

Coupling human and biophysical models of the land system at the global scale

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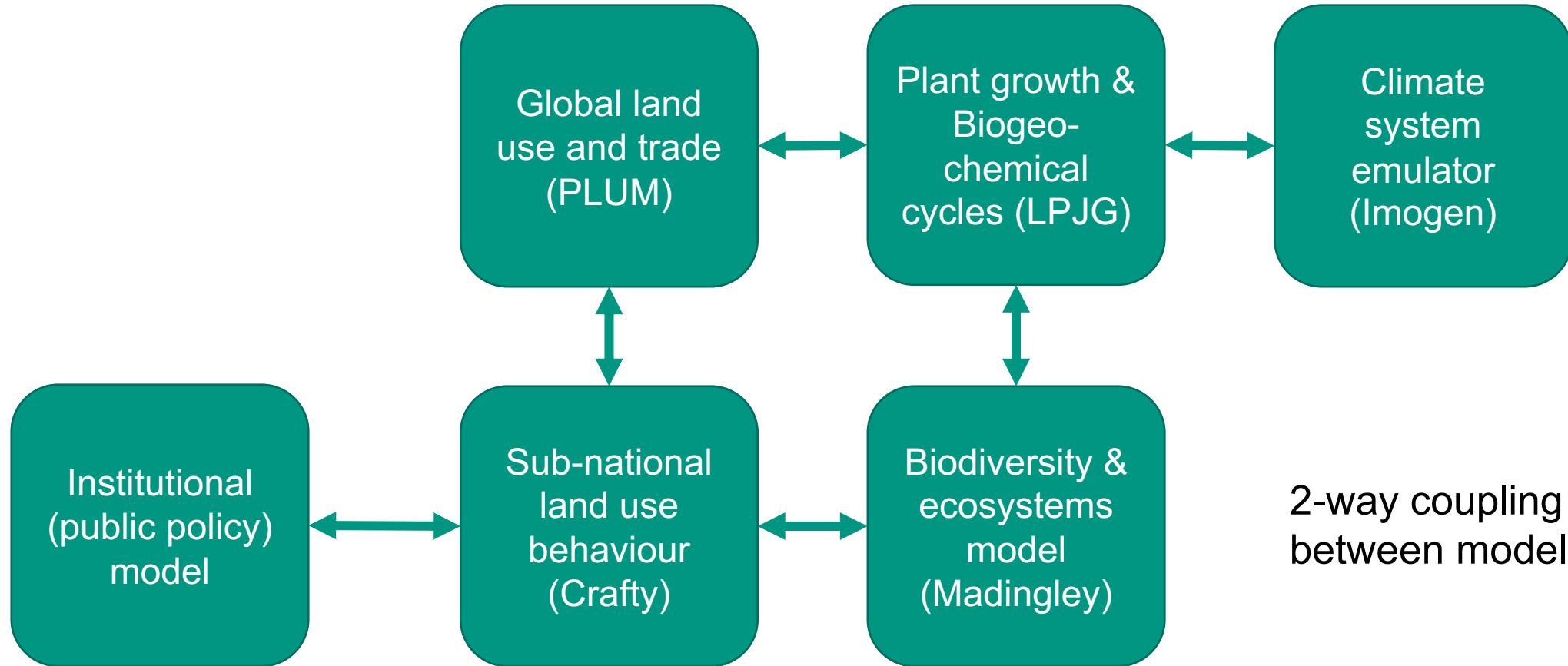


Institute Of Meteorology and Climate Research, Atmospheric Environmental Research, IMK-IFU
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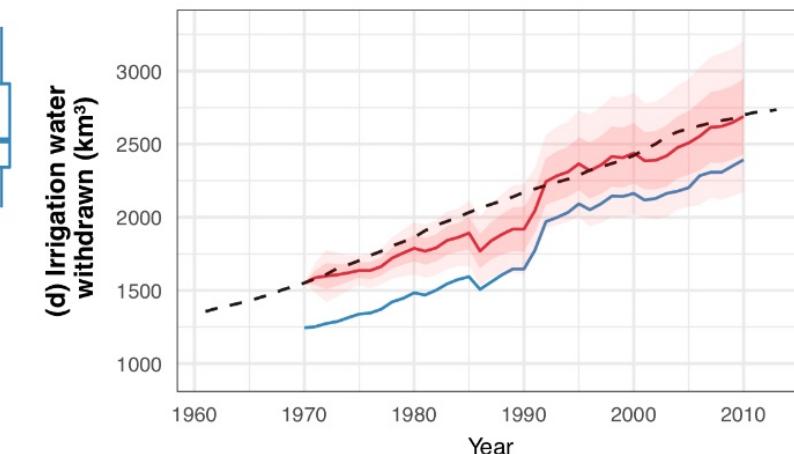
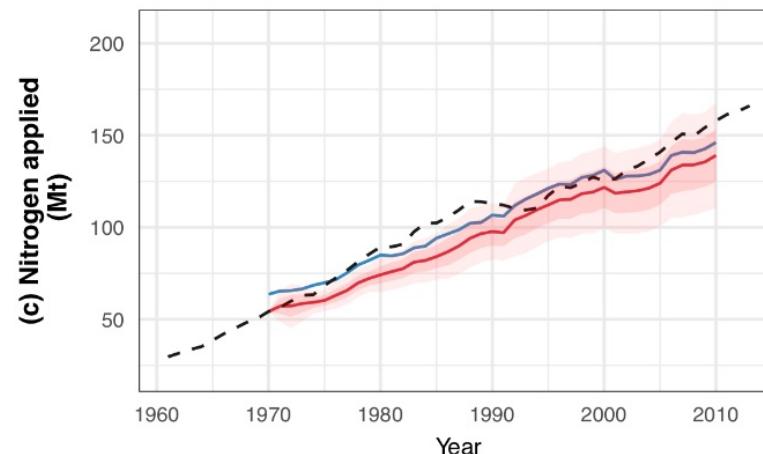
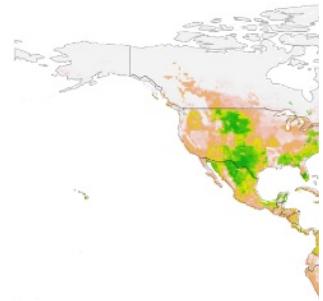
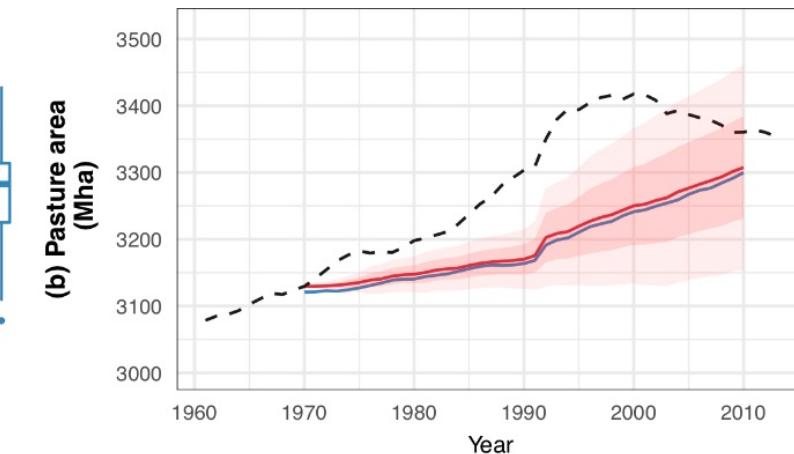
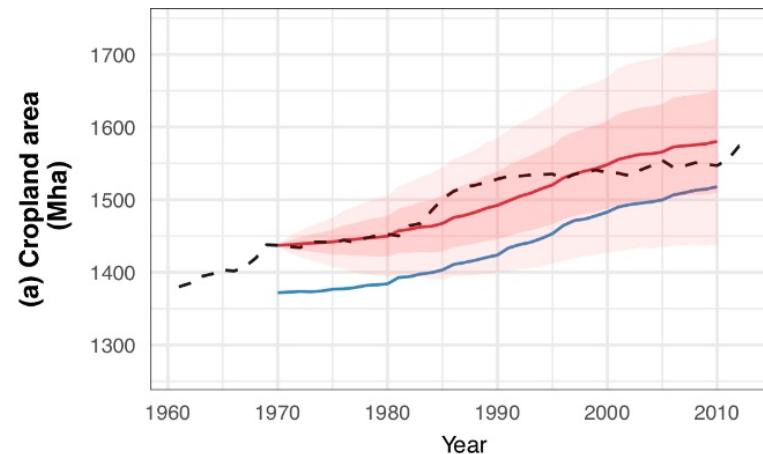
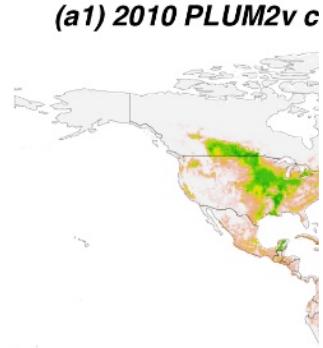
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The Land System Modular model (LandSyM model)



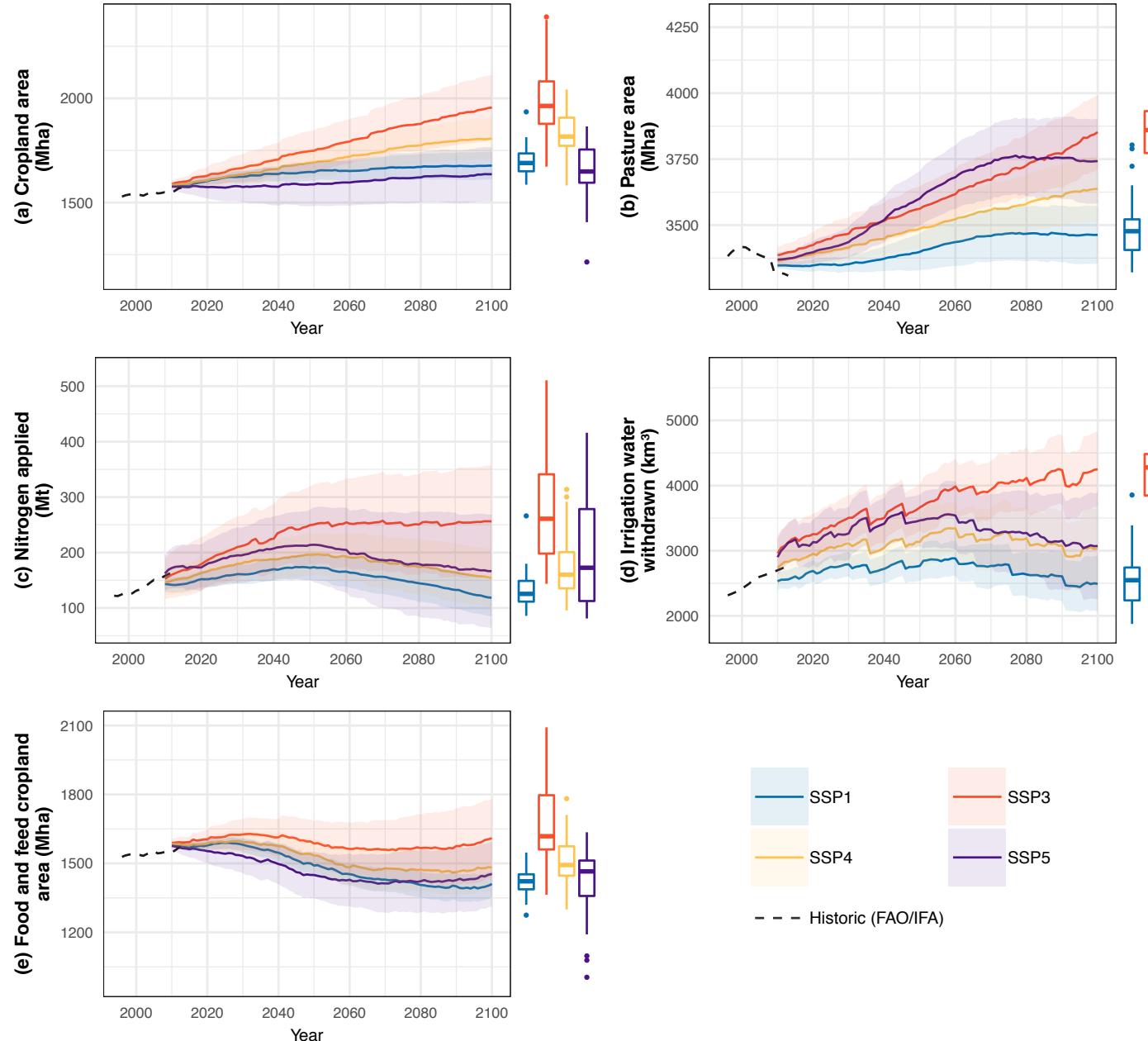
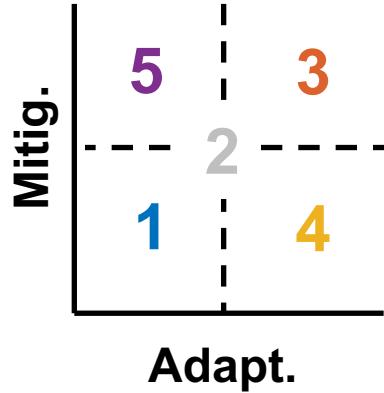
Comparison of 1970-2010 agricultural land use data against LPJ-GUESS-PLUM simulation results



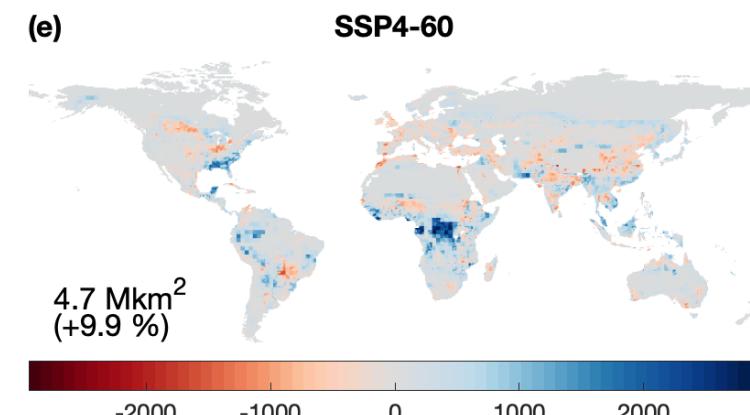
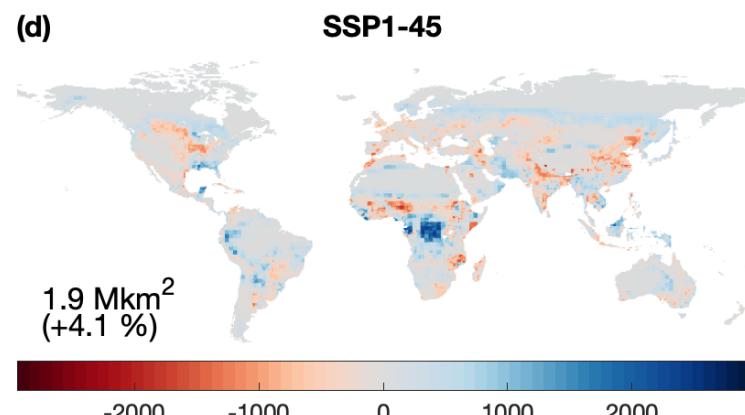
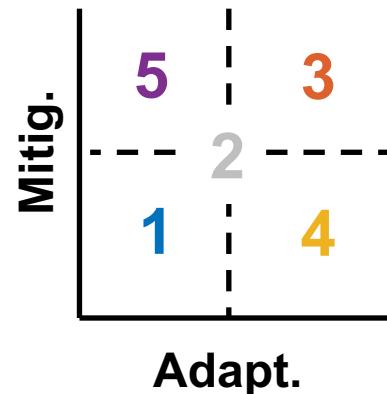
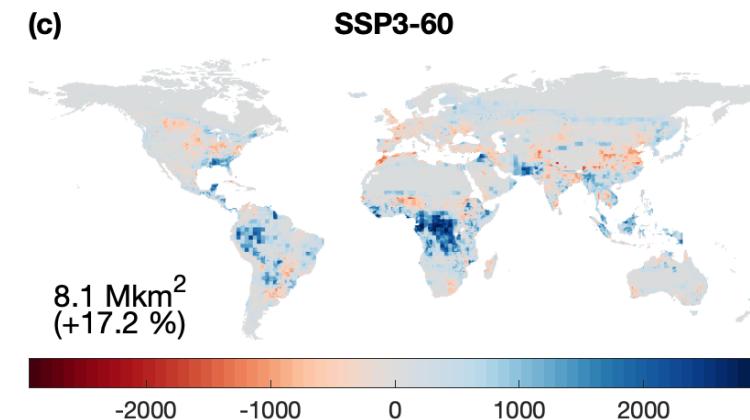
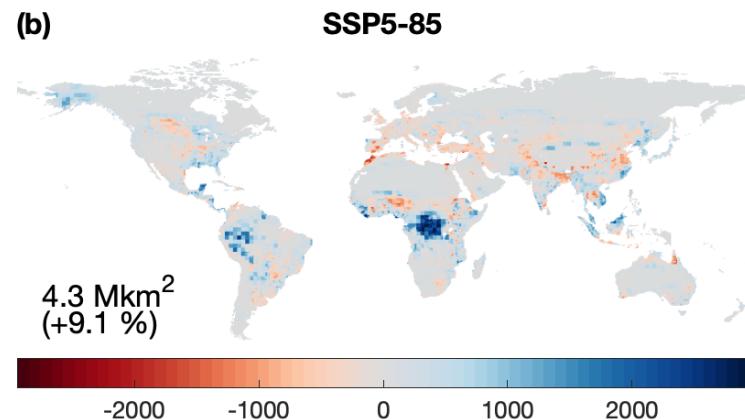
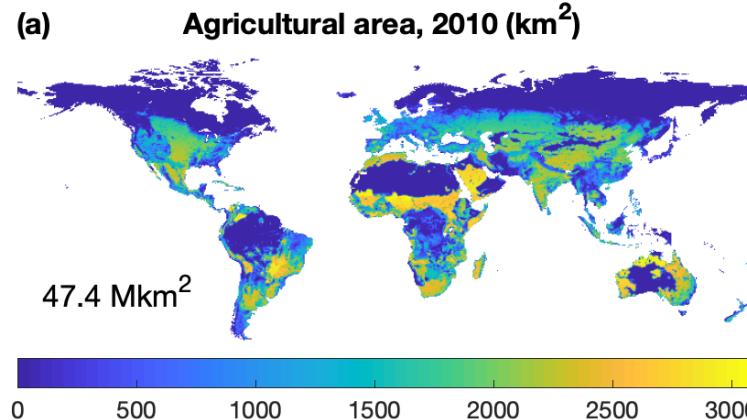
■ 1970–2010 modeled (rebased at 1970) ■ 1970–2010 modeled (unadjusted) - - Historic (FAO/IFA)

Cover fraction

Land use areas & intensities

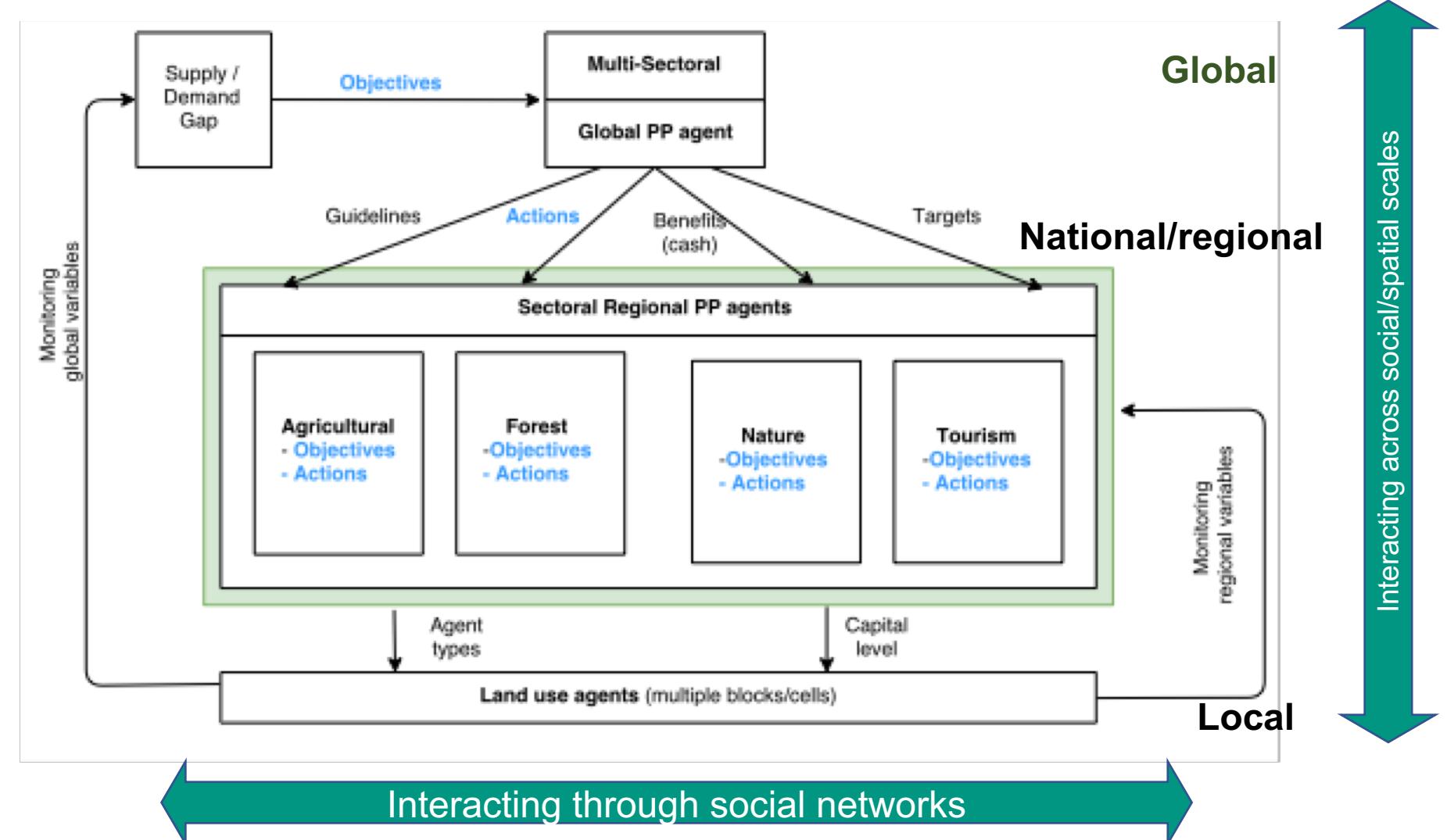


Agricultural expansion at 2100



Modelling institutions (public policy) in CRAFTY

- Institutional agents monitor changes in the environment (ES supply-demand ratios)
- And act when a certain threshold is met
- Actions include:
 - Regulation
 - Subsidy
 - Deregulate
 - Awareness raising (social & human capital)



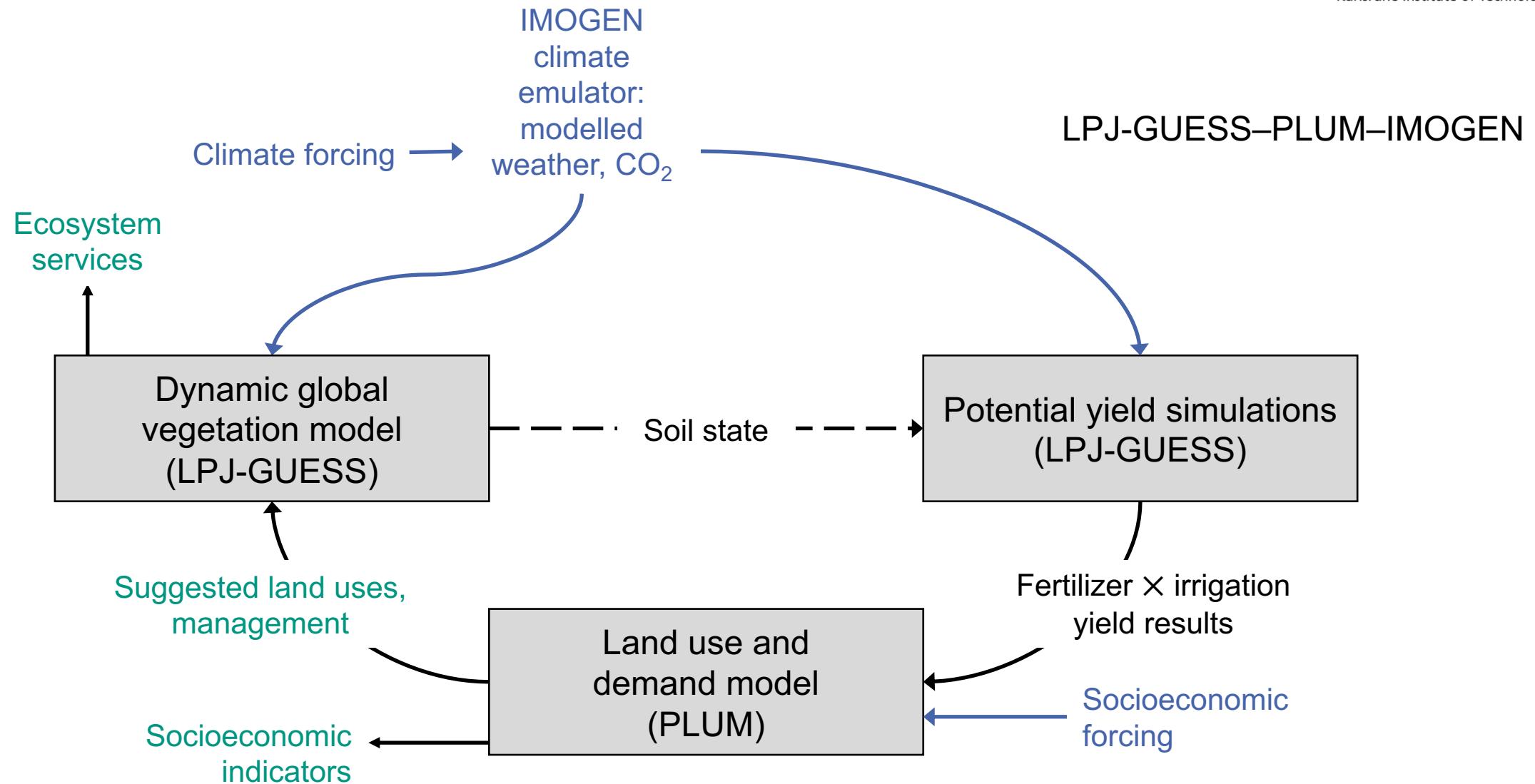
Any questions?



The need for new coupled land system models that ...

- Account for the wide range of human behavioural and decisional processes
- Deal with international trade in land commodities
- Represent nature (ecosystems) in a process-based way, including biogeochemical cycling
- Link to impacts on biodiversity and ecosystem state
- Accommodate feedbacks between the human and biophysical systems
- Provide impacts of land system change on the climate system (e.g. C and N dynamics)
- Do all of this from the global to the local scales
- Introducing ...

The Land System Modular model (LandSyM)



Land use and commodity production

9 Crop types

- Wheat
- Maize
- Rice
- Fruit & Veg
- Oilcrops
- Pulses
- Starchy roots
- Sugar
- Energy crops

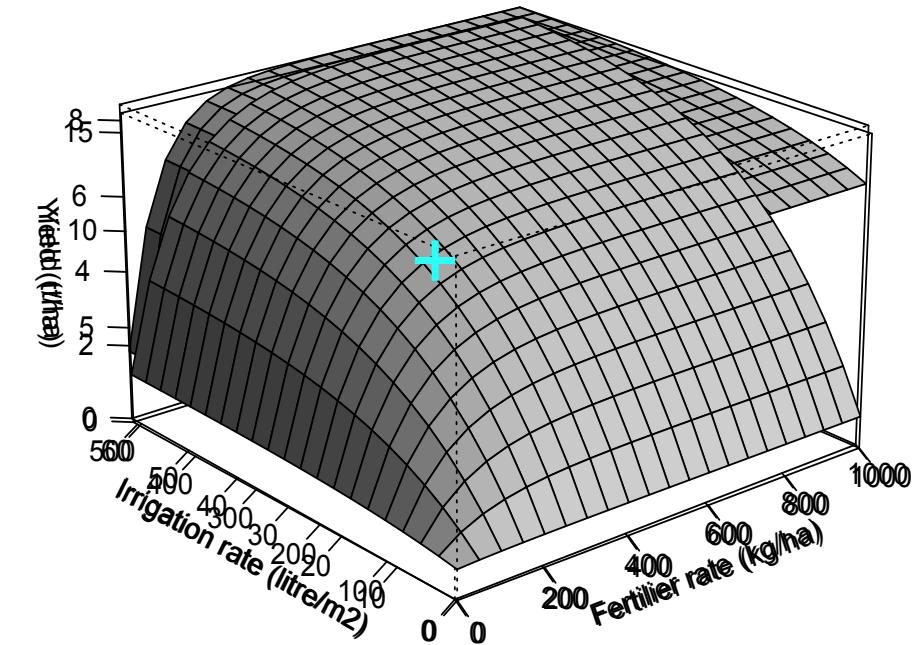
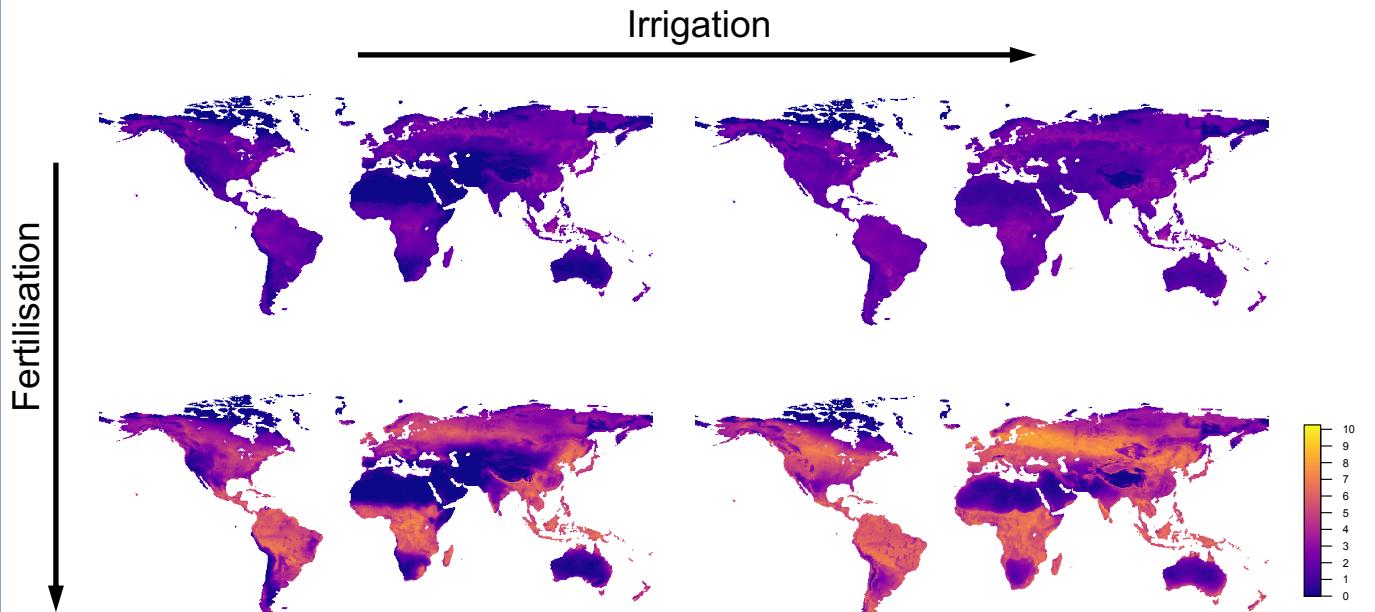
2 Animal product groups

- Monogastrics
- Ruminants

Yield potential maps for each crop, fertilizer rate and irrigation/rainfed.



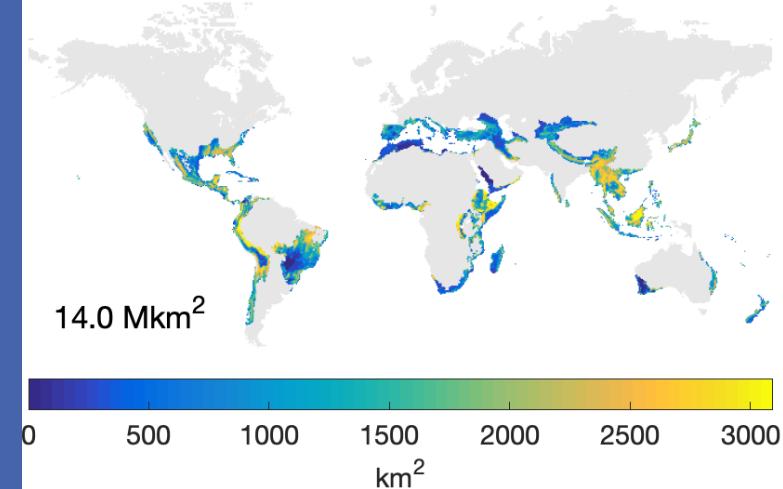
Used to create yield response to intensity for each crop and grid cell



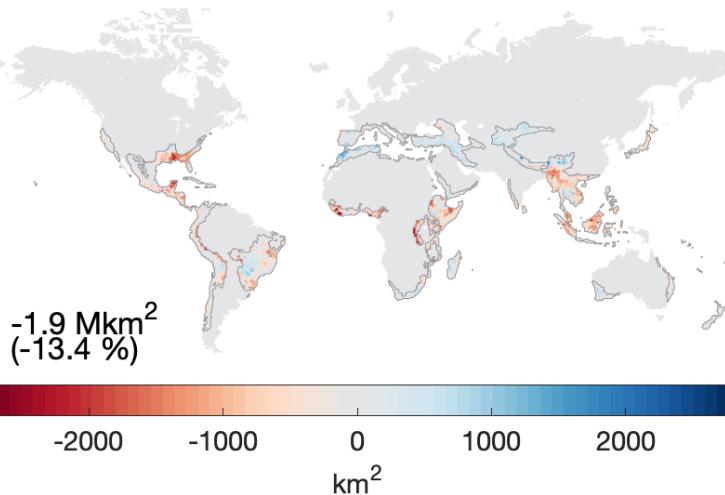
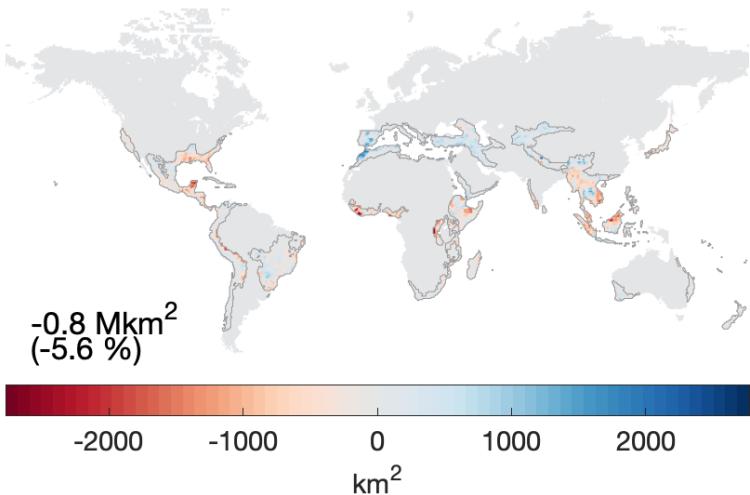
Maize, California Central Valley, US
(37°N, 120°W)

Natural area loss in biodiversity hotspots

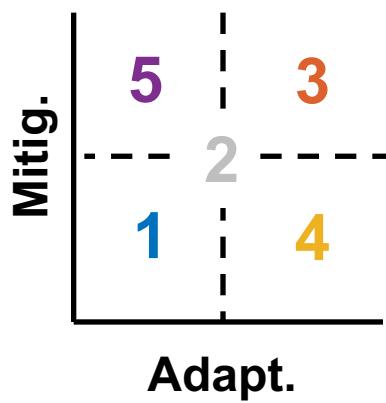
BD hotspot area, 2010 (km^2)



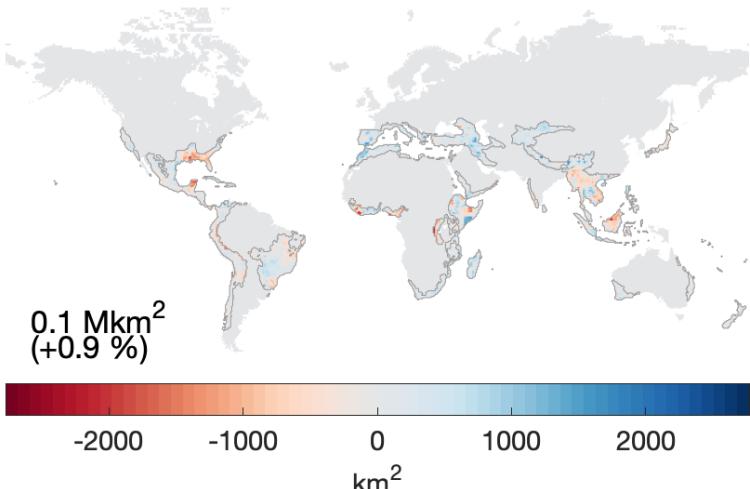
SSP5-85



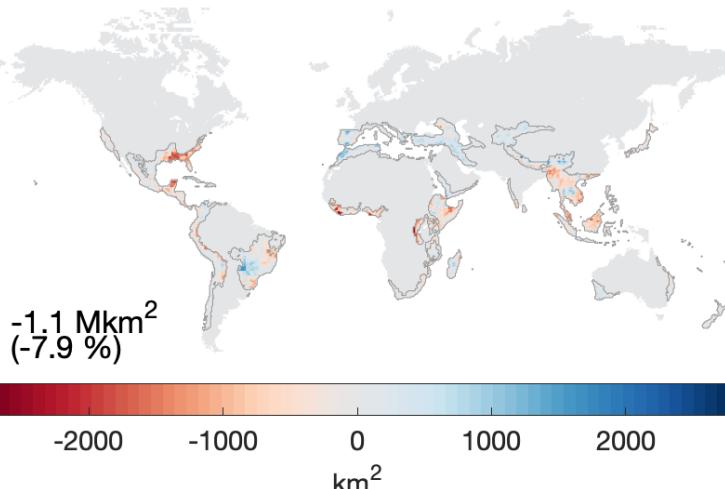
Conservation International hotspots
(Myers et al., 2010, *Nature*)



SSP1-45

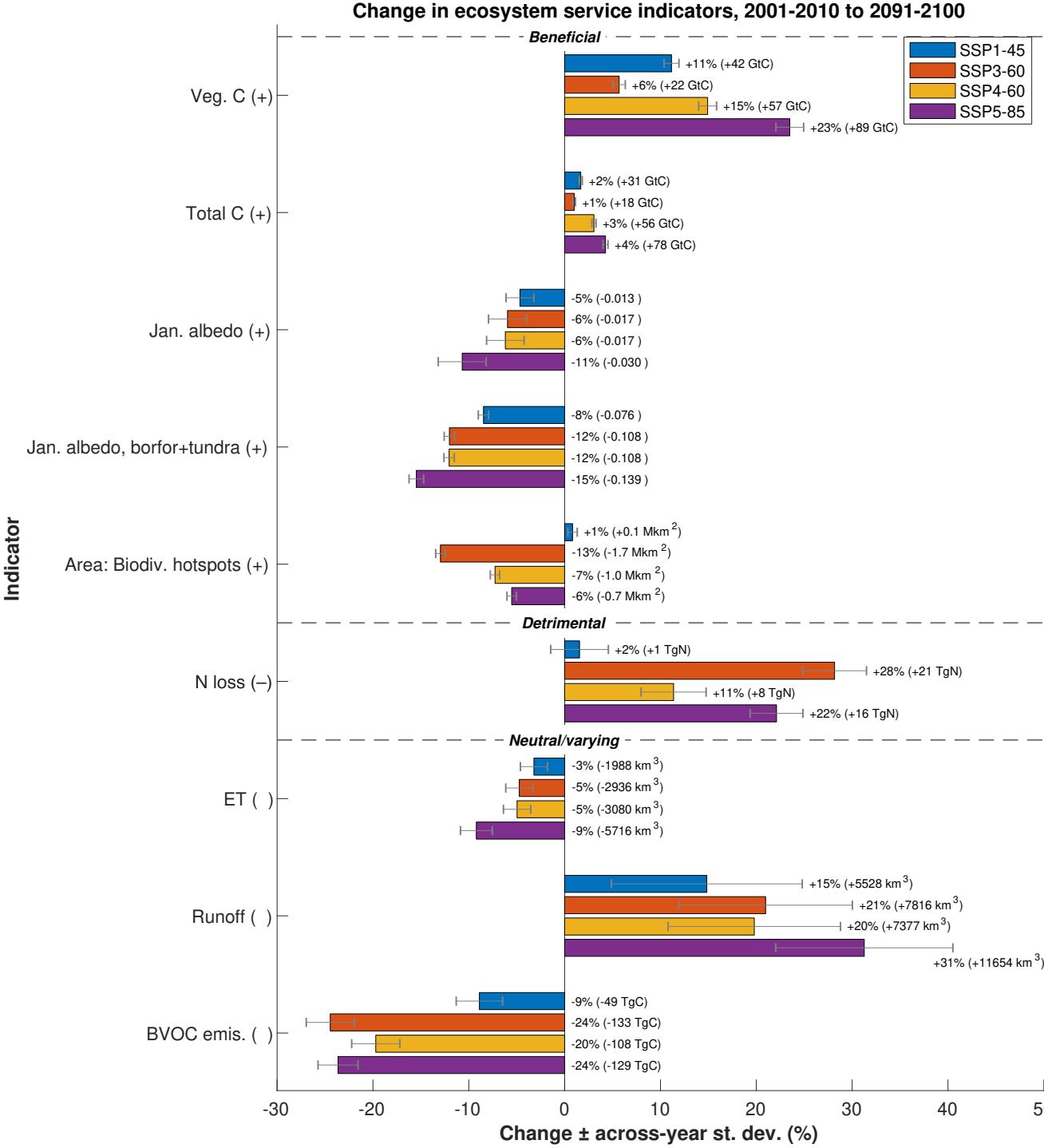


SSP4-60

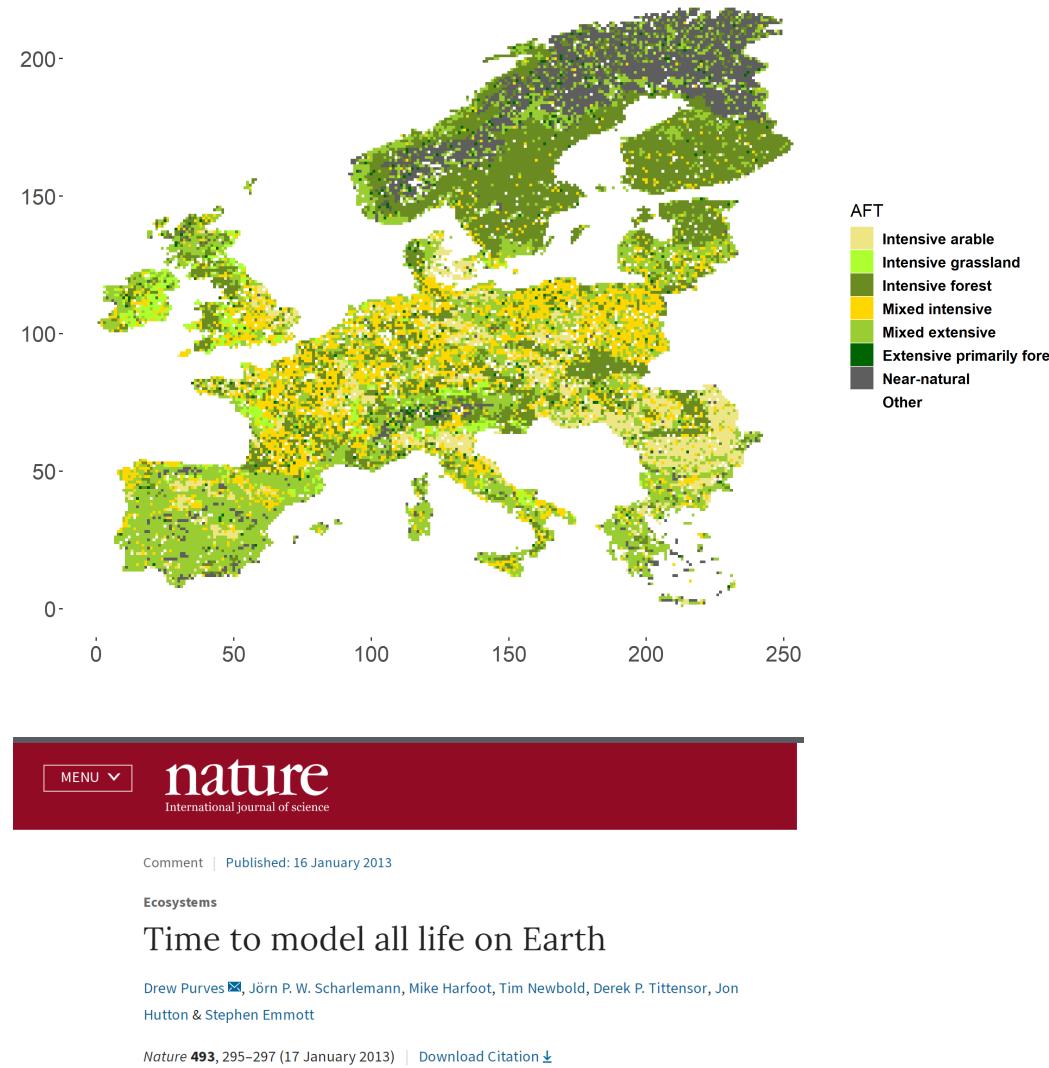


Ecosystem service indicator summary

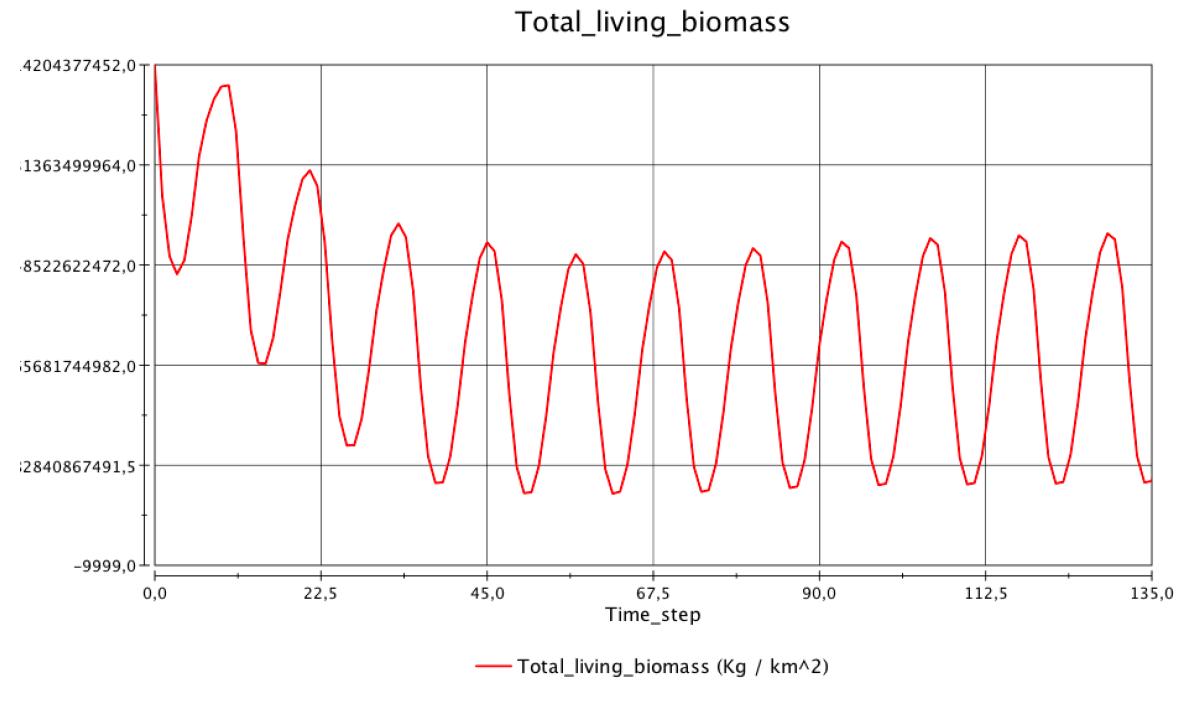
Mark Rounsevell



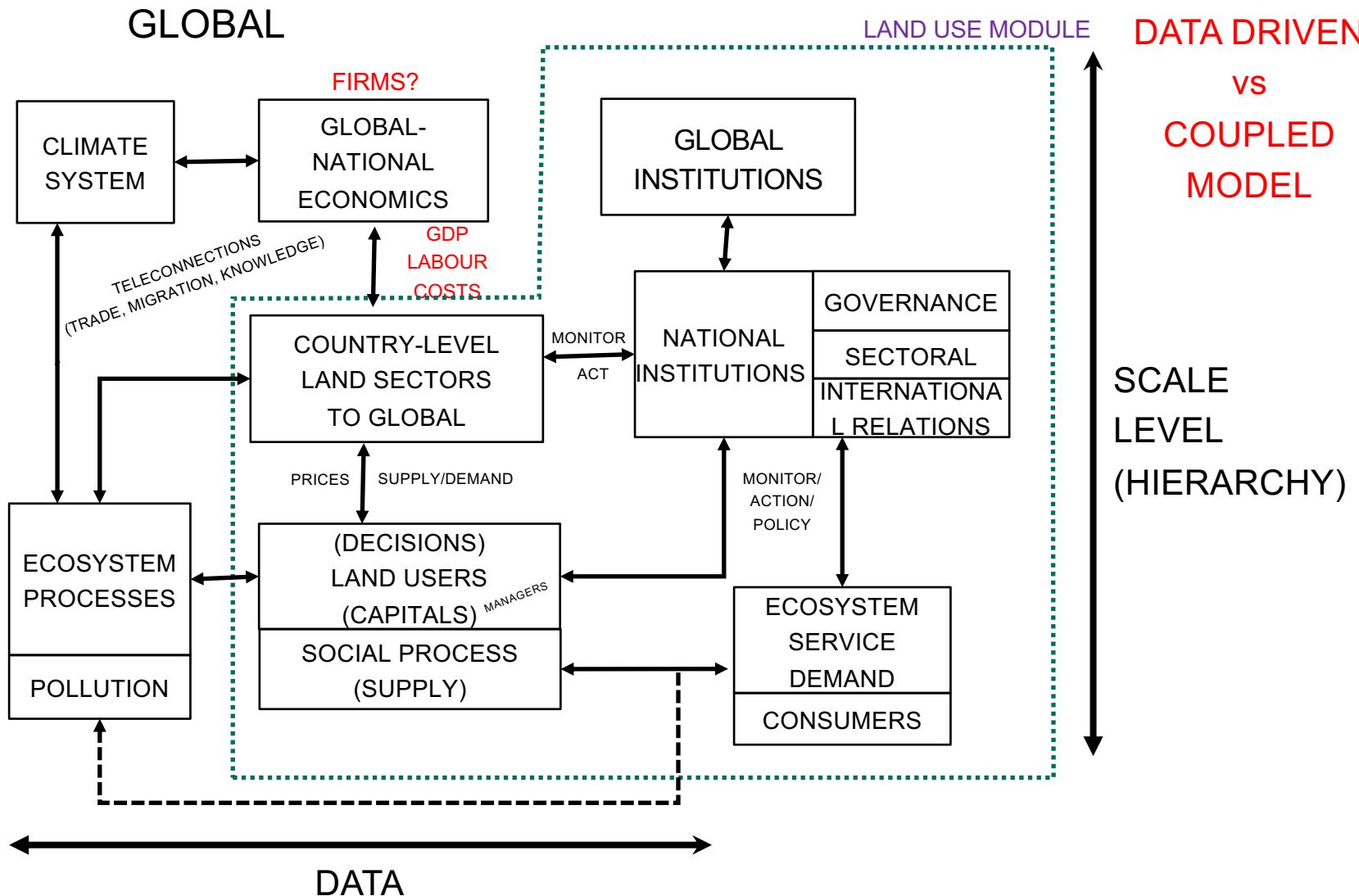
Modelling ecosystem impacts: coupling to the Madingley model



- ‘*Next-generation*’ model of ecosystems and biodiversity
- Cohort-based ecological dynamics
- Modelled ecosystems respond to Human Appropriation of Net Primary Productivity (HANPP)



Structure of a global scale land system model



Coupling CRAFTY within the LandSyM model

The need to model endogenise institutional (public policy processes)

Concluding remarks

- There is a need to build ‘bottom-up’, global scale, land system models that:
 - Are process-based
 - Couple the human and biophysical dimensions of land systems
 - Go beyond traditional economic paradigms in representing human behaviour
 - Operate across multiple scales, and for multiple, land-based sectors
 - Accounts for feedbacks to the climate system
 - Evaluates the impacts of land system change on biodiversity and ecosystem function
 - Endogenises institutional (public policy) processes
- The LandSyM model attempts to achieve this

