



# Modelling Scenarios of Land Use Change

Alessandro Gimona, Marie Castellazzi, Bethany Wilkins, Doug Wardell-Johnson, Mostafa Tavana, Dave Miller, Mike Rivington, Keith Matthews

End of Year 2 Workshop, 27<sup>th</sup> March 2024



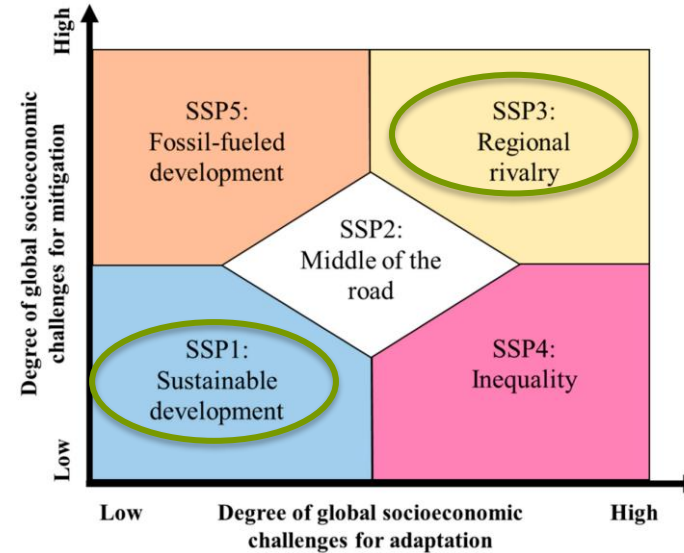
The James  
**Hutton**  
Institute

# Land Use Transformations

Climate-Food-Biodiversity-Ecosystem Services

<https://storymaps.arcgis.com/stories/c3d3feff85f14460b6c973127089d6f9>

- **To achieve policy goals such as Net Zero and biodiversity protection - rural land use must change to reduce net emissions while making space for nature**
- Scotland has ambitious nature and climate laws, and policy is being reformed to shape land use change accordingly
- However, the land use system **is embedded in the wider society and its future social and economic trajectory**



The James  
**Hutton**  
Institute



# Overview diagram

**Beyond SG Goals,**  
 CCC  
 Recommendations  
 (Climate Change Committee)



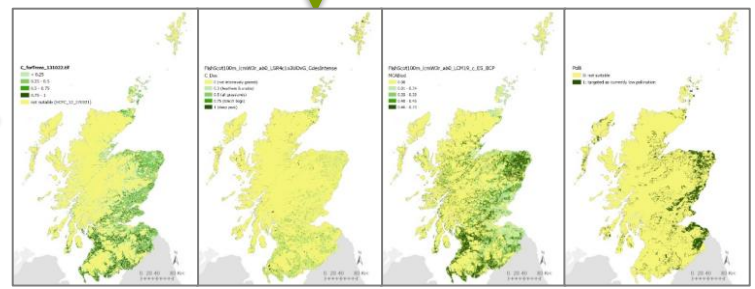
**LUC –Tendencies**  
 Define LU change objectives

New Woodlands	Increase
Silvo-Arable	Increase
Silvo-Pastoral	Increase
Intensive Grasslands	Decrease
Intensively grazed Heathers & bogs	Decrease
Urban (& Suburban)	Increase

**Actor/Farm**  
 Characteristics



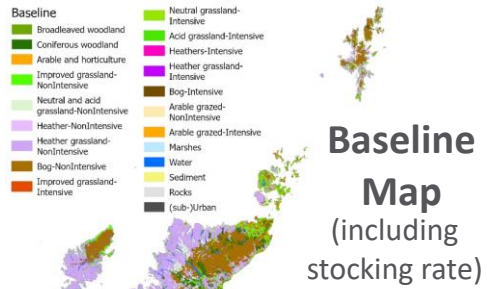
**Biophysical constraints and opportunities**  
 (includes climate & future land capability)



**Spatial Allocation Model**

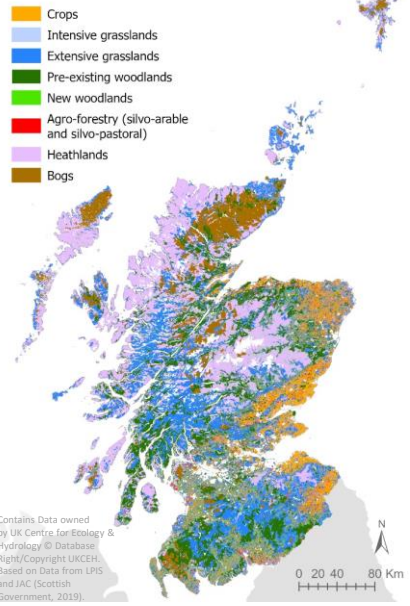
**Opportunities for Four Ecosystem services**

- Carbon storage through tree planting
- Emission reduction through deintensification
- Biodiversity enhancement through tree planting
- Pollination (to support food production)



**Model Output**

2050 scenario map

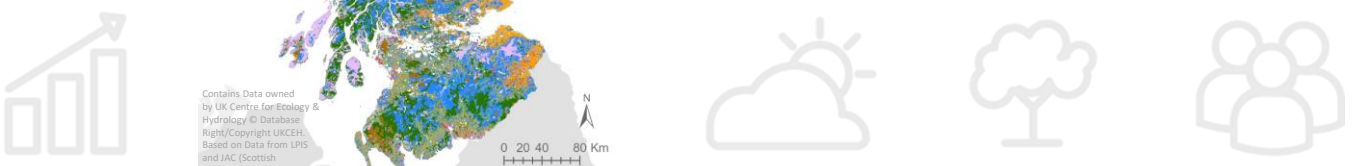


**New Woodlands : + 500,000 ha**  
**Silvo-Arable : + 60,000 ha**  
**Silvo-Pastoral : + 262,000 ha**



The James  
**Hutton**  
 Institute

Contains data from :  
 Morton, R. D., Marston, C. G., O'Neil, A. W., & Rowland, C. S. (2020). Land Cover Map 2019 (25m rasterised land parcels, GB) [Data set]. NERC Environmental Information Data Centre. <https://doi.org/10.5285/F15289DA-6424-4A5E-BD92-48C4D9C830CC>.  
 Wardell-Johnson, D. (2022) Stocking rates derived from IACS 2019 version 4.  
 Based on data from Land Parcel Information System (2019) courtesy of Rural Payments and Inspections Division, Scottish Government.  
 Based on data from the June Agricultural Census (2019) courtesy of Rural and Environment Science and Analytical Services, Agricultural Statistics team, Scottish Government.



# Land use Change Analysis – Evaluating LUC scenarios accounting for Farm Types

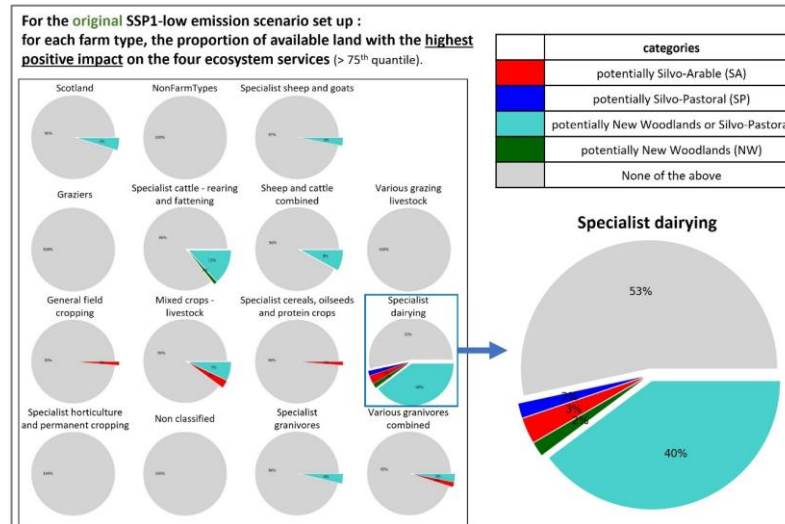
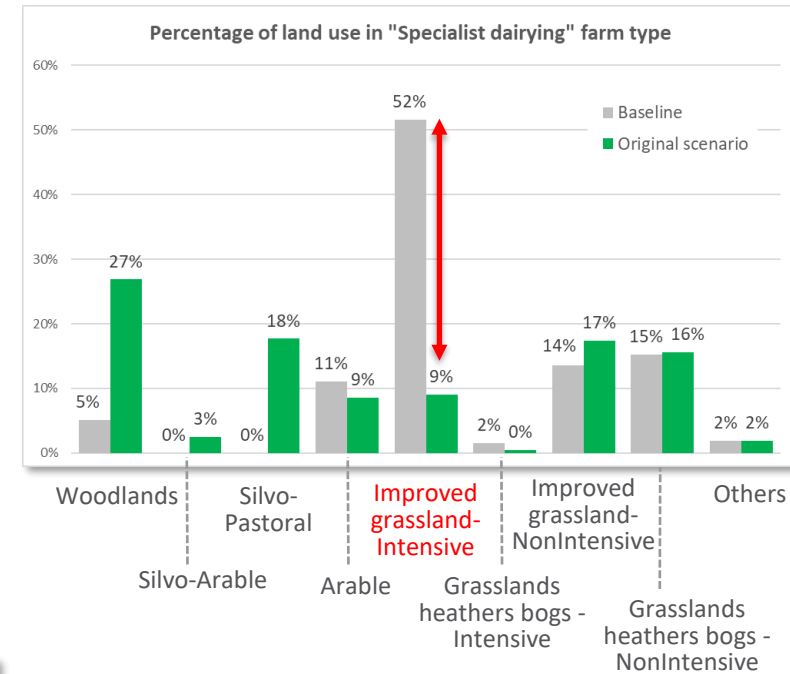


The James  
**Hutton**  
Institute

## “Specialist dairying” farm type:



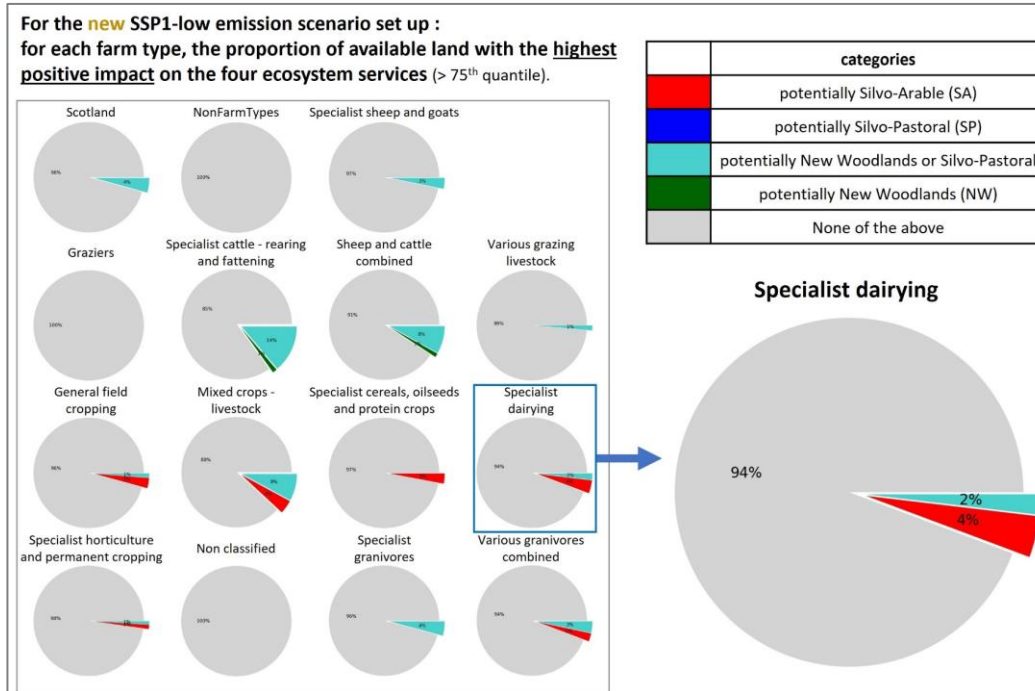
- 2% of Scotland area, heavily impacted by the original scenario
- Intensive improved grassland decrease from 52% to 9% of the farm type
- Reasons :
  - **Very suitable** to enhance the four benefits pursued
  - 47% rated in the highest quarter for positive impact on the 4 Ecosystem Services



[cf. Story Map – Adding Farm Structure to LUC Modelling](#)

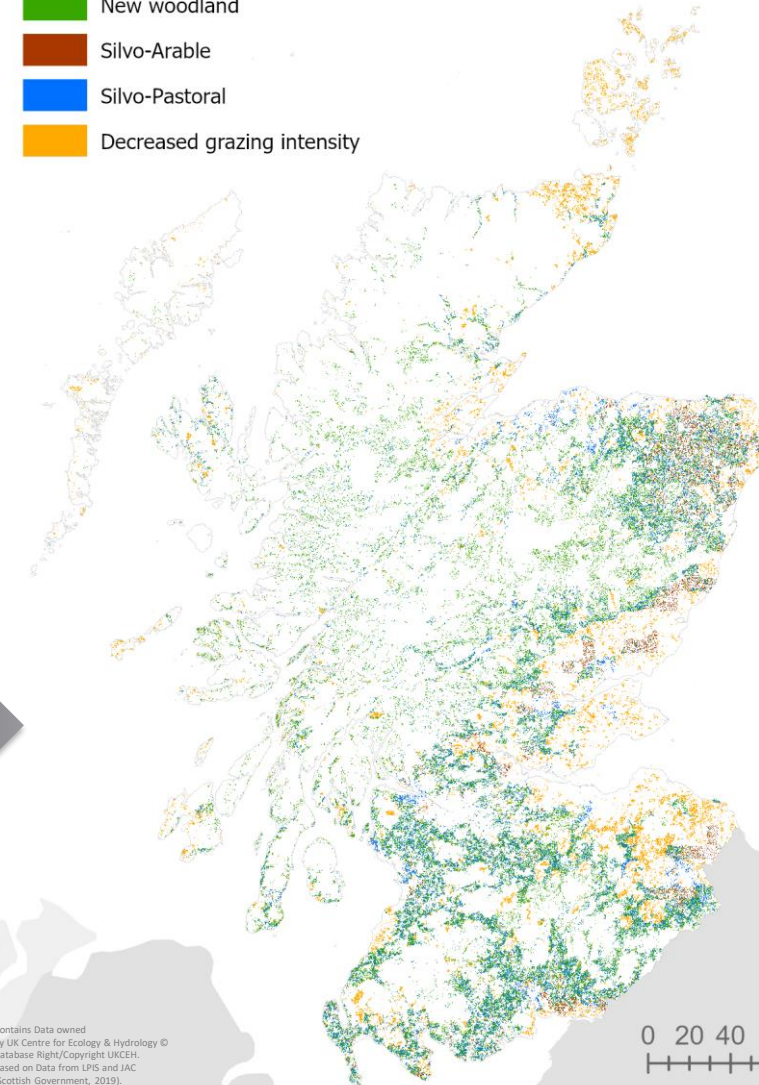
# Alternative scenario protecting “Specialist dairying” intensive improved grasslands

- Limit change in Dairy Farms -> 6%.
- => Burden of land use change now more shared across farm types



## Main land use changes

- New woodland
- Silvo-Arable
- Silvo-Pastoral
- Decreased grazing intensity



**protecting intensively grazed improved grassland of “Specialist dairying”**

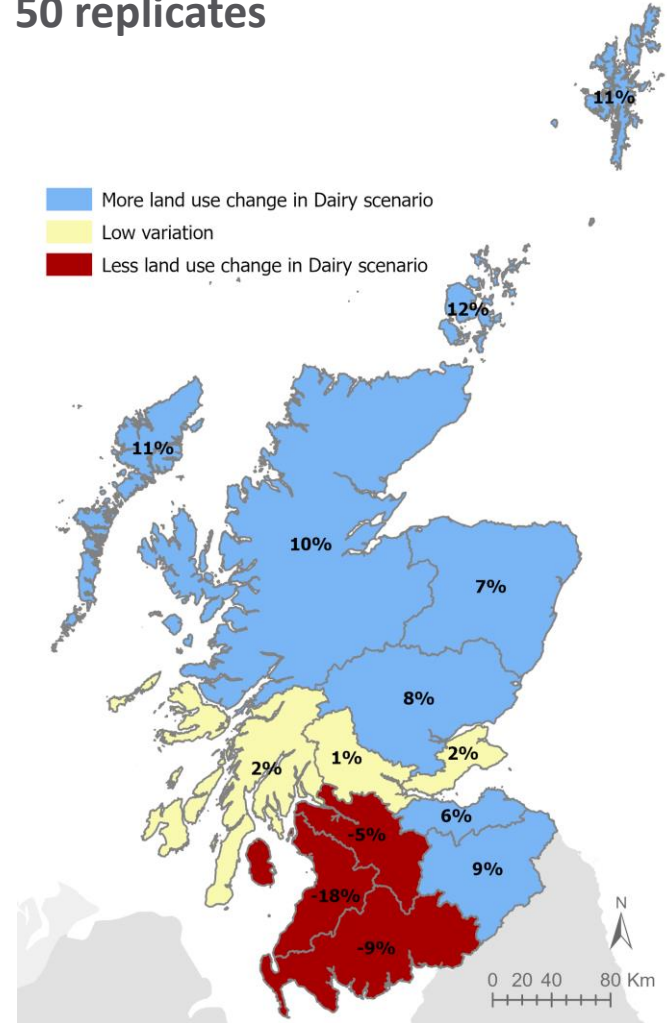


# Difference in land use change SSP1 vs SSP1-"dairy"



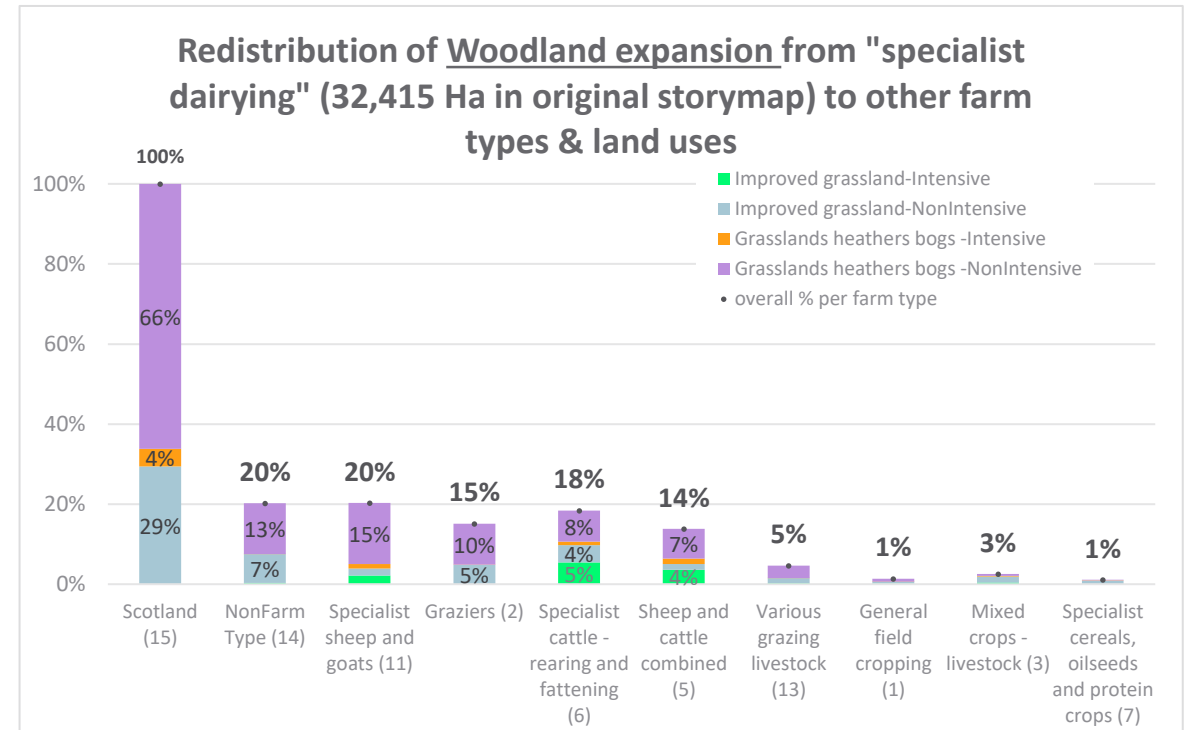
The James  
**Hutton**  
Institute

Average difference over  
50 replicates



#: difference from original SSP1 scenario land use change allocation

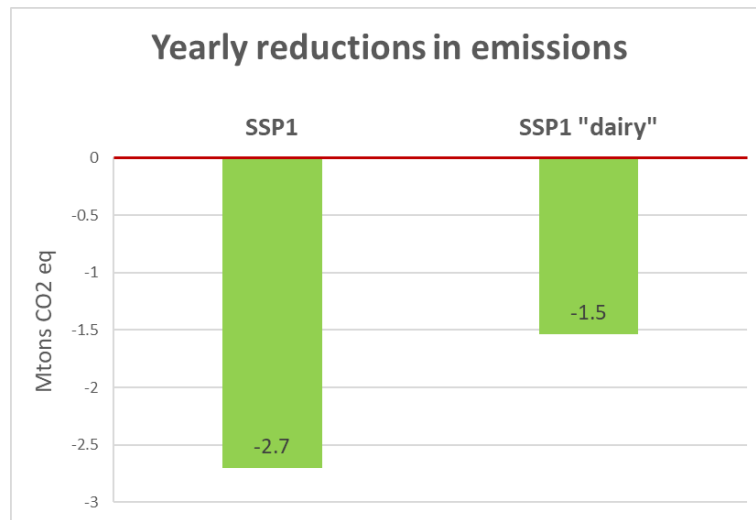
Different configuration, same total amount of woodland and agroforestry



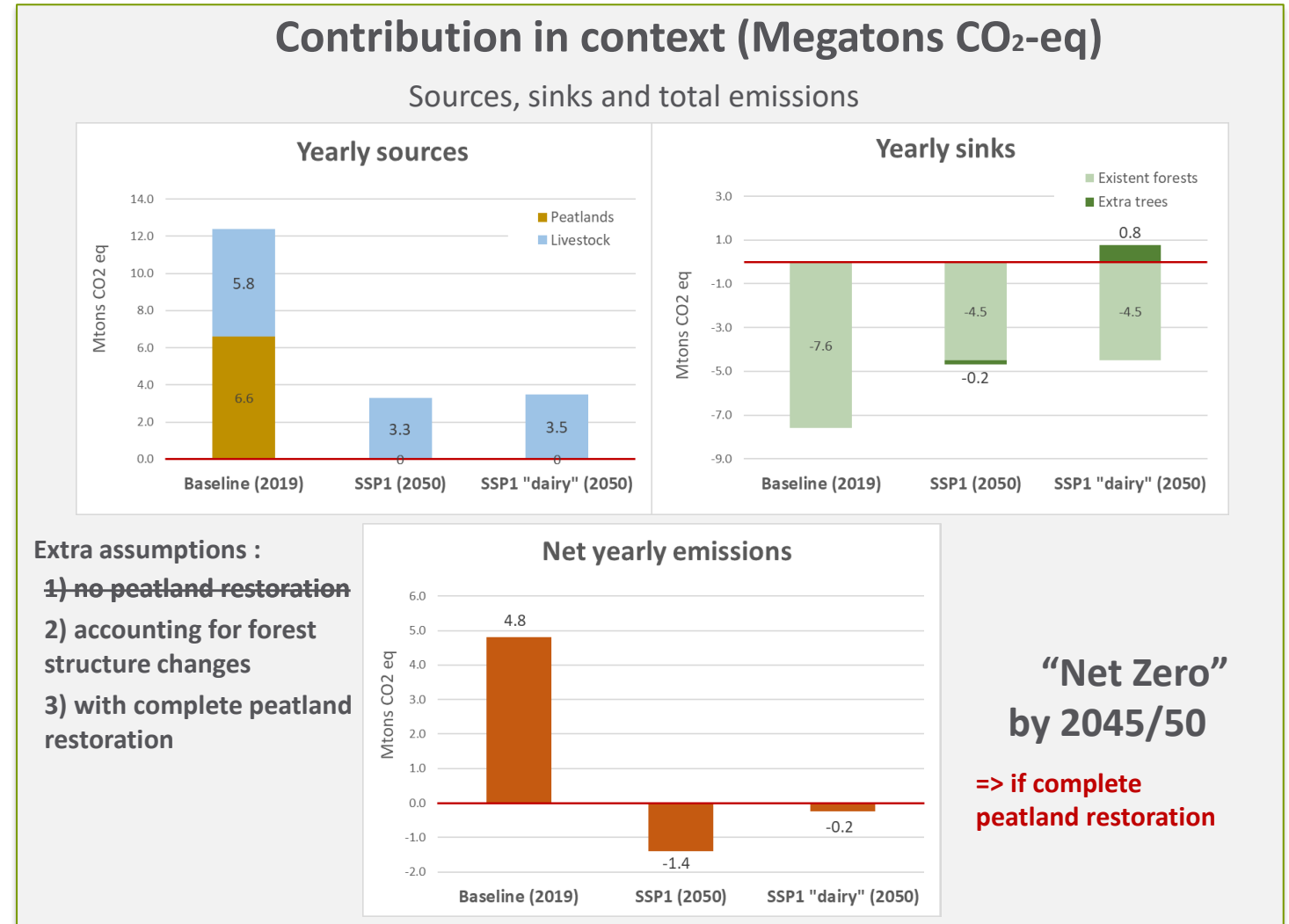
# Effect on Emissions (average per year)



The James  
**Hutton**  
Institute



=> Smaller reduction by preserving dairy, intensively grazed, improved grasslands



Extra assumptions :

- 1) no peatland restoration
- 2) accounting for forest structure changes
- 3) with complete peatland restoration

**"Net Zero"**  
by 2045/50

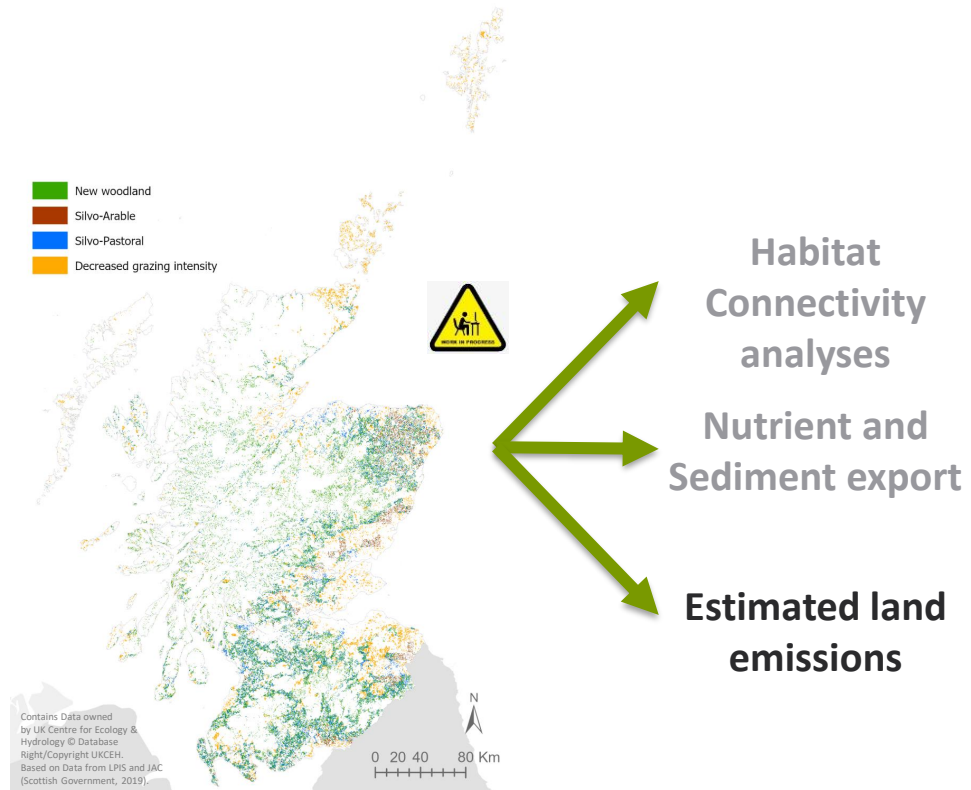
=> if complete peatland restoration

## References

Peatland emissions : Artz, pers. comm.  
Livestock : SG emission factors  
Trees : WCC (including soil C losses)  
Forest structure : Forest Research ([Forestry Statistics 2021](#), table 4.2)

Previous [estimates](#) of trees contribution did not fully account for soil C loss

# Future Work



## Storymap (on-going updating)



<https://storymaps.arcgis.com/stories/24ca106666e24fa1aa7ba81e42ad0b81>







The James  
**Hutton**  
**Institute**

# Thanks for your attention

Contact:

Alessandro.Gimona@hutton.ac.uk



C3 - Land Transformations – RESAS Research Programme

