



# Achieving global SDGs in the Water-Land-Energy-Food-Climate Nexus

*A global-scale scenario analysis on synergies and trade-offs*

EU Green Week: SIM4NEXUS workshop

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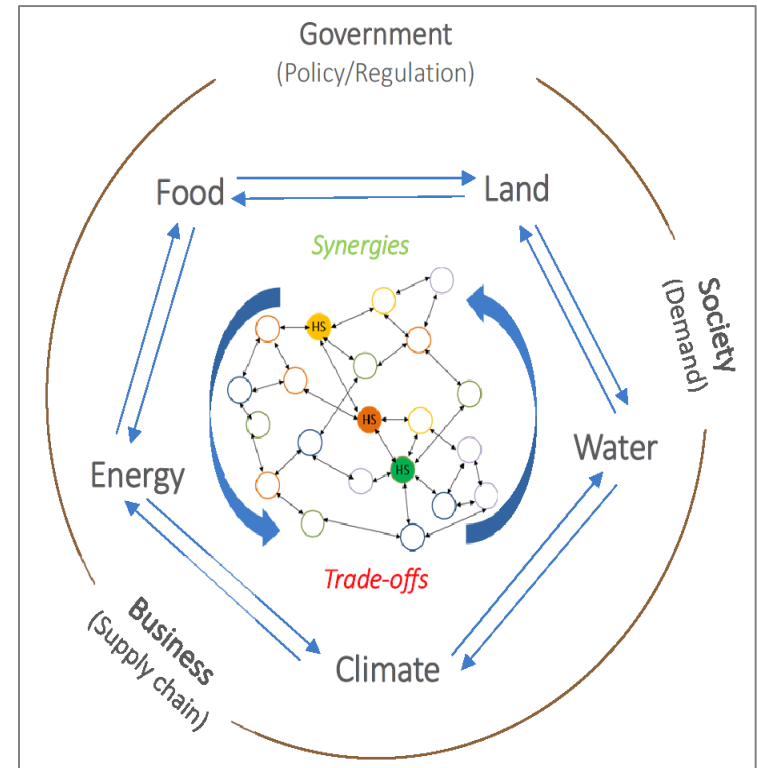
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13–17 MAY 2019**



# The Water-Land-Energy-Food-Climate Nexus

- Components inherently interconnected
- Integrated approach required
- From identification to quantification of synergies and trade-offs
  - Applying models and scenarios
- To inform and guide:
  - Coherent policy-making
  - Coherent action in business and society



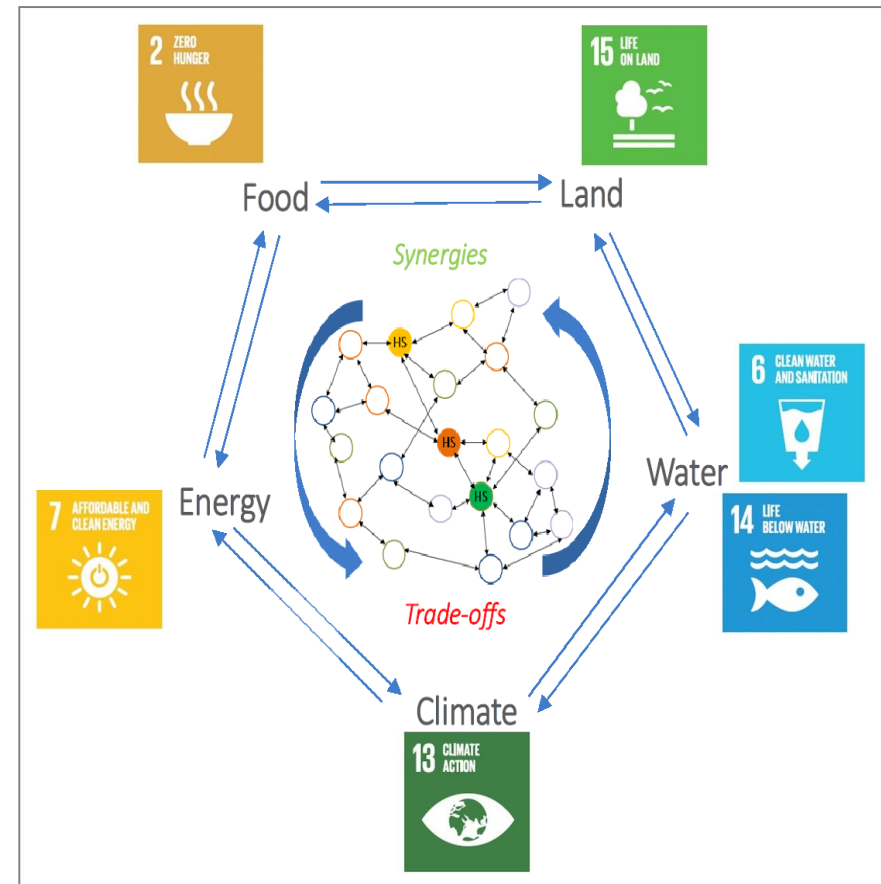
# Global targets: the SDGs

- Global-scale analysis
- Sustainable development goals to define targets



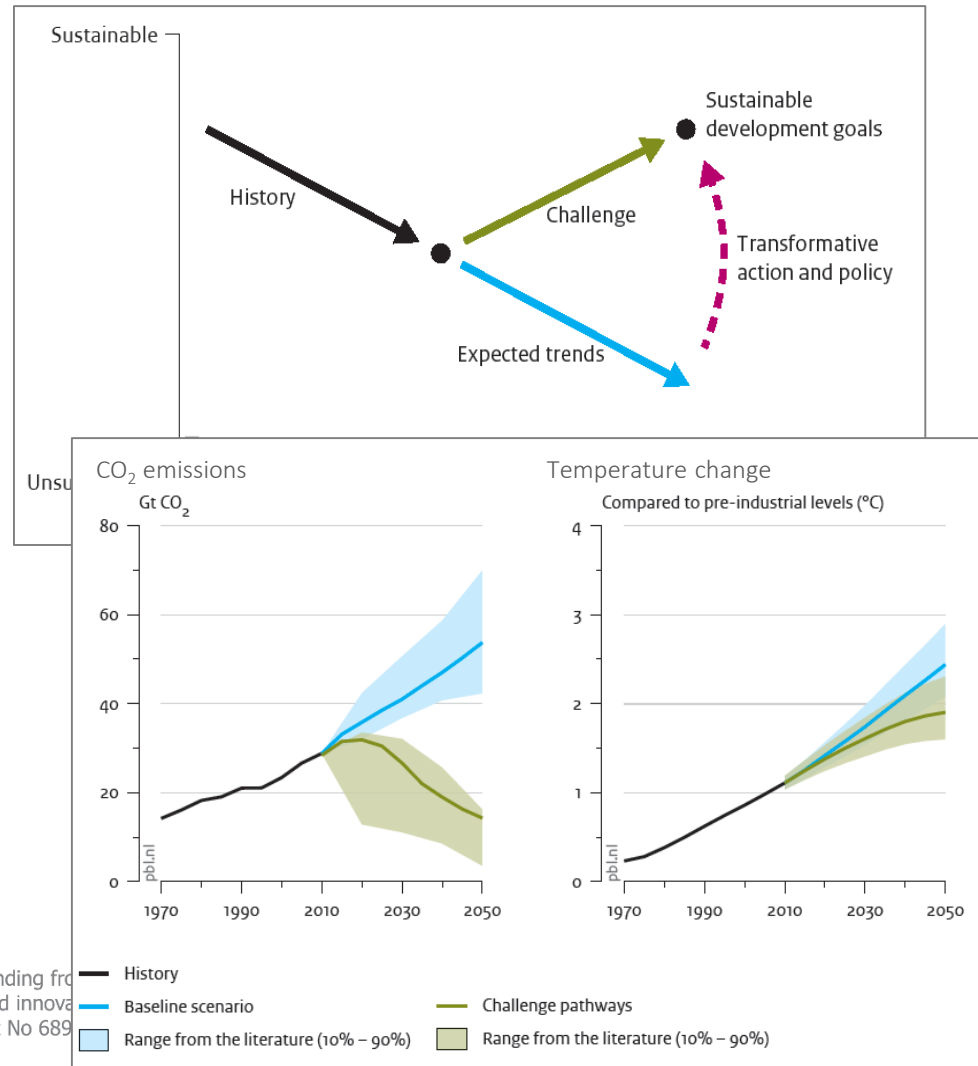
# Combining the Nexus and SDGs

- Challenge to quantify nexus interactions
  - SDGs used to define targets
- Challenge in SDGs to investigate policy coherence
  - Nexus approach used to evaluate synergies and trade-offs









# Designing target scenarios

- Scenarios aiming for SDGs
- Famous example: climate scenarios aiming for 2°/1.5°
- Scenarios for each nexus component
- To quantify synergies and trade-offs









# Designing target scenarios

Scenario		
Reference		
 	Energy and climate	
	Land and biodiversity	
	Food	
 	Water	









# Designing target scenarios

	Scenario	Policies
	Reference	-
 	Energy and climate	<ul style="list-style-type: none"> <li>- Global CO<sub>2</sub> price: increased renewables and bio-energy use</li> <li>- Forest protection, reforestation</li> </ul>
	Land and biodiversity	<ul style="list-style-type: none"> <li>- Nature protection</li> </ul>
	Food	<ul style="list-style-type: none"> <li>- Reduced meat consumption</li> <li>- Improved agricultural efficiency</li> </ul>
 	Water	<ul style="list-style-type: none"> <li>- Limited irrigation expansion, increased irrigation efficiency</li> <li>- Improved sanitation, high wastewater treatment efficiency</li> <li>- Improved fertilizer efficiency</li> </ul>



# Designing target scenarios

Scenario		Indicators
Reference		-
 	Energy and climate	<i>Temperature change</i> <i>Renewable energy share</i>
	Land and biodiversity	<i>Forest share of total land</i>
	Food	<i>Food price</i>
 	Water	<i>Water withdrawal</i> <i>Nitrogen concentration</i>





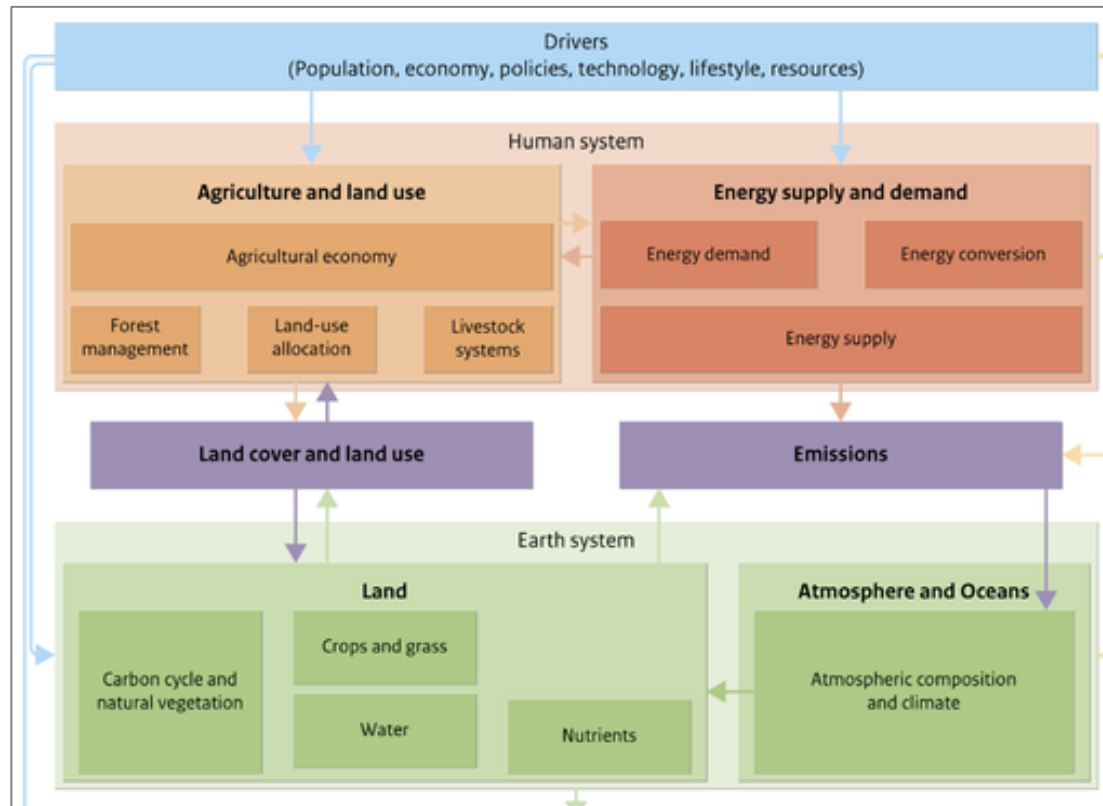
# Various models in SIM4NEXUS to develop scenarios

- 6 models with varying strengths
  - CAPRI (UPM, Spain)
  - E3ME (CamEcon, United Kingdom)
  - IMAGE-GLOBIO (PBL, Netherlands):
  - MAGNET (WEcR, Netherlands):
  - MAgPIE (PIK, Germany)
  - OSeMOSYS (KTH, Sweden)
- Today focus on IMAGE-GLOBIO



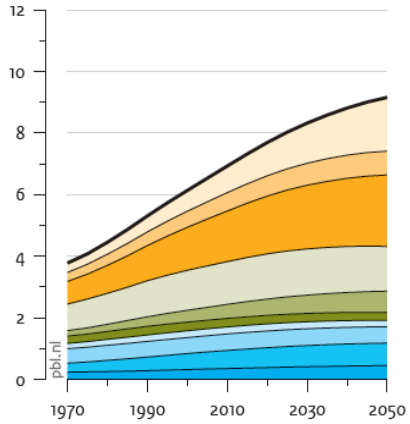
# IMAGE-GLOBIO model

- Integrated assessment model to assess global environmental change



### Population

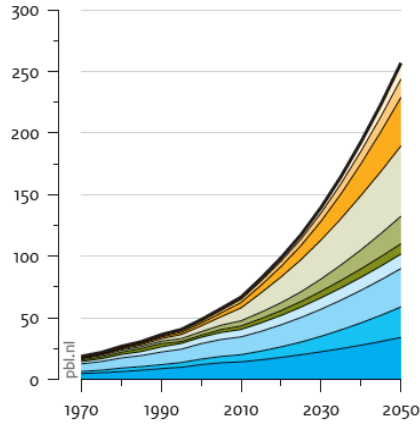
billion people



- Sub-Saharan Africa
- China region
- Japan, Korea and Oceania
- Southeast Asia
- Middle East and northern Africa
- Western and central Europe
- South Asia
- Russian region and central Asia
- Central and South America
- North America

### GDP

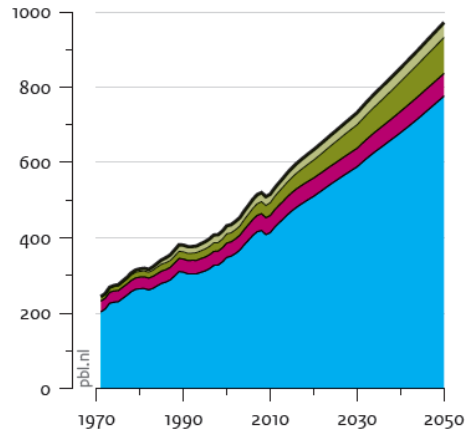
trillion USD (2005)



- Japan, Korea and Oceania
- Western and central Europe
- Central and South America
- North America

### Energy demand

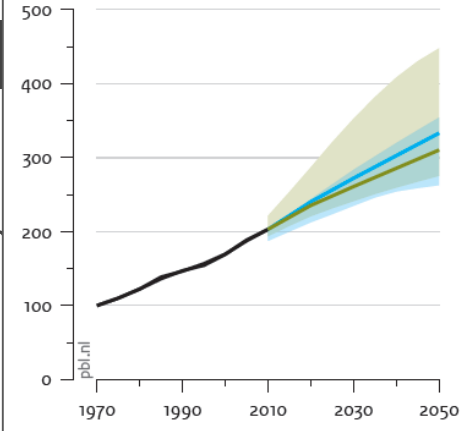
EJ per year



- Nuclear energy
- Fossil fuels + CCS
- Renewable energy
- Fossil fuels
- Bioenergy + CCS
- Bioenergy

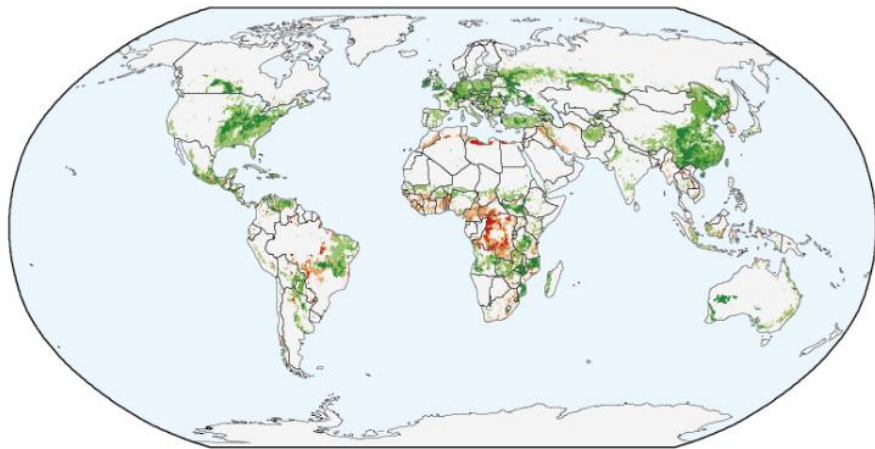
### Food demand

Index (1970 = 100)



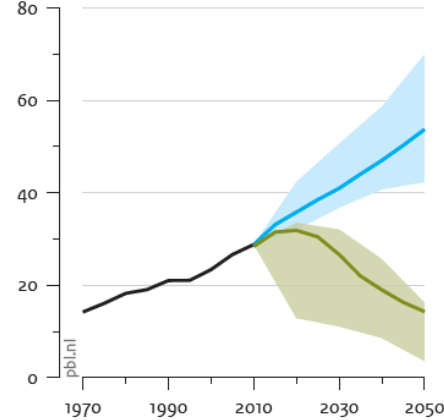
- History
- Baseline scenario
- Range from the literature
- Animal production
- Animal production
- Crop production
- Crop production

### Land-use change



### CO<sub>2</sub> emissions

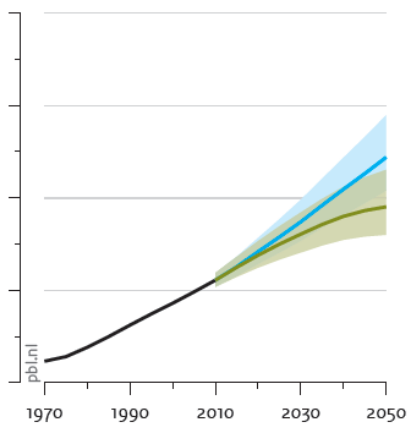
Gt CO<sub>2</sub>



- History
- Baseline scenario
- Range from the literature (10% - 90%)
- Challenge pathways
- Range from the literature (10% - 90%)

### Temperature change

Compared to pre-industrial levels (°C)

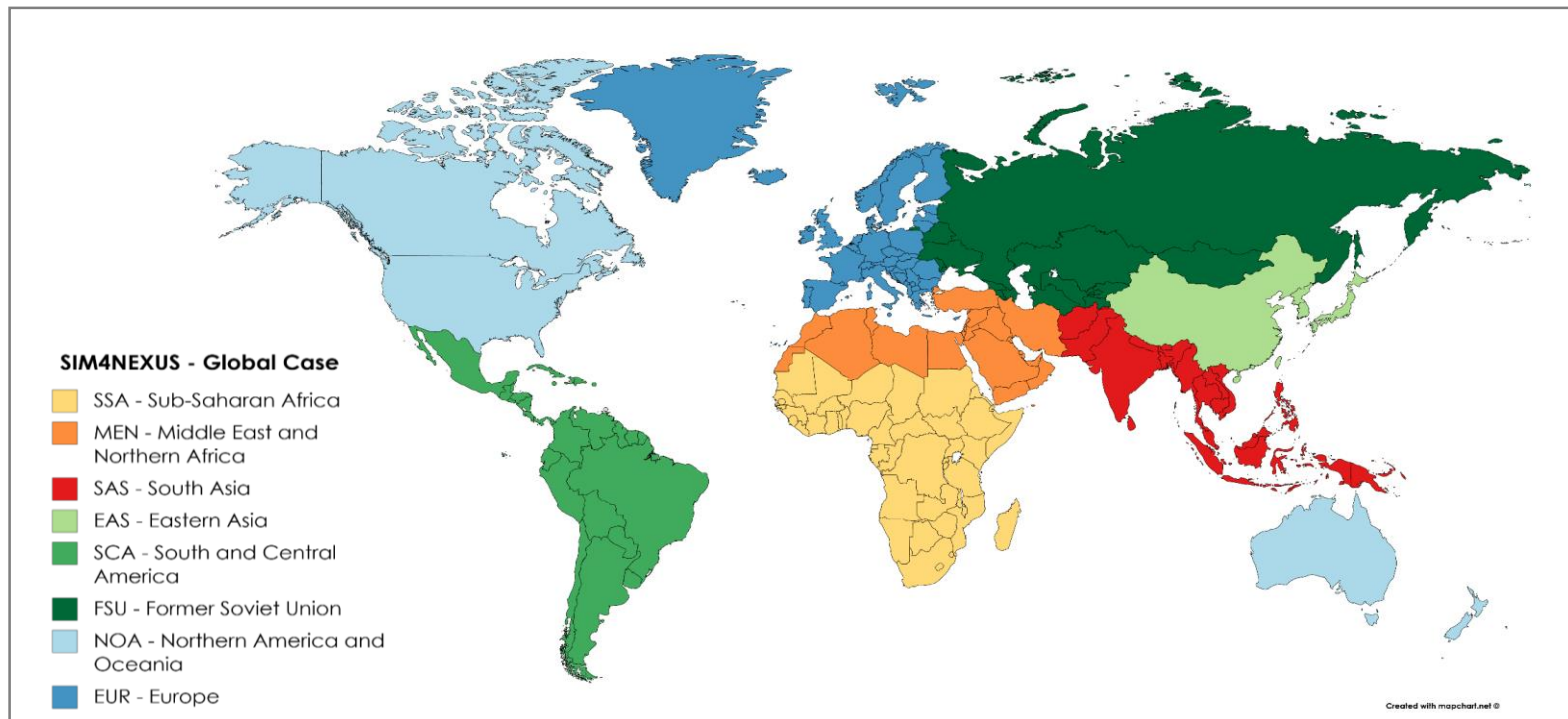


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Union's Horizon 2020 research and innovation grant agreement No.

# Global-scale analysis

- 8 world regions



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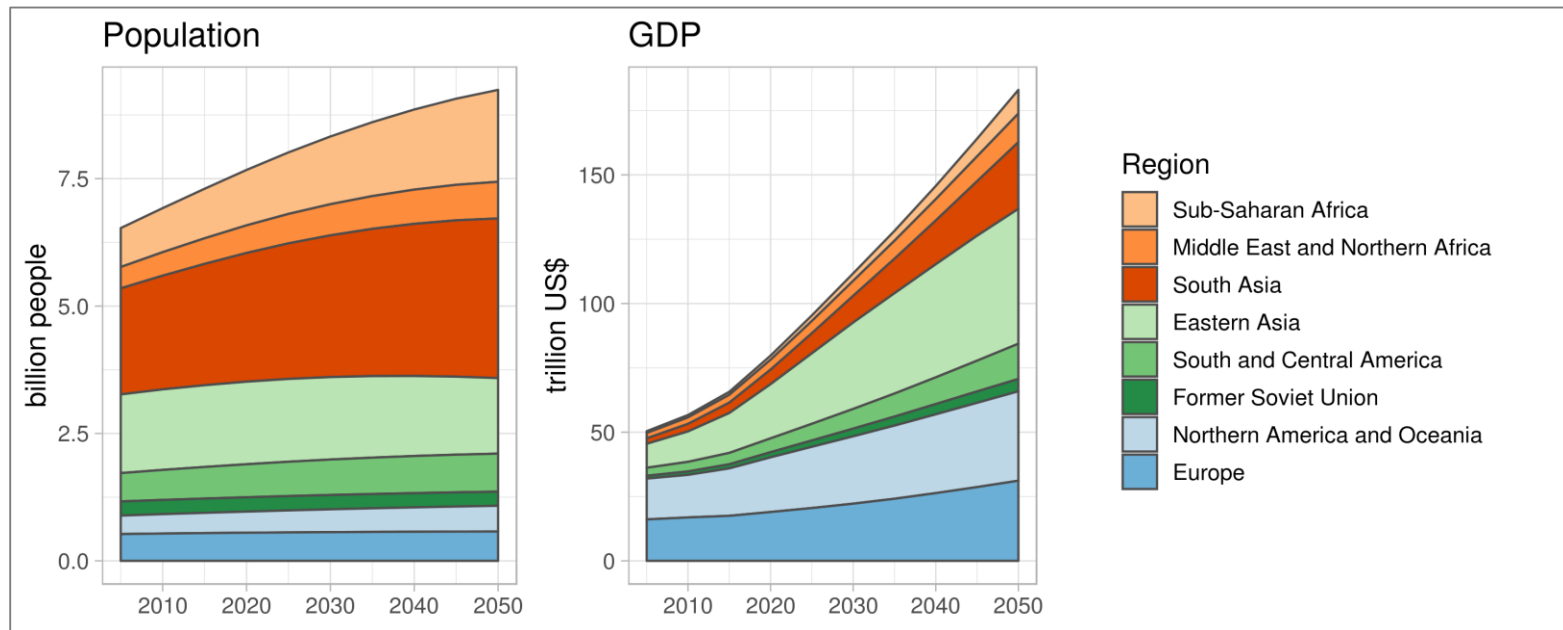
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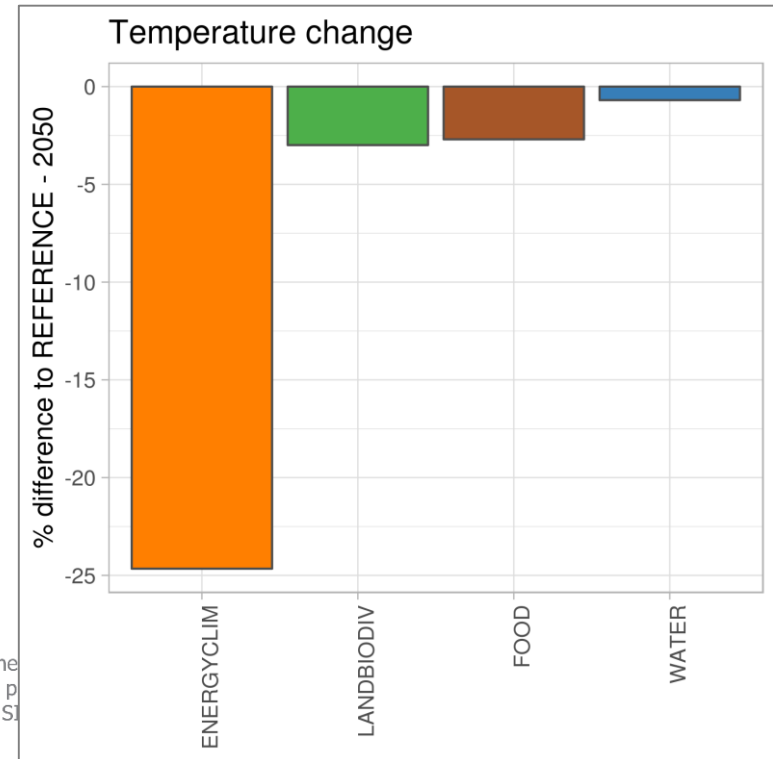
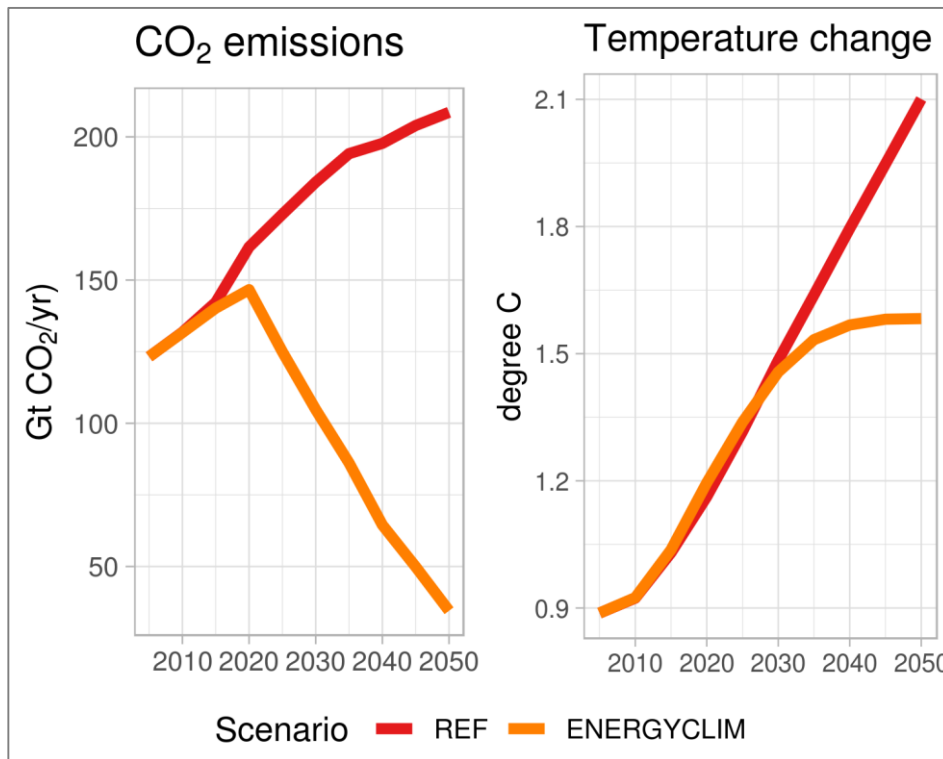
# Reference scenario

- SSP2 - business as usual/middle of the road





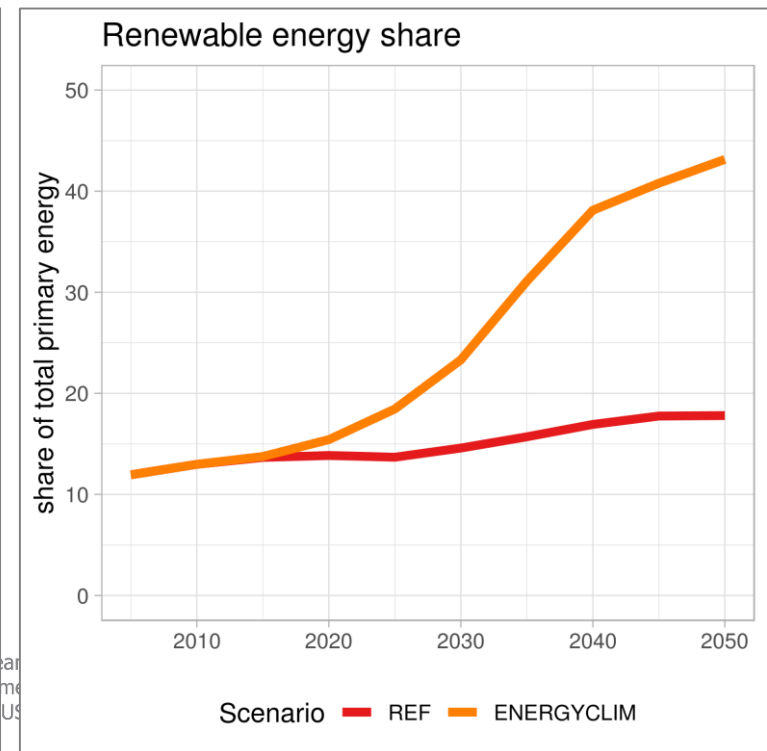
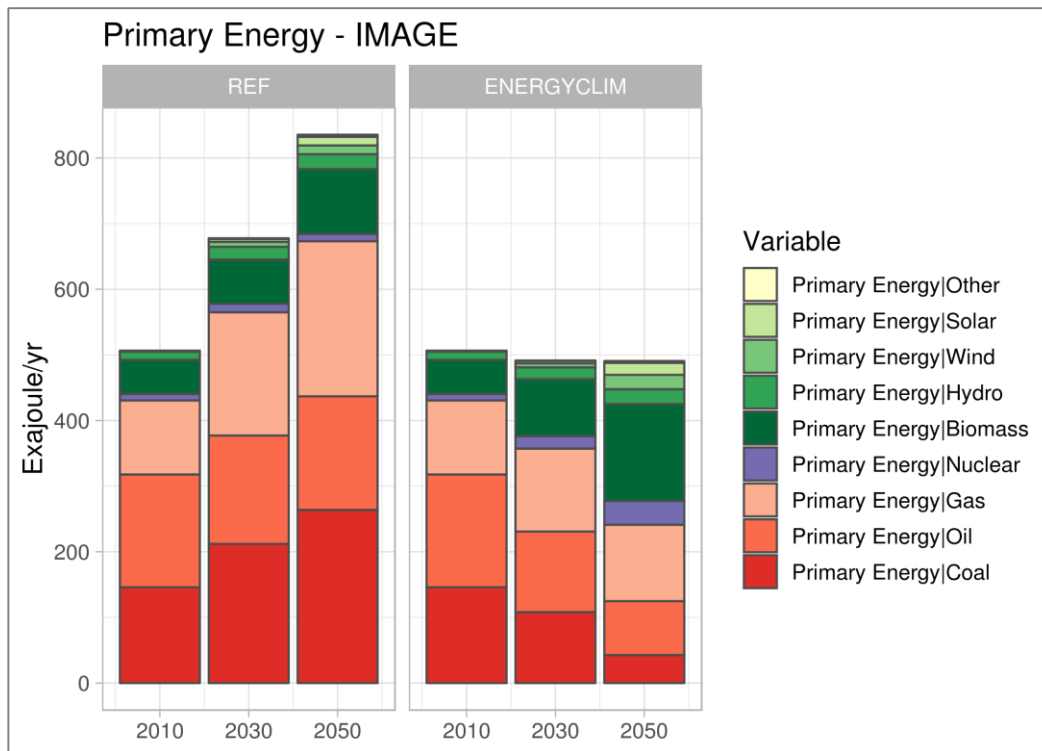
# Energy and Climate scenario

Scenario	Indicators	Policies
Energy and climate  	- <i>Temperature change</i> - <i>Renewable energy share</i>	- <i>Global CO<sub>2</sub> price: increased renewables and bio-energy use</i> - <i>Forest protection, reforestation</i>





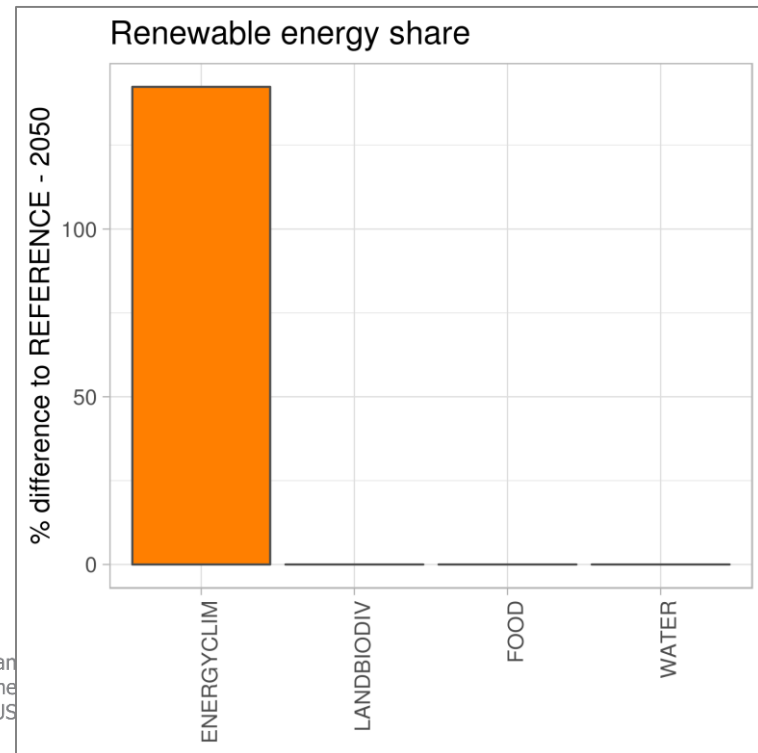
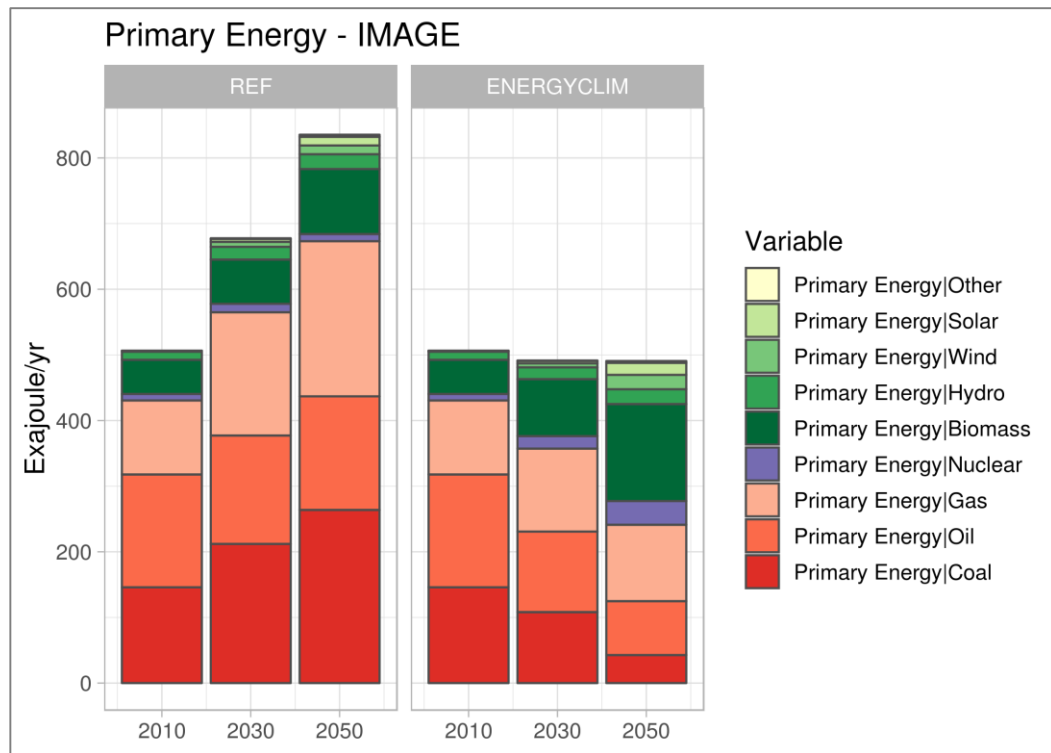
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# Energy and Climate scenario

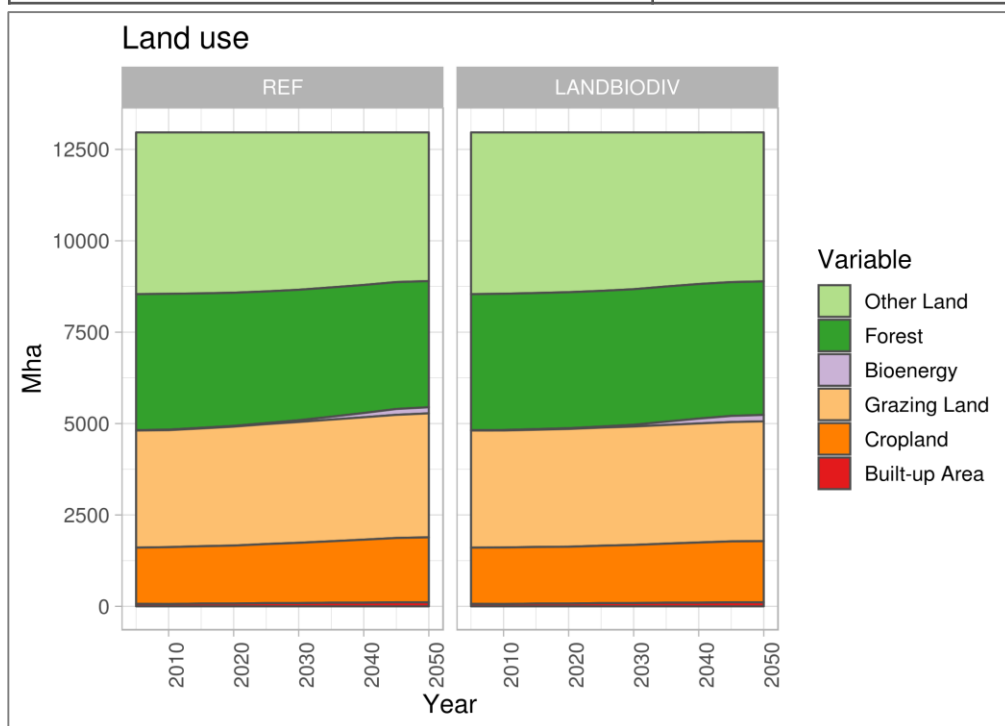
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# Land and Biodiversity scenario

	Scenario	Indicators	Policies
	Land and biodiversity	<i>Forest share of total land</i>	- Nature protection




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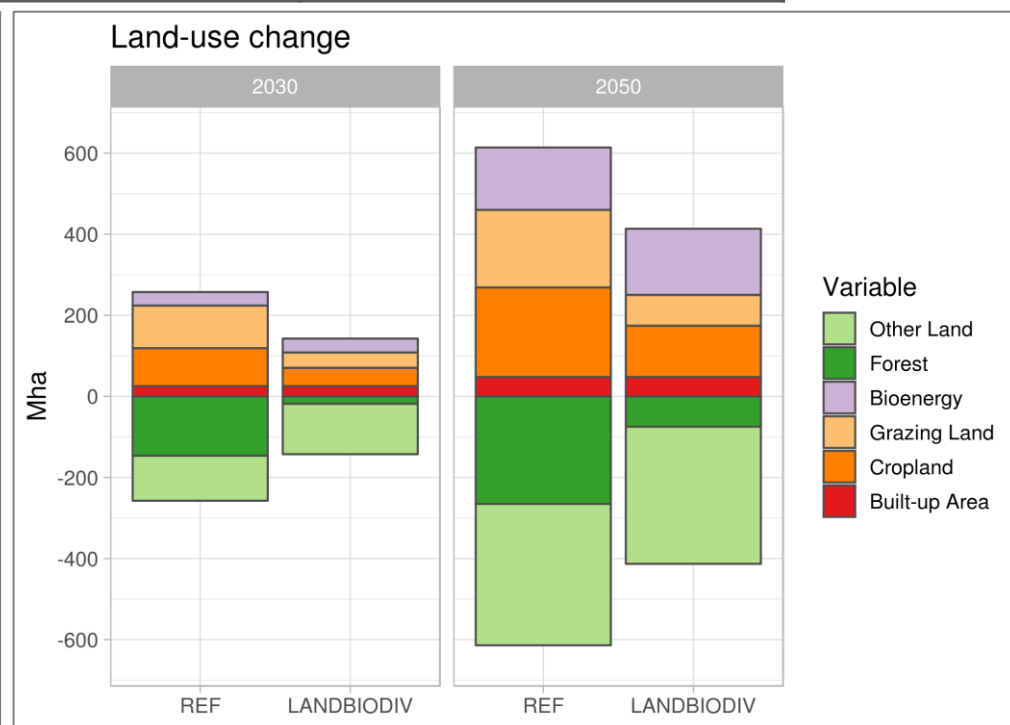
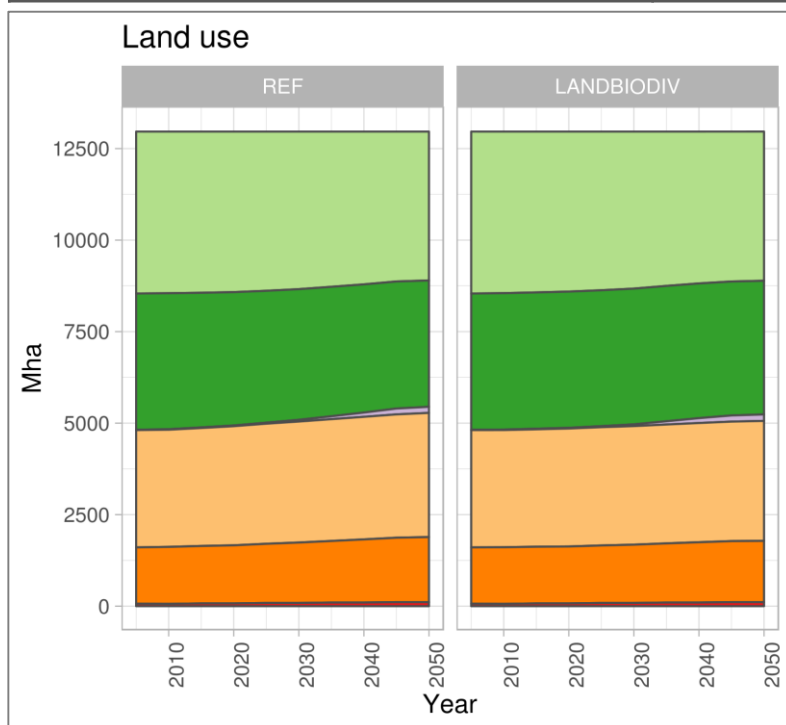
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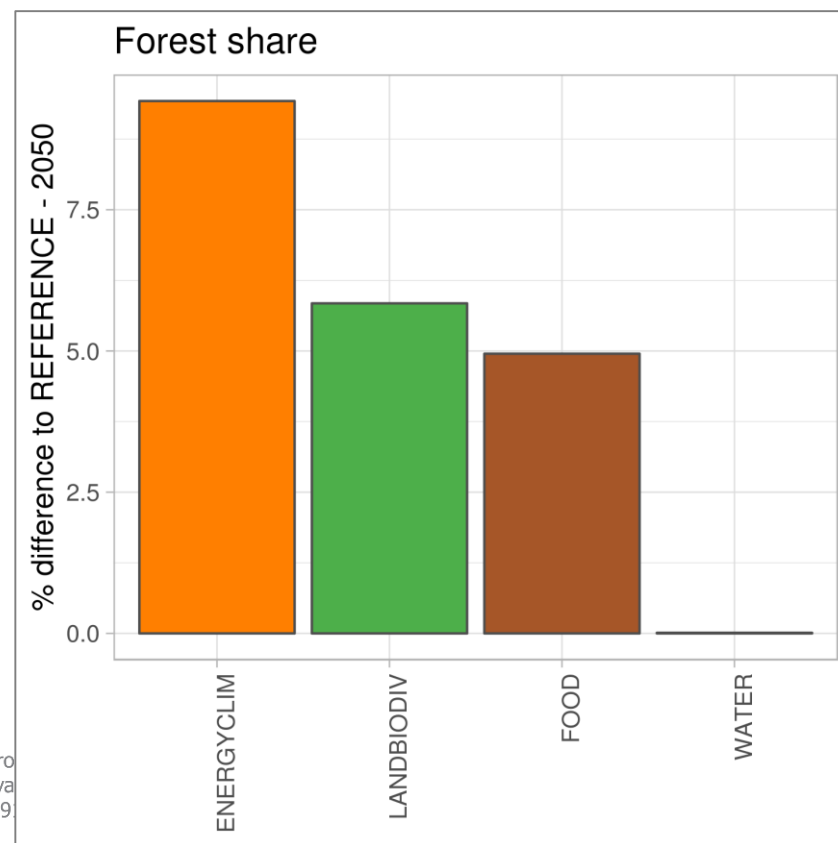
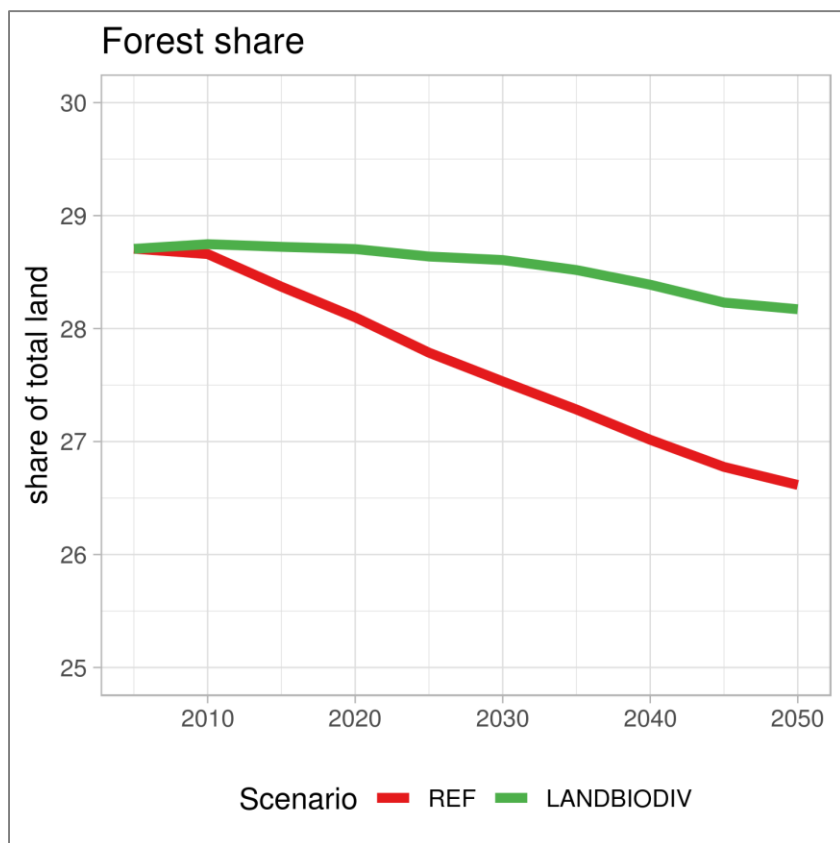
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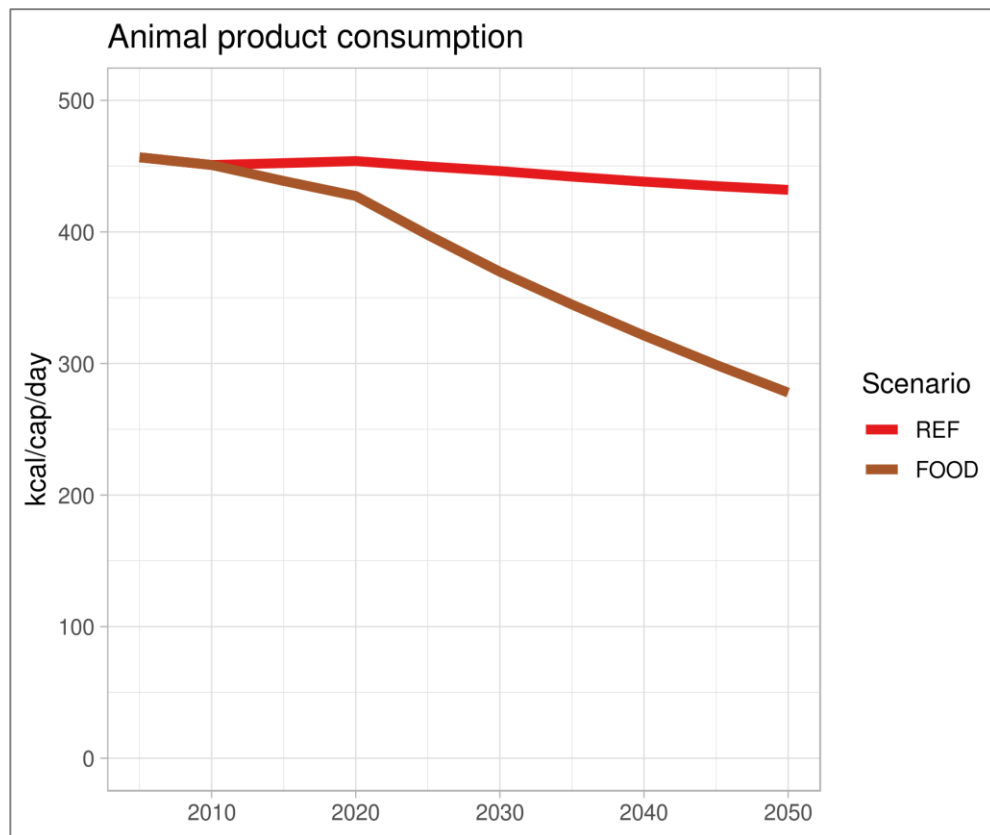
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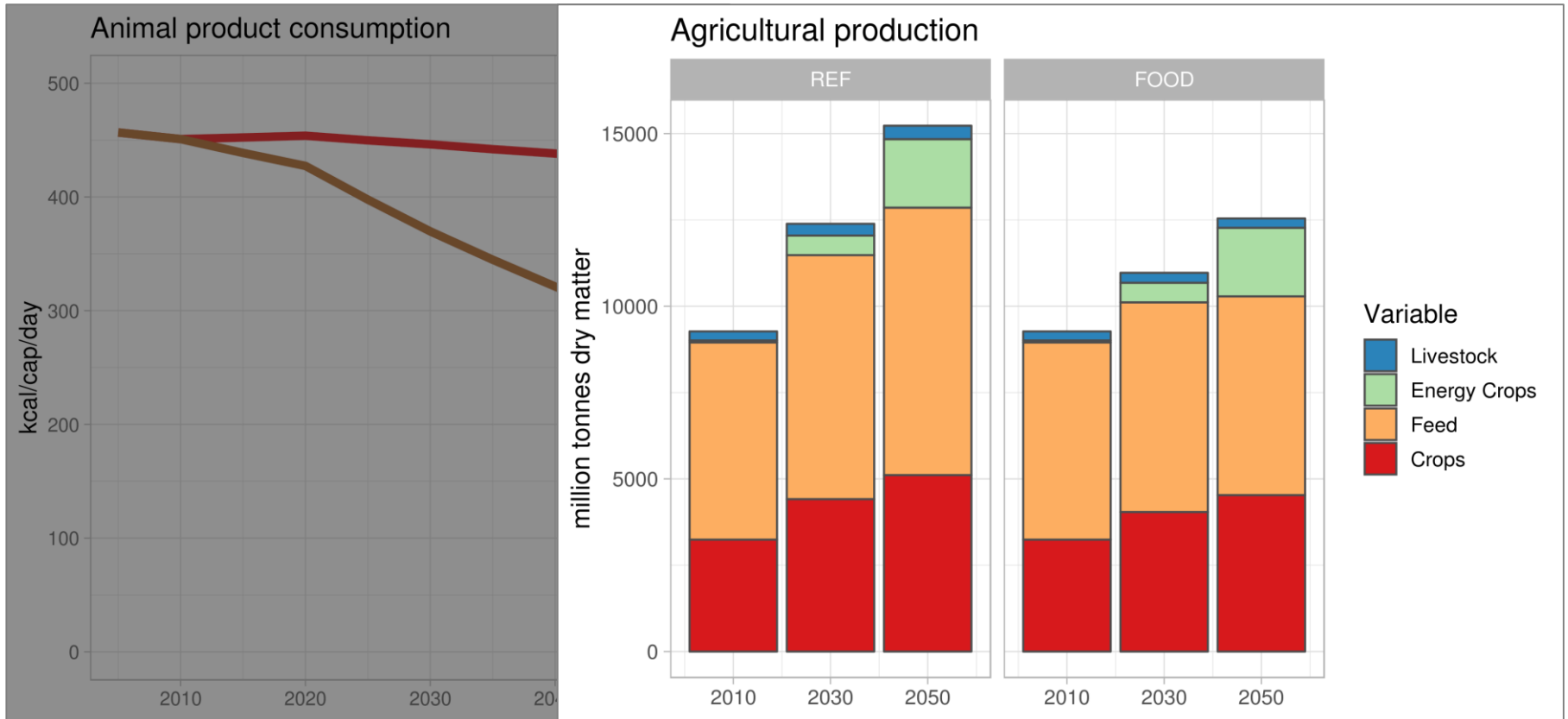
# Food scenario

Scenario	Indicators	Policies
 2 ZERO HUNGER	Food	<i>Food price</i> - Reduce meat consumption - Improved agricultural efficiency




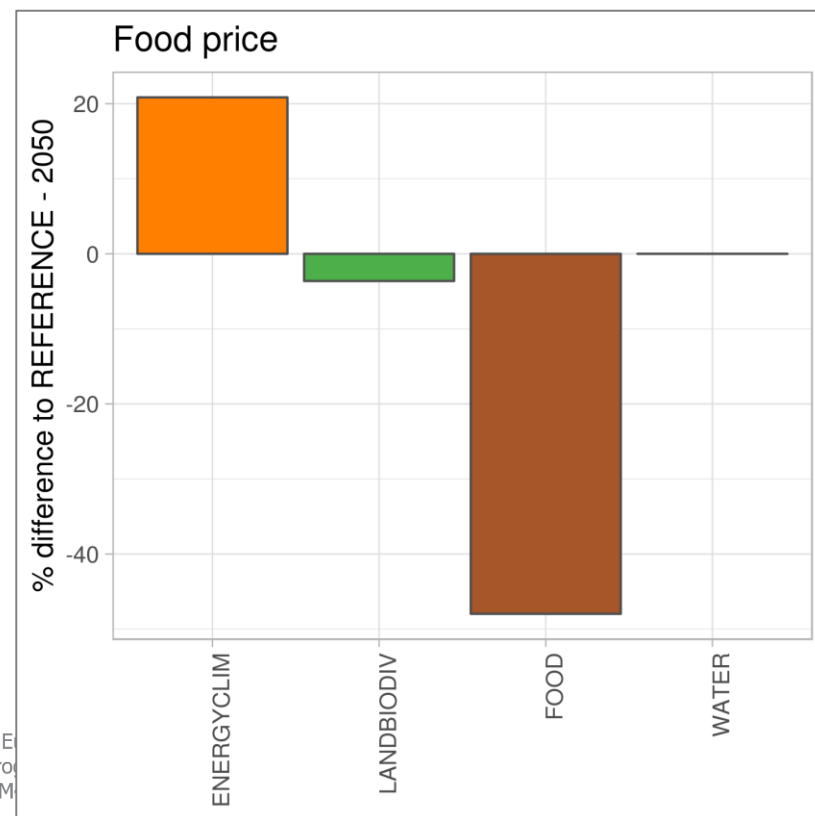
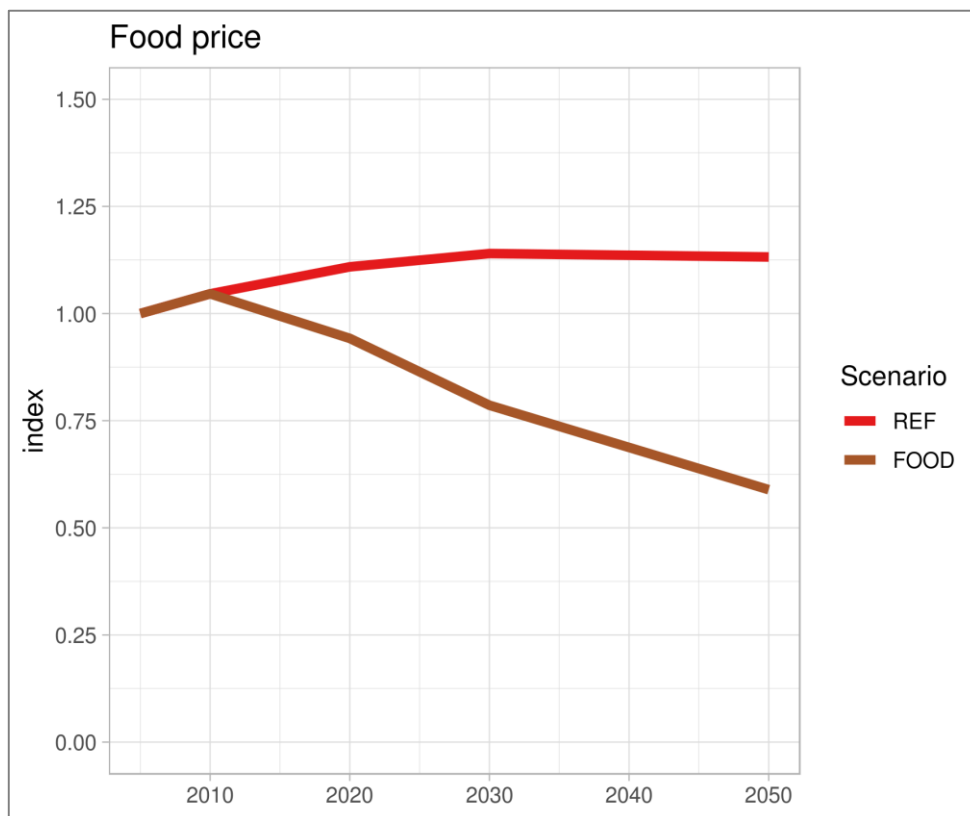
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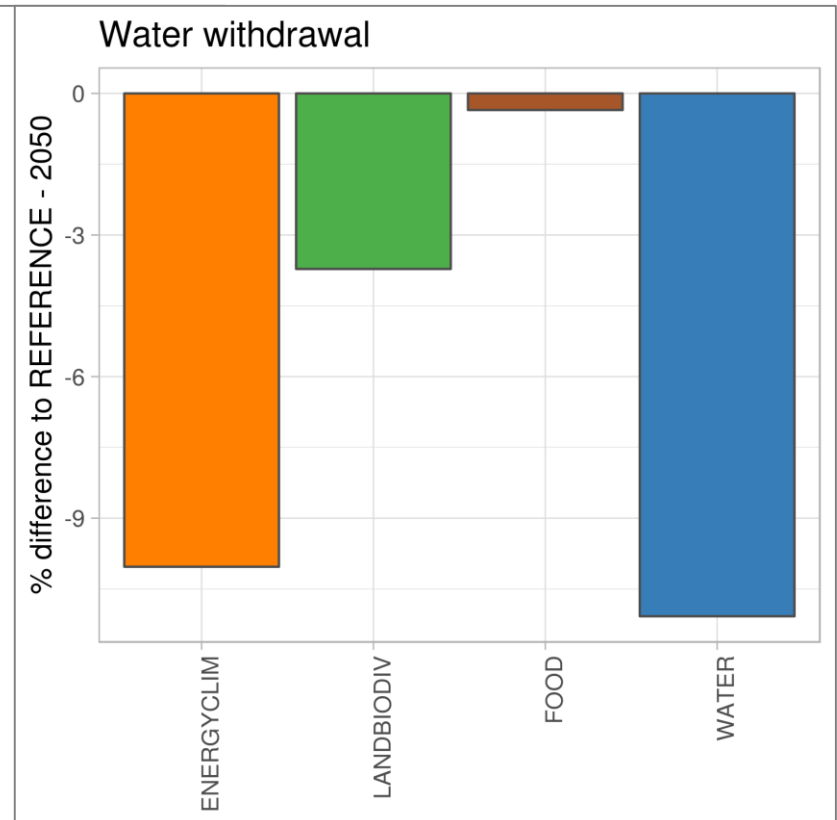
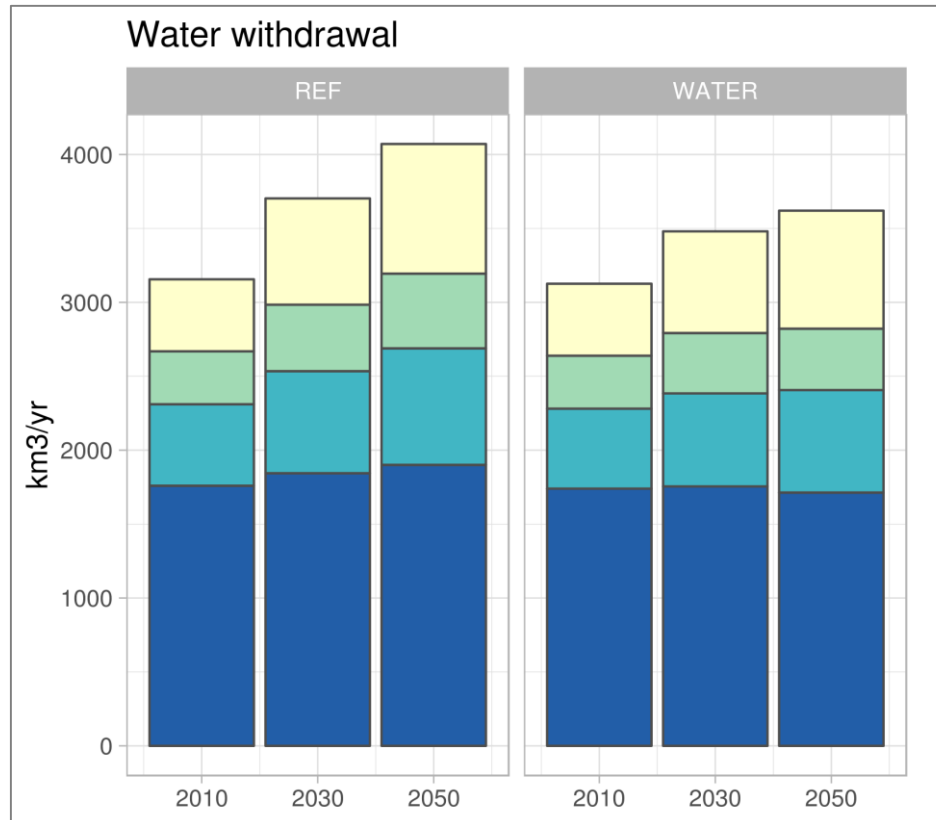
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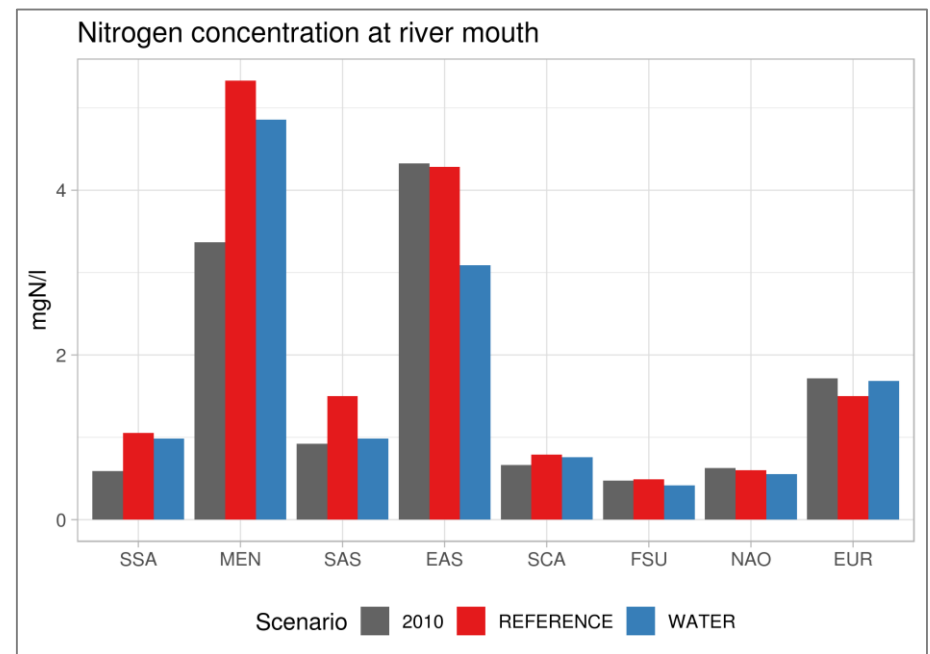
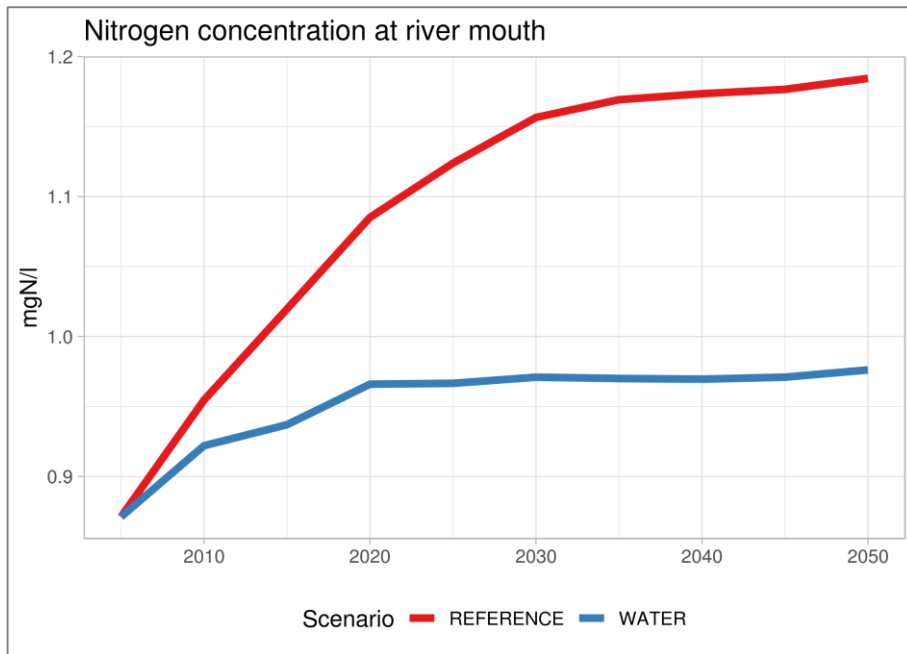
# Water scenario

Scenario		Indicators	Policies
 6 CLEAN WATER AND SANITATION	 14 LIFE BELOW WATER	Water	<i>Water withdrawal</i> Nitrogen concentration
			- Limited irrigation expansion, increased irrigation efficiency - Improved sanitation, high wastewater treatment efficiency - Improved fertilizer efficiency



# Water scenario

Scenario		Indicators	Policies
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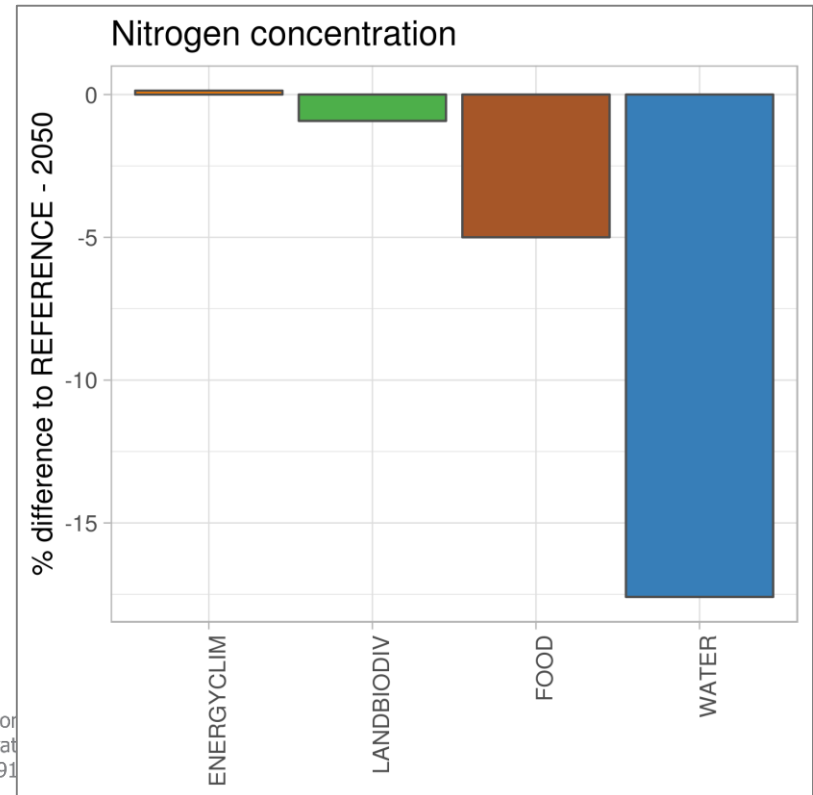
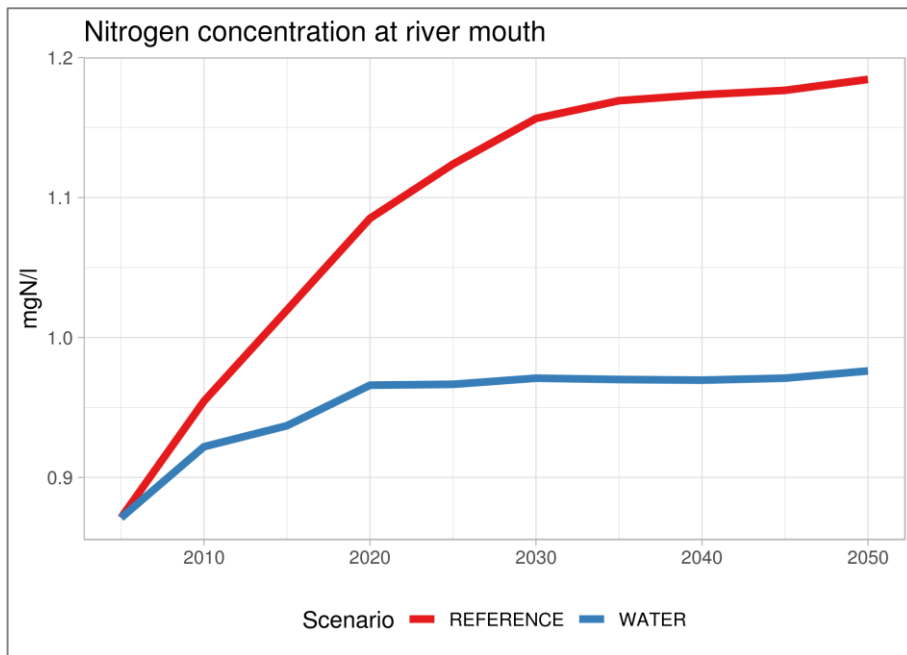


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# Water scenario

Scenario		Indicators	Policies	
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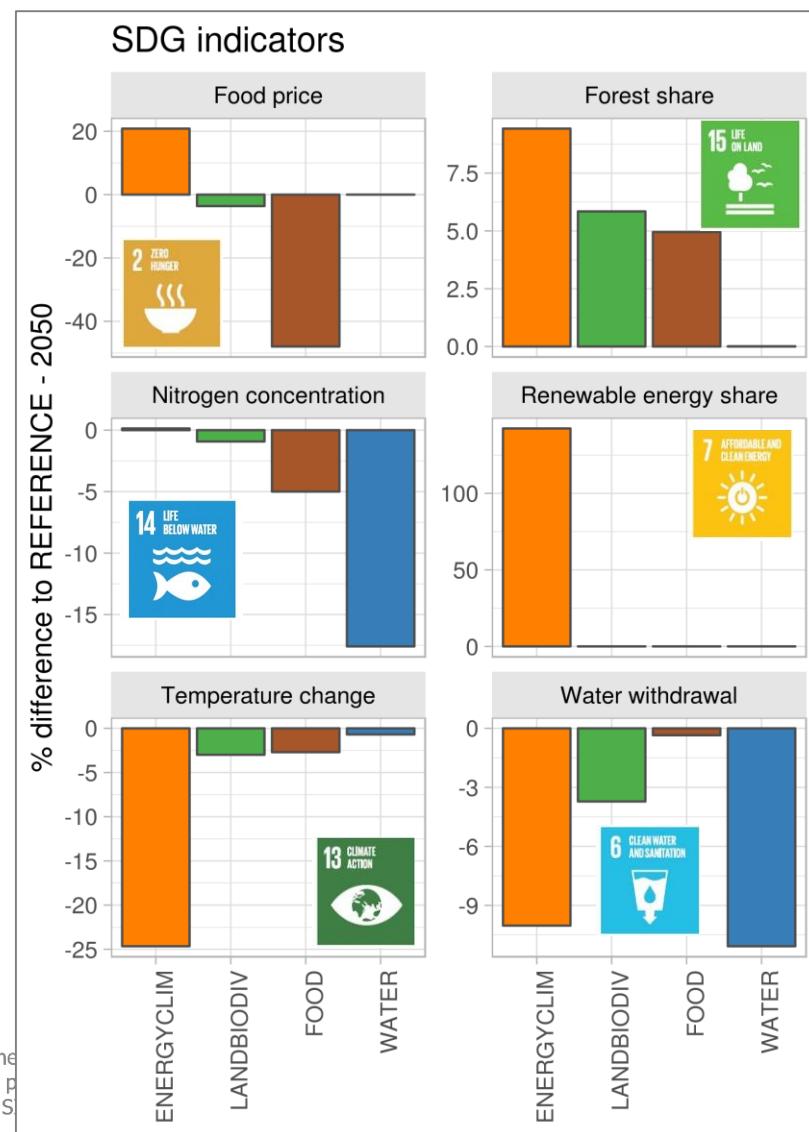
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# Multiple synergies and trade-offs

- Trade-offs:
  - ENERGYCLIM on food prices and nitrogen concentration
    - SDG13 → SDG2&SDG6
- Synergies:
  - ENERGYCLIM on forest share and water withdrawal
    - SDG13 → SDG15&SDG6
  - FOOD on nitrogen concentration, temperature change and forest share
    - SDG2 → SDG6&SDG13&SDG15
  - LANDBIODIV and FOOD on temperature change
    - SDG2 and SDG15 → SDG13



# To conclude

- Risk of incoherent policies identified: trade-offs
- No-risk policies identified: synergies
- First step towards quantification.
  
- Extend results and conclusions to multi-model exercise
- Further detail indicators:
  - Undernourishment, terrestrial/aquatic biodiversity, water stress
- Regional analysis crucial for many SDGs



# To discuss

- How much (more) detail is required from our Nexus-SDG analysis to be useful for policy, business and society?



# Thanks for your attention!

For further information please consult  
[www.sim4nexus.eu](http://www.sim4nexus.eu),  
follow us at @SIM4NEXUS

Jonathan Doelman – [jonathan.doelman@pbl.nl](mailto:jonathan.doelman@pbl.nl)

Further info on the IMAGE-GLOBIO model:  
[www.pbl.nl/image](http://www.pbl.nl/image)

Or follow us on twitter: @IMAGE\_PBL



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# Backup slide



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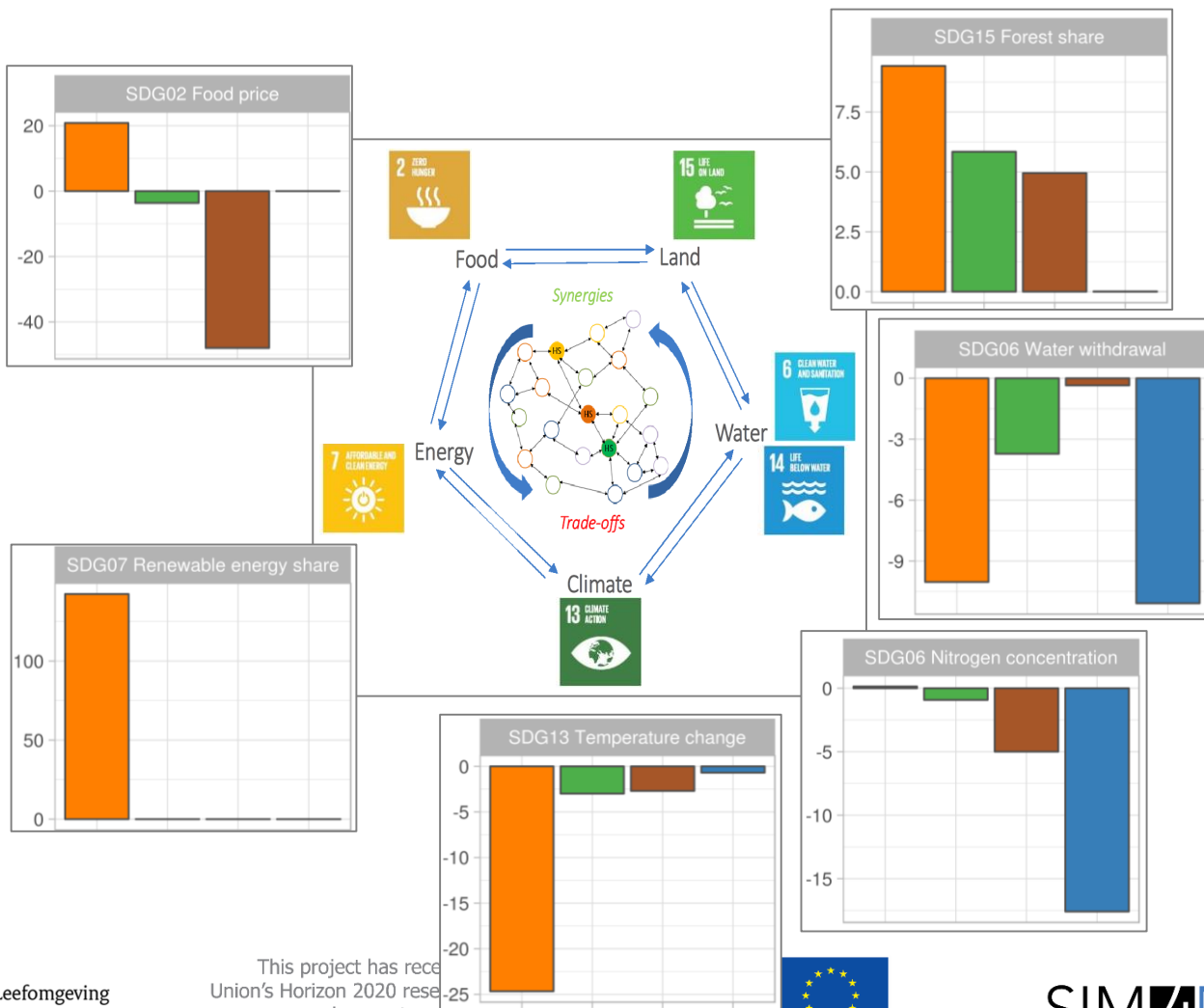


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# Synergies and trade-offs

## Scenario

- ENERGYCLIM
- LANDBIODIV
- FOOD
- WATER



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