Integrated system dynamics modelling of the water-energy-food-land-climate nexus in Latvia: exploring the impact of policy measures in a nexus-wide context

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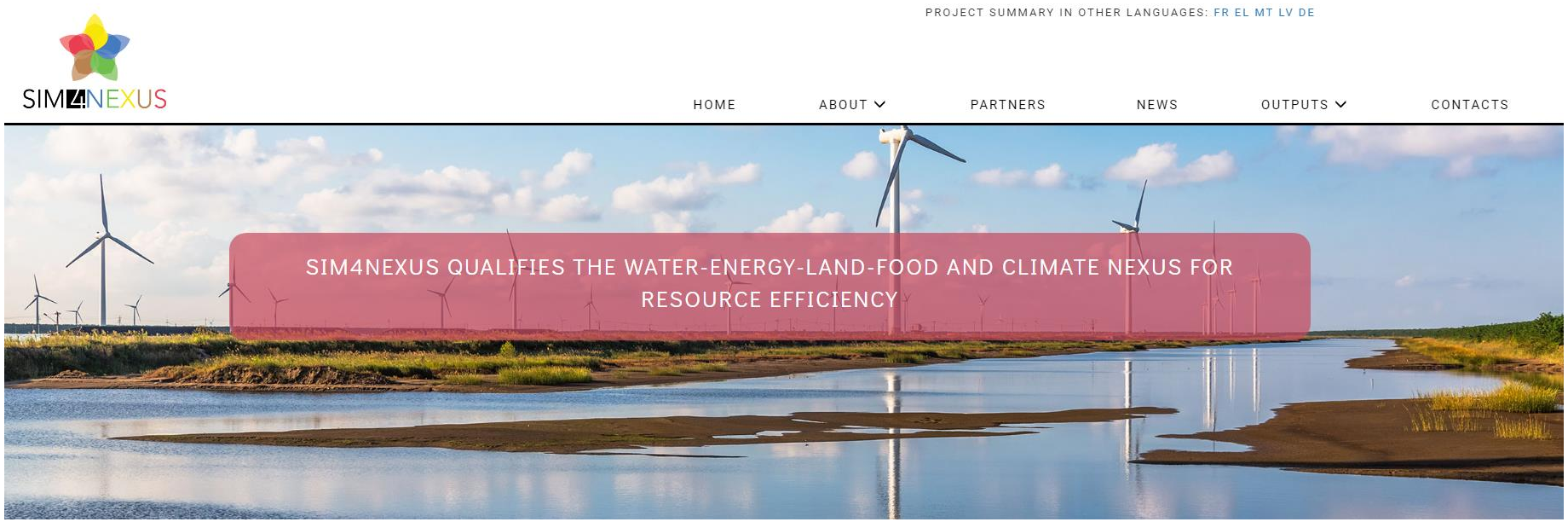


AIMS

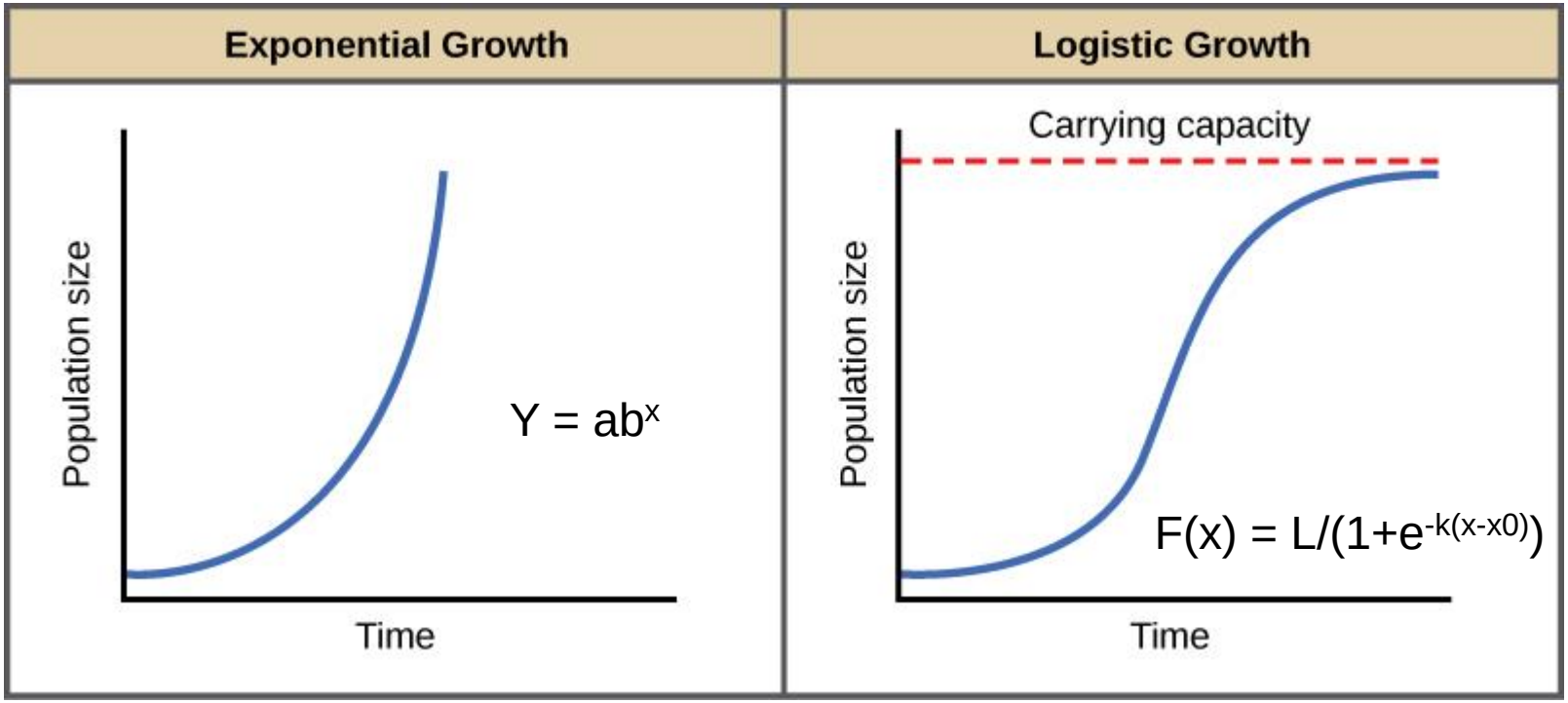
- Develop and apply a system dynamics model of the Latvian water-energy-food-land-climate nexus
  - Model run at monthly timestep from 2000-2050
  - >3000 interacting variables
- Identify system trajectories under BAU conditions
- Assess trajectories when Latvian national level policies are applied
  - Identify possible trade-offs or synergies
- Offer support for intergrated policy making

SYSTEM DYNAMICS

- SDM was developed in the 1960s by Jay Forrester to study feedback problems in industry
- Models feedback and complexity in a system
- Applicable at any scales for many problems
- Philosophy of ‘everything is interlinked’ and systems thinking
- Famous ‘Limits to Growth’ example

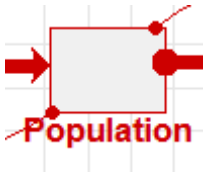
SYSTEM DYNAMICS

- Apart from positive and negative feedback..
- SDM also addresses growth, decay, limits and complexity



SYSTEM DYNAMICS

- 3 main modelling elements
  - Stocks – store material



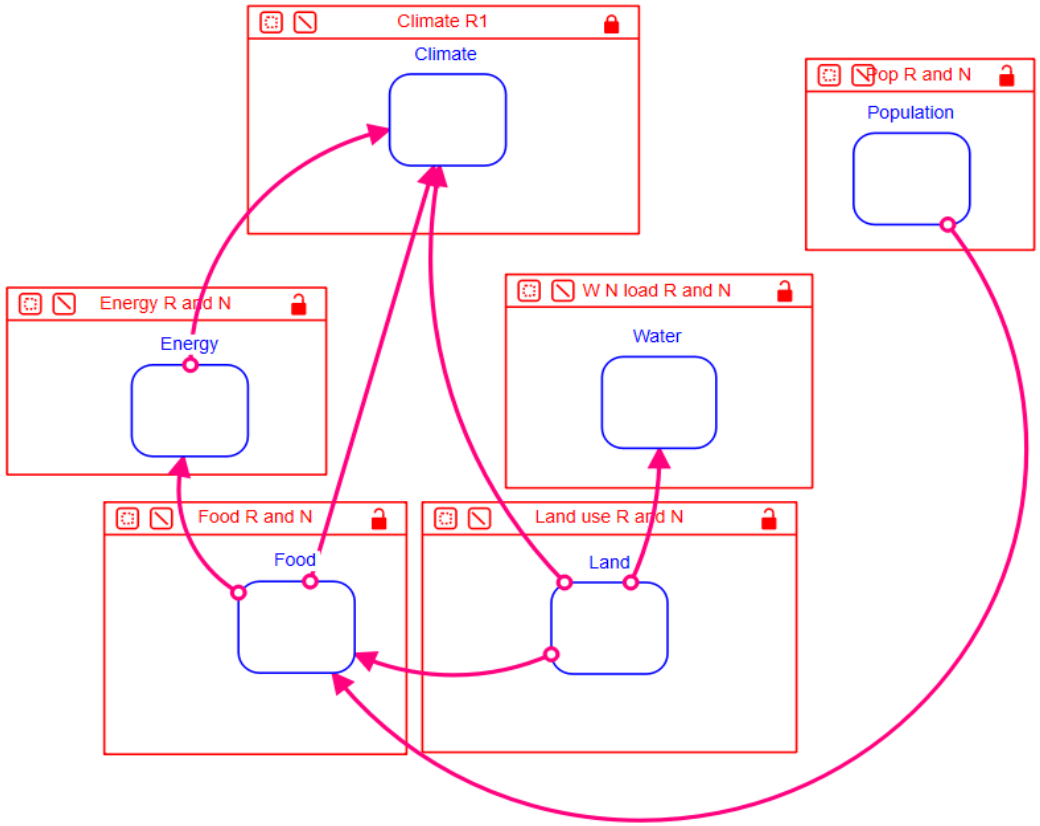
  - Flows – move material in/out of stocks

  - Converters – alter flow rates

- Connectors link all the elements

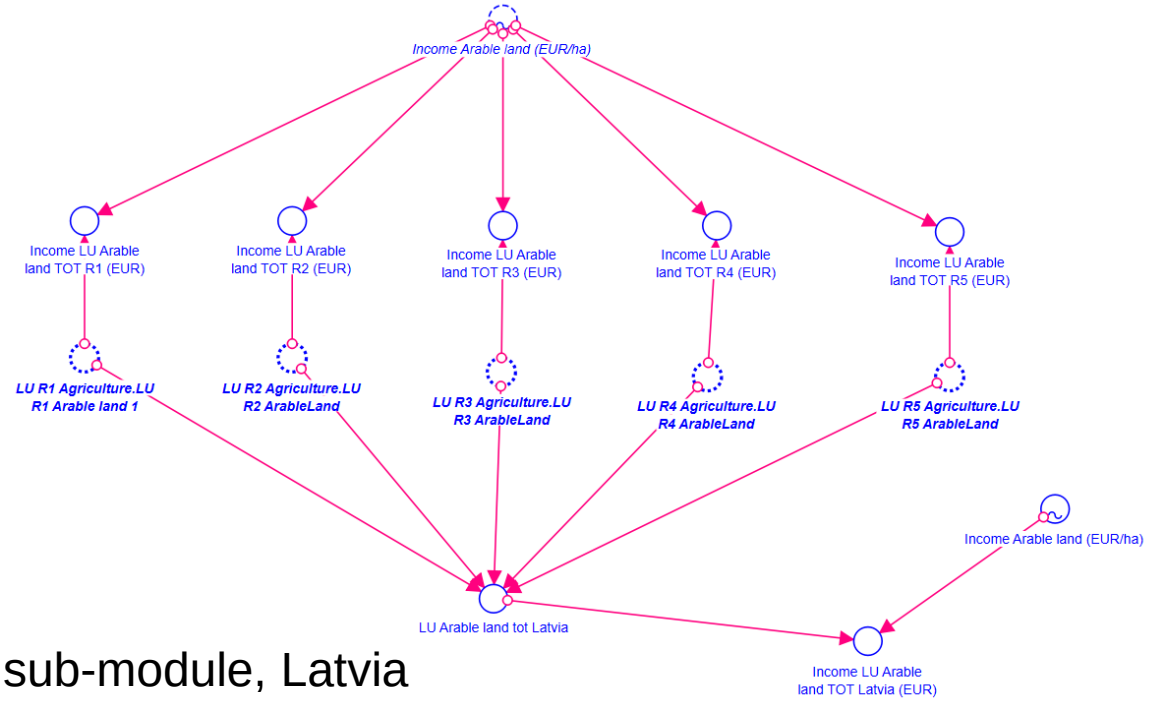
LATVIAN SDM

- All 5 nexus sectors linked, and driven by population changes



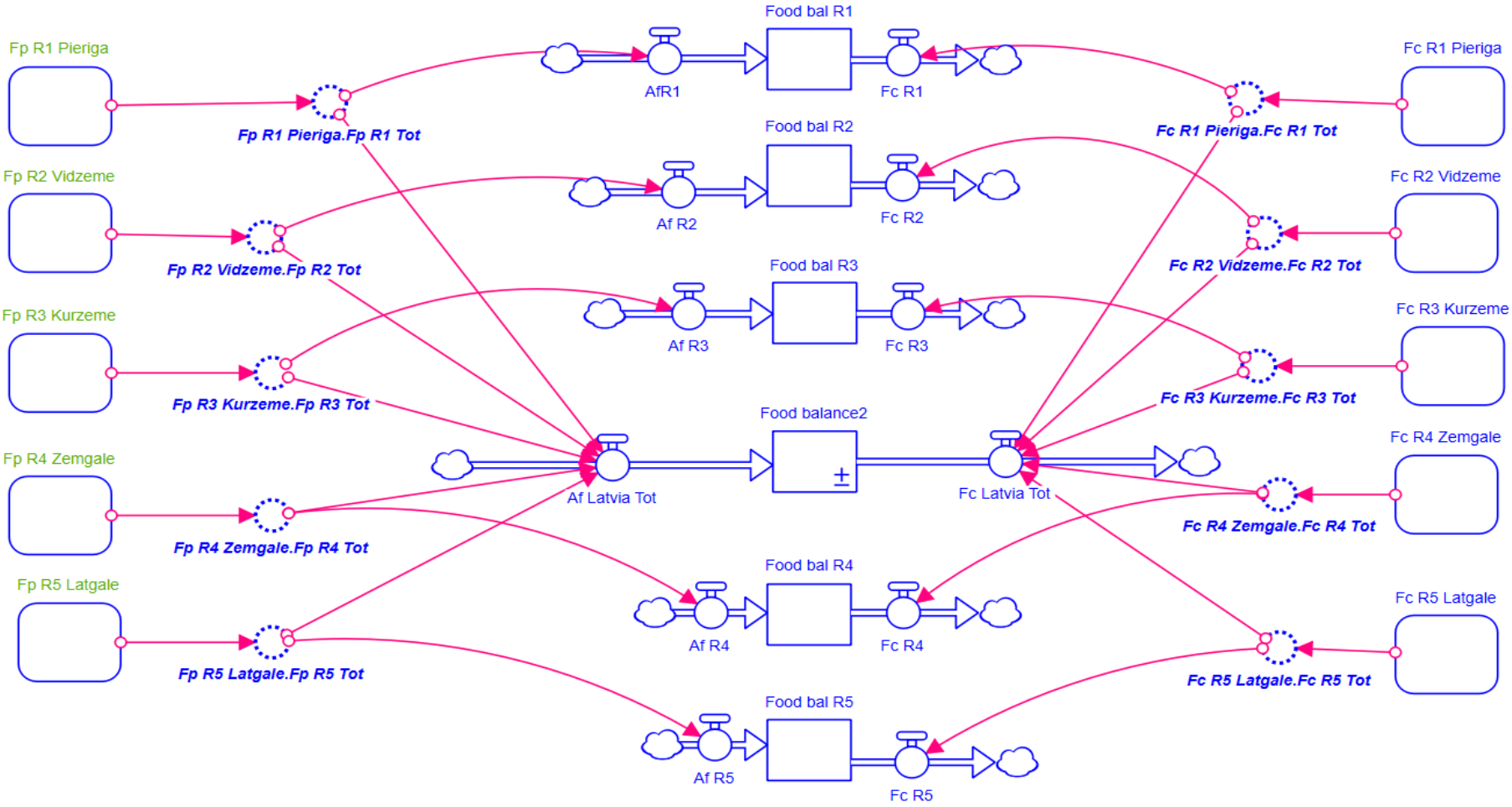
LATVIAN SDM

- Latvia split into 5 regions.
- The WEFLC sectors are represented as ‘archetypes’, whose structure is identical between regions, but the data differ



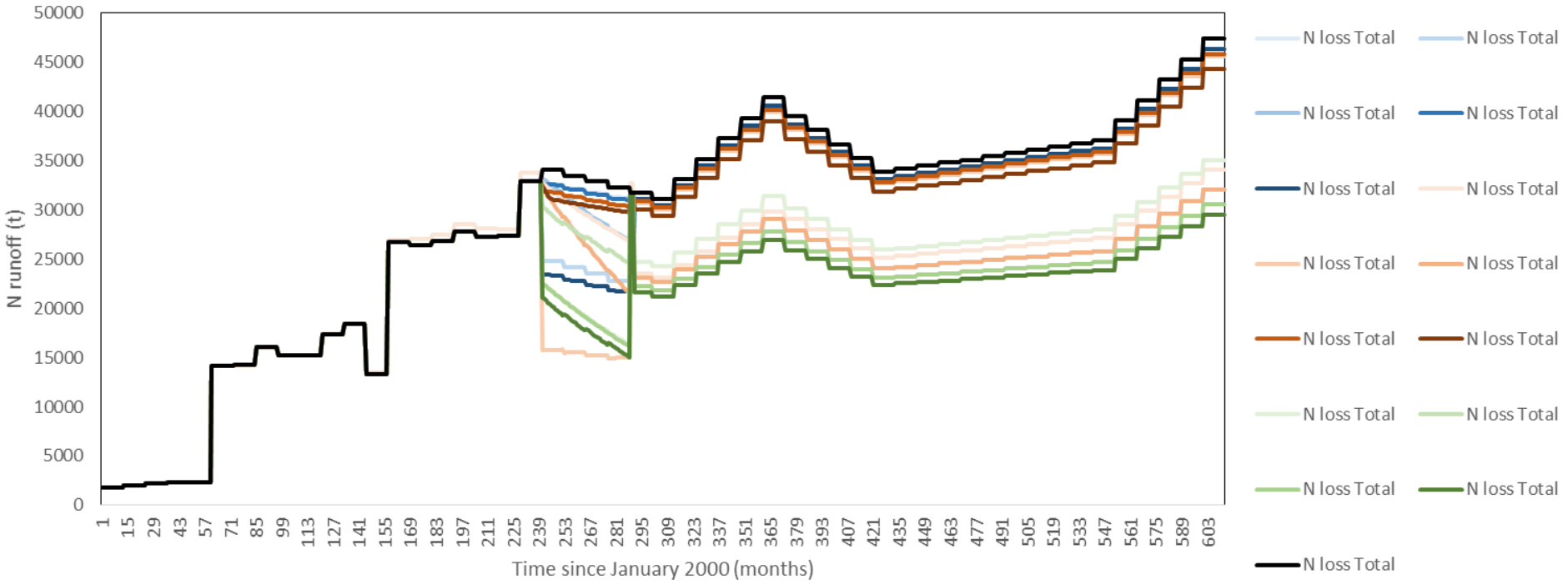
Arable land use sub-module, Latvia

LATVIAN SDM



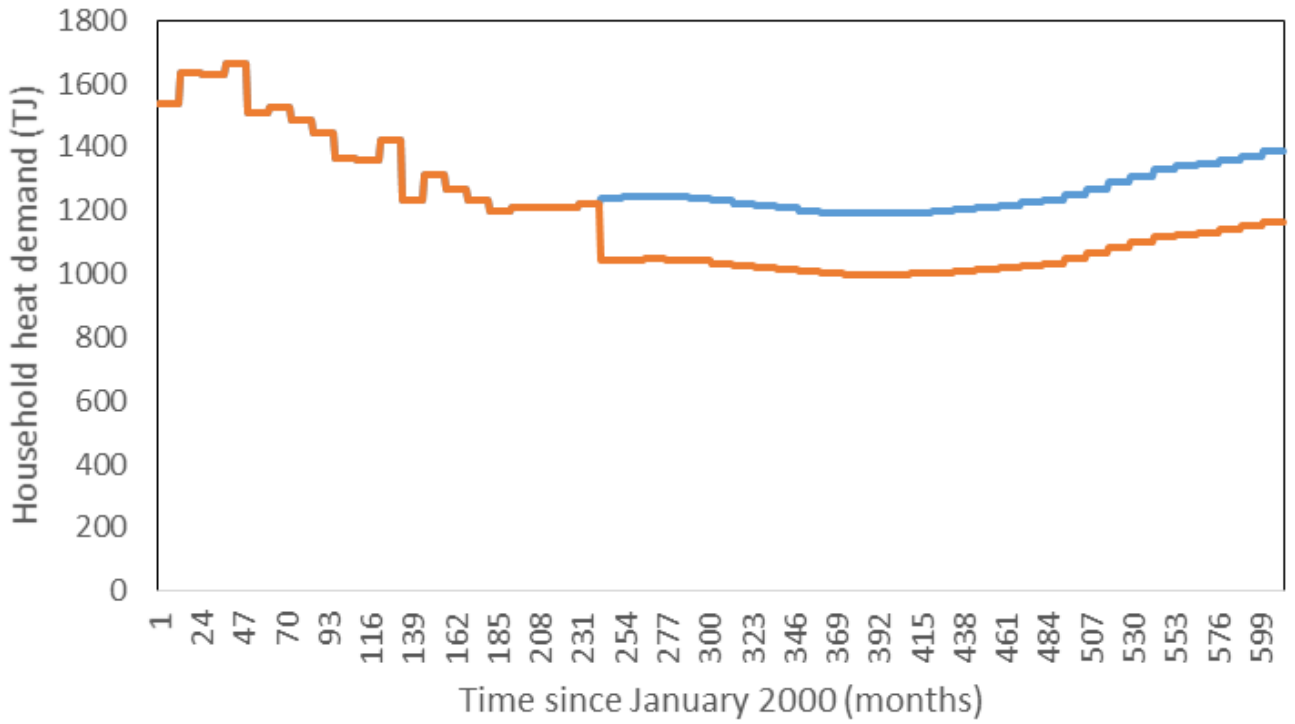
Top-level food module, Latvia

RESULTS



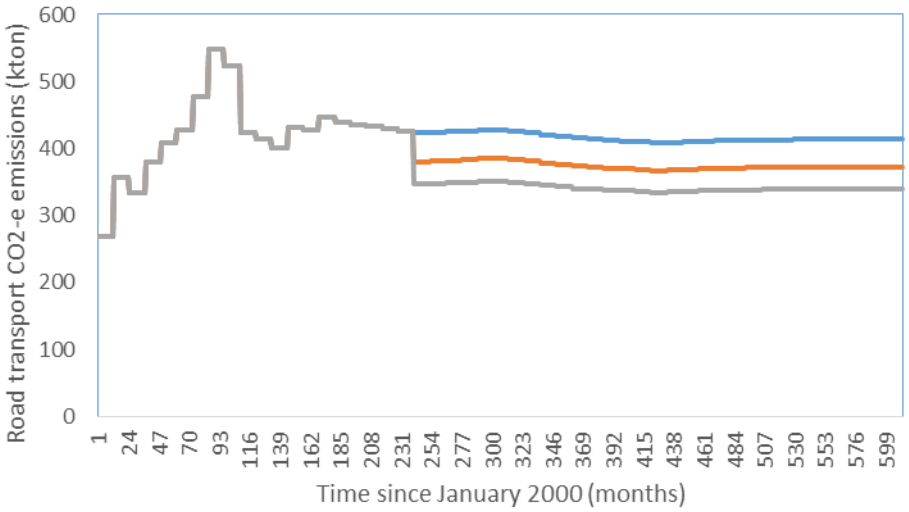
Total Latvian N runoff under baseline (black line) and policy conditions

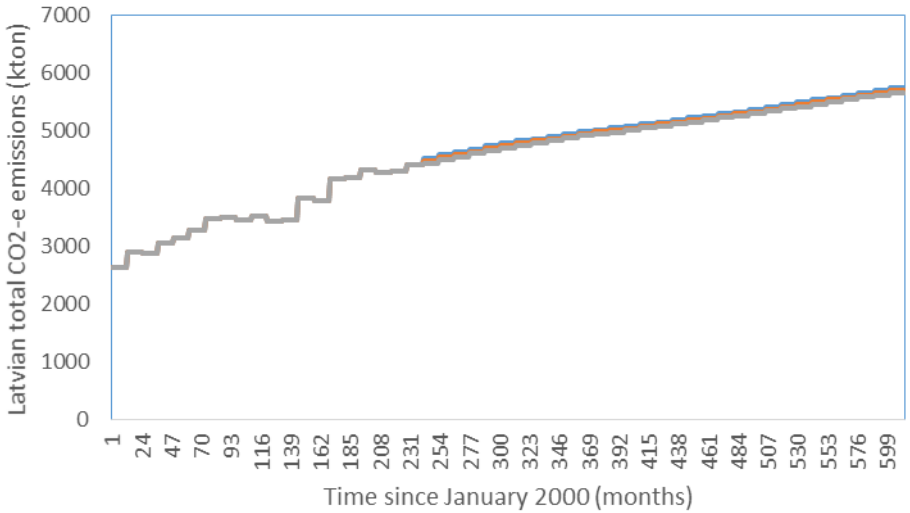
RESULTS



Total Latvian household heat energy demad under baseline (blue line) and policy conditions

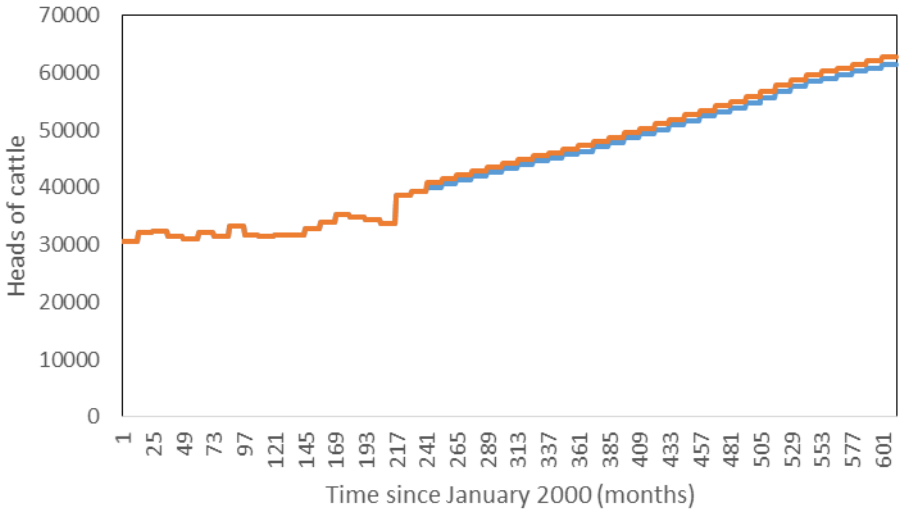
RESULTS

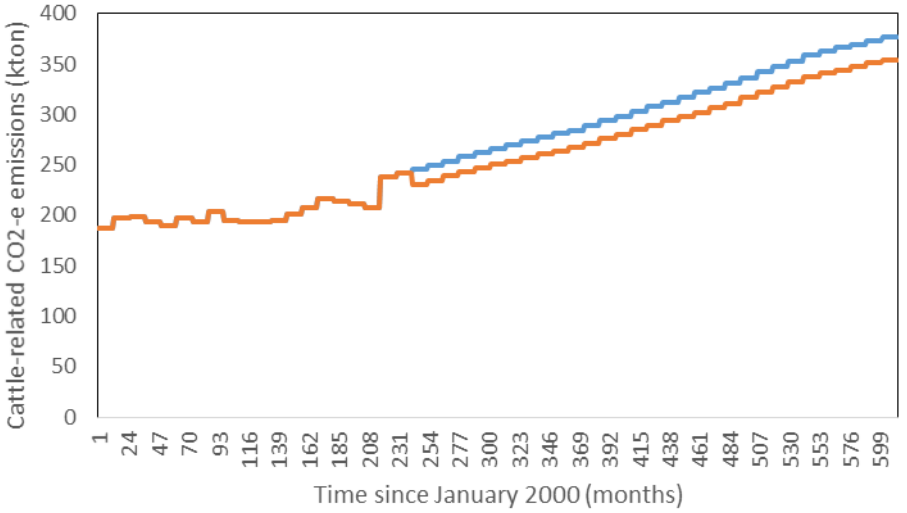




Road-transport related emissions and associated total Latvian emissions under baseline (blue) and policy (orange and grey) conditions

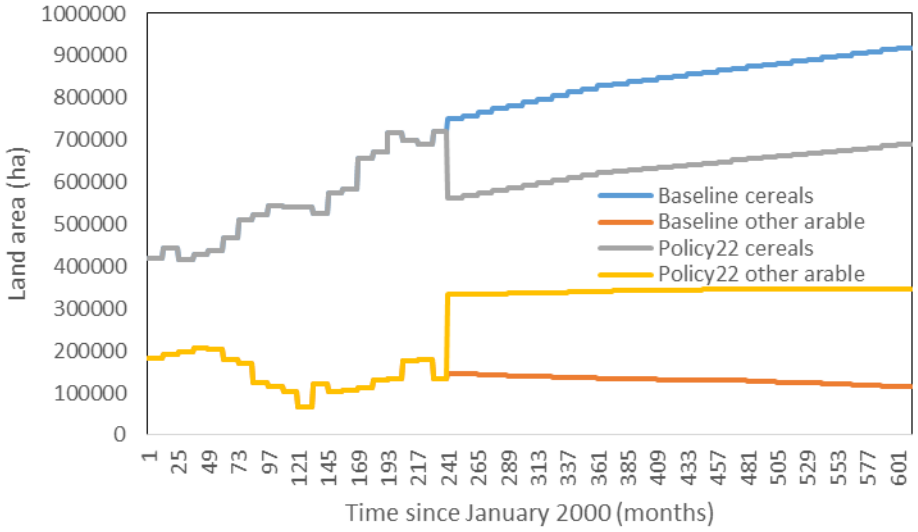
RESULTS

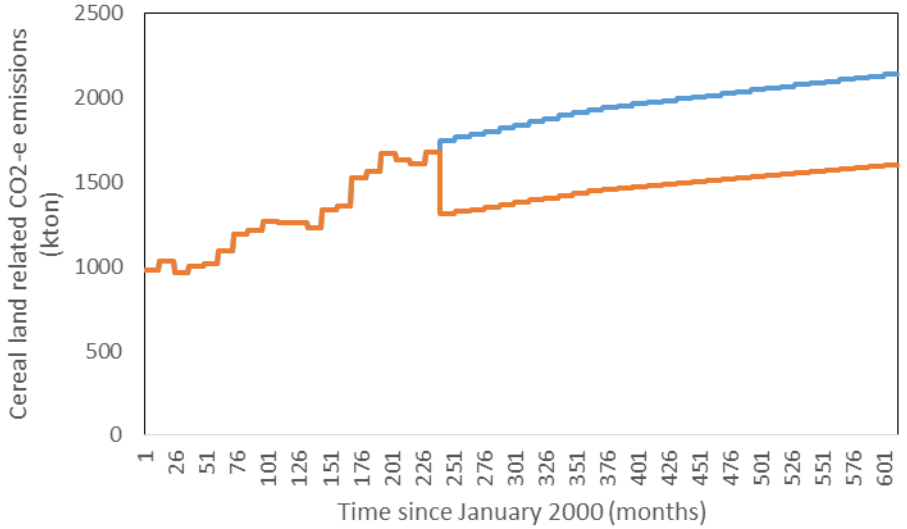


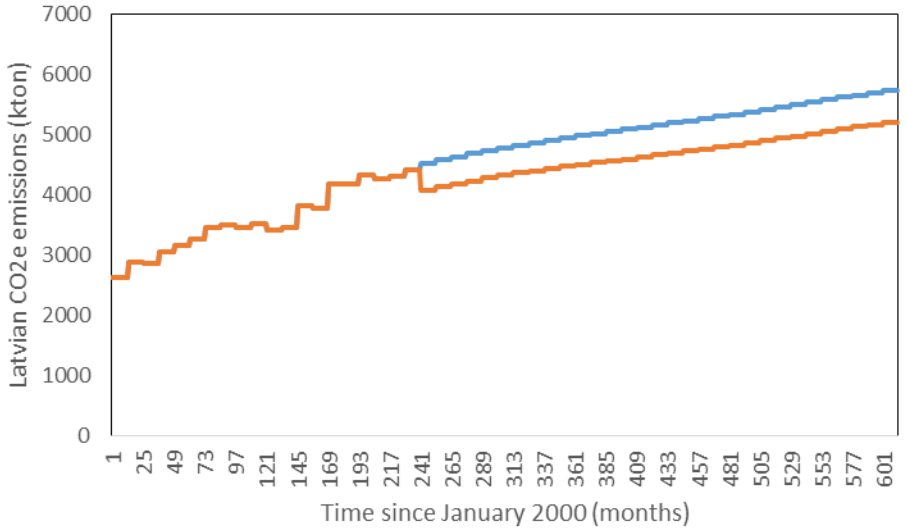


Total number of cattle and associated cattle related CO2-e emissions in Latvia under Baseline (blue) and policy (orange) conditions

RESULTS







Above: Latvian area of cereals and other arable land under baseline (blue, orange) and policy (grey, yellow) conditions.

Cereal-related CO2-e emissions (top) and total Latvian CO2-e emissions (bottom) under baseline (blue) and cereal policy (orange) conditions

DISCUSSION

- Sectoral policies have nexus-wide impacts not usually accounted for
- Policy to reach a target in one sector (e.g. increasing cereal lands for food security) prohibits reaching targets in other sectors (e.g. reducing N runoff, reducing CO2-e emissions)
- This is one of the first studies to consistently and holistically study nexus-wide impacts of sectoral policy goals.
- Quantitative results lend weight to statements suggesting more cross-sectoral policy coherence is required at a range of geographical scales.

CONCLUSIONS

- Quantitative, integrated system dynamics model of the WEFLC nexus in Latvia developed.
- Policy goals applied: impacts compared to baseline and cross-nexus impacts assessed.
- Policy goals in one sector may prohibit attainment in other sectors
- Much greater policy coordination required at a range of scales.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