Modelling Scenarios of Land Use Change

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The James Hutton Institute

C3 - Land Transformations – RESAS Research Programme

The Scottish Government
Riaghaltas na h-Alba

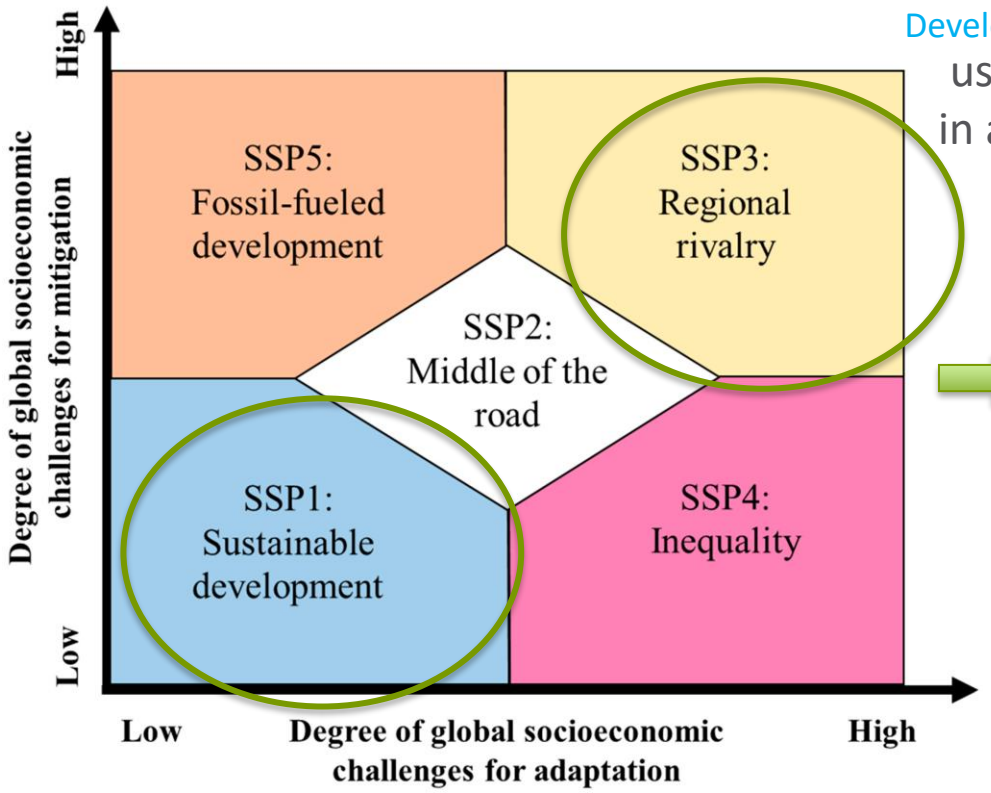
Land Use Transformations

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**

Shared Socioeconomic pathways (SSPs)

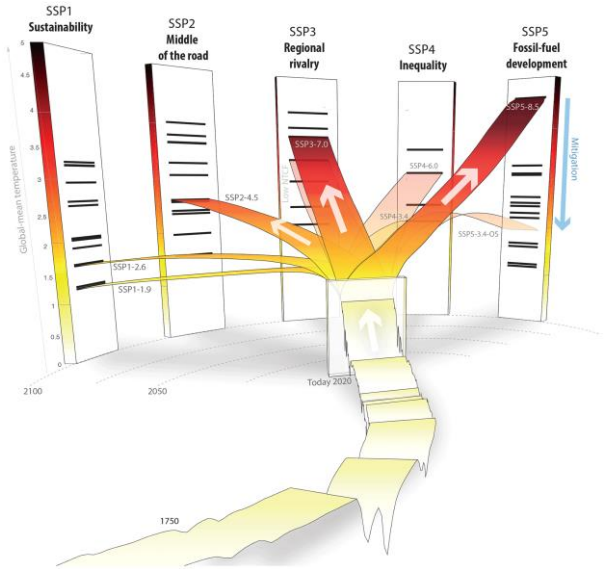


Source: https://www.mdpi.com/1660-4601/15/1/3

Developed by UNFCCC
used by IPCC
in assessment

narrative for each

Intended to span the range of
plausible futures
(imply land use futures)



seeks **to quantify what needs to change**
given the objectives of an SSP to be delivered

UK-SSP1 – Sustainable development

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Main features

- National cooperation
- Mostly renewable energy
- Strong support for regionalisation
- Green technology
- Low-consumption lifestyles
- Circular economy
- Public support for pro-environmental policies

Sustainable land-use change

Overview diagram

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

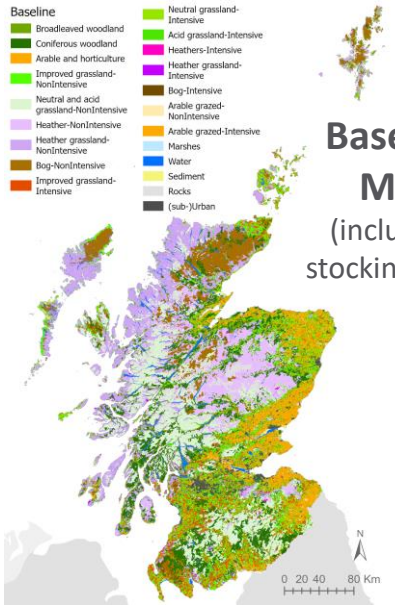
Actor/Farm Characteristics

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

Opportunity Maps (multiple benefits from LUC)

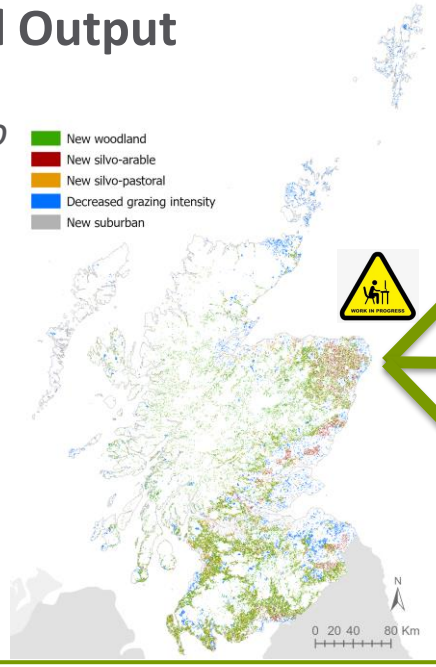
Restrictions
A map generated to restrict land use change in designated areas (e.g peatlands)

Spatial Allocation Model



Baseline Map
(including stocking rate)

Model Output
2050 scenario map



- Connectivity analyses
- Nutrient and Sediment export
- Estimated land emissions

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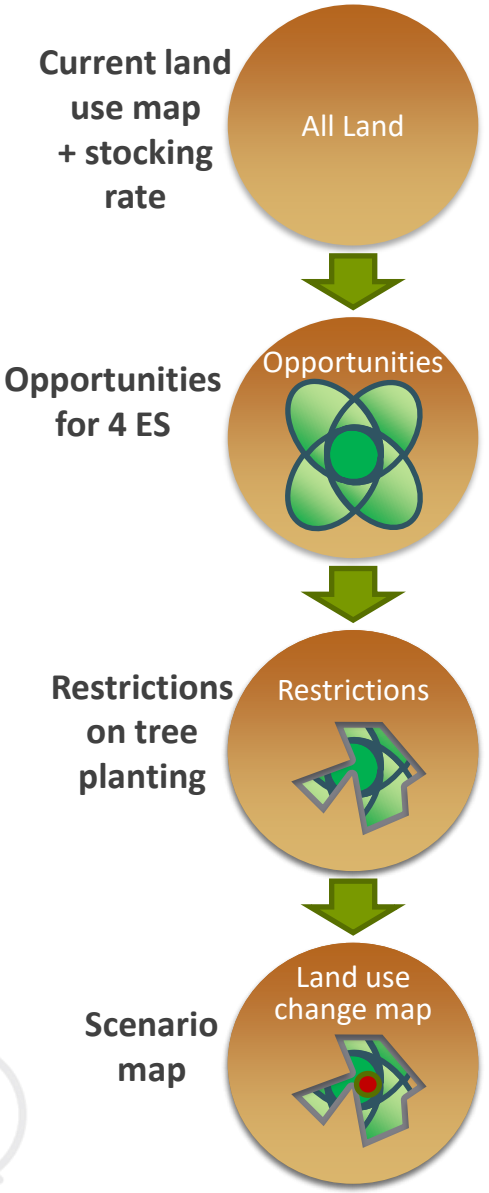
Mapping the SSP1 Low Emission Scenario for Scotland

land use changes **biased towards** areas with greater multi-benefits :

- carbon storage & emission reduction, biodiversity and pollination, diffuse pollution



Land Use 2050 & Components

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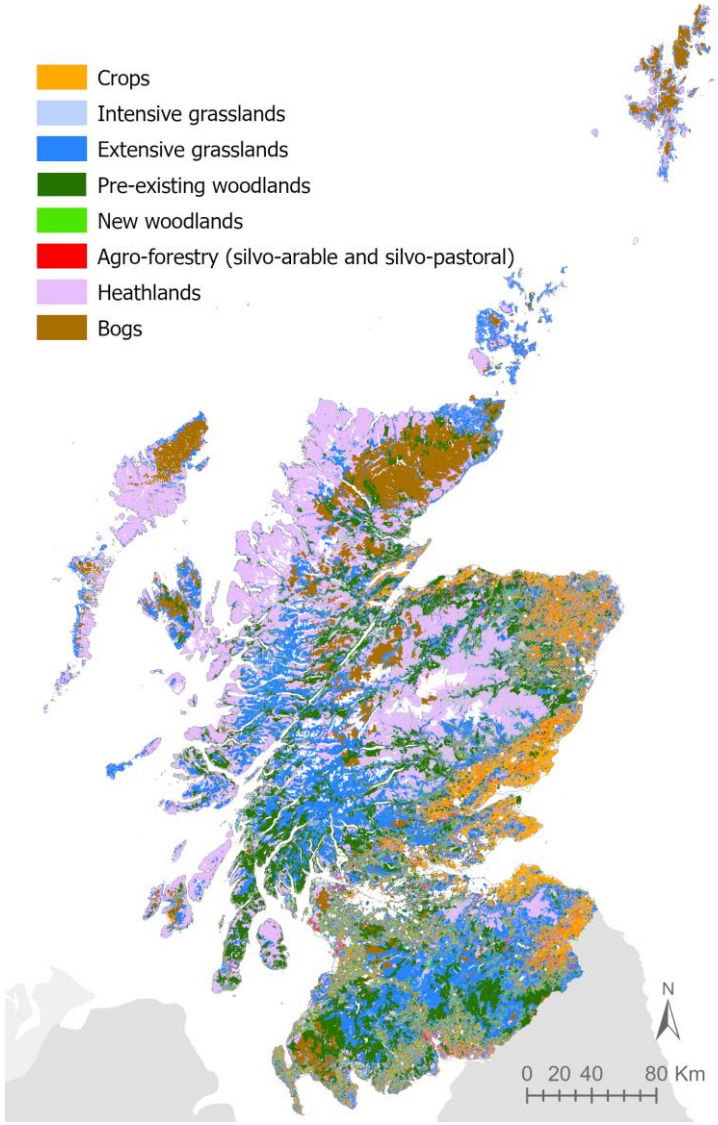
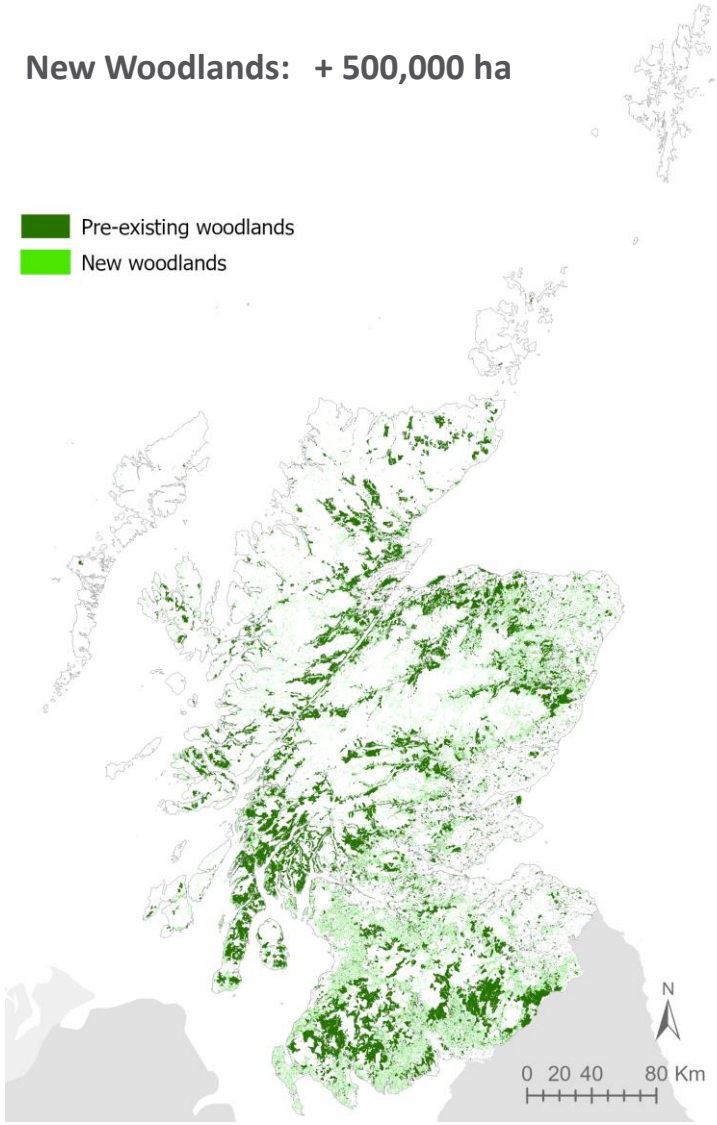
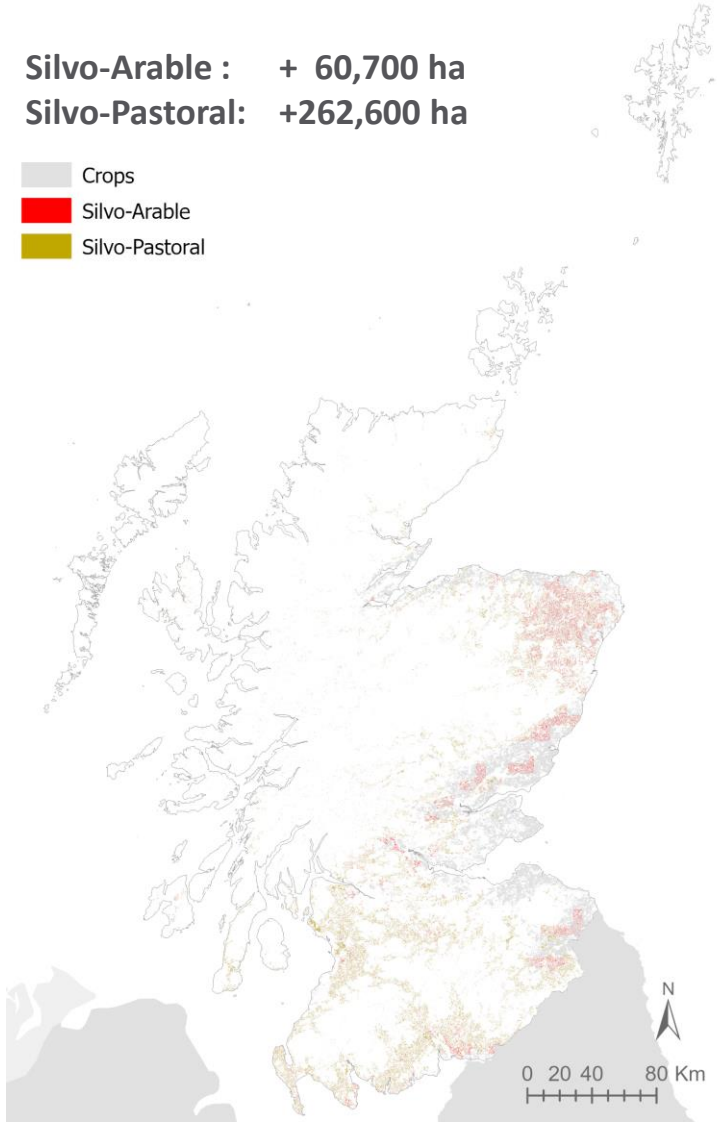


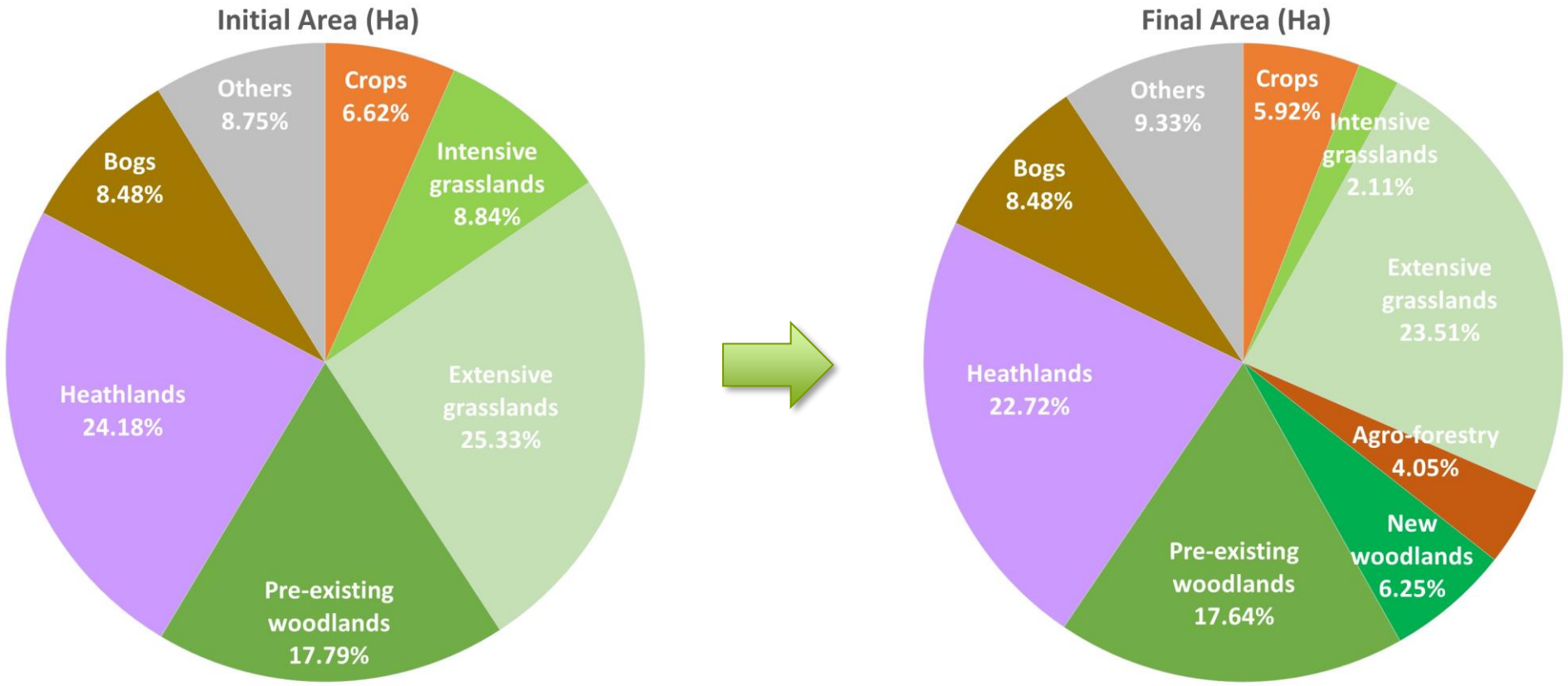
New Woodlands: + 500,000 ha



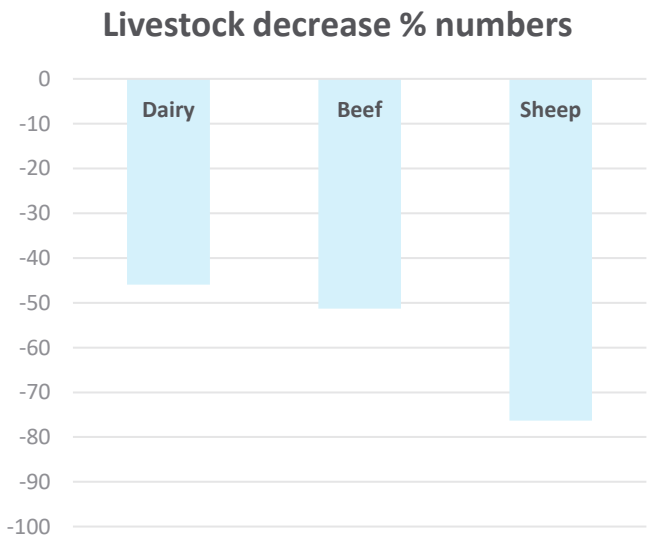
Silvo-Arable : + 60,700 ha
Silvo-Pastoral: +262,600 ha



Simplified Land Use Composition



Decrease in livestock & CO_2 eq emissions



Can trees offset livestock emissions?

- Total livestock emissions (CO_2 eq) decrease -42% per year *by 2050*
- Woodlands + Agroforestry, ca 840,000 ha *by 2050*

With immediate **linear decrease (2023-2050)** in livestock, *cumulative* residual emissions would still be some **60 Mtons.**

=> This would need several hundred thousand ha of trees to offset

<u>The more change is delayed, the more trees needed to offset</u>

Conclusions

Our approach allows to:

account for the fact that land use change is likely to be embedded in wider societal evolution

BUT also :

type of change constrained by *detailed* biophysical landscape attributes
=> from non-spatial to spatial scenario

to do so we can

take in outputs of other models as constraints and opportunities

compare ESS-impacts (and trade-offs) of different scenarios

Implications

More operational mitigation objectives; better risk management, resilience and preparation for adaptation

Thanks for your attention

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Relevant papers

Gimona, A. McKeen, M., Baggio-Compagnucci, A, Simonetti, E. Pakeman, R. (2023) Complementary effects of biodiversity and ecosystem services on spatial targeting for agri-environment pay ments. Land Use Policy 126, 106532. https://doi.org/10.1016/j.landusepol.2022.106532

Baggio-Compagnucci A., Ovando P., Hewitt R.J., Canullo R., Gimona, A. (2022) Barking up the wrong tree? Can forest expansion help meet climate goals? Environmental Science & Policy. vol.136, p.237-249. https://doi.org/10.1016/j.envsci.2022.05.011.

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