



NEXOGENESIS
STREAMLINING WATER RELATED POLICIES

Land-use change projections for Lielupe river basin: Downscaling with MagnetGrid

Wageningen Research

Walter Rossi Cervi, Wil Hennen, Diti Oudendag and Vincent Linderhof

February 7, 2024



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003881.

Summary

- Background - why
- Approach: Downscaling G-RDEM socio-economic results
- Results
- Conclusions



Background – why downscaling

- Projections for future based upon
 - Economic expectations (production consumption and trade)
 - Climate change projections (affecting crop productivity etc.)
 - =>How much land would be needed to make supply of food meet demand for food?
- Issues with these economic projections:
 - Available at national level, not river basin =>
 - Results in annual changes of prices an
- Lielupe river basin
- Transboundary



Source: <https://nexogenesis.eu/case-study-2-lielupe-river-basin/>



Background - SSPs

- Shared Socioeconomic Pathways (SSPs) climate change projections of projected socioeconomic global changes up to 2100 as defined in the IPCC Sixth Assessment Report on climate change in 2021
- **For NEXOGENESIS**
- SSP2 “Middle of the road“
The world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns
- SSP4 “Inequality - A road divided“
Highly unequal investments in human capital, combined with increasing disparities in economic opportunity and political power, lead to increasing inequalities and stratification both across and within countries.



Background

- A Representative Concentration Pathway (RCP) is a greenhouse gas concentration trajectory adopted by the IPCC. The pathways describe different climate change scenarios, all of which are considered possible depending on the amount of greenhouse gases (GHG) emitted in the years to come.
- **For NEXOGENESIS**
- RCP 2.6
- RCP 8.5

SSP2, RCP 2.6	SSP2, RCP 8.5
SSP4, RCP 2.6	SSP4, RCP 8.5

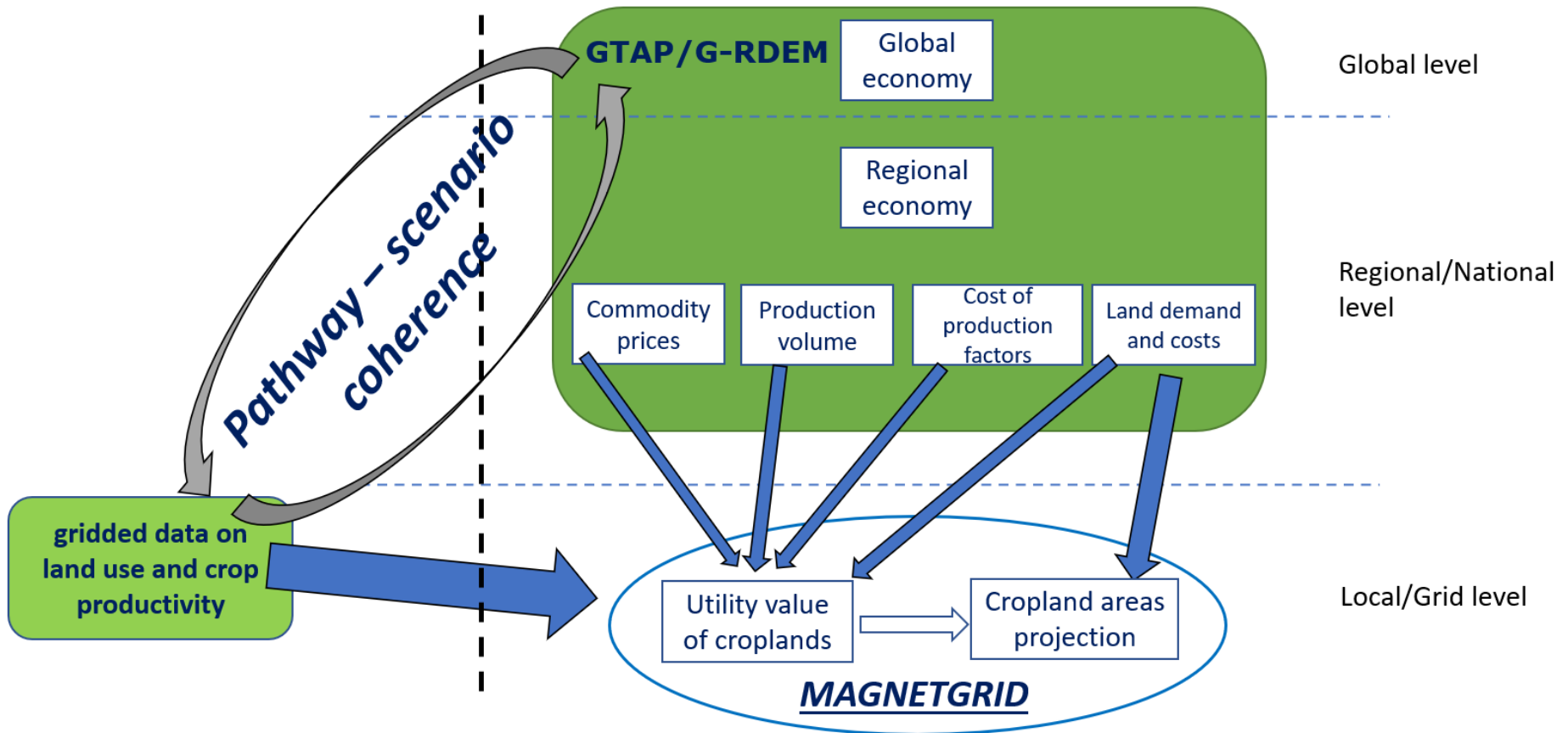


Approach - MagnetGrid

- G-RDEM is a macro-economic model employed to assess several Water-Energy-Food-Ecosystems related socio-economic indicators under different global future projections on climatic and demographic changes;
- Limitations: G-RDEM results at national level, results are relative annual changes with limited interaction with indicators that have high spatial variability (e.g. land use, land productivity);
- Objective: an adapted a downscaling method to G-RDEM to provide spatially explicit results on land use related indicators for the river basin case studies;



Downscaling G-RDEM results using MagnetGrid



Downscaling G-RDEM results using MagnetGrid

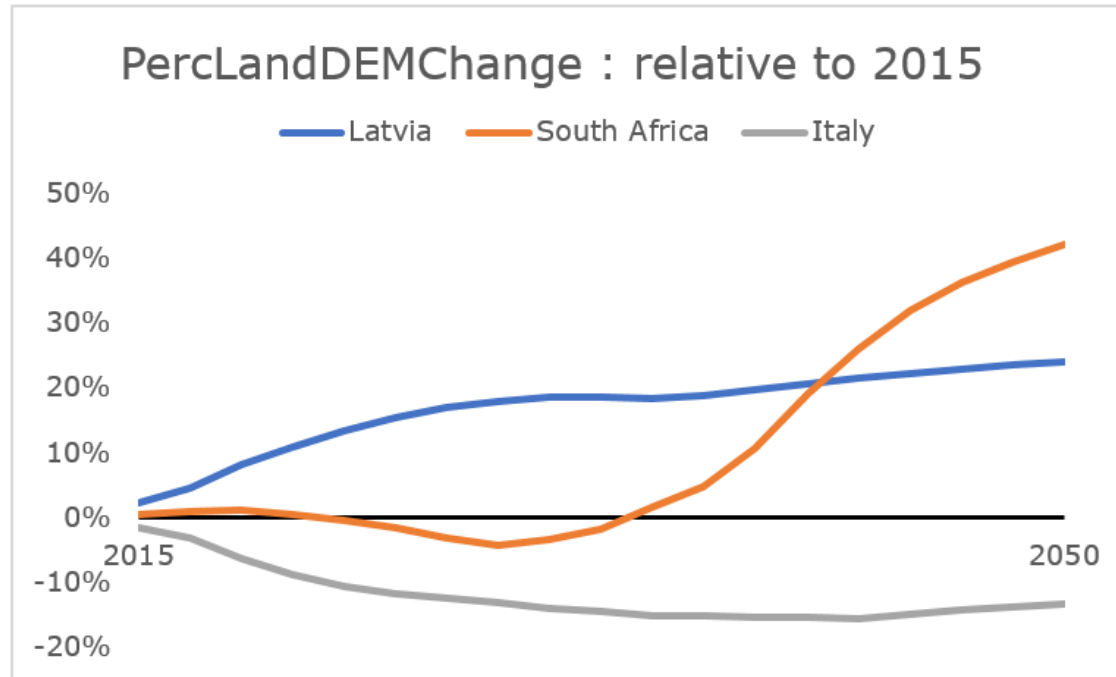
output of G-RDEM (national level)

land demand
land demand, crop production
total land prices
land demand, crop production, land prices, capital value, intermediate value, labour value, net subsidies (ProdTax)
land demand, crop production, land prices, capital value, intermediate value, labour value, net subsidies (ProdTax)

output of MagnetGrid (grid level)	Variation
agricultural land use area (ha)	time (e.g. 2030,2050), space (grid), macro-scenarios (SSPs, RCPs), policy shocks, 9 crop types including grazing grasslands
agricultural productivity (t/ha)	time (e.g. 2030,2050), space (grid), macro-scenarios (SSPs, RCPs), policy shocks, 9 crop types including grazing grasslands
agricultural land prices (\$/ha)	time (e.g. 2030,2050), space (grid), macro-scenarios (SSPs, RCPs), policy shocks, 9 crop types including grazing grasslands
agricultural production costs (\$/t)	time (e.g. 2030,2050), space (grid), macro-scenarios (SSPs, RCPs), policy shocks, 9 crop types including grazing grasslands
agricultural opportunity costs (\$/ha)	time (e.g. 2030,2050), space (grid), macro-scenarios (SSPs, RCPs), policy shocks, 9 crop types including grazing grasslands



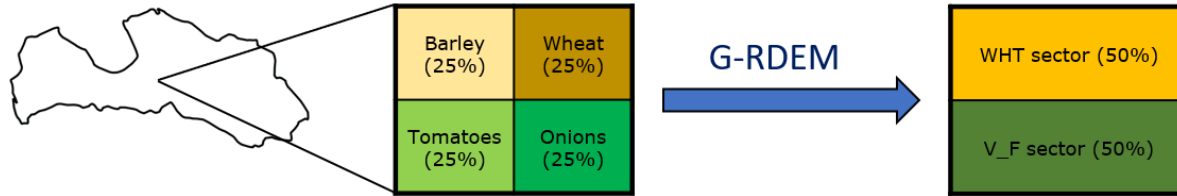
Pre-processing and initial G-RDEM data analysis



Downscaling components

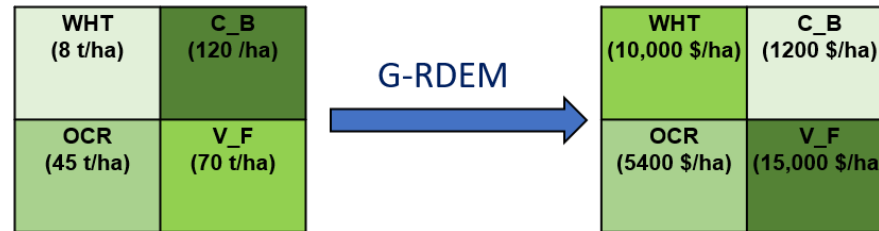
• 1- Spatial data

- Data conversion;
- Aggregation;
- Set basic framework;



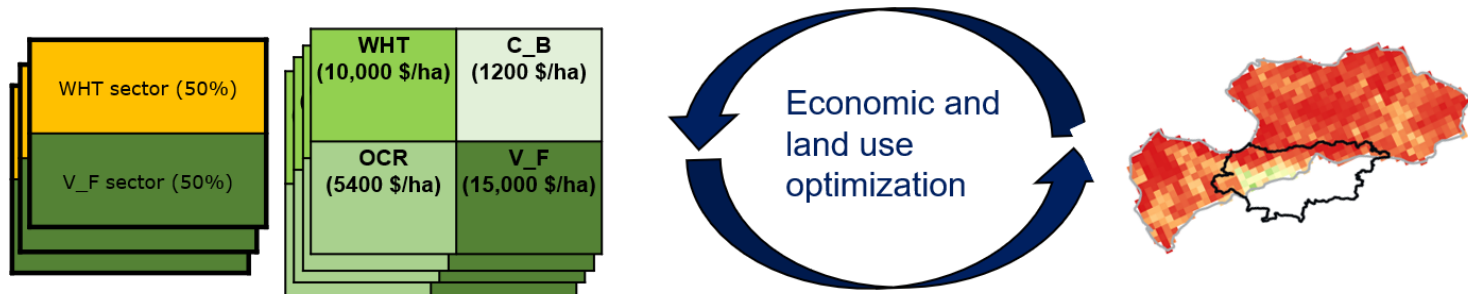
• 2- Cost-benefit analysis

- Cropland NPV;
- Set transition rules;



• 3- Land use allocation

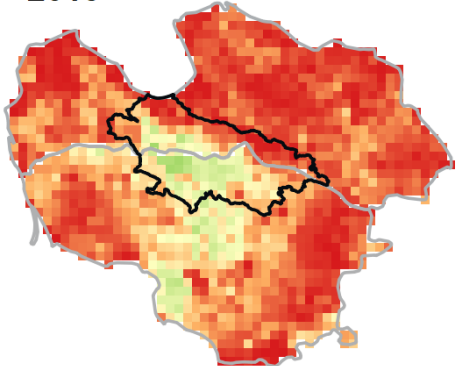
- Land utility;
- Cropland simulation;



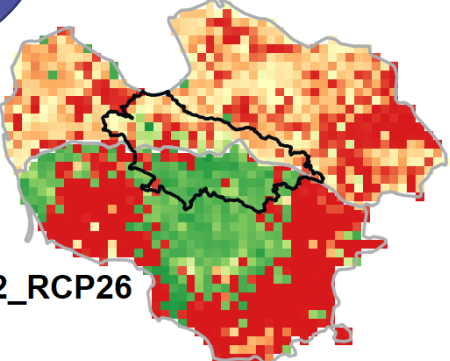
Lielupe basin results

Spatio-temporal
distribution
2015 - 2050

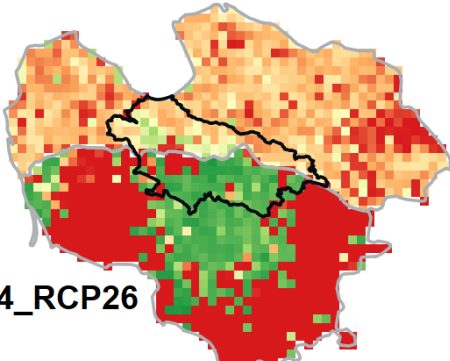
BASELINE YEAR
2015



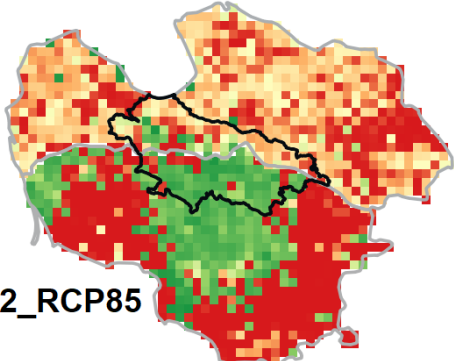
SSP2_RCP26



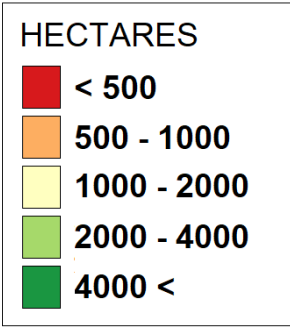
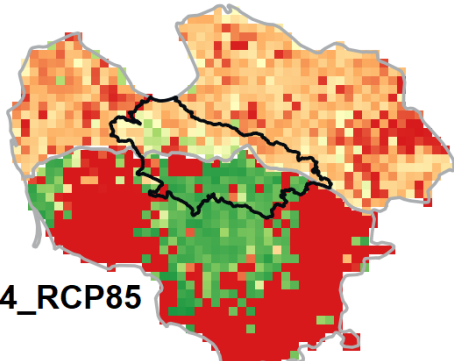
SSP4_RCP26



SSP2_RCP85

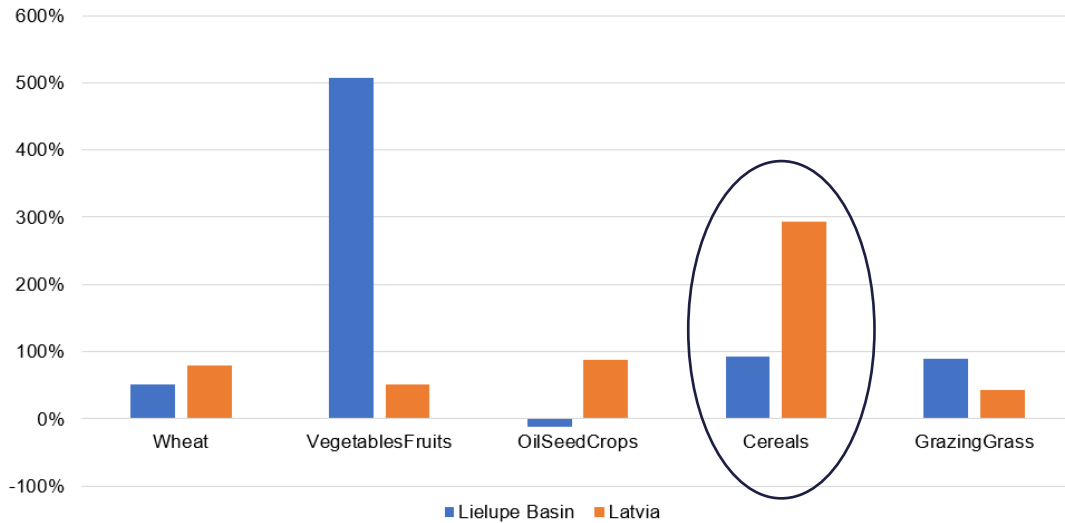


SSP4_RCP85



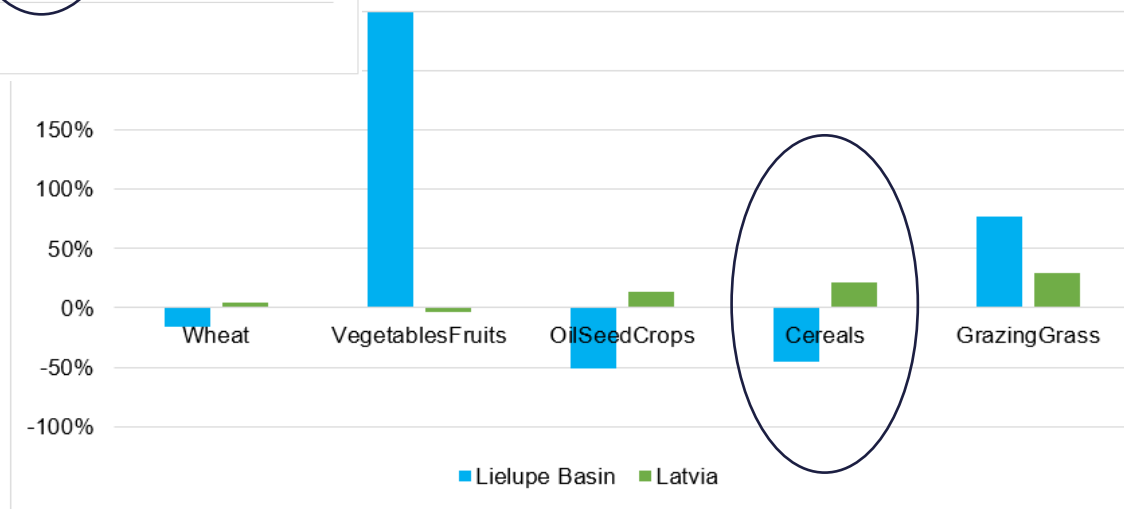
Lielupe basin results

Agricultural Land Area (changing rate 2015 - 2050)

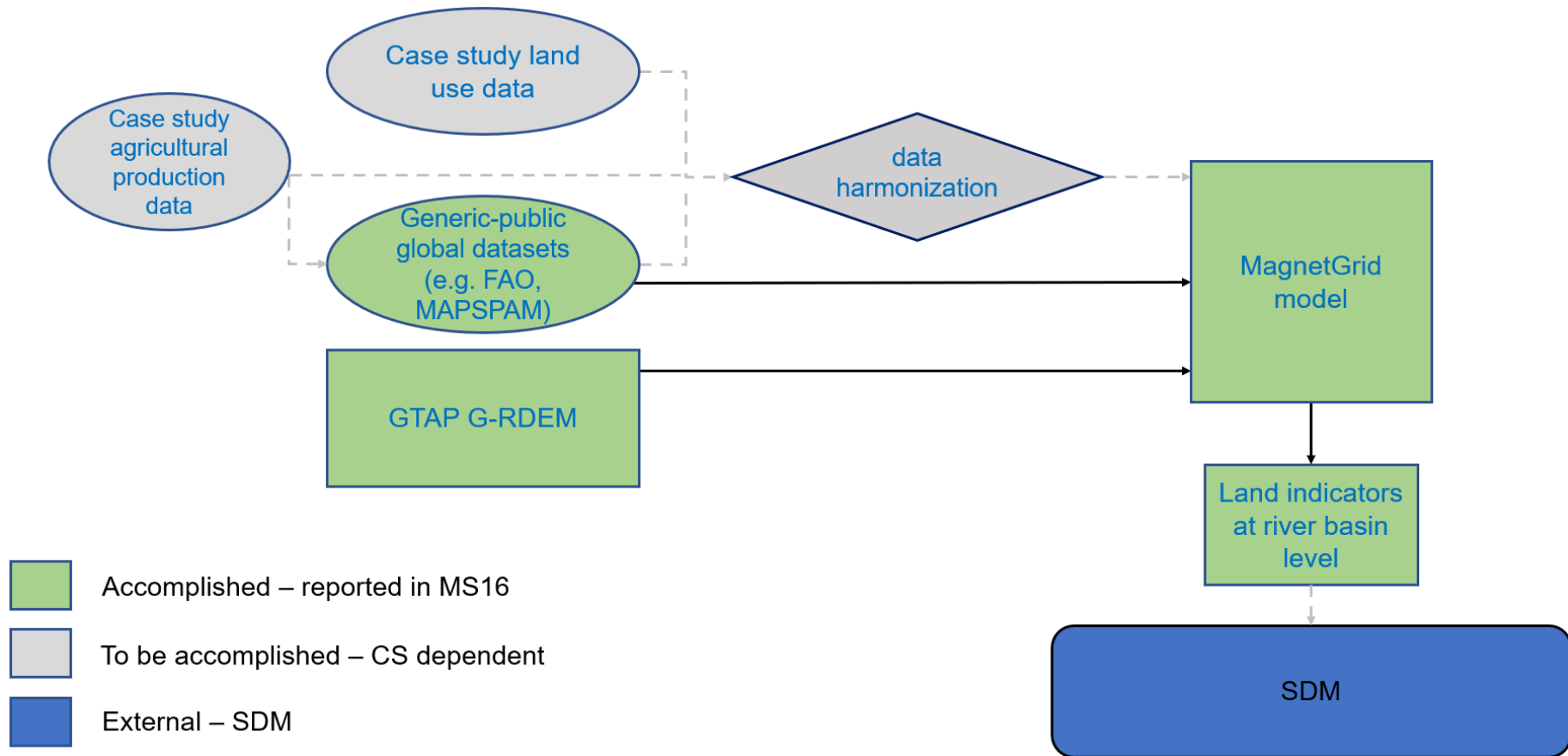


Percentage changes 2015-2050

Production quantity (changing rate 2015 - 2050)



Application with case studies SDMs



Results

- Comparison of baseyear (2015) vs. 2050 (SSP2 & RCP 2.6)

	Latvia- RB	RB Lithuani a	River basin	Latvia	Lithuania	River basin
Wheat	36.0	45.9	42.4	29.2	35.0	33.3
Vegetables and fruits	4.4	4.1	4.2	14.3	5.1	7.8
Cereals (excl. wheat)	10.9	9.0	9.7	11.2	25.8	21.4
Oil seed crops	10.1	15.7	13.7	4.7	15.8	12.5
Cattle (pasture land)	38.7	25.2	30.1	39.2	17.8	24.2
Other crops	0.0	0.0	0.0	1.4	0.0	0.4
Sugar crops	0.0	0.3	0.2	0.0	0.5	0.4
Total	100	100	100	100	100	100
Increase agricultural land				86.5	144.2	123.5



Results

Comparison of SSP2 and SSP4 given RCP 2.6

	SSP2			SSP4		
	RCP 2.6			RCP 2.6		
	Latvia- RB	RB Lithuania	River basin	Latvia-RB	RB Lithuania	River basin
Wheat	29.2	35.0	33.3	35.5	33.5	34.0
Vegetables and fruits	14.3	5.1	7.8	14.4	4.5	6.8
Cereals (excl. wheat)	11.2	25.8	21.4	5.2	12.6	10.9
Oil seed crops	4.7	15.8	12.5	1.4	0.0	0.3
Cattle (pasture land)	39.2	17.8	24.2	13.2	24.1	21.5
Other crops	1.4	0.0	0.4	30.4	24.9	26.2
Sugar crops	0.0	0.5	0.4	0.0	0.5	0.3
Total	100	100	100	100	100	100
Increase agricultural land	86.5	144.2	123.5	69.6	202.6	155.0



Results

Comparison of RCP 2.6 and RCP 8.5 given SSP2

	SSP2			SSP2		
	RCP 2.6			RCP 8.5		
	Latvia- RB	RB Lithuania	River basin	Latvia- RB	RB Lithuania	River basin
Wheat	29.2	35.0	33.3	27.8	35.2	33.0
Vegetables and fruits	14.3	5.1	7.8	14.3	5.1	7.9
Cereals (excl. wheat)	11.2	25.8	21.4	11.0	25.9	21.4
Oil seed crops	4.7	15.8	12.5	4.7	15.9	12.5
Cattle (pasture land)	39.2	17.8	24.2	40.8	17.9	24.8
Other crops	1.4	0.0	0.4	1.4	0.0	0.4
Sugar crops	0.0	0.5	0.4	0.0	0.5	0.4
Total	100	100	100	100	100	100
Increase agricultural land	86.5	144.2	123.5	86.5	142.9	122.7



Conclusions

- Projections for the future based on SSP and RCP scenarios
- The projections with the G-RDEM model are given.
- The results should be interpreted with care. Figures are derived from economic projections and these indicators might lead to land demand projections beyond your expectations. However, the results should be the start of a fruitful discussion on the future for the Lielupe river basin!

