Klimawandel und Landwirtschaft

Kontakt:

Adrian Müller, Forschungsinstitut für biologischen Landbau FiBL

adrian.mueller@fibl.org

Skript:

Muller, A., 2018, Klimawandel und das Ernährungssystem, https://orgprints.org/id/eprint/34466/

Worum geht es?

- **Was ist klimafreundliche Landwirtschaft und Ernährung?**

- **Was heisst Anpassung an den Klimawandel in der Landwirtschaft?**

- **Fragen aufwerfen, konstruktive Verunsicherung, Betonung der Komplexität, klare Argumentationen; weniger «Wissen pauken»**

Form

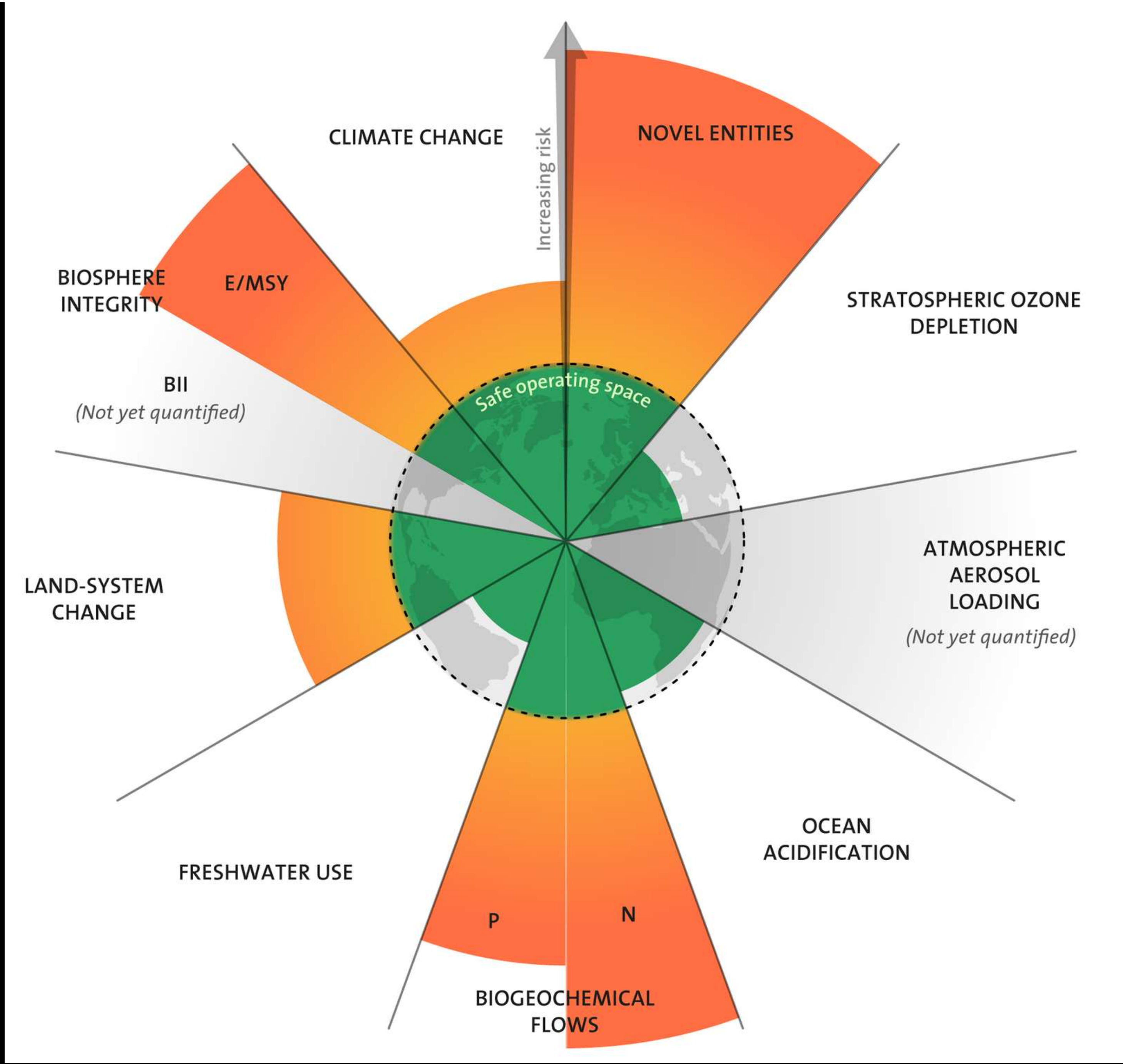
- **Inhalte im Dialog vermitteln (Block I)**
- **Gruppenarbeit (Block II)**
- **Präsentation und Diskussion (Block III)**

Workshop „Klima und Landwirtschaft“

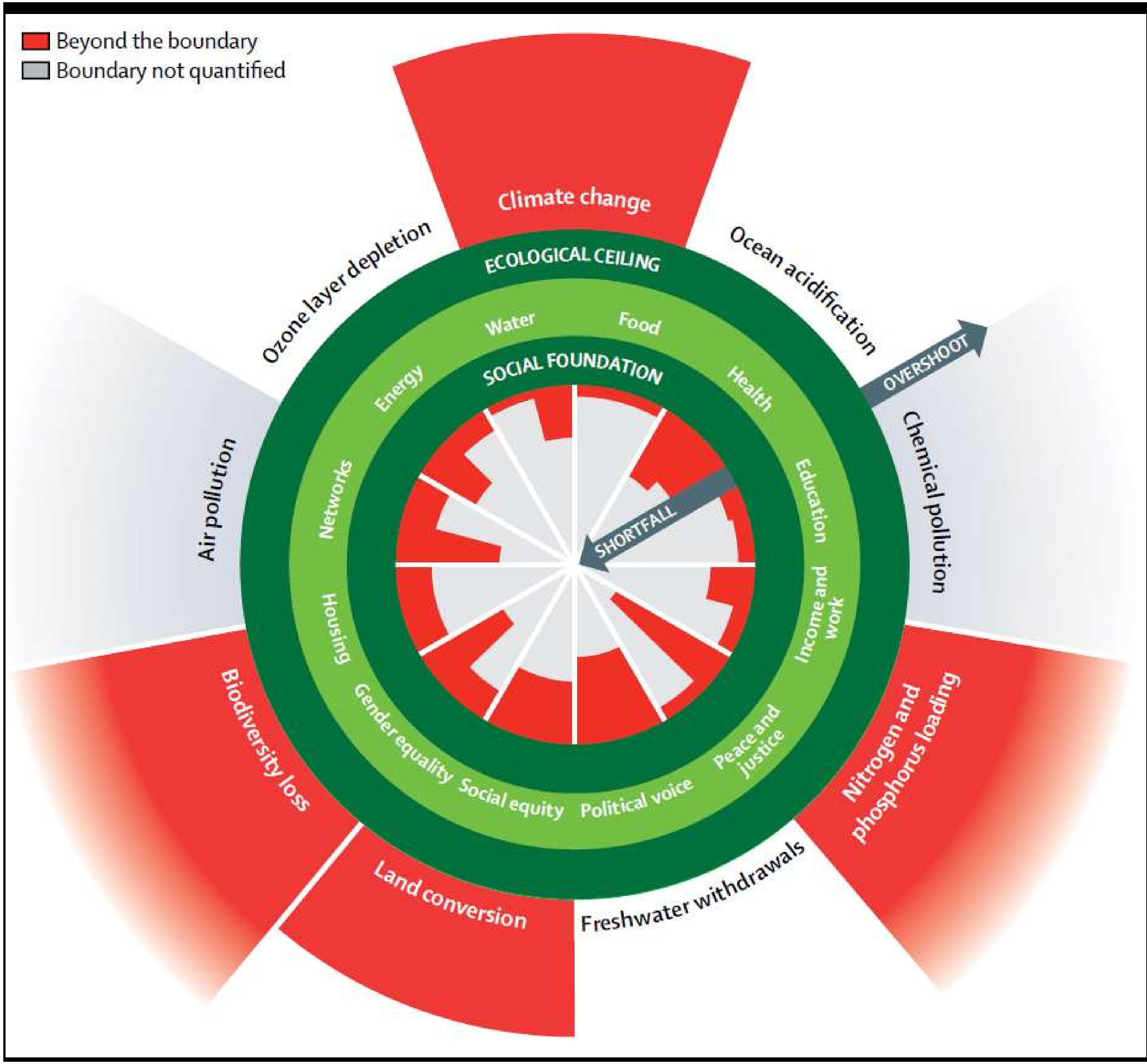
Mittwoch 7.6.2023

9.00 – 10.00	**Einführung, Block I**
10.00 – 10:15	*Pause*
10.15 – 11.50	**Block II**
12.00 – 13.15	**Block III**

Allgemeines



Stockholm Resilience Center 2022



Raworth 2017

Emissionen aus der Landwirtschaft

Schweiz

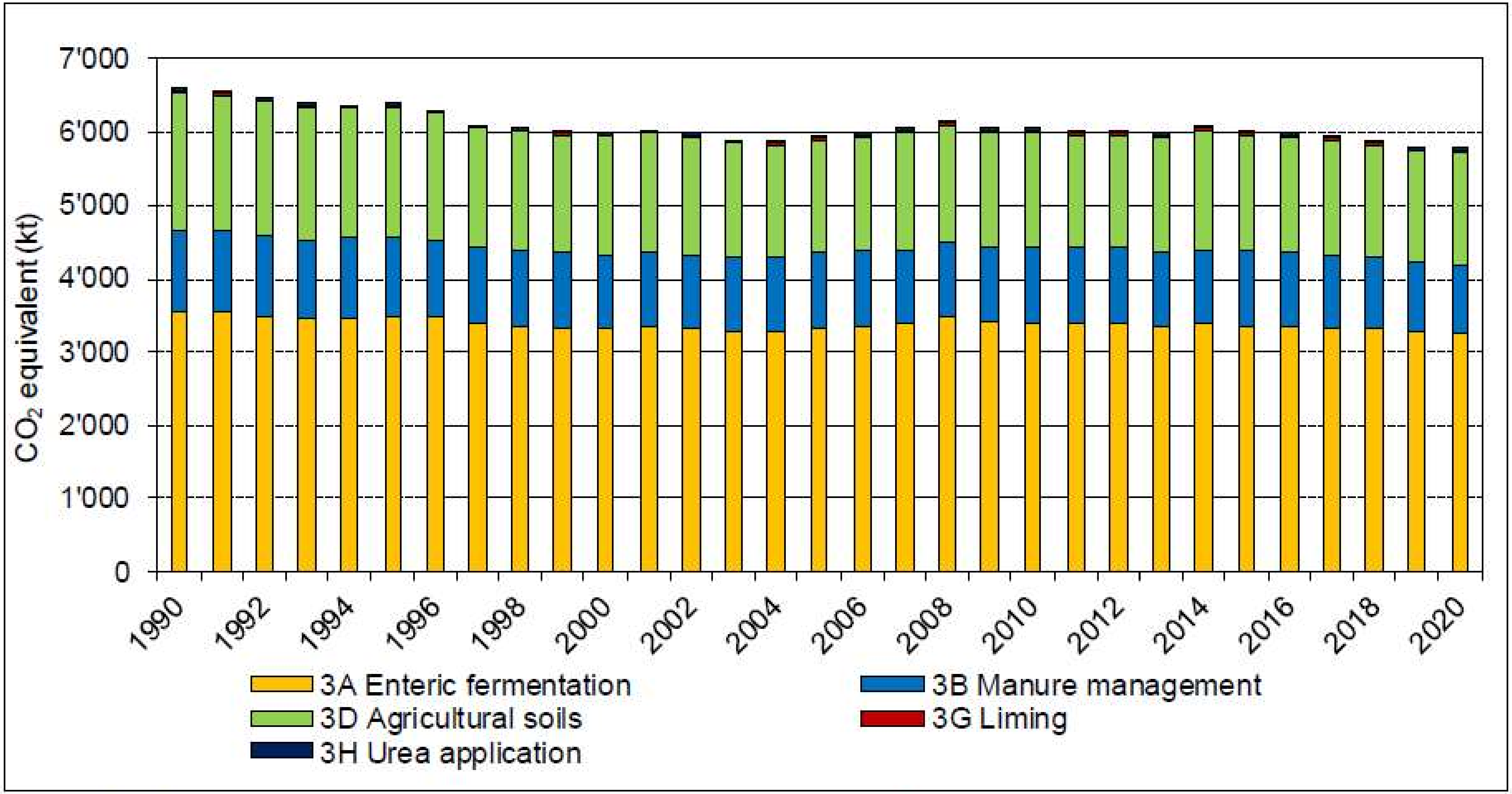


Figure 5-1 Greenhouse gas emissions of the agricultural sector in CO_2 equivalent (kt).

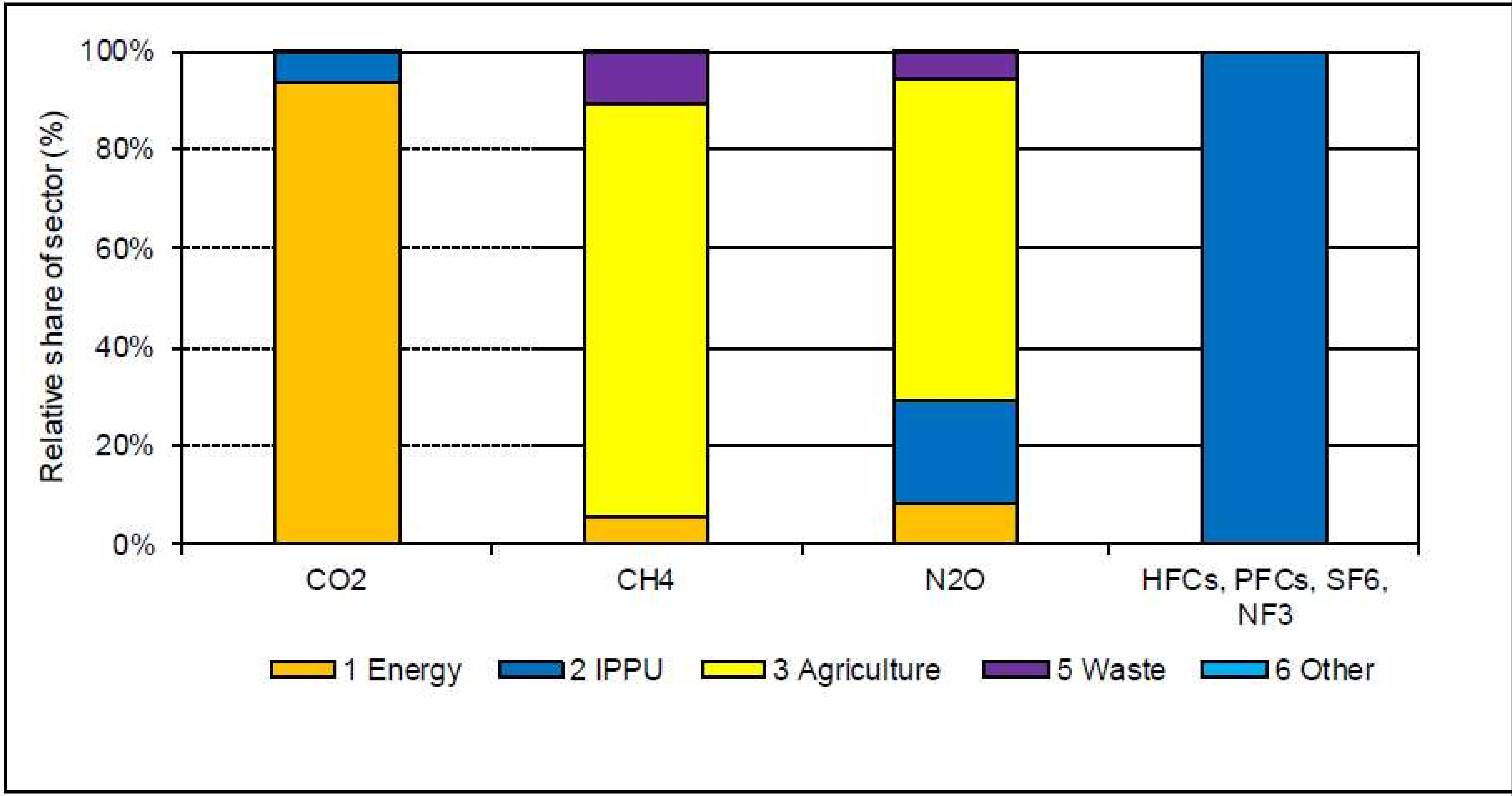


Figure 2-2 Relative contributions of the individual sectors (excluding LULUCF, excluding indirect CO_2) to GHG emissions in 2020.

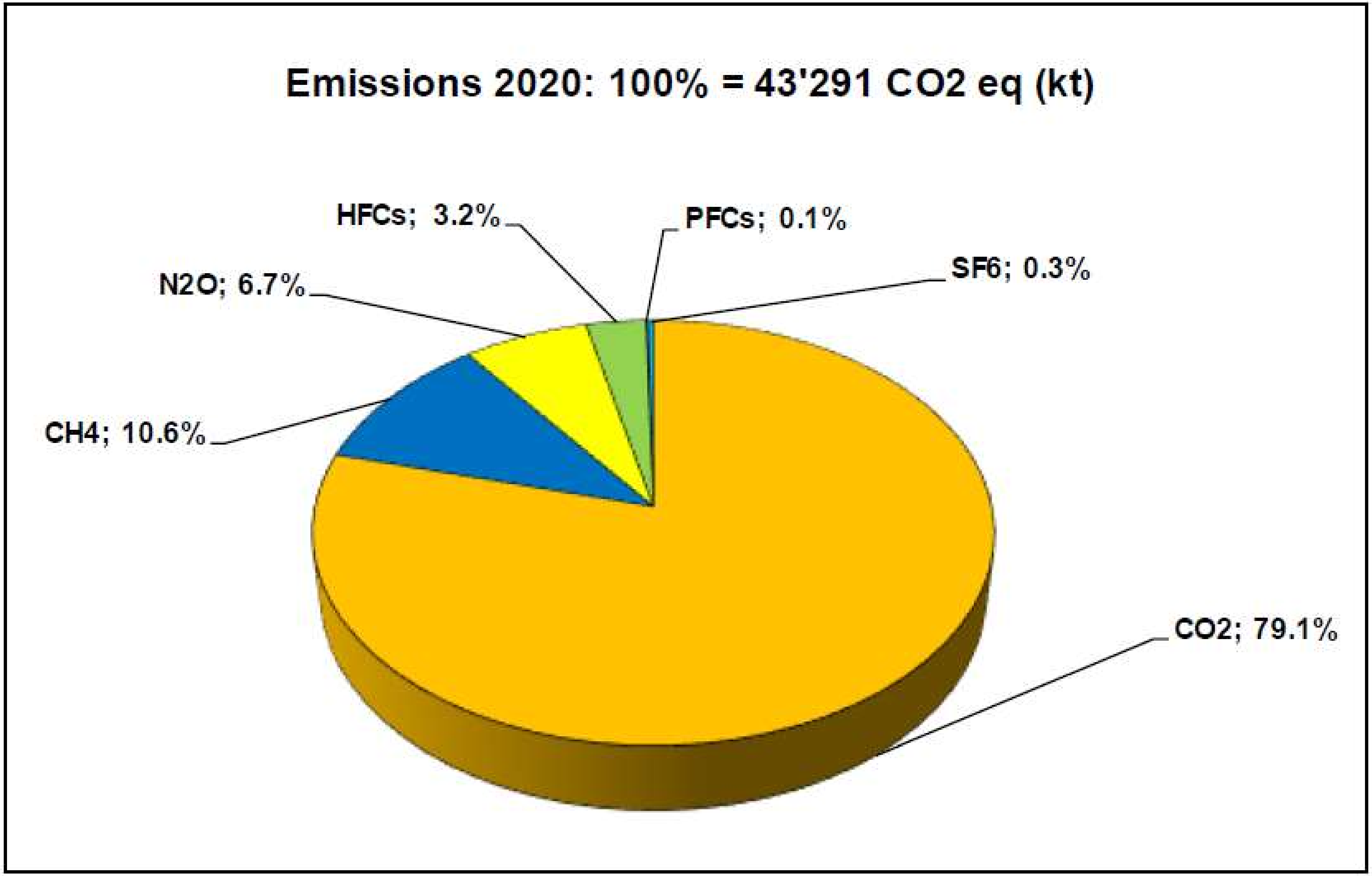


Figure 2-1 Contribution of individual gases to total greenhouse gas emissions in 2020 (excluding LULUCF, excluding indirect CO_2).

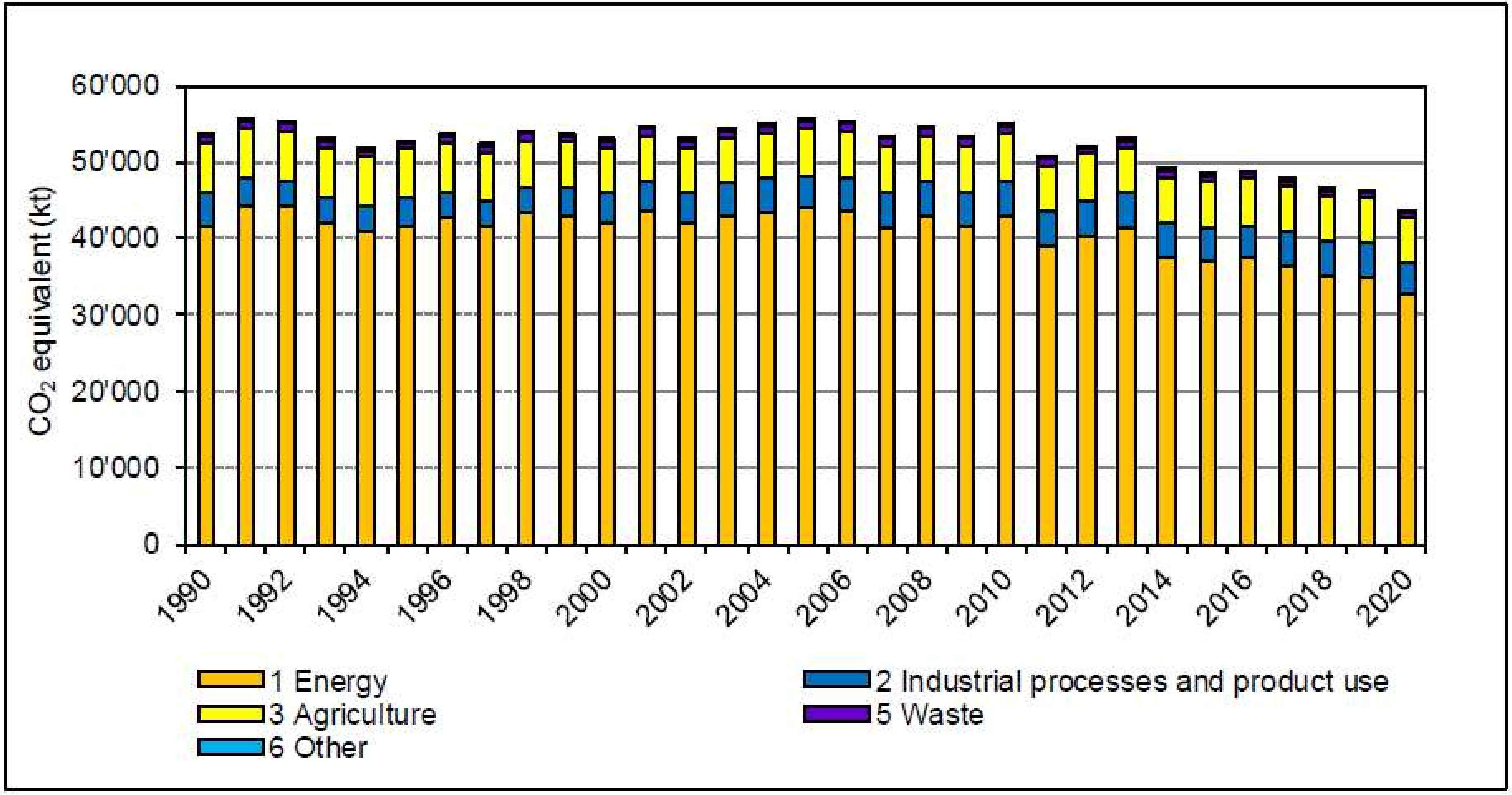


Figure 2-4 Greenhouse gas emissions in CO_2 equivalent (kt) by sectors (excluding LULUCF, excluding indirect CO_2).

Abbildung 10: *Übersicht der Handlungsfelder.*

BLW 2011

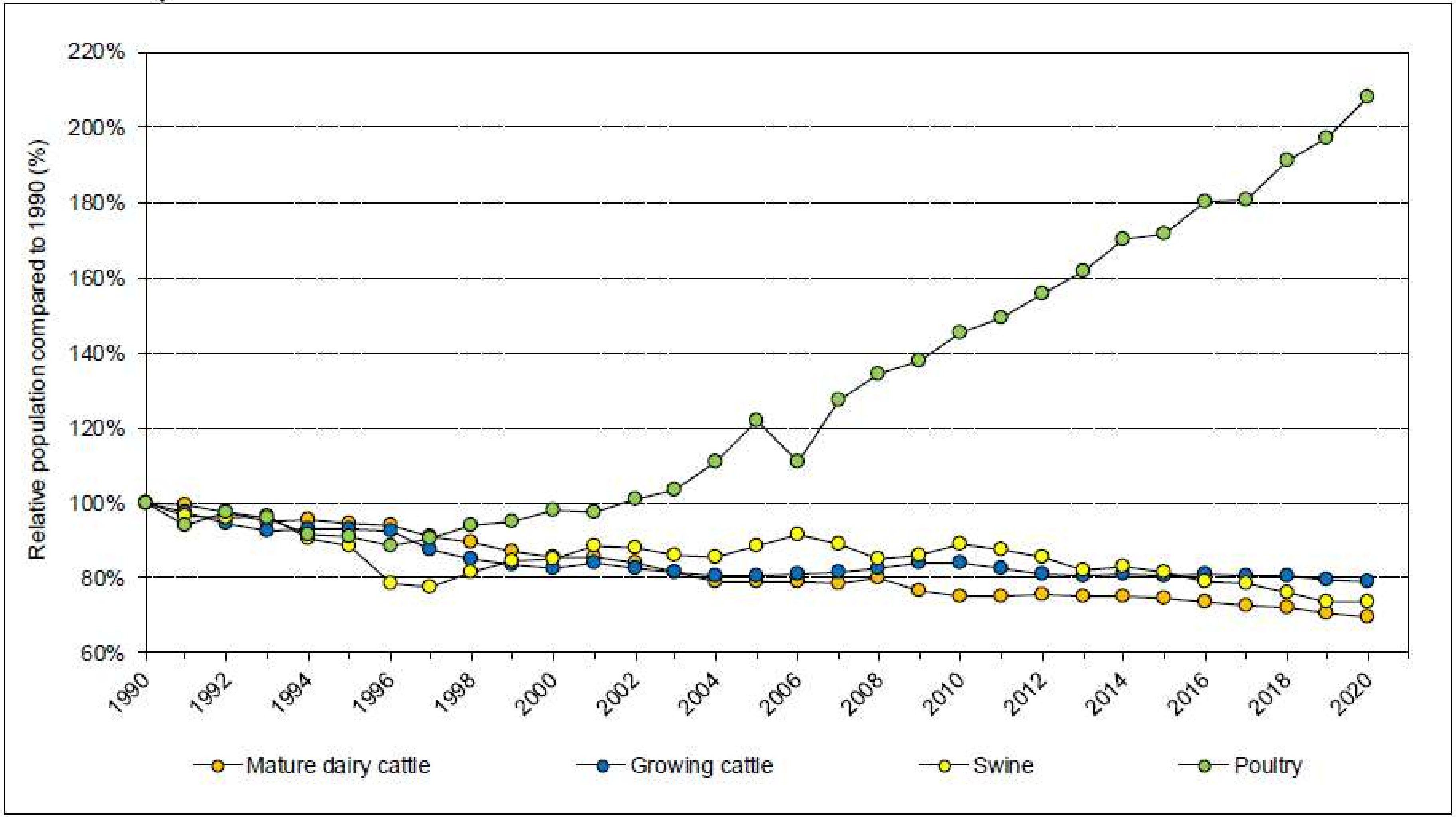


Figure 5-5 Relative development of the populations of main animal categories. The category with the strongest increase, i.e. other mature cattle, is not displayed, as it increases to over 1000% of the 1990 value by 2020.

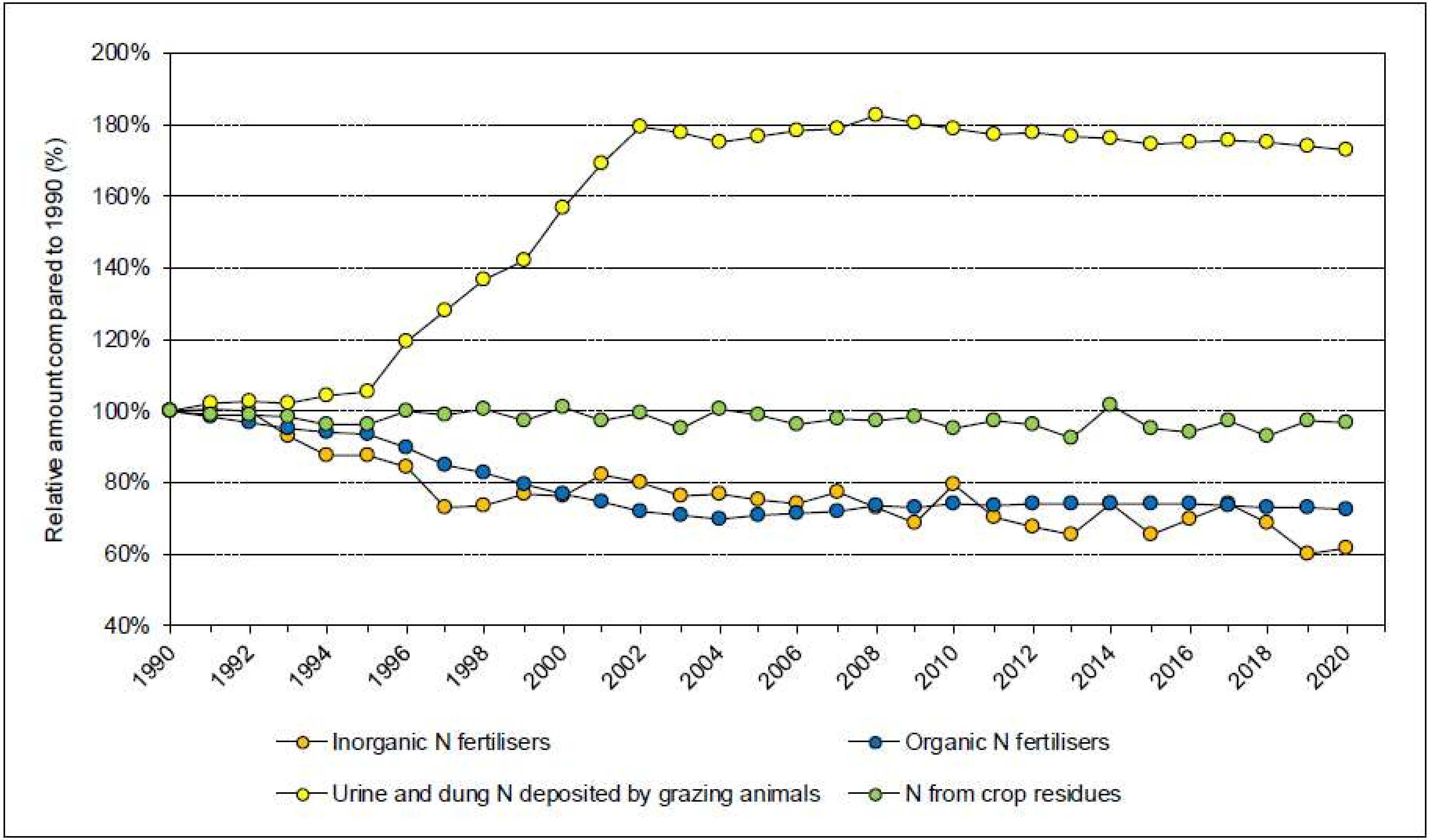
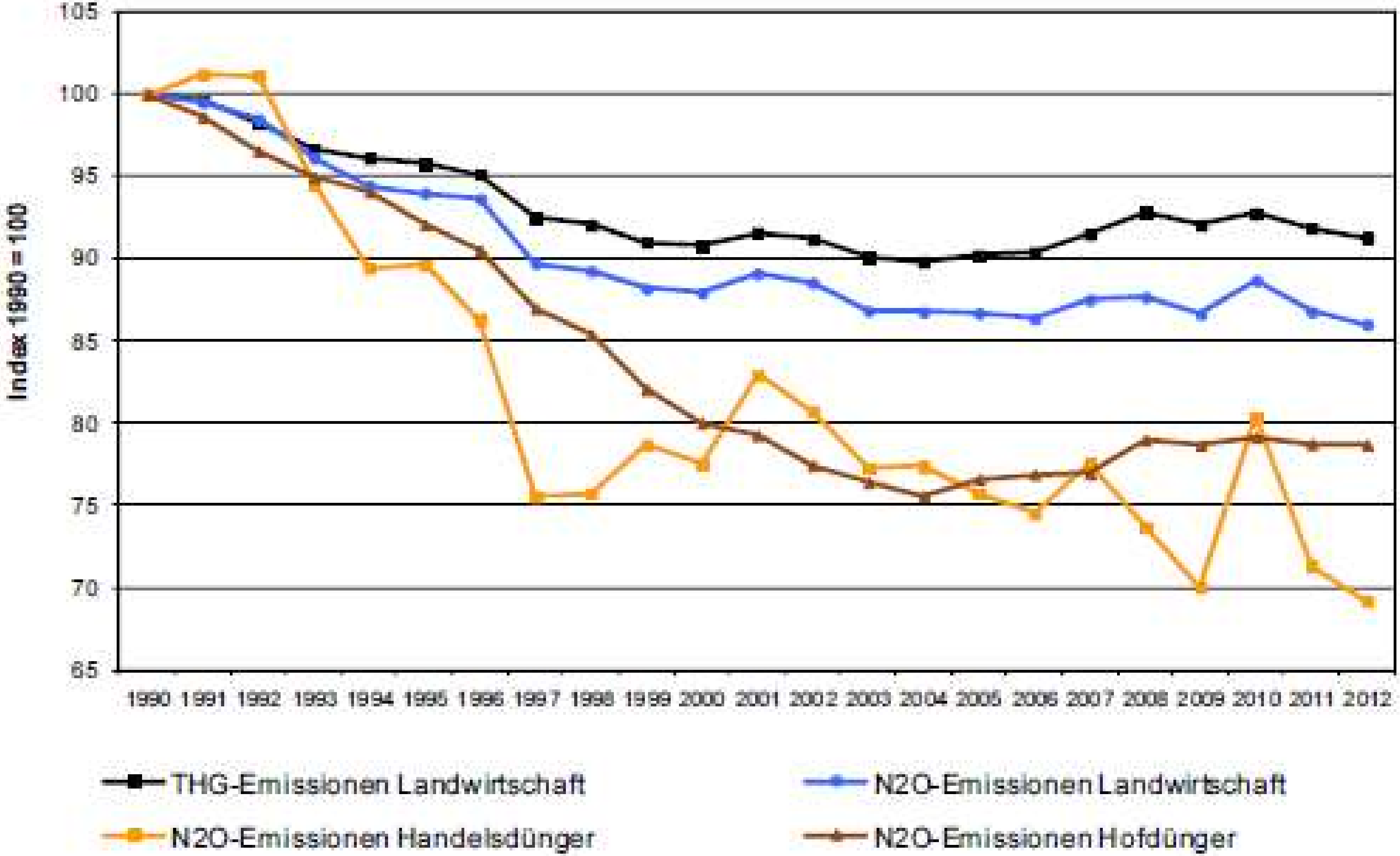
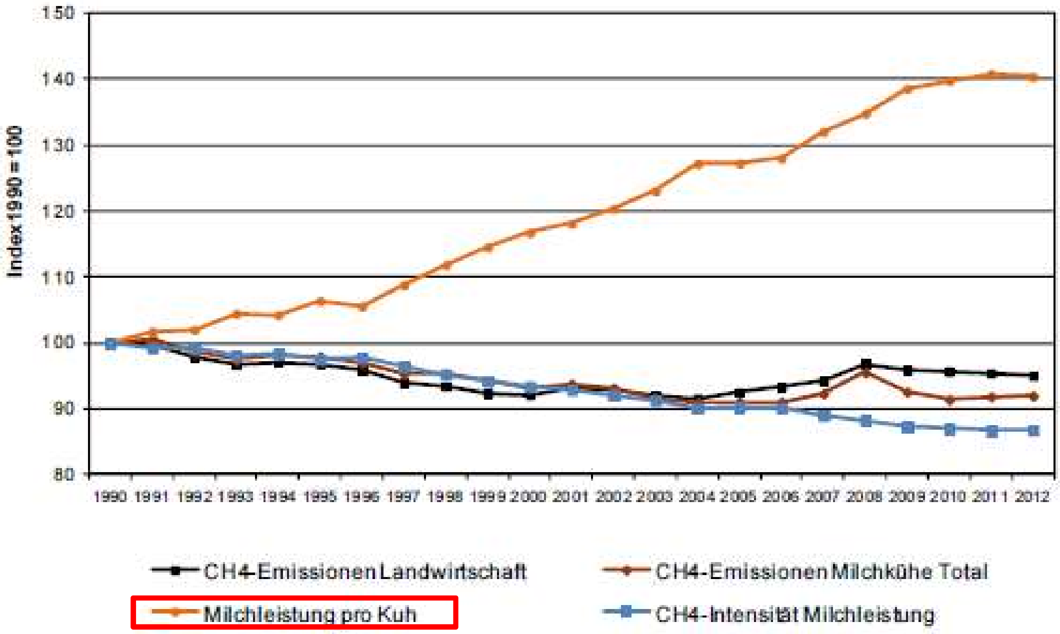


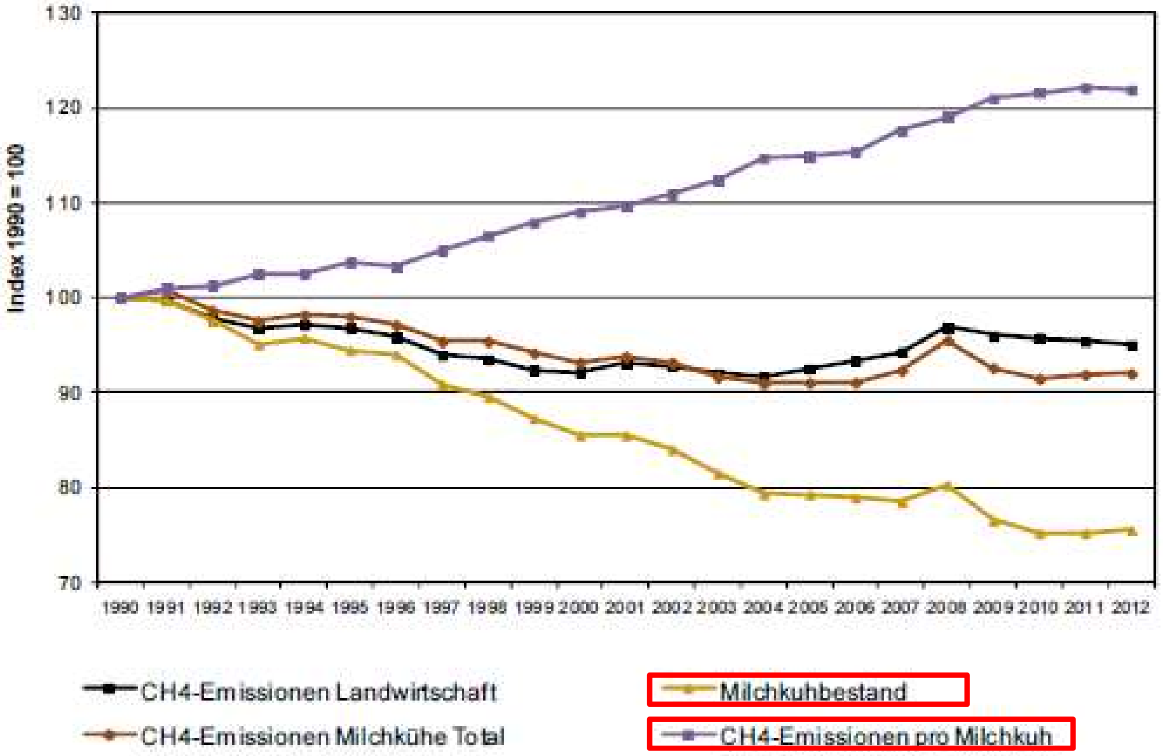
Figure 5-7 Relative development of the most important activity data for 3Da Direct N_2O emissions from managed soils.

Landwirtschaft



Landwirtschaft





BAFU 2014

Klimastrategie Landwirtschaft und Ernährung 2050 – BLW/BLV/BAFU

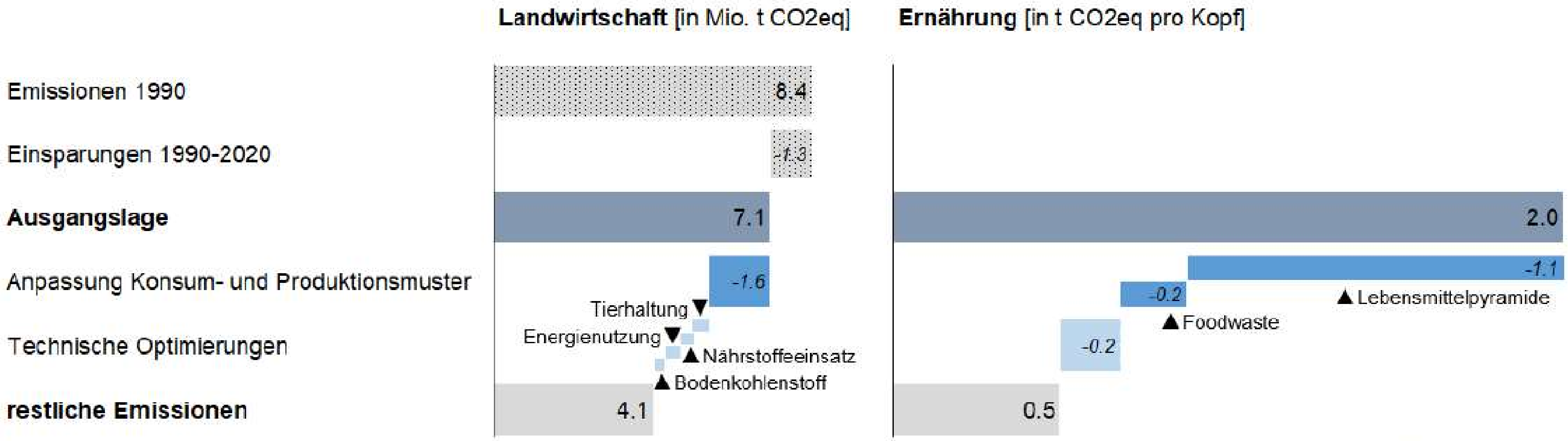
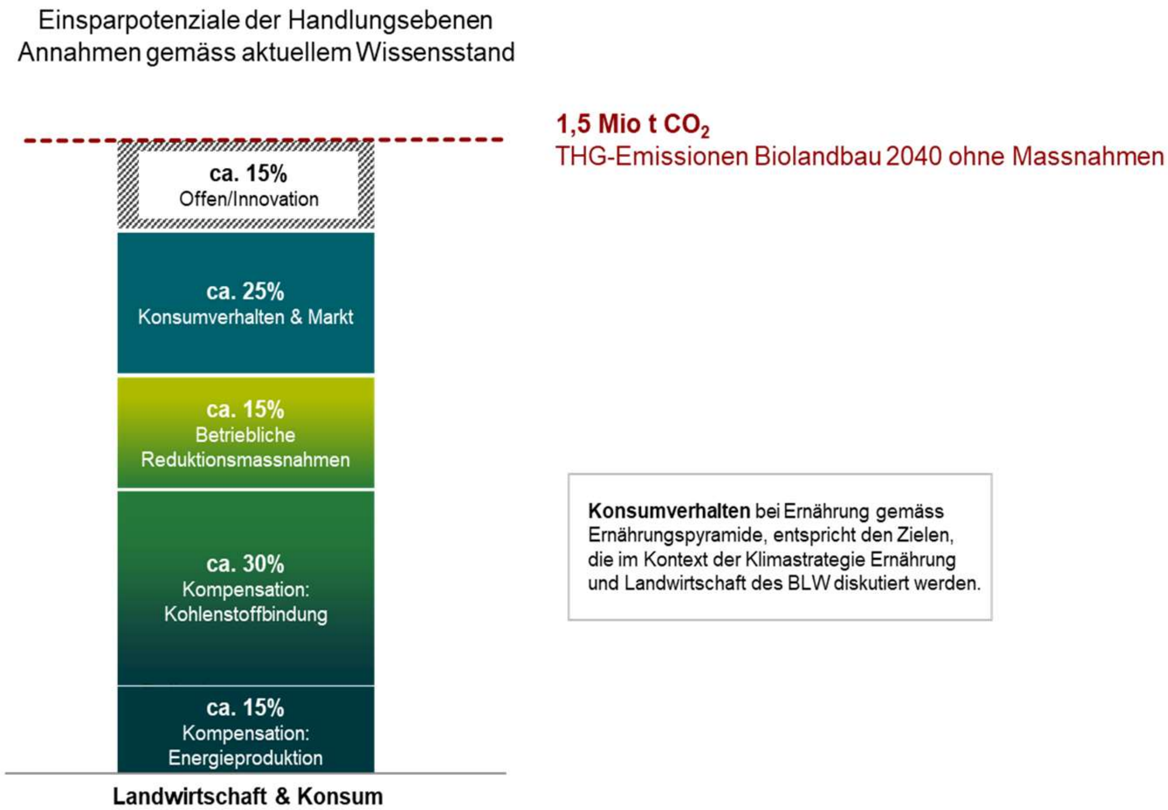


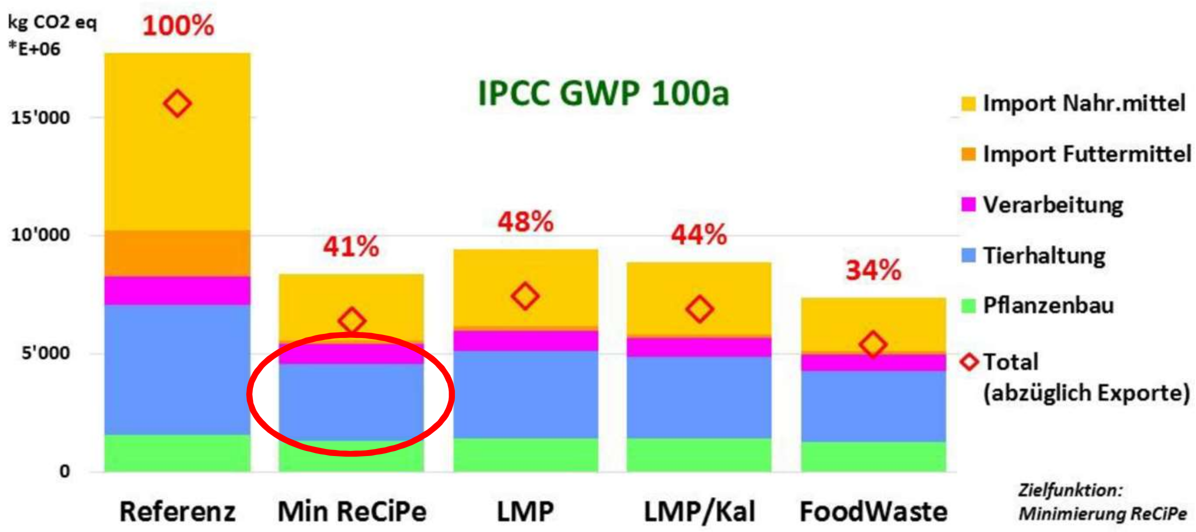
Figure 6 : Émissions actuelles de gaz à effet de serre, potentiels de réduction jusqu'en 2050 et émissions restantes dans l'alimentation et l'agriculture du point de vue de la production et de la consommation sur la base de l'inventaire des gaz à effet de serre, respectivement du compte global de l'environnement [45]

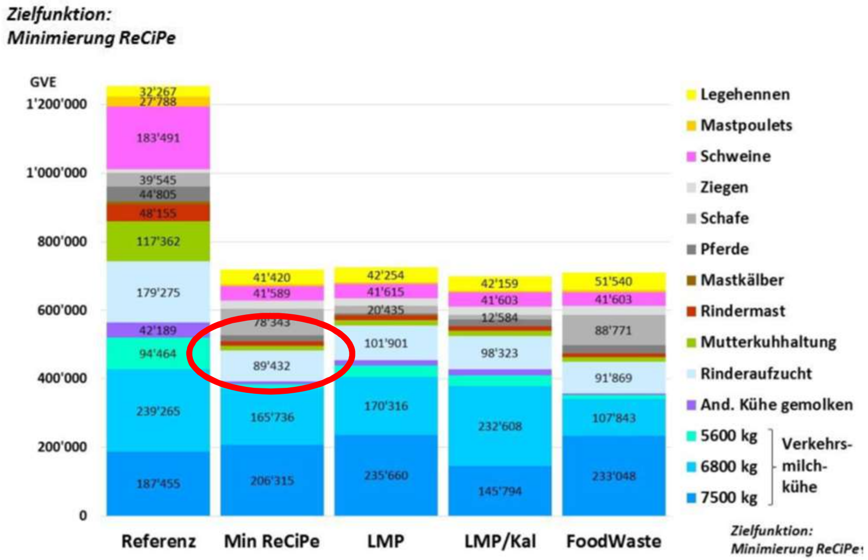
Vision klimaneutral Biolandwirtschaft 2040 – FiBL/BioSuisse



Konsumverhalten bei Ernährung gemäss Ernährungspyramide, entspricht den Zielen, die im Kontext der Klimastrategie Ernährung und Landwirtschaft des BLW diskutiert werden.

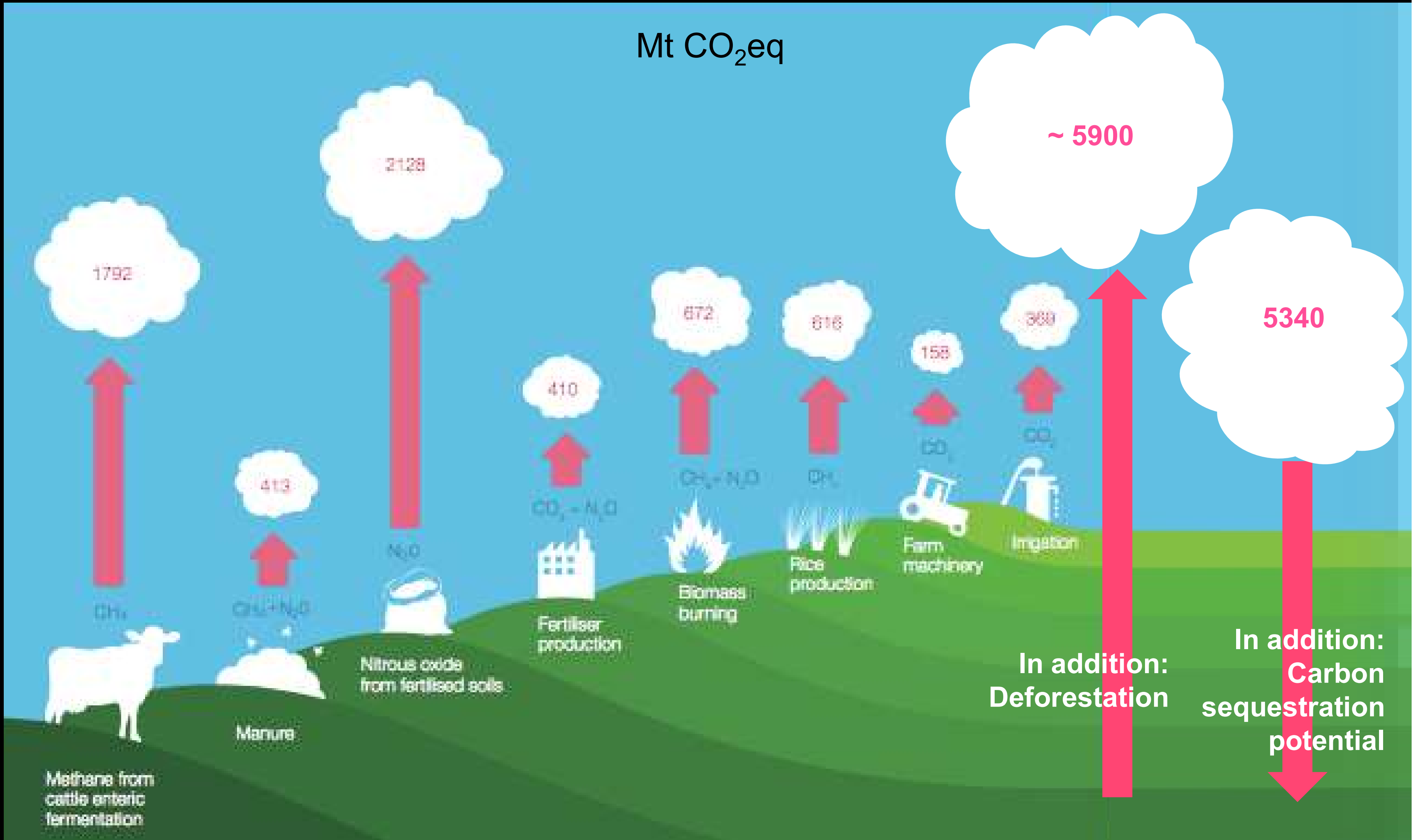
Klimaoptimiertes Ernährungssystem - Agroscope



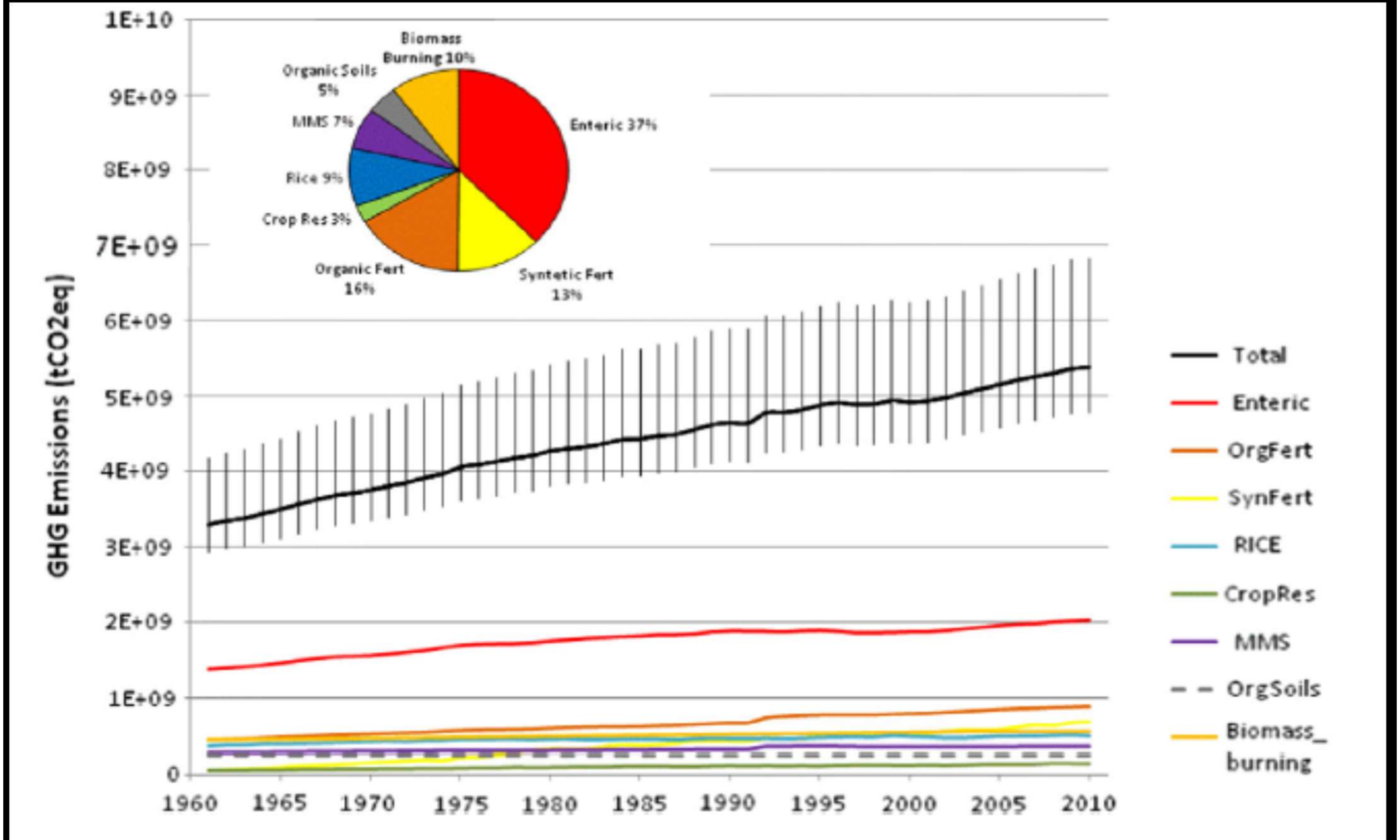


Zimmermann et al. 2017

Global

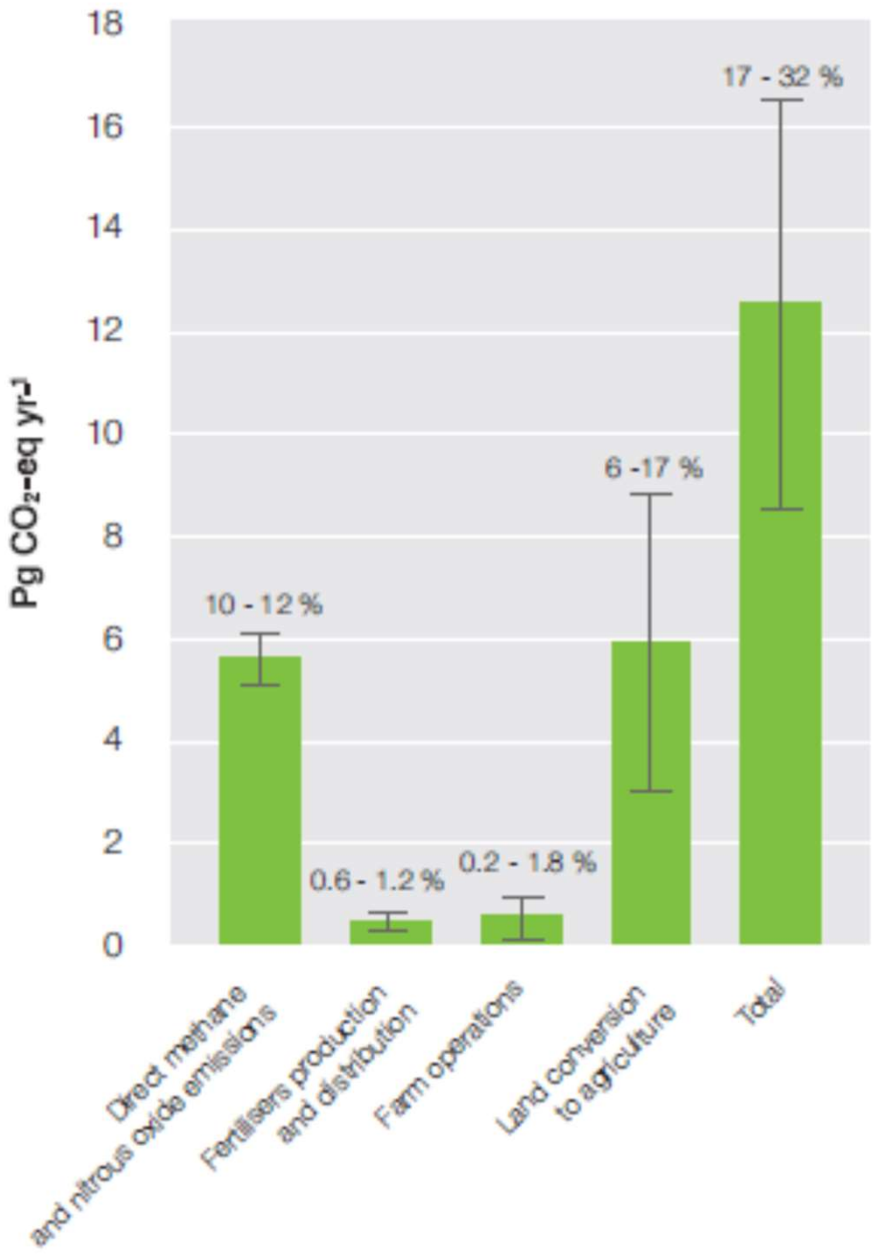


Mt CO2eq
1792
Methane from cattle enteric fermentation
413
Manure
2128
Nitrous oxide from fertilised soils
410
Fertiliser production
672
Biomass burning
616
Rice production
158
Farm machinery
369
Irrigation
~ 5900
In addition: Deforestation
5340
In addition: Carbon sequestration potential



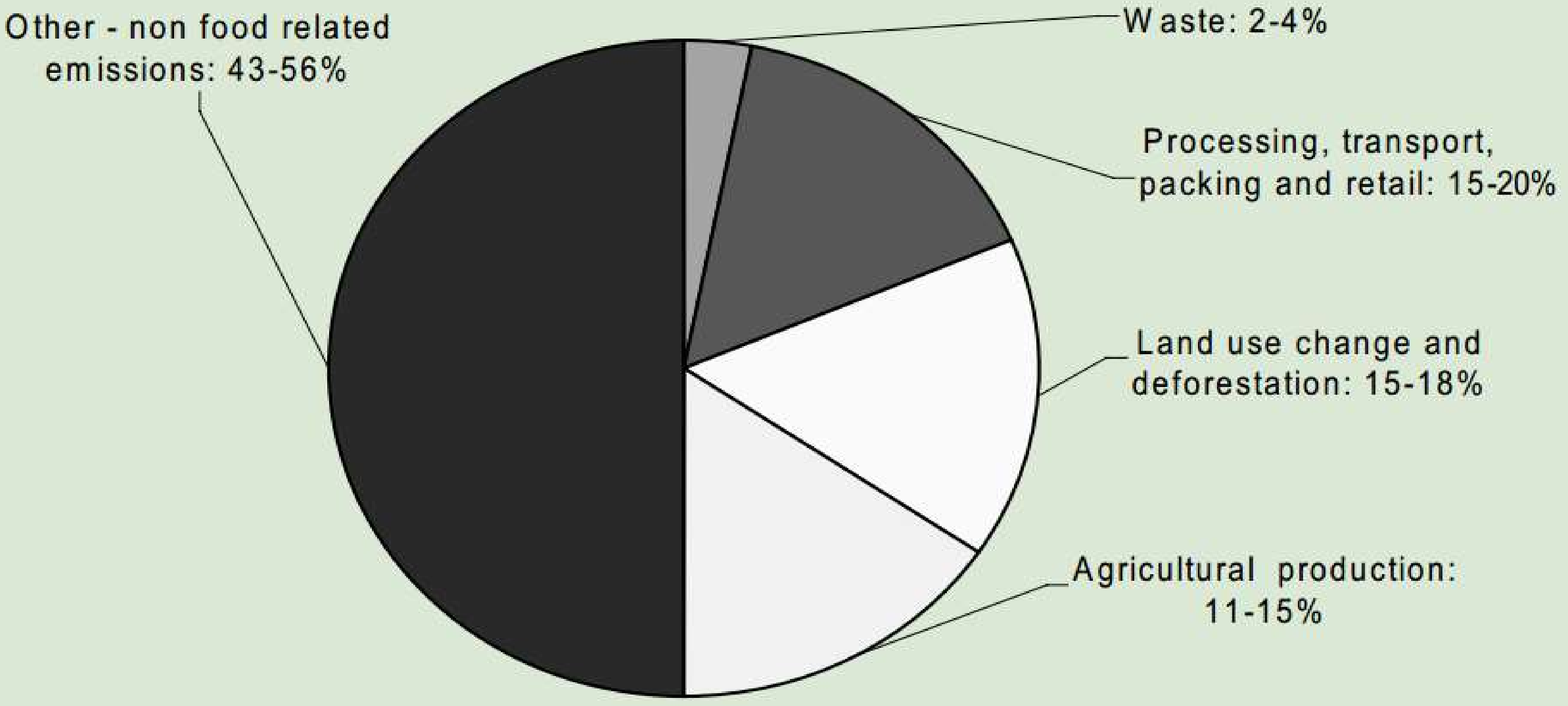
Tubiello et al. 2013

Figure 1. Global contribution of agriculture to greenhouse gas emissions.



Bellarby et al. 2008

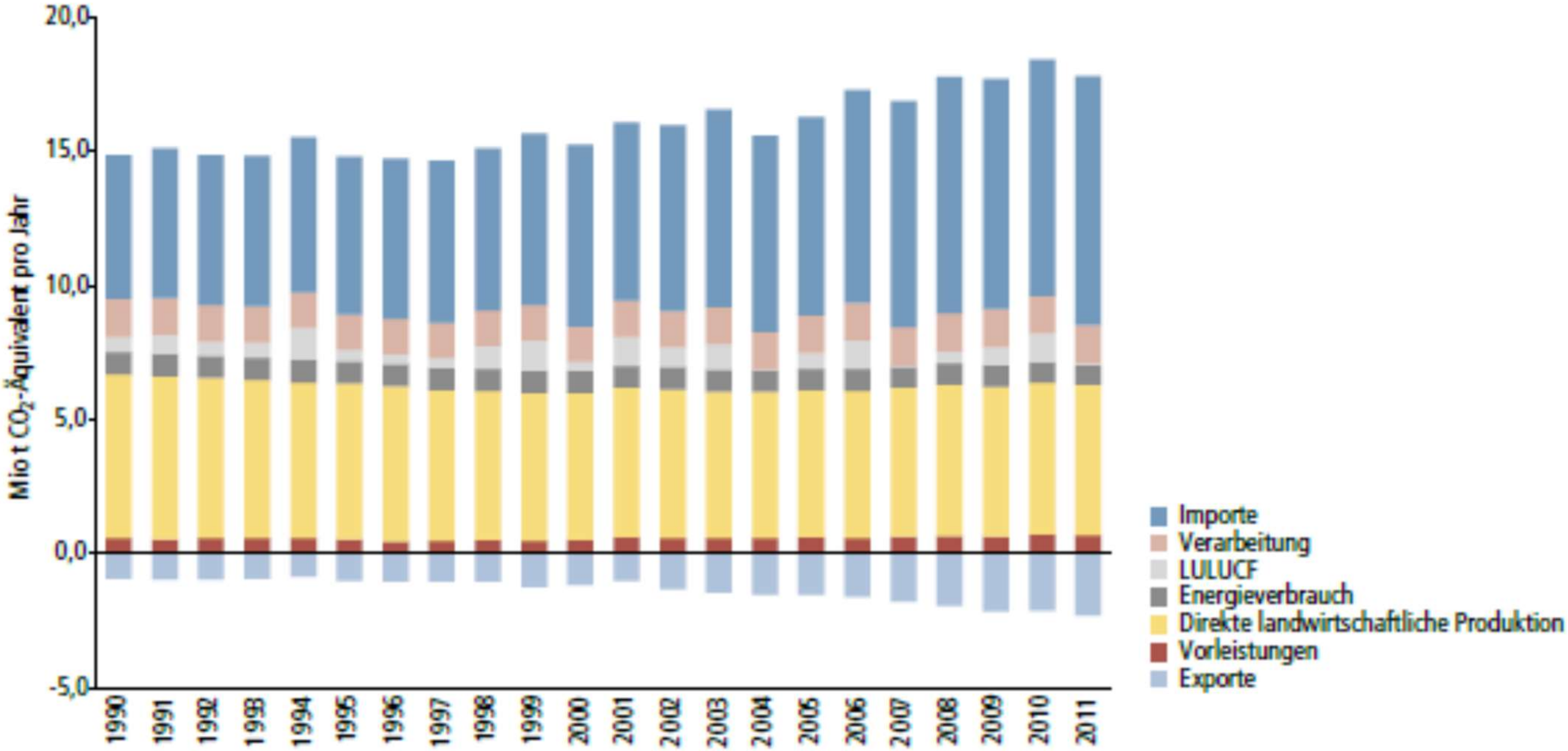
Figure 9: Contribution of the global food production system to total GHG emissions



Source: Estimates of GRAIN

GRAIN 2014

Schweiz – graue Emissionen



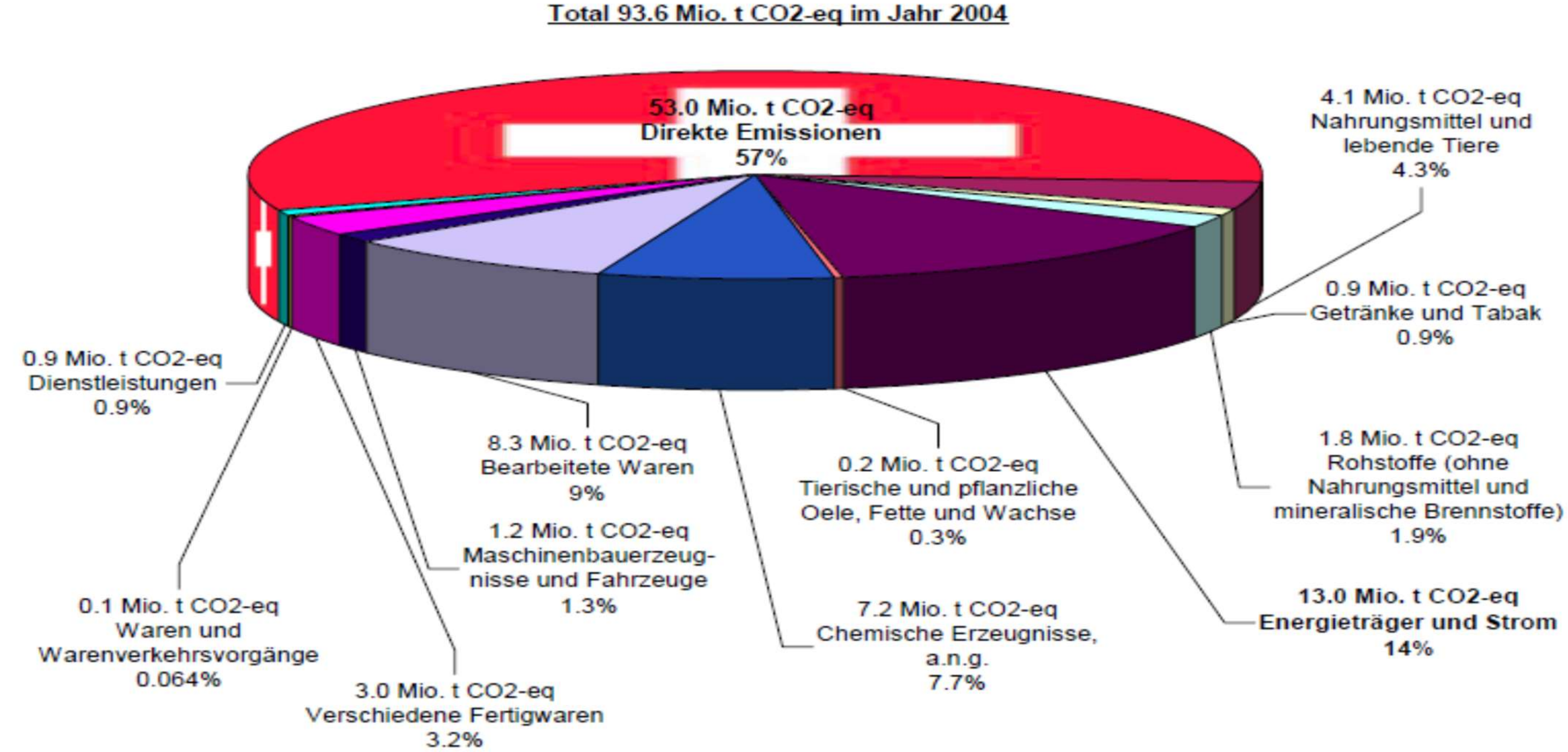
LULUCF: Landnutzung und Landnutzungsänderung *(Land Use / Land Use Change and Forestry)*

Abb. 2 | Treibhausgasemissionen der Schweizer Land- und Ernährungswirtschaft 1990–2011.

Bretscher et al. 2014

Abb. A > Weisse und graue Treibhausgas-Emissionen in der Schweiz im Jahr 2004 (Mio. Tonnen CO_2-eq pro Jahr).

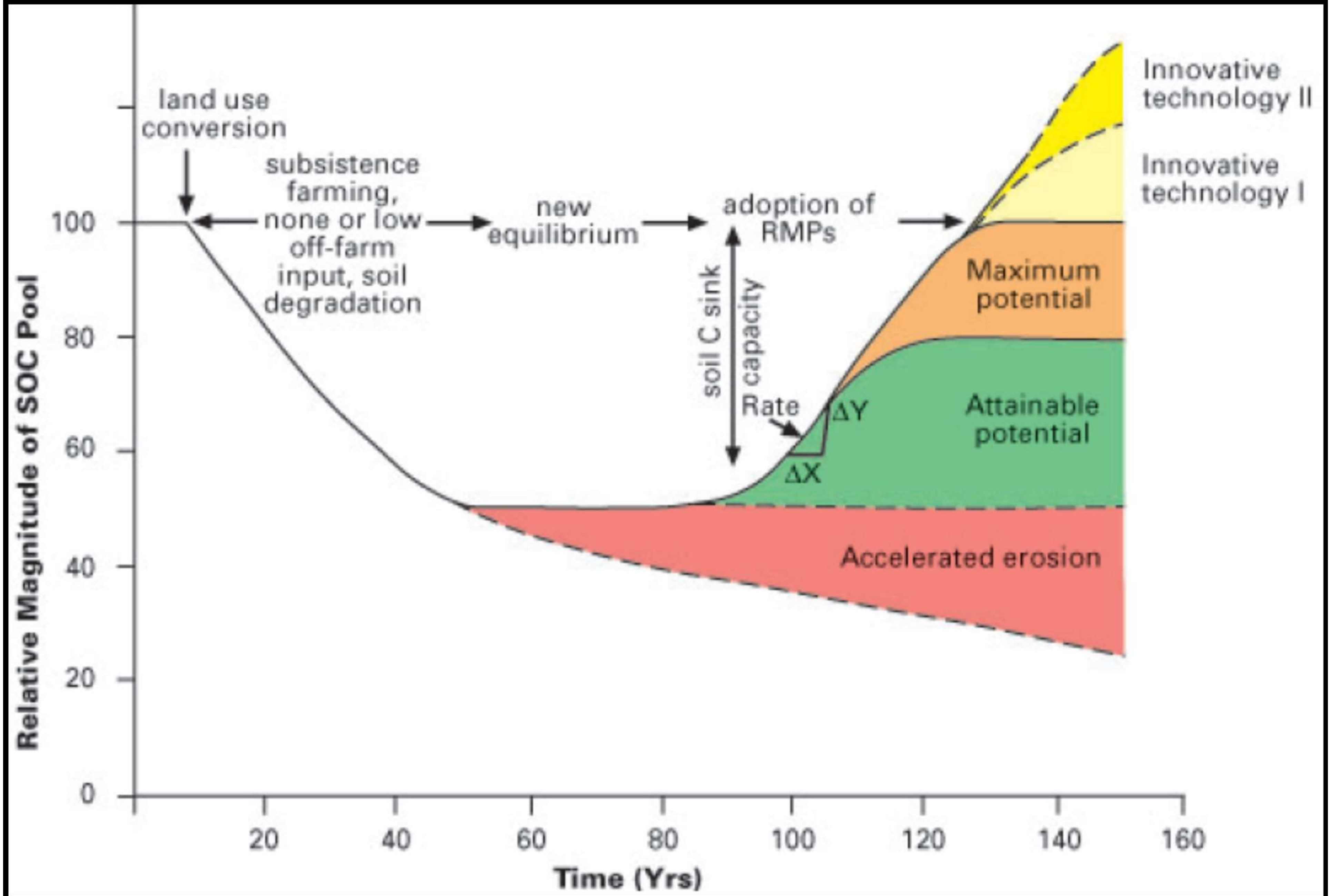
In dieser Grafik werden die weissen und grauen Emissionen aller in der Schweiz konsumierten Waren und Dienstleistungen berücksichtigt. Die direkten Emissionen betragen 53 Mio. Tonnen. Die grössten Netto-Importe kommen aus dem Energiebereich mit 13 Mio. Tonnen. Dienstleistungen (inkl. die Bilanz des Flugverkehrs vom und nach dem Ausland) tragen nur knapp 1 Mio. t zum Gesamtsaldo bei.

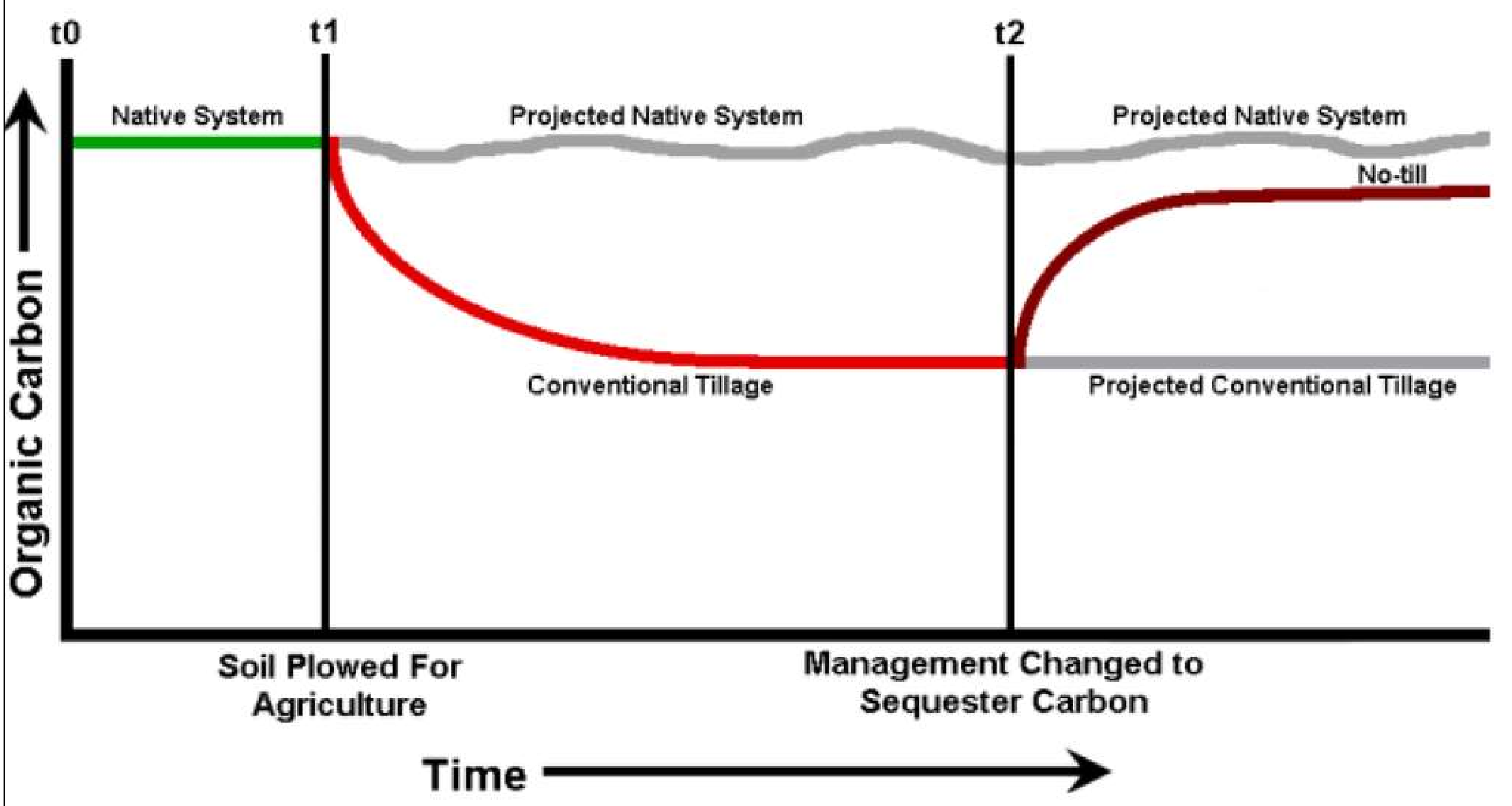


Quelle: Berechnung ESU-services GmbH.

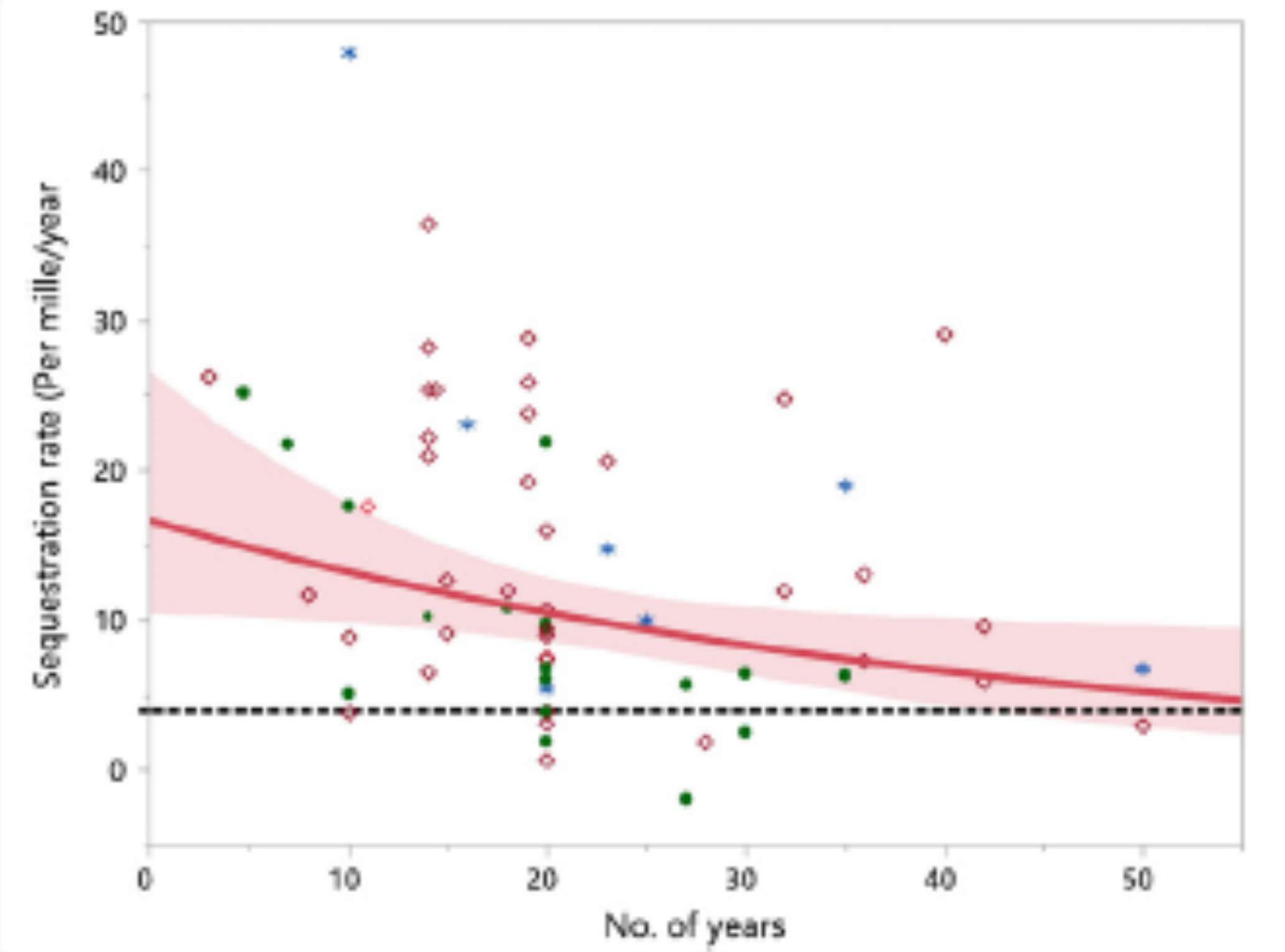
Jungbluth et al. 2007

Bodenkohlenstoff


land use conversion
subsistence farming, none or low off-farm input, soil degradation
new equilibrium
adoption of RMPs
soil C sink capacity
Rate
ΔY
ΔX
Innovative technology II
Innovative technology I
Maximum potential
Attainable potential
Accelerated erosion
Relative Magnitude of SOC Pool
0
20
40
60
80
100
20
40
60
80
100
120
140
160
Time (Yrs)


t0
t1
t2
Native System
Projected Native System
Projected Native System
No-till
Conventional Tillage
Projected Conventional Tillage
Organic Carbon
Soil Plowed For Agriculture
Management Changed to Sequester Carbon
Time

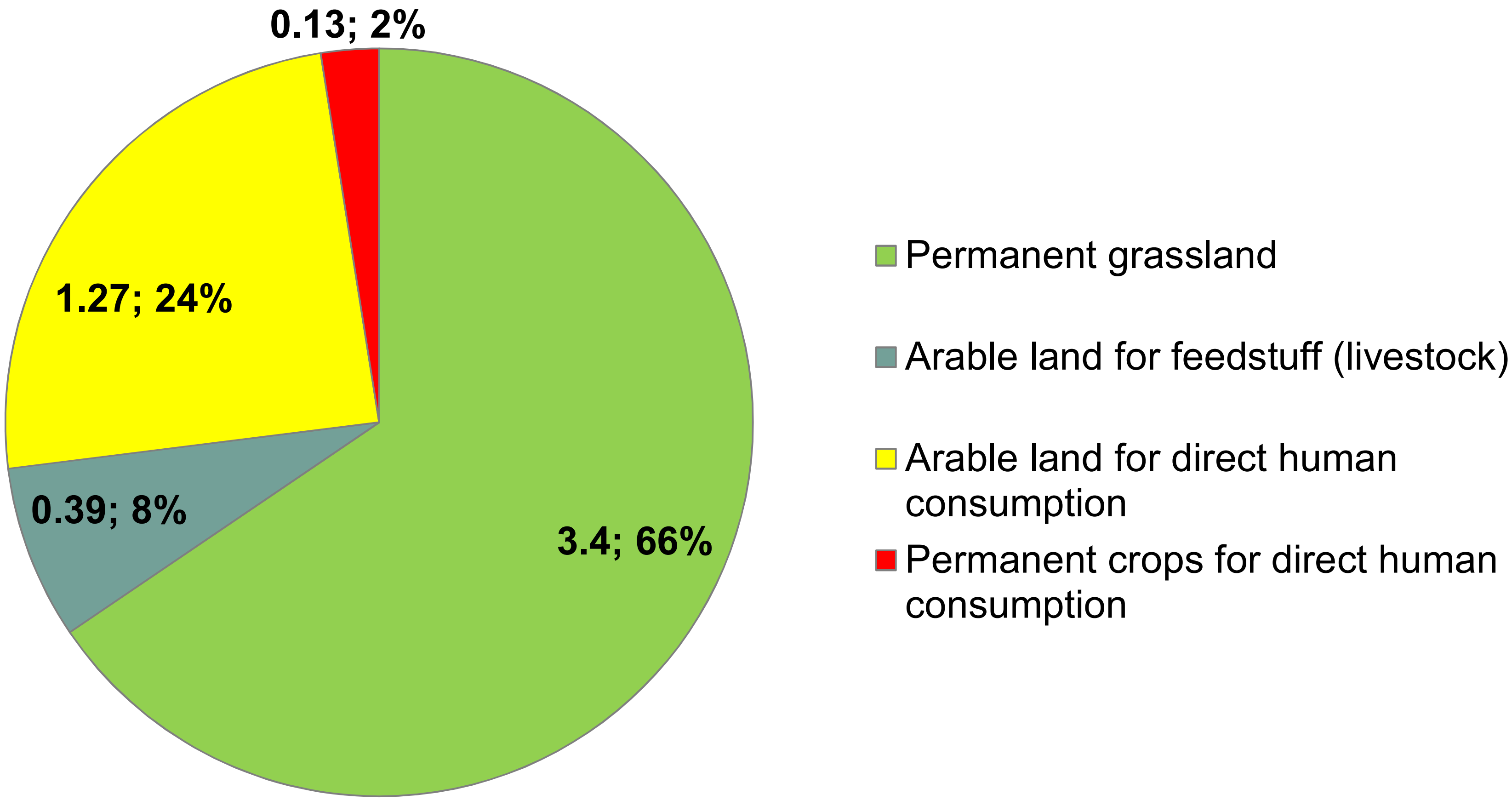
Brevik 2013



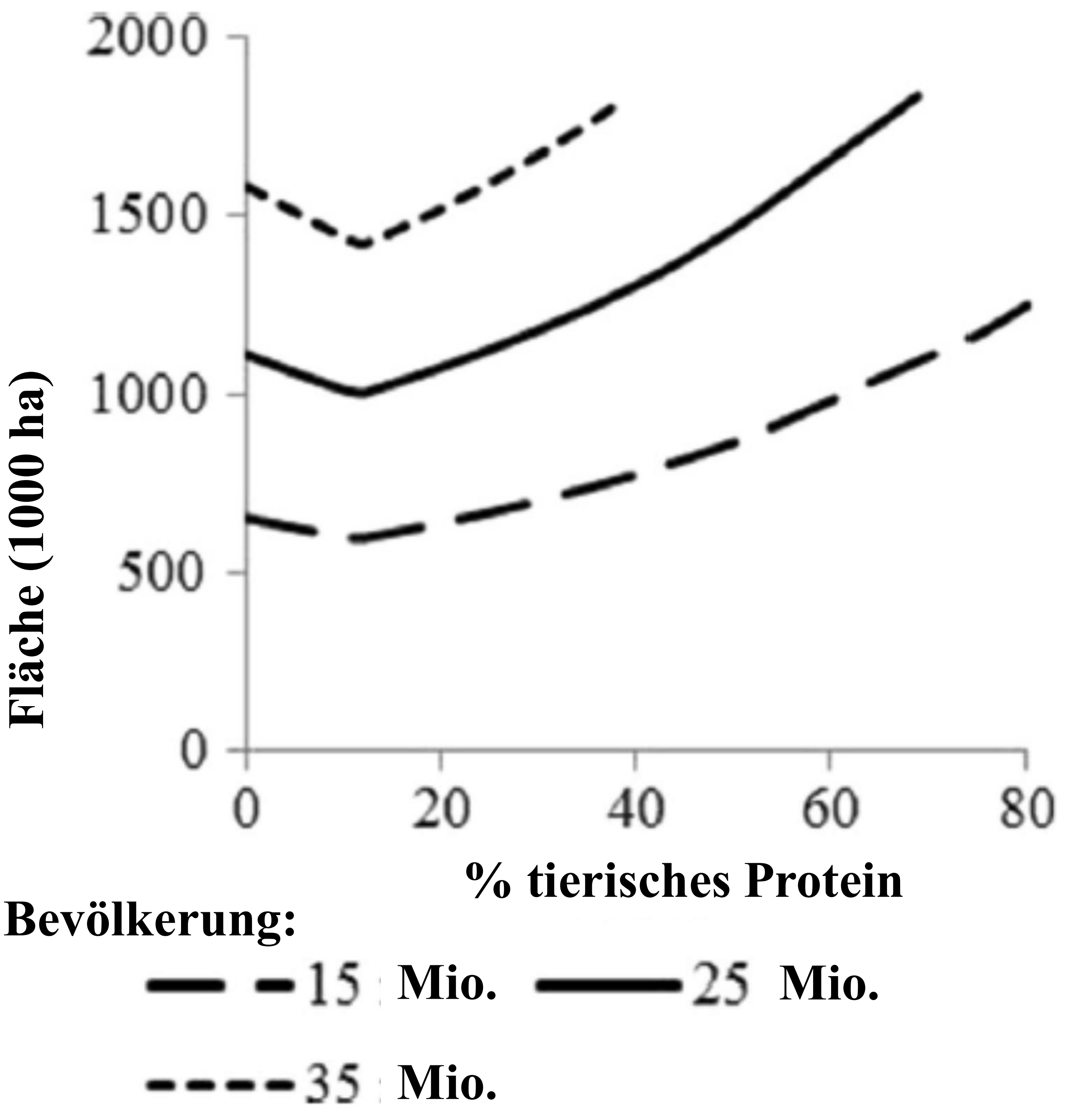
Minansny et al. 2017

Grasland

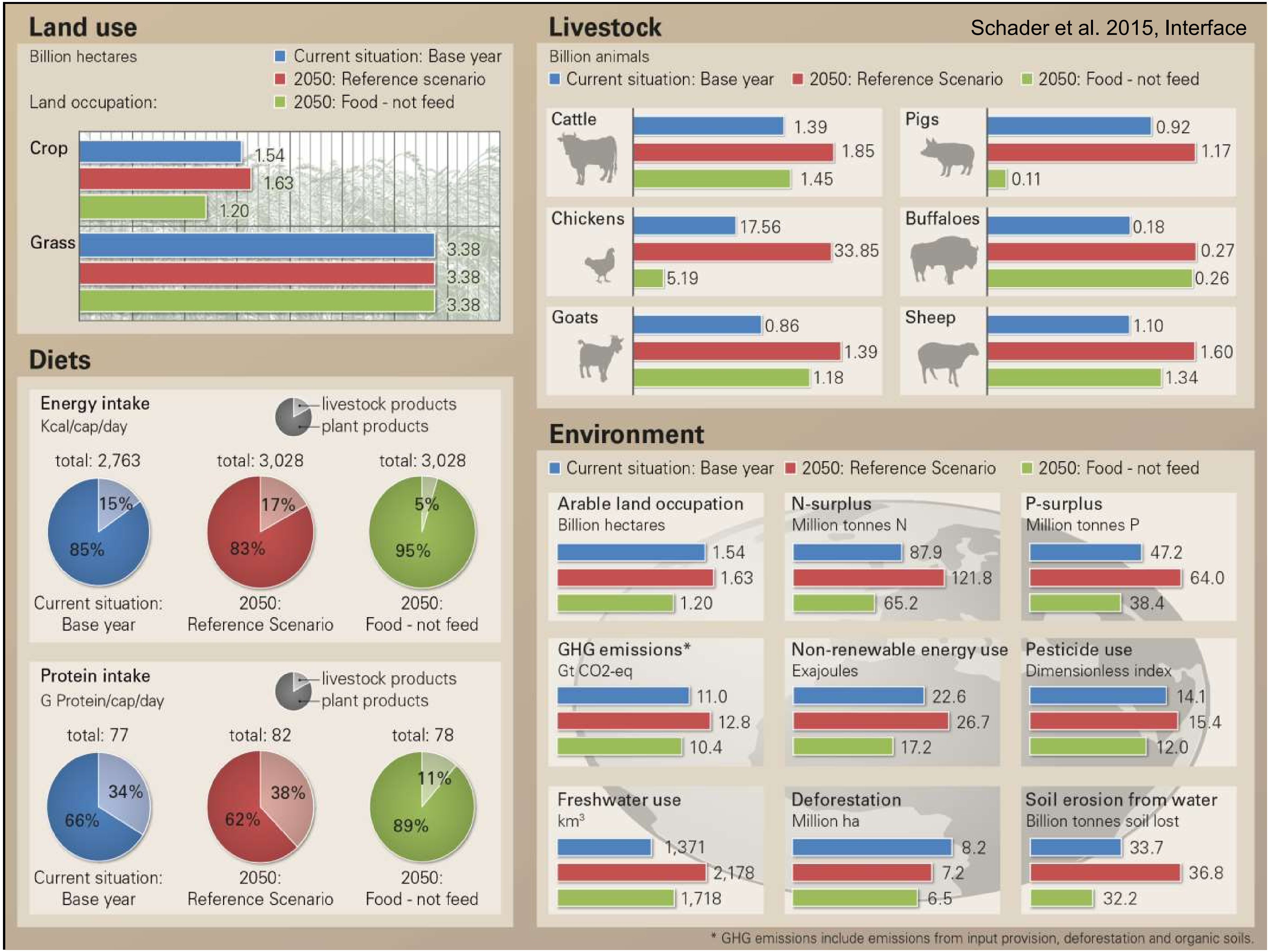
Landnutzung weltweit
(in Milliarden ha / Prozent)



Quelle: FAO



Van Kernebeek et al. 2015, Int J Life Cycle Assess


Land use
Billion hectares
Land occupation:
Current situation: Base year
2050: Reference scenario
2050: Food - not feed
Crop
1.54
1.63
1.20
Grass
3.38
3.38
3.38
Livestock
Schader et al. 2015, Interface
Billion animals
Current situation: Base year
2050: Reference Scenario
2050: Food - not feed
Cattle
1.39
1.85
1.45
Pigs
0.92
1.17
0.11
Chickens
17.56
33.85
5.19
Buffaloes
0.18
0.27
0.26
Goats
0.86
1.39
1.18
Sheep
1.10
1.60
1.34
Diets
Energy intake
Kcal/cap/day
livestock products
plant products
total: 2,763
15%
85%
Current situation: Base year
total: 3,028
17%
83%
2050: Reference Scenario
total: 3,028
5%
95%
2050: Food - not feed
Protein intake
G Protein/cap/day
livestock products
plant products
total: 77
34%
66%
Current situation: Base year
total: 82
38%
62%
2050: Reference Scenario
total: 78
11%
89%
2050: Food - not feed
Environment
Current situation: Base year
2050: Reference Scenario
2050: Food - not feed
Arable land occupation
Billion hectares
1.54
1.63
1.20
N-surplus
Million tonnes N
87.9
121.8
65.2
P-surplus
Million tonnes P
47.2
64.0
38.4
GHG emissions*
Gt CO2-eq
11.0
12.8
10.4
Non-renewable energy use
Exajoules
22.6
26.7
17.2
Pesticide use
Dimensionless index
14.1
15.4
12.0
Freshwater use
km³
1,371
2,178
1,718
Deforestation
Million ha
8.2
7.2
6.5
Soil erosion from water
Billion tonnes soil lost
33.7
36.8
32.2
* GHG emissions include emissions from input provision, deforestation and organic soils.

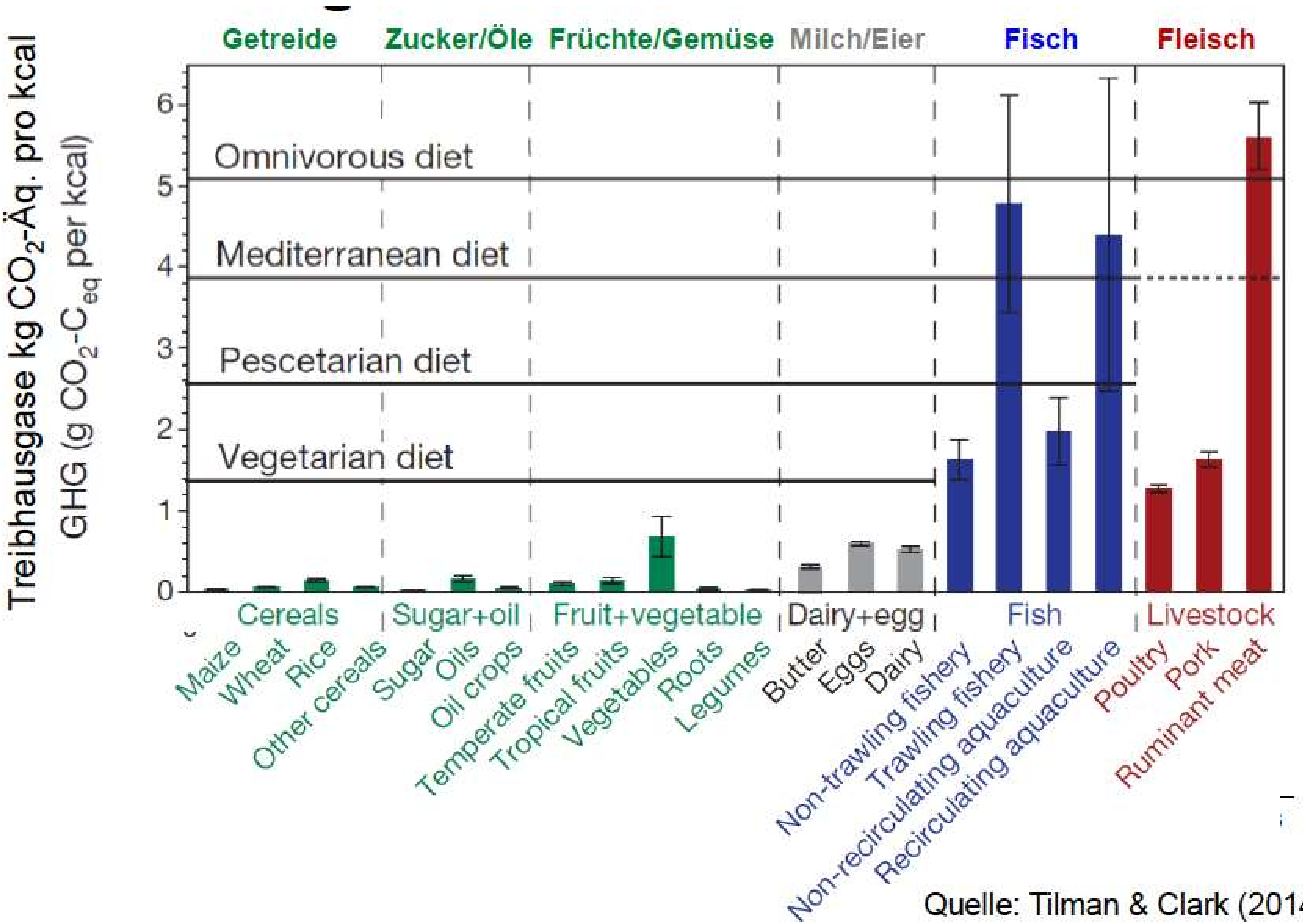
Flächenverbrauch, % im Vergleich zur Referenz

% Wastage reduction	% Concentrates	Climate change impact: zero	medium	high
0	100	0	21	46
	50	-16	2	25
	0	-26	-9	12
25	100	-6	14	39
	50	-22	4	18
	0	-30	-14	6
50	100	-11	8	30
	50	-25	-9	10
	0	-35	-19	-1

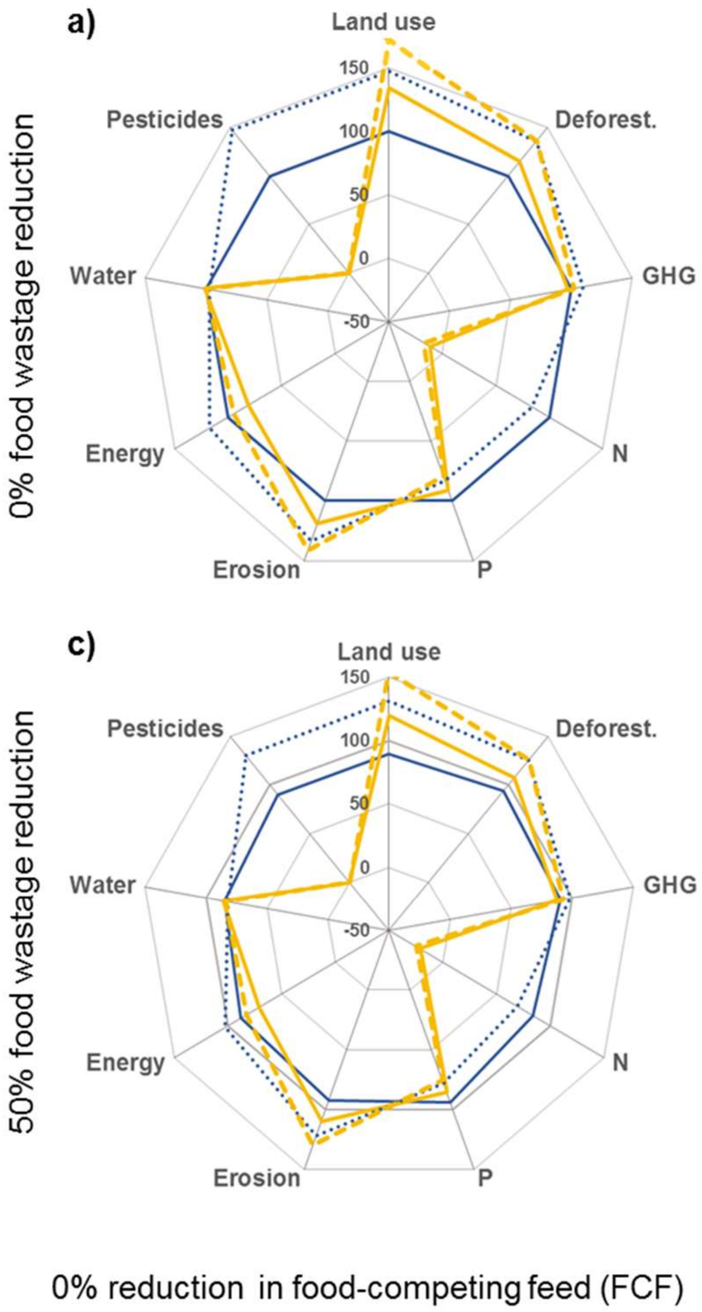
N-Bilanz: kgN/ha (globaler Durchschnitt)

% Wastage reduction	% Concentrates	Climate change impact: zero	medium	high
0	100	25	23	21
	50	20	18	17
	0	15	13	12
25	100	23	21	19
	50	18	17	15
	0	13	12	11
50	100	21	19	17
	50	16	15	14
	0	11	10	10

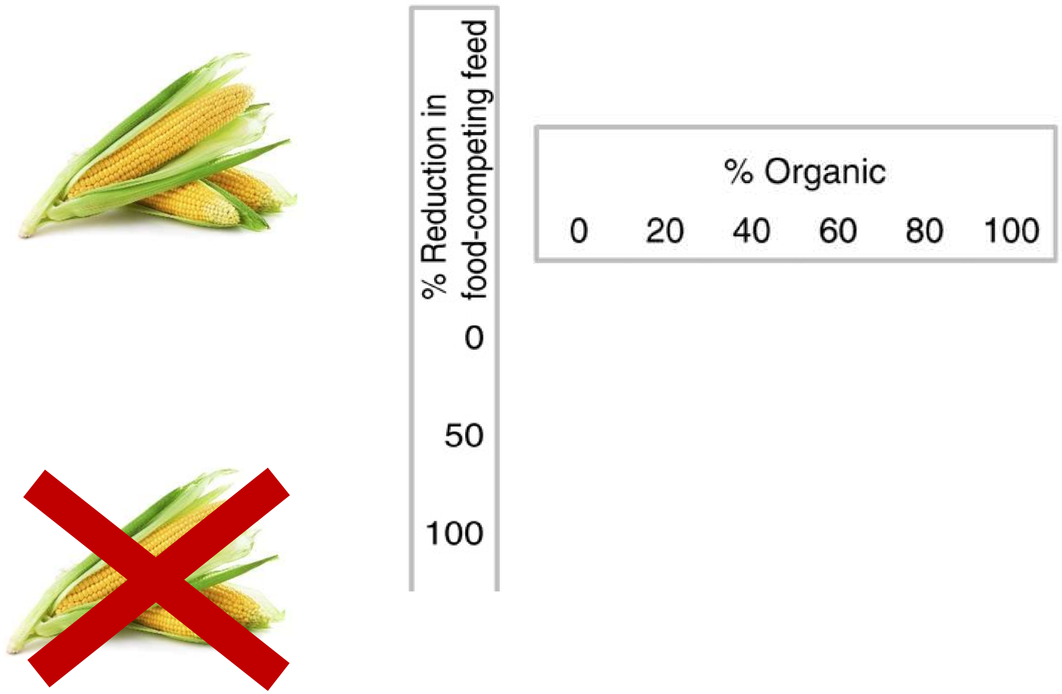
Nachhaltige Landwirtschaft



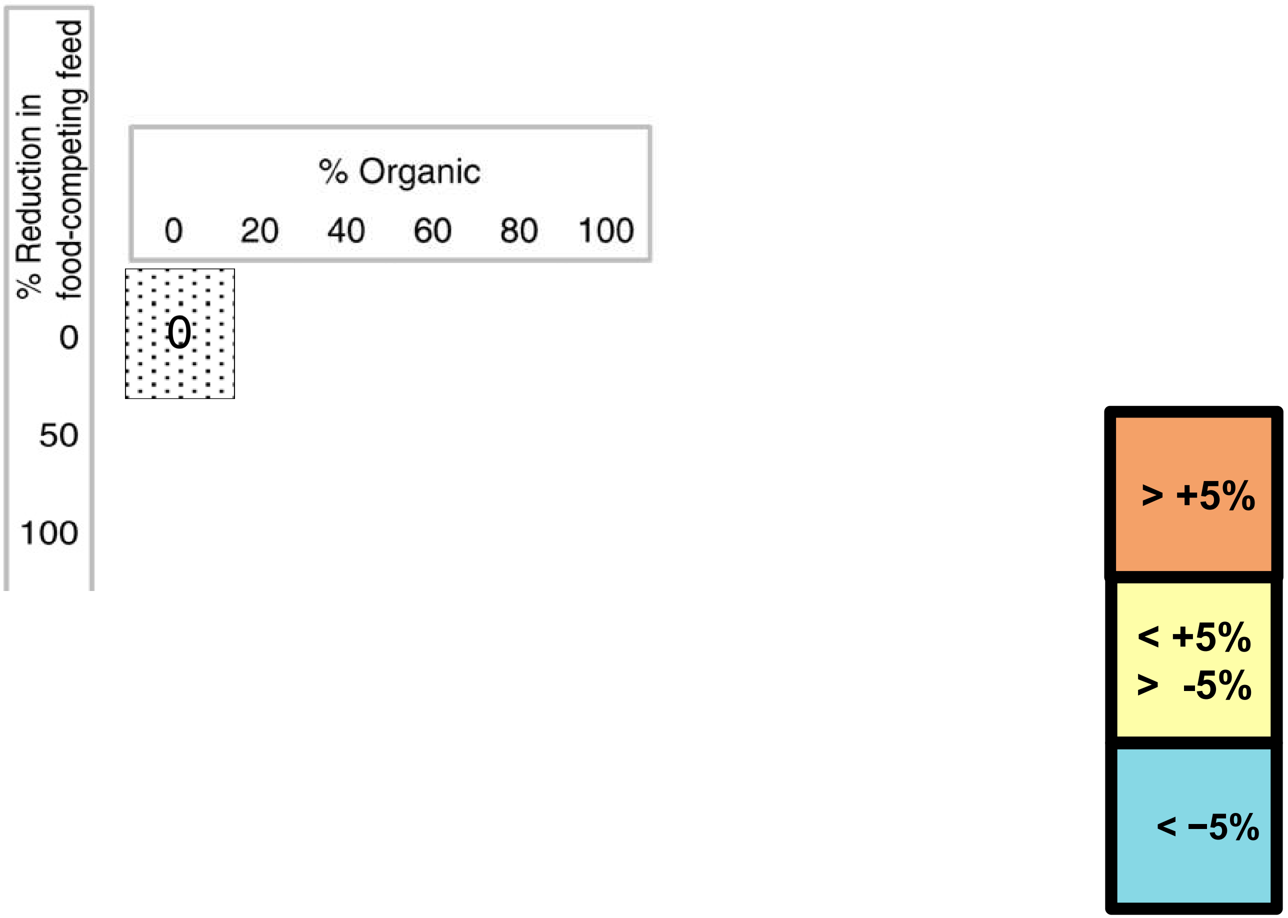
Quelle: Tilman & Clark (2014)



Muller et al. 2017, Nature Communications



Muller et al. 2017; Courtesy: R. Zürcher



Muller et al. 2017; Courtesy: R. Zürcher

% Reduction in food-competing feed	% Organic 0	20	40	60	80	100
0	0	5	10	17	25	33
50	–16	–12	–8	–4	2	8
100	–26	–24	–20	–16	–12	–8

> +5%

< +5%
> -5%

< −5%

Muller et al. 2017; Courtesy: R. Zürcher

% Reduction in food-competing feed	% Organic 0	20	40	60	80	100
0	0	5	10	17	25	33
50	–16	–12	–8	–4	2	8
100	–26	–24	–20	–16	–12	–8

> +5%

< +5%
> -5%

< −5%

Muller et al. 2017; Courtesy: R. Zürcher

Muller et al. 2017; Courtesy: R. Zürcher

Climate change impact on yields

% Wastage reduction	% Reduction in food-competing feed	Zero: % Organic 0	20	40	60	80	100	Medium	High
0	0	0	5	10	17	25	33		
	50	−16	−12	−8	−4	2	8		
	100	−26	−24	−20	−16	−12	−8		
25	0								
	50								
	100								
50	0								
	50								
	100								

> +5%

< +5%
> -5%

<−5%

Climate change impact on yields

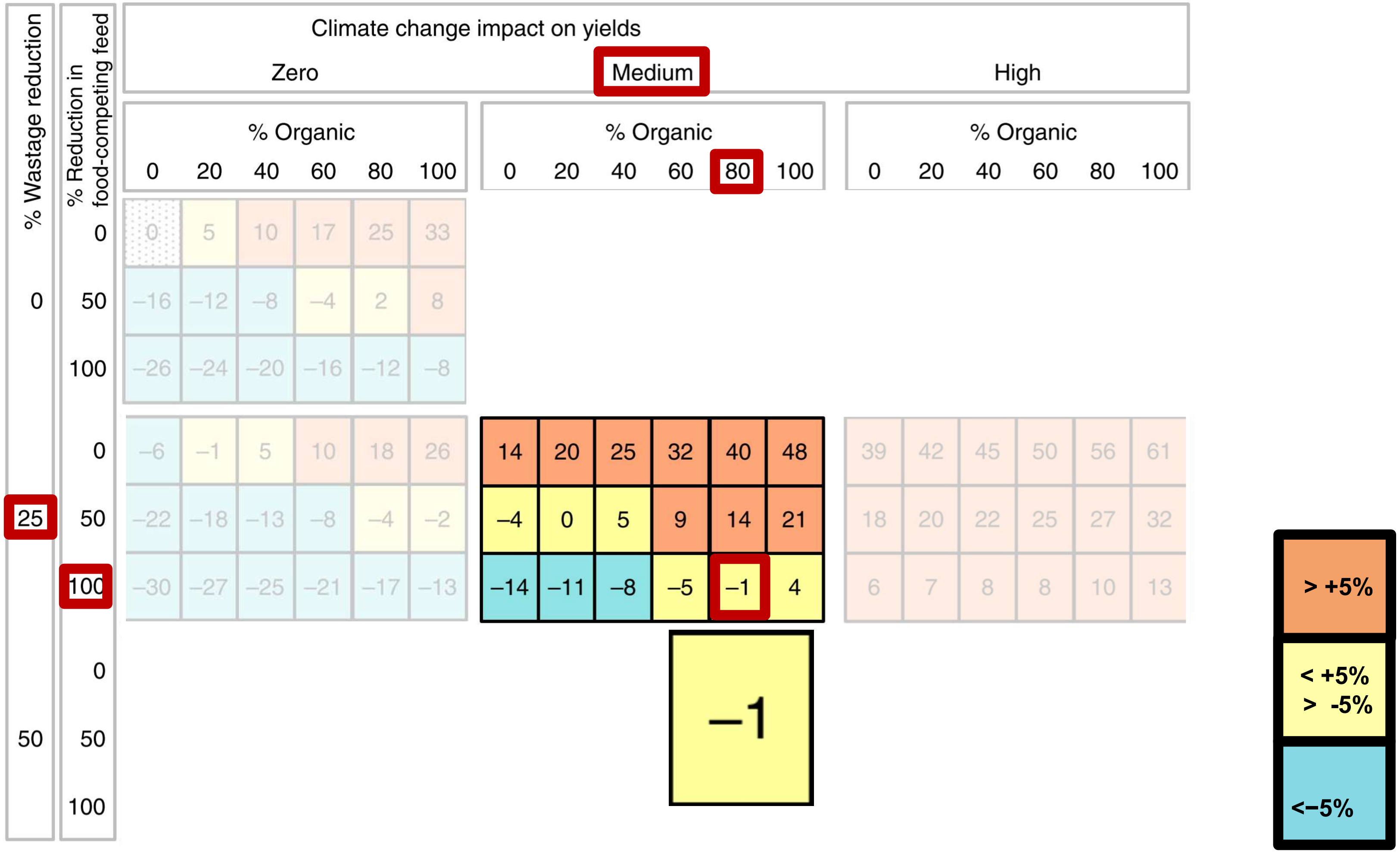
% Wastage reduction	% Reduction in food-competing feed	Zero: % Organic 0	20	40	60	80	100	**Medium**: % Organic 0	20	40	60	80	100	High: % Organic 0	20	40	60	80	100
0	0	0	5	10	17	25	33												
	50	–16	–12	–8	–4	2	8												
	100	–26	–24	–20	–16	–12	–8												
25	0	–6	–1	5	10	18	26	14	20	25	32	40	48	39	42	45	50	56	61
	50	–22	–18	–13	–8	–4	–2	–4	0	5	9	14	21	18	20	22	25	27	32
	100	–30	–27	–25	–21	–17	–13	–14	–11	–8	–5	–1	4	6	7	8	8	10	13
50	0																		
	50																		
	100																		

> +5%

< +5%
> -5%

<–5%

Muller et al. 2017; Courtesy: R. Zürcher



Muller et al. 2017; Courtesy: R. Zürcher

Climate change impact on yields

Zero

% Wastage reduction	% Reduction in food-competing feed	% Organic 0	20	40	60	80	100
0	0	0	5	10	17	25	33
0	50	−16	−12	−8	−4	2	8
0	100	−26	−24	−20	−16	−12	−8
25	0	−6	−1	5	10	18	26
25	50	−22	−18	−13	−8	−4	−2
25	100	−30	−27	−25	−21	−17	−13
50	0	−11	−7	−1	5	11	20
50	50	−25	−23	−19	−14	−9	−4
50	100	−35	−32	−29	−25	−22	−18

Medium

% Wastage reduction	% Reduction in food-competing feed	% Organic 0	20	40	60	80	100
0	0	21	26	33	40	47	57
0	50	2	7	10	16	22	27
0	100	−9	−6	−3	1	5	9
25	0	14	20	25	32	40	48
25	50	−4	0	5	9	14	21
25	100	−14	−11	−8	−5	−1	4
50	0	8	13	18	25	32	40
50	50	−9	−6	−2	3	8	14
50	100	−19	−17	−13	−10	−7	−3

High

% Wastage reduction	% Reduction in food-competing feed	% Organic 0	20	40	60	80	100
0	0	46	50	54	[redacted]	[redacted]	[redacted]
0	50	25	26	29	[redacted]	[redacted]	[redacted]
0	100	12	13	14	15	[redacted]	[redacted]
25	0	39	42	45	50	[redacted]	[redacted]
25	50	18	20	22	25	[redacted]	[redacted]
25	100	6	7	8	8	[redacted]	[redacted]
50	0	30	34	38	42	[redacted]	[redacted]
50	50	10	12	15	17	21	25
50	100	−1	0	1	3	4	7

> +5%

< +5% > −5%

<−5%

Muller et al. 2017; Courtesy: R. Zürcher

Climate change impact on yields

% Wastage reduction	% Reduction in food-competing feed	Zero: % Organic 0	20	40	60	80	100	Medium: % Organic 0	20	40	60	80	100	High: % Organic 0	20	40	60	80	100
0	0	0	5	10	17	25	33	21	26	33	40	47	57	46	50	54	58	64	71
	50	–16	–12	–8	–4	2	8	2	7	10	16	22	27	25	26	29	32	35	40
	100	–26	–24	–20	–16	–12	–8	–9	–6	–3	1	5	9	12	13	14	15	17	20
25	0	–6	–1	5	10	18	26	14	20	25	32	40	48	39	42	45	50	56	61
	50	–22	–18	–13	–8	–4	–2	–4	0	5	9	14	21	18	20	22	25	27	32
	100	–30	–27	–25	–21	–17	–13	–14	–11	–8	–5	–1	4	6	7	8	8	10	13
50	0	–11	–7	–1	5	11	20	8	13	18	25	32	40	30	34	38	42	47	53
	50	–25	–23	–19	–14	–9	–4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	100	–35	–32	–29	–25	–22	–18	–19	–17	–13	–10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

> +5%

< +5% > -5%

<–5%

Muller et al. 2017; Courtesy: R. Zürcher

Climate change impact on yields

% Wastage reduction	% Reduction in food-competing feed	Zero: % Organic 0	20	40	60	80	100	Medium: % Organic 0	20	40	60	80	100	High: % Organic 0	20	40	60	80	100
0	0	0	5	10	17	25	33	21	26	33	40	47	57	46	50	54	58	64	71
0	50	–16	–12	–8	–4	2	8	2	7	10	16	22	27	25	26	29	32	35	40
0	100	–26	–24	–20	–16	–12	–8	–9	–6	–3	1	5	9	12	13	14	15	17	20
25	0	–6	–1	5	10	18	26	14	20	25	32	40	48	39	42	45	50	56	61
25	50	–22	–18	–13	–8	–4	–2	–4	0	5	9	14	21	18	20	22	25	27	32
25	100	–30	–27	–25	–21	–17	–13	–14	–11	–8	–5	–1	4	6	7	8	8	10	13
50	0	–11	–7	–1	5	11	20	8	13	18	25	32	40	30	34	38	42	47	53
50	50	–25	–23	–19	–14	–9	–4	–9	–6	–2	3	8	14	10	12	15	17	21	25
50	100	–35	–32	–29	–25	–22	–18	–19	–17	–13	–10	–7	–3	–1	0	1	3	4	7

> +5%

< +5%
> -5%

<−5%

Muller et al. 2017; Courtesy: R. Zürcher

Nährstoffversorgung

Nährstoffversorgung:

Nicht nur die Produkte, sondern auch der Dünger wird auf den Flächen produziert.

Es ist eine Herausforderung, eine genügende Nährstoffversorgung zu gewährleisten – primär N und P

Climate change impact on yields

% Wastage reduction	% Reduction in food-competing feed	Zero: % Organic 0	20	40	60	80	100	Medium: % Organic 0	20	40	60	80	100	High: % Organic 0	20	40	60	80	100
0	0	25	21	15	10	4	−3	23	19	14	8	3	−3	21	16	12	7	1	−4
	50	20	16	12	7	2	−4	18	14	10	6	1	−4	17	13	9	4	0	−5
	100	15	11	7	3	−1	−5	13	10	7	3	−1	−5	12	9	5	2	−2	−6
25	0	23	19	14	8	2	−4	21	17	12	7	1	−4	19	15	10	5	0	−5
	50	18	14	10	6	1	−5	17	13	9	5	0	−5	15	11	7	3	−1	−5
	100	13	10	6	2	−2	−6	12	9	5	2	−2	−6	11	8	4	1	−3	−6
50	0	21	17	12	7	1	−5	19	15	10	5	0	−6	17	13	9	4	−1	−6
	50	16	12	8	4	0	−6	15	11	7	3	−1	−6	14	10	6	2	−2	−6
	100	11	8	5	1	−3	−7	10	7	4	1	−3	−7	10	7	3	0	−3	−7

> 10kg/ha	**Surplus**
between 10 and 5kg/ha	**Optimal**
between +5 and -5 kg/ha	**Critical**
<-5kg/ha	**Deficit**

Climate change impact on yields

Zero (% Organic)

% Wastage reduction	% Reduction in food-competing feed	0	20	40	60	80	100
0	0	25	21	15	10	4	–3
0	50	20	[illegible]	[illegible]	[illegible]	2	–4
0	100	15	[illegible]	[illegible]	[illegible]	–1	–5
25	0	23	[illegible]	[illegible]	[illegible]	2	–4
25	50	18	14	10	6	1	–5
25	100	13	10	6	2	–2	–6
50	0	21	17	12	7	1	–5
50	50	16	12	8	4	0	–6
50	100	11	8	5	1	–3	–7

25

Medium (% Organic)

% Wastage reduction	% Reduction in food-competing feed	0	20	40	60	80	100
0	0	23	19	14	8	3	–3
0	50	18	14	10	6	1	–4
0	100	13	10	7	3	–1	–5
25	0	21	17	12	7	1	–4
25	50	17	13	9	5	0	–5
25	100	12	9	5	2	–2	–6
50	0	19	15	10	5	0	–6
50	50	15	11	7	3	–1	–6
50	100	10	7	4	1	–3	–7

High (% Organic)

% Wastage reduction	% Reduction in food-competing feed	0	20	40	60	80	100
0	0	21	16	12	7	1	–4
0	50	17	13	9	4	0	–5
0	100	12	9	5	2	–2	–6
25	0	19	15	10	5	0	–5
25	50	15	11	7	3	–1	–5
25	100	11	8	4	1	–3	–6
50	0	17	13	9	4	–1	–6
50	50	14	10	6	2	–2	–6
50	100	10	7	3	0	–3	–7

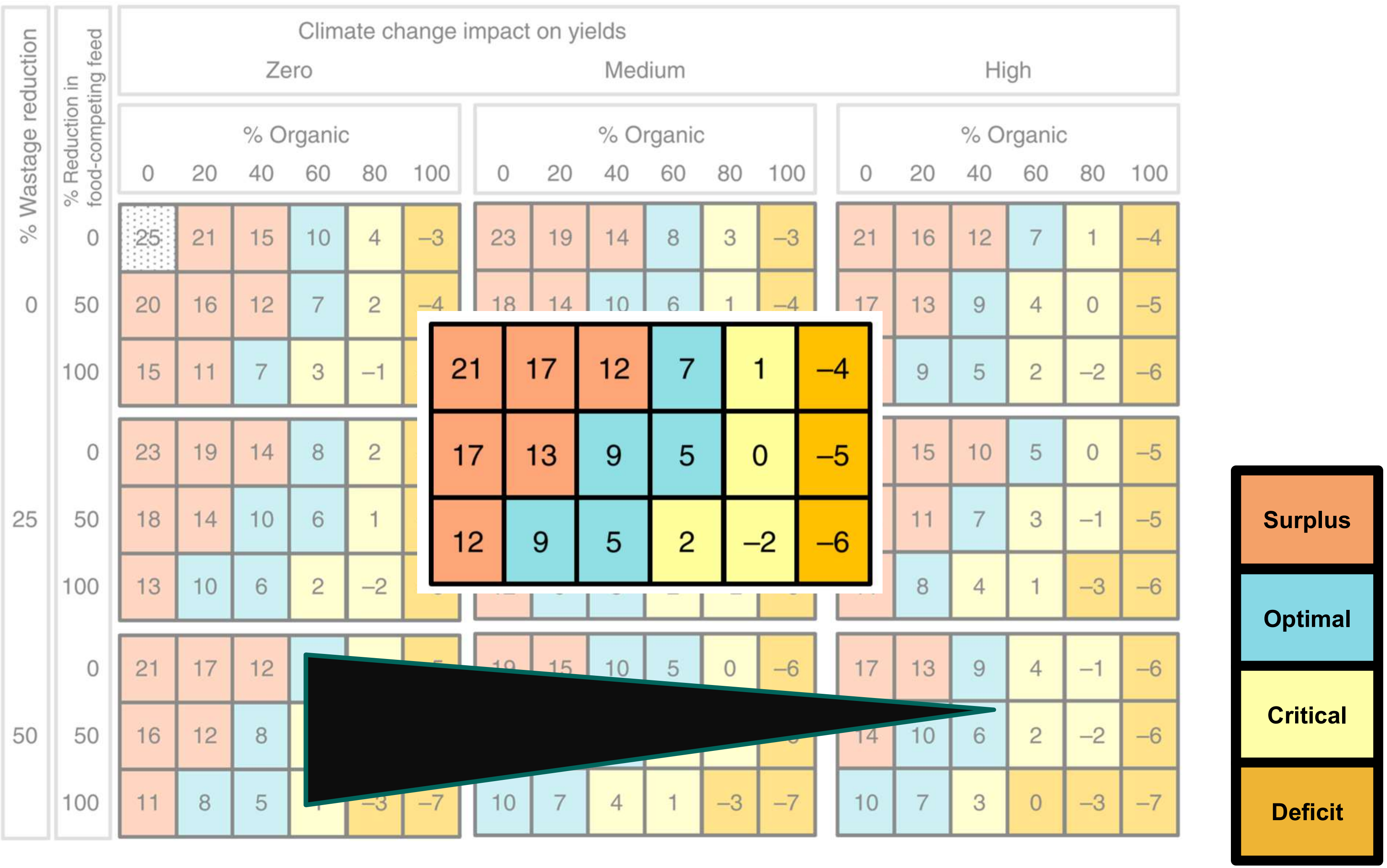
Surplus

Optimal

Critical

Deficit

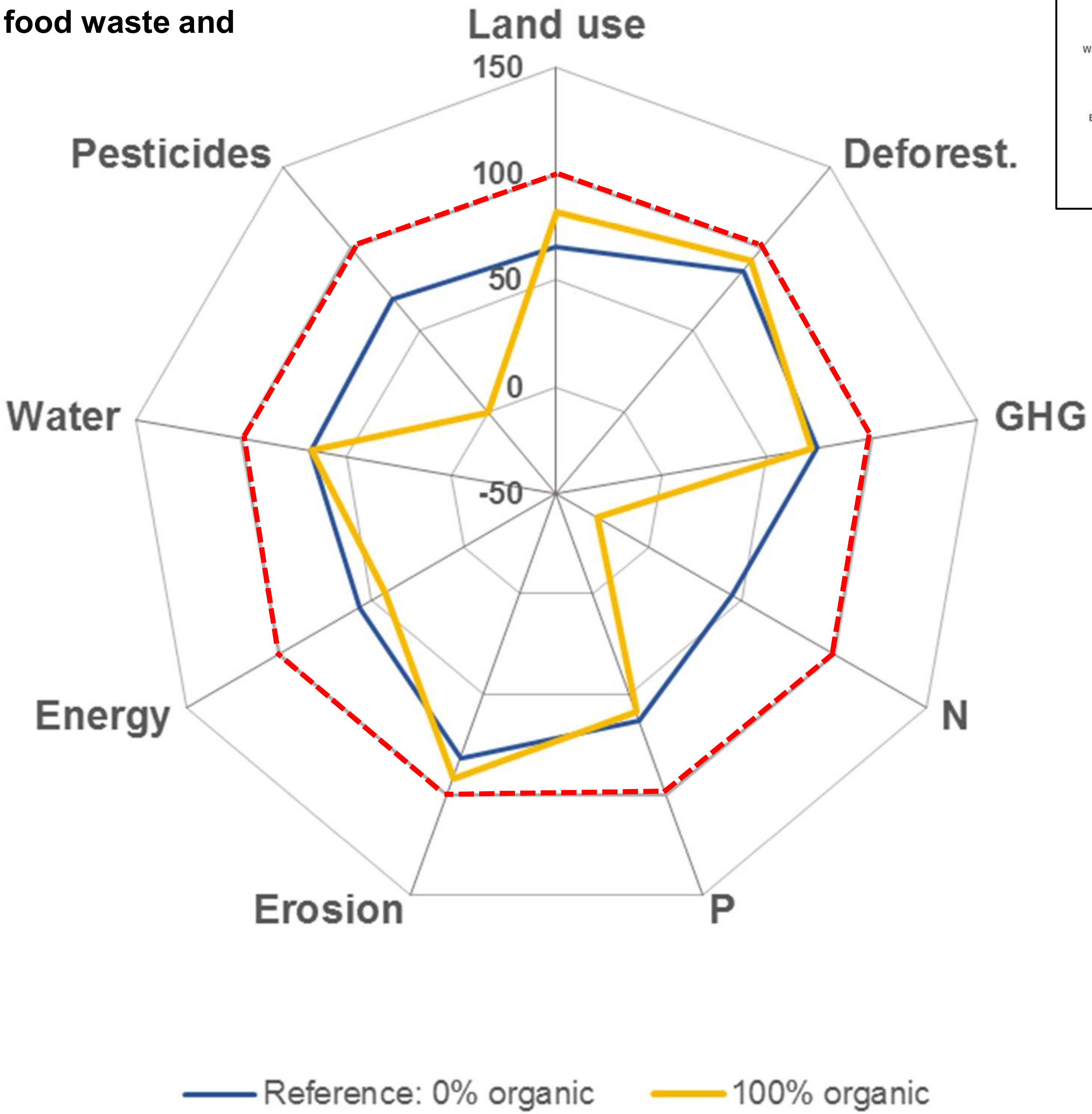
Muller et al. 2017; Courtesy: R. Zürcher

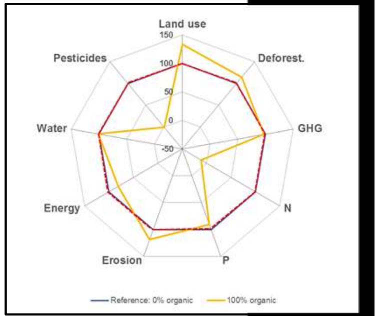


Muller et al. 2017; Courtesy: R. Zürcher

Weitere Umweltindikatoren neben Landverbrauch und N-Überschüssen

100% food competing feed reduction
50% less food waste and loss





Muller et al. 2017

Es geht nicht primär darum, auf 100% Bio umzustellen – die Kombination verschiedener Strategien ist vielversprechend und nötig

Climate change impact on yields

% Wastage reduction	% Reduction in food-competing feed	Zero: % Organic 0	20	40	60	80	100	Medium: % Organic 0	20	40	60	80	100	High: % Organic 0	20	40	60	80	100
0	0	0	5	10	17	25	33	21	26	33	40	47	57	46	50	54	58	64	71
	50	−16	−12	−8	−4	2	8	2	7	10	16	22	27	25	26	29	32	35	40
	100	−26	−24	−20	−16	−12	−8	−9	−6	−3	1	5	9	12	13	14	15	17	20
25	0	−6	−1	5	10	18	26	14	20	25	32	40	48	39	42	45	50	56	61
	50	−22	−18	−13	−8	−4	−2	−4	0	5	9	14	21	18	20	22	25	27	32
	100	−30	−27	−25	−21	−17	−13	−14	−11	−8	−5	−1	4	6	7	8	8	10	13
50	0	−11	−7	−1	5	11	20	8	13	18	25	32	40	30	34	38	42	47	53
	50	−25	−23	−19	−14	−9	−4	−9	−6	−2	3	8	14	10	12	15	17	21	25
	100	−35	−32	−29	−25	−22	−18	−19	−17	[illegible]	[illegible]	[illegible]	−3	−1	0	1	3	4	7

3

Climate change impact on yields

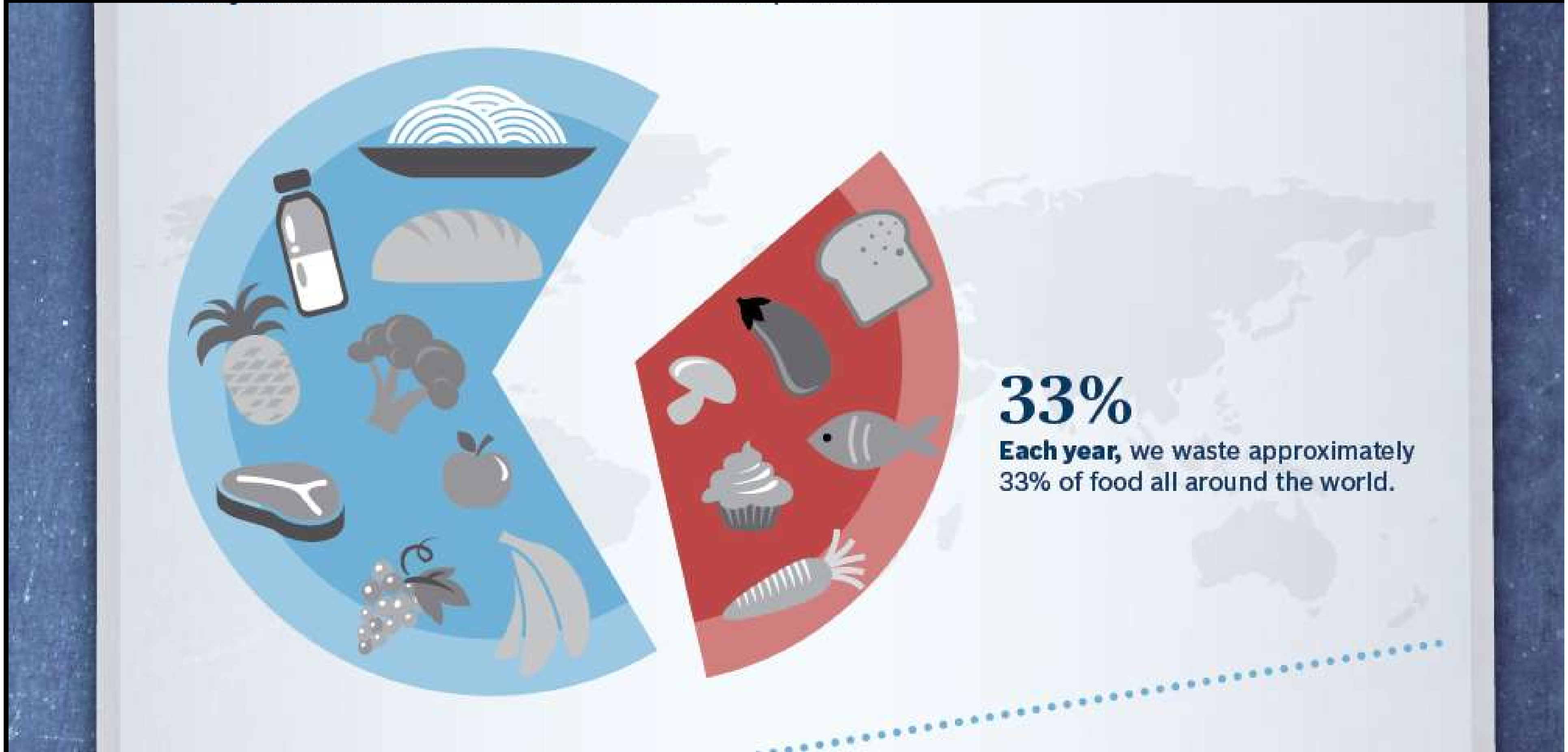
% Wastage reduction	% Reduction in food-competing feed	Zero: % Organic 0	20	40	60	80	100	Medium: % Organic 0	20	40	60	80	100	High: % Organic 0	20	40	60	80	100
0	0	25	21	15	10	4	−3	23	19	14	8	3	−3	21	16	12	7	1	−4
	50	20	16	12	7	2	−4	18	14	10	6	1	−4	17	13	9	4	0	−5
	100	15	11	7	3	−1	−5	13	10	7	3	−1	−5	12	9	5	2	−2	−6
25	0	23	19	14	8	2	−4	21	17	12	7	1	−4	19	15	10	5	0	−5
	50	18	14	10	6	1	−5	17	13	9	5	0	−5	15	11	7	3	−1	−5
	100	13	10	6	2	−2	−6	12	9	5	2	−2	−6	11	8	4	1	−3	−6
50	0	21	17	12	7	1	−5	19	15	10	5	0	−6	17	13	9	4	−1	−6
	50	16	12	8	4	0	−6	15	11	7	3	−1	−6	14	10	6	2	−2	−6
	100	11	8	5	1	−3	−7	10	7	[illegible]	[illegible]	[illegible]	−7	10	7	3	0	−3	−7

3

Muller et al. 2017; Courtesy: R. Zürcher

Abfälle

Nahrungsmittelabfälle und -verluste



Quelle: FAO 2013 / Boisch

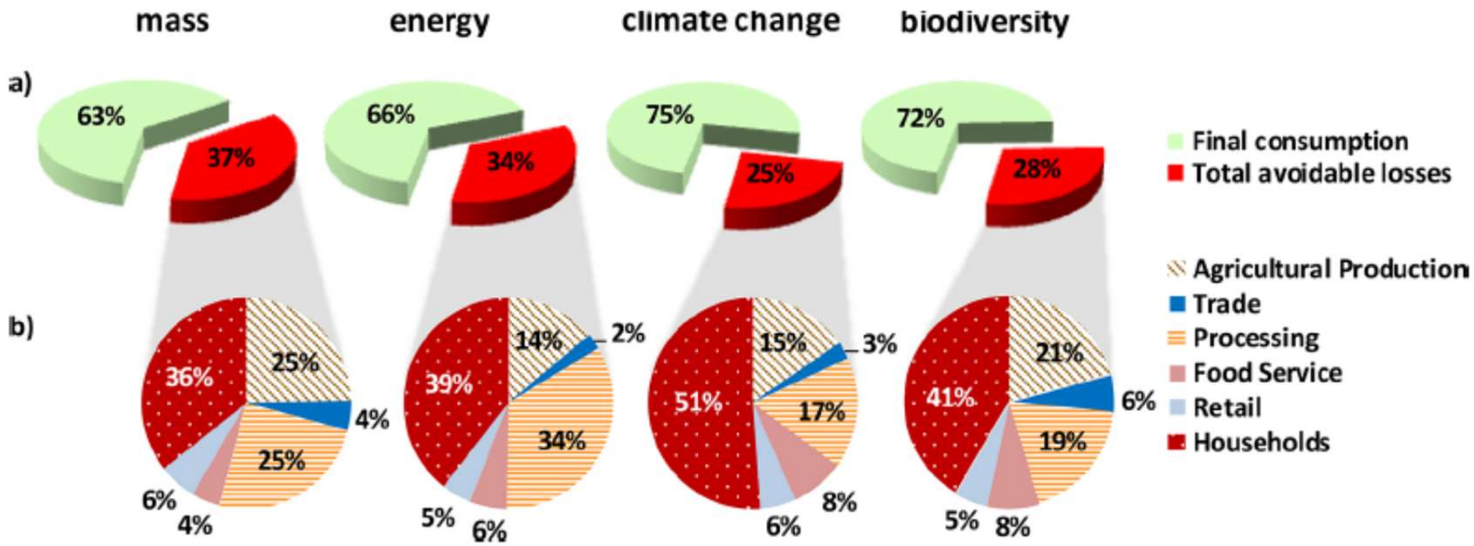


Figure 2. Share of FW and final consumption (a) and share of FW arising at the various stages of the FVC (b) in terms of mass, metabolizable energy, and impacts on climate change and global biodiversity.

Beretta et al. 2017

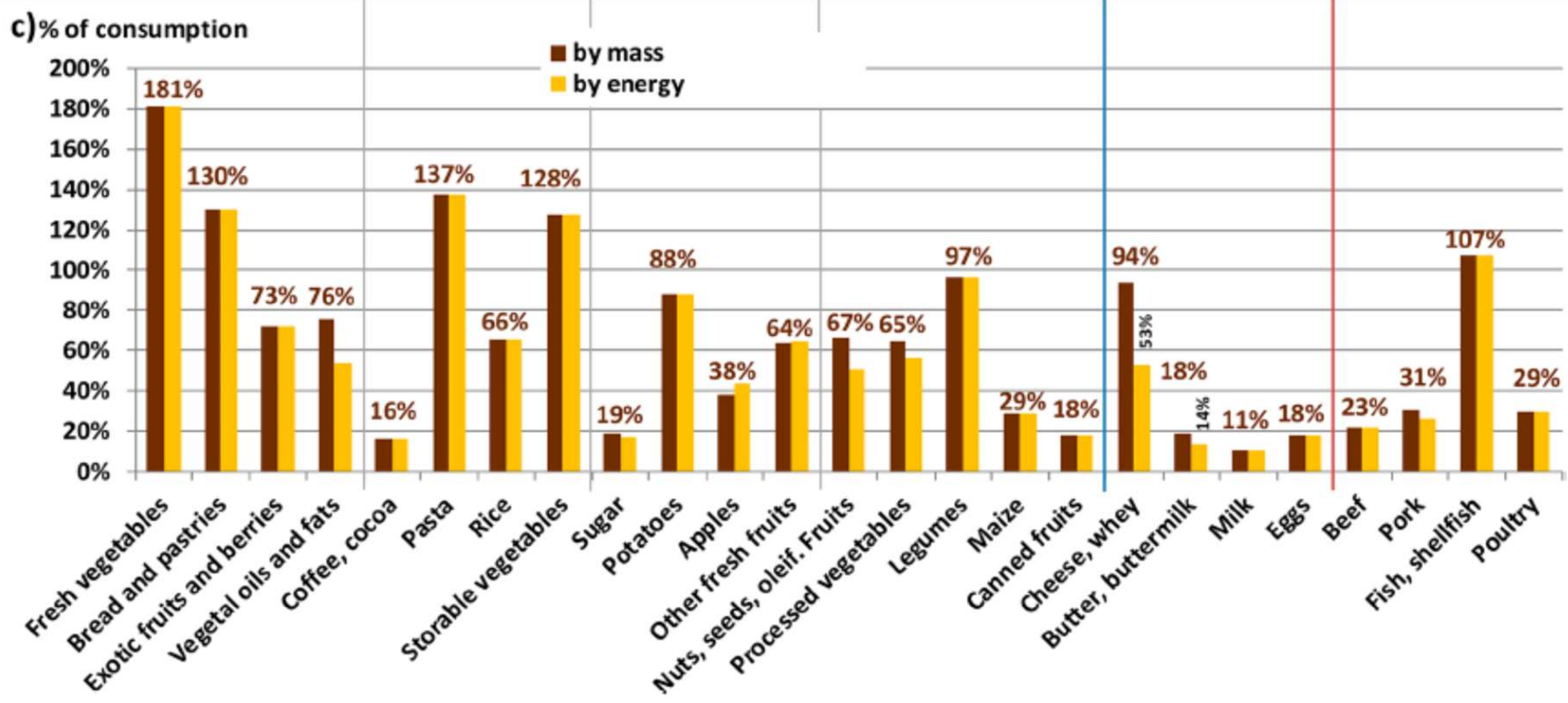


Figure 3. (a) GHG emissions (GWP 100) per person and year caused by the production and supply of food that is wasted at the various stages of the FVC and GHG savings from FW treatment. (b) GHG emissions per kg of FW from the production, supply, and treatment of food, including credits for FW treatment. The results are shown for food wasted in agricultural production, the processing industry, and in households. (c) Relative FW amounts compared to final consumption (=100%) by mass and energy. The corresponding results for global temperature change (GTP 100) are shown in Figure S27 in the SI.

Beretta et al. 2017

Suffizienz

Resultate

- “Effizienz” – “relativer Ressourceneinsatz”
  spielt eine wichtige Rolle

- “Suffizienz” – “absoluter Ressourcenverbrauch”
  leistet aber auch einen wesentlichen Beitrag

- “Konsistenz” – “Welche Rolle spielen Ressourcen im Gesamtkontext?”
  kann dazu beitragen, gangbare Wege aufzuzeigen

Anpassung

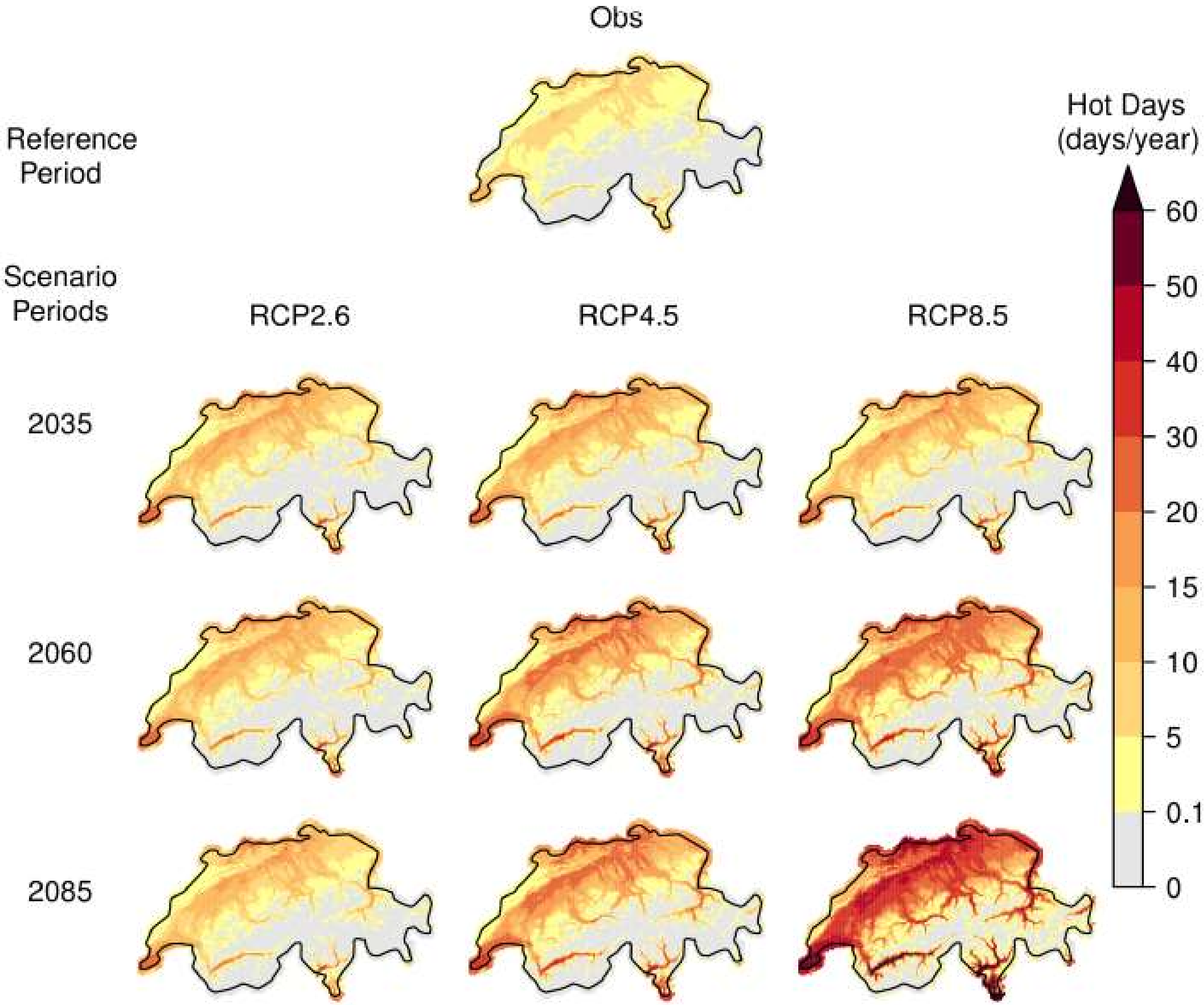


Figure 6.3. Hot days frequency. First row: 2-km observational grid in the reference period 1981 - 2010. Lower rows: Projected ensemble median number (multi-model combination) of the bias-corrected RCM data (QM to high-resolution grid) for the three scenario periods (rows) and the three forcing scenarios (columns). See Figure 13.49 for the respective change signals. Note that the model uncertainty of the change signal is not reflected by the ensemble median number displayed here and can be substantial.

CH2018

Box 11.1: Temperature evolution 1864 - 2099

The temperature evolution from the year 1864 (when systematic observations began) to the future year 2099 is shown in Figure 11.1. The projected warming of the annual mean at the end of the century (2070 - 2099) relative to the reference period (1981 - 2010) ranges from 0.6 to 1.9 °C under the optimistic RCP2.6 emission scenario to 3.3 to 5.4°C under the business-as-usual scenario RCP8.5. The temperature curves of the two scenarios begin to diverge around the year 2030. The warming over Switzerland is markedly stronger than in the global mean. The figure also confirms that the climate models are able to reproduce the current climate variability reasonably well. Another important point is that natural variability is large and strongly modulates the forced anthropogenic trend. Even in a high-emission scenario such as RCP8.5, extended periods (up to 3 decades) without warming in Switzerland are possible; however, the warming could also be much faster than anticipated (cf. Chapter 7).

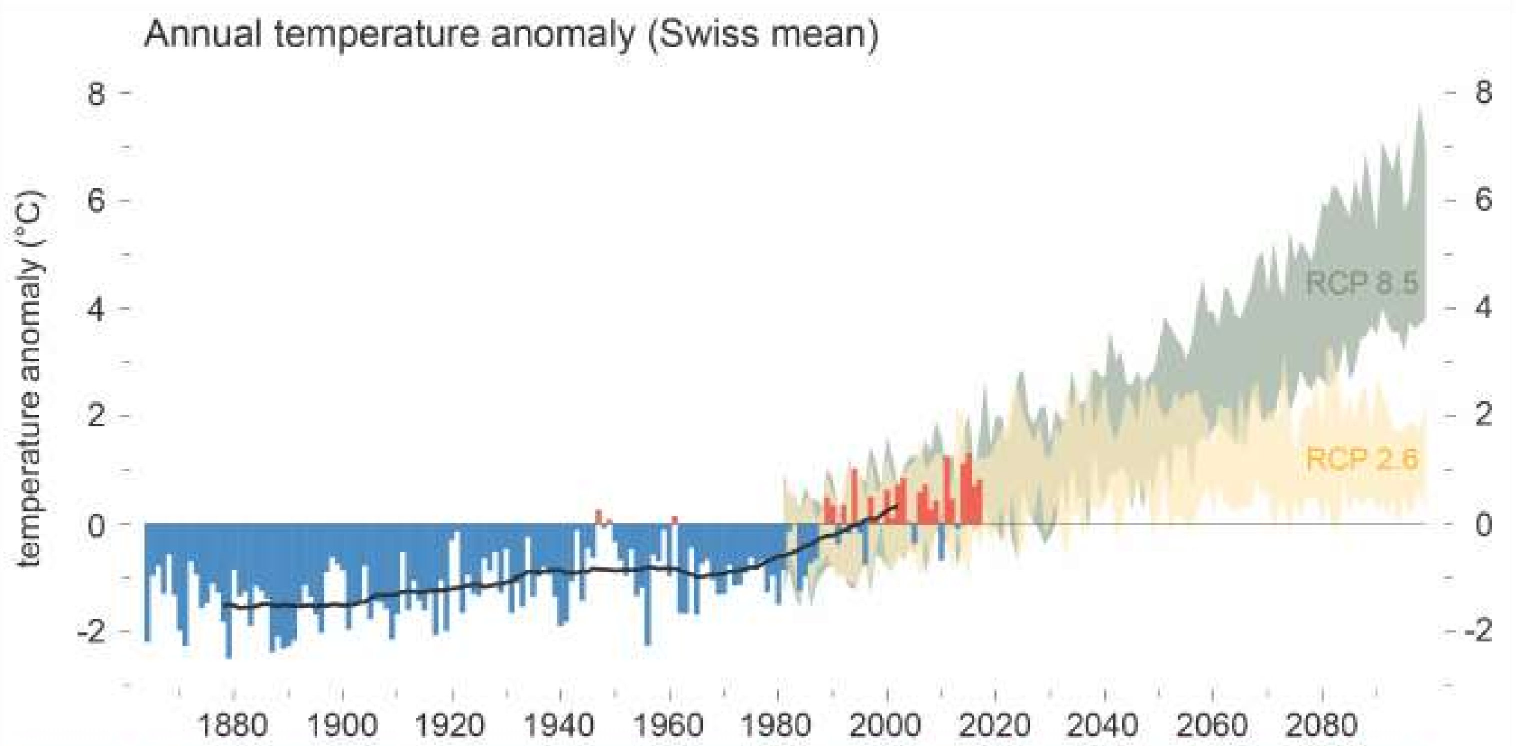
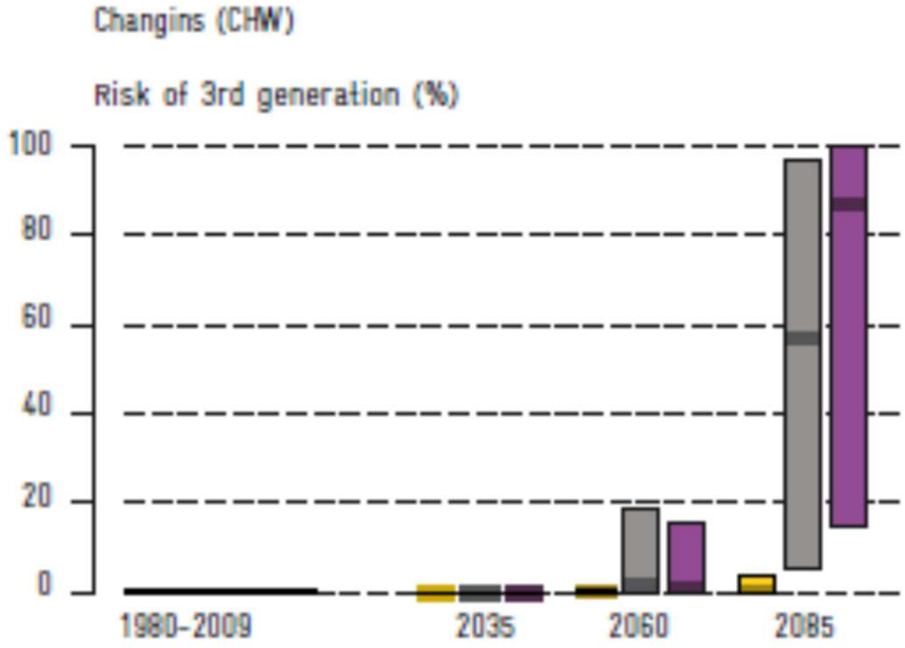
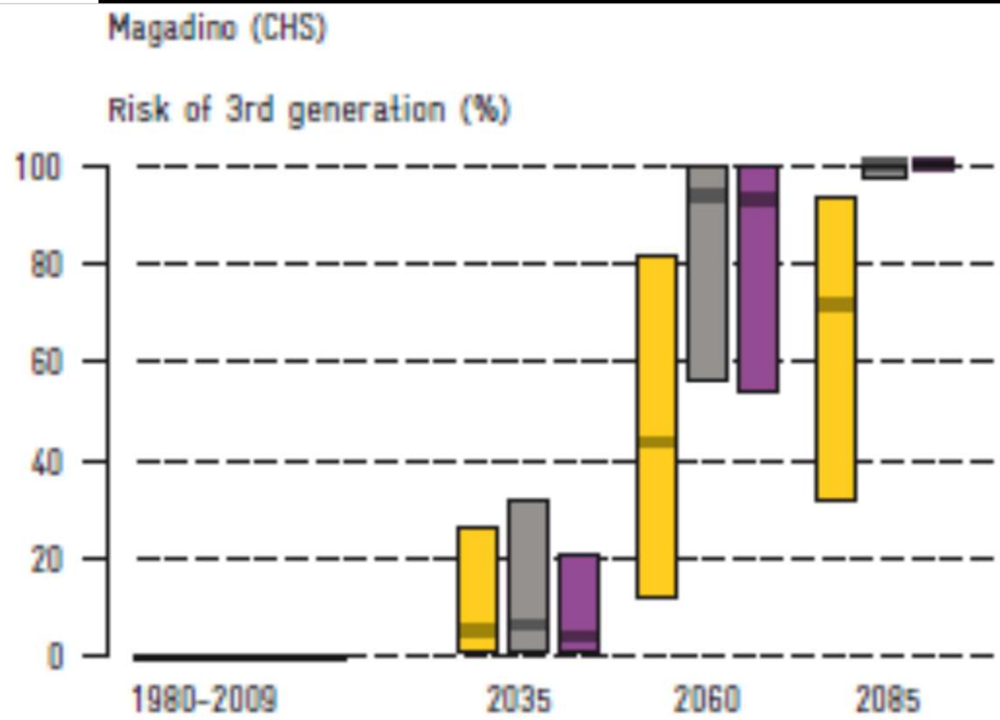
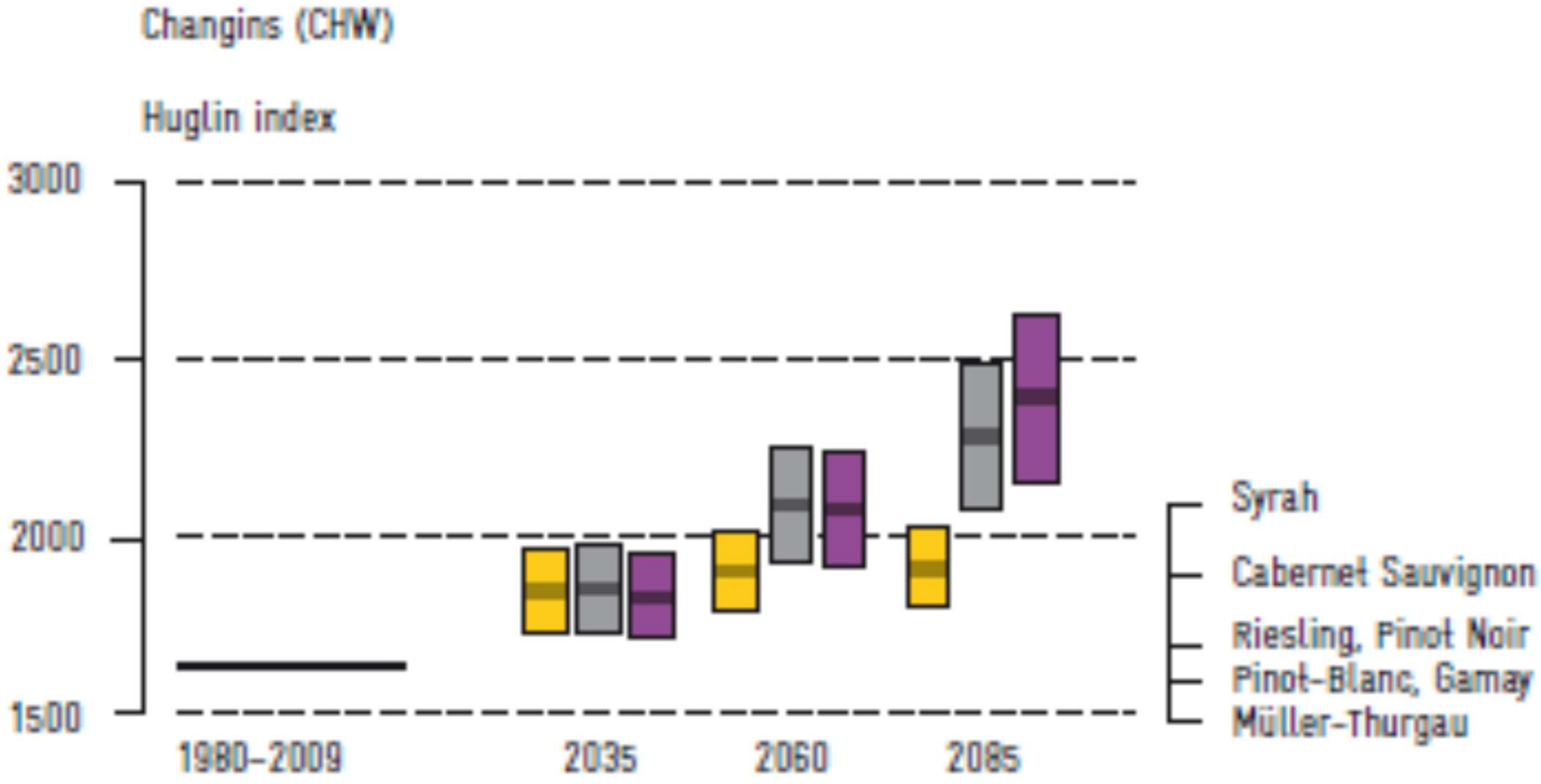


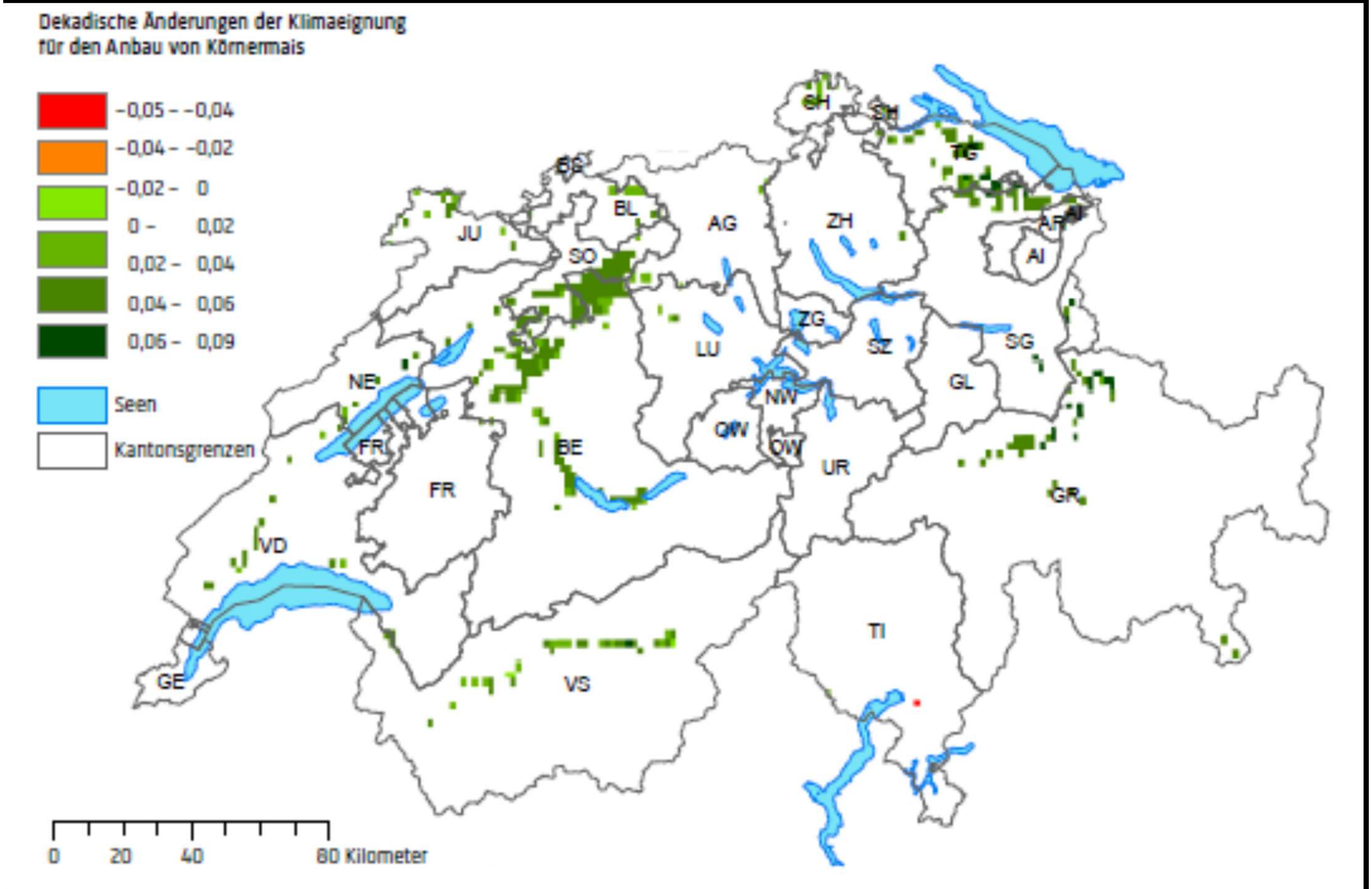
Figure 11.1. Evolution of Swiss annual mean temperature from 1864 to 2099, shown as deviation (°C) from the baseline 1981 - 2010. The bars show the observations from 1864 to 2017 (negative anomalies in blue, positive anomalies in red). The green (orange) shading shows the projected (5th to 95th percentile) range using the RCP8.5 (RCP2.6) scenario.



CH2014 - Impacts




Changins (CHW)
Huglin index
3000
2500
2000
1500
1980–2009
2035
2060
2085
Syrah
Cabernet Sauvignon
Riesling, Pinot Noir
Pinot-Blanc, Gamay
Müller-Thurgau


Dekadische Änderungen der Klimaeignung
für den Anbau von Körnermais
−0,05 – −0,04
−0,04 – −0,02
−0,02 – 0
0 – 0,02
0,02 – 0,04
0,04 – 0,06
0,06 – 0,09
Seen
Kantonsgrenzen
SH
TG
BS
BL
JU
AG
ZH
AR
AI
SO
ZG
SG
LU
SZ
NE
GL
NW
OW
BE
FR
UR
GR
VD
TI
GE
VS
0
20
40
80 Kilometer

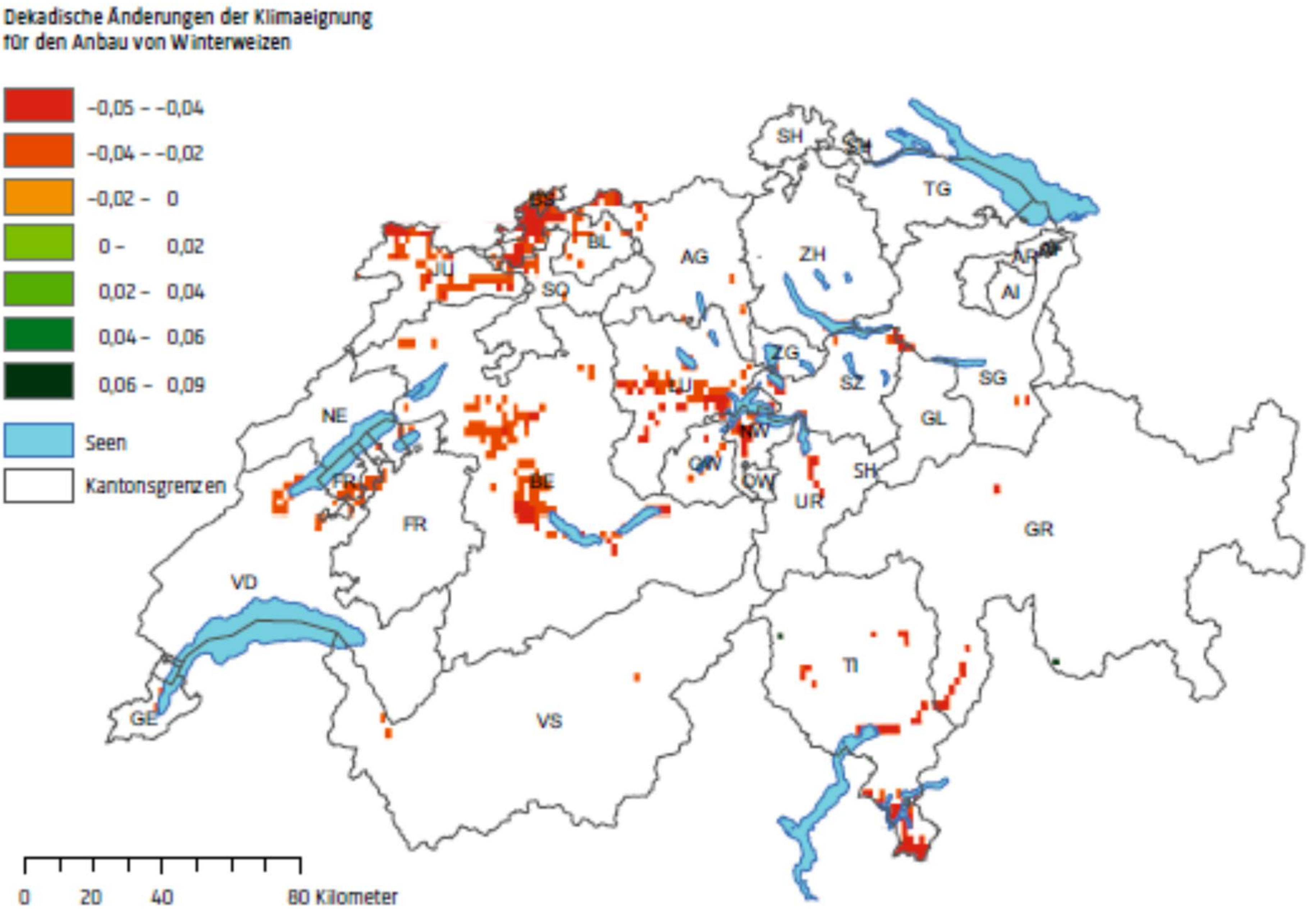
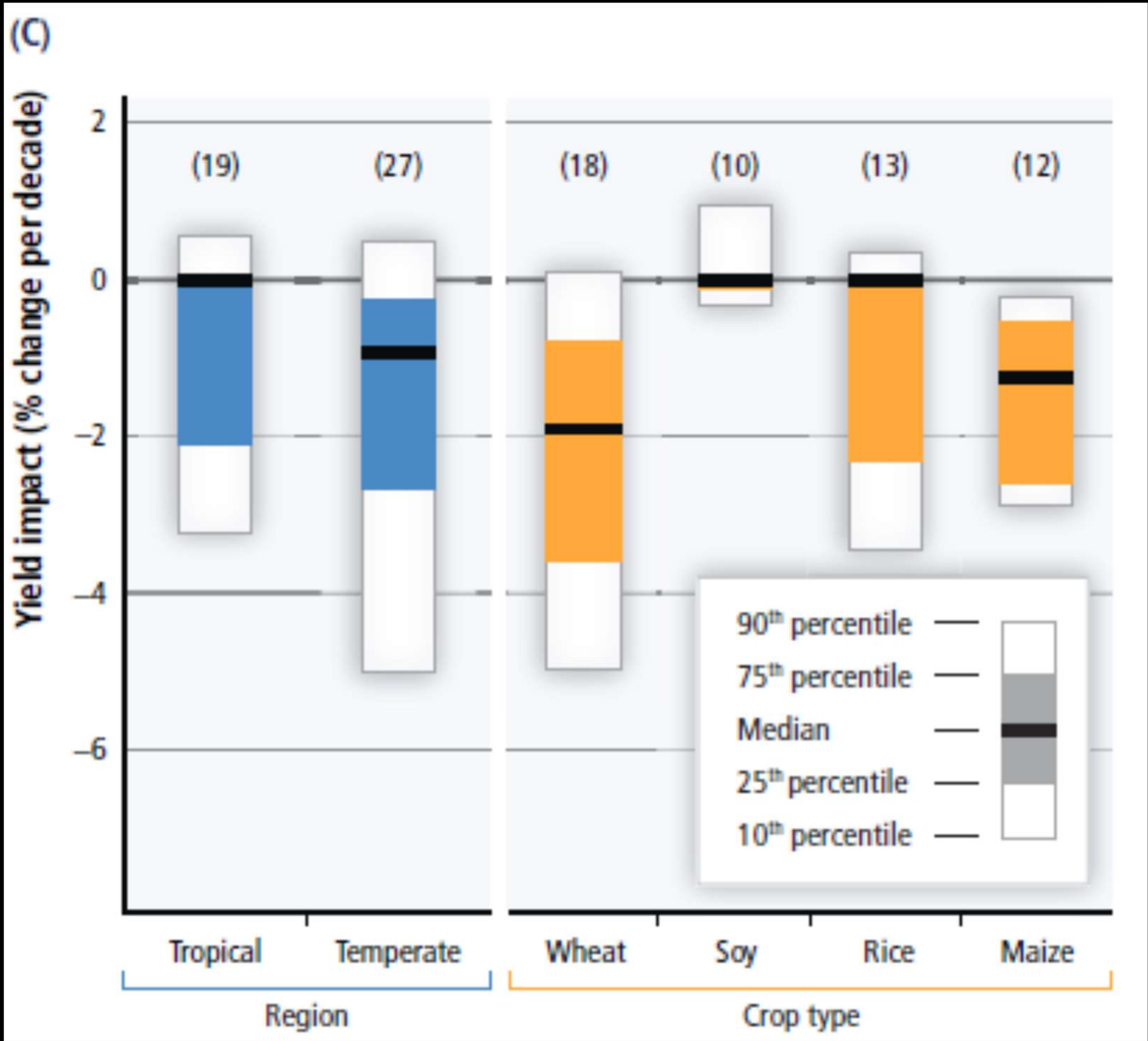


Abbildung 2.15: Änderung im Index der Klimaeignung für Mais (a) und Weizen (b) in Gebieten mit einem signifikanten Trend von 1983 bis 2010. (Quelle: Holzkämper et al. 2014)



IPCC AR5 WG II 2014

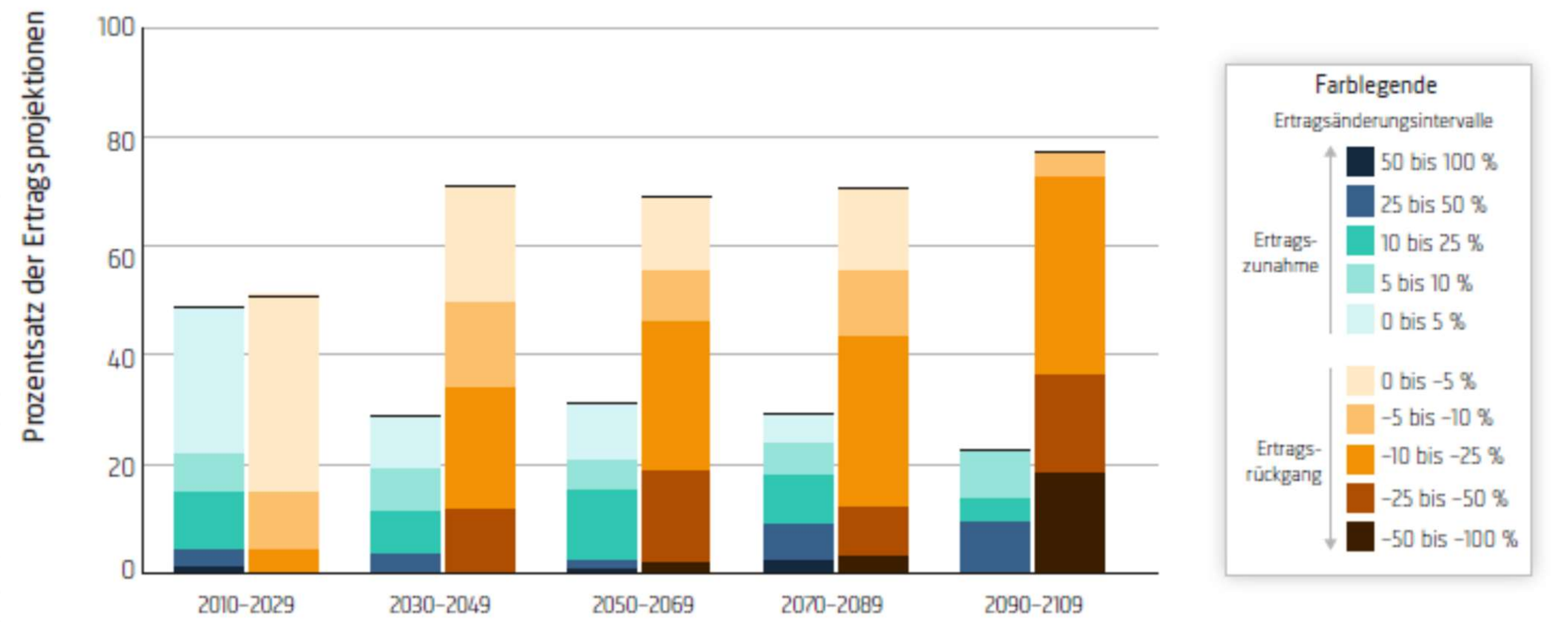


Abbildung 2.16: Relative Anteile der negativen und positiven Projektionen für Änderungen im Ertrag landwirtschaftlicher Kulturen für tropische und gemässigte Klimaregionen. Die Grafik vereint die Ergebnisse für verschiedene Emissionsszenarien sowie für Simulationen mit und ohne Anpassungsmassnahmen (Summe = 100%). Die Grafik zeigt, dass die Anteile der positiven Auswirkungen zunehmend sinken, während jene der negativen Auswirkungen steigen. Die Säulen sind aufgeteilt nach dem Ausmass der Ertragsveränderung (in Prozent) im Vergleich zu den Erträgen Ende des 20. Jahrhunderts. Nach 2050 überwiegen negative Ertragsveränderungen von mehr als fünf Prozent. (Quelle: IPCC 2014/WGII/Chap.7/Fig. 7-05)

CO_2-eq Concentrations in 2100 (CO_2-eq)[6] Category label (conc. range)	Subcategories	Relative position of the RCPs[4]	Change in CO_2-eq emissions compared to 2010 (in %)[3]		Likelihood of staying below a specific temperature level over the 21st century (relative to 1850-1900)[4,5]			
			2050	2100	1.5°C	2°C	3°C	4°C
< 430	*Only a limited number of individual model studies have explored levels below 430 ppm CO_2-eq*[10]							
450 (430 – 480)	Total range[1,7]	*RCP2.6*	-72 to -41	-118 to -78	*More unlikely than likely*	*Likely*	*Likely*	*Likely*
500 (480 – 530)	No overshoot of 530 ppm CO_2-eq		-57 to -42	-107 to -73	*Unlikely*	*More likely than not*		
	Overshoot of 530 ppm CO_2-eq		-55 to -25	-114 to -90		*About as likely as not*		
550 (530 – 580)	No overshoot of 580 ppm CO_2-eq		-47 to -19	-81 to -59		*More unlikely than likely*[9]		
	Overshoot of 580 ppm CO_2-eq		-16 to 7	-183 to -86				
(580 – 650)	Total range	*RCP4.5*	-38 to 24	-134 to -50				
(650 – 720)	Total range		-11 to 17	-54 to -21		*Unlikely*	*More likely than not*	
(720 – 1000)[2]	Total range	*RCP6.0*	18 to 54	-7 to 72	*Unlikely*[8]		*More unlikely than likely*	
>1000[2]	Total range	*RCP8.5*	52 to 95	74 to 178		*Unlikely*[8]	*Unlikely*	*More unlikely than likely*

Kosten um das 2-Grad-Ziel wahrscheinlich (>66%) zu erreichen (% vom globalen Konsum im Jahr XX):

2030: 1-4%
2050: 2-6%
2100: 3-11%

Jährlicher Wachstumsverlust: 0.05%

Jährliche Kosten des Klimawandels: 0.2-2%

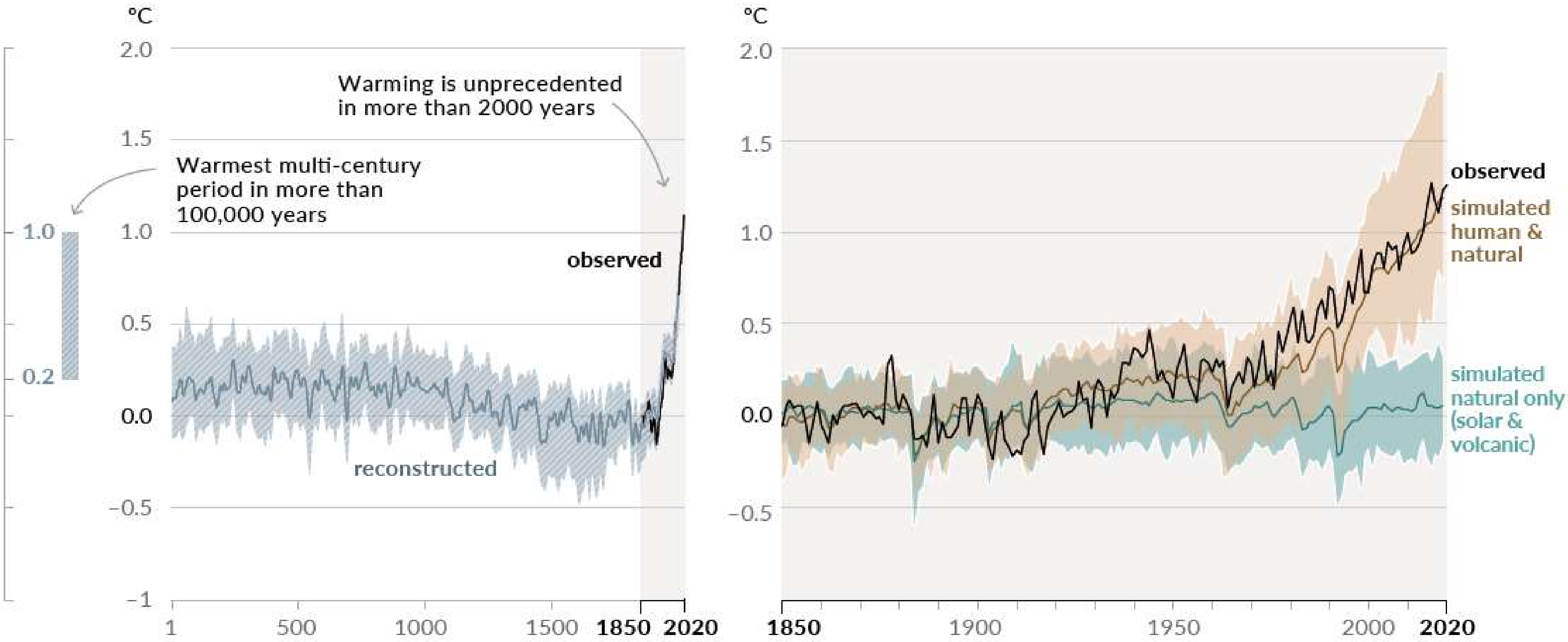
Quelle: IPCC AR5 2013

Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

Changes in global surface temperature relative to 1850–1900

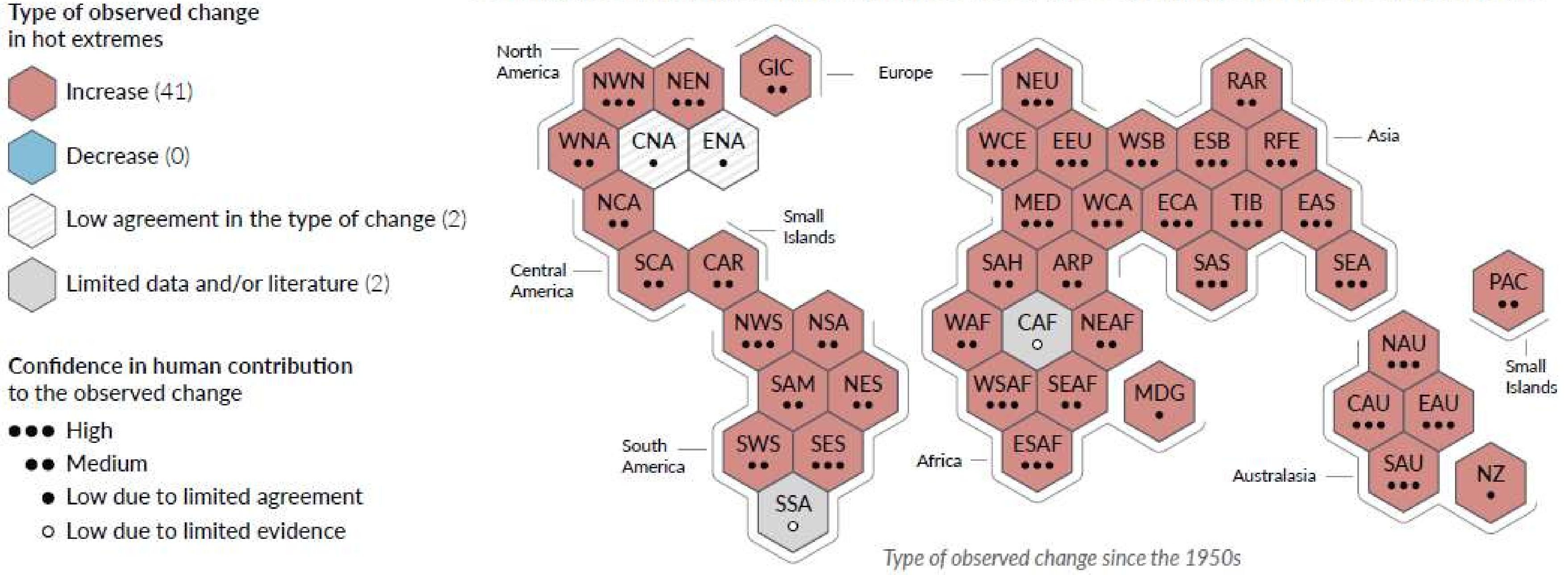
(a) Change in global surface temperature (decadal average) as reconstructed (1–2000) and **observed** (1850–2020)

(b) Change in global surface temperature (annual average) as **observed** and simulated using human & natural and only natural factors (both 1850–2020)



Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

(a) Synthesis of assessment of observed change in **hot extremes** and confidence in human contribution to the observed changes in the world's regions



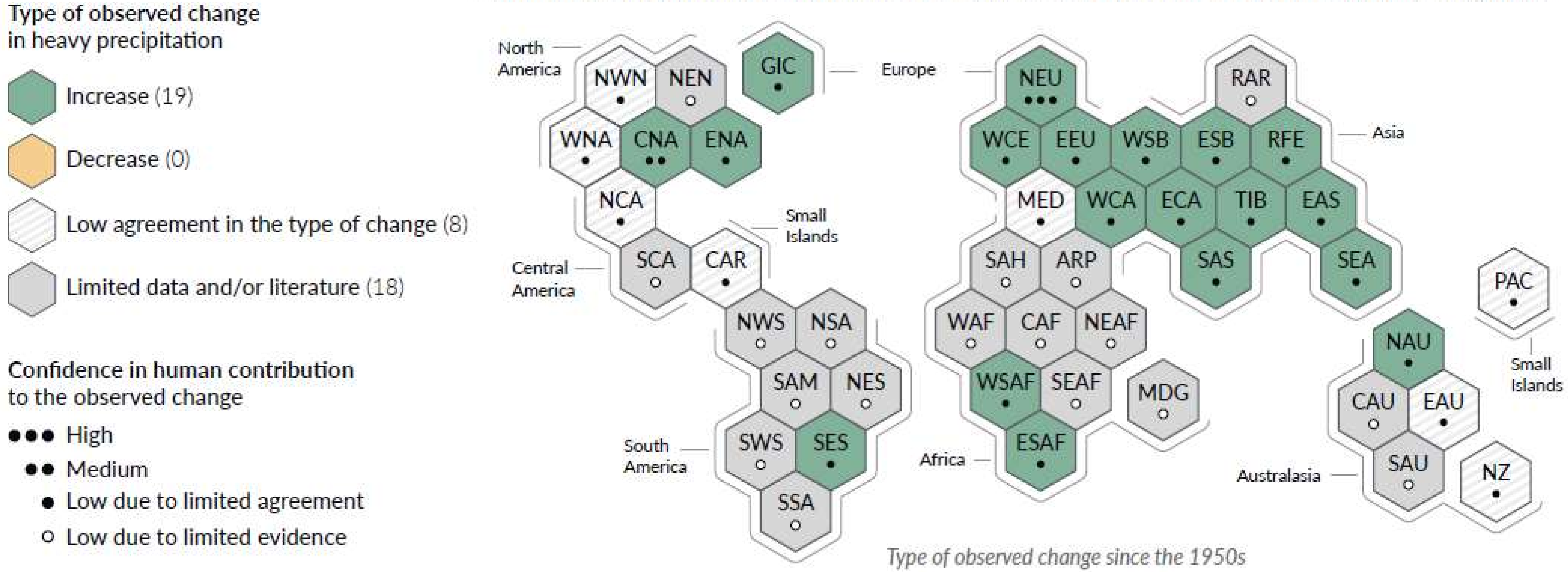
Type of observed change since the 1950s

Each hexagon corresponds to one of the IPCC AR6 WGI reference regions

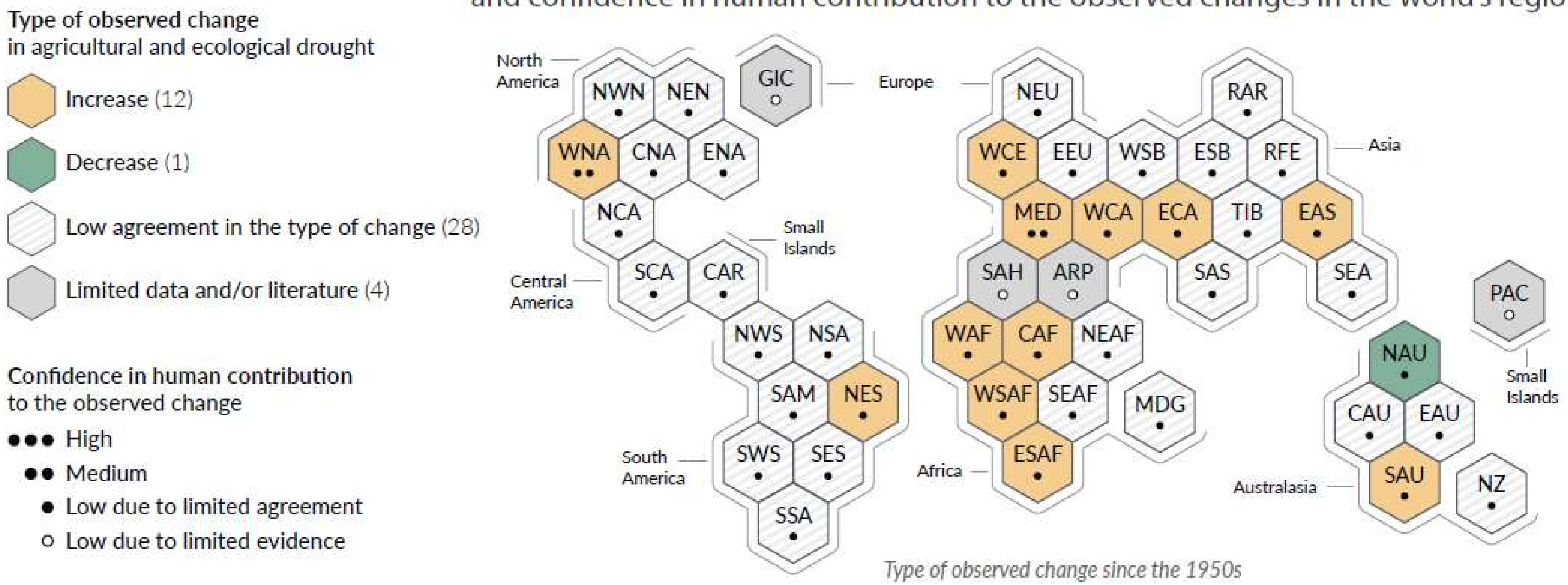
NWN *North-Western North America*

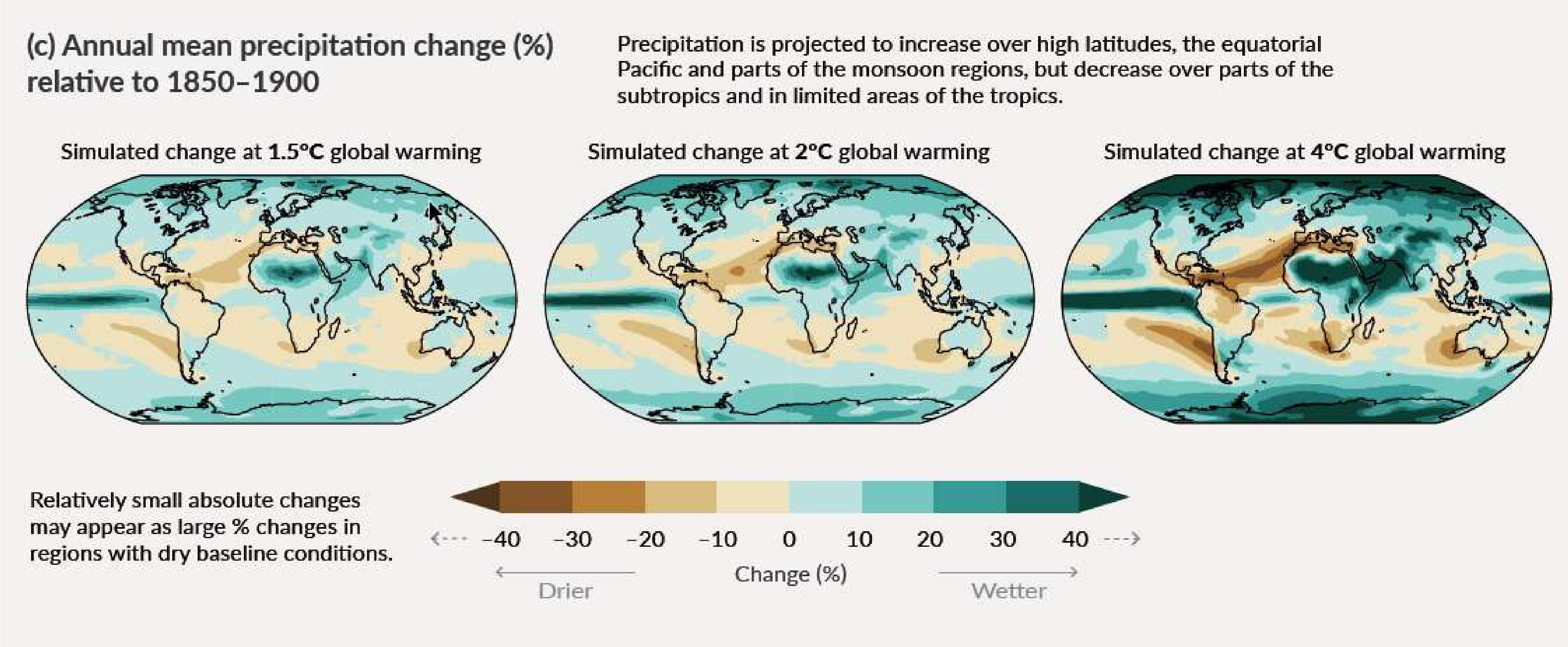
IPCC AR6 WG I 2021

(b) Synthesis of assessment of observed change in **heavy precipitation** and confidence in human contribution to the observed changes in the world's regions



(c) Synthesis of assessment of observed change in **agricultural and ecological drought** and confidence in human contribution to the observed changes in the world's regions

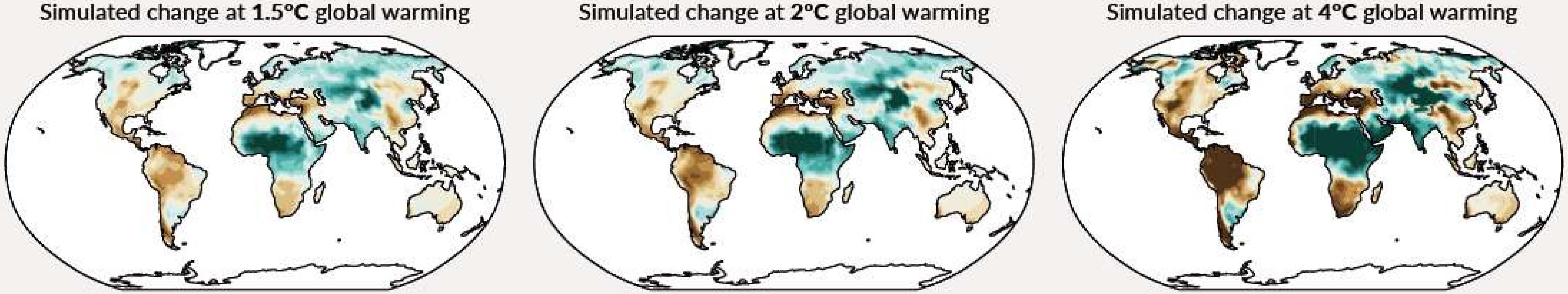




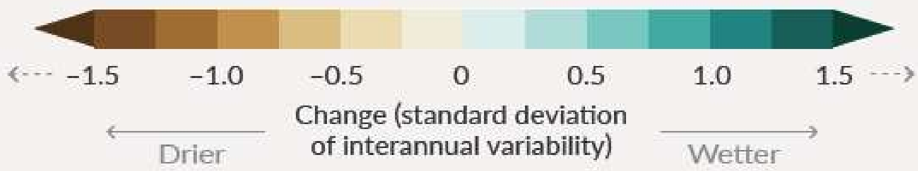
IPCC AR6 WG I 2021

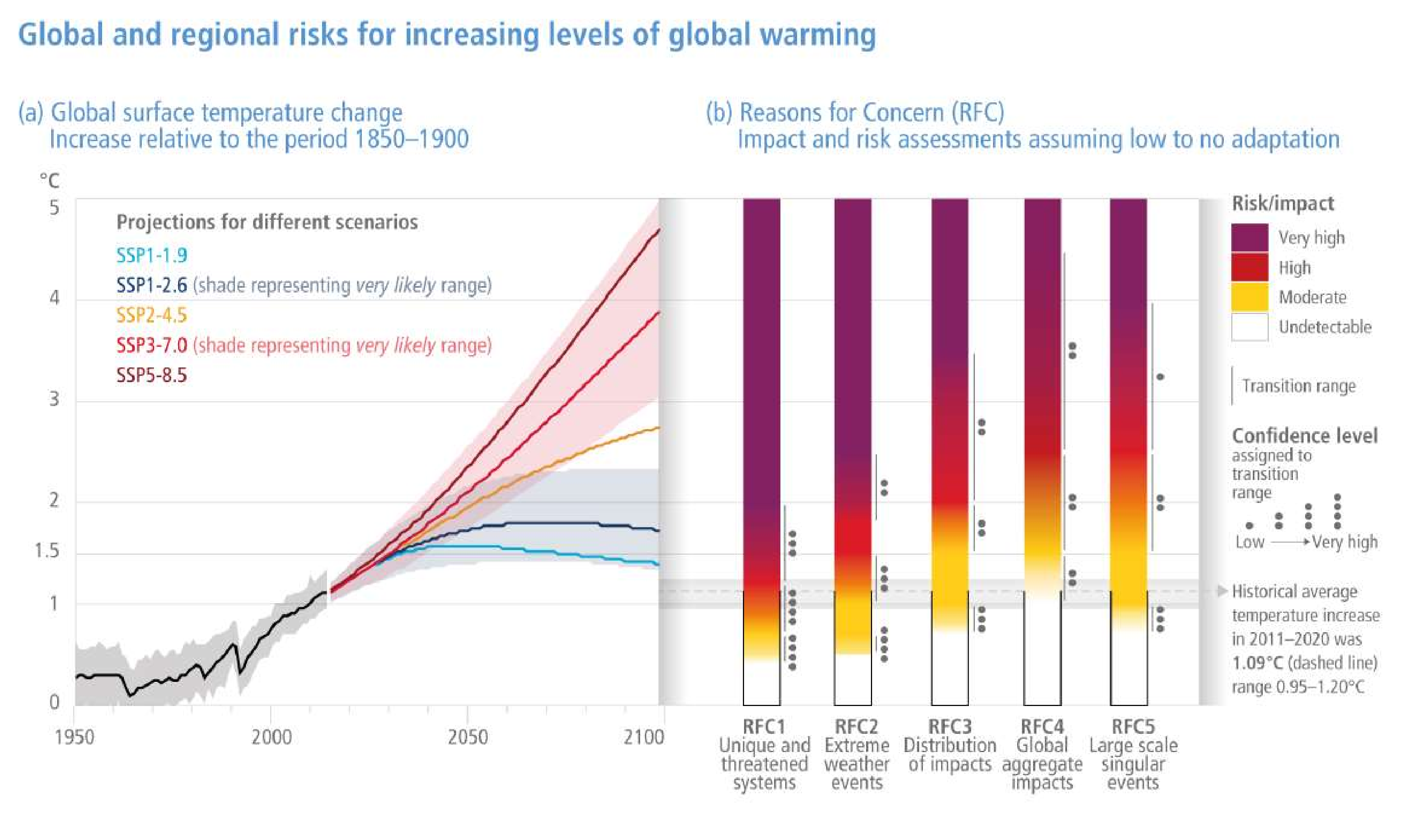
(d) Annual mean total column soil moisture change (standard deviation)

Across warming levels, changes in soil moisture largely follow changes in precipitation but also show some differences due to the influence of evapotranspiration.

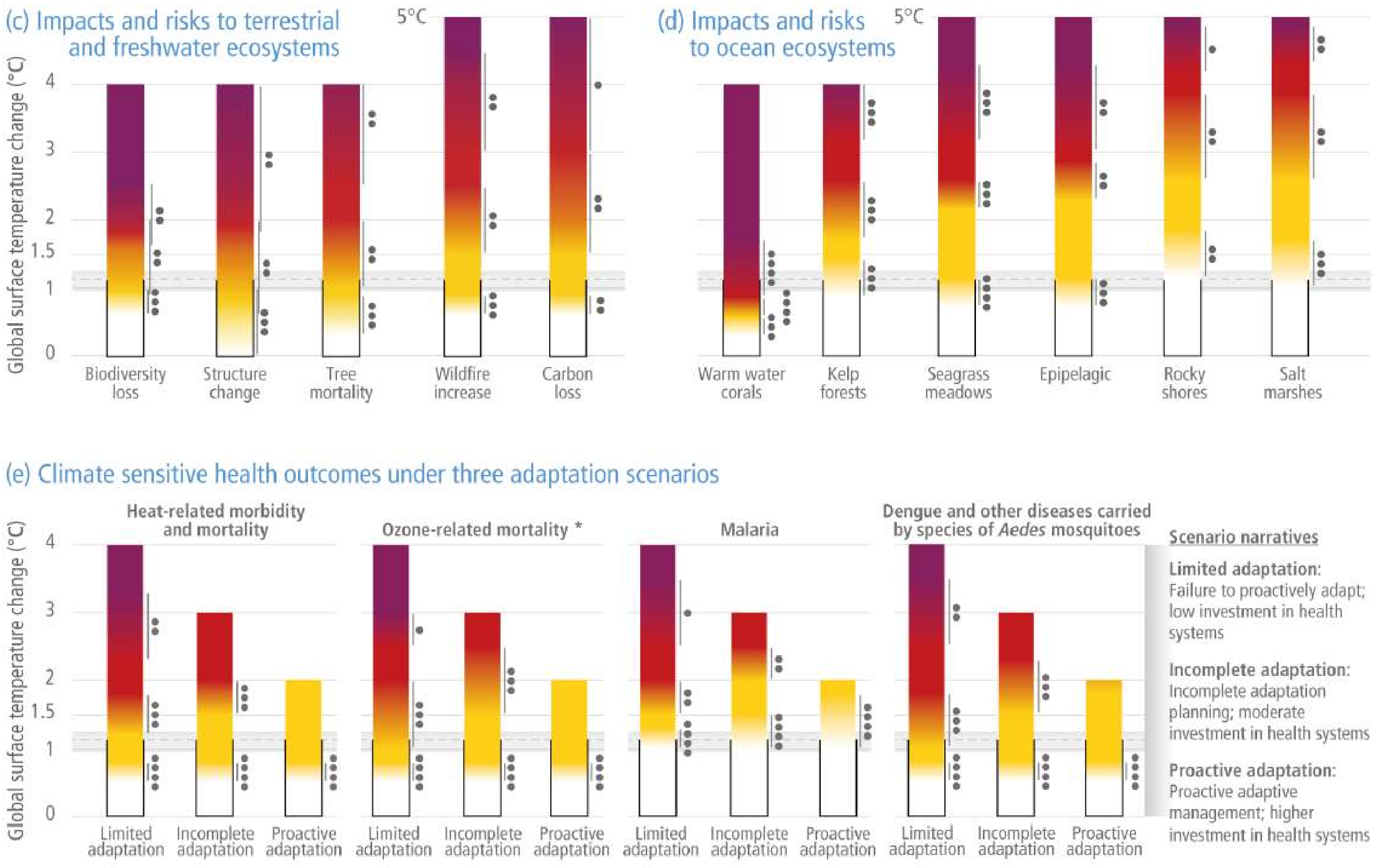


Relatively small absolute changes may appear large when expressed in units of standard deviation in dry regions with little interannual variability in baseline conditions.





IPCC AR6 WG II 2022



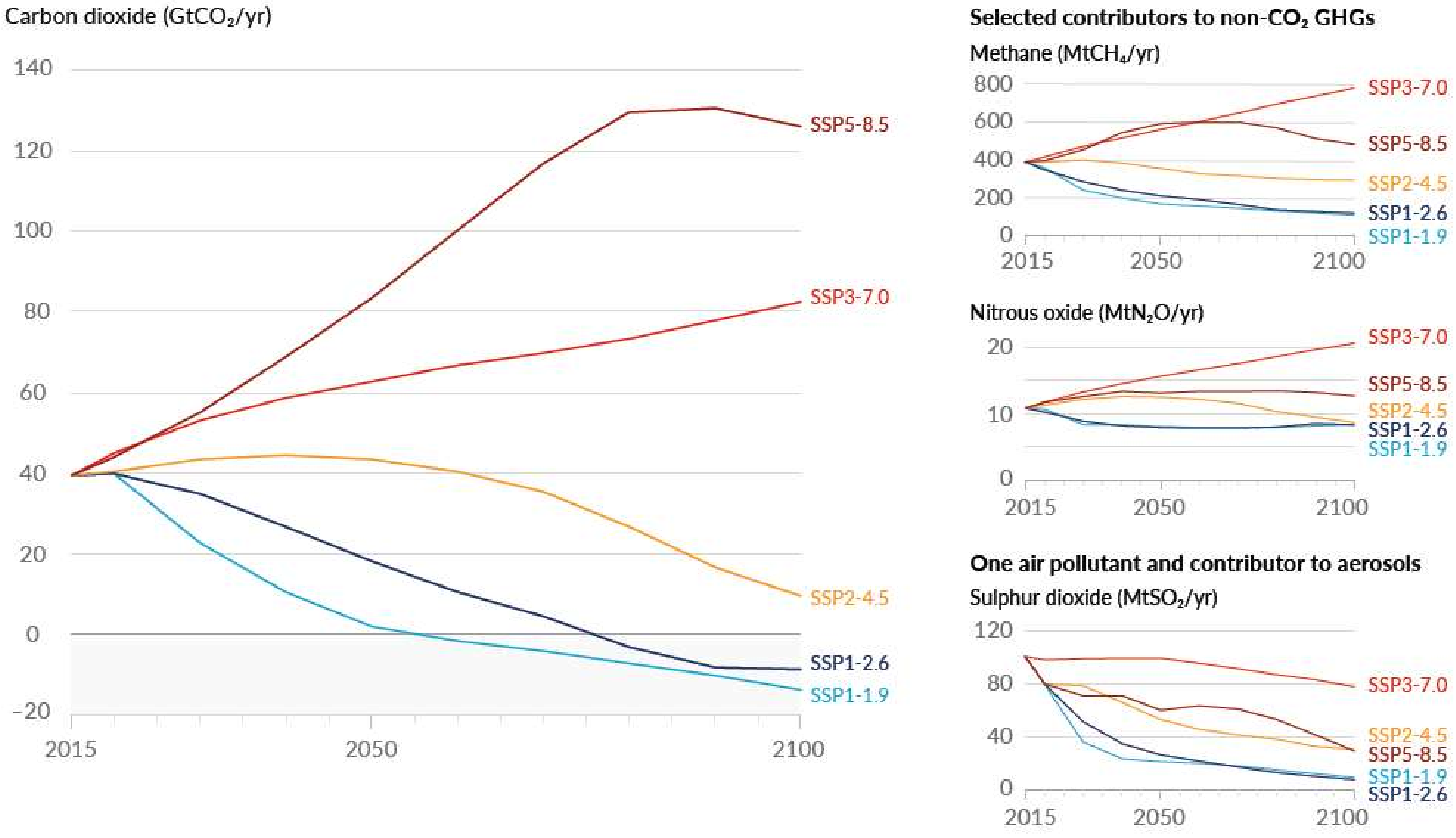
* Mortality projections include demographic trends but do not include future efforts to improve air quality that reduce ozone concentrations.

IPCC AR6 WG II 2022

Emissionsprojektionen

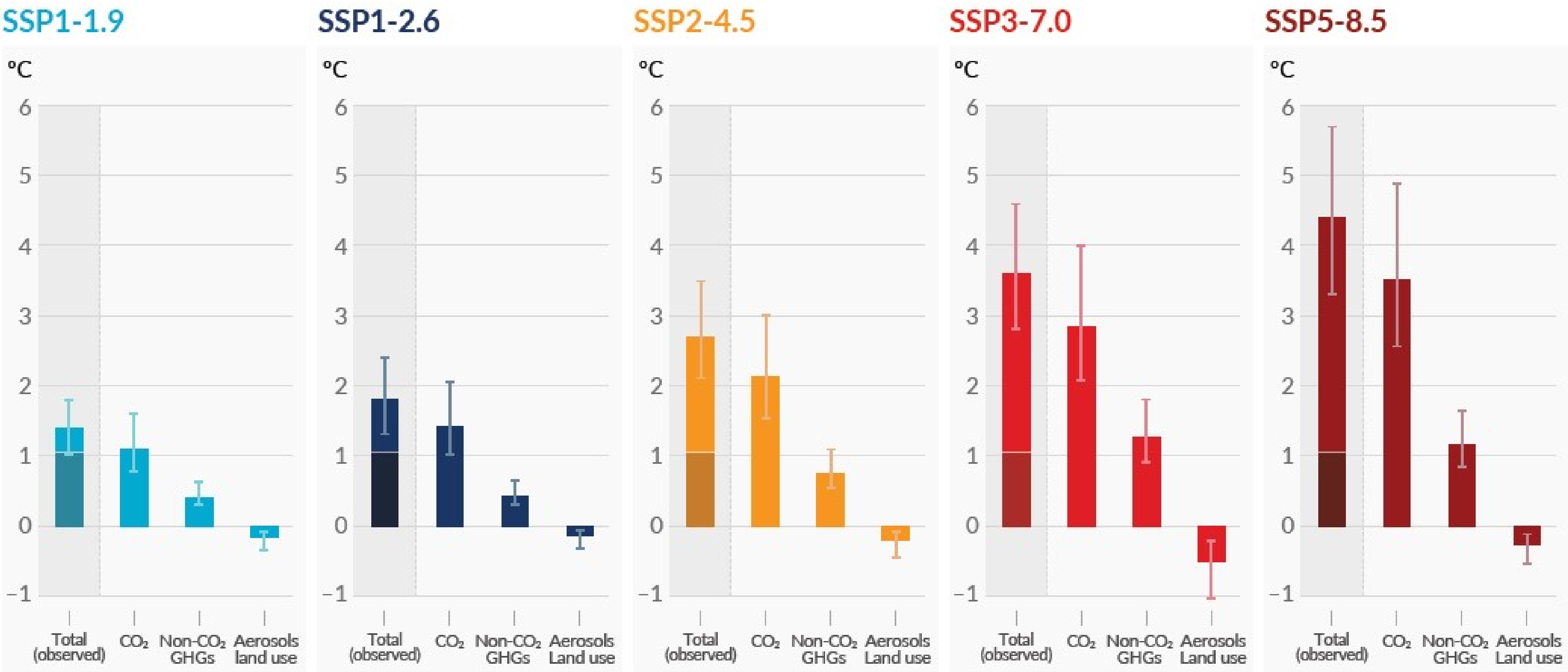
Future emissions cause future additional warming, with total warming dominated by past and future CO_2 emissions

(a) Future annual emissions of CO_2 (left) and of a subset of key non-CO_2 drivers (right), across five illustrative scenarios



(b) Contribution to global surface temperature increase from different emissions, with a dominant role of CO_2 emissions

Change in global surface temperature in 2081–2100 relative to 1850–1900 (°C)



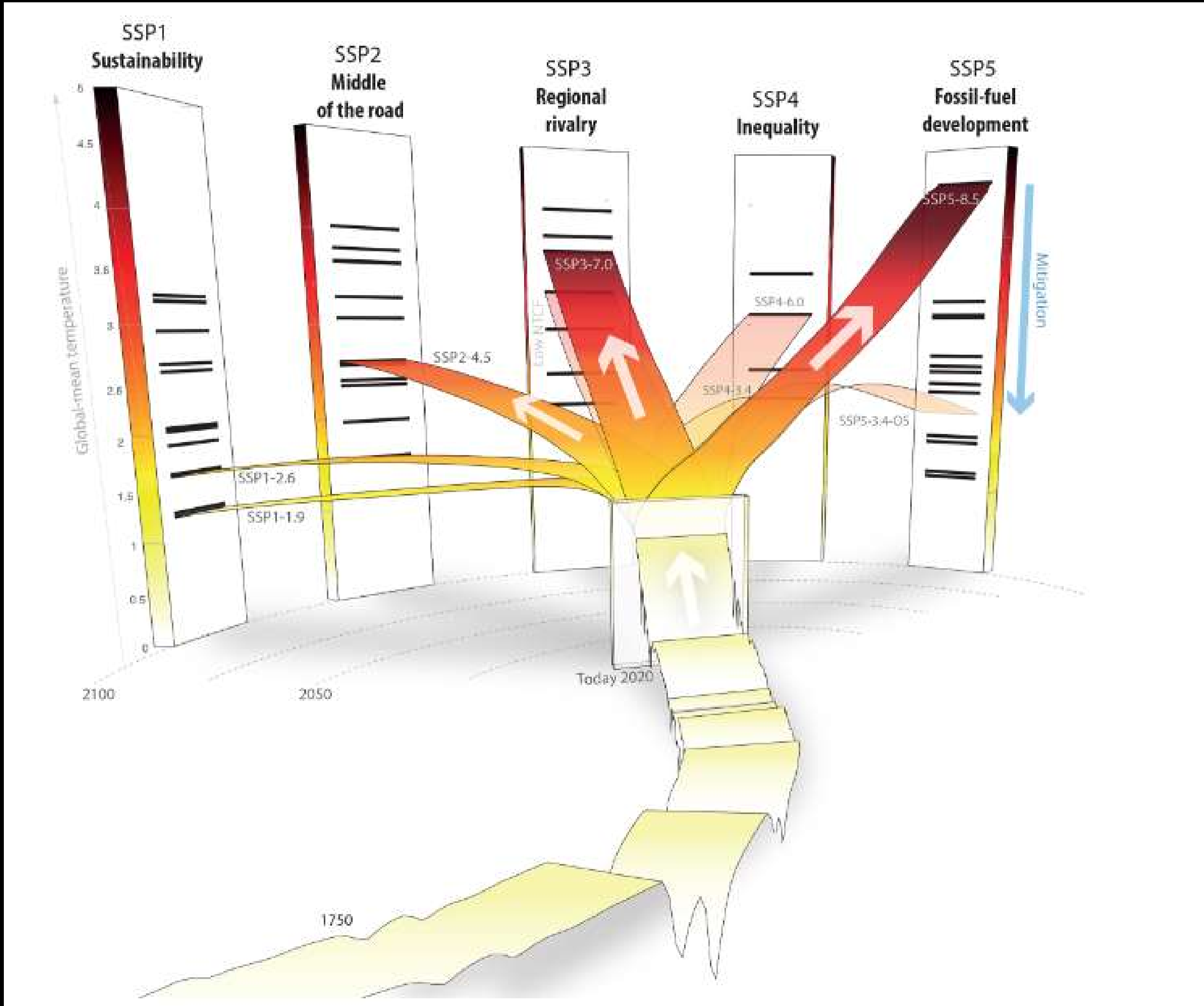
Total warming (observed warming to date in darker shade), warming from CO_2, warming from non-CO_2 GHGs and cooling from changes in aerosols and land use

IPCC AR6 WG I 2021

Table SPM.1 | Changes in global surface temperature, which are assessed based on multiple lines of evidence, for selected 20-year time periods and the five illustrative emissions scenarios considered. Temperature differences relative to the average global surface temperature of the period 1850–1900 are reported in °C. This includes the revised assessment of observed historical warming for the AR5 reference period 1986–2005, which in AR6 is higher by 0.08 [–0.01 to +0.12] °C than in AR5 (see footnote 10). Changes relative to the recent reference period 1995–2014 may be calculated approximately by subtracting 0.85°C, the best estimate of the observed warming from 1850–1900 to 1995–2014.
{Cross-Chapter Box 2.3, 4.3, 4.4, Cross-Section Box TS.1}

	Near term, 2021–2040		Mid-term, 2041–2060		Long term, 2081–2100	
Scenario	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7

IPCC AR6 WG I 2021



Meinshausen et al. 2020

Projected global GHG emissions from NDCs announced prior to COP26 would make it *likely* that warming will exceed 1.5°C and also make it harder after 2030 to limit warming to below 2°C.

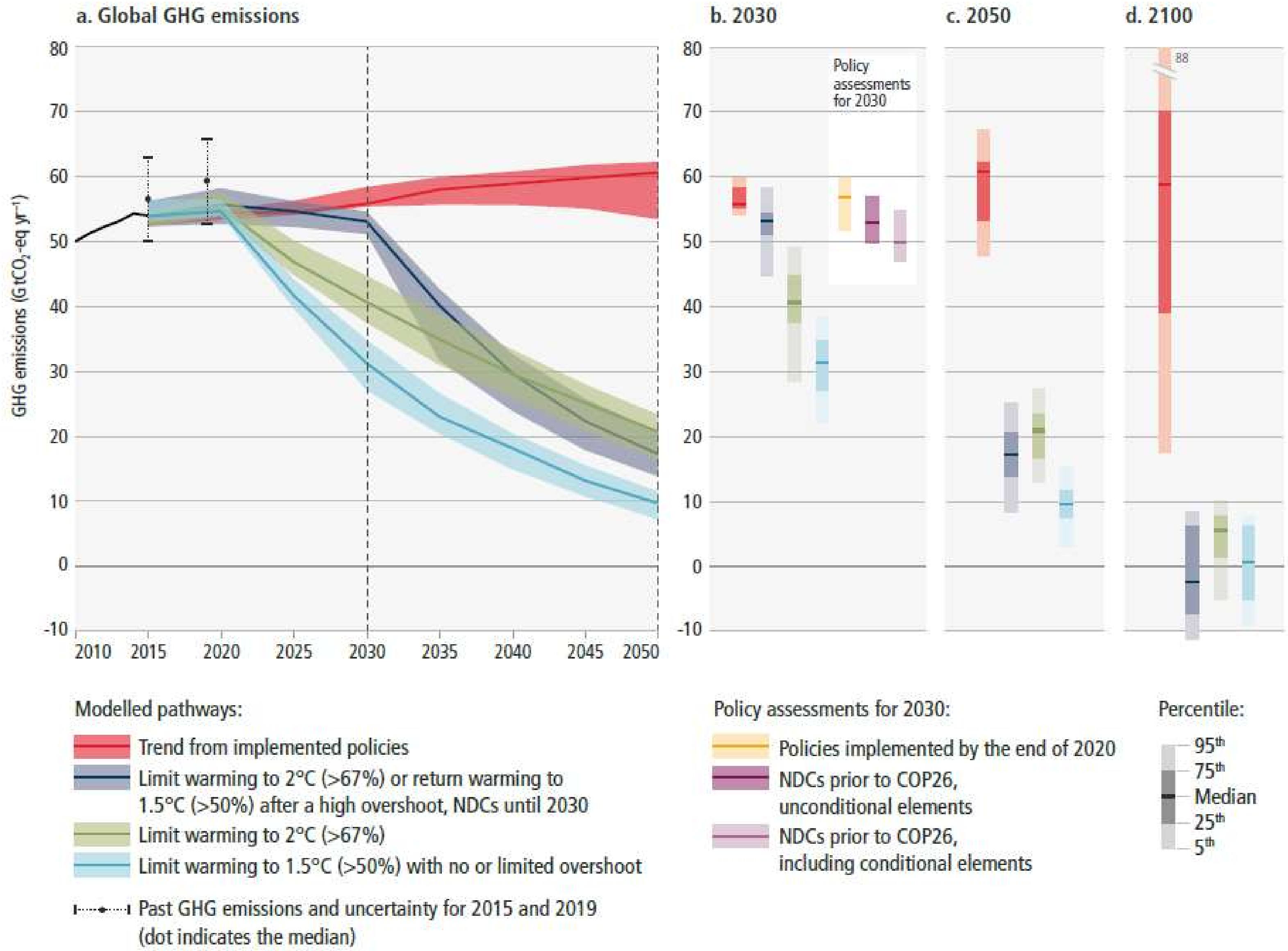
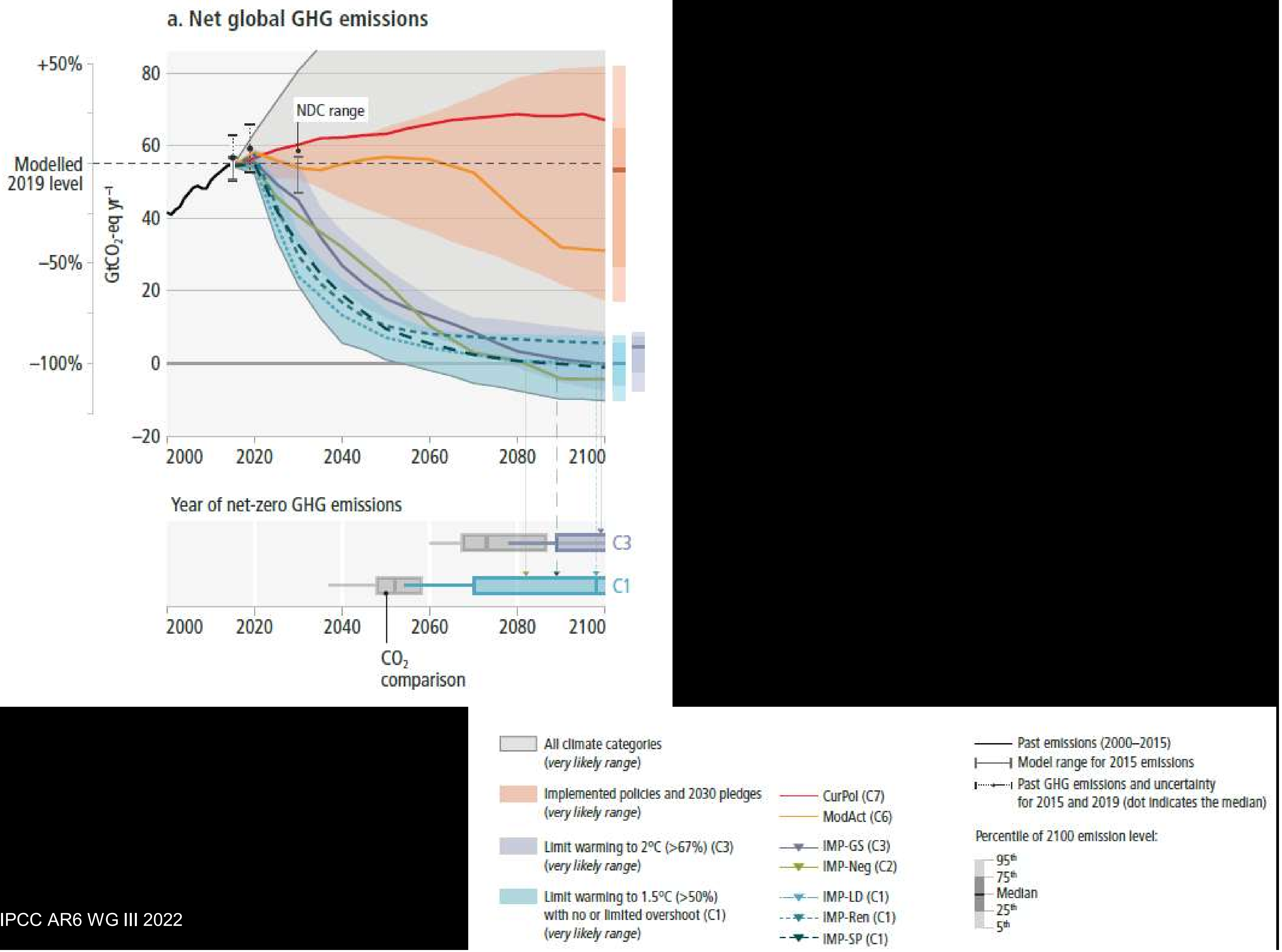


Figure SPM.4 | Global GHG emissions of modelled pathways (funnels in Panel a, and associated bars in Panels b, c, d) and projected emission outcomes from near-term policy assessments for 2030 (Panel b).

IPCC AR6 WG III 2022



IPCC AR6 WG III 2022

[redacted]

Blöcke II und III

[redacted]

Block II: Gruppenarbeit

Setting und Frage:

- Setting: strategische Sitzung einer Studierendenvereinigung; NGO; Bauernverband; Avenir Suisse, etc. zum Klimaschutz in der Landwirtschaft.

- Sie sollen als Gruppe das vorgegebene Thema möglichst gut verkaufen („pro“) oder kritisieren („kontra“).

- Sie sind keine Expertinnen und Experten, aber Sie müssen diese verstehen und aus dem Expertenwissen möglichst gute Argumentationen zusammenstellen können.

- Es geht im Workshop primär um die Auseinandersetzung mit der hohen Komplexität dieser Fragestellungen, um die Diskussion, die Argumentation, weniger um abschliessende Antworten.

Block II: Gruppenarbeit

Die Aufgaben bei den Gruppenarbeiten sind die folgenden:

- Die Argumentation für Ihren Standpunkt pro/kontra möglichst gut zurechtzulegen und dann zu präsentieren.

- Die Gegenargumente zu antizipieren und versuchen zu kontern.

- Allenfalls: zentrale Wissenslücken identifizieren und evtl. Ideen formulieren, wie diese geschlossen werden könnten.

Block II: Gruppenarbeit

Für die Präsentation und Diskussion in Block III müssen Sie also die Argumentation für eine mündliche Diskussion erarbeitet haben. Ein paar Punkte dazu:

- Nutzen Sie das Internet oder fragen Sie mich bei allfälligen Wissenslücken.
- Versuchen Sie möglichst präzise zu formulieren und zu argumentieren.
- Überlegen Sie sich die möglichen Gegenargumente der gegnerischen Gruppe und wie sie diese kontern könnten.
- Was oft hilfreich ist (aber nicht nötig): halten Sie Ihre Antworten, Argumente, etc. in schriftlicher Form und möglichst detailliert fest.
- Bereiten sie ein Poster vor, nutzen sie Klebezettel, Flipchart, oder auch nur die freie Rede – das können Sie halten, wie Sie wollen.

Block II: Gruppenarbeit

4 Gruppen à je 4-5 Personen

Rolle der Personen innerhalb der Gruppen:

- 1-2 Visionärinnen/Visionäre: sehen Möglichkeiten, Stärken (Pro: 1-2, Kontra 1)
- 1-2 Kritiker/Kritikerinnen: sehen Probleme, Schwächen (Pro: 1, Kontra 1-2)
- 1 Diskussionsleitung: hält die Gruppe zusammen; themenfokussiert, zielgerichtet, konstruktiv
- 1 Protokollführer/in – schreibt präzise, präsentiert gut

Block III: Präsentation

Detaillierter Ablauf zur Präsentation und Diskussion:

- Auslosung der Themenreihenfolge
- Auslosung welche Gruppe zuerst präsentiert
- Die Protokollführer/innen der pro/kontra-Gruppen stellen nacheinander jeweils ihre Argumentation vor (je maximal knapp 10‘, ohne Diskussion dazwischen)
- Diskussion zwischen den Gruppen; die gegnerischen Gruppen versuchen die Argumente der anderen zu entkräften (also mitschreiben bei der Präsentation der anderen, dann kontern).
- Diskussion im Plenum

Diskussion zwischen den Gruppen/mit dem Plenum: total 15‘

Dies alles finden Sie auch auf dem Handout.