



Participatory approaches to spatial planning for managing ecosystem service provision from farm woodlands

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Background

- Ecosystem services are the aspects of ecosystems utilised (actively or passively) to produce human well-being
- There is increased policy interest in valuing a broader range of ecosystem services in environmental management.
- Engagement of local people in ecosystem management is fundamental to making operational approaches viable.

Spatial dimensions of Ecosystem services

Ecosystem Services

Supporting



Provisioning



Regulating



Cultural



Ecosystem services often involve stocks and flows of material or individuals across landscapes: water, soil, carbon, organisms

The areal extent and spatial configuration of landscape features (trees, ponds, wetlands) affect these flows and hence the provision of services

Change in land use or management and the presence of landscape features affect multiple ecosystem services simultaneously

Farm woodlands



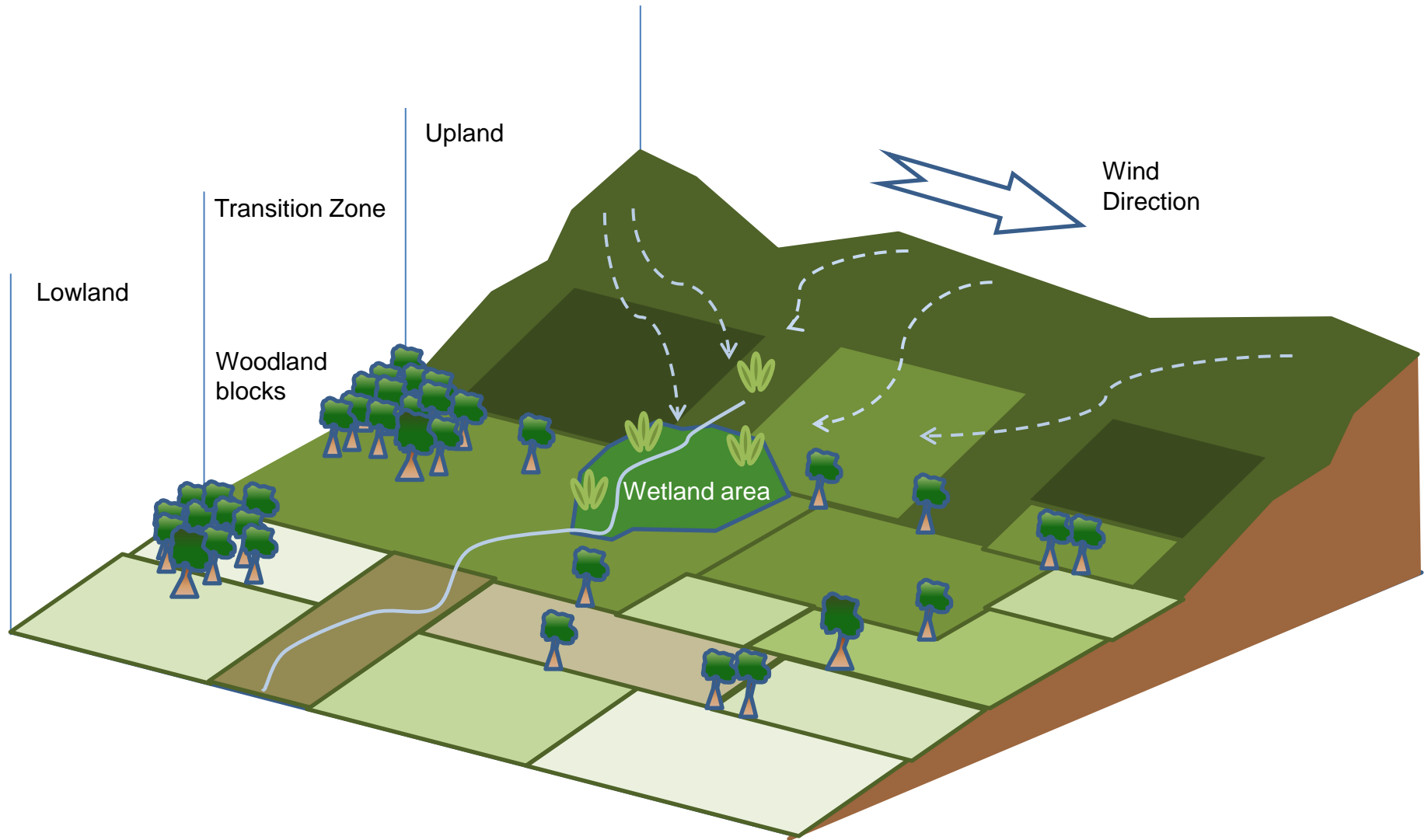
The total land area of Wales is 2.1m ha of which 81% is in some form of agricultural use

Farm woodlands have the potential to deliver a broad range of ecosystem services



Where farm woodlands are located in a landscape has a significant influence on the nature of the services that they can supply

Natural Capital – the starting point

Changes to tree cover?



How farmers might enhance tree cover

Ecosystem Services	
Supporting	Provisioning 
	Regulating
	Cultural 

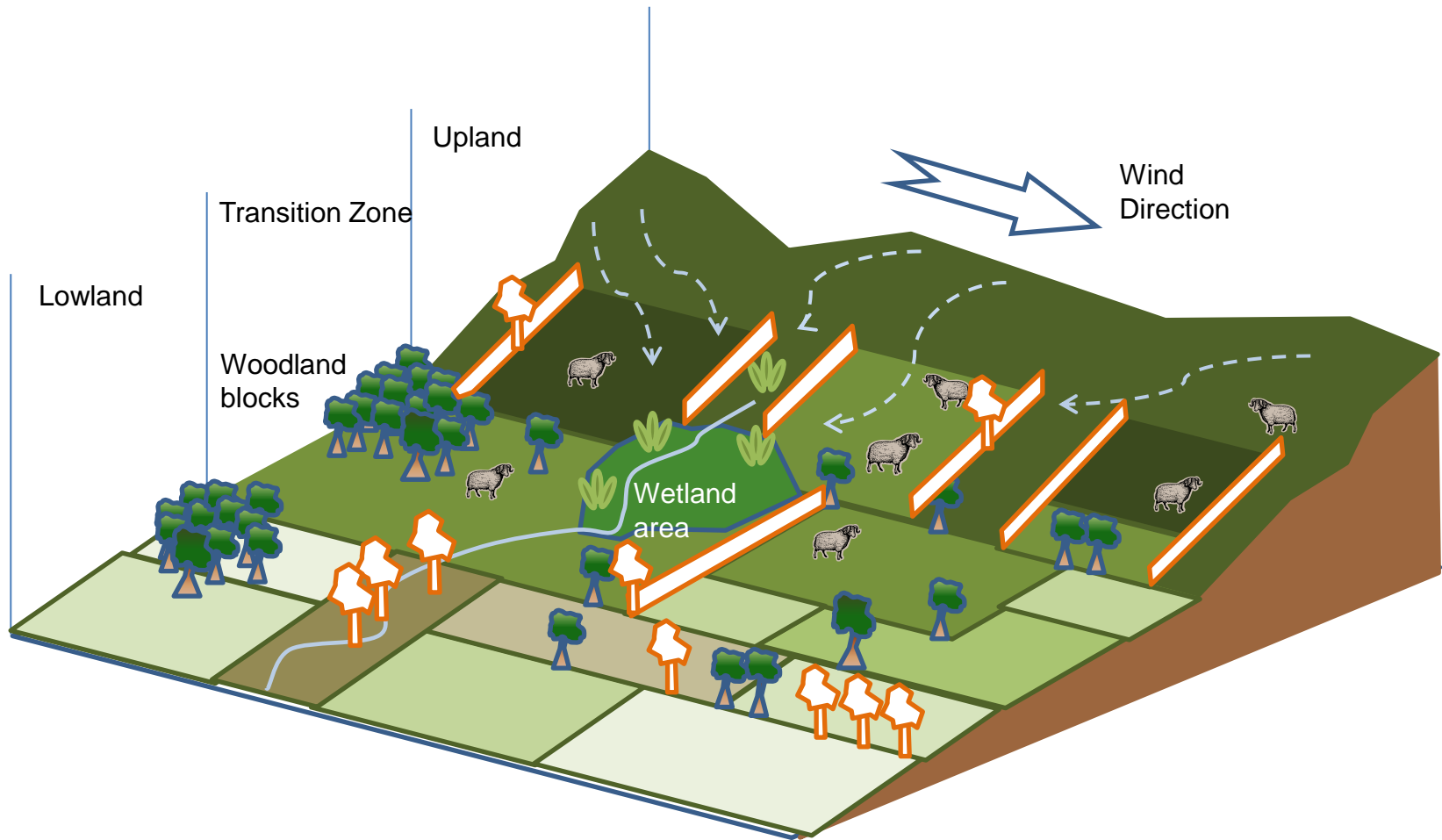
Farmers' livelihoods prioritise the supply of:

- food
- fibre
- fuel

from the landscape

In situ benefits
Beneficiaries – the farmers and 'consumers'

How farmers might enhance tree cover



How public agencies might enhance tree cover

Ecosystem Services

Supporting



Provisioning

Regulating



Cultural



Focus on delivery of

Public benefits:

Water regulation,

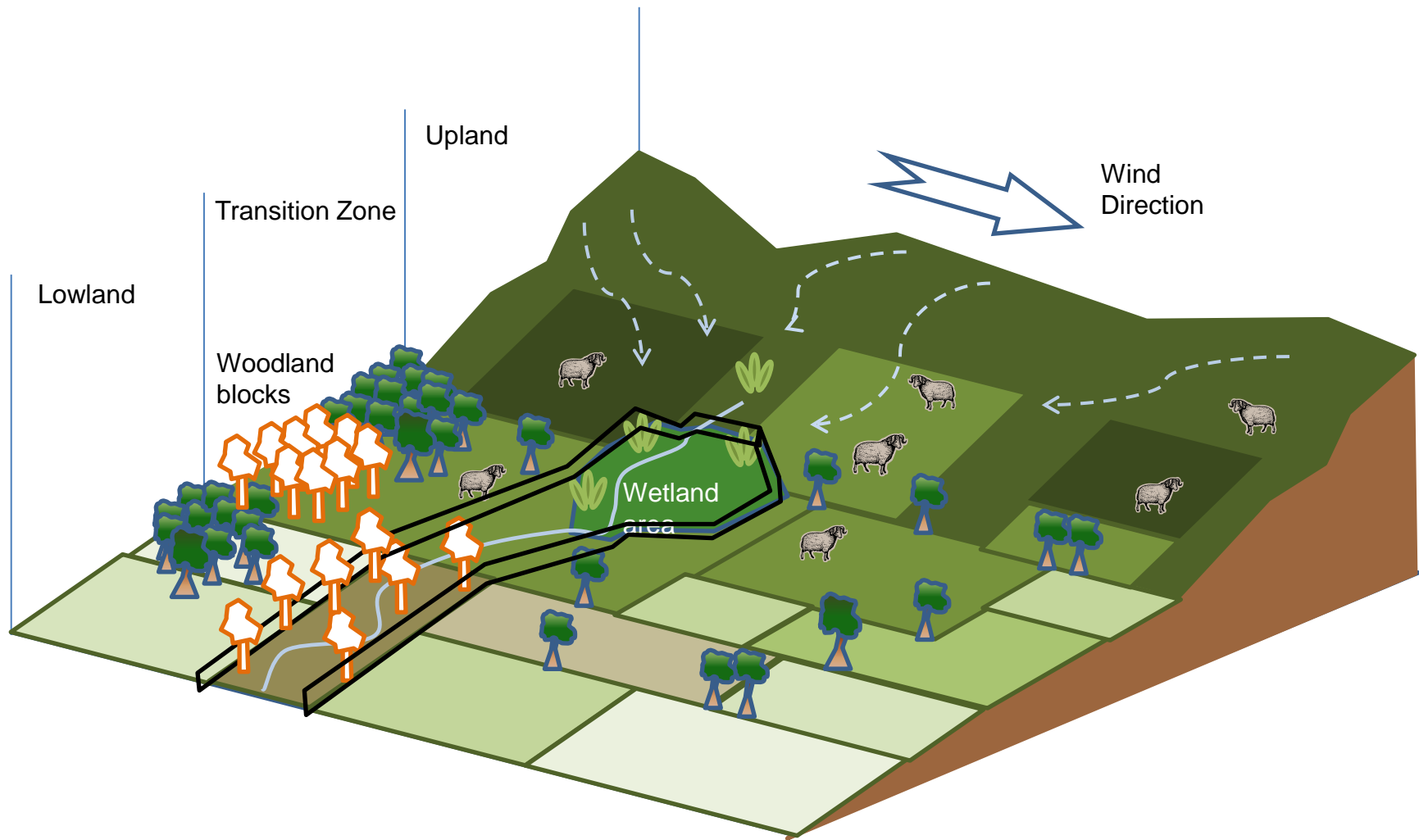
Carbon storage,

**Natural hazard
regulation - Flooding**

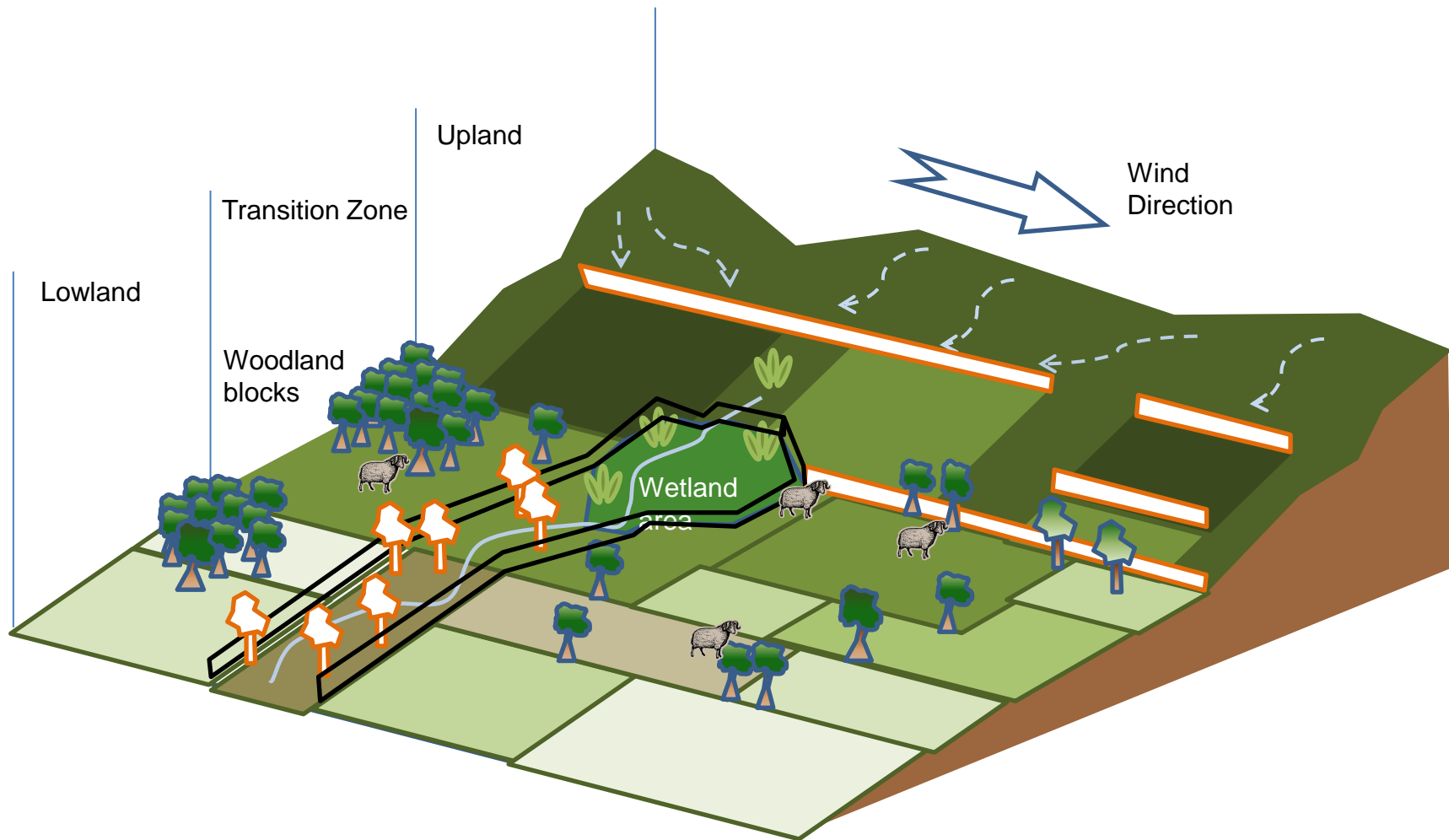
In many cases
beneficiaries are
'downstream' from the
interventions

Many services currently
lack formal markets

How current agri-environment schemes might enhance tree cover



How considering flood risk might enhance tree cover



Requirements for managing ecosystem service provision

- Farmers need to make informed decisions at 'landscape' scales,
 - see their farm in its landscape context and consider collective action (binding social capital)
- Policy makers and implementers need to be able to see and prioritise opportunities for making and managing change (and to make policy spatially explicit)
- There needs to be dialogue amongst sectors (e.g. FC, EA, CCW in Wales) seeking synergy and managing trade-offs
- Downstream stakeholders need to appreciate impacts of land use decisions on their wellbeing (bridging social capital).

Initial Specification

- The mapped output needed to integrate across scales from field to 'landscape'.
- The output needed to be spatially explicit
- Multiple services need to be mapped together
- To be useful in any landscape the tool must be able to utilise generally available data in the first instance.
- Integrate scientific evidence with local knowledge.
- The output should support the implementation of policy at landscape scales.

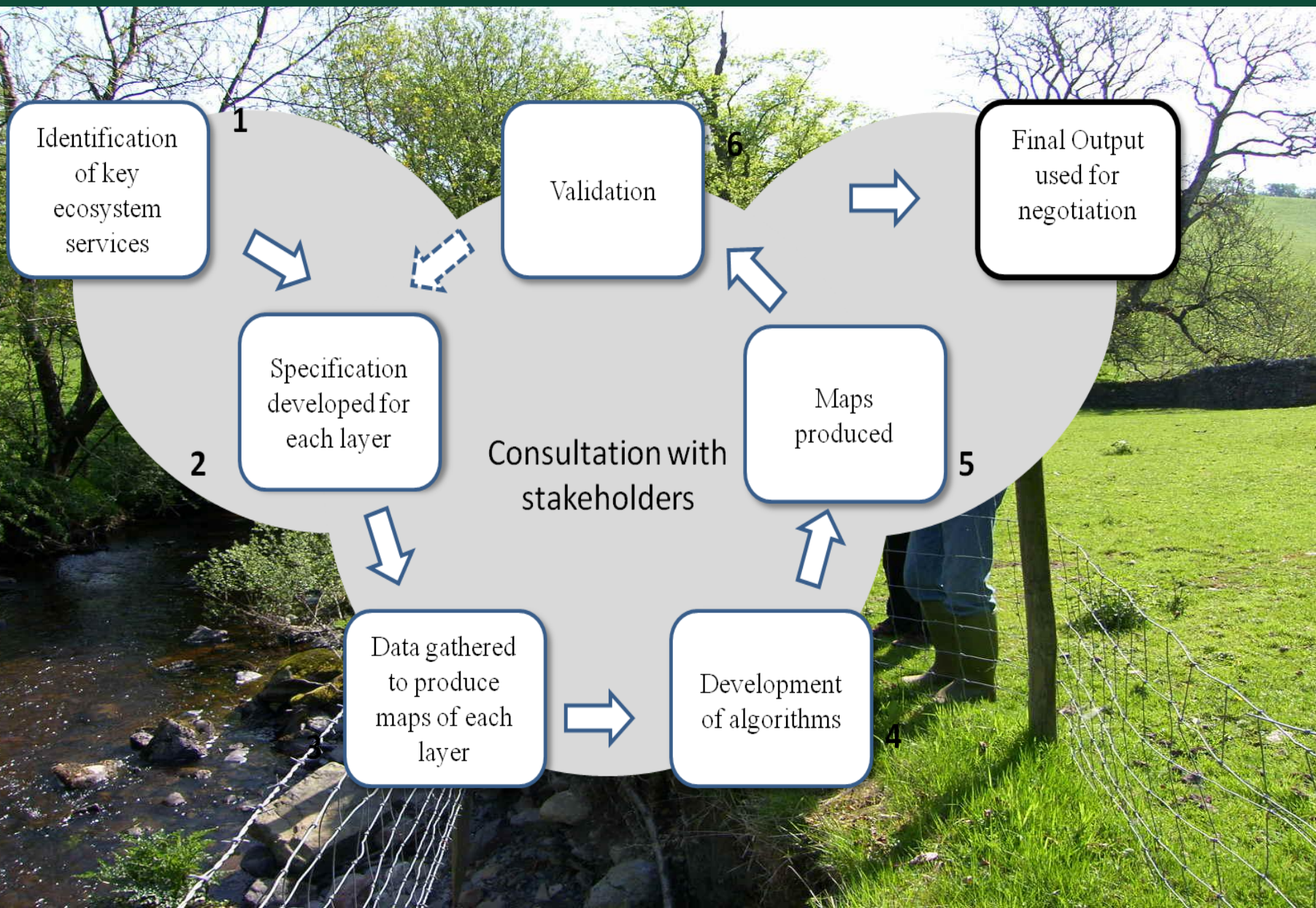
Polyscape - a multiple criteria GIS toolbox

- Designed as a negotiation tool not as a prescriptive model
- Works at **local** scales with resolution appropriate for field decisions considering small (10 km²) to medium (1000 km²) landscape contexts
- Embraces the reality of 'data sparse' environments, using national scale digital elevation, land use/cover and soil data in the first instance

Polyscape - a multiple criteria GIS toolbox

- Spatially explicit evaluation of synergies and trade-offs from farm woodlands for
 - **Surface water regulation,**
 - **farm productivity,**
 - **sediment transport,**
 - **carbon storage** and
 - **biodiversity** (woodland habitat connectivity)
- Incorporates participatory validation and, the **incorporation of local knowledge** about where farmers do and do not want trees,
 - ensures local engagement and ownership.

Participation and Knowledge Exchange



Sources of data

Data set	Type	Resolution	Notes
CCW 1980s Phase 1	Land use	10m ²	Data drawn from field survey 1980s
CCW 2009 Phase 1	Land use	5m ²	Remote sensed data 2009.
NSRI Soilscales	Soil	1 km ²	Farewell <i>et al.</i> , 2011
OS Land PROFILE	DTM	10m ²	
EA Flood risk	Flood risk	1m ² -10m ²	Uses DTM and LIDAR
Core and Focal Habitat Network	Habitat network	20m ²	Watts <i>et al.</i> , 2008

What single layer colours mean?

Areas with priority for
maintaining current land use



High



Moderate

Areas with moderate or
unknown potential for land
use change



Areas with high priority for
land use change



Moderate

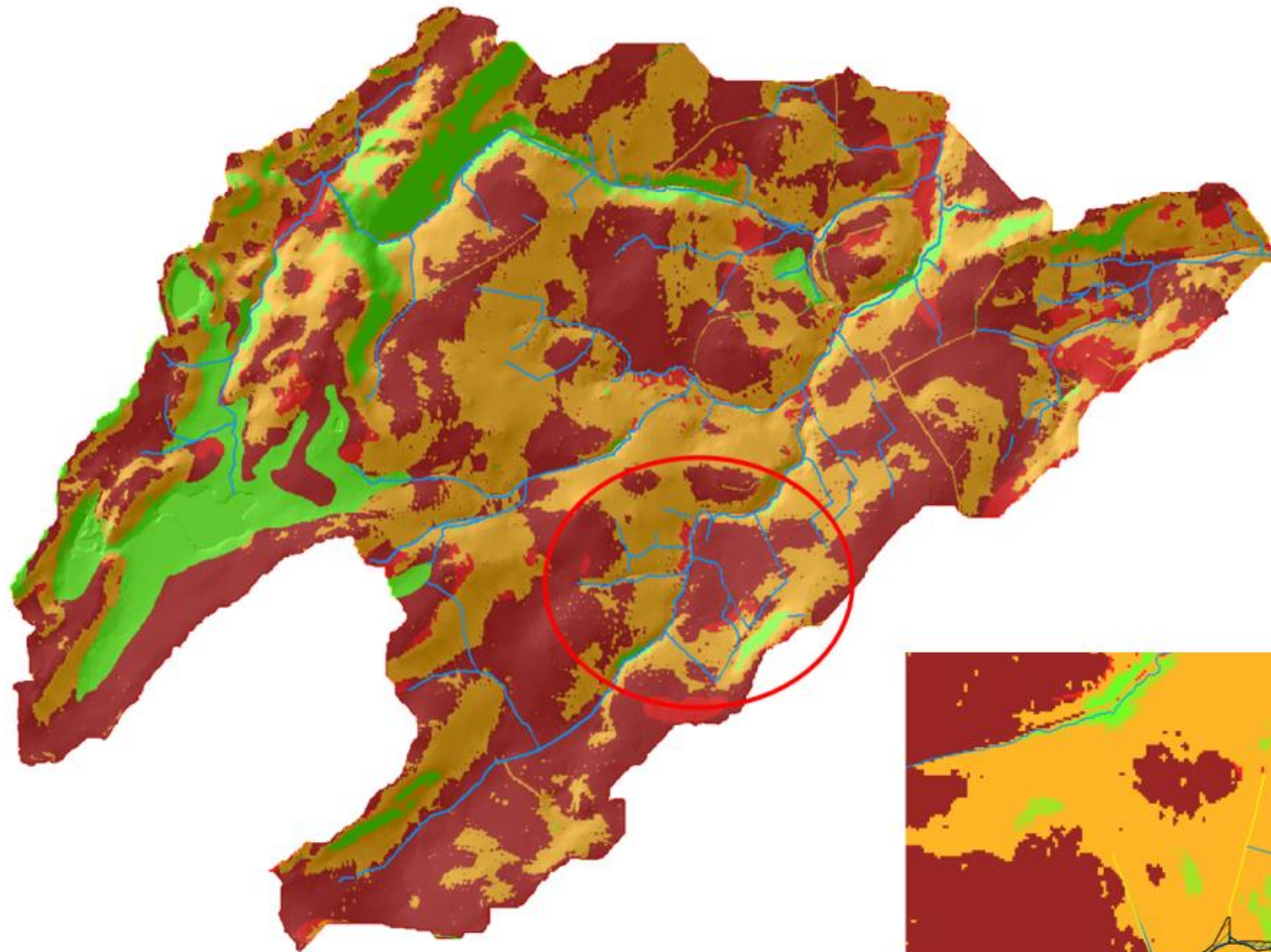


High

Farm productivity layer (Pontbren)

- The base layer (represents farmer's livelihood)
 - derived from participatory research at Pontbren
- Difficult to represent all decisions (idiosyncratic behaviour)
- Inputs are digital elevation, soil type, and critical slope values
- The algorithm categorises land value according to its degree of waterlogging, fertility and slope

Farm productivity layer – Marginal land identified in green – make interventions on wet and sloping areas **not flat and dry (red)**; much of the catchment negotiable (orange).

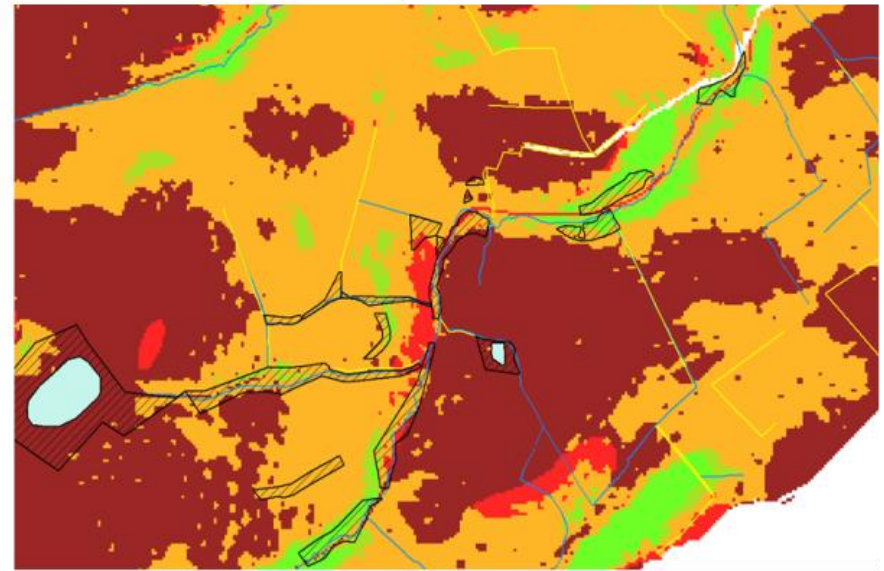


Legend

Polyscape farm impact

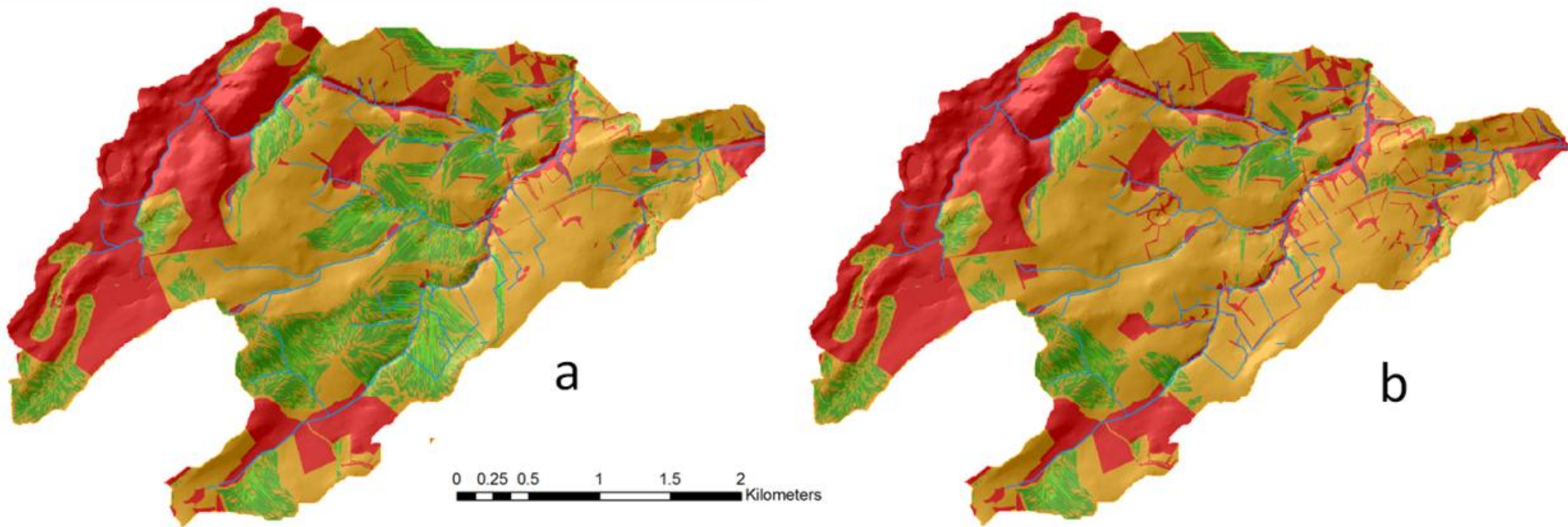
- high existing value
- existing value
- marginal
- high opportunity for change
- Stream networks

0 0.25 0.5 1 1.5 2 Kilometers



Water regulation maps for Pontbren

Opportunities for tree planting because high flow (grassland with $> 500 \text{ m}^2$ contribution, green); Moderate Flow 100 – 500 m^2 ; negligible flow, with $<100 \text{ m}^2$ contribution (orange); already has trees or other flow sinks (red).



Pre intervention

Post intervention

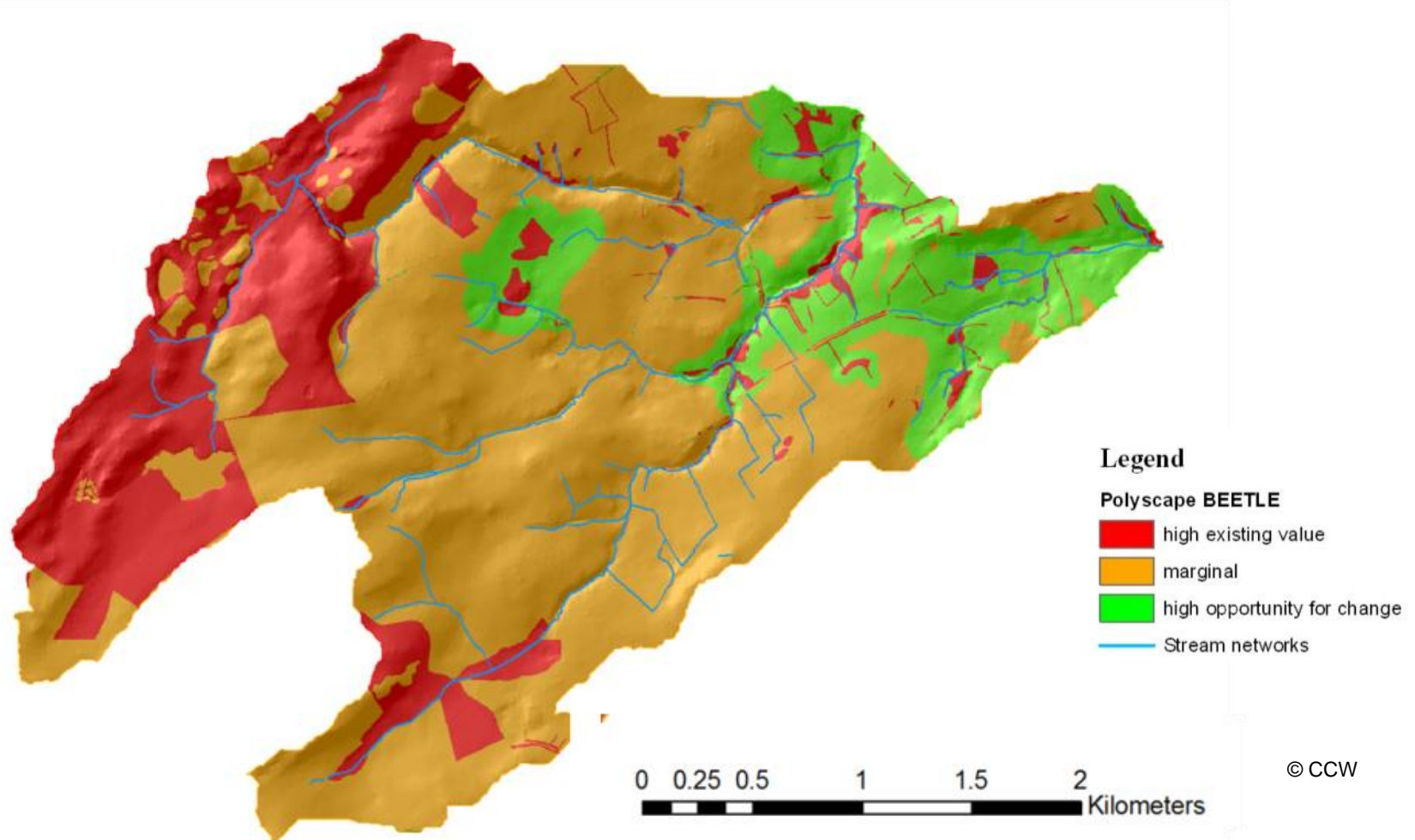
Legend

Polyscape Hydrology layer

- high existing value
- marginal
- opportunity for change
- high opportunity for change
- Stream networks

Woodland habitat connectivity at Pontbren

Plant trees to enlarge existing woodland networks (green); not where there are trees or other key habitats already (red); large area where farmers may wish to plant trees that have low habitat value (orange)



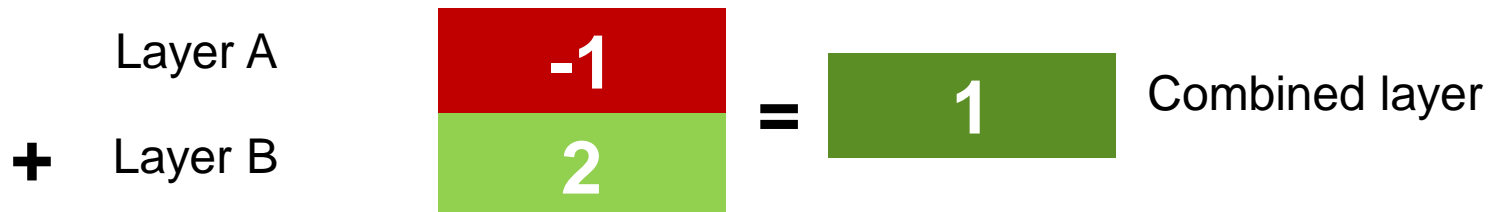
Trade-off layer

Numerical score allocated to each zone



Additive approach taken to combining layers

Example



Combining layers in Polyscape

What trade-off layer colours mean?

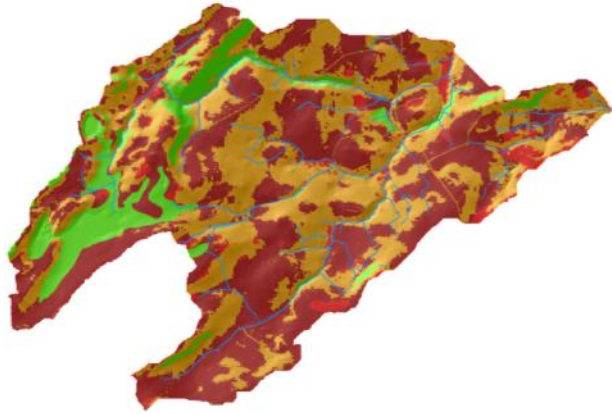
1. A 'Conservative' approach:

$$\begin{array}{l} \text{Layer A} \\ + \text{ Layer B} \end{array} \begin{array}{|c|} \hline -1 \\ \hline 2 \\ \hline \end{array} = \begin{array}{|c|} \hline -1 \\ \hline \end{array} \text{ Combined layer}$$

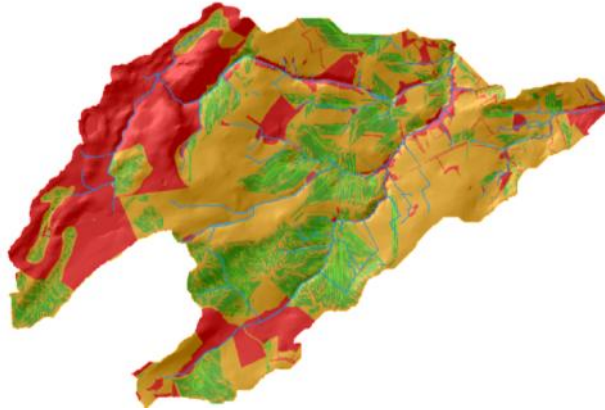
2. A 'Opportunistic' approach:

$$\begin{array}{l} \text{Layer A} \\ + \text{ Layer B} \end{array} \begin{array}{|c|} \hline -1 \\ \hline 2 \\ \hline \end{array} = \begin{array}{|c|} \hline 2 \\ \hline \end{array} \text{ Combined layer}$$

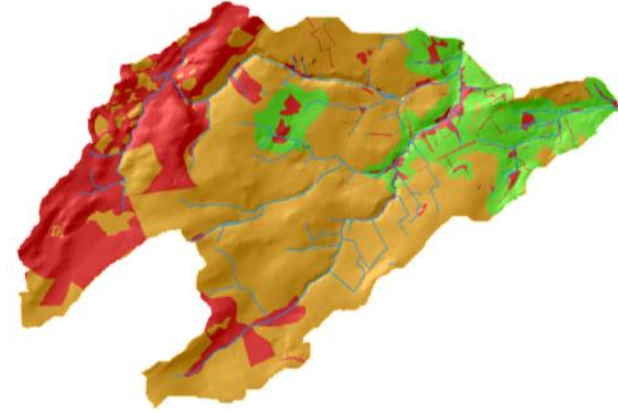
Trade offs - Pontbren



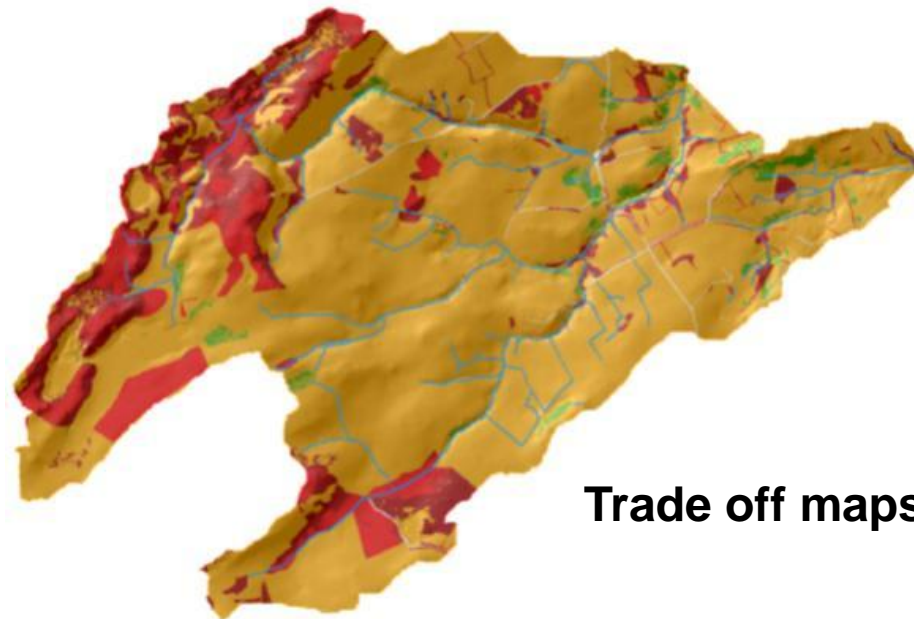
Agriculture



Surface runoff



Habitat connectivity



Trade off maps

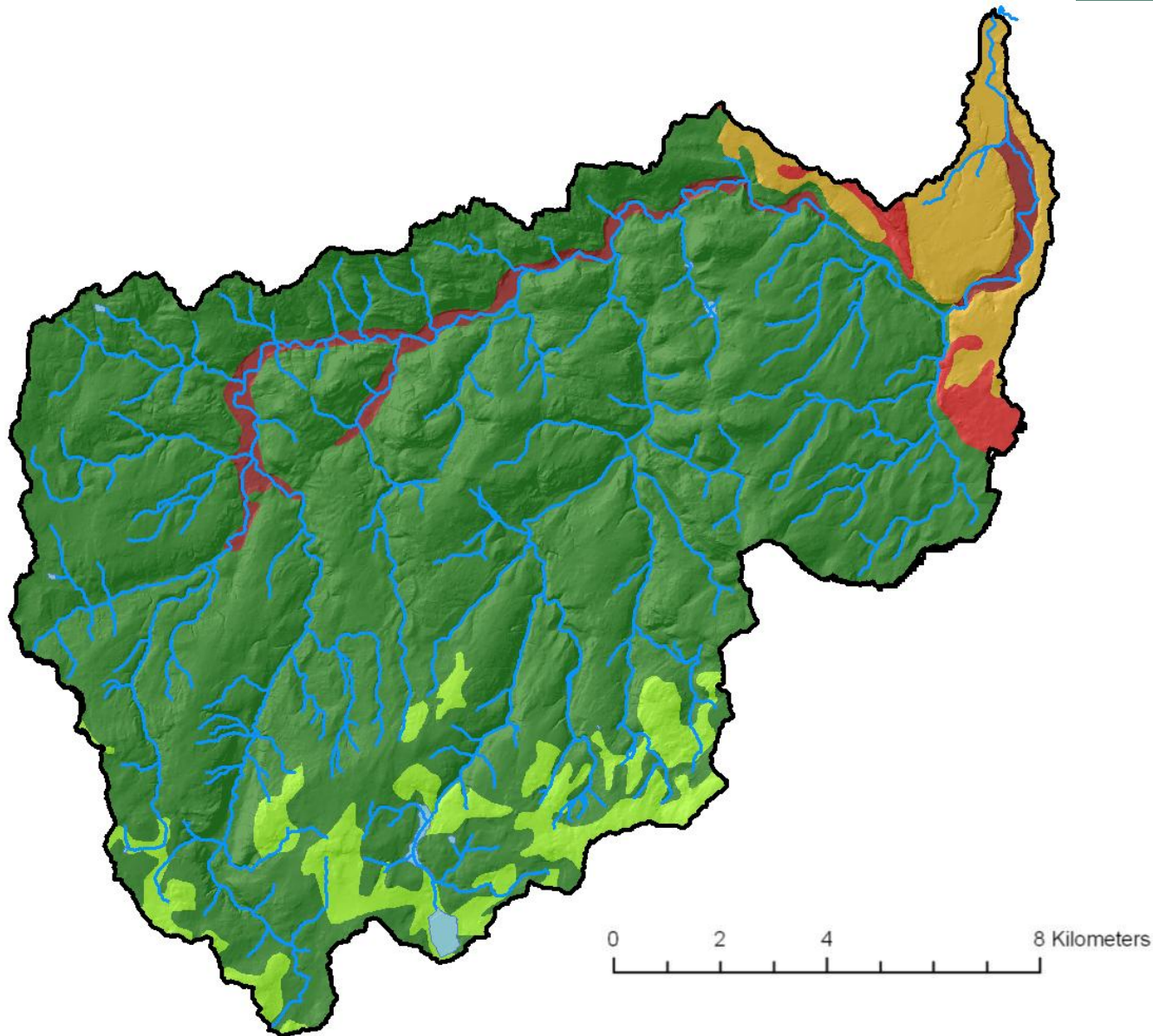
Pontbren (1000 ha)



The Elwy Catchment - 230 km²

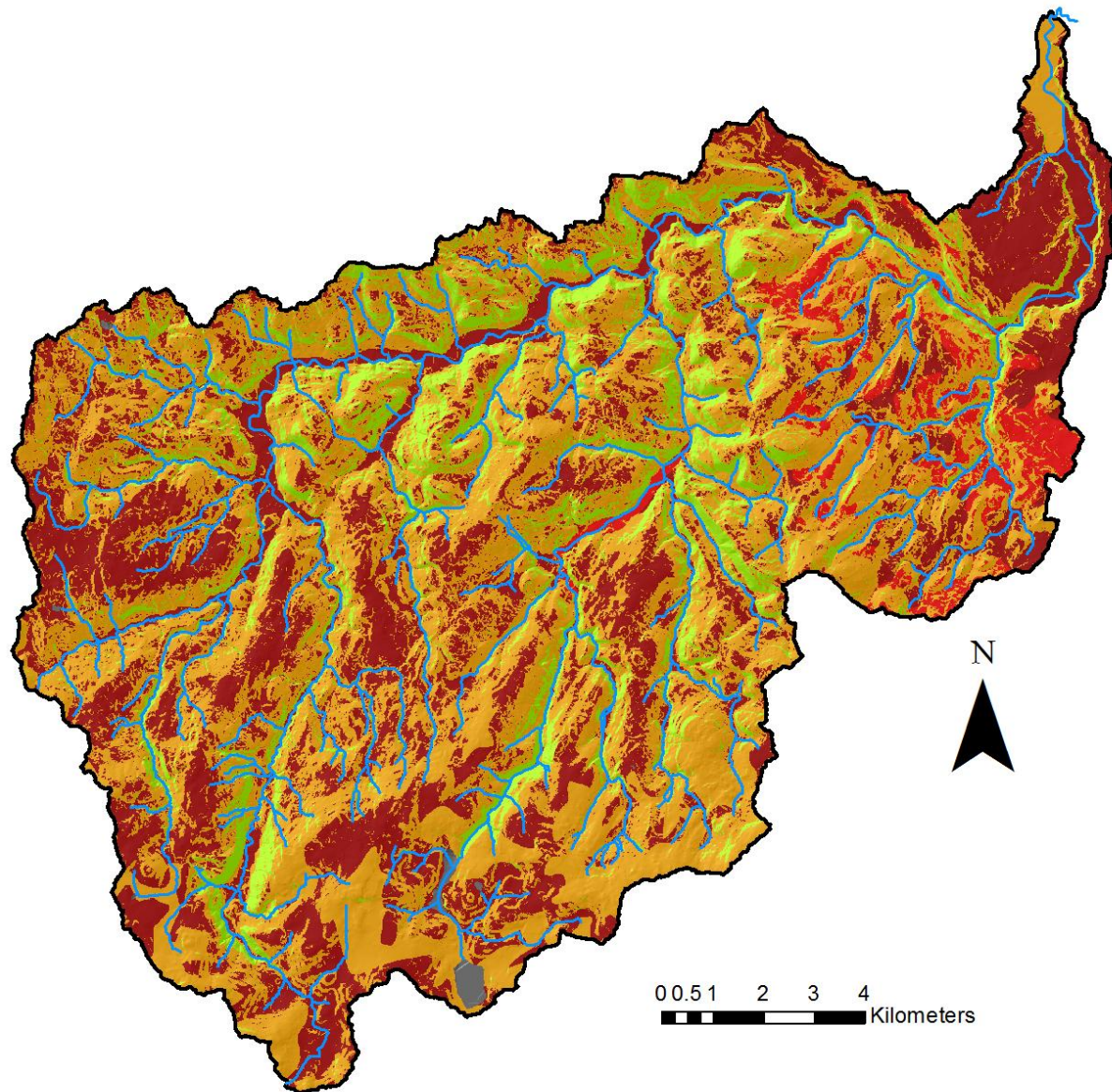
Issues with water quality/ sediment loads

Basic soil
fertility map –
based on NSRI
Soilscape data



Agricultural impact – farmers bravado

Slope threshold 15°



Increase in area that farmers recognise as valuable

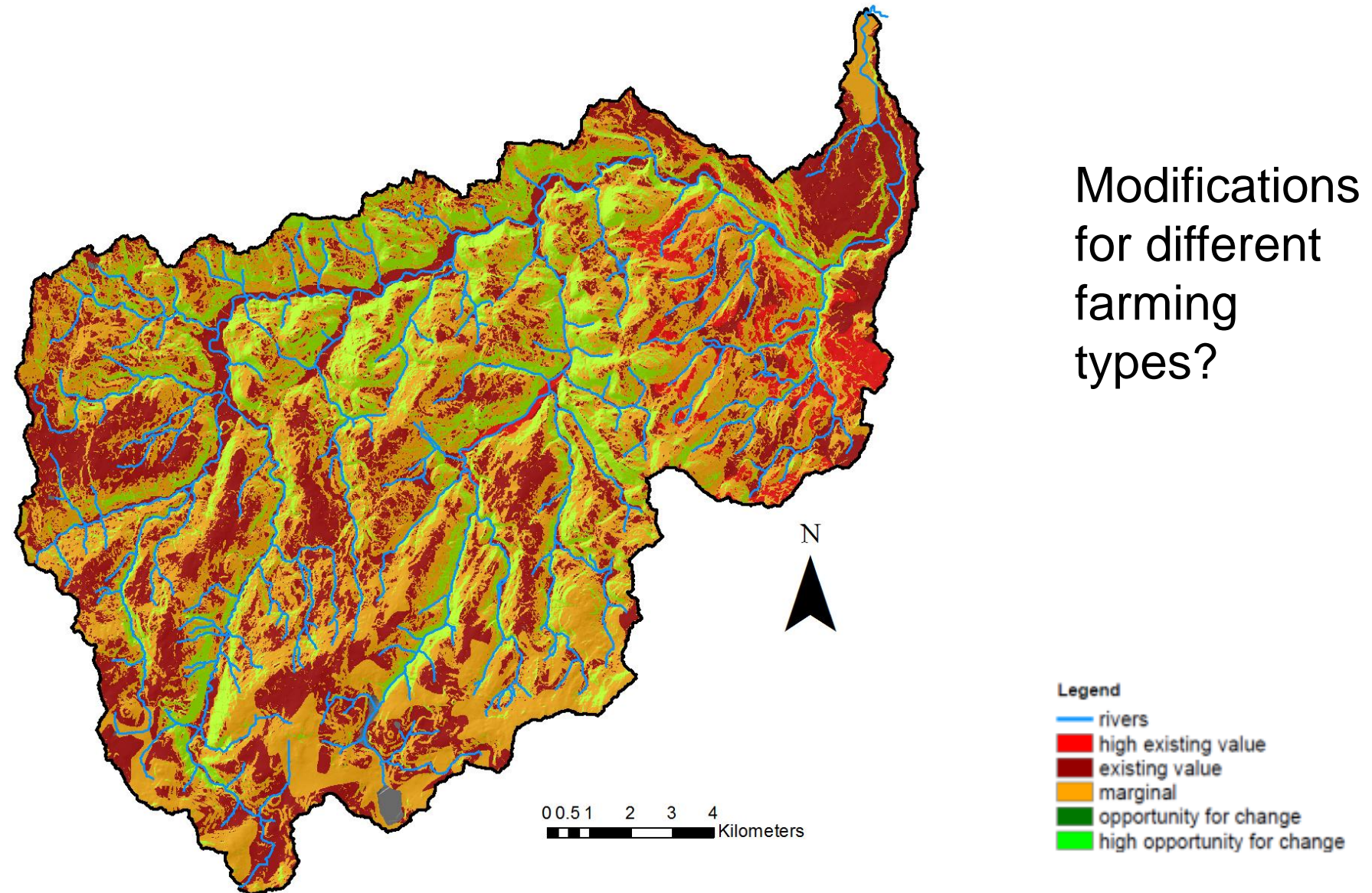
Opportunities for farm woodlands mainly along steeper valley sides

Legend

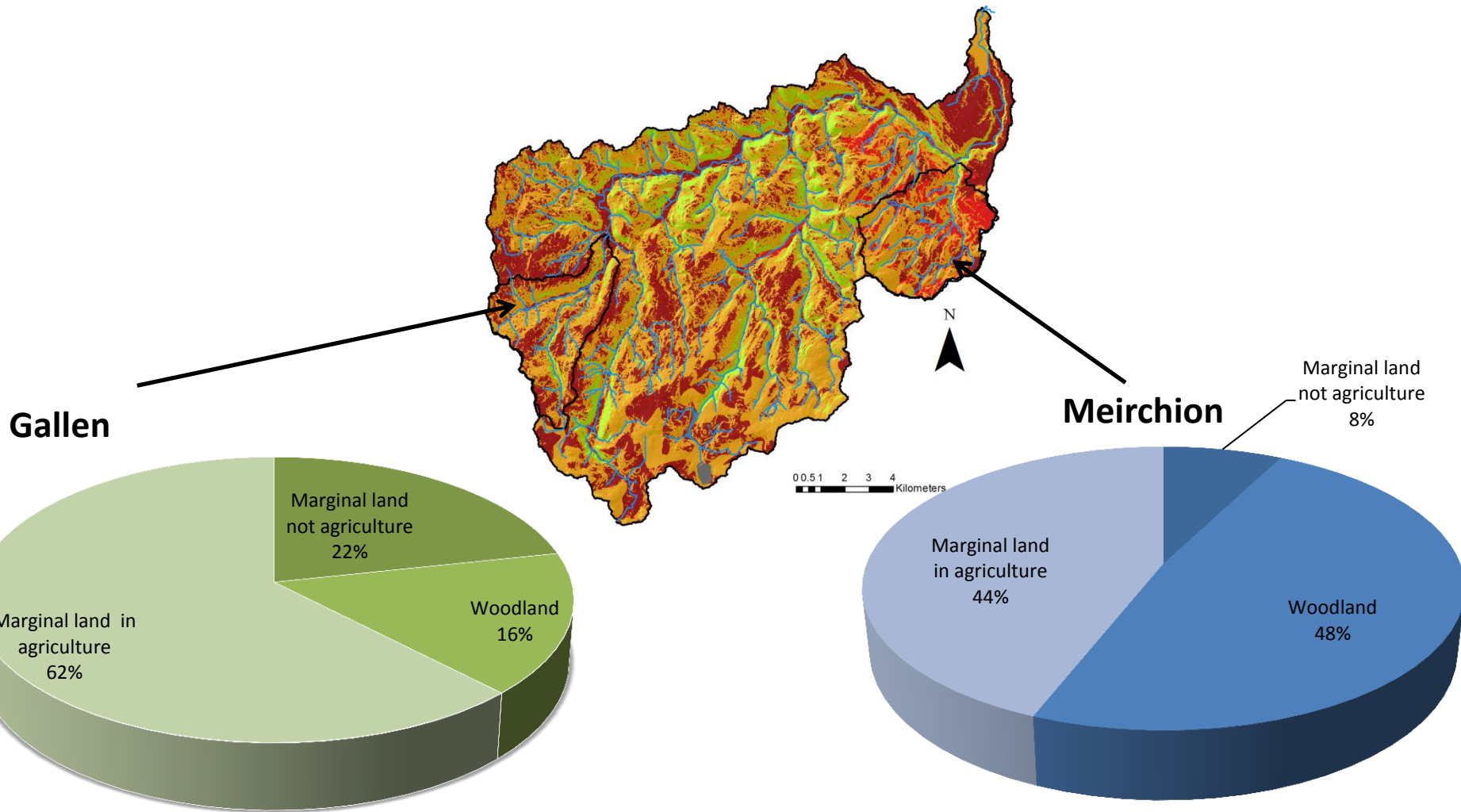
- rivers
- high existing value
- existing value
- marginal
- opportunity for change
- high opportunity for change

Agricultural impact – farmer reality?

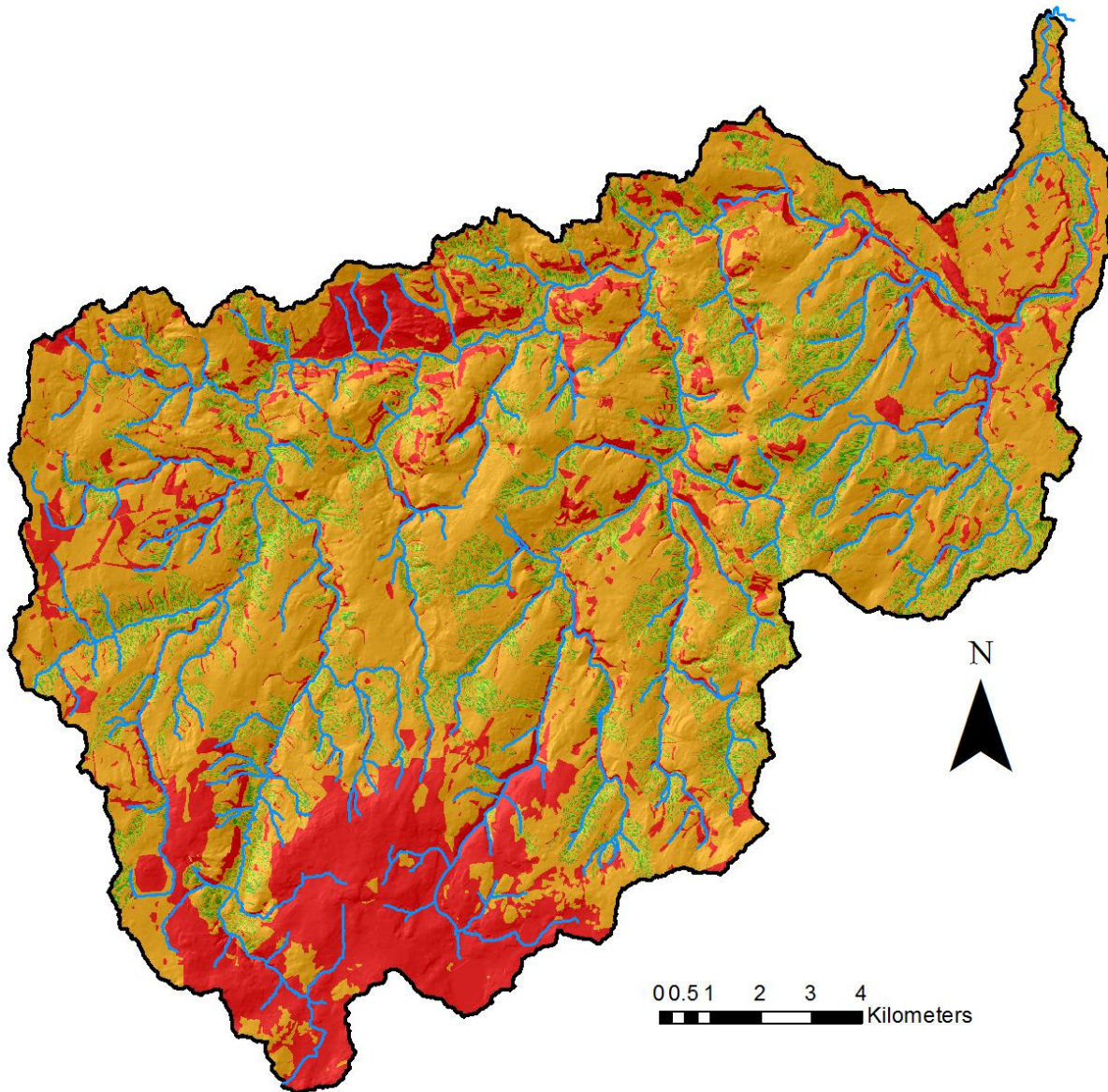
Slope threshold 12°



Potential utilisation of marginal land?



Water regulation - Elwy



Based on 10m² DTM and 1980s land use data.

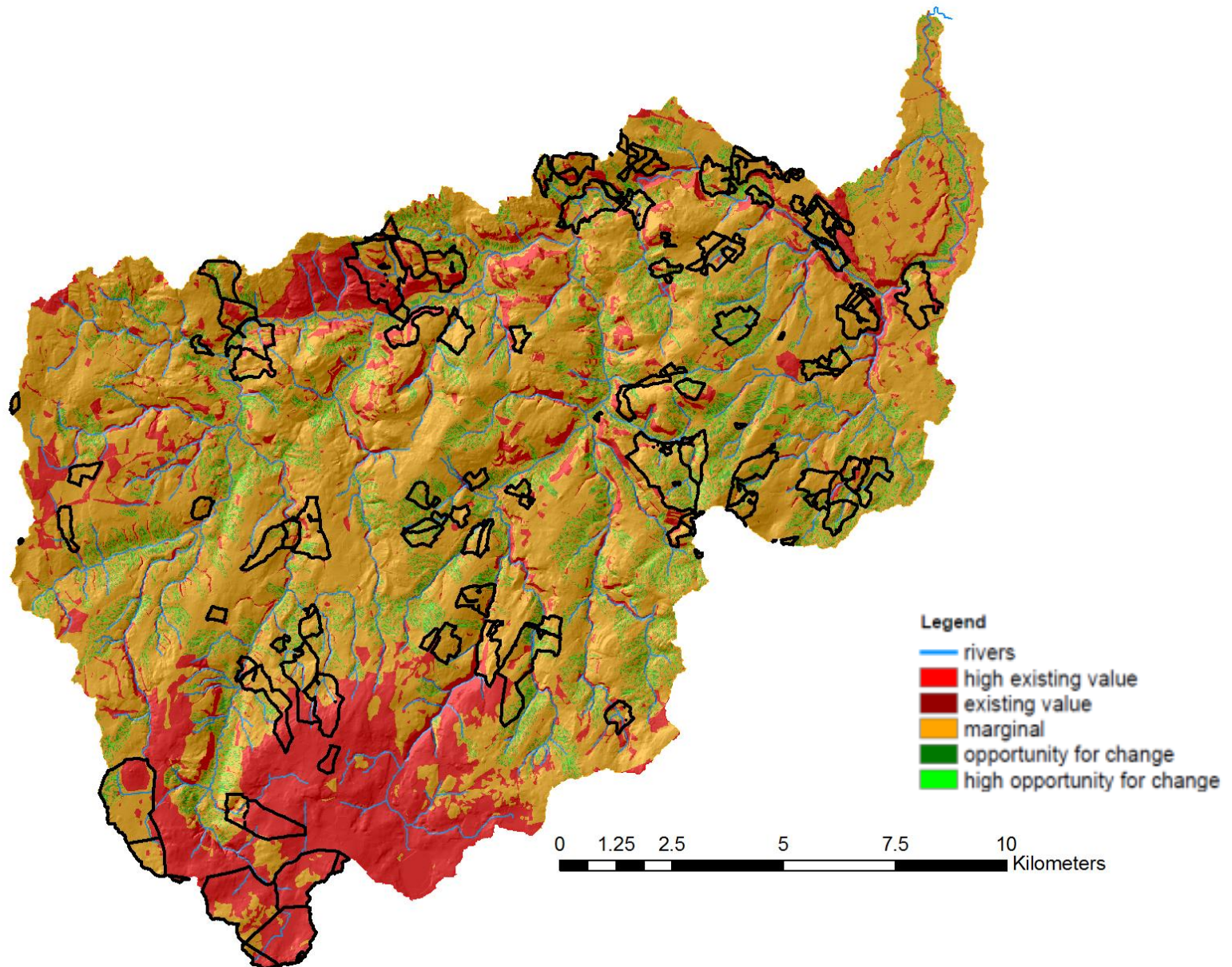
Red areas indicate sinks (woodland, wetland or depressions)

light green indicates high flow areas

Legend

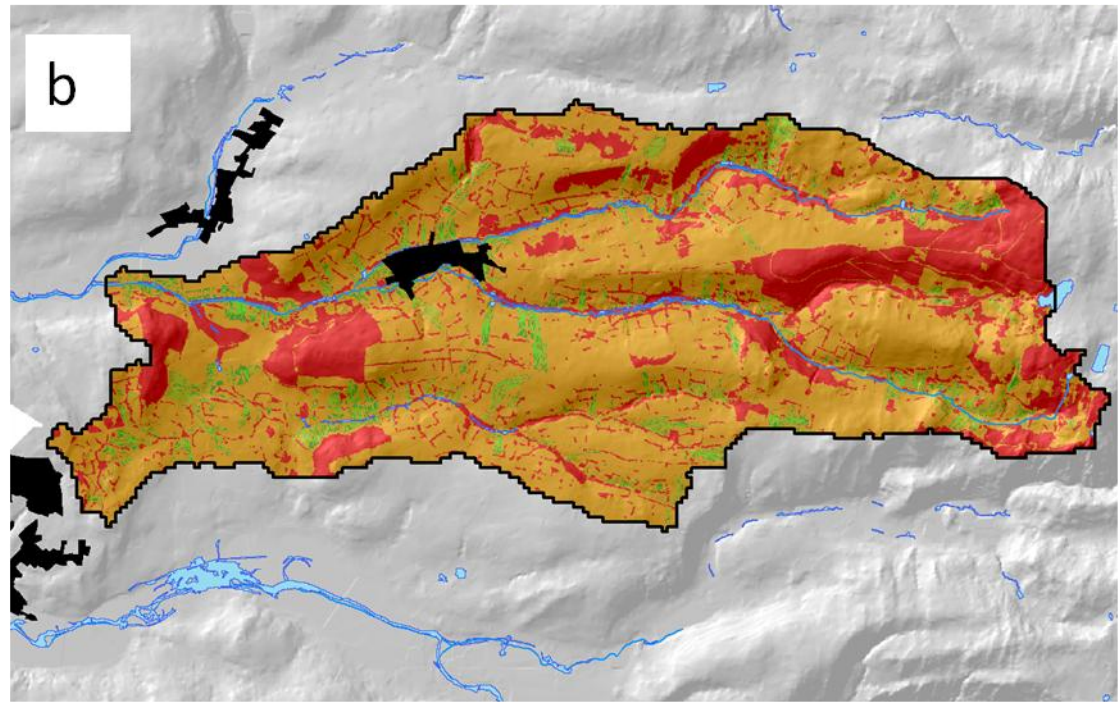
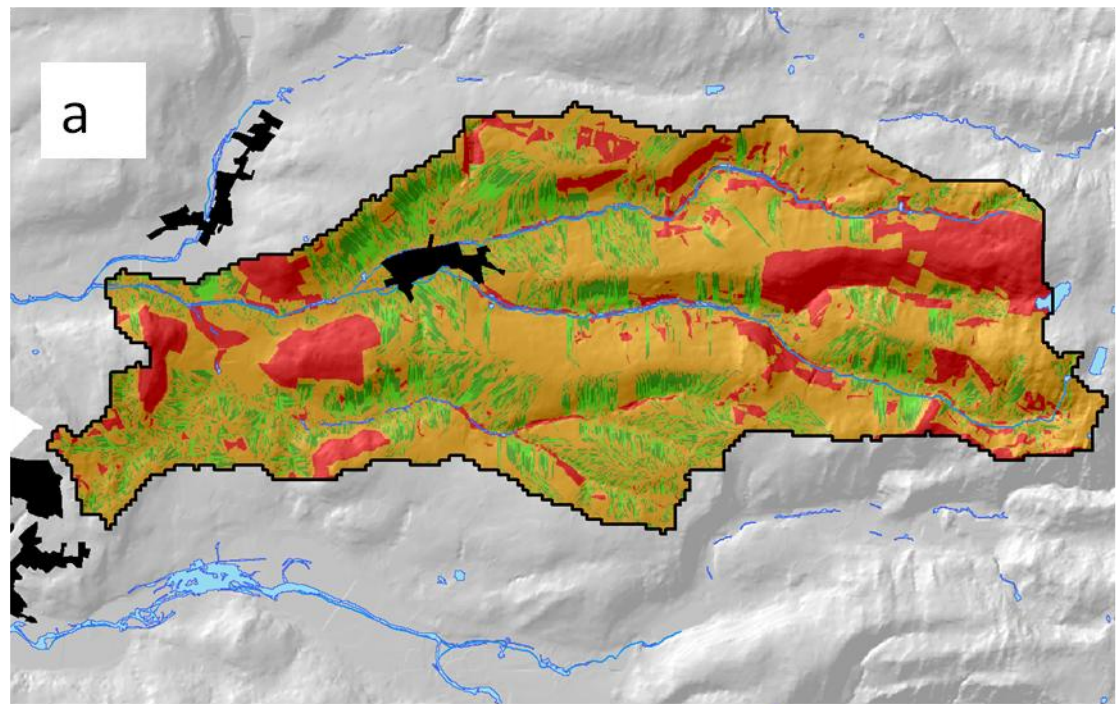
- rivers
- high existing value
- existing value
- marginal
- opportunity for change
- high opportunity for change

Agri-environment schemes - Elwy



Incorporating Higher Resolution Data

Remote sensed data can
offer higher resolution



Key findings

Facilitates wide stakeholder engagement

Use of proxies is a pragmatic compromise to data sparse environments

Facilitates cross sector evaluation and interdisciplinary research

Iterative development and application of tools encourages adaptive strategies necessary to address ecosystem service challenges

Conclusions

- There is a strong need to implement policy at local scales for effective ecosystem management.
- Use of mapped output as a basis for collective decision taking (and assessment of impacts of taking decisions and making change)
- Decentralised and integrated governance structures amongst agencies and training in participatory methodology are also required.
- Polyscape provides a tangible framework for shifting implementation of land use policy towards locally relevant and integrated ecosystem service provision.