

The potential consequences of biodiversity initiatives on global food production



Roslyn Henry

Biodiversity and why is it important?

Biodiversity is the variety of life and the interactions between living things at all levels on land, in water and in the sea and air – genes, populations, species and ecosystems.

Biodiversity provide us with services essential for human well-being such as food and feed, medicines, energy and fibres



\$44 trillion of economic value generation – over half the world's total GDP – is moderately or highly dependent on nature and its services



*“Biodiversity is critical for safeguarding global **food security**, underpinning **healthy and nutritious diets**, improving rural **livelihoods** and **enhancing the resilience** of people and communities.”* FAO's Director-General José Graziano da Silva.

Climate change is *somewhat* reversible but once we lose species and genetic diversity within those species, we cannot get it back.

Maintaining biodiversity feeds back into agricultural production

Only 30 crops provide an estimated 90% of the world population's dietary energy requirements, with wheat, rice and maize alone providing about half the dietary energy consumed globally.

Less than 14 species of mammals and birds account for 90% of livestock production.

Genetic diversity

Nutrition

Soil health

Pollination

Pest/pathogen control

LIVING PLANET REPORT 2022

**WILDLIFE POPULATIONS
PLUMMET BY 69%**

The Living Planet Report 2022 is WWF's most comprehensive study to date of trends in global biodiversity and the health of our planet. The latest flagship publication reveals global wildlife populations have plummeted by 69% on average since 1970. The staggering rate of decline is a severe warning that the rich biodiversity that sustains all life on our planet is in crisis, putting every species at risk – including us.

Biodiversity trends

MEA (2005) : Current extinction rates are 100-1000 times higher than the typical background rate.

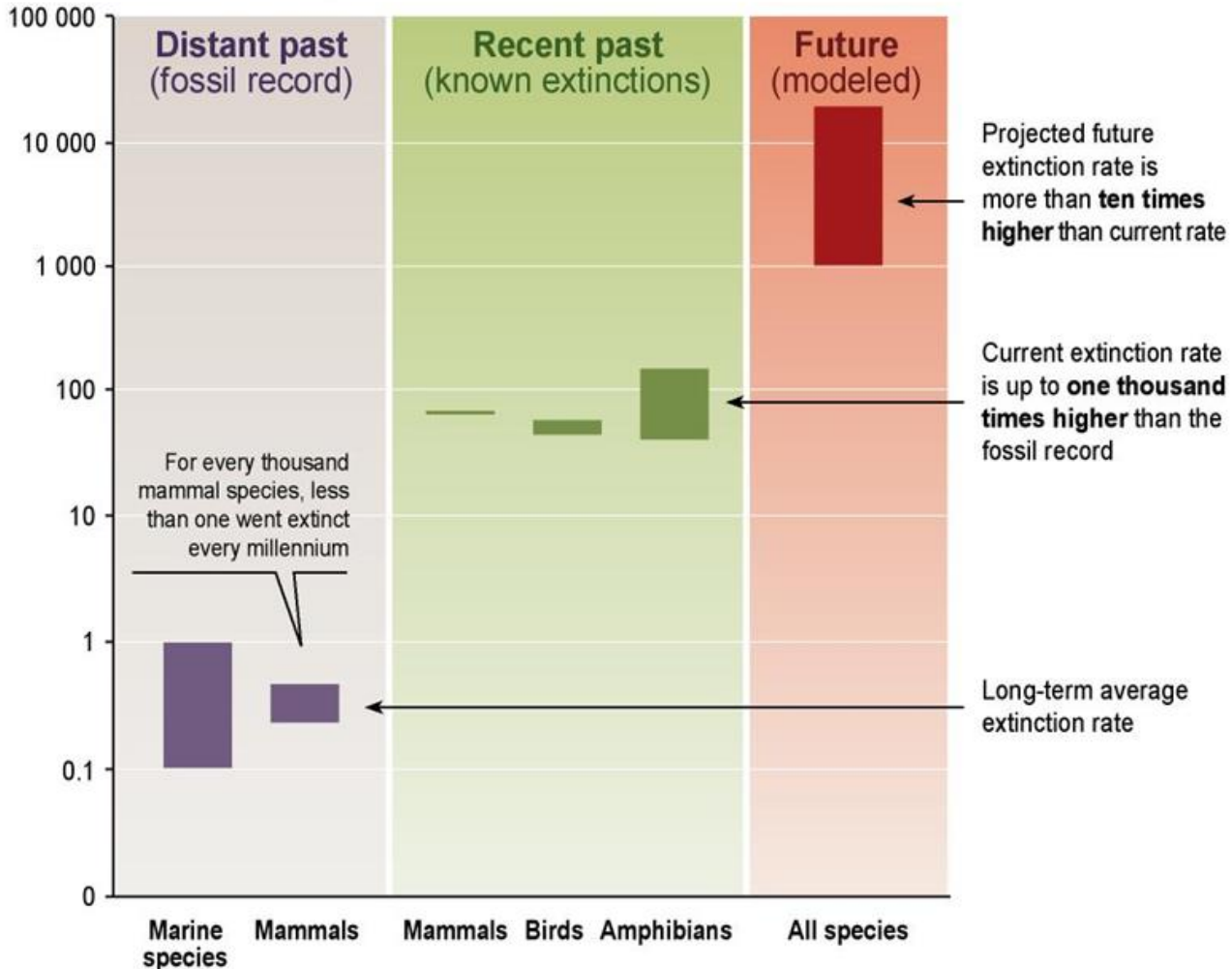
If current trends continue this will rise to 10000 times by the end of the century.

CBD: 'Agricultural land-use conversion is expected to remain the largest driver of biodiversity loss to 2050'.

Agricultural expansion leading cause of tropical deforestation.

Past, Present and Future Projections of Extinction Rate

Extinctions per thousand species per millennium



Ideas for preventing further biodiversity loss

Land Sharing: A situation where 'low-yield farming enables biodiversity to be maintained within the agricultural landscape'.

vs

Land Sparing: Where 'high-yielding agriculture is practiced, requiring a smaller area of land to attain the same yields and therefore leaving greater areas of natural habitat untouched.'

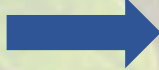


Increasingly the scientific research indicates for biodiversity land sparing is the best approach.

Area based conservation for biodiversity protection...



Despite an increase in policies and actions to support biodiversity, indicators show that the drivers of biodiversity loss have worsened and biodiversity further declined between 2011 and 2020. At the global level **none of the 20 Aichi Biodiversity Targets** agreed by Parties to the CBD in 2010 have been fully achieved.



Post-2020 Global Biodiversity Framework

As the United Nations Decade on Biodiversity 2011-2020 comes to an end, IUCN actively supports the development of what needs to be an ambitious new global biodiversity framework.



International Union for Conservation of Nature

ISSUES BRIEF

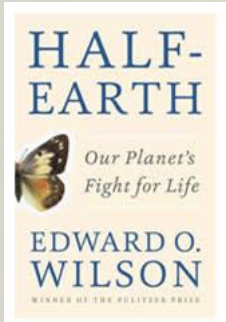
JULY 2022

POST-2020 GLOBAL BIODIVERSITY FRAMEWORK

- In December 2022, Parties to the UN Convention on Biological Diversity will meet to determine the post-2020 global biodiversity framework.
- Despite commitments made in 2010, biodiversity has further declined over the past decade.
- An ambitious new biodiversity framework is needed to achieve the UN Sustainable Development Goals, and the vision of living in harmony with nature by 2050.
- The framework must aim to halt biodiversity loss by 2030 and achieve recovery by 2050, which requires additional investment in nature equivalent to between 0.7 and 1% of annual global GDP.
- Targets in the framework should be measurable, underpinned by science, and have explicit outcomes.

Area based targets are part of discussions: “Ensure that at least 30 per cent globally of land areas and of sea areas, especially areas of particular importance for biodiversity and its contributions to people, are conserved ...”

Area based conservation is contentious...



The High Ambition Coalition (HAC) for Nature and People is an intergovernmental group of 70 countries co-chaired by Costa Rica and France and by the United Kingdom as Ocean co-chair, championing a global deal for nature and people with the central goal of protecting at least 30 percent of world's land and ocean by 2030. The 30x30 target is a global target which aims to halt the accelerating loss of species, and protect vital ecosystems that are the source of our economic security.



Half-Earth or Whole Earth? Radical ideas for conservation, and their implications

Published online by Cambridge University Press: 05 December 2016

Bram Büscher, Robert Fletcher, Dan Brockington, Chris Sandbrook, William M. Adams, Lisa Campbell, Catherine Corson, Wolfram Dressler, Rosaleen Duffy and Noella Gray

...Show all authors v

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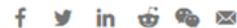
Article Metrics



E.O. Wilson
Sir David Attenborough
Sir Tim Smit
Razan Al Mubarak
Hindou Oumarou Ibrahim
Johan Rockström

Leave
No Species
Behind.
half-earth day 2021

RESEARCH ARTICLE | SCIENCE POLICY



A "Global Safety Net" to reverse biodiversity loss and stabilize Earth's climate

E. DINERSTEIN, A. R. JOSHI, C. VYNNE, A. T. L. LEE, F. PHARAND-DESCHÊNES, M. FRANÇA, S. FERNANDO, T. BIRCH, K. BURKART, D. OLSON

+2 authors Authors Info & Affiliations

SCIENCE ADVANCES • 4 Sep 2020 • Vol 6, Issue 36 • DOI: 10.1126/sciadv.abb2824



Dr Anwesha Dutta (CMI, Norway) gathered a group of scholars, including Professor Rosaleen Duffy, together to respond to Dinerstein, E. et al. "A 'Global Safety Net' to reverse biodiversity loss and stabilize Earth's climate".

Brief Communication | Published: 18 November 2019

Protecting half of the planet could directly affect over one billion people

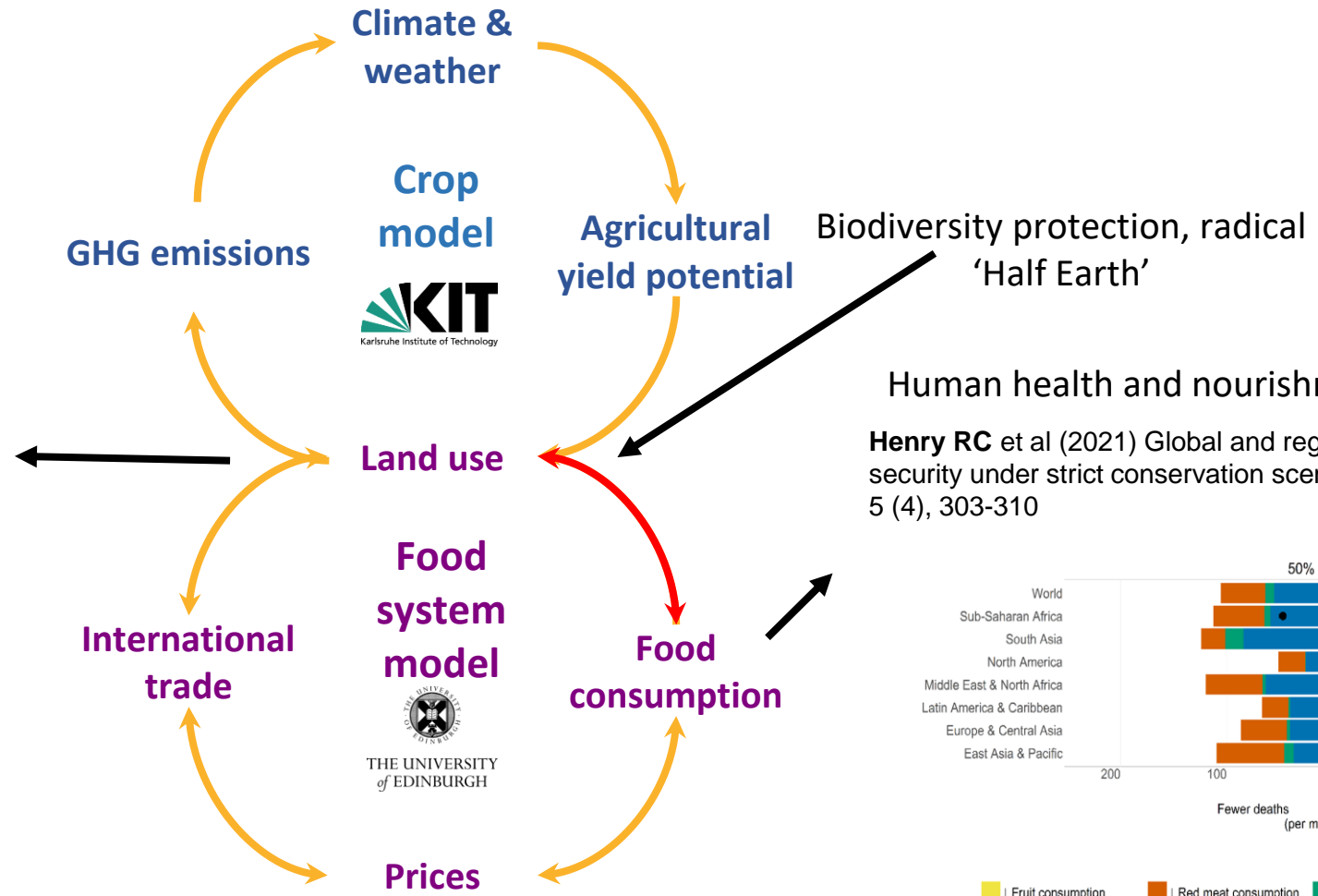
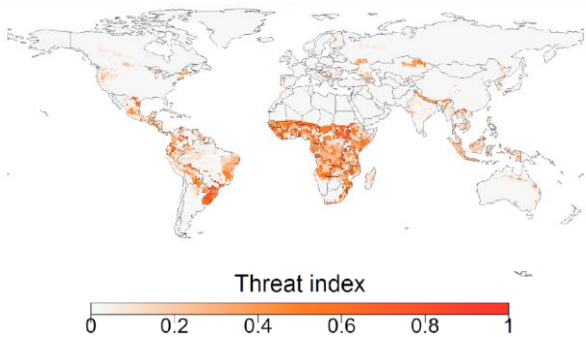
Judith Schleicher, Julie G. Zaehring, Constance Fastré, Bhaskar Vira, Piero Visconti & Chris Sandbrook

Nature Sustainability 2, 1094–1096 (2019) | Cite this article

3358 Accesses | 27 Citations | 494 Altmetric | Metrics

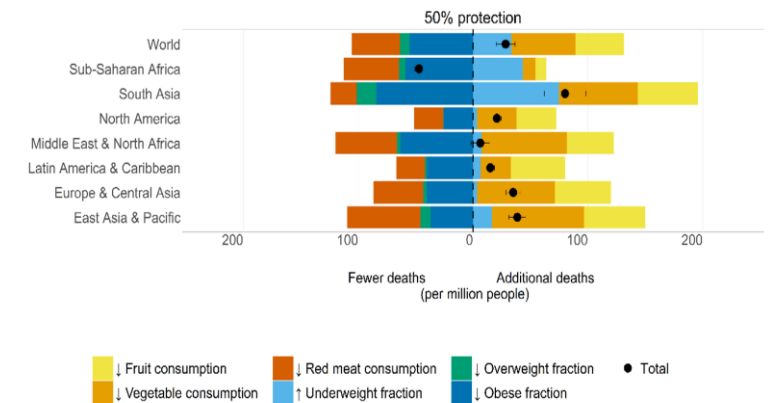
Edinburgh University: Global land use and food system modelling 'LandSyMM'

Land cover and intensity change in regions of high biodiversity in the future



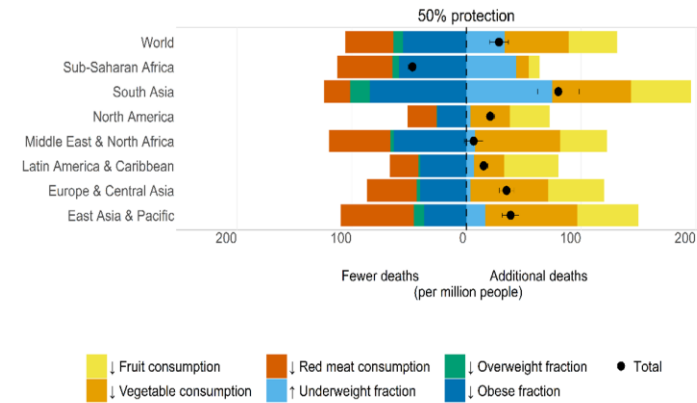
Human health and nourishment

Henry RC et al (2021) Global and regional health and food security under strict conservation scenarios. *Nature Sustainability* 5 (4), 303-310



Henry RC et al (2019) The role of global dietary transitions in biodiversity loss. *Global Environmental Change*, 58, 101956.

Quantify impact of strict conservation scenarios on human health and food security

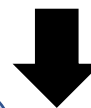


Reference
 No protected areas expansion. Agriculture permitted in existing protected areas but not allowed to expand

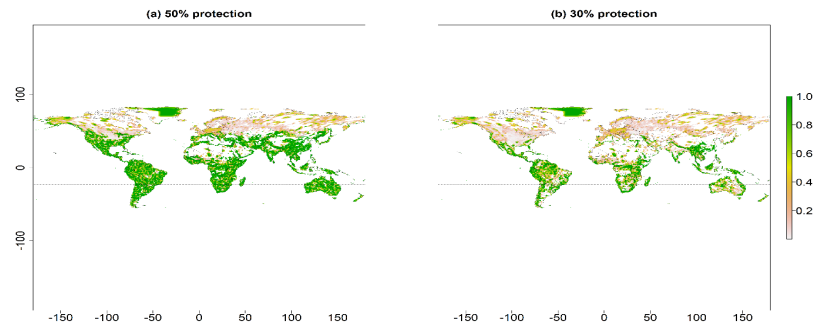
30% protection
 Between 2020-2040 protected areas expand such that 30% of terrestrial surface is strictly protected

50% protection
 Between 2020-2040 protected areas expand such that 50% of terrestrial surface is strictly protected

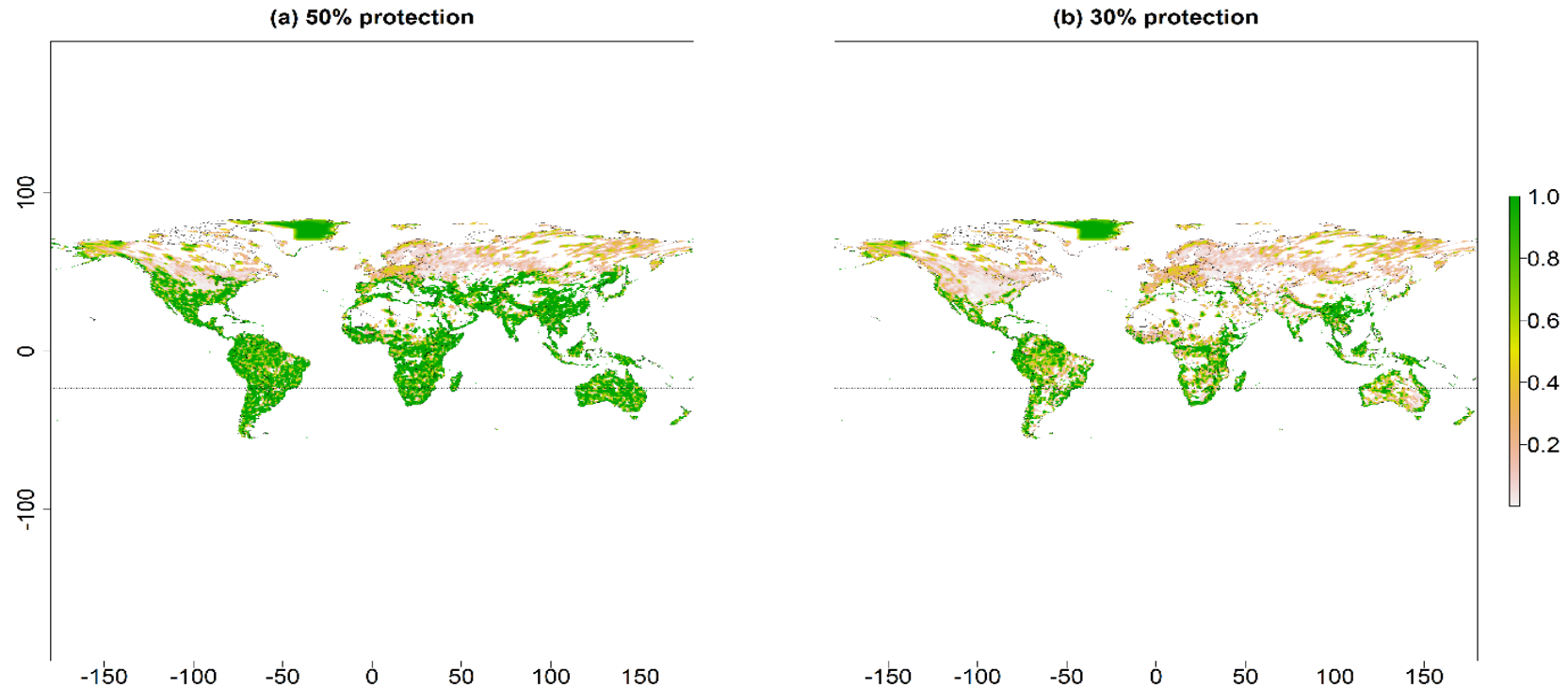
2060



Protected areas
prioritisation maps for
30% and 50%



Where are the priority areas?



Distribution data on birds, mammals, amphibians and reptiles was used to calculate the optimal conservation areas to protect as many species from extinction as possible.

Bias towards the tropics – regions that harbour high levels of biodiversity.



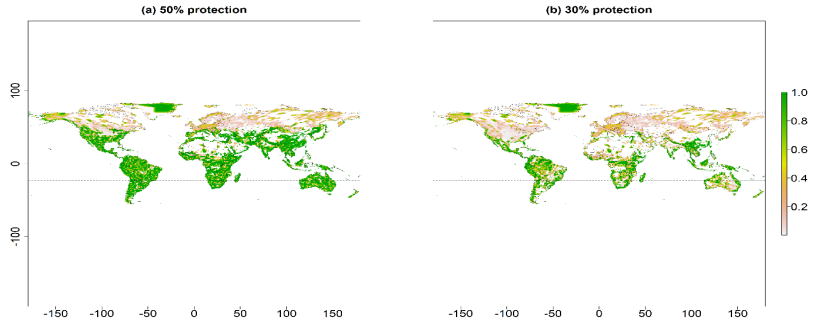
Protected areas
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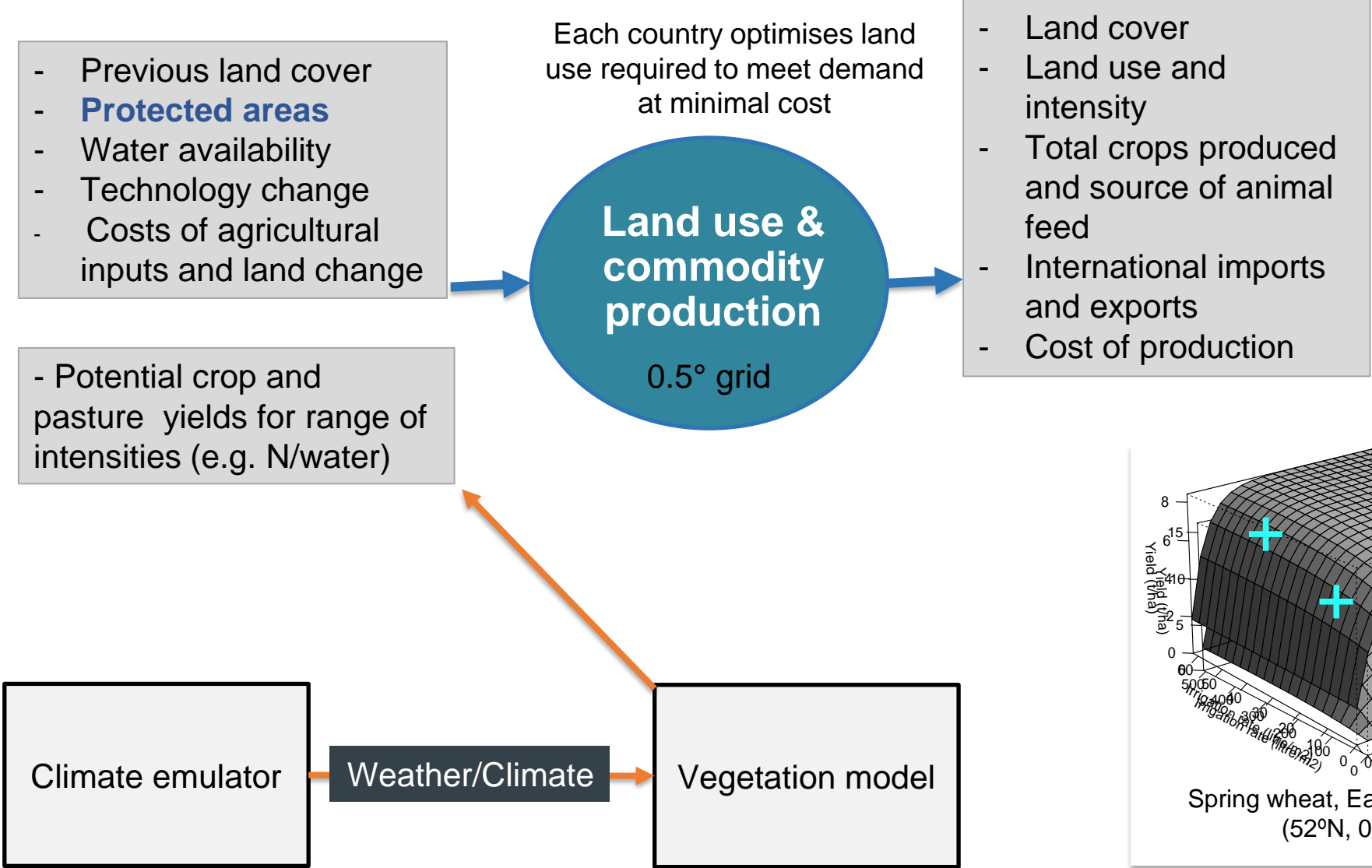
2020-2040 protected
areas gradually
implemented,
agriculture excluded



Supply of food
commodities adjust



Land use and commodity production





Protected areas prioritisation maps for 30% and 50%

2020-2040 protected areas gradually implemented, agriculture excluded



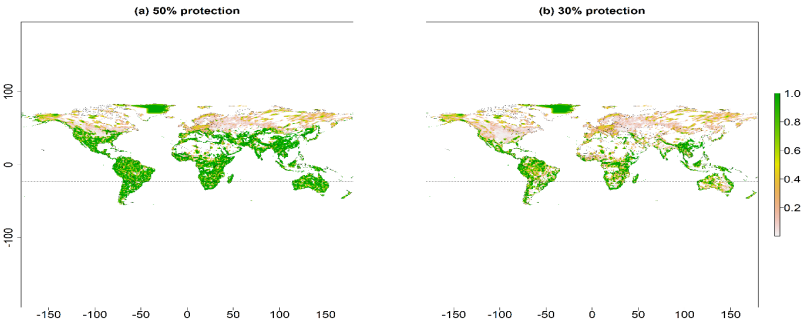
Supply of food commodities adjust



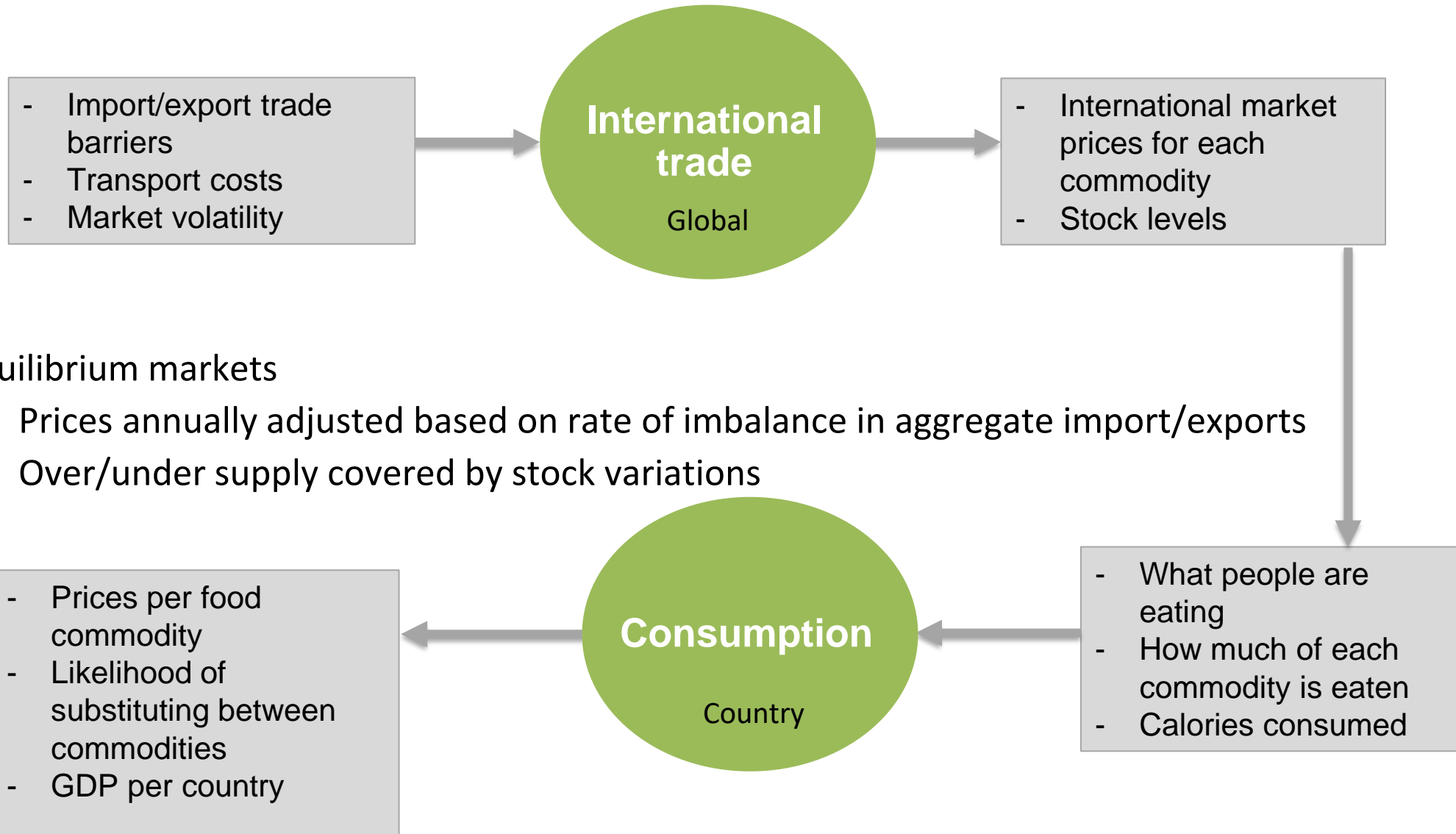
Changes in price



Changes in consumption



Trade, prices and consumption



Non-equilibrium markets

- Prices annually adjusted based on rate of imbalance in aggregate import/exports
- Over/under supply covered by stock variations



Protected areas prioritisation maps for 30% and 50%

2020-2040 protected areas gradually implemented, agriculture excluded

Supply of food commodities adjust



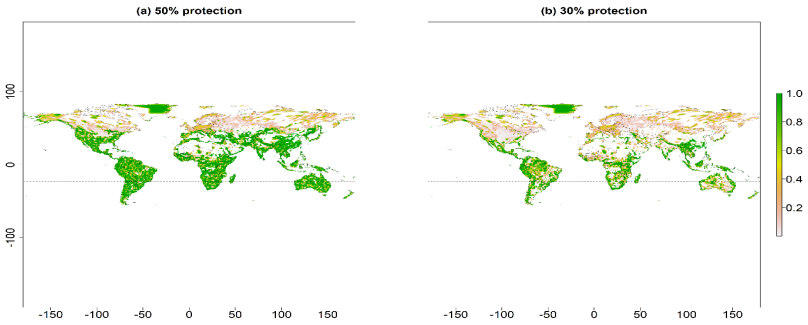
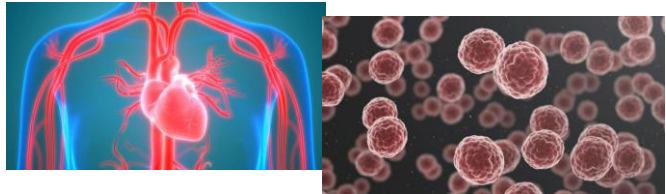
Changes in price



Changes in consumption



Changes mortality from diet and weight related causes
Springmann et al. (2018)



Risk factor	Relative risk per cause of death					
	Coronary heart disease	Stroke	All cancers	Colorectal cancer	Type-II diabetes	Other causes
Fruit consumption	0.95	0.77	0.94			
Vegetable consumption	0.87	0.95	0.94			
Red meat consumption		1.10		1.15	1.14	
Underweight	0.68	1.03	1.11			1.75
Normal weight						
Overweight	1.31	1.07	1.10		1.54	0.96
Obese	1.78	1.55	1.40		7.37	1.33

Changes in mortality from weight and diet

Relationships drawn from scientific (mostly medical) literature between consumption of particular food groups and risk of developing diseases.

Dietary factors

Increasing red meat in diets linked to:

- ↑ Risk of stroke
- ↑ Risk of Type-II diabetes
- ↑ Risk of bowel cancer

Increasing fruit and vegetable intake linked to:

- ↓ Risk of coronary heart disease
- ↓ Risk of Stroke
- ↓ Risk of cancer

Weight factors

Increasing obesity linked to:

- ↑ Risk of stroke
- ↑ Risk of Type-II diabetes
- ↑ Risk of cancer
- ↑ Risk of coronary heart disease
- ↑ Other causes of morbidity

Increasing malnourishment linked to:

- ↓ Risk of Stroke
- ↓ Risk of cancer
- ↓ Other non specific causes of morbidity



Protected areas prioritisation maps for 30% and 50%

2020-2040 protected areas gradually implemented, agriculture excluded

Supply of food commodities adjust



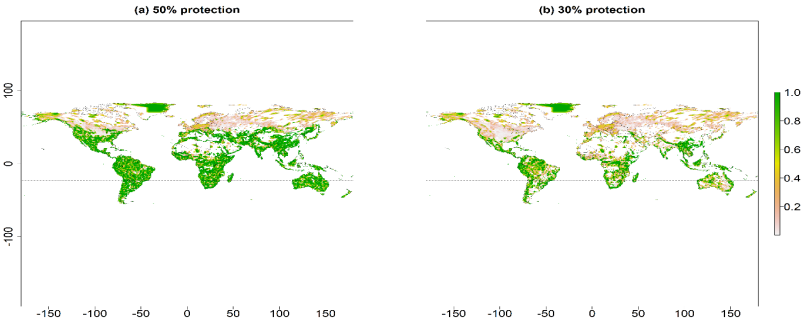
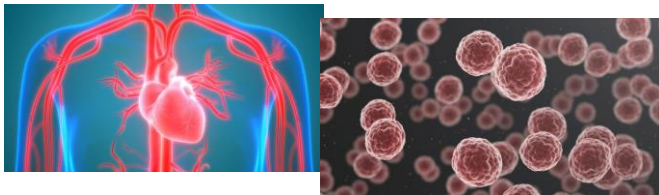
Changes in price



Changes in consumption



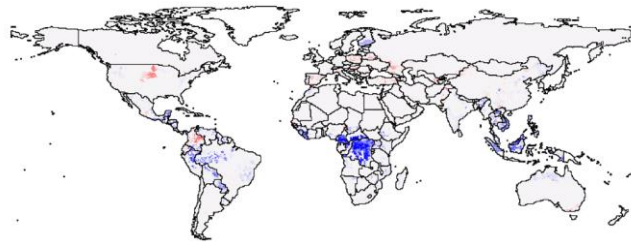
Changes mortality from diet and weight related causes
Springmann et al. (2018)



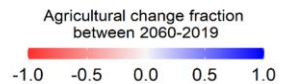
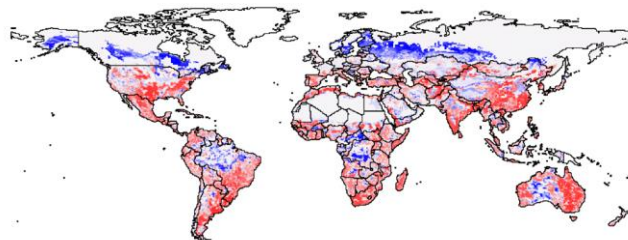
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Agricultural land displaced to higher latitudes

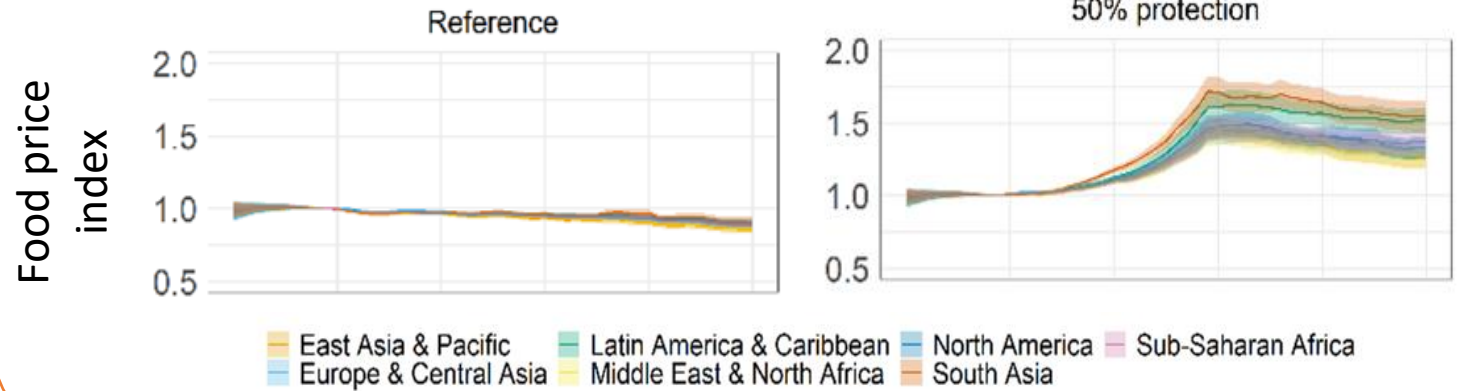
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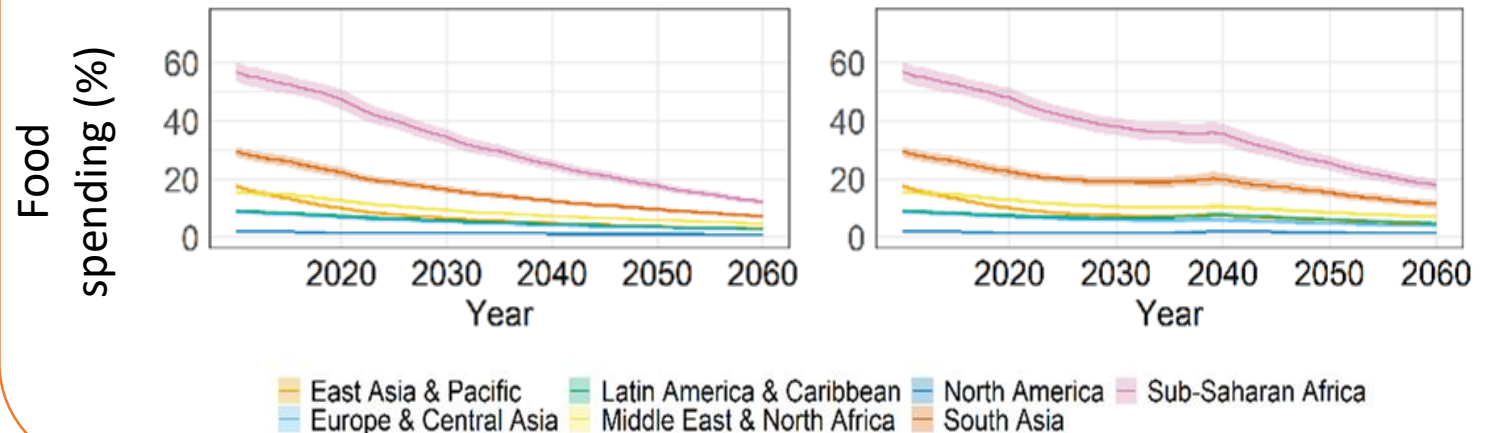
50% protection

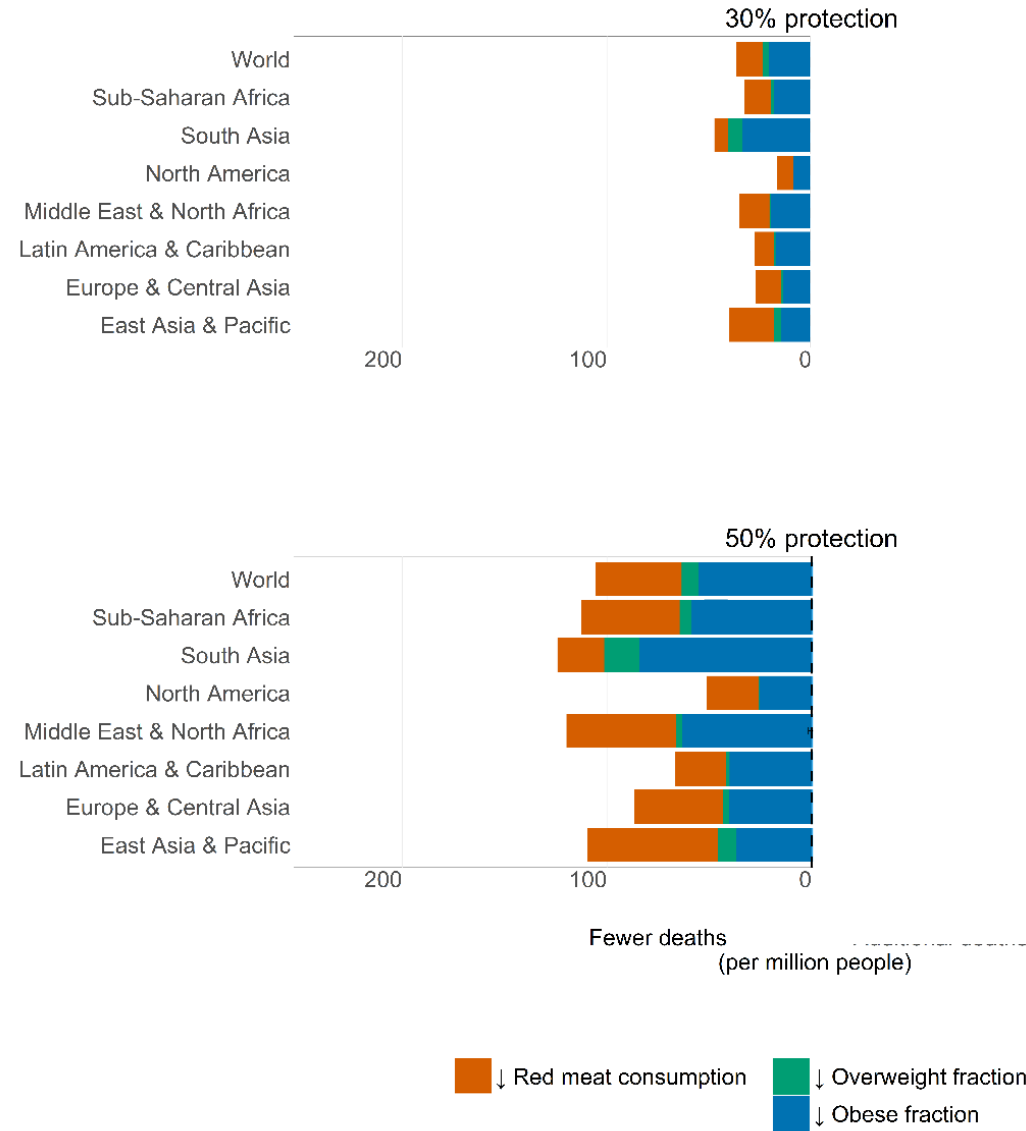


Increased food prices in protection scenarios



Developed regions buffered by food price increases in terms of affordability

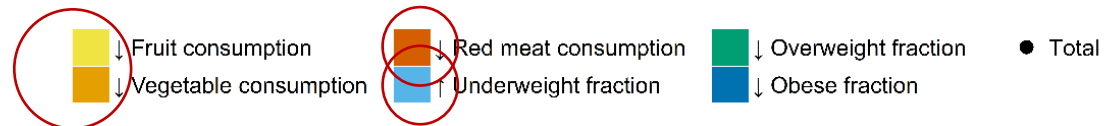
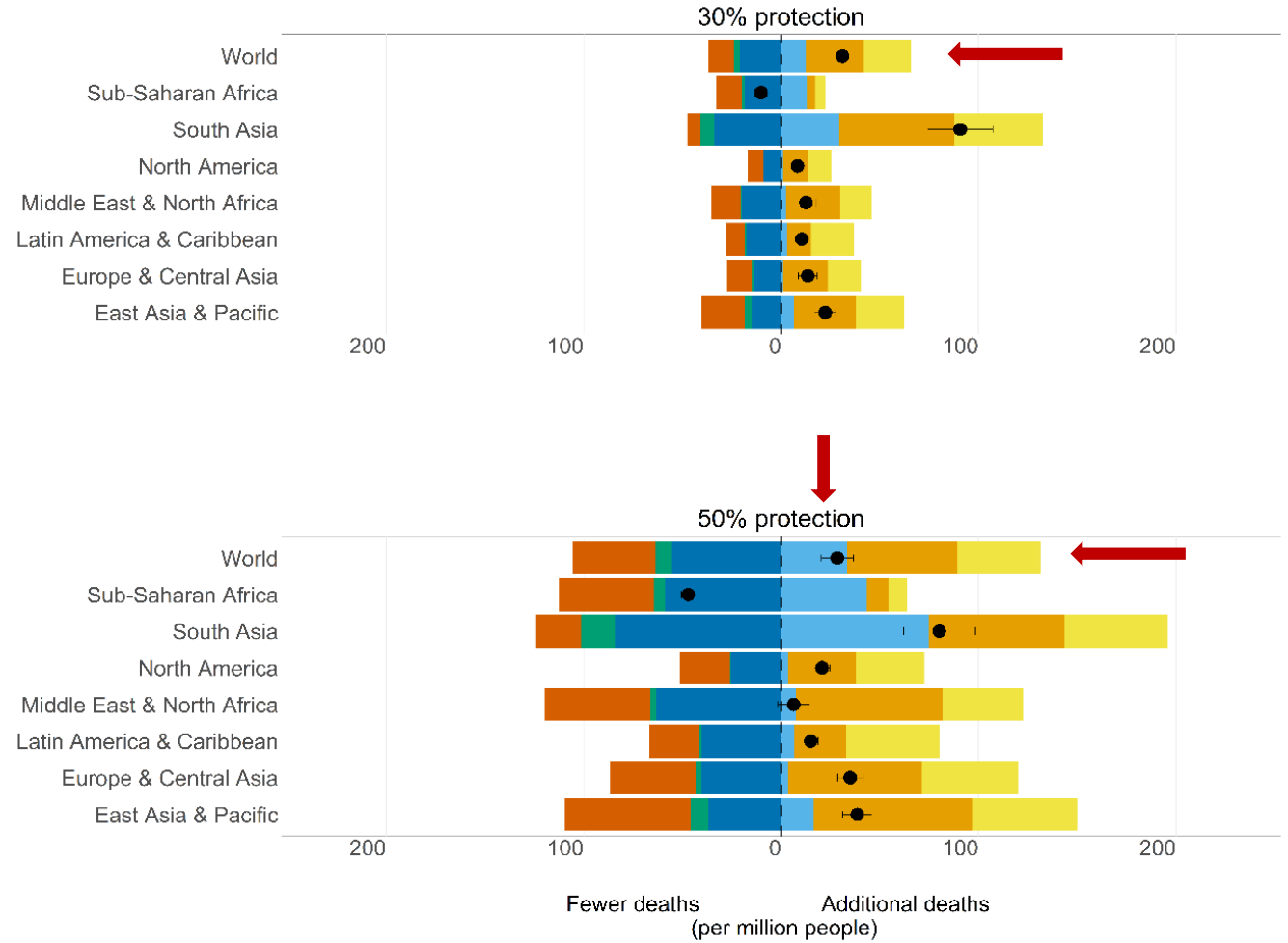




Strict protected area expansion increases global mortality by 4%

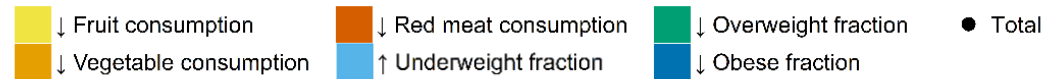
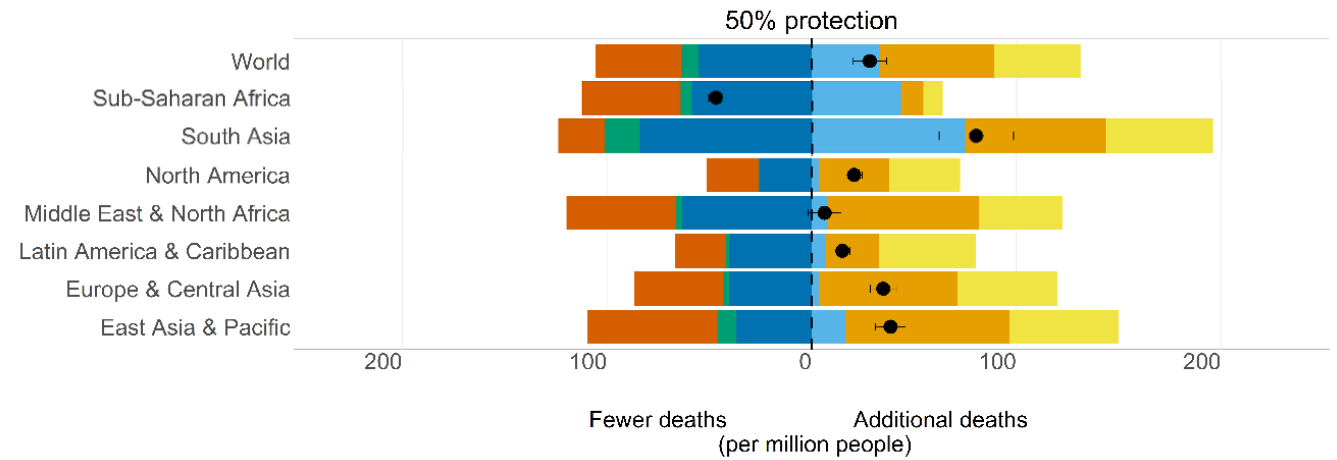
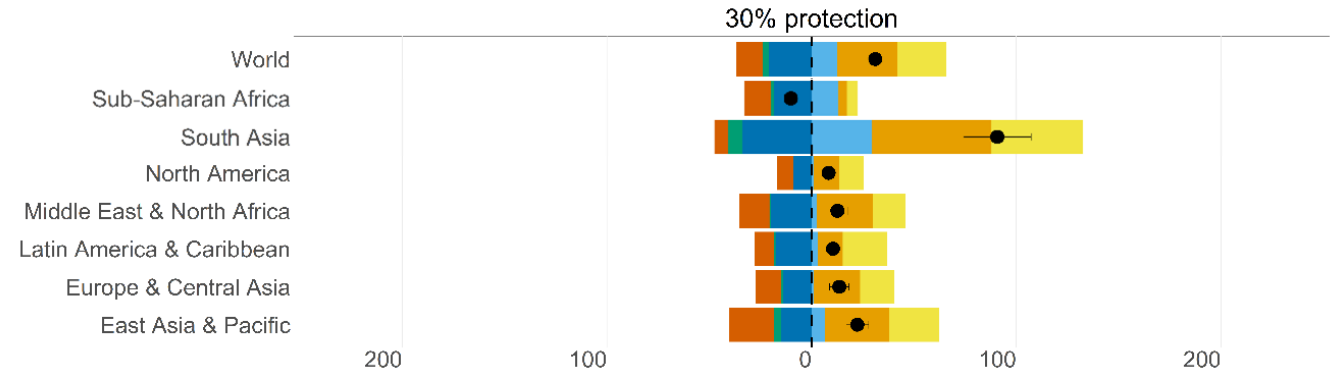
Lower RM consumption benefits outweighed by reduced FV consumption

Moving from 30% -> 50% protection triples underweight related mortality



South Asia and Sub-Saharan Africa
have the largest additional
underweight-related deaths

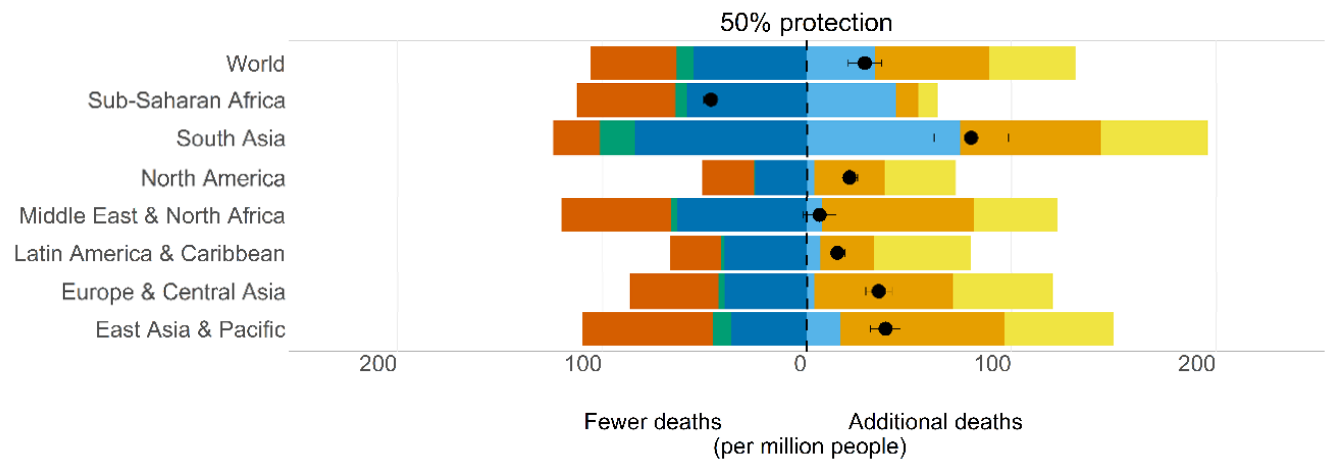
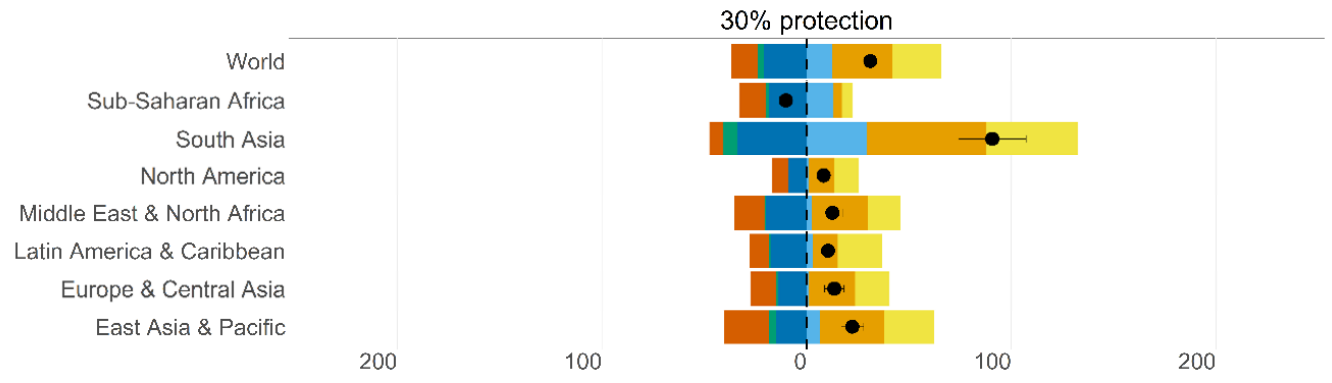
83% of all global additional
underweight related deaths in these
regions



South Asia and Sub-Saharan Africa have the largest additional underweight-related deaths

83% of all global additional underweight related deaths in these regions

N. America and Europe have the lowest additional underweight-related deaths



■ ↓ Fruit consumption
 ■ ↓ Red meat consumption
 ■ ↓ Overweight fraction
 ● Total
■ ↓ Vegetable consumption
■ ↑ Underweight fraction
■ ↓ Obese fraction

Strict protected areas could adversely affect human health and food security...

- Protected area implementation is a tricky issue, how to protect biodiversity without negative human consequences, particularly for already food insecure developing regions
- A lot of ruminating about potential negative consequences of too strict protection, this was one of few studies to try to quantify it
- Assumptions are **extreme**, agricultural exclusion, future work could relax assumptions and test PA that are proposed by post 2020 biodiversity framework
- Didn't include positive health effects of biodiversity
- Didn't consider economic or physical displacement effects, could have further repercussions



Other studies?

Brief Communication | [Published: 14 August 2018](#)

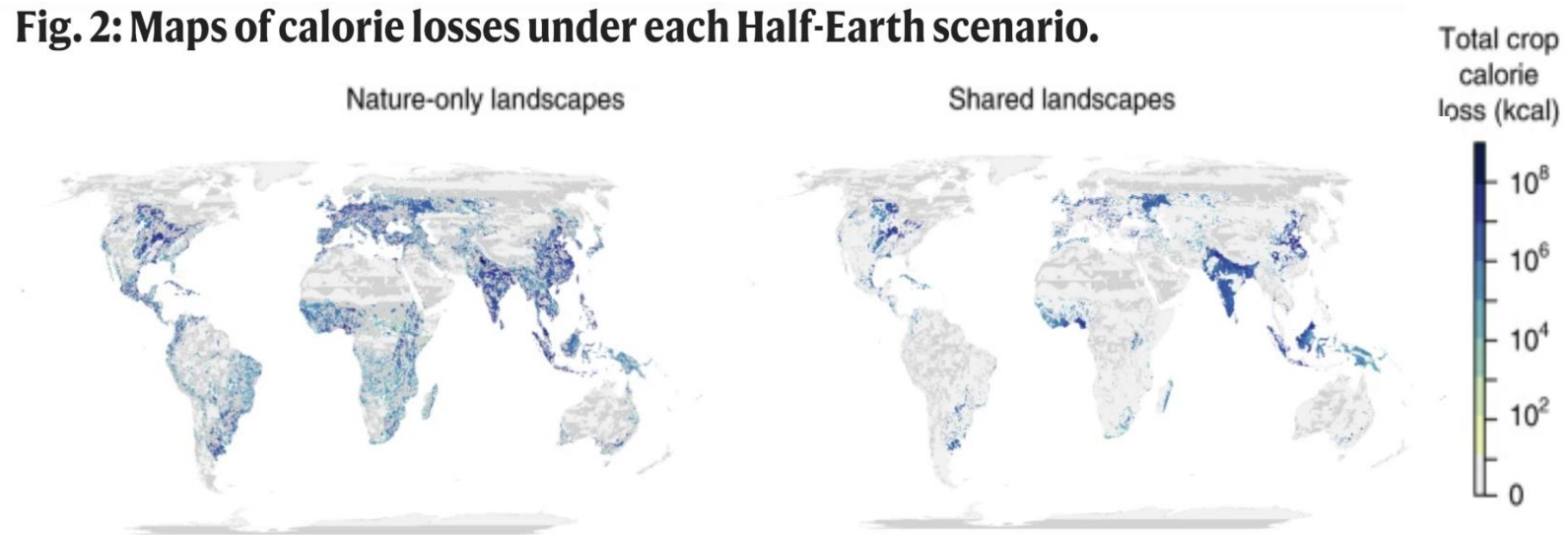
The challenge of feeding the world while conserving half the planet

[Zia Mehrabi](#) , [Erle C. Ellis](#) & [Navin Ramankutty](#)

50% of terrestrial surface is **nature only landscapes** – agriculture displaced

50% of terrestrial surface is **shared landscape** – crop and conservation production can coexist

Fig. 2: Maps of calorie losses under each Half-Earth scenario.



“the trade-offs between agriculture and Half-Earth will be much lower if landscapes are allowed to remain as mosaics of shared land uses”

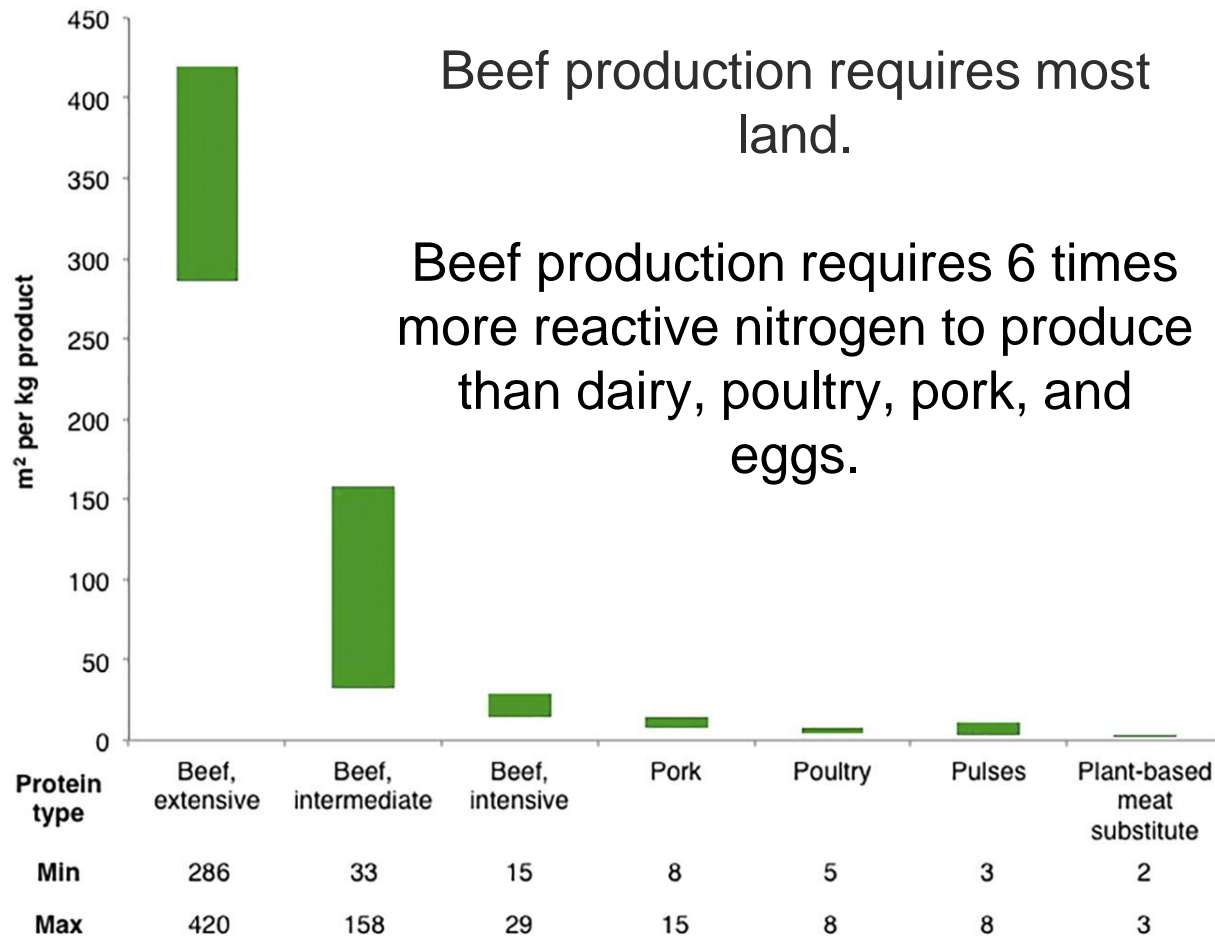


All this is not to
say we should
avoid
conservation!

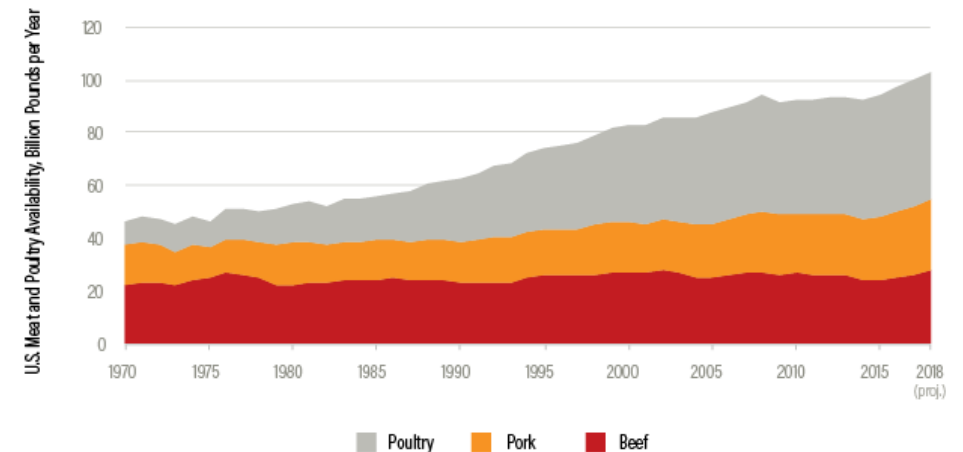
Rather, we need
to find a balance.

We need both biodiversity and agriculture, but how do we find the balance?

Consumer change – addressing meat consumption?



U.S. Beef Production Held Steady since 1970, as Chicken Production Increased by 5 Times



Source: USDA (2017).
Note: The beef category includes small amounts of lamb, mutton and veal.

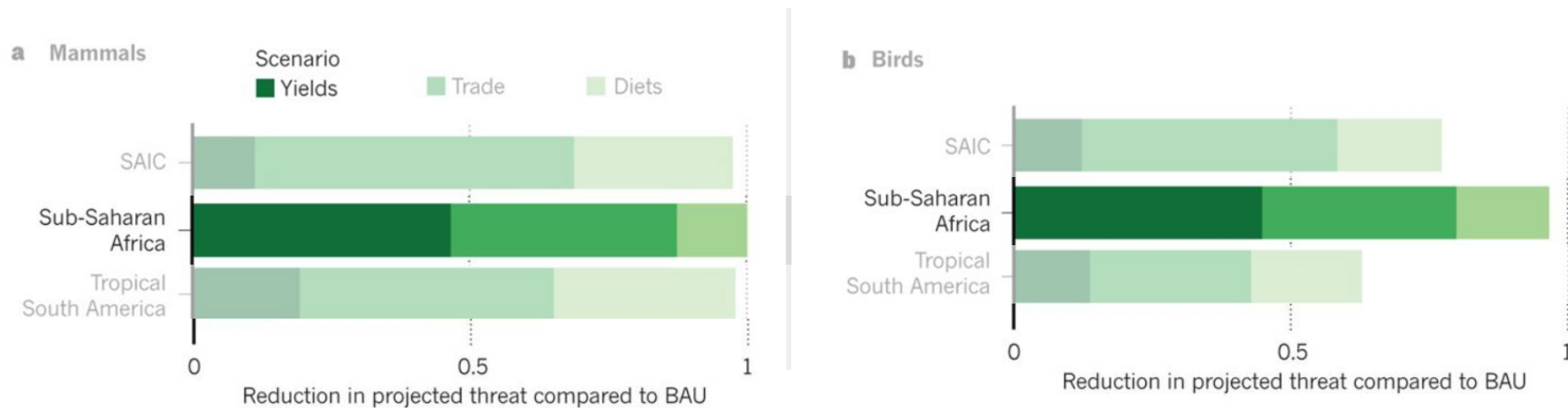
Intensification and closing yield gaps

Reducing the difference between the forecasted yield and the attainable yield.

Ninety-six countries, especially in Africa, but also in South America, have actual yields that are less than half of those that could be attained if yield-enhancing methods and technologies were adopted

Meat yields (measured as the amount of meat produced per animal) remain much lower in developing countries than in the advanced livestock sectors of North America and Europe.

In sub-Saharan African closing yield gaps by 80% would decrease the demand for further cropland in sub-Saharan Africa by 55%.



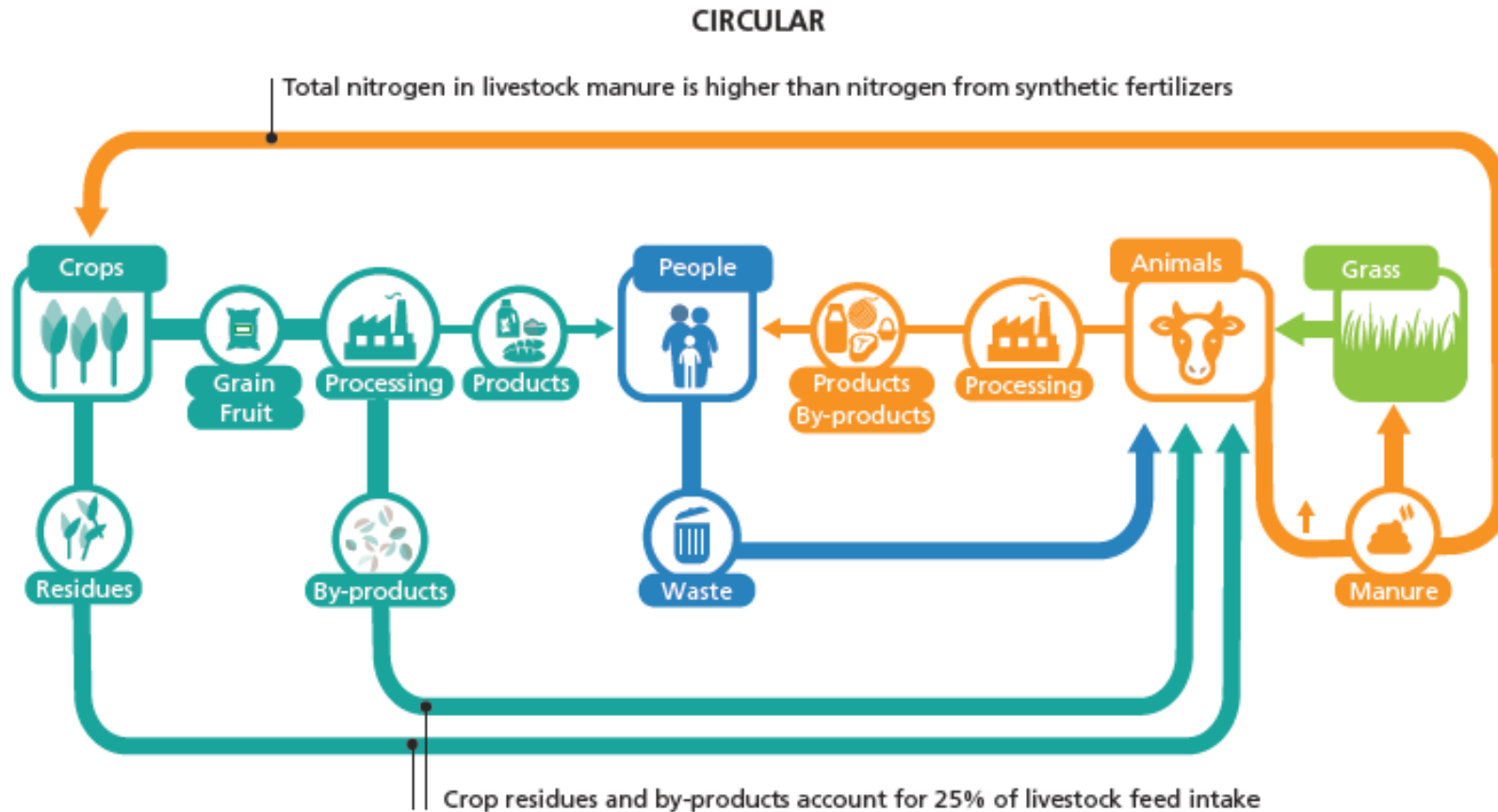
Closing yield gaps without negative consequences: a role for crop-livestock systems

Agricultural systems in developed world and emerging economies associated with increasing levels of specialisation i.e. uniform intensive crop production systems and highly concentrated livestock production.

However integrated crop-livestock systems are major contributors to global food production, most of the world's 430 million low-income livestock keepers are found in mixed systems. The most economically important livestock systems in Asia, Latin America and North Africa are mixed systems.

In low income countries there is a growing trend towards mixed farming particularly in Sub Saharan Africa as population levels rise.

Crop-livestock systems more environmentally friendly



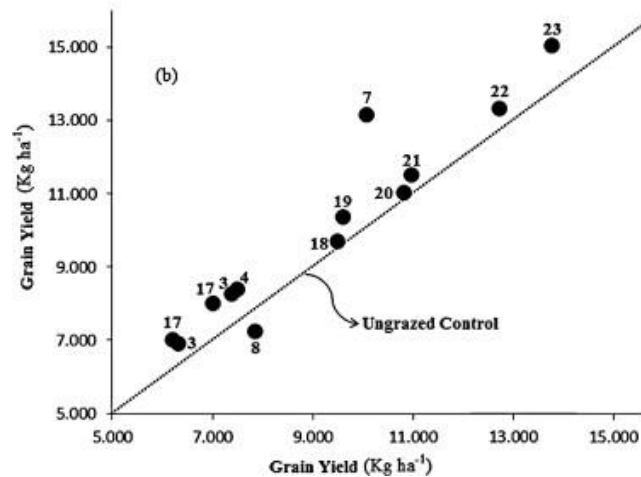
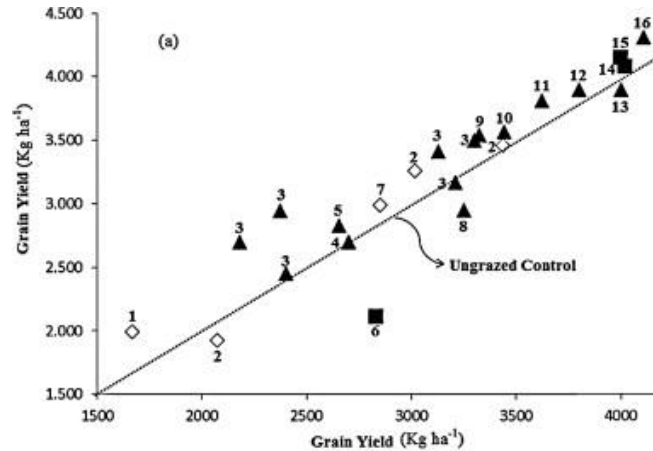
Source: FAO, 2018o.



Crop-livestock systems could help to close yield gaps

In the Brazilian subtropics, grain yields from crops cultivated in succession or rotation with pastures were higher compared to the non-grazed control crops, demonstrating that grazing affects subsequent grain yields in a positive manner.

In India, improved dual-purpose varieties of sorghum and millet have allowed smallholders to increase the milk production of buffalos and cows by up to 50% without reducing the grain output from their crops.



Model for developed countries too





A question for
us all...

In the UK how
do we strike the
balance?

Thanks!

Roslyn.henry1@abdn.ac.uk