (and high?) flows

Breach in embankments & new pond areas to permit temporary flood storage right bank during high flow events.



→ Effective added storage in  
low flow floods *and*  
→ Added habitat complexity

# Re-meandering leads to major hydromorphological changes

Hydro-morphological improvements may lead to **reduced flood risk**.

Hydrographs and modelling show indications of reduced flood risk from re-meandered sections of once straightened channels

Improvements driven by restoration of river banks and channels through re-meandering, weir removal, etc lead to **improved WFD Ecological Status** - from Bad to Moderate.

Before re-meandering



After re-meandering



Model outputs at Cringeltie/Lake Wood under 1:2 years flood scenarios

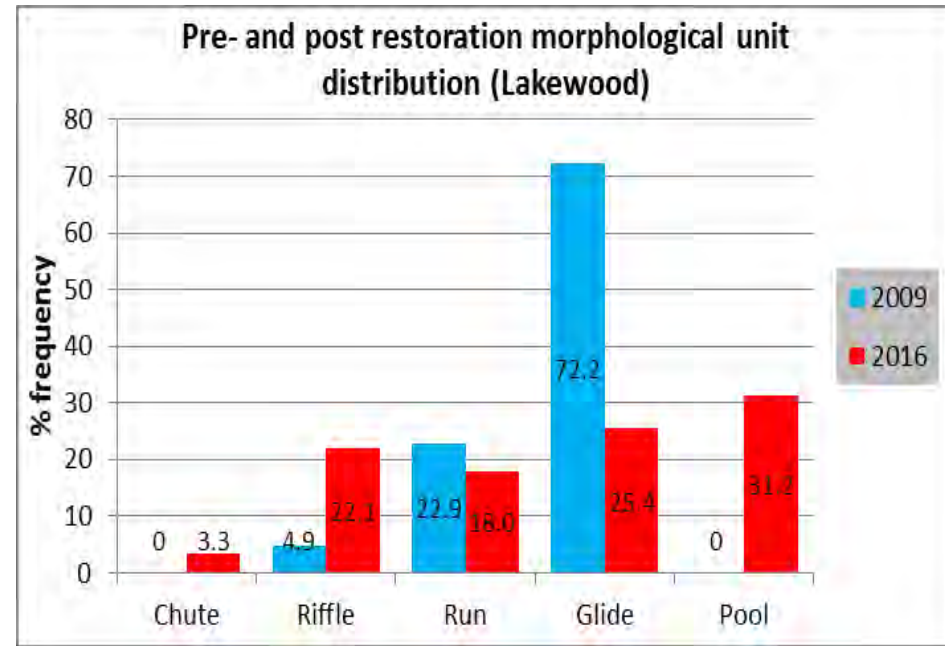


# → leading to measured changes in biodiversity and ecosystem service delivery

An increase in overall **physical diversity of habitats** within re-meandered sections, and an increase in habitat area.

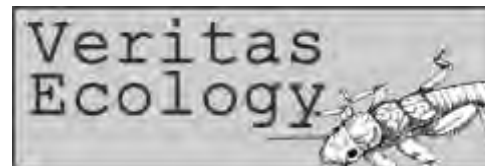
A increase in the number and extent of **spawning habitats for salmon**, as indicated by changes in the spatial distribution of favoured micro-habitats for salmonids

A rapid recolonization of re-meandered **channels by aquatic macroinvertebrates**. Species richness and diversity increased post-restoration, towards that found in un-impacted reaches



Pre- and post- restoration morphological unit distribution. Numbers represent percentage cumulative length of each morphological unit.

**Cbec Ltd**





# Maximizing ecosystem services requires Working with Landowners and Farmers - willingness to change?



Need to address the best ways to encourage farmers to **voluntarily** take up land management practices that deliver '**other**' ecosystem services

- Attitudes to NFM
- Support needed to implement NFM?



Based on surveys across the whole Tweed catchment – 50 respondents (87% male) recruited from farming & rural networks

- Incentives
  - Easements
- Farming ecosystem services ?

