Planning tools for landscape-level restoration based on enhancing multiple benefits from Nature-Based Solutions

The Need for Transformative Land Use Change to Tackle the Climate and Biodiversity Crises

(RESAS C5)

Alessandro Gimona, Marie Castellazzi

Integrated landscape – level approach

- **Strategic Land Use Planning:** Effective implementation of NbS requires careful spatial planning, data-driven decision-making, and multi-stakeholder governance to balance opportunities and trade-offs.

- **Comprehensive Approach:** Opportunity mapping focuses on ecosystem services and biodiversity benefits, with specific criteria for land cover changes, emphasizing areas for preservation and those *suitable for transformation.*

Land Use Change - Principles

- **Habitat Expansion and Restoration**

- **Where LC provides multiple benefits**

How:
- **Use of Modelling for Decision Support**
- **Derive Opportunity Maps as Multiple Spatial Criteria for Land Use Change**
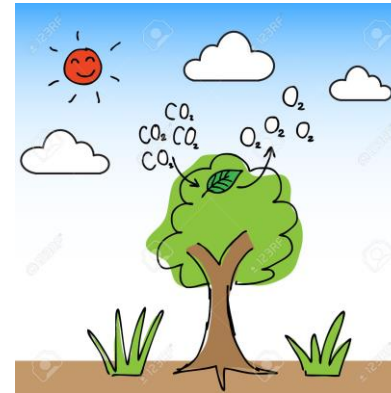
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Criteria

- **Mitigation of Diffuse Pollution**
  Nitrogen & Phosphorus

- **Mitigation of Climate effects**
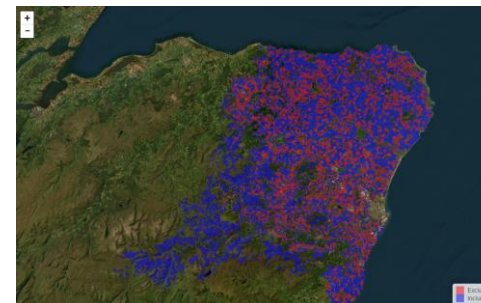 Carbon & Temperature (shading)

18 maps

- **Biodiversity Conservation**
  Woodland Connectivity
  Protection of Open-ground Species
  Expansion of seminatural grasslands
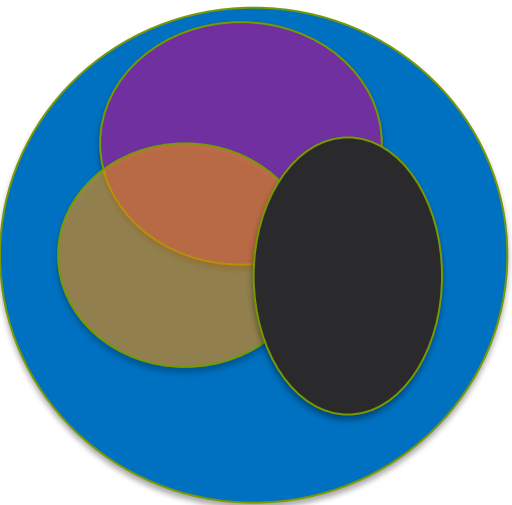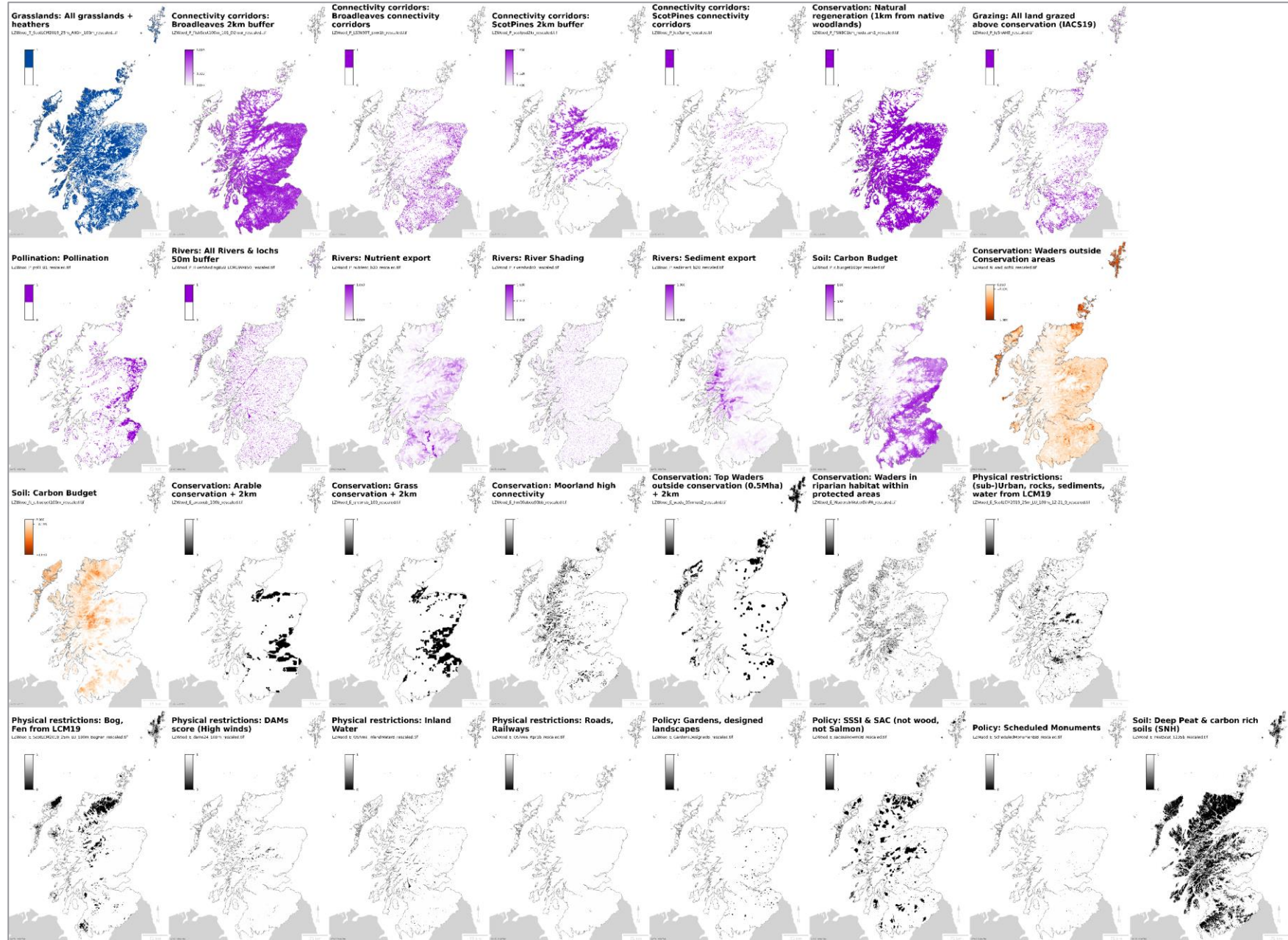 Protection of non-woodland connectivity corridors

Example : Woodland expansion layers

Legend:
- Positive
- Negative
- Excluded

High Nature Value Grasslands (HNV)

- **High Nature Value Grasslands:** Cover a small percentage of Scotland, yet are important for biodiversity preservation and GHG emission prevention, especially with conservation-focused grazing management.

- **Carbon Storage Potential:** Acid grasslands store 30% more soil carbon, while species-rich neutral grasslands also enhance carbon sequestration compared to improved grasslands.

- **Restoration and Management:** Restoring intensively grazed grasslands and *reducing stocking rates* can boost biodiversity and significantly lower CO_2-equivalent emissions.

- **Agroforestry Considerations:** Integrating tree planting can offer benefits but must be carefully managed to avoid impacting open-ground species like waders.
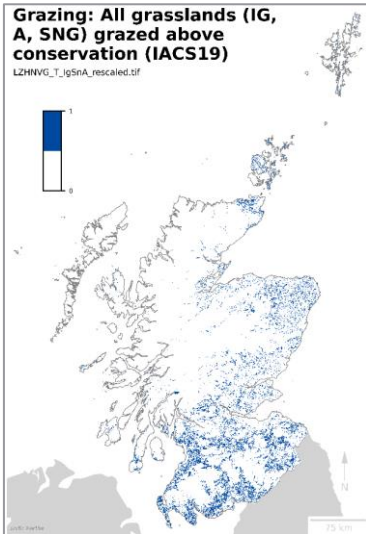
HNV expansion/restoration

Quantiles-based priority areas
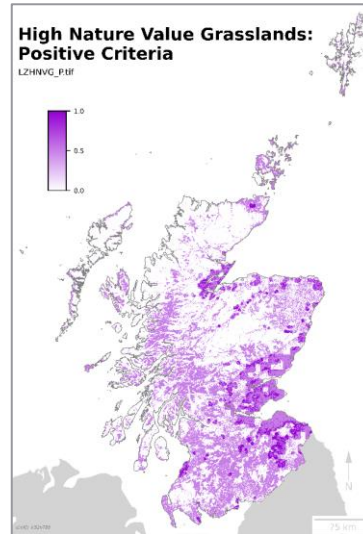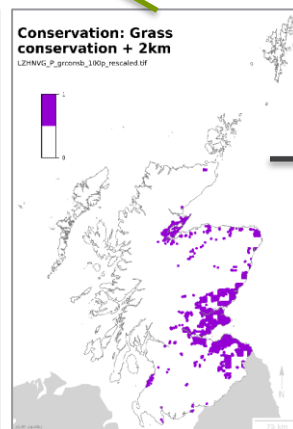

Spatial criteria

Target areas

Grazing: All grasslands (IG, A, SNG) grazed above conservation (IACS19)
LZHNVG_T_IgSnA_rescaled.tif

Positive criteria areas

High Nature Value Grasslands: Positive Criteria
LZHNVG_P.tif

&

High Nature Value Grasslands: Final 3 tiers Landscape Zonations
LZHNVG_LZ_High3Medium2Low1.tif

3 - High (98,448ha, 0.34%)
2 - Medium (560,814ha, 1.95%)
0 - Other (28,047,477ha, 97.7%)

Agriculture: Grasslands (improved & semi-natural; LCM19)
LZHNVG_P_ScotLCM2019_25mLU_IGSMG_rescaled.tif

Conservation: Grass conservation + 2km
LZHNVG_P_grcomb_100p_rescaled.tif
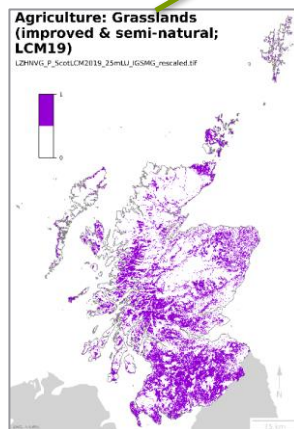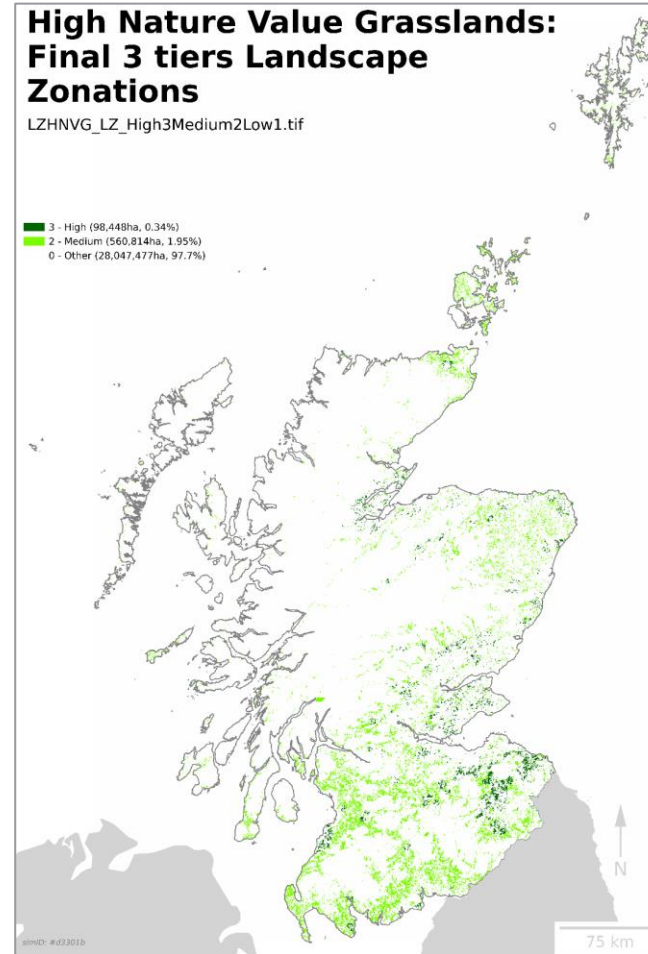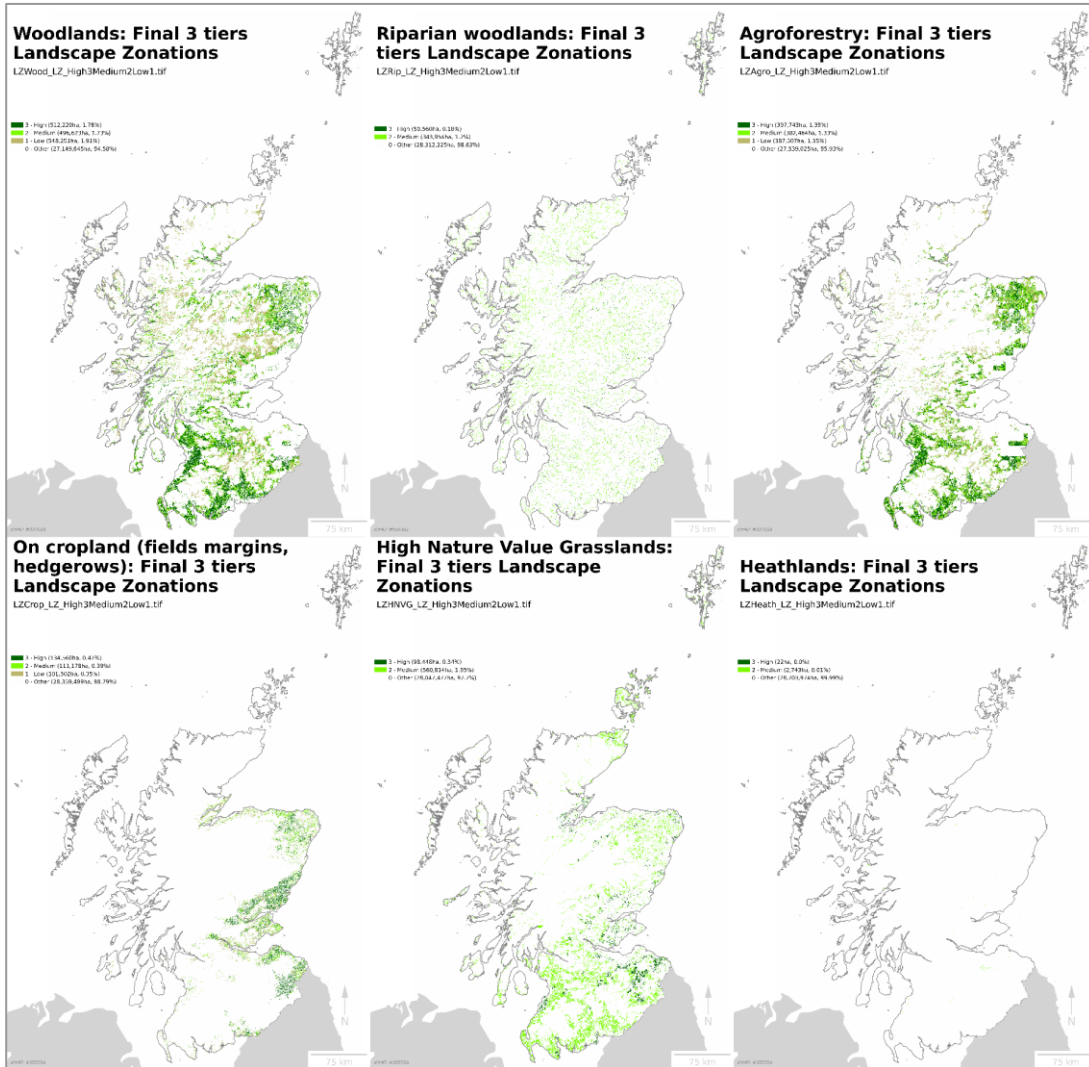
Complementary effects of biodiversity and ecosystem services on spatial targeting for agri-environment payments (2023).

Alessandro Gimona, Margaret McKeen, Andrea Baggio, Enrico Simonetti, Laura Poggio, Robin J. Pakeman, *Land Use Policy*

Within country targeting of agri-environment funding: a test of different methods
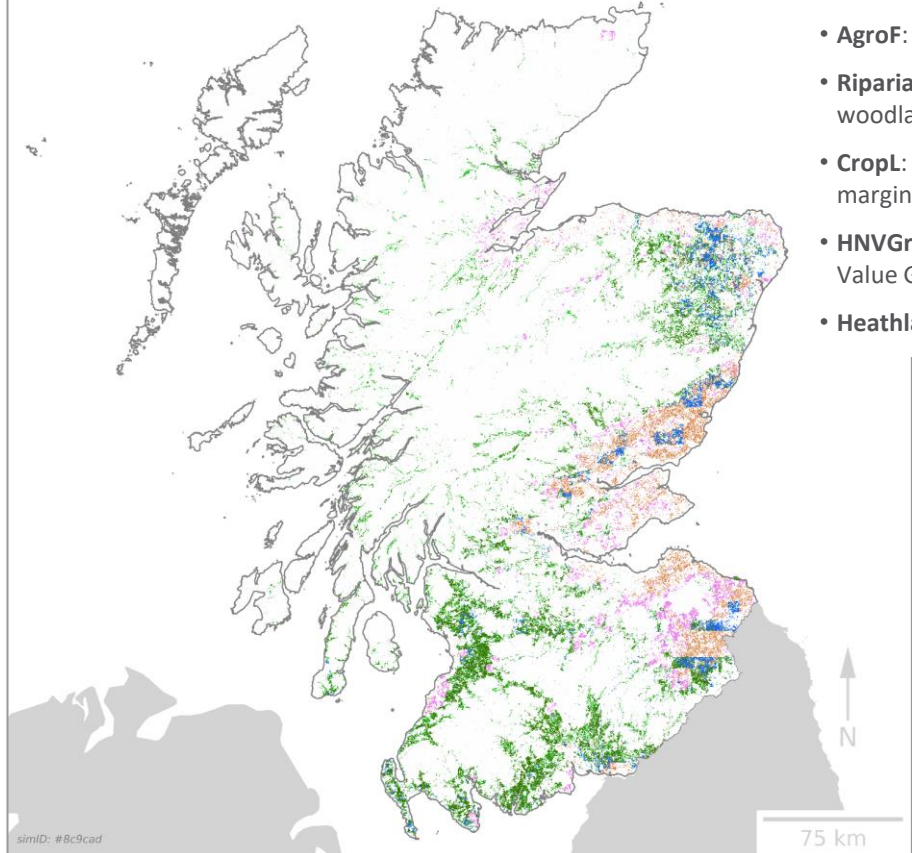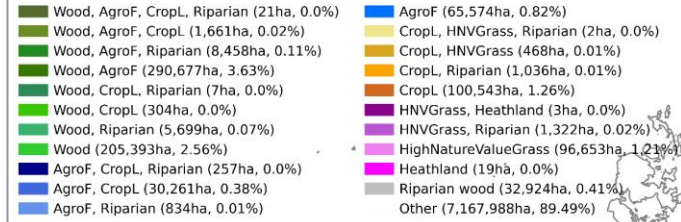*Glob. Ecol. Conserv*., 17 (2019), R.J. Pakeman, M. McKeen

Intermediate results

Woodlands: Final 3 tiers Landscape Zonations
LZWood_LZ_High3Medium2Low1.tif

Riparian woodlands: Final 3 tiers Landscape Zonations
LZRip_LZ_High3Medium2Low1.tif

Agroforestry: Final 3 tiers Landscape Zonations
LZAgro_LZ_High3Medium2Low1.tif

On cropland (fields margins, hedgerows): Final 3 tiers Landscape Zonations
LZCrop_LZ_High3Medium2Low1.tif

High Nature Value Grasslands: Final 3 tiers Landscape Zonations
LZHNVG_LZ_High3Medium2Low1.tif

Heathlands: Final 3 tiers Landscape Zonations
LZHeath_LZ_High3Medium2Low1.tif

Overlay of the 6 Top Tiers
(all dark green areas)

Final Landscape Zonation of High priorities
LZ_AggregationHighs.tif

- Wood, AgroF, CropL, Riparian (21ha, 0.0%)
- Wood, AgroF, CropL (1,661ha, 0.02%)
- Wood, AgroF, Riparian (8,458ha, 0.11%)
- Wood, AgroF (290,677ha, 3.63%)
- Wood, CropL, Riparian (7ha, 0.0%)
- Wood, CropL (304ha, 0.0%)
- Wood, Riparian (5,699ha, 0.07%)
- Wood (205,393ha, 2.56%)
- AgroF, CropL, Riparian (257ha, 0.0%)
- AgroF, CropL (30,261ha, 0.38%)
- AgroF, Riparian (834ha, 0.01%)
- AgroF (65,574ha, 0.82%)
- CropL, HNVGrass, Riparian (2ha, 0.0%)
- CropL, HNVGrass (468ha, 0.01%)
- CropL, Riparian (1,036ha, 0.01%)
- CropL (100,543ha, 1.26%)
- HNVGrass, Heathland (3ha, 0.0%)
- HNVGrass, Riparian (1,322ha, 0.02%)
- HighNatureValueGrass (96,653ha, 1.21%)
- Heathland (19ha, 0.0%)
- Riparian wood (32,924ha, 0.41%)
- Other (7,167,988ha, 89.49%)

- **Wood**: Woodlands
- **AgroF**: AgroForestry
- **Riparian**: Riparian woodlands
- **CropL**: Crop land (fields margins, hedgerows)
- **HNVGrass**: High Nature Value Grasslands
- **Heathland**

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75 km

From suitability to actual change:
LandSFACTS land use model

CCC Recommendations
(Climate Change Committee)

LUC –Tendencies
Define LU change objectives

Constraining Suitability

Opportunities of LUC for Ecosystem Services
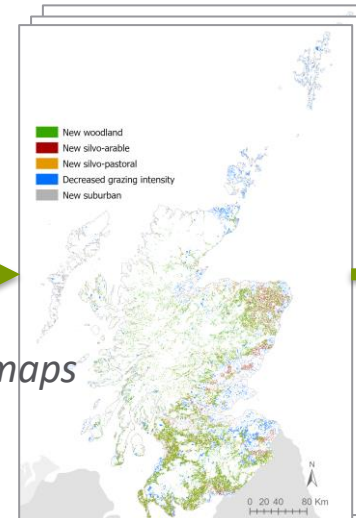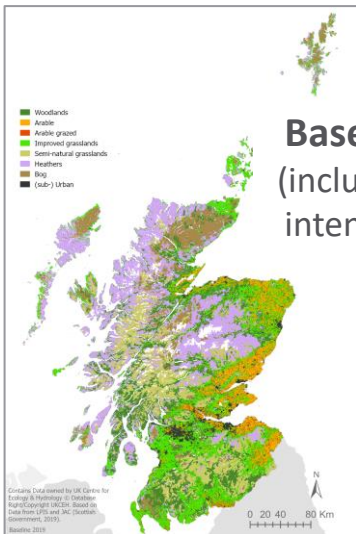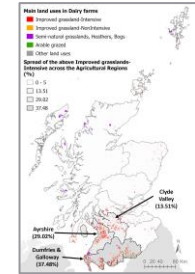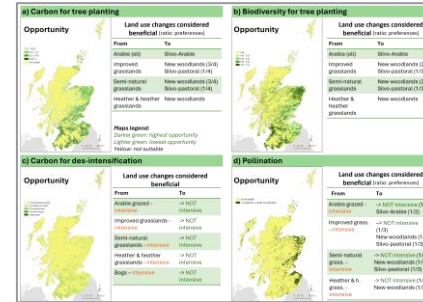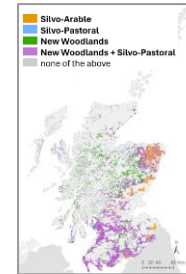
Farm Types constraints
(e.g. dairy)

Baseline Map
(includes grazing intensity - IACS)

LandSFACTS, spatial land use model

Model Output

2050 scenario maps

Ecosystem Services Assessments
(Carbon, nutrient export, connectivity, etc…)

Storymaps: Land Use Transformations & Adding Farm Types

Example

Creation of:

- 500K ha of woodlands
- 300K ha of agroforestry
- 250K ha of extensive grasslands
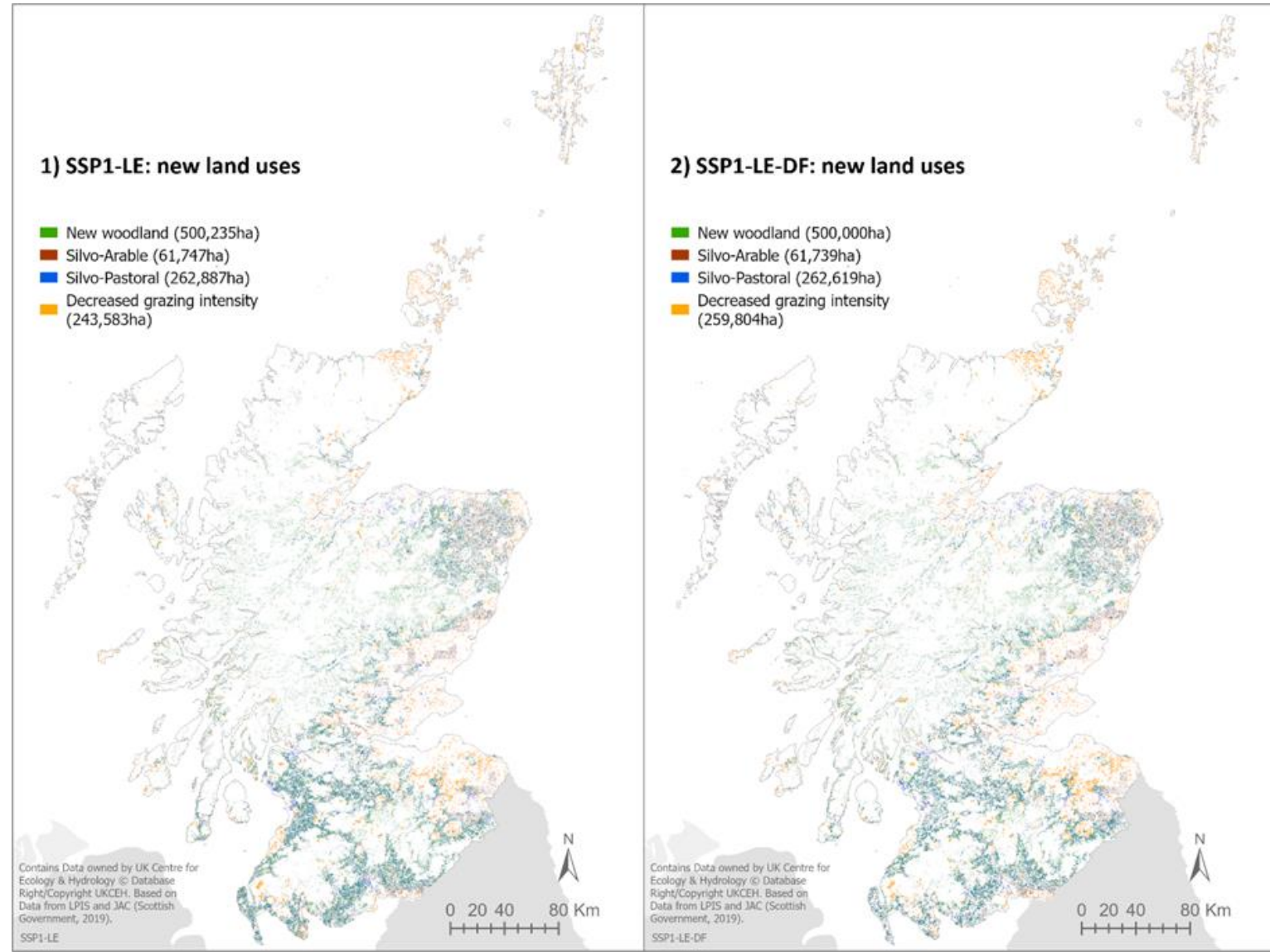
Tools to improve ESS and Biodiversity

- ECOFOREST (afforestation, whole catchments, landscape level)

- RIVERTOOL (riparian woodlands)

- LandSFACTS (multiple land use types and ESS at the same time)

ECOFOREST where to expand forests

RIVERTOOL : Planting for River Shading

12 Positive and 2 negative

Data from Faye Jackson and Iain Malcolm, Marine Scotland, see *Jackson et al. 2021*

Thanks for your attention

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