"How should mitigation research and implementation be approached in a food insecure world".

Mercedes Bustamante
Department of Ecology, University of Brasília, Brazil

Galway, April 2017 – CCAFS meeting




Some points of the IPCC AR5

- AFOLU sector - 24% of global emissions
- Uncertainty ~50% from land use (emissions from fossil fuels ~10%)
- Mitigation options: Production and demand-side

- **Transformation pathways**:
- In the majority**, deforestation is largely halted** by mid-century.

- Scenarios differ but indicate **many changes in the land surface**, different assumptions about:
  - land use costs, potential large-scale bioenergy production, as well as the potential for afforestation and reduced deforestation.

Framing questions

- What should the R&D community be doing differently?
- What should we be doing more of?
- What should we doing less of?
- What concepts need to be ditched?

- Recent papers (2016-2017) on mitigation of climate change and food security
- Some gaps on **mitigation** but also some aspects of **food security under climate change**

Gaps and emerging topics

- 1. Characterization of management practices
- 2. Relevance of smallholders for food security – barriers for adoption of conservation agric.
- 3. Landscape management and Land optimization models (LCA)
- 4. Other aspects of food security under climate change.

Gaps and emerging topics

- 1. Characterization of management practices
- 2. Relevance of smallholders for food security – barriers for adoption of conservation agric.
- 3. Landscape management and Land optimization models (LCA)
- 4. Other aspects of food security under climate change.

Integrated Assessment Models

AFOLU Bottom-up

Include (1) biogeochemistry models (BGC) and (2) land use change models (LUC)

- Brilli et al. (*in press*) compared a broad range of models incorporating C and N fluxes in agroecosystems into biogeochemical frameworks.

→

- Predictions from different models show **large variability** due definition of pedo-climatic conditions**, management practices,** multiplicity of scales.

Global Change Biology

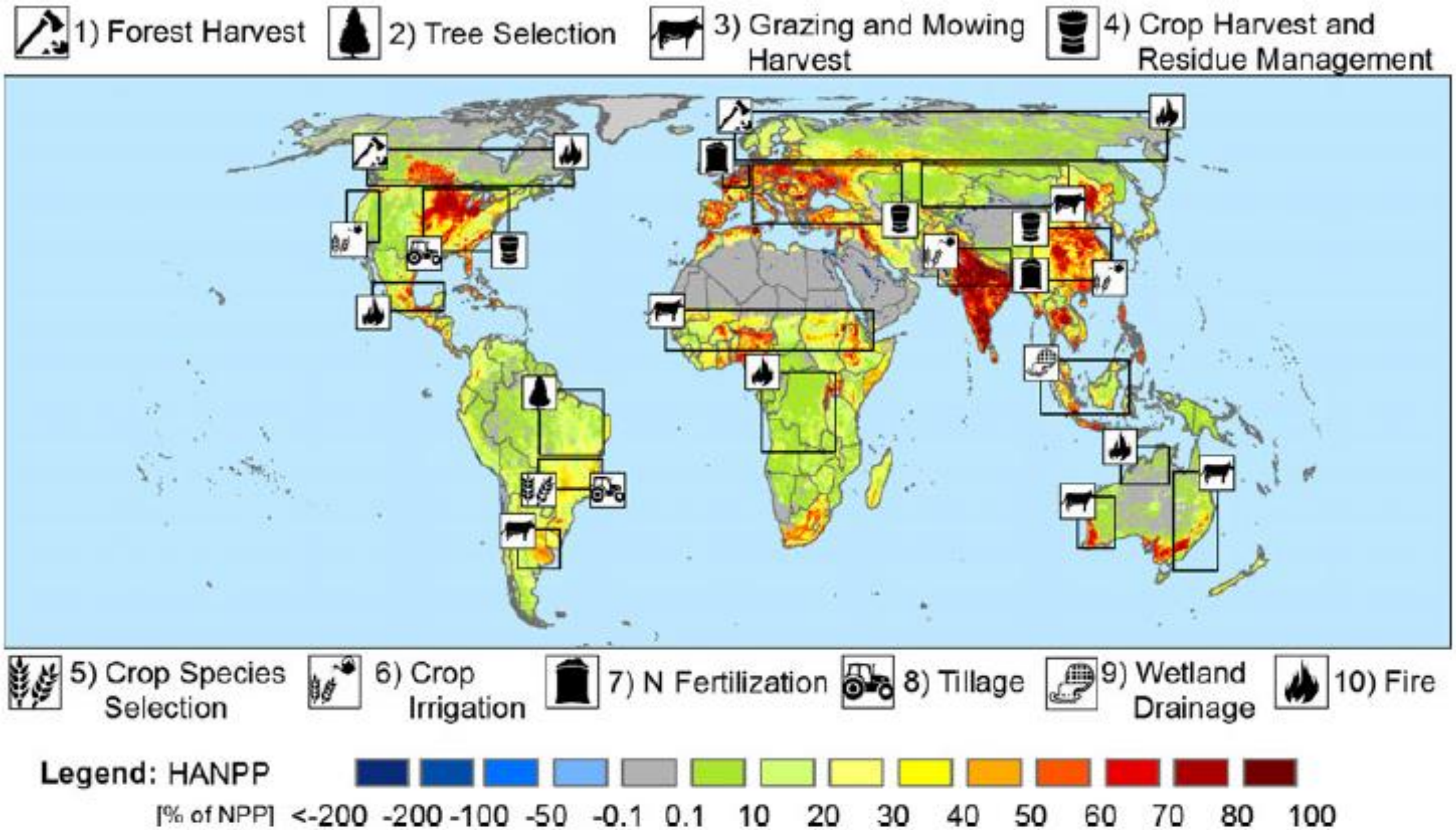
Global Change Biology (2017) 23, 512–533, doi: 10.1111/gcb.13443

RESEARCH REVIEW

Land management: data availability and process understanding for global change studies

KARL-HEINZ ERB[1], SEBASTIAAN LUYSSAERT[2,3], PATRICK MEYFROIDT[4,5], JULIA PONGRATZ[6], AXEL DON[7], SILVIA KLOSTER[6], TOBIAS KUEMMERLE[8,9], TAMARA FETZEL[1], RICHARD FUCHS[10], MARTIN HEROLD[11], HELMUT HABERL[1], CHRIS D. JONES[12], ERIKA MARÍN-SPIOTTA[13], IAN MCCALLUM[14], EDDY ROBERTSON[12], VERENA SEUFERT[15], STEFFEN FRITZ[14], AUDE VALADE[16], ANDREW WILTSHIRE[12] and ALBERTUS J. DOLMAN[10]

- **Large knowledge gaps - ** effects of land management.
- Land management activities based on their:
- **global prevalence** across a diversity of biomes
- **strong biophysical and biogeochemical effects**.



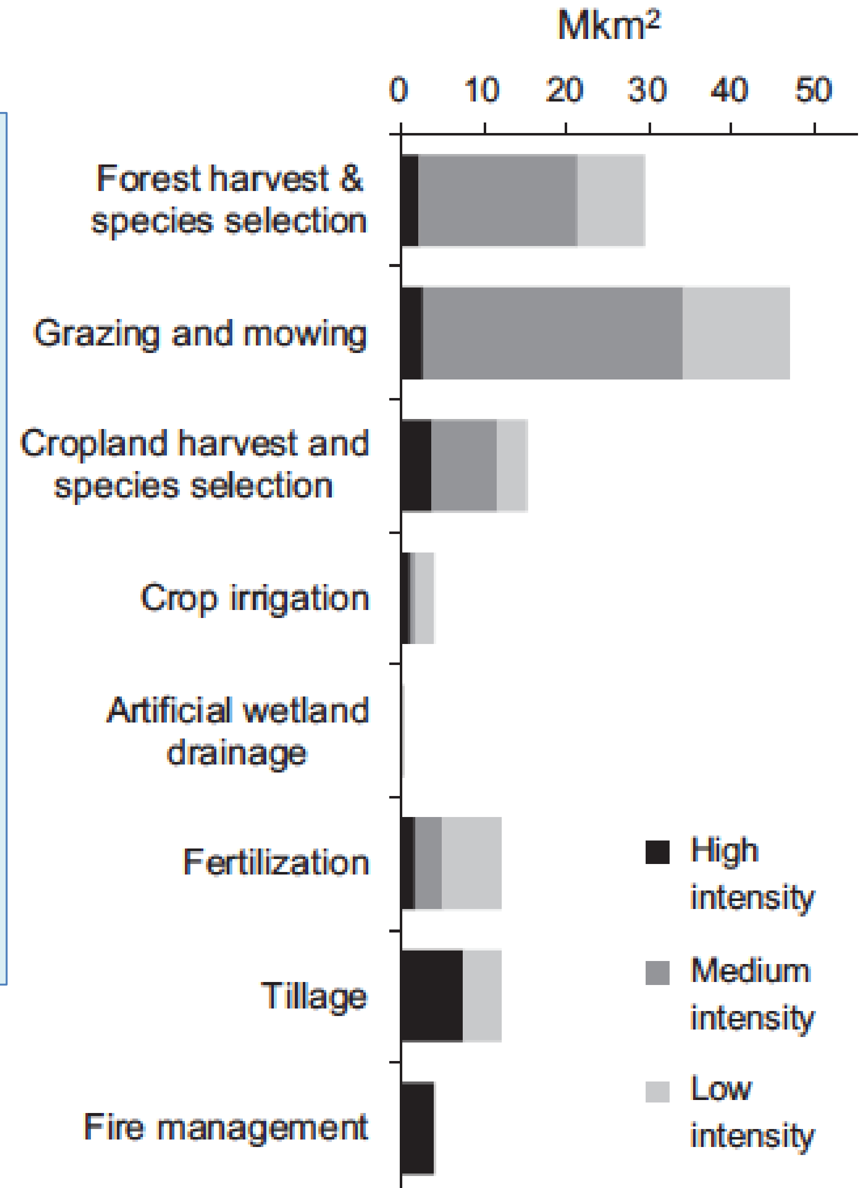
Erb et al. 2017

<u>The ten selected management activities and a selection of geographic regions where these activities play an important role.</u> The background map displays **the human appropriation of net primary production** (Haberl et al., 2007; Copyright 2007 National Academy of Sciences, USA), that is the ratio between annual potential net primary production (NPP) and NPP remaining in ecosystems after harvest. Negative values indicate areas where due to management NPP remaining in ecosystems surmounts the hypothetical potential NPP.

- Global extent and intensity of land management activities.

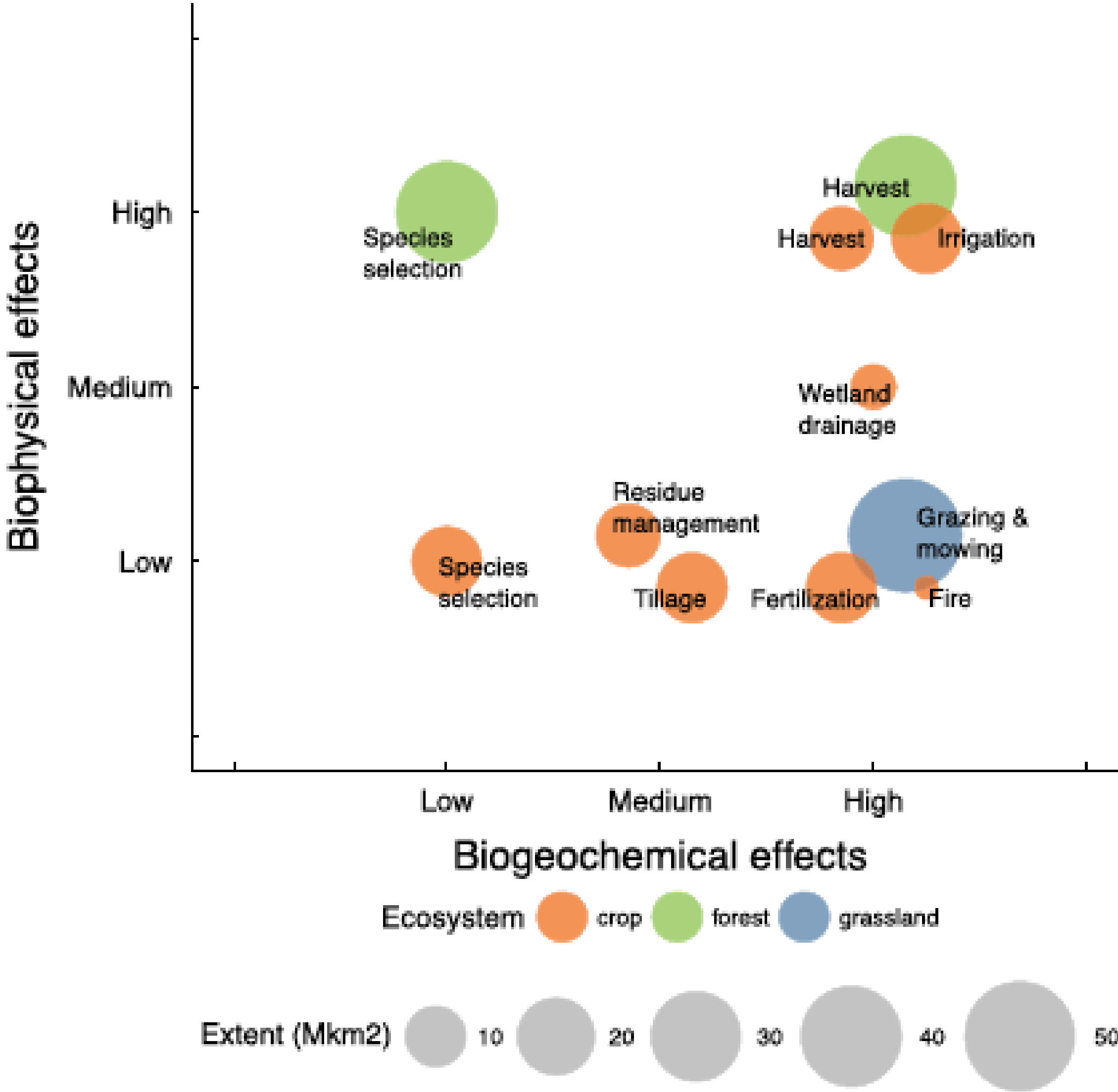
- Globally, ~ 80% of the 130 Mkm^2 of ice-free land is under management.

- Intensity of management (area)
- 10% - intense
- 50% - medium
- 20% - extensive



Note that the bars are not additive, as, for example, crop irrigation, fertilization and tillage all occur on cropland.

Erb et al. 2017



Biogeochemical effects: changes in greenhouse gas (GHG) and aerosol concentrations caused by changes in surface emissions (CO, CO_2, H_2O, N_2O, NOx, NH_3, CH_4) or by changes in atmospheric chemistry (CH_4, O_3, H_2O, SO_2, biogenic secondary organic aerosols).
Biophysical effects: changes in surface reflectivity (i.e. albedo) and changing surface fluxes of energy and moisture through sensible heat fluxes and evapotranspiration

Extent and biogeochemical and biophysical effects of management activities (Erb et al. 2017).

Management activities into three groups:

1. for which data sets are available, and for which a good knowledge base exists (*cropland harvest and irrigation*);

2. for which sufficient knowledge on biogeochemical and biophysical effects exists but robust global data sets are lacking (*forest harvest, tree species selection, grazing and mowing harvest, N fertilization*);

3. with severe data gaps concomitant with an unsatisfactory level of process understanding (*crop species selection, artificial wetland drainage, tillage and fire management and crop residue management, and element of crop harvest*).

Gaps and emerging topics

- ✓ 1. Characterization of management practices
- 2. Relevance of smallholders for food security – barriers for adoption of conservation agric.
- 3. Landscape management and Land optimization models (LCA)
- 4. Other aspects of food security under climate change.

Agriculture, Ecosystems and Environment 220 (2016) 164–174

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

Does conservation agriculture deliver climate change mitigation through soil carbon sequestration in tropical agro-ecosystems?

David S. Powlson[a,*], Clare M. Stirling[b], Christian Thierfelder[c], Rodger P. White[d], M.L. Jat[e]

In smallholder farming in tropical regions - social and economic barriers can greatly limit adoption of CA, further decreasing realistic mitigation potential.

Mitigation potential of CA practices:

Small degree of climate change mitigation through soil carbon sequestration.

Improved management of nitrogen (N) fertilizer in regions where N use is already high - more effective and sustainable mitigation option.

Mitigation potential, and other benefits, from **crop diversification are frequently overlooked** when considering CA and warrant greater attention.

*Partially funded by CCAFS

www.elsevier.com/locate/worlddev

World Development Vol. 87, pp. 1–15, 2016

http://dx.doi.org/10.1016/j.worlddev.2015.05.012

The State of Family Farms in the World

BENJAMIN E. GRAEUB[a], M. JAHI CHAPPELL[b,c], HANNAH WITTMAN[d], SAMUEL LEDERMANN[e], RACHEL BEZNER KERR[f] and BARBARA GEMMILL-HERREN[a,*]

- Family-based agriculture – central to food security, socio-ecological sustainability, and equitable economic development.
- 500 million family farmers in the world who produce 80% of the world's food (FAO's SOFA report (2014) .
- Diversity within this global sector (farm characteristics and position within the global food system) = significant challenges for systematic policy design and development (Smith & Haddad, 2015).

Gaps and emerging topics

- ✓ 1. Characterization of management practices
- ✓ 2. Relevance of smallholders for food security – barriers for adoption of conservation agric.
- 3. Landscape management and Land optimization models (LCA)
- 4. Other aspects of food security under climate change.

ELSEVIER
www.elsevier.com/locate/worlddev

CrossMark

World Development Vol. 87, pp. 180–203, 2016
0305-750X/
http://dx.doi.org/10.1016/j.worlddev.2016.06.013

Low Emission Development Strategies in Agriculture. An Agriculture, Forestry, and Other Land Uses (AFOLU) Perspective

ALESSANDRO DE PINTO [a], MAN LI [a], AKIKO HARUNA [a], GLENN GRAHAM HYMAN [b], MARIO ANDRÉS LONDOÑO MARTINEZ [c], BERNARDO CREAMER [b], HO-YOUNG KWON [a], JHON BRAYAN VALENCIA GARCIA [b], JEIMAR TAPASCO [b] and JESUS DAVID MARTINEZ [b,*]

- Importance of **considering the full scope of interactions and changes in the various land uses** when planning for GHG reduction policies.

- The fate of forests matters

1 ha allocated to agriculture increases GHG emissions ~2.5 Mg CO_2 eq/yr

1 ha of forest lost in the Amazon results in a loss of carbon stock ~367 Mg CO_2 eq

Int J Life Cycle Assess (2016) 21:677–687
DOI 10.1007/s11367-015-0923-6

CrossMark

LCA OF NUTRITION AND FOOD CONSUMPTION

Saving land to feed a growing population: consequences for consumption of crop and livestock products

Heleen R. J. Van Kernebeek[1] · Simon J. Oosting[1] · Martin K. Van Ittersum[2] · Paul Bikker[3] · Imke J. M. De Boer[1]

- A **land use optimization** model including **crop and animal production.**
- Optimization of production and demand-side measures.
- The optimal % animal protein in the human diet depended on population size and the relative share of land unsuitable for crop production.

Gaps and emerging topics

- ✓ 1. Characterization of management practices
- ✓ 2. Relevance of smallholders for food security – barriers for adoption of conservation agric.
- ✓ 3. Landscape management and Land optimization models (LCA)
- 4. Other aspects of food security under climate change

Global and regional health effects of future food production under climate change: a modelling study

Marco Springmann, Daniel Mason-D'Croz, Sherman Robinson, Tara Garnett, H Charles J Godfray, Douglas Gollin, Mike Rayner, Paola Ballon, Peter Scarborough

Lancet 2016; 387: 1937–46

- **More research has focused on questions of food security but less on wider health impacts of future changes in agricultural production.**

- Modeling study - estimated excess mortality attributable to agriculturally mediated changes in dietary and weight-related risk factors by cause of death for 155 world regions in the year 2050.

Number of deaths attributable to climate-related changes in weight and diets for the combination of four emissions pathways

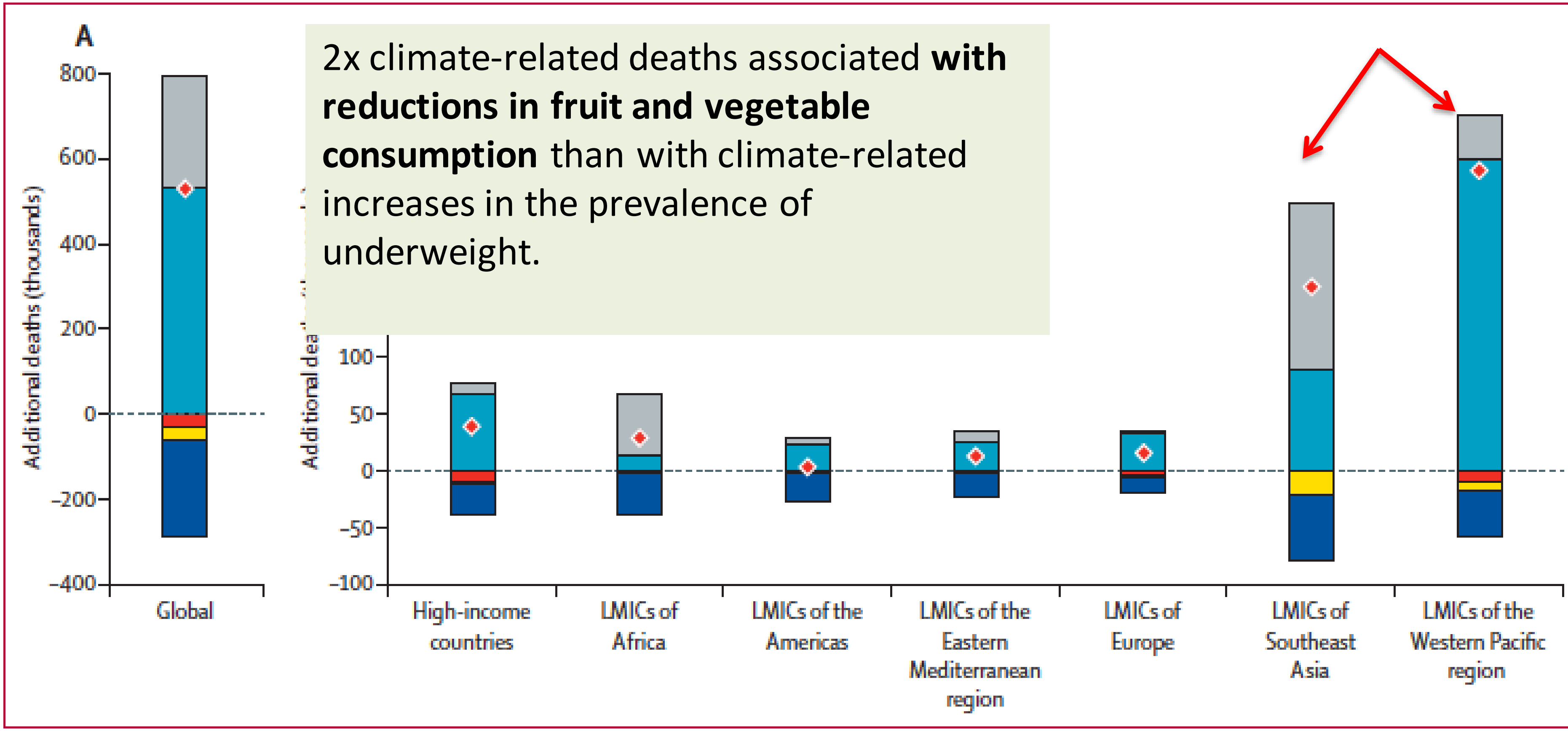
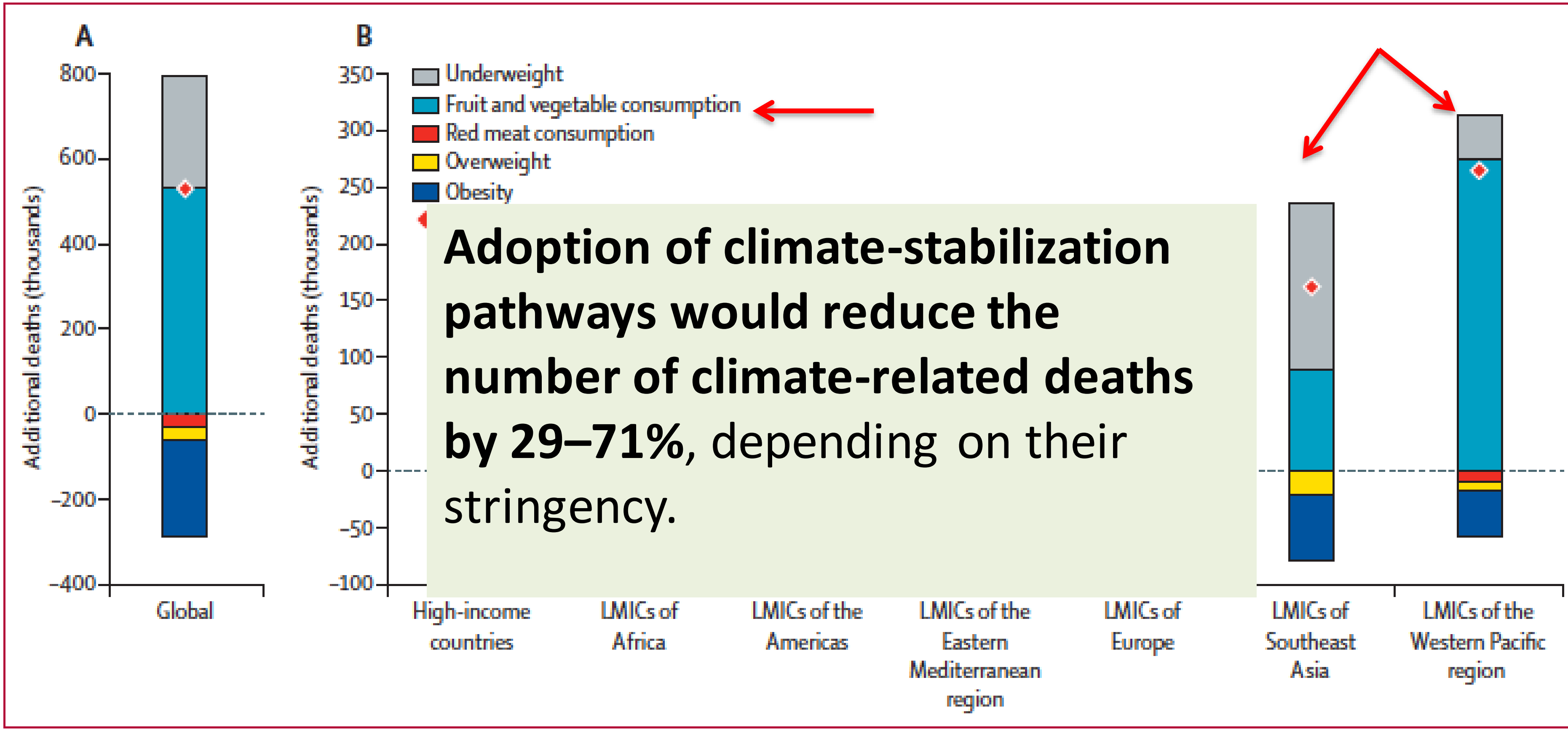


Figure 2: Climate-related deaths (in thousands) in 2050 by risk factor
(A) Climate-related deaths worldwide and (B) by region. The risk factors include changes in fruit and vegetable consumption, red meat consumption, and the prevalence of underweight, overweight, and obesity. The regional aggregates include all regions (global), high-income countries, and LMICs of Africa, the Americas, the Eastern Mediterranean region, Europe, Southeast Asia, and the Western Pacific Region. LMICs=low-income and middle-income countries. Confidence intervals are listed in appendix pp 67–70.

Springmann et al. 2016.

Number of deaths attributable to climate-related changes in weight and diets for the combination of four emissions pathways



Adoption of climate-stabilization pathways would reduce the number of climate-related deaths by 29–71%, depending on their stringency.

Figure 2: Climate-related deaths (in thousands) in 2050 by risk factor
(A) Climate-related deaths worldwide and (B) by region. The risk factors include changes in fruit and vegetable consumption, red meat consumption, and the prevalence of underweight, overweight, and obesity. The regional aggregates include all regions (global), high-income countries, and LMICs of Africa, the Americas, the Eastern Mediterranean region, Europe, Southeast Asia, and the Western Pacific Region. LMICs=low-income and middle-income countries. Confidence intervals are listed in appendix pp 67–70.

Springmann et al. 2016.

Gaps and emerging topics

- 1. Characterization of management practices
- 2. Relevance of smallholders for food security – barriers for adoption of conservation agric.
- 3. Landscape management and Land optimization models (LCA)
- 4. Other aspects of food security under climate change.

Thank you!

mercedes@unb.br