



POTSDAM INSTITUTE FOR
CLIMATE IMPACT RESEARCH

Food systems and climate change – role of demand side management for climate change mitigation

Prajal Pradhan

Climate Change Seminar, Asian Institute of Technology

4th Febuary 2020

Climate Change and Land

An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems

Summary for Policymakers



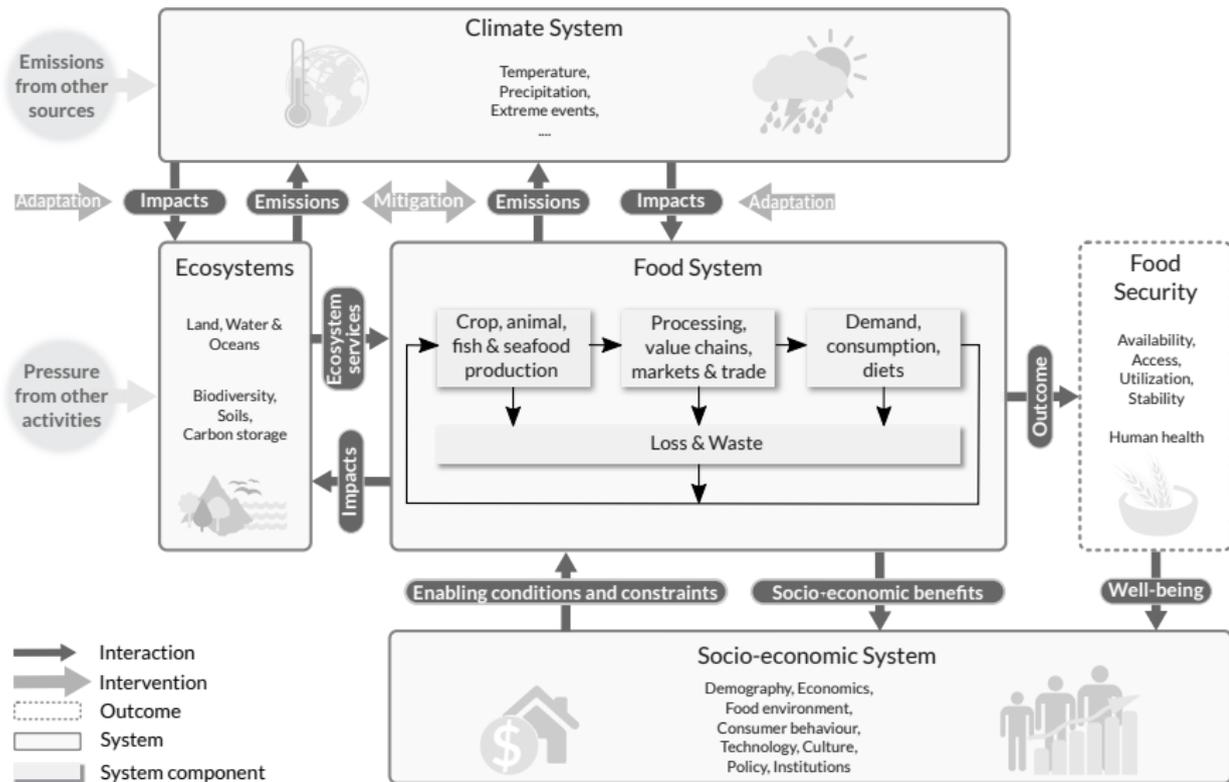
WG I WG II WG III



CLIMATE CHANGE AND LAND

An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.

Food systems



Food system is broken

MARCO ANTONIO REZINDO BRAZIL PHOTOS/LIGHTPOCKET/GETTY



A cattle rancher in Brazil, where pressures to produce more meat collide with the need to reduce deforestation and greenhouse-gas emissions.

Fix the broken food system in three steps

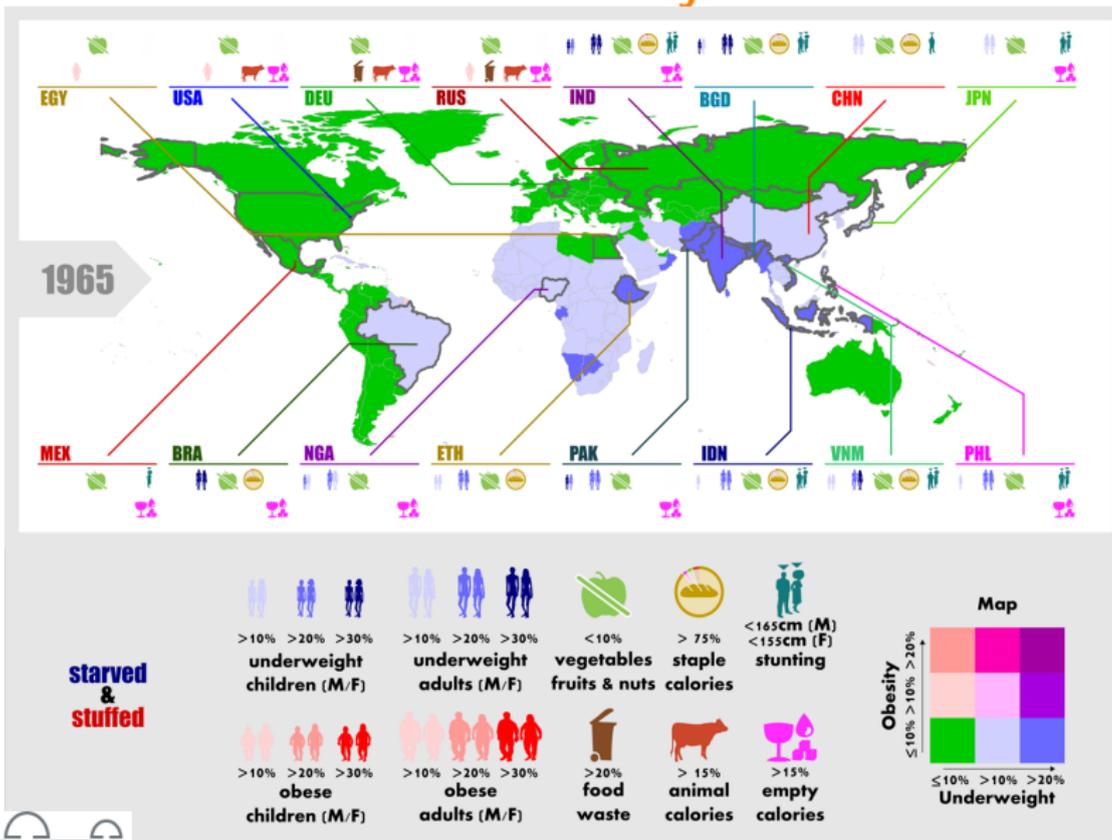
Map, model and manage agriculture, biodiversity, trade and nutrition – and build a global network, urge **Guido Schmidt-Traub**, **Michael Obersteiner** and **Aline Mosnier**.



Schmidt-Traub et al. 2019 (*Nature*)

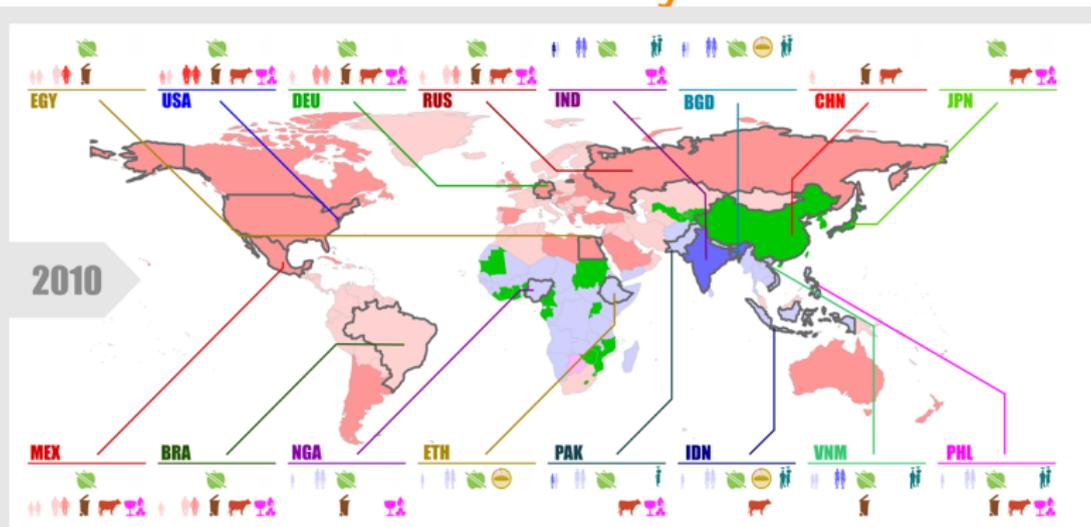
Prajal Pradhan *Climate Resilience: Climate Impacts & Adaptation*

Status and trend: food security



Bodisky et al. (Under Review)

Status and trend: food security



**starved
&
stuffed**



>10% >20% >30%
underweight children (M/F)



>10% >20% >30%
underweight adults (M/F)



<10%
vegetables fruits & nuts



>75%
staple calories



<165cm (M)
<155cm (F)
stunting



>10% >20% >30%
obese children (M/F)



>10% >20% >30%
obese adults (M/F)



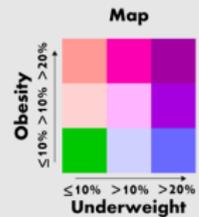
>20%
food waste



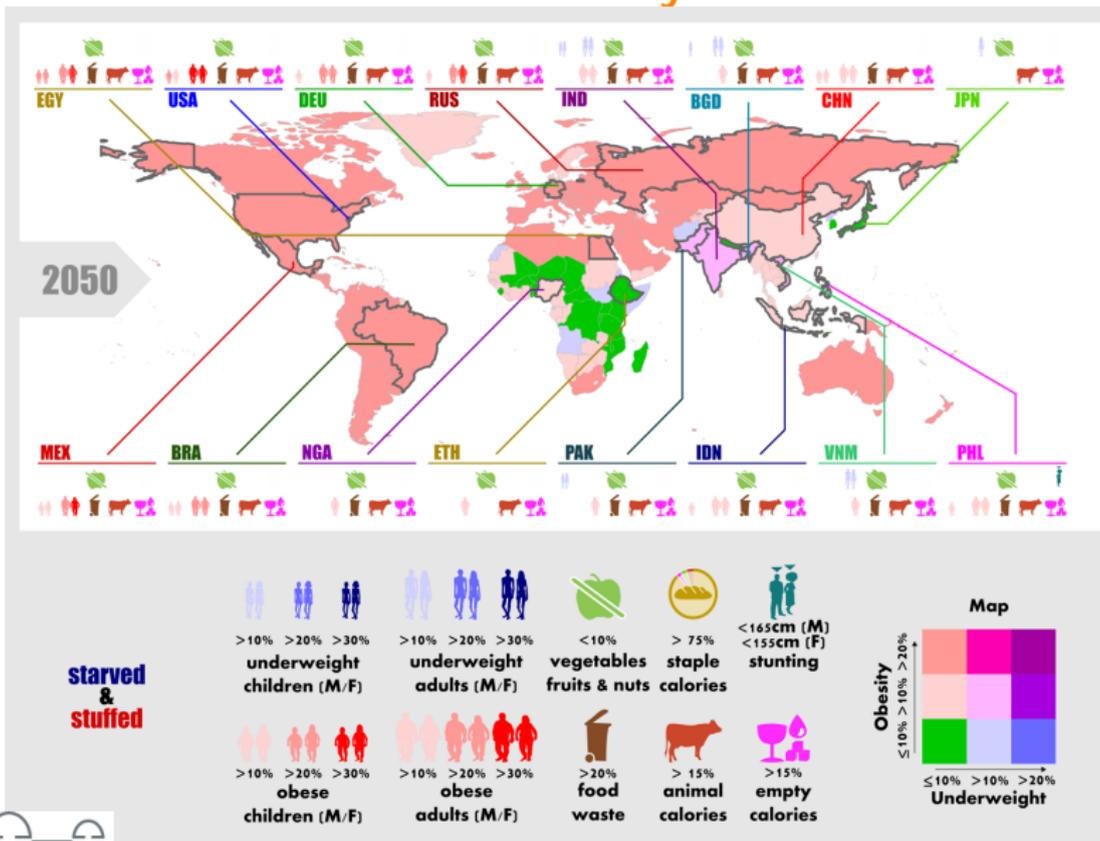
>15%
animal calories



>15%
empty calories



Status and trend: food security



Environmental implications

Table 1 | Comparison of 2007–2016 mean values and standard deviations of emissions from AFOLU⁶ and global food system⁵ emissions by component, including food loss and waste

Components	AFOLU		Food system	
	Emissions (GtCO ₂ e yr ⁻¹) ^a	Percentage of anthropogenic GHG emissions (%) ^b	Emissions (GtCO ₂ e yr ⁻¹) ^a	Percentage of anthropogenic GHG emissions (%) ^b
Agriculture	6.2 ± 1.4 ^{18,19}	9–14	6.2 ± 1.4 ^{18,19}	9–14
FOLU ^c	5.8 ± 2.6 ⁶	6–16	4.9 ± 2.5 ¹⁸	5–14
Pre- to post-production	-	-	2.6–5.2 ^{7,8}	5–10 ^d
Total	12.0 ± 2.9	17–29	10.8–19.1	21–37

^aMean and 95% confidence interval, using GWP values of the IPCC AR5 with no climate feedback (GWP-CH₄ = 28; GWP-N₂O = 265).

^bComputed using a total emissions value for the period 2007–2016 of 52 GtCO₂e per year⁶. ^cFood-related FOLU for food system columns.

^dRounded to nearest fifth percentile due to assessed uncertainty in estimates.



Climate change mitigation potentials

Table 2 | Food system supply-side and demand-side technical and economic mitigation potentials⁵

Mitigation potential	Supply side (GtCO ₂ e yr ⁻¹)	Demand side (GtCO ₂ e yr ⁻¹)
Technical	2.3-9.6	0.7-8.0
Economic	1.5-4.0 ^a	1.8-3.4 ^b

^aBy 2030 at prices ranging from 20-100 USD per tCO₂e. ^bBy 2050 at prices ranging from 20-100 USD per tCO₂e.

Mitigation synergies and co-benefits



Mitigation and adaptation potential: None (Grey), Limited (Light Green), High (Medium Green), Very High (Dark Green)

Rosenzweig et al. 2020 (*Nature Food*)

Mitigation synergies and co-benefits

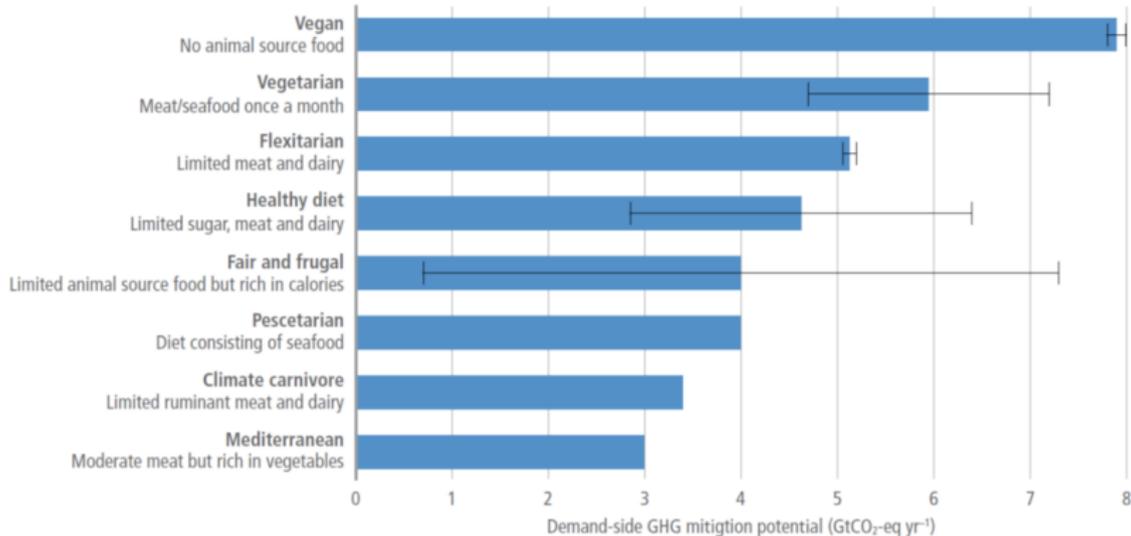
Demand management



Demand-side mitigation: dietary changes

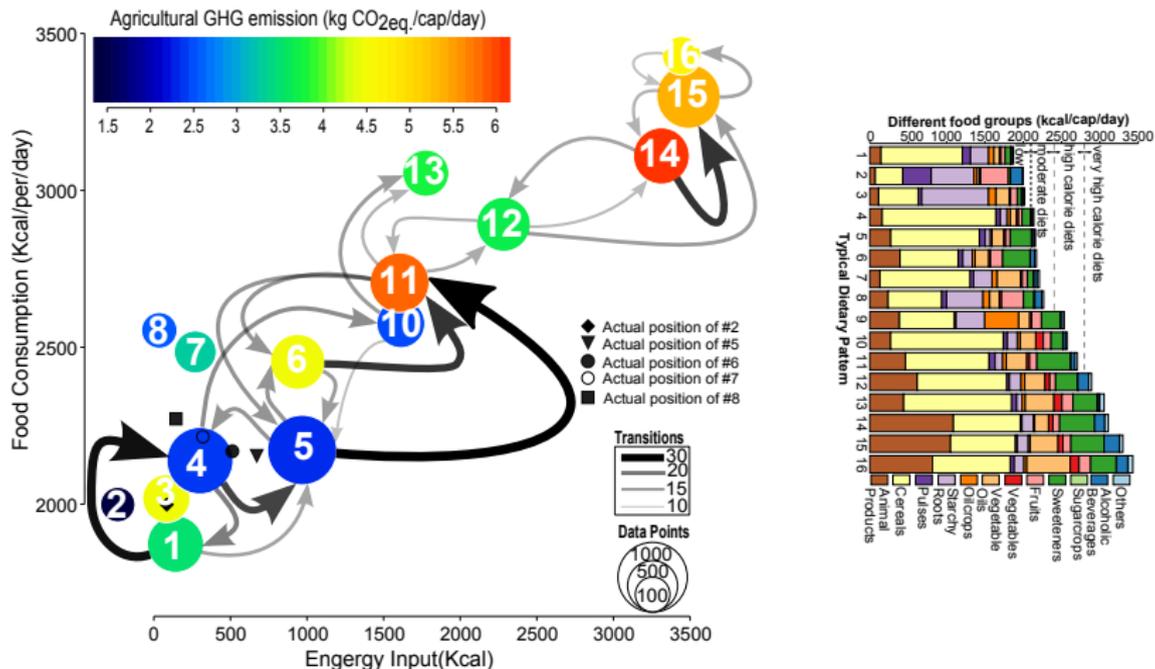
Demand-side mitigation

GHG mitigation potential of different diets



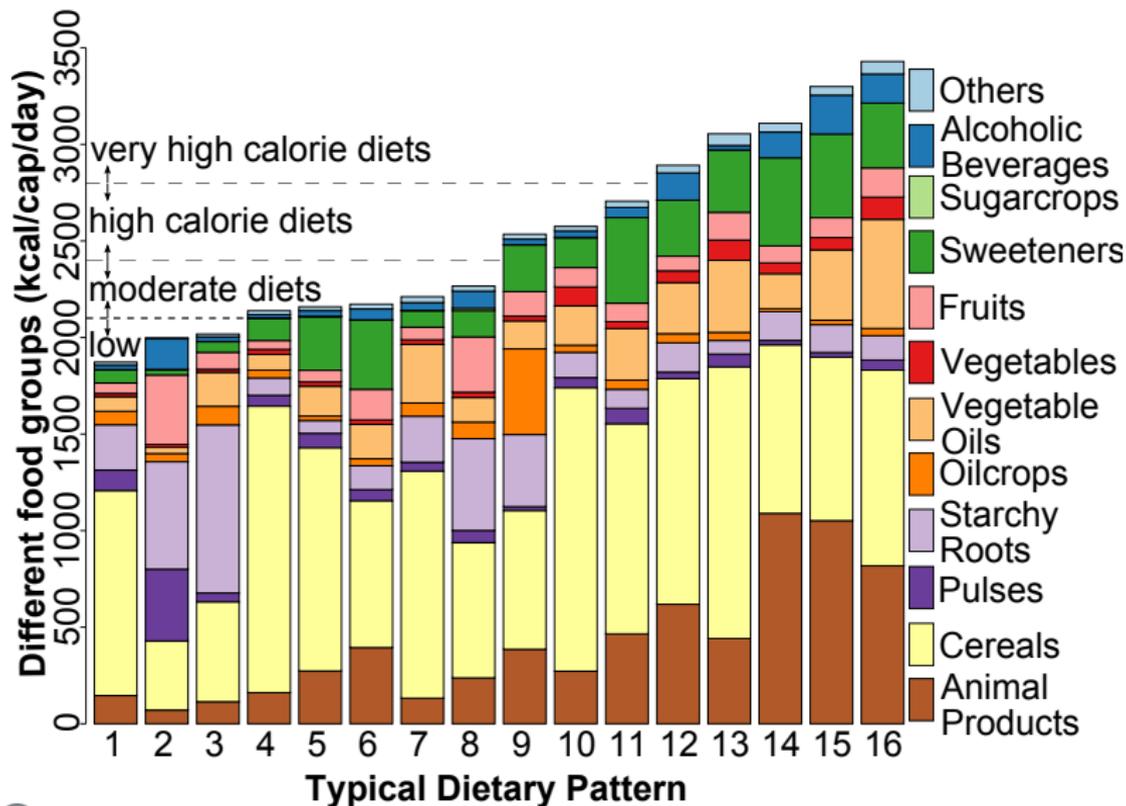
Diet matters

Energy, emissions, water, land use, etc.



(Pradhan et al. 2013, PLoS ONE)

Diet matters



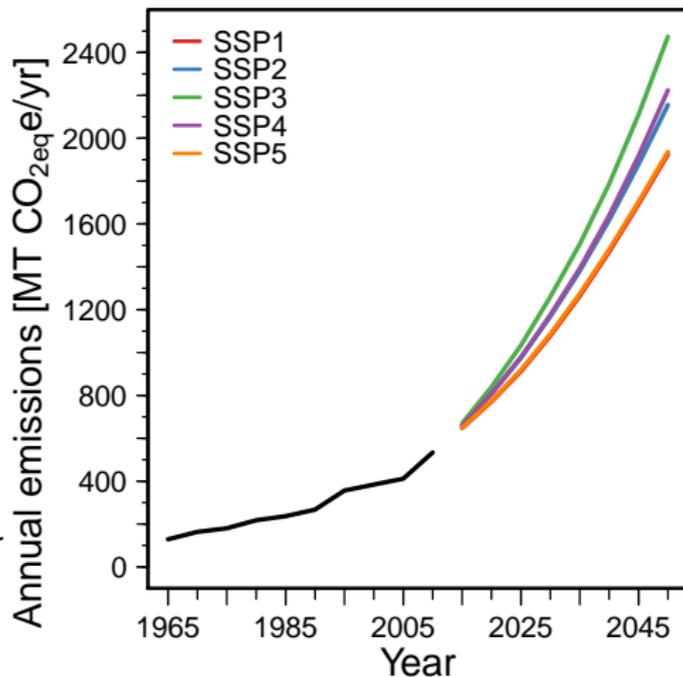
Dietary shifts 1961–2007



(Pradhan et al. 2013a, PLoS ONE)

Reducing food waste

- emissions increased from 130 Mt CO_{2eq.}/yr to 530 Mt CO_{2eq.}/yr between 1965 and 2010
- may increase tremendously to 1.9–2.5 Gt CO_{2eq.}/yr by 2050



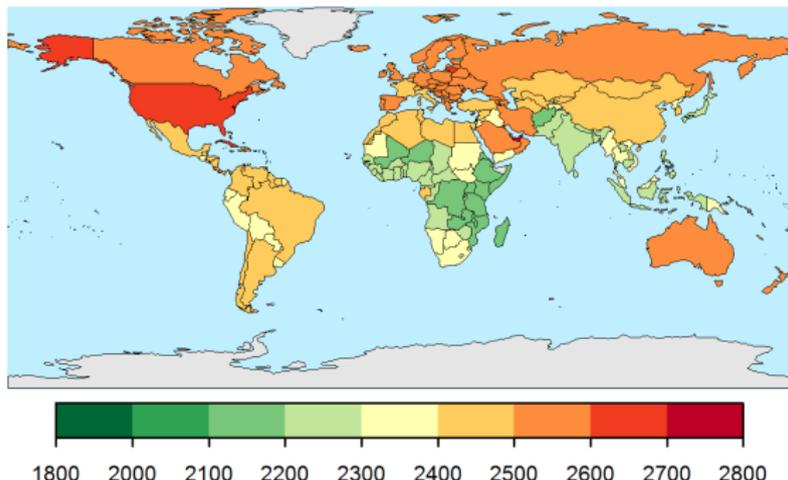
Food loss and waste

- **30%–40%** of food is lost and wasted in both developing and developed countries (Godfray et al. 2010)
- food is lost and wasted **across various stages** of the food supply chain (FAO 2011)

Food loss and waste

- **30%–40%** of food is lost and wasted in both developing and developed countries (Godfray et al. 2010)
- food is lost and wasted **across various stages** of the food supply chain (FAO 2011)
- food loss – food decreased during **production, post-harvest, and processing**
- food waste – **food discarded at consumer level**

Food energy requirements

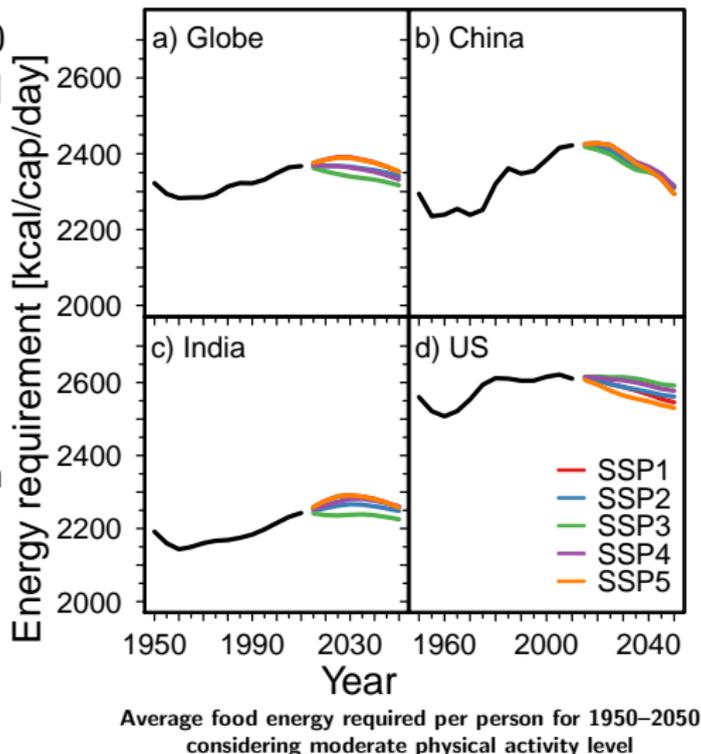


Country scale food energy requirements for 2010 considering moderate PAL in kcal/cap/d

- country with **heavy body weights** required larger food energy (e.g. United States, Australia, etc.)
- counties with **larger share of adult population** compare to younger population require larger food energy (e.g. China)

Food requirements trend and projection

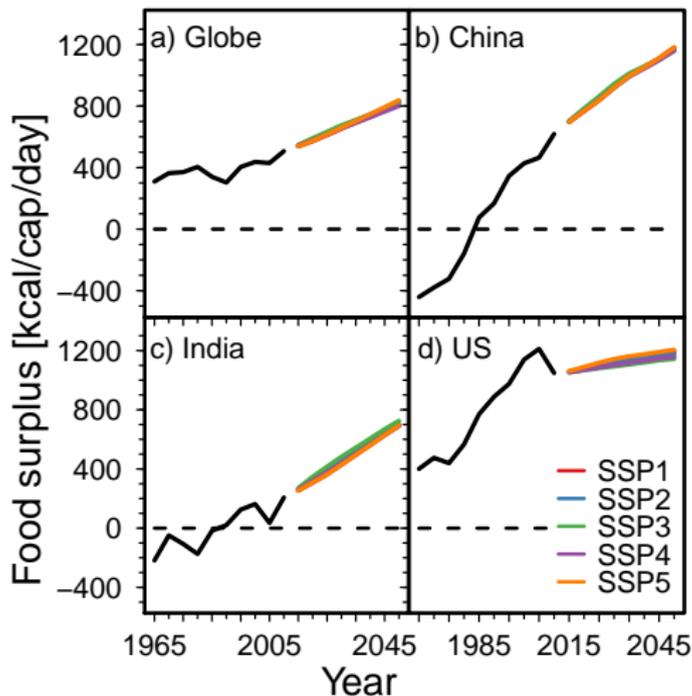
- Globe: between 2300 and 2400 kcal/cap/d
- China: increased from 2200 to 2400 kcal/cap/d in 2010 and may decrease to 2300 kcal/cap/d by 2050
- India: varies between 2150–2250 kcal/cap/d
- US: varies between 2500–2600 kcal/cap/d



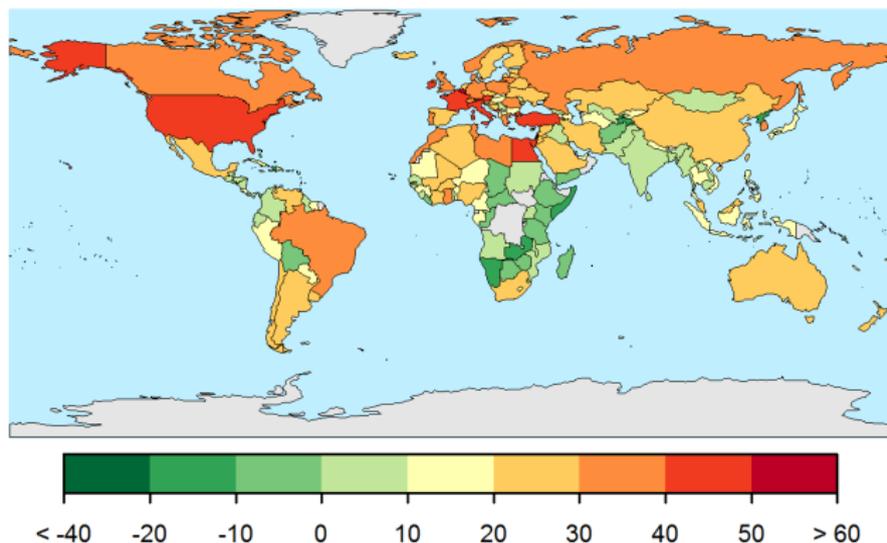
Food waste

Global food availability increased from 2200 kcal/cap/d in 1961 to 2870 kcal/cap/day in 2011

Current food waste:
500 kcal/cap/d on a
global scale,
600 kcal/cap/d in China,
1000 kcal/cap/d in US



Share of food waste/deficit

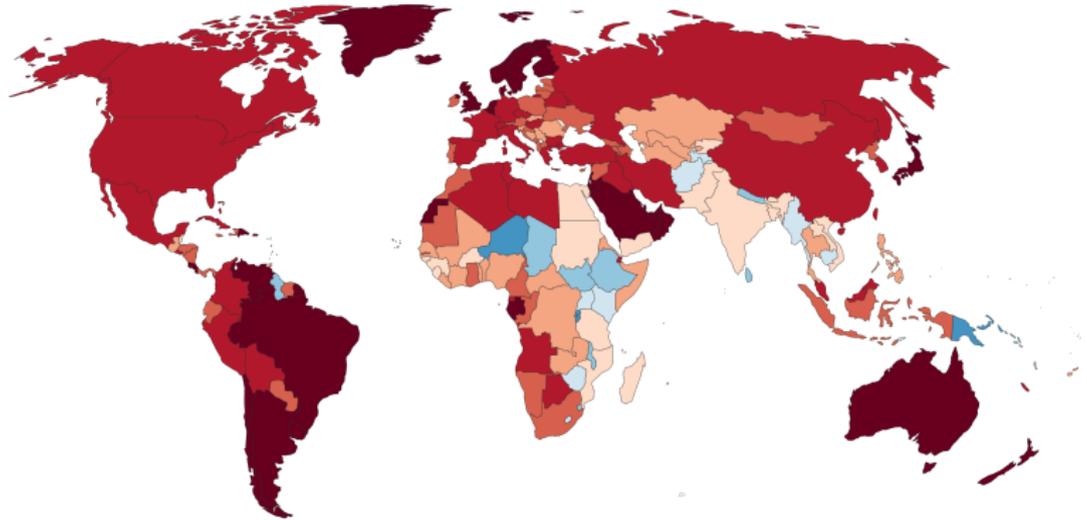


Share of food waste/deficit (+/-) on country scale compare to food requirement for 2010 in percentage

- food waste is larger in developed and transition countries
- most of Sub-Saharan African countries has food deficit

Urbanization

By 2050, 68% of the global population will be living in urban areas. Therefore, urban food systems play important role in climate change mitigation.



No data 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%



<https://ourworldindata.org/>

Urban and Peri-urban agriculture

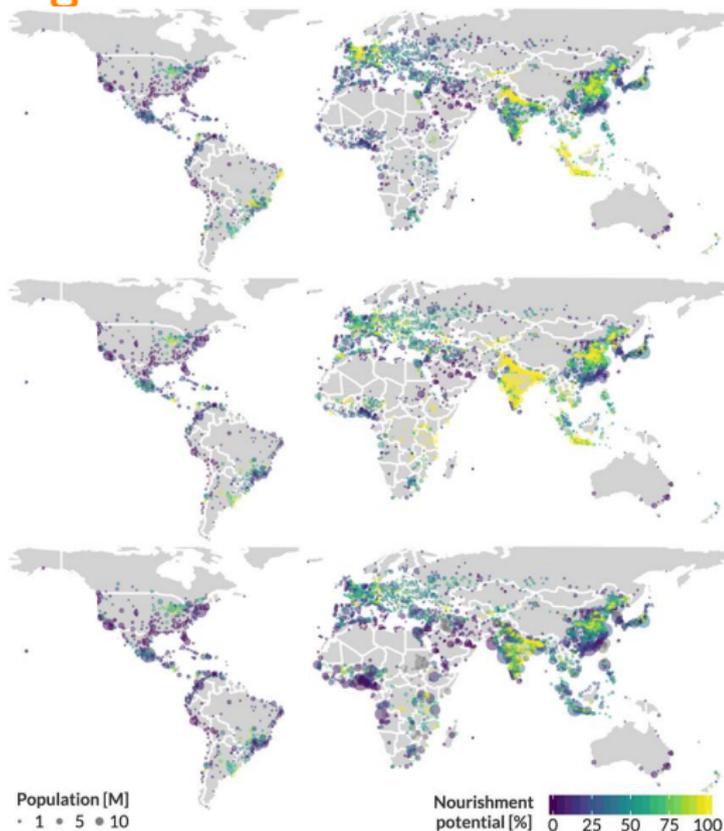
	Pop.	Share
2010	1.09	30.6
2010 CYG	1.26	35.3
2050 CC	1.40	22.1

Pop.: population in billion

Share: Share of the urban
population (%)

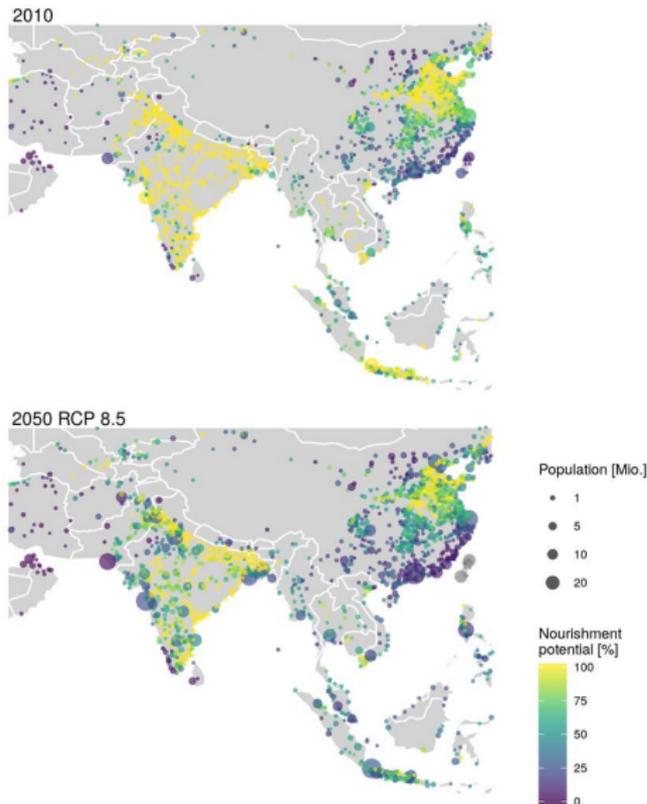
CYG: closing crop yield gaps

CC: Climate change RCP 8.5



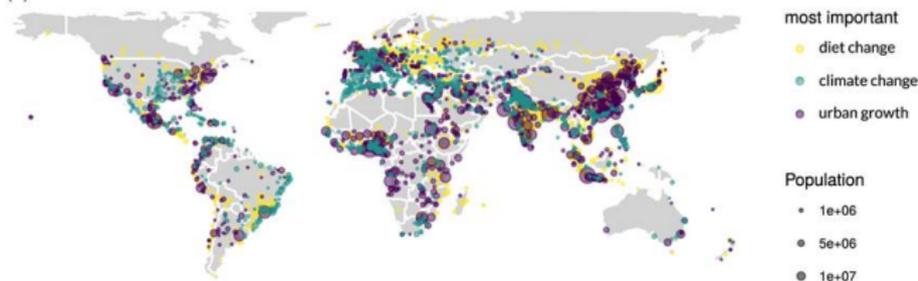
Urban and Peri-urban agriculture

- large amount of urban hinterland are already used in some regions (e.g. Southern and South-East Asia)
- further extension is not an option to ensure future food security
- only remaining options are improving productivity and closing yield gaps



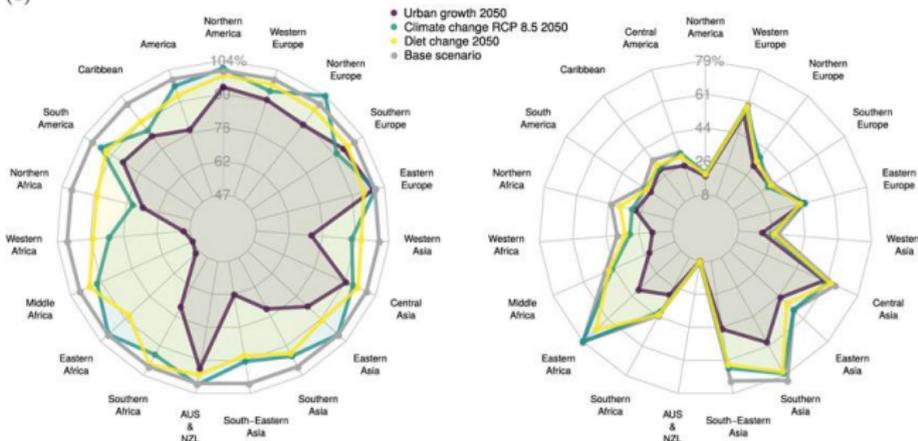
Urban and Peri-urban agriculture 2050

(a)

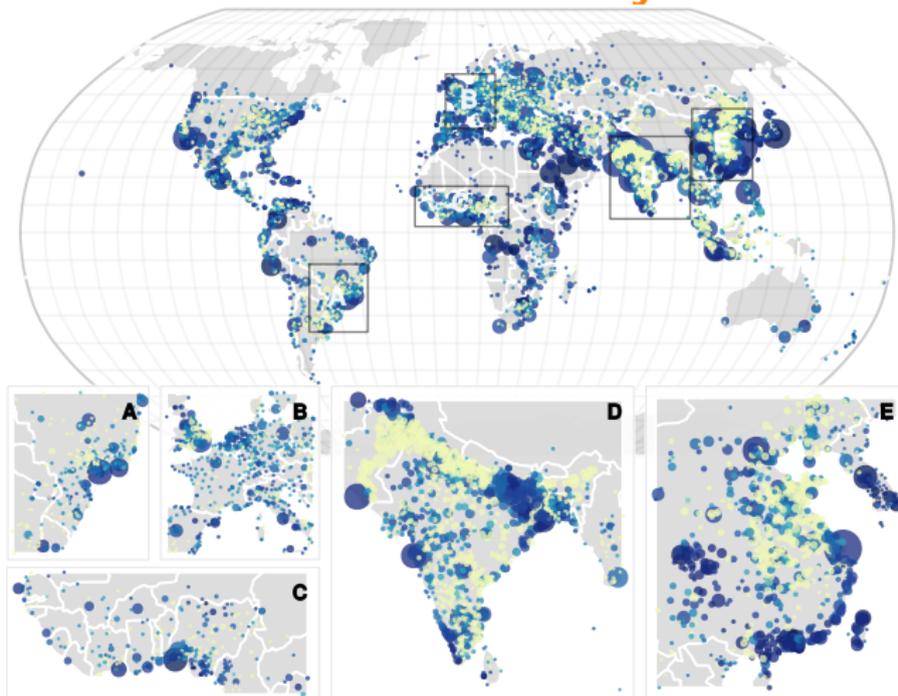


- for 16 out of 19 regions urban growth will have the largest impact
- for 9 regions diet changes have the second largest impact

(b)



Regionalized vs Globalized food systems



Net food distance (million kcal km per year)



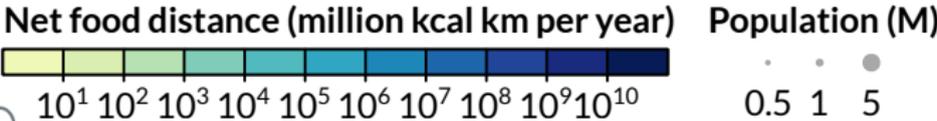
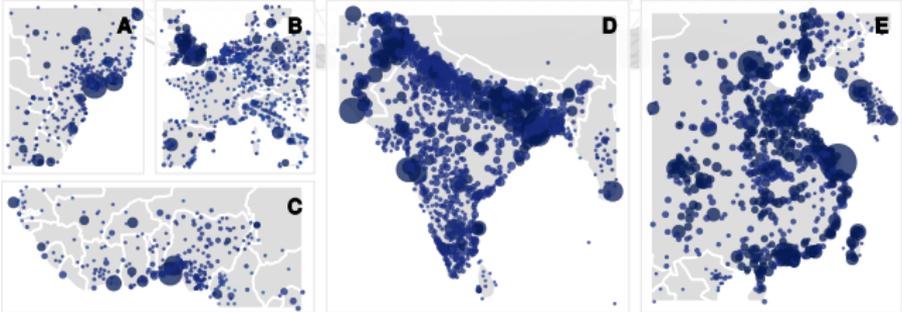
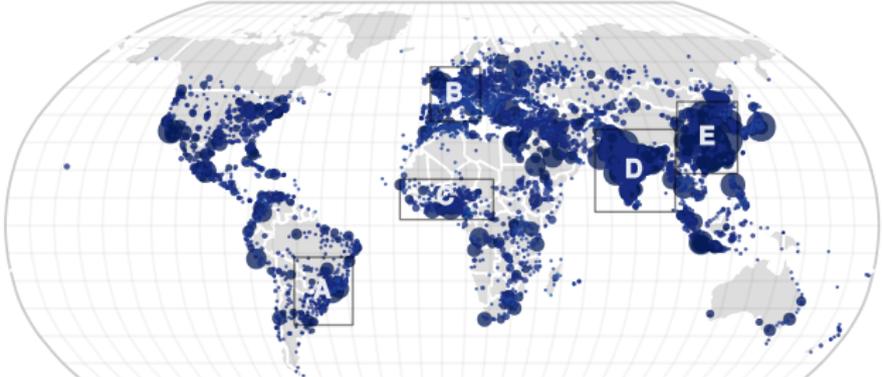
10^1 10^2 10^3 10^4 10^5 10^6 10^7 10^8 10^9 10^{10}

Population (M)



0.5 1 5

Regionalized vs Globalized food systems



Emissions under different food systems (2010)

Food systems	Baseline	FW	CYG	FW & CYG	FG
Regionalized	0.150	0.103	0.089	0.061	0.287
Globalized	1.872	1.748	1.869	1.745	1.738

FW: food waste reduction by 50%

CYP: closing crop yield gaps by 50%

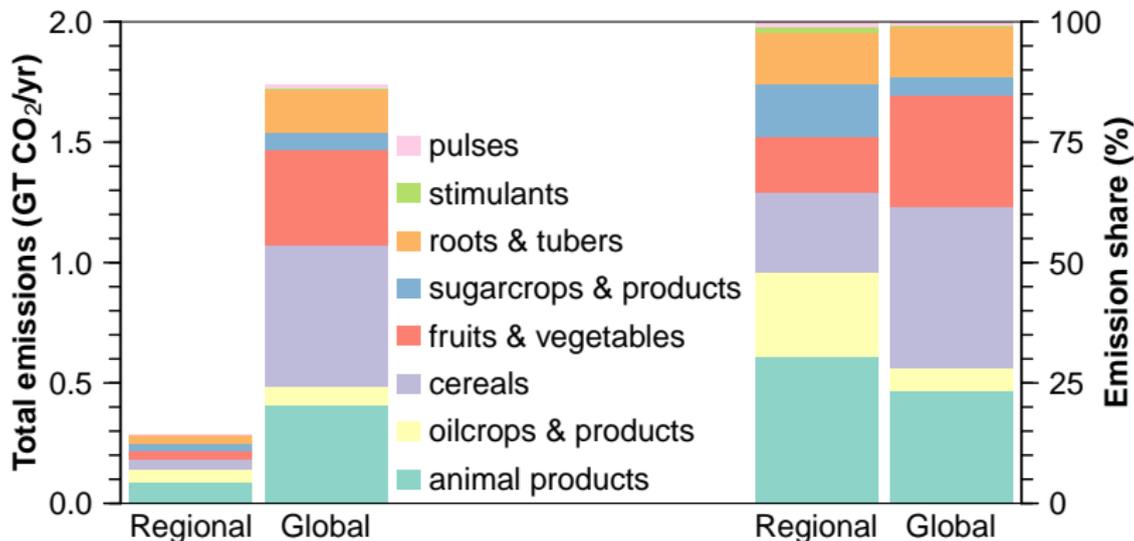
FW-CYP: combination of FW and CYP

FG: eight food groups

Global food transport emissions in 2010 is 0.7 GT CO_{2eq}/yr

Regionalization of urban food systems by consuming **local and regional** food can **halve the emissions** due to food transport

Food transport emissions (food groups)



transport emission is the largest for animal products

Scenario 2050

	Demand	Supply	Reg.	Glob.	Glob./Reg.
Scenario I	POP	RCP2.6 +CO2	0.250	2.203	8.8
Scenario II	POP, DP	RCP2.6 +CO2	0.919	2.999	3.3
Scenario III	POP, DP, FE	RCP2.6 +CO2	0.585	2.771	4.7
Scenario IV	POP, DP, FE, FW	RCP2.6 +CO2	0.441	2.413	5.5
Scenario V	POP, DP	RCP2.6	0.760*	2.999	3.9
Scenario VI	POP, DP	RCP8.5	0.636*	3.002	4.7

Glob.: Globalized

Reg.: Regionalized

DP: Dietary changes

POP: Demographic growth SSP2

FW: Food waste reduction by 75%

FE: Improved feed conversion efficiency

* May require agricultural expansion to feed the urban population.

Summary

- currently food systems are broken
- response options are available throughout the food systems, from production to consumption, to fix the broken food systems
- demand-side response options include – dietary changes, reducing food waste, urban & peri-urban agriculture, and shortening food supply chain



Thank You...

Supported by



Federal Ministry for the
Environment, Nature Conservation,
Building and Nuclear Safety



Federal Ministry of
Education
and Research

pradhan@pik-potsdam.de
 [@prajdhan](https://twitter.com/prajdhan)

