IAM COMPACT Study 7

Dietary shift to lower animal protein consumption

September 12, 2023

BC3

Outline

Motivation and the Model

Motivation

Literature has analyzed how a transition to healthy diets can benefit health, biodiversity, land use, and climate (Lancet-EAT)

But...

- ⋆ it is unclear how this transition will occur
- ⋆ the system-wide effects that could derive from this transition

We'll study the Flexitarian Vegetarian or Vegan (**FVV**) diet, ie., a diet encompassed in any of these categories.

Objective

1. Create a model to deal with the uncertainty of the scenario projections
2. Study the following effects:
   - SDG 2: Alimentation
   - SDG 3: Health
   - SDG 6: Water management
   - SDG 13: Emissions
   - SDG 15: Land use

Objective

1. Create a model to deal with the uncertainty of the scenario projections
2. Study the following effects:
   - SDG 2: Alimentation
     - Macronutrients consumption
   - SDG 3: Health
   - SDG 6: Water management
   - SDG 13: Emissions
   - SDG 15: Land use

Objective

1. Create a model to deal with the uncertainty of the scenario projections
2. Study the following effects:
   - SDG 2: Alimentation
   - SDG 3: Health
     - Premature deaths due to AP
   - SDG 6: Water management
   - SDG 13: Emissions
   - SDG 15: Land use

Objective

1. Create a model to deal with the uncertainty of the scenario projections
2. Study the following effects:
   - SDG 2: Alimentation
   - SDG 3: Health
   - SDG 6: Water management
     - Water consumption (total)
     - Water consumption by crop and livestock
     - Irrigated and Rainfed water demand
   - SDG 13: Emissions
   - SDG 15: Land use

Objective

1. Create a model to deal with the uncertainty of the scenario projections
2. Study the following effects:
   - SDG 2: Alimentation
   - SDG 3: Health
   - SDG 6: Water management
   - SDG 13: Emissions
     - GHG emissions
     - CH_4 agricultural emissions
     - N_2O agricultural emissions
   - SDG 15: Land use

Objective

1. Create a model to deal with the uncertainty of the scenario projections
2. Study the following effects:
   - SDG 2: Alimentation
   - SDG 3: Health
   - SDG 6: Water management
   - SDG 13: Emissions
   - SDG 15: Land use
     - Area of forest, pasture, cropland, and other land
     - Re-forestation
     - Cropland management (area and fertilizer demand)
     - Crop loss due to AP
     - Carbon stock

The model

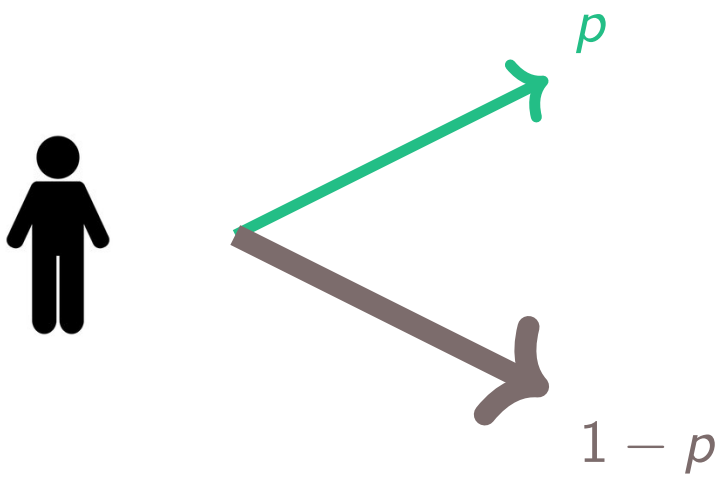
Assumptions

1. Each person decides to become FVV independently but is influenced by 3 factors:
   - Social pressure weight
   - Percentage of the population following the FVV diet by 2100
   - Peak year when the majority of the population will shift

2. Once a person decides to follow the FVV diet, will stick to this decision for the rest of the century

The model

Binomial distribution with probability p

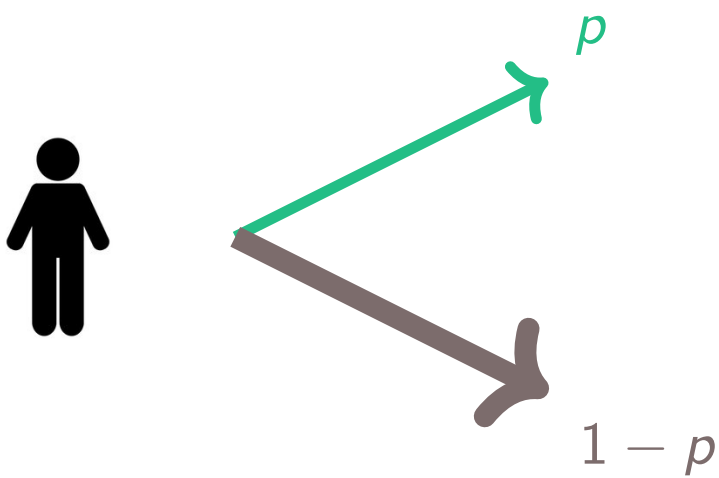


Where the probability p is influenced by

- ⋆ Social pressure weight
- ⋆ Percentage of the population following the FVV diet by 2100
- ⋆ Peak year when the majority of the population will shift

The model

Binomial distribution with probability p

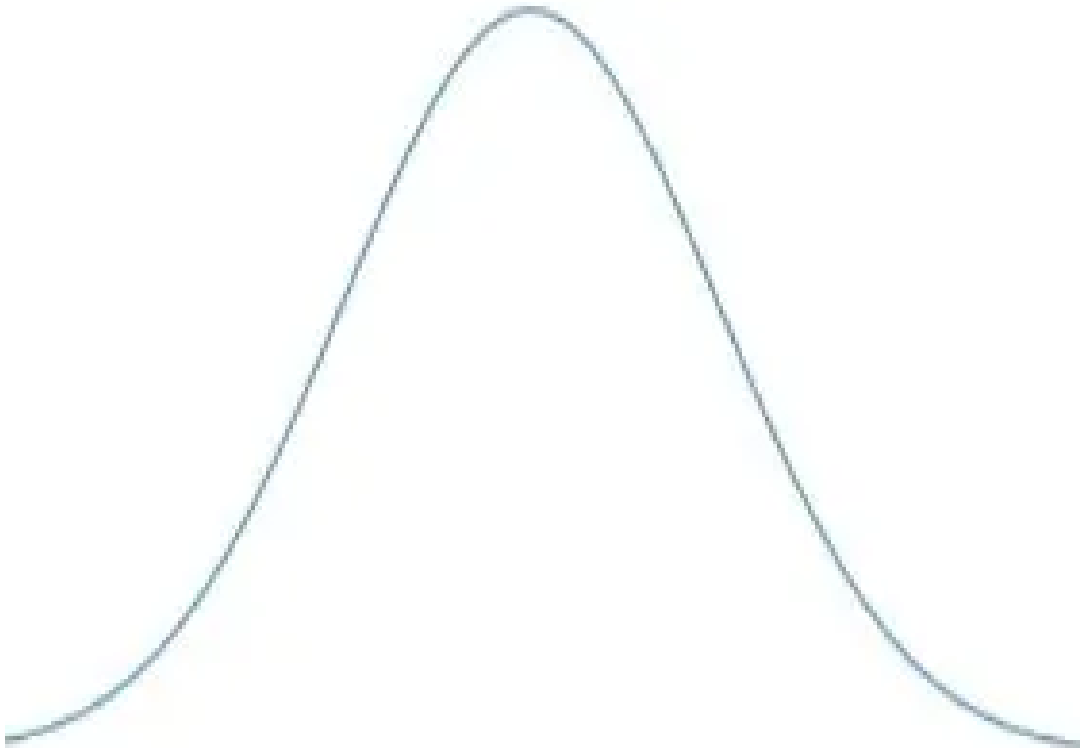


Where the probability p is influenced by

- ⋆ Social pressure weight → Exogenous
- ⋆ Percentage of the population following the FVV diet by 2100
- ⋆ Peak year when the majority of the population will shift

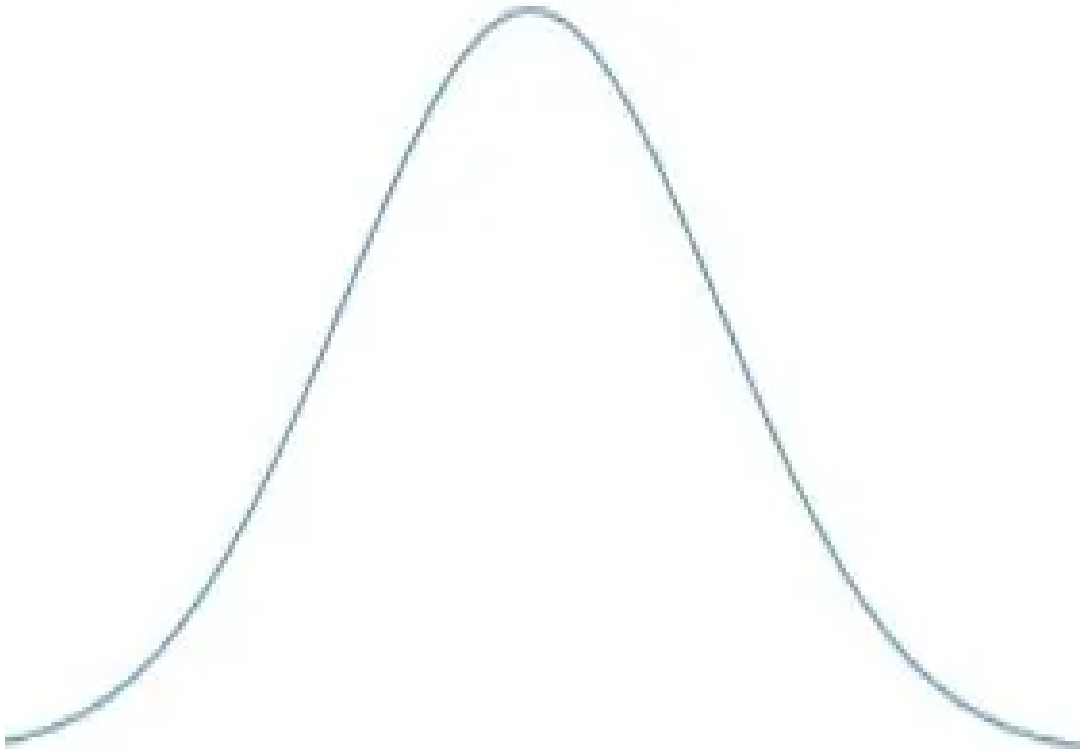
Uncertainty considerations

Each factor value is randomly chosen from a Normal Distribution $N(\mu, \sigma)$

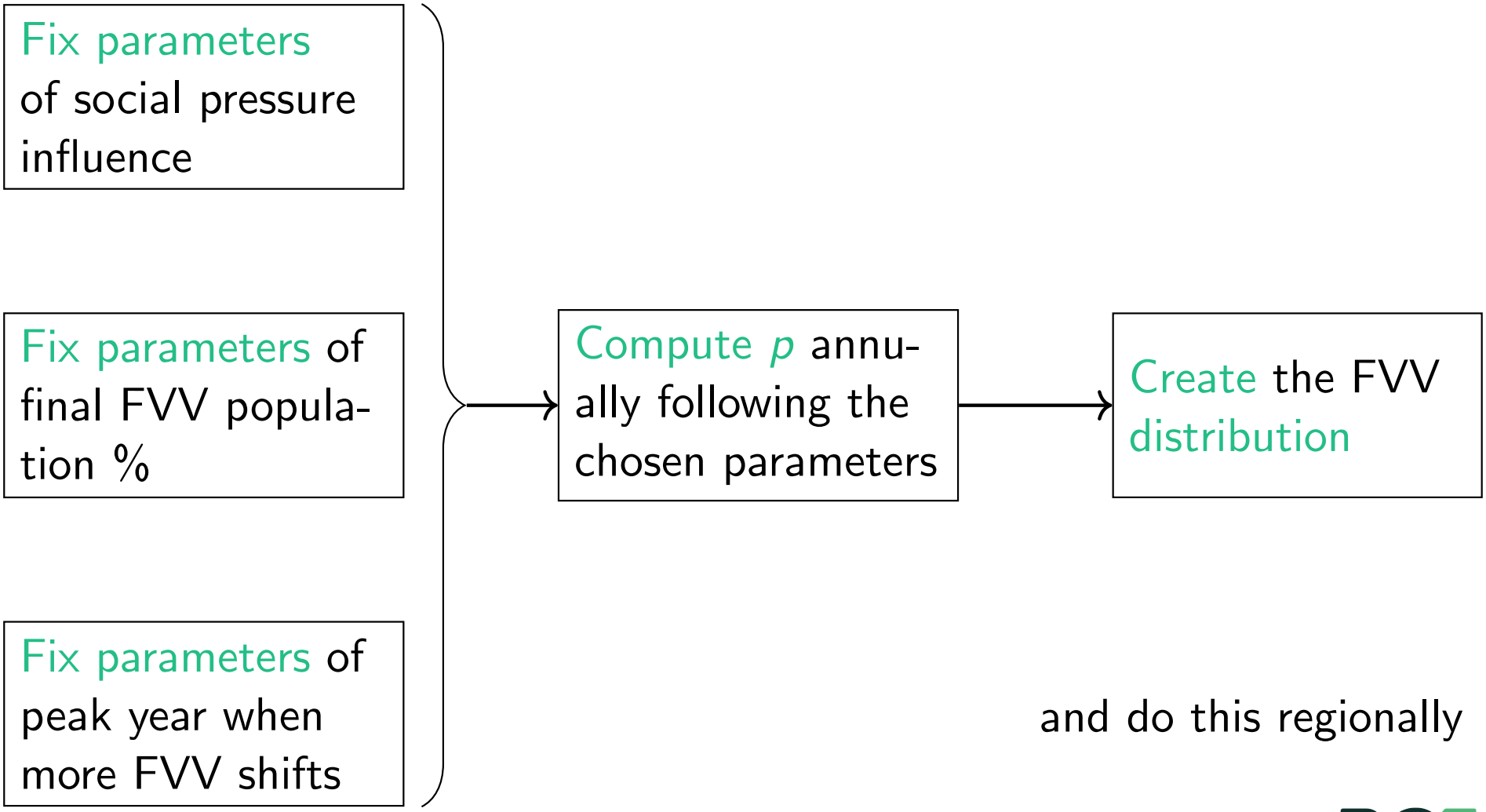


Uncertainty considerations

Each factor value is randomly chosen from a Normal Distribution $N(\mu, \sigma)$

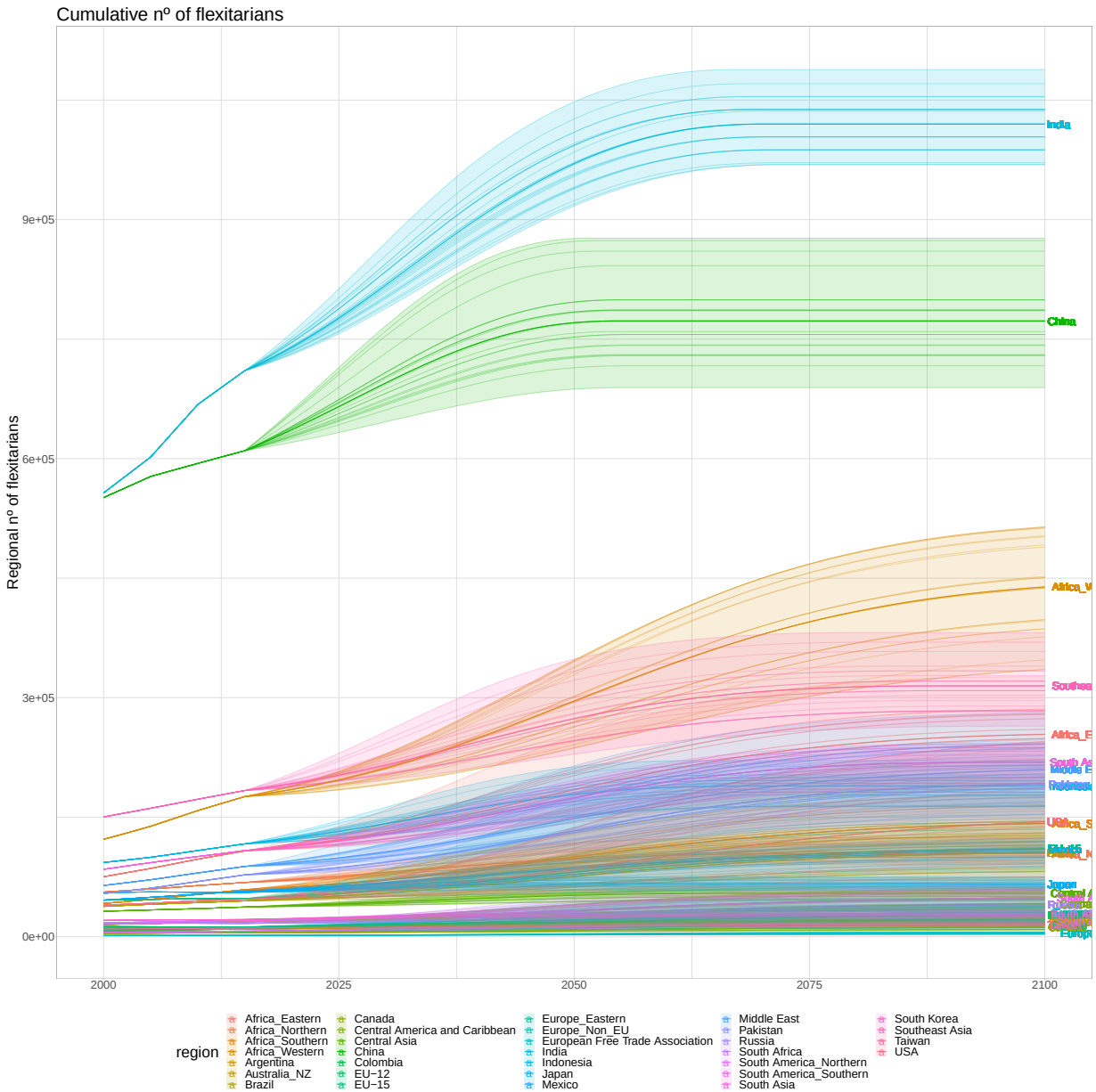


Recap

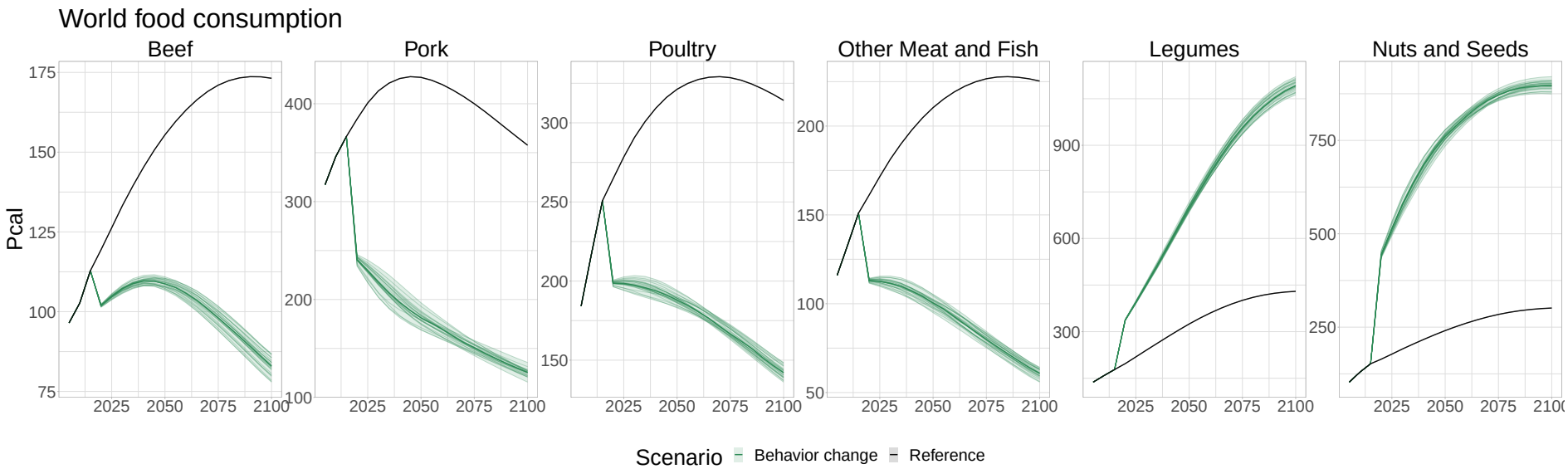


and do this regionally

Example


Cumulative nº of flexitarians
Regional nº of flexitarians
9e+05
6e+05
3e+05
0e+00
2000
2025
2050
2075
2100
India
China
region
Africa_Eastern
Africa_Northern
Africa_Southern
Africa_Western
Argentina
Australia_NZ
Brazil
Canada
Central America and Caribbean
Central Asia
China
Colombia
EU−12
EU−15
Europe_Eastern
Europe_Non_EU
European Free Trade Association
India
Indonesia
Japan
Mexico
Middle East
Pakistan
Russia
South Africa
South America_Northern
South America_Southern
South Asia
South Korea
Southeast Asia
Taiwan
USA

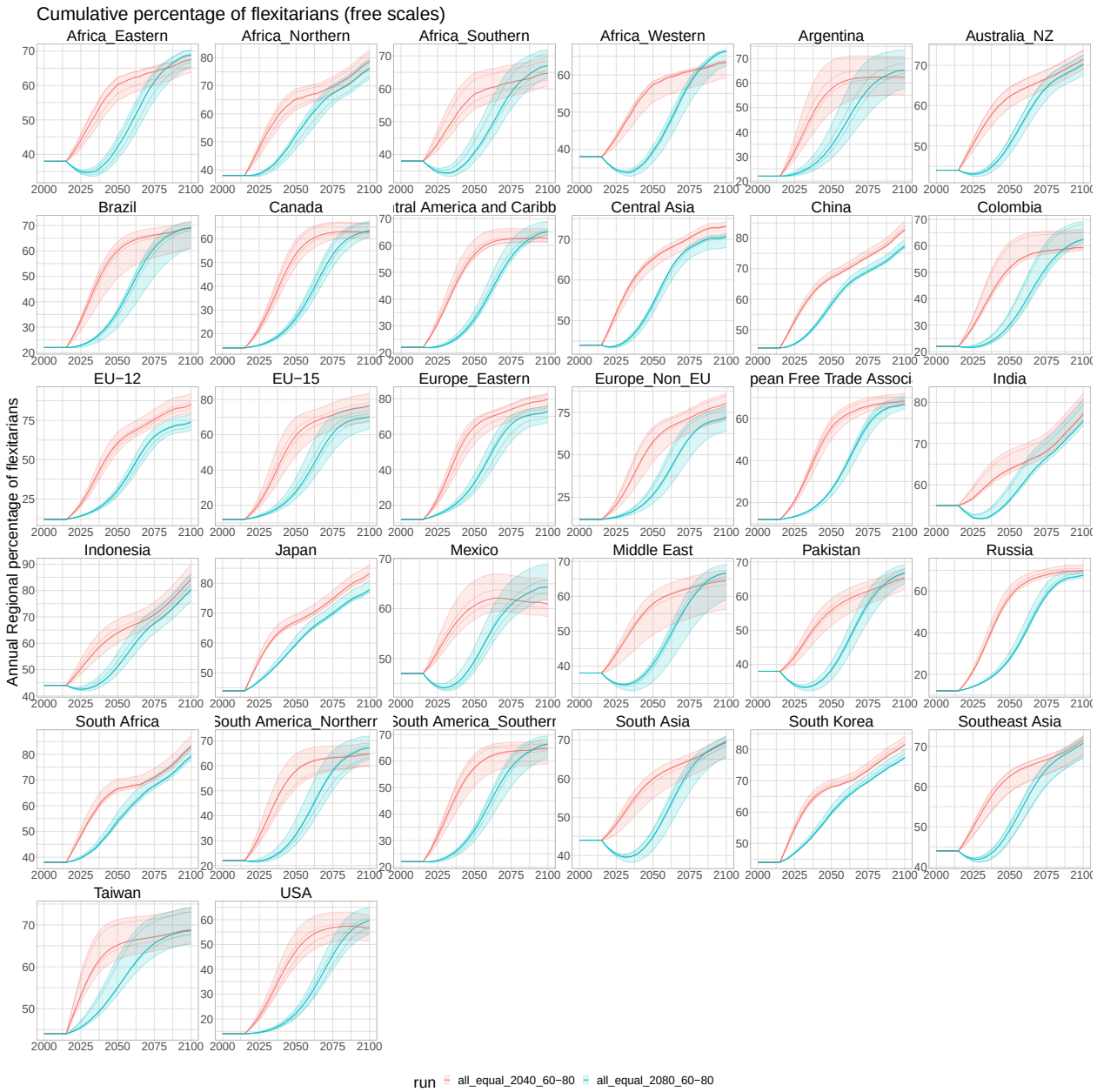
Example


World food consumption
Beef
Pork
Poultry
Other Meat and Fish
Legumes
Nuts and Seeds
Pcal
175
150
125
100
75
400
300
200
100
300
250
200
150
200
150
100
50
900
600
300
750
500
250
2025
2050
2075
2100
Scenario
Behavior change
Reference

Example


Nº of new flexitarians (free scales)
Africa_Eastern
Africa_Northern
Africa_Southern
Africa_Western
Argentina
Australia_NZ
Brazil
Canada
ral America and Carib
Central Asia
China
Colombia
EU−12
EU−15
Europe_Eastern
Europe_Non_EU
ean Free Trade Assoc
India
Indonesia
Japan
Mexico
Middle East
Pakistan
Russia
South Africa
outh America_Northe
outh America_Southe
South Asia
South Korea
Southeast Asia
Taiwan
USA
Annual World nº of new flexitarians
run
all_equal_2040_60−80
all_equal_2080_60−80

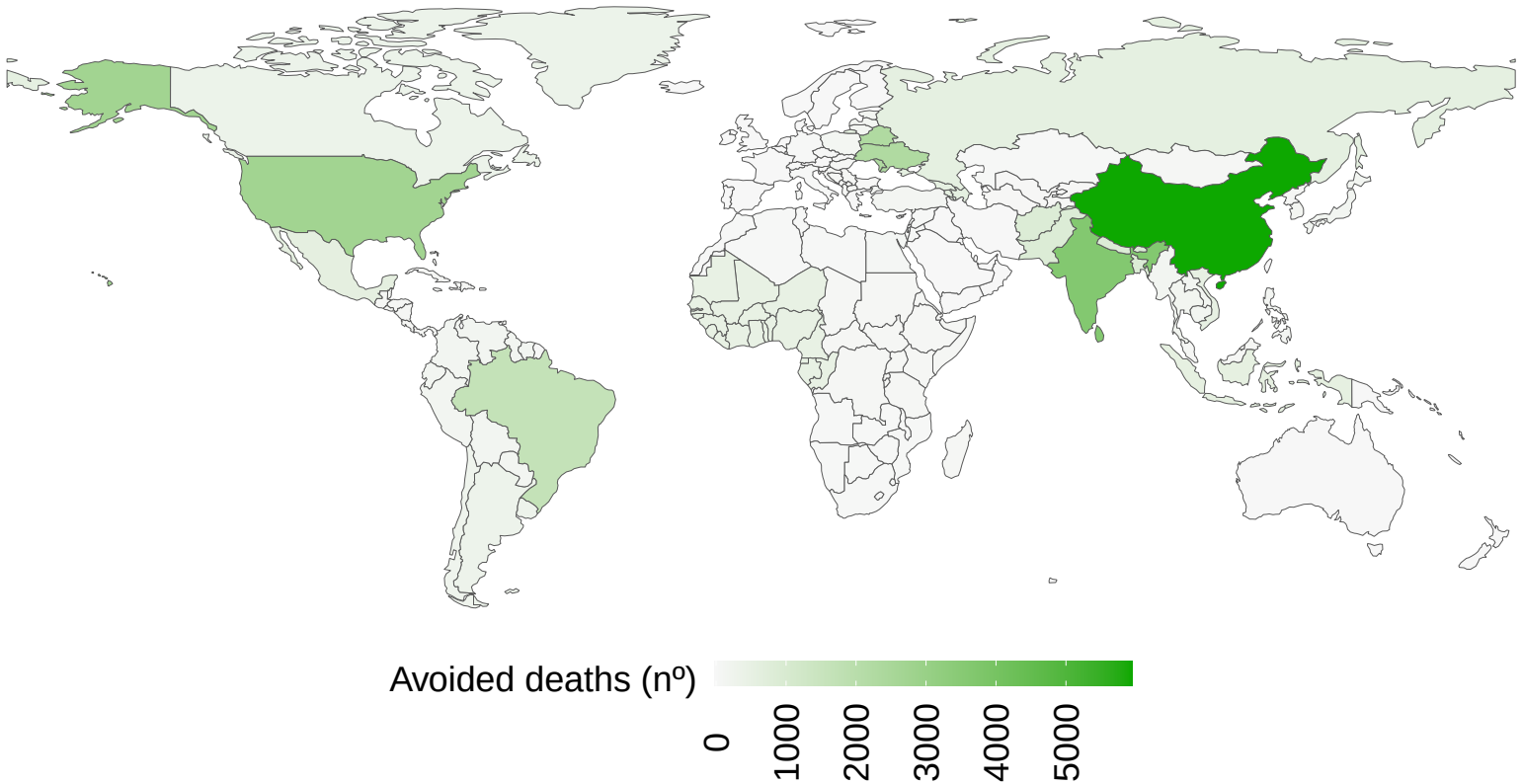
Example


Cumulative percentage of flexitarians (free scales)
Annual Regional percentage of flexitarians
Africa_Eastern
Africa_Northern
Africa_Southern
Africa_Western
Argentina
Australia_NZ
Brazil
Canada
tral America and Caribb
Central Asia
China
Colombia
EU−12
EU−15
Europe_Eastern
Europe_Non_EU
pean Free Trade Associ
India
Indonesia
Japan
Mexico
Middle East
Pakistan
Russia
South Africa
South America_Northern
South America_Southern
South Asia
South Korea
Southeast Asia
Taiwan
USA
run
all_equal_2040_60−80
all_equal_2080_60−80

System-wide effects

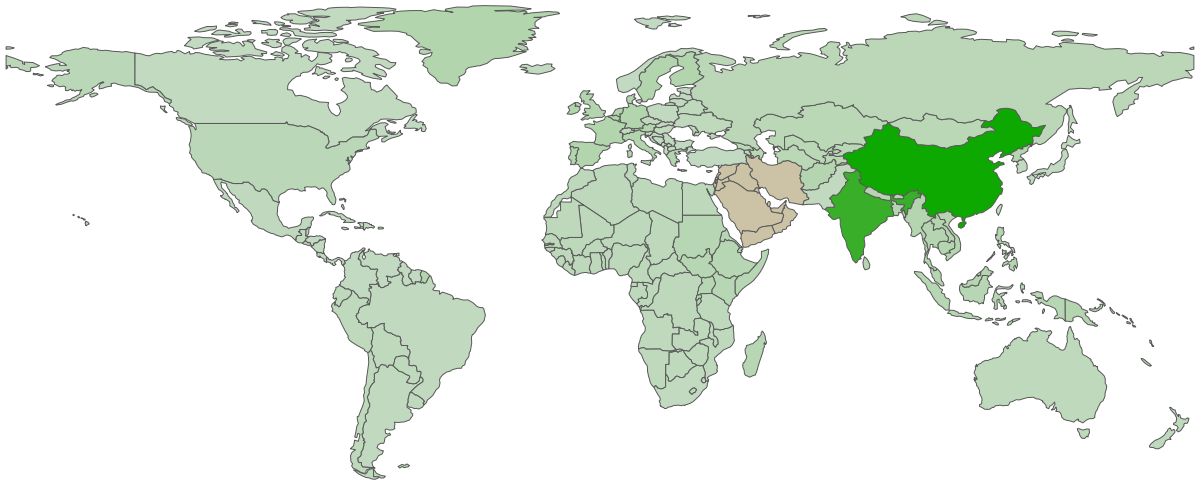
Avoided premature deaths

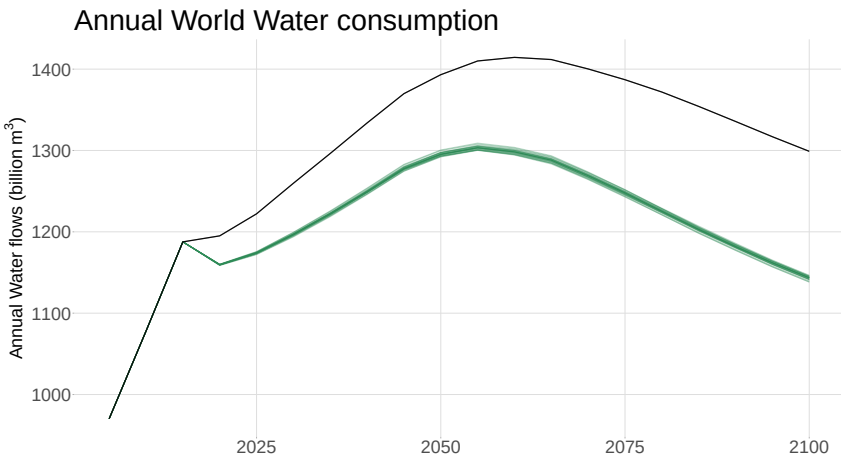
Annual avoided deaths in 2030



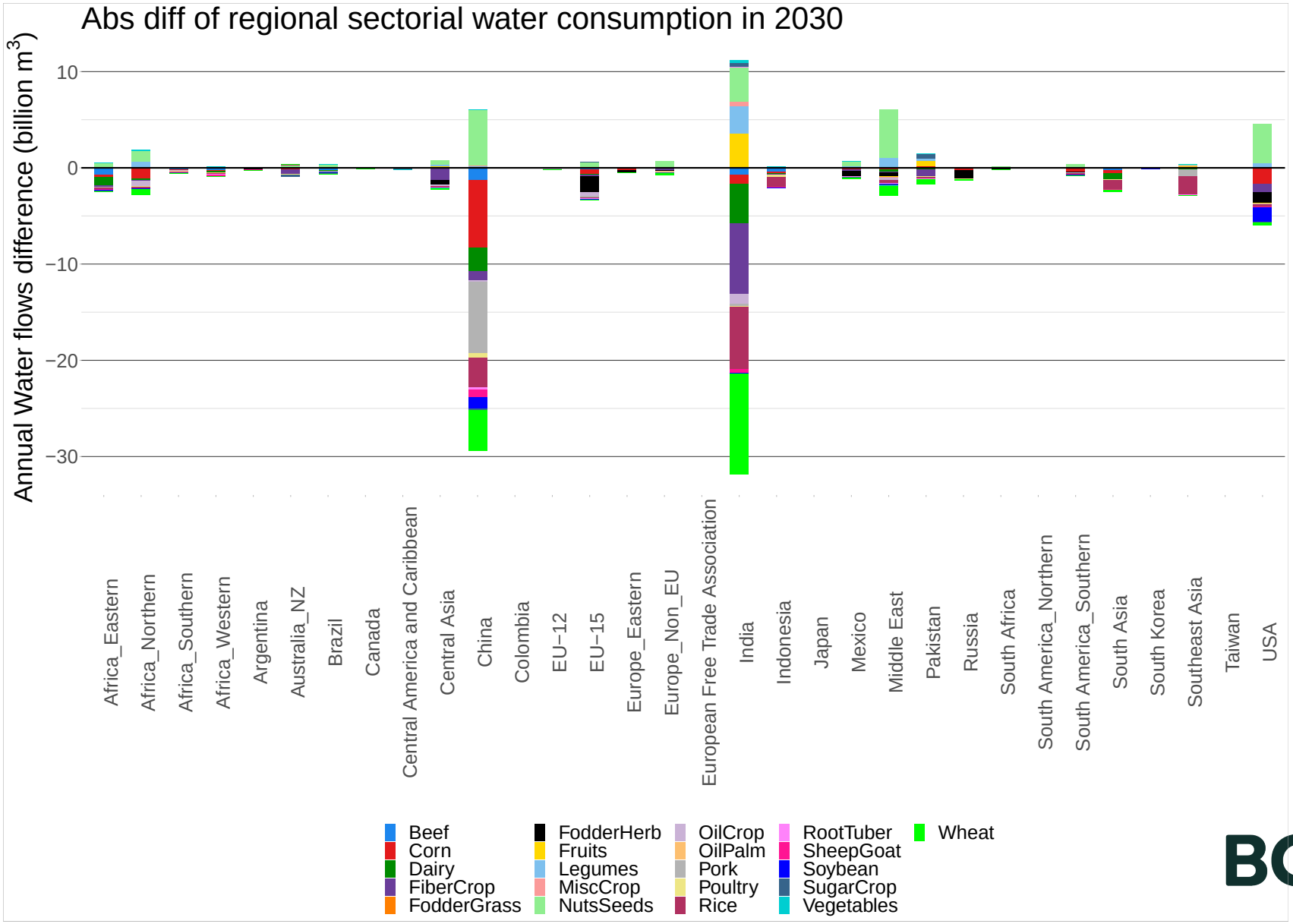
Water consumption

Annual water consumption abs difference in 2030



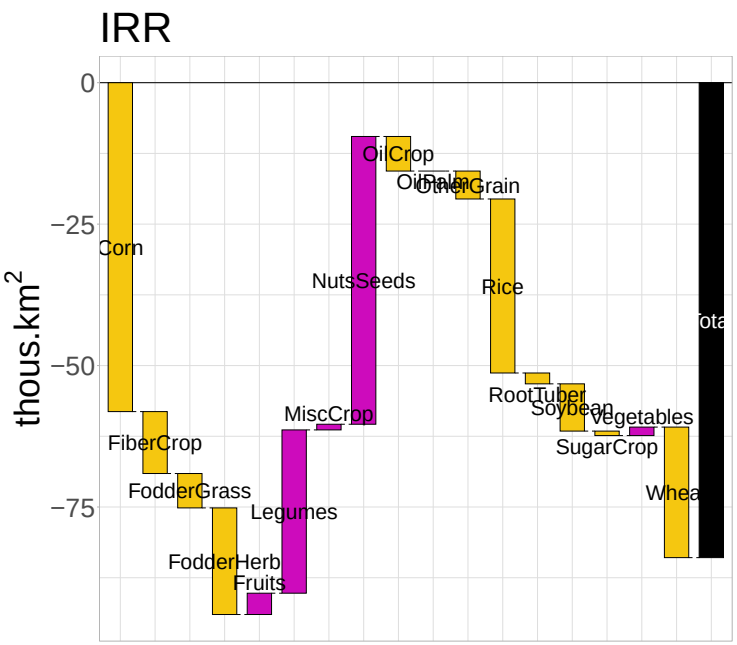


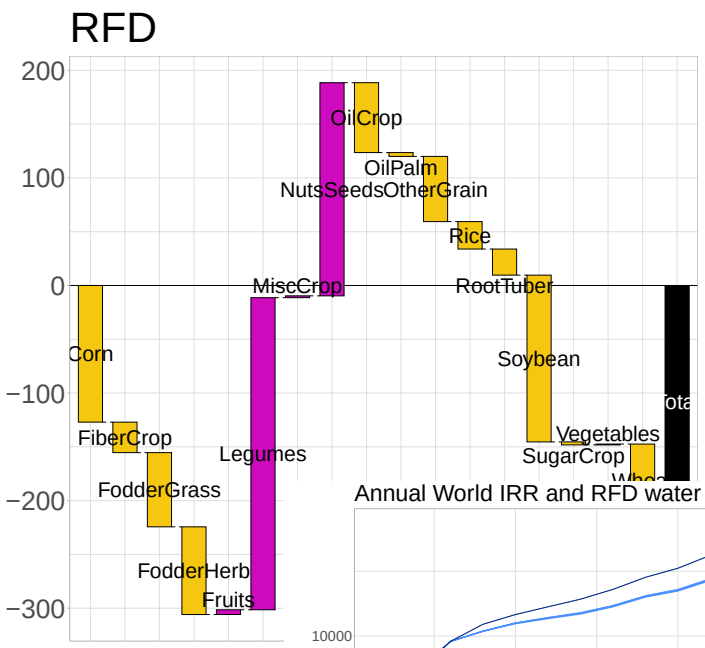
Water consumption by crop and livestock

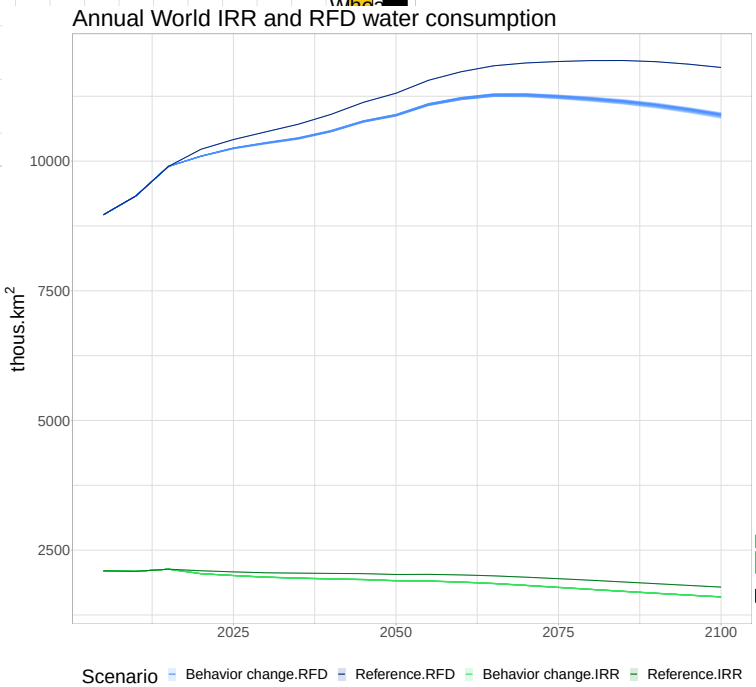


Irrigated and Rainfed water demand

Annual World IRR and RFD abs difference (beh.change − ref)

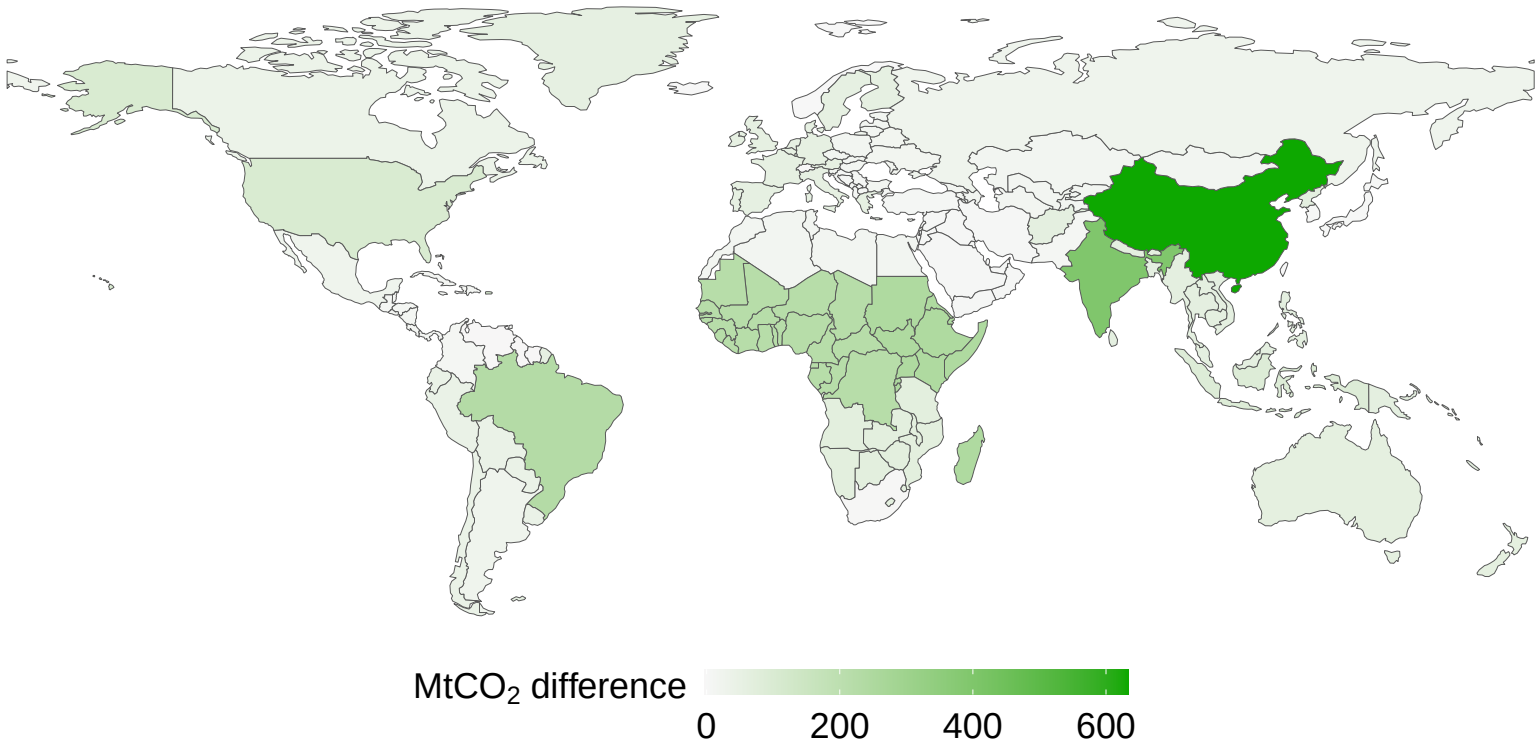




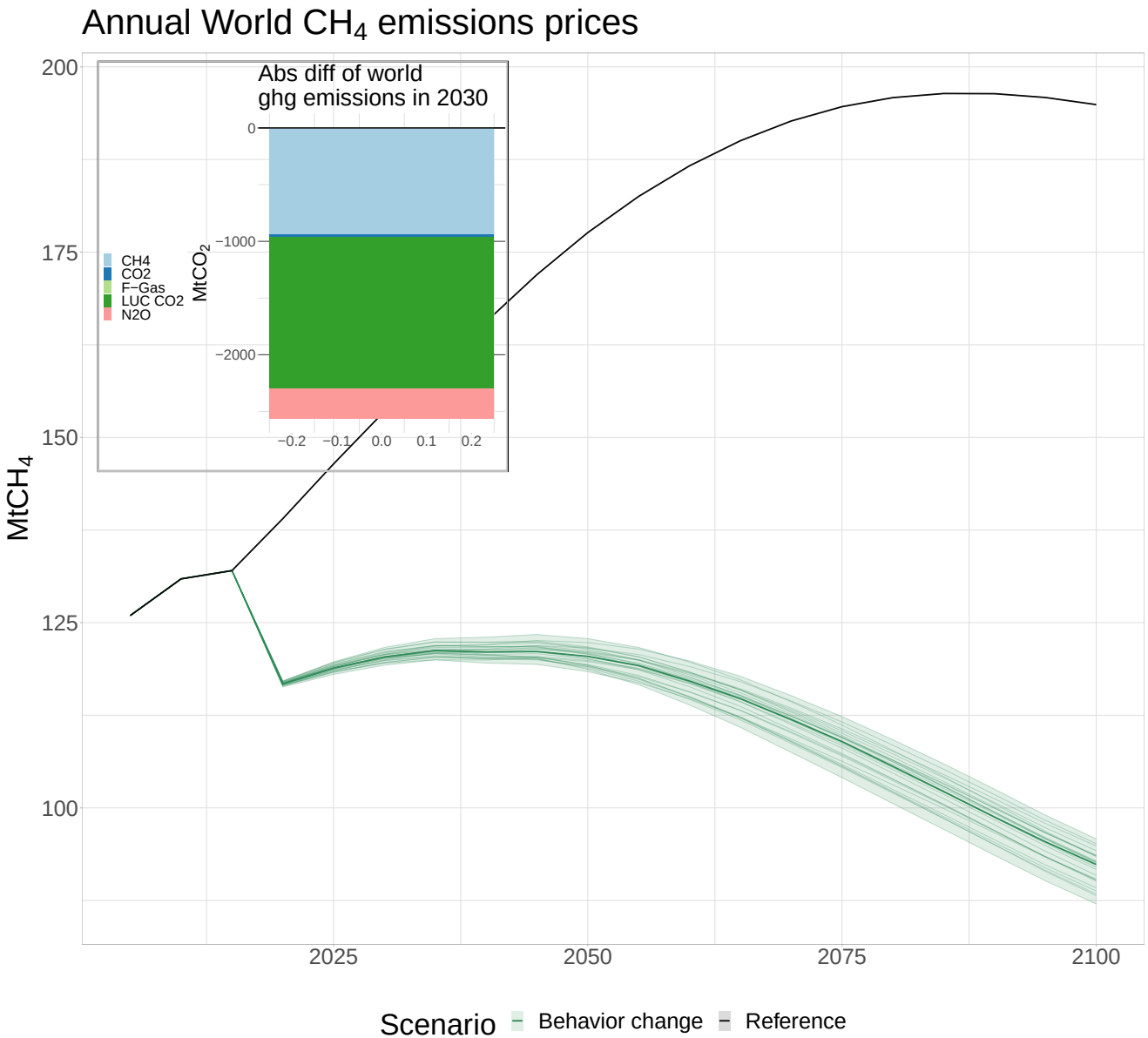


GHG emissions

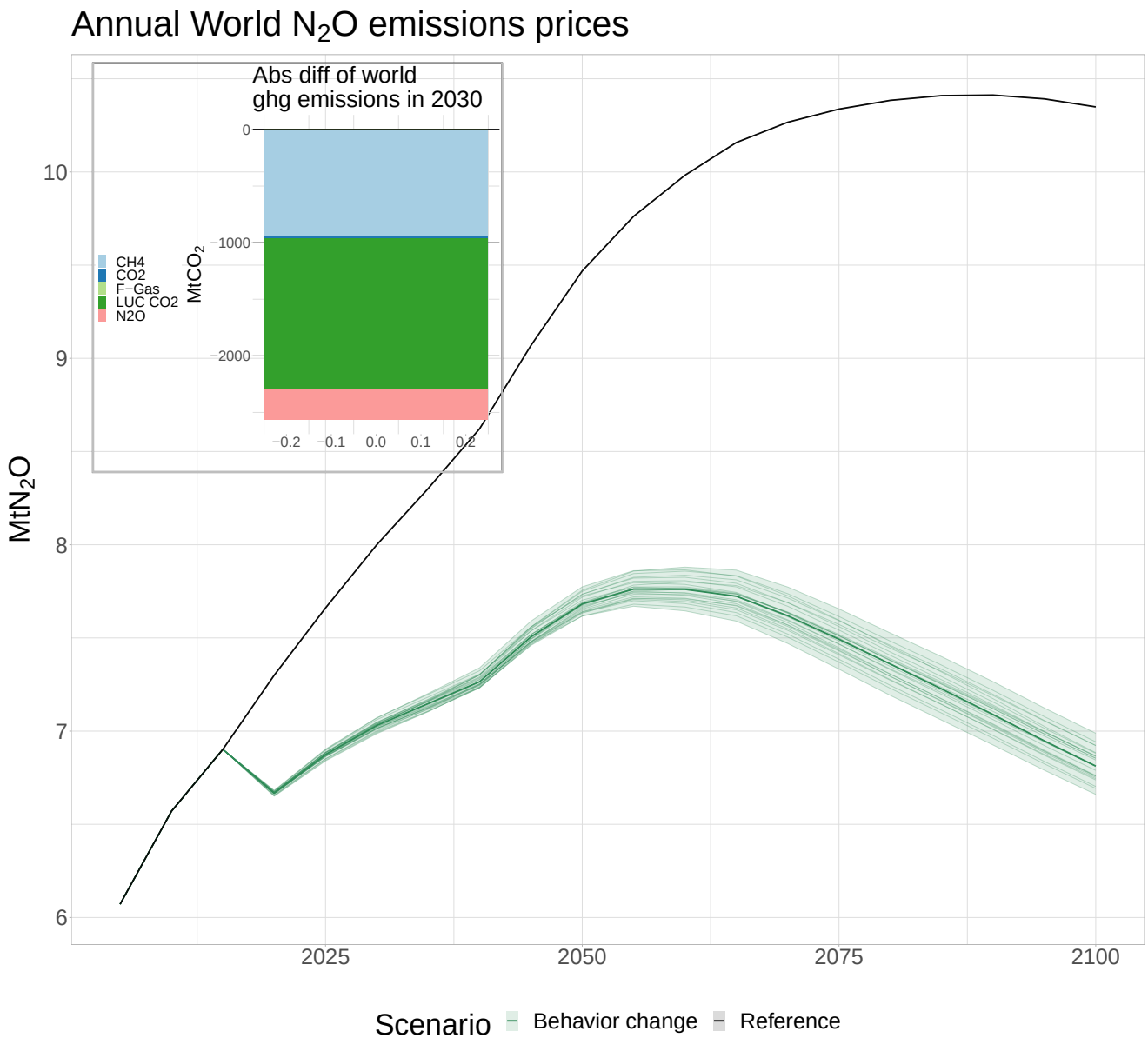
Abs GHG avoided emissions in 2030



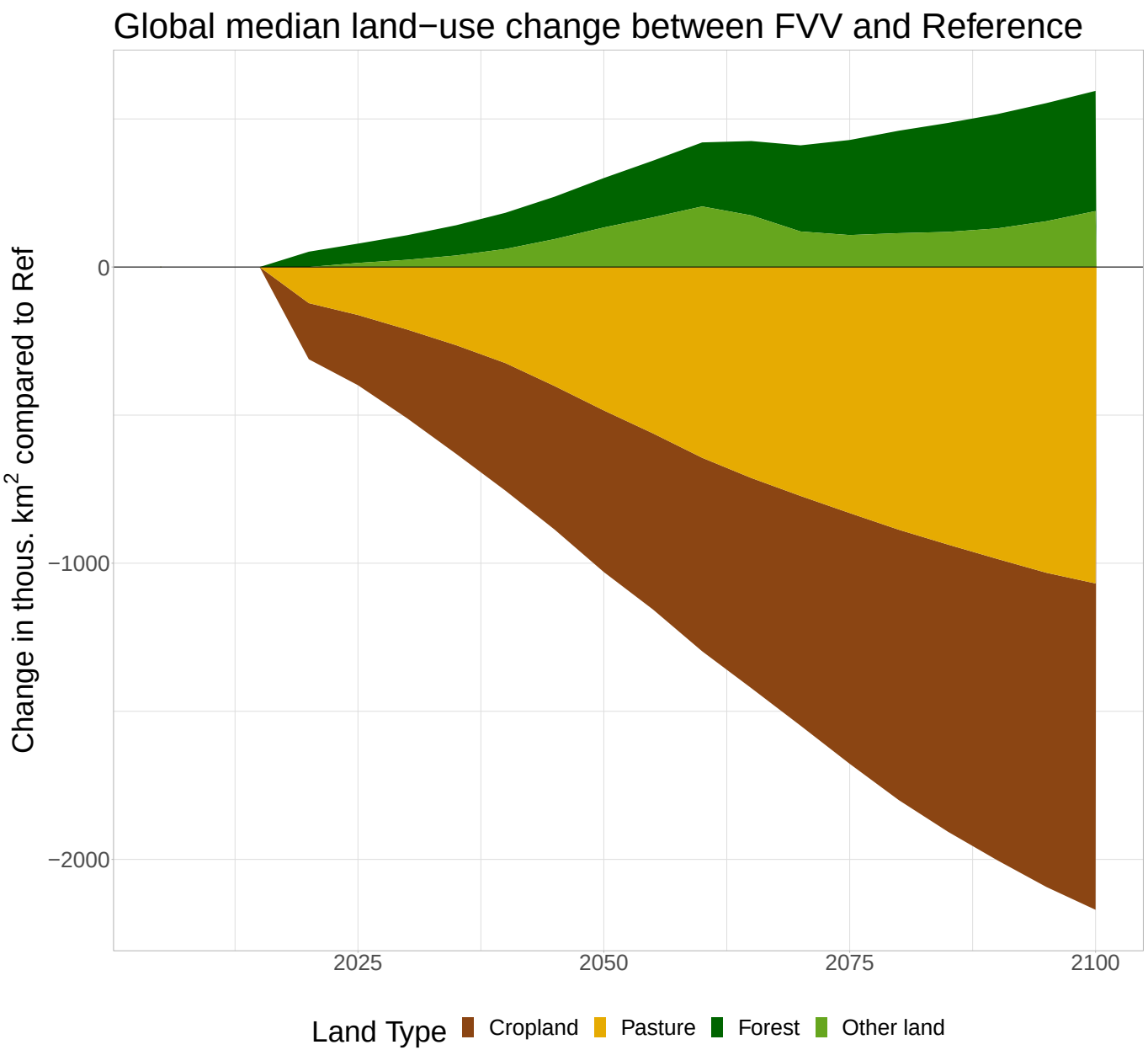
CH4 agricultural emissions



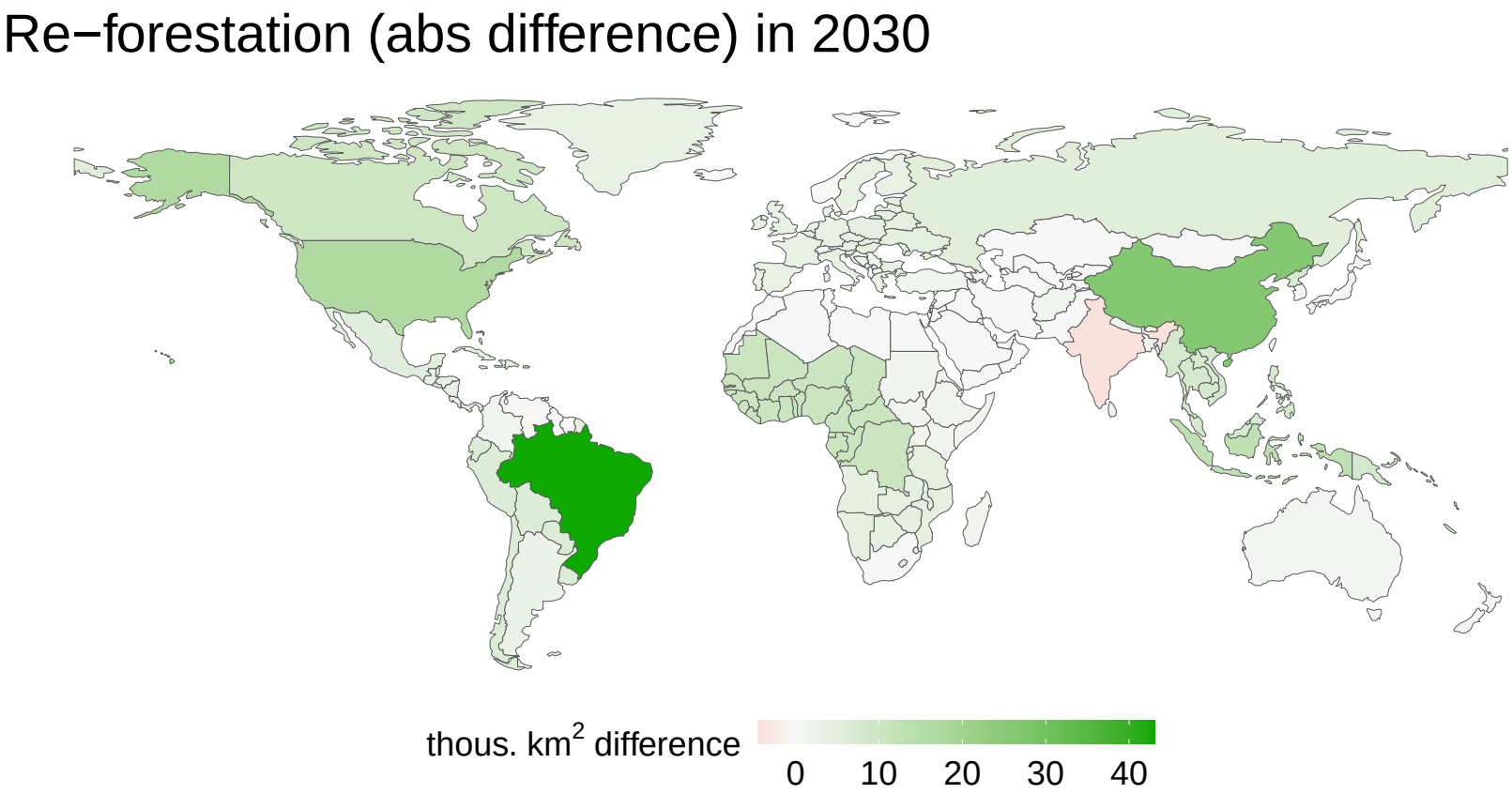
N2O agricultural emissions



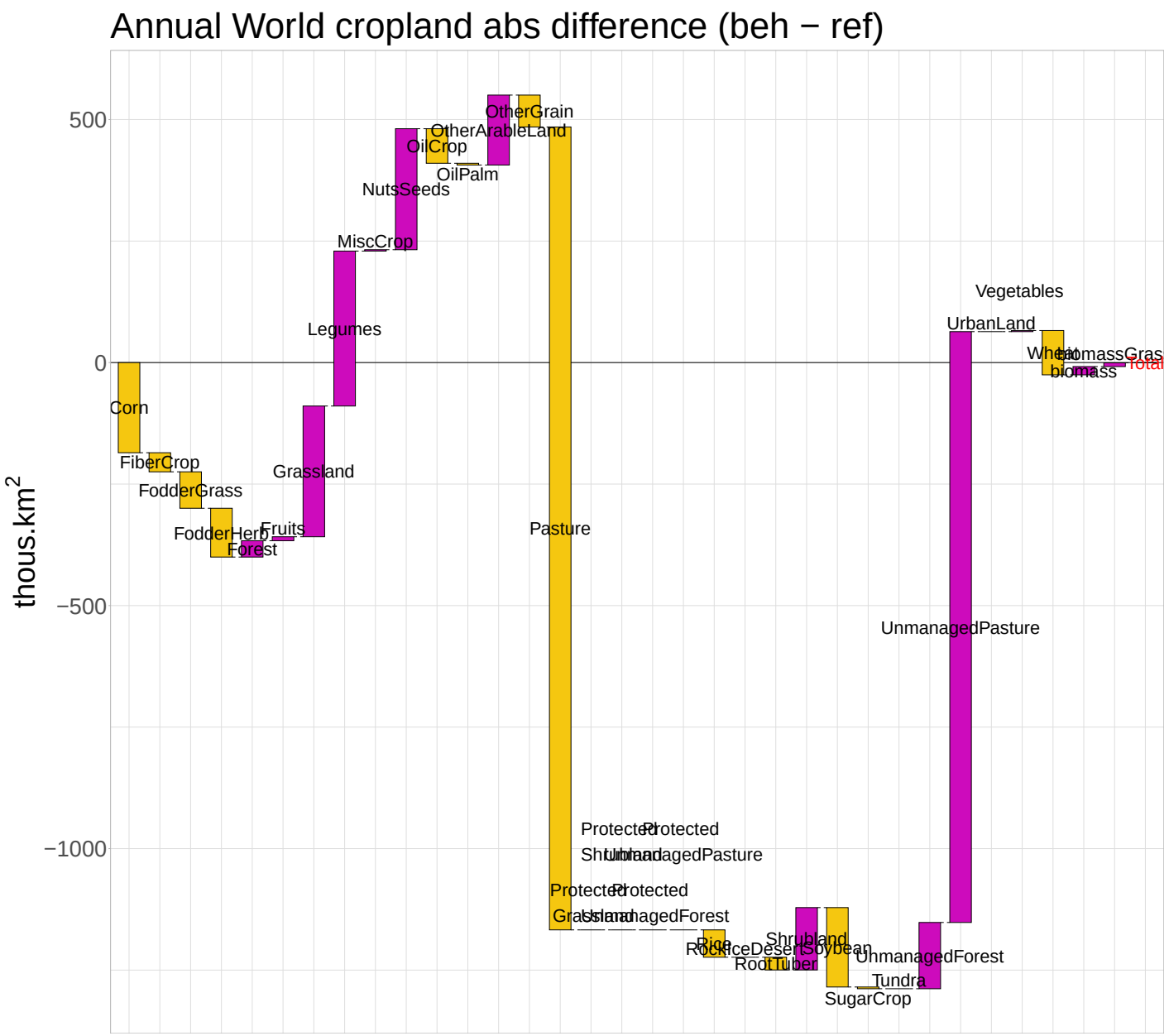
Land use


Global median land−use change between FVV and Reference
Change in thous. km^2 compared to Ref
0
−1000
−2000
2025
2050
2075
2100
Land Type
Cropland
Pasture
Forest
Other land

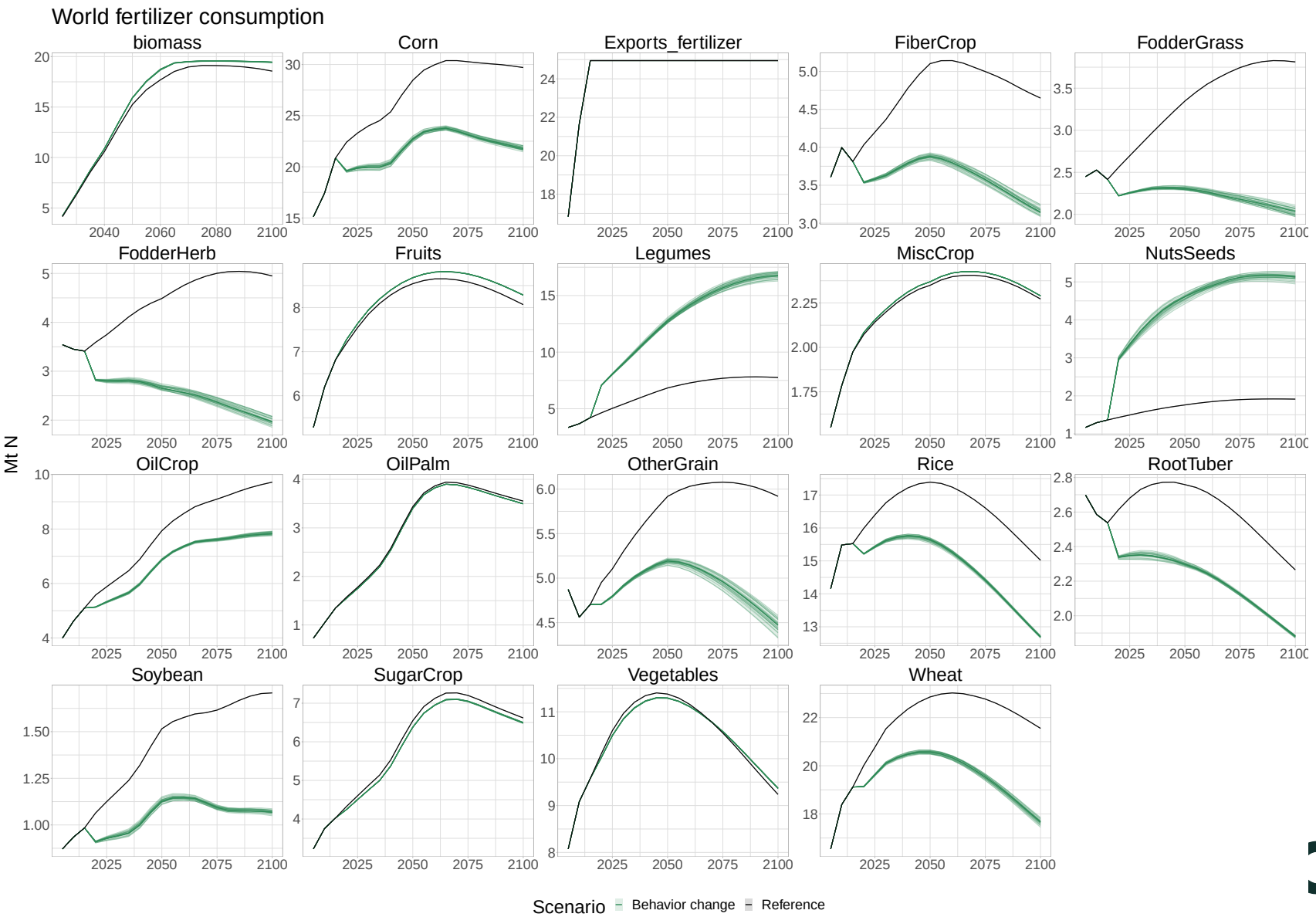
Re-forestation



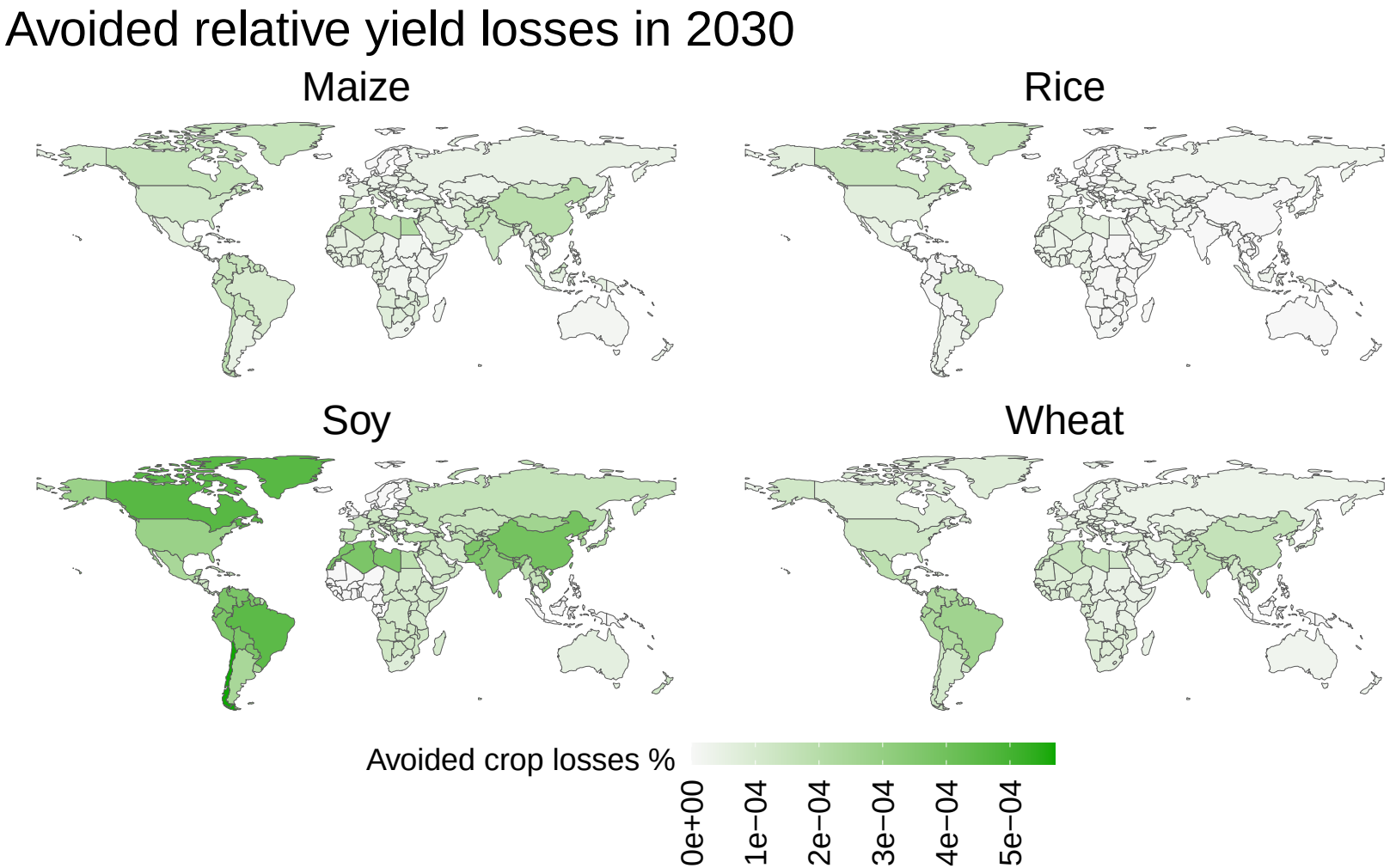
Cropland management



Cropland management



Crop loss due to AP



Doubts

- ⋆ Does it make sense the cropland area dynamic?
- ⋆ Does it make sense nutritionally speaking the FVV diet? (Reducing animal protein and increasing nuts and legumes)

Future work

- ⋆ Study nutritional values and other system-wide impacts.
- ⋆ Create multiple scenarios to see which one has better system-wide effects. Maybe considering different regional levels of FVV?
- ⋆ Do a similar study for trade (with VWT) and transport. Maybe simplified?