Presenter

Samuel Myers, MD, MPH
Senior Research Scientist
Harvard T.H. Chan School of Public Health
Clinical Instructor, Harvard Medical School
Director, Planetary Health Alliance

APHA AMERICAN PUBLIC HEALTH ASSOCIATION *For science. For action. For health.*

CLIMATE *for* HEALTH™

ecoAmerica *start with people*

Climate Change and Children: A Focus on Nutrition

Samuel S Myers, MD, MPH

Senior Research Scientist, Harvard TH Chan School of Public Health

Director, Planetary Health Alliance

planetaryhealthalliance.org
pha@harvard.edu

HARVARD T.H. CHAN SCHOOL OF PUBLIC HEALTH

Harvard University Center for the Environment

PLANETARY HEALTH ALLIANCE

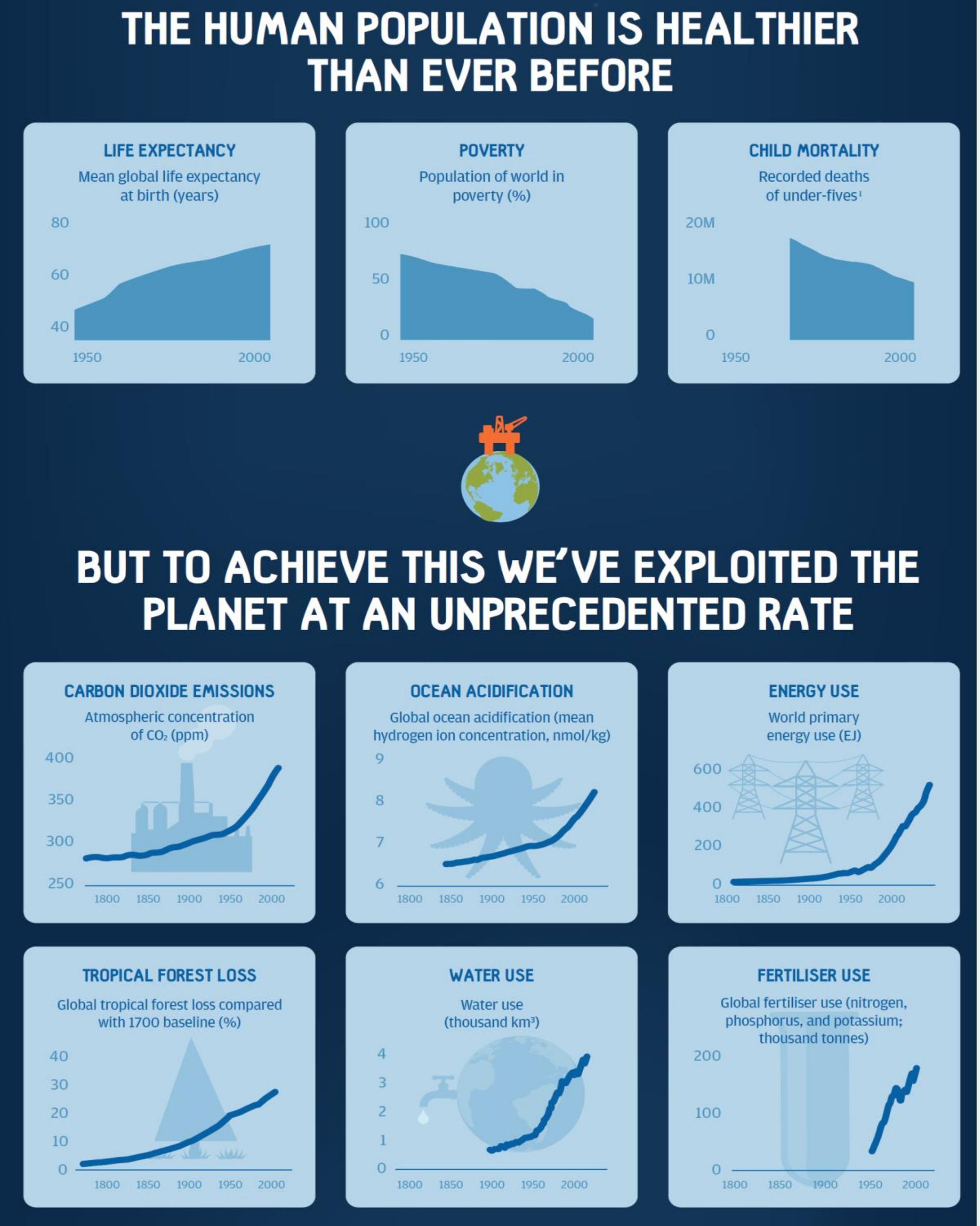
Global Malnutrition

- 800 million people are undernourished.
- 45% of deaths in children <5 are due to undernutrition
- 161 million children < 5 are stunted; 51 million are wasted
- Over 1 million deaths (2011) from stunting; 875,000 deaths from wasting
- 2 Billion suffer from micronutrient deficiencies.

Brief introduction to Planetary Health

"The health of human civilization and the state of the natural systems on which it depends."

The "Blue Marble" taken from Apollo 17 in 1972



THE ECOLOGICAL PARADOX

PLANETARY HEALTH ALLIANCE

The ROCKEFELLER FOUNDATION THE LANCET

CrossMark

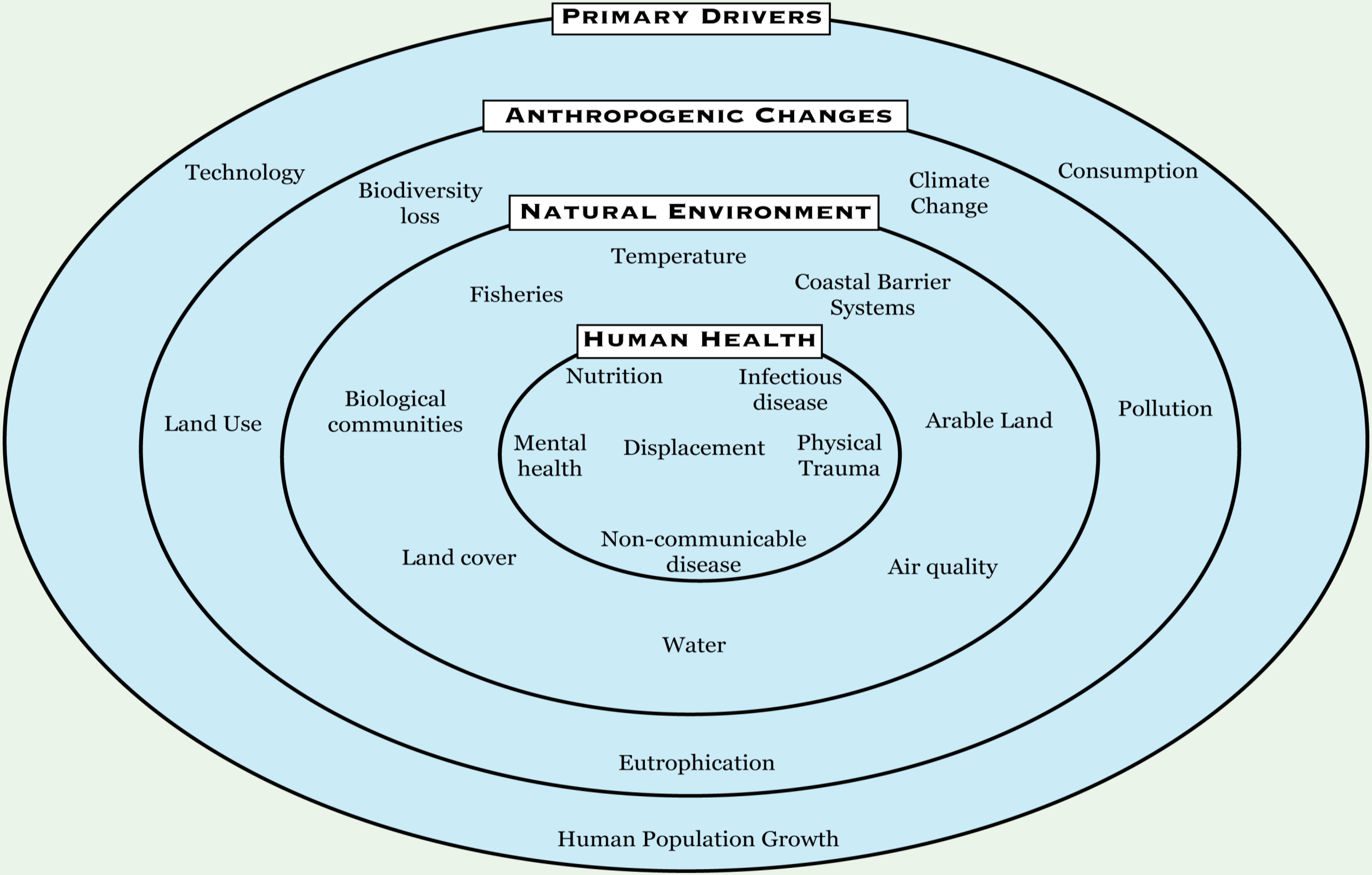
The Rockefeller Foundation–*Lancet* Commission on planetary health

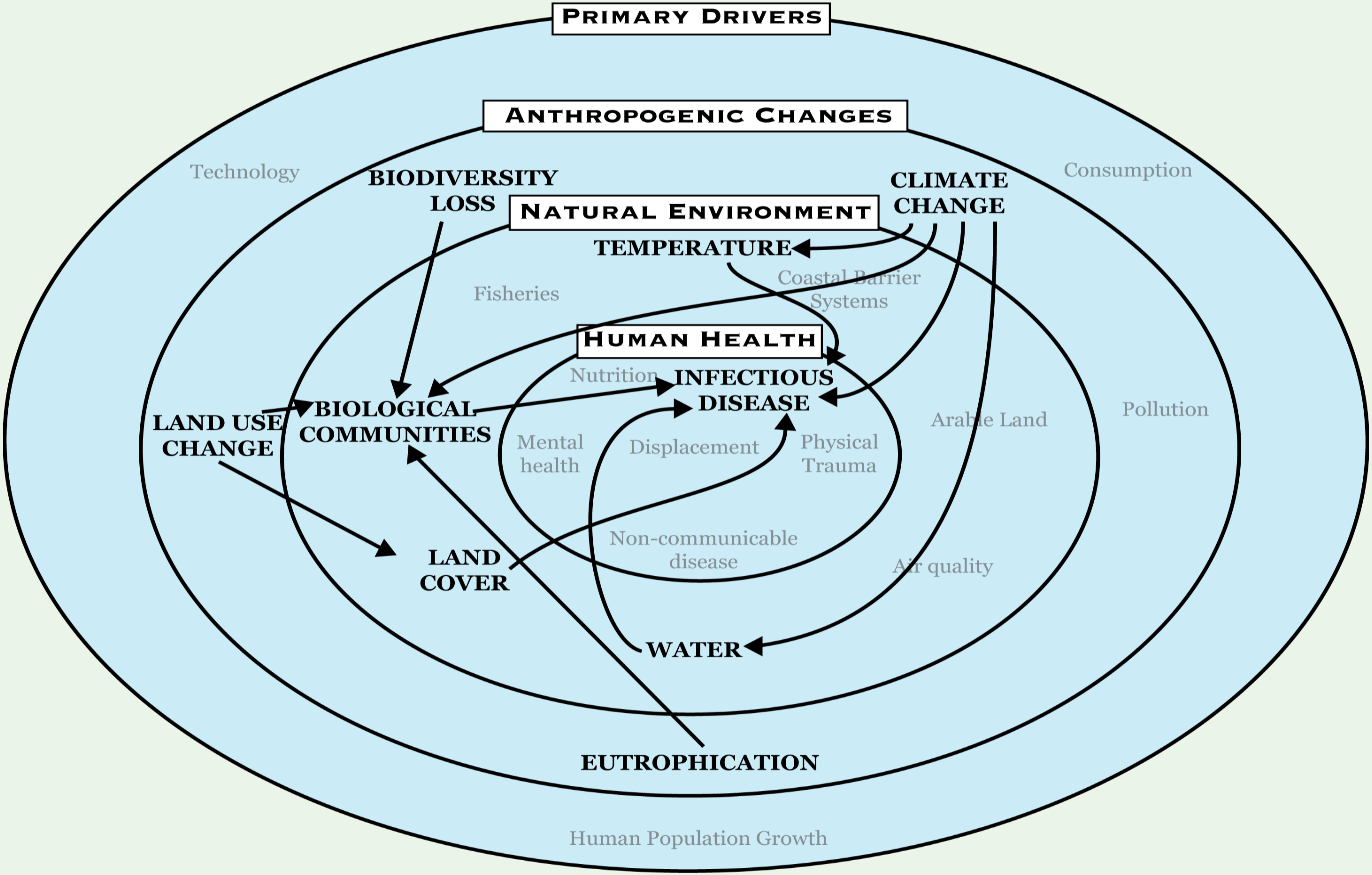
Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–*Lancet* Commission on planetary health

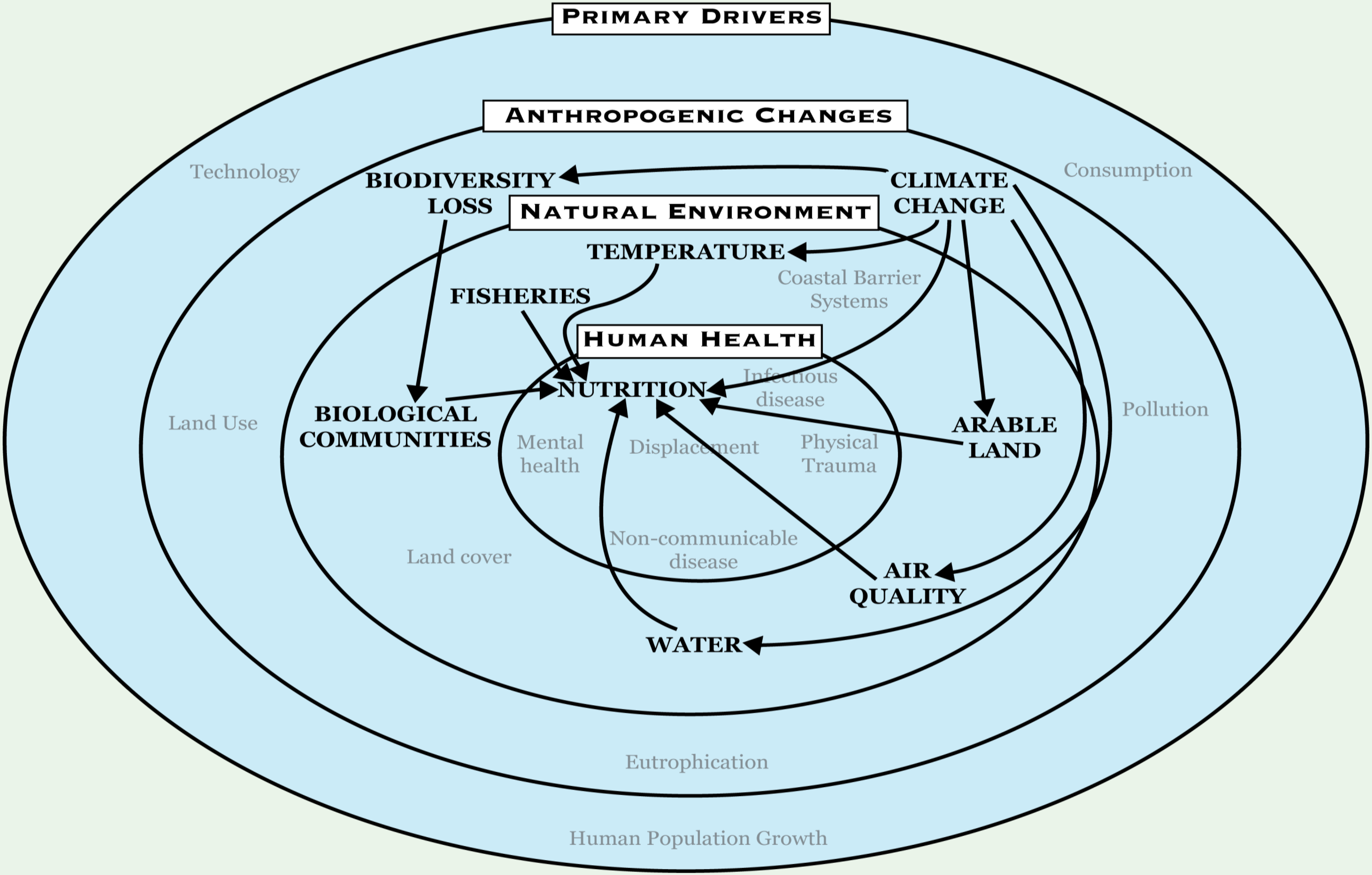
Sarah Whitmee, Andy Haines, Chris Beyrer, Frederick Boltz, Anthony G Capon, Braulio Ferreira de Souza Dias, Alex Ezeh, Howard Frumkin, Peng Gong, Peter Head, Richard Horton, Georgina M Mace, Robert Marten, Samuel S Myers, Sania Nishtar, Steven A Osofsky, Subhrendu K Pattanayak, Montira J Pongsiri, Cristina Romanelli, Agnes Soucat, Jeanette Vega, Derek Yach

"As a Commission, we are deeply concerned that the ***explanation is straightforward and sobering: we have been mortgaging the health of future generations*** to realize economic and development gains in the present. By unsustainably exploiting nature's resources, human civilization has flourished but now risks substantial health effects from the degradation of nature's life support systems in the future."

PLANETARY HEALTH ALLIANCE


Primary Drivers
Anthropogenic Changes
Natural Environment
Human Health
Technology
Biodiversity loss
Climate Change
Consumption
Temperature
Fisheries
Coastal Barrier Systems
Nutrition
Infectious disease
Biological communities
Land Use
Arable Land
Pollution
Mental health
Displacement
Physical Trauma
Non-communicable disease
Land cover
Air quality
Water
Eutrophication
Human Population Growth


PRIMARY DRIVERS
ANTHROPOGENIC CHANGES
NATURAL ENVIRONMENT
HUMAN HEALTH
Technology
Consumption
Pollution
Human Population Growth
BIODIVERSITY LOSS
CLIMATE CHANGE
TEMPERATURE
Coastal Barrier Systems
Fisheries
LAND USE CHANGE
BIOLOGICAL COMMUNITIES
Nutrition
INFECTIOUS DISEASE
Mental health
Displacement
Physical Trauma
Arable Land
Non-communicable disease
LAND COVER
Air quality
WATER
EUTROPHICATION



PRIMARY DRIVERS
ANTHROPOGENIC CHANGES
NATURAL ENVIRONMENT
HUMAN HEALTH
Technology
Consumption
BIODIVERSITY LOSS
CLIMATE CHANGE
TEMPERATURE
Coastal Barrier Systems
FISHERIES
NUTRITION
Infectious disease
BIOLOGICAL COMMUNITIES
Land Use
Mental health
Displacement
Physical Trauma
ARABLE LAND
Pollution
Non-communicable disease
Land cover
AIR QUALITY
WATER
Eutrophication
Human Population Growth

The Gordian Knot of Food Security

Transition to Western diets

Population and Economic Growth

Biofuels

Surprises?

Rising temperatures and variability

Water Scarcity

Arable land loss

Air pollution (ozone)

Loss of Pollinators

Changes in Nutrient content

Fisheries Declines

Wildlife Declines

Changes in pests and pathogens

More frequent and intense natural disasters

Changes in solar radiation?

Changes in soil microbes?

Are anthropogenic CO_2 emissions threatening human nutrition?

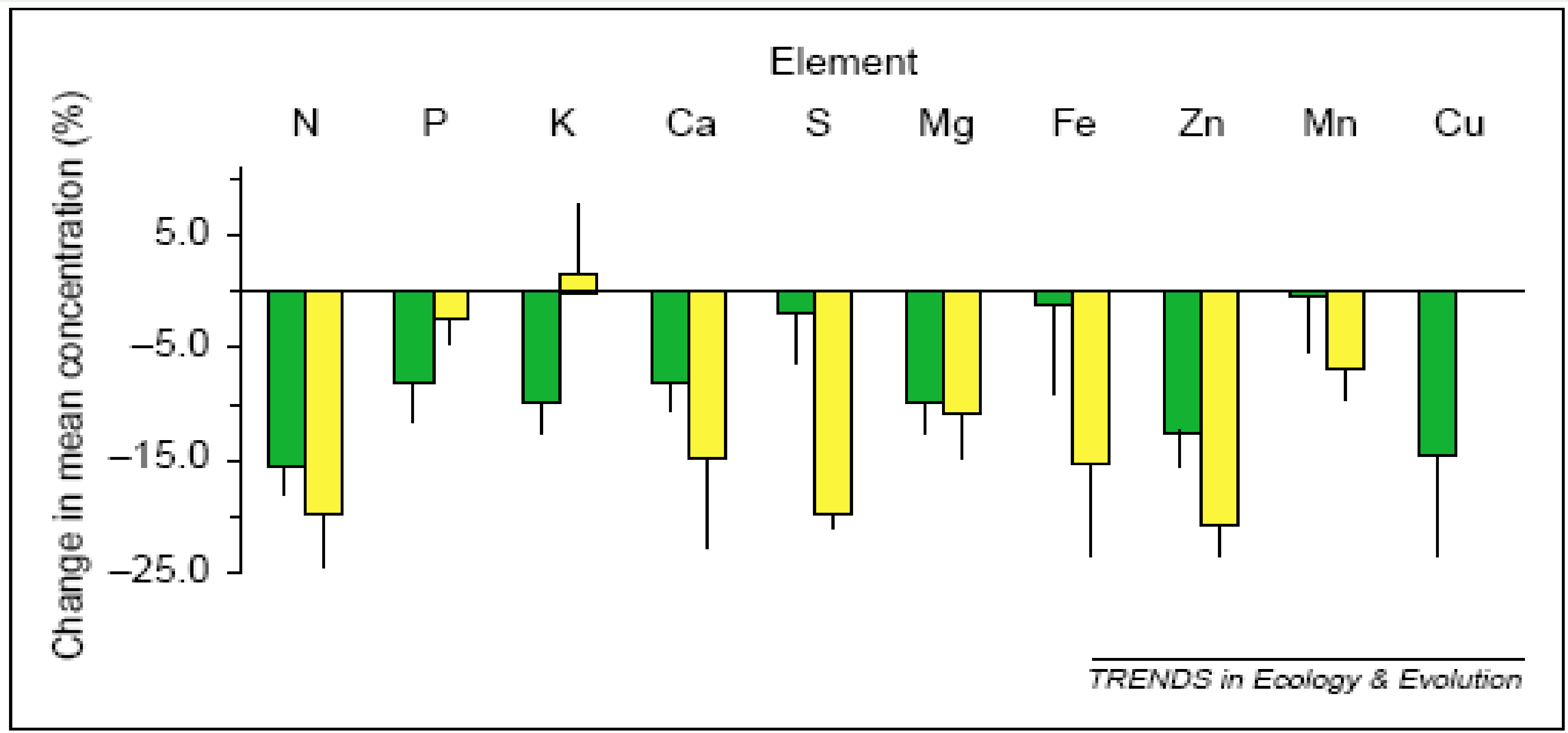


Fig. 1. Changes (%) in the mean concentration of essential elements in plants grown in twice-ambient atmospheric [CO2] relative to those grown at ambient levels [all plants (foliar), green; wheat (grains), yellow]. (From: Loladze, I. (2002).

Rice, Japan

Field Peas, Australia

Sorghum, Arizona

Wheat, Australia

Maize, Illinois

Soybean, Illinois

Data Summary

Table 1: Characteristics of agricultural experiments

Crops	**Country**	**Treatments used**	**Years grown**	**# of Replicates***	**# of Cultivars**	**CO_2 ambient/elev (ppm)**
Wheat						
Site 1:	Australia	2 water levels, 2 N treatments, 2 Sowing times	2007-10	4	8	382/546-550
Site 2:	Australia	1 Water level, 1 N treatment 2 Sowing times	2007-9	4	1	382/546-550
Field Peas	Australia	2 water levels	2010	4	4	382/546-550
Rice						
Site 1:	Japan	1 N treatment, 2 warming treatments	2007-8	3	3	376-379/570-576
Site 2:	Japan	3 N treatments, 2 warming treatments	2010	4	18	386/584
Maize	U.S.	2 N treatments	2008	4	2	385/550
Soybeans	U.S.	1 treatment	2001, 02, 04, 2006-08	4	7	372-385/550
Sorghum	U.S.	2 water levels,	1998-99	4	1	363-373/556-579

* “# of replicates” refers to the number of identical cultivars grown under identical conditions in the same year and location but in separate FACE rings

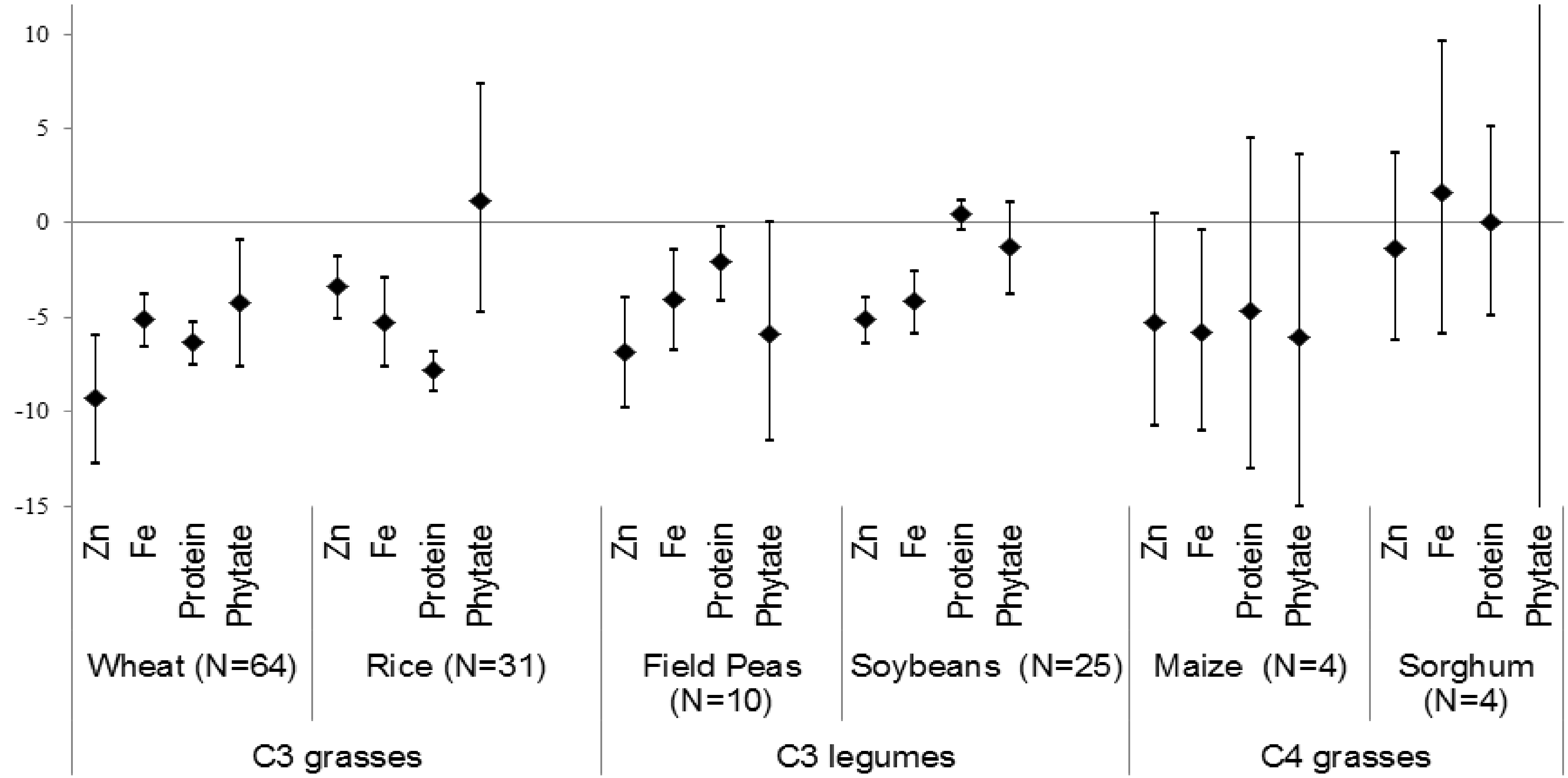
- 41 Cultivars across 7 sites on 3 continents for 6 crop types
- 1152 Crop Samples
- 286 “experiments” pooled replicates (ambient versus elevated CO2)
- > 10X all previously published data combined

LETTER

5 JUNE 2014 | VOL 510 | NATURE | 139

Increasing CO_2 threatens human nutrition

Samuel S. Myers[1,2], Antonella Zanobetti[1], Itai Kloog[3], Peter Huybers[4], Andrew D. B. Leakey[5], Arnold J. Bloom[6], Eli Carlisle[6], Lee H. Dietterich[7], Glenn Fitzgerald[8], Toshihiro Hasegawa[9], N. Michele Holbrook[10], Randall L. Nelson[11], Michael J. Ottman[12], Victor Raboy[13], Hidemitsu Sakai[9], Karla A. Sartor[14], Joel Schwartz[1], Saman Seneweera[15], Michael Tausz[16] & Yasuhiro Usui[9]



Results Summary

- All C_3 crops show significant reductions in iron and zinc
- C_3 grains show significant reductions in protein
- C_4 crops less affected
- Roughly 2.75 billion people living in 50 countries receive at least 70% of their dietary zinc and/or iron from C3 crops and will be placed at significant risk
- Baseline of 2 billion deficient 63 million LY lost



Implications for Global Zinc Deficiency

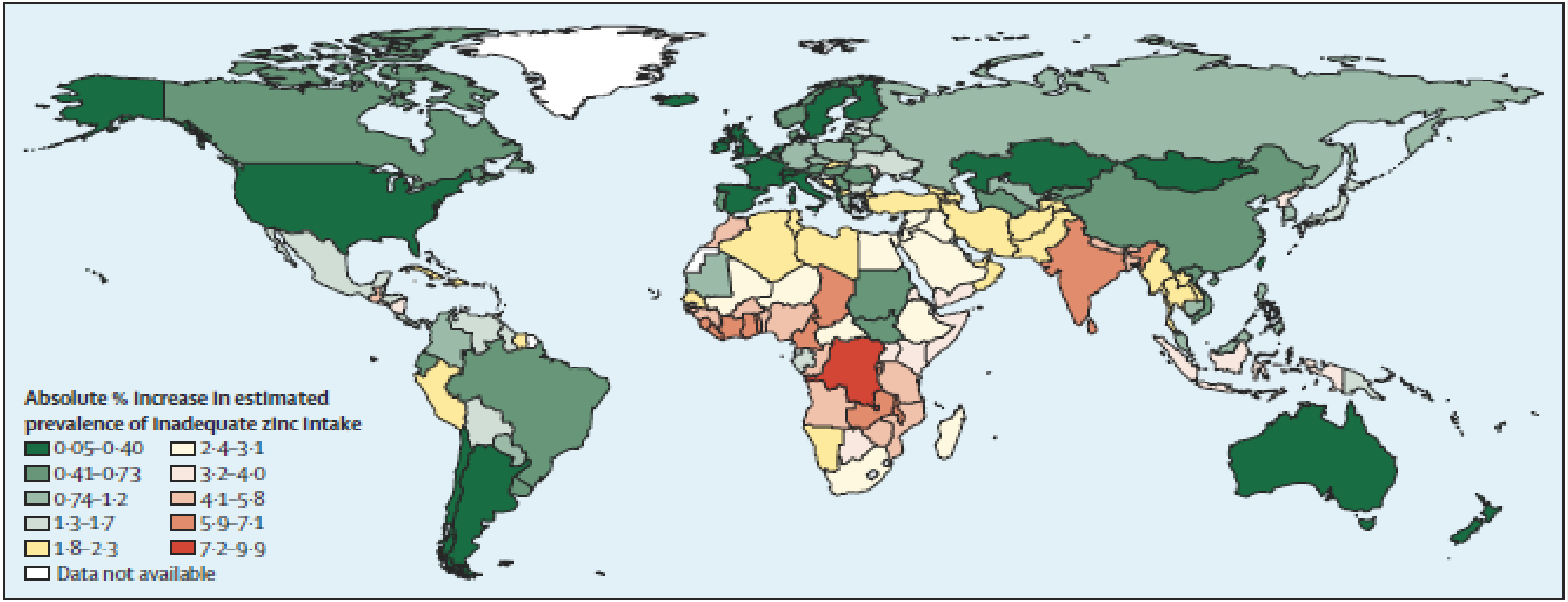
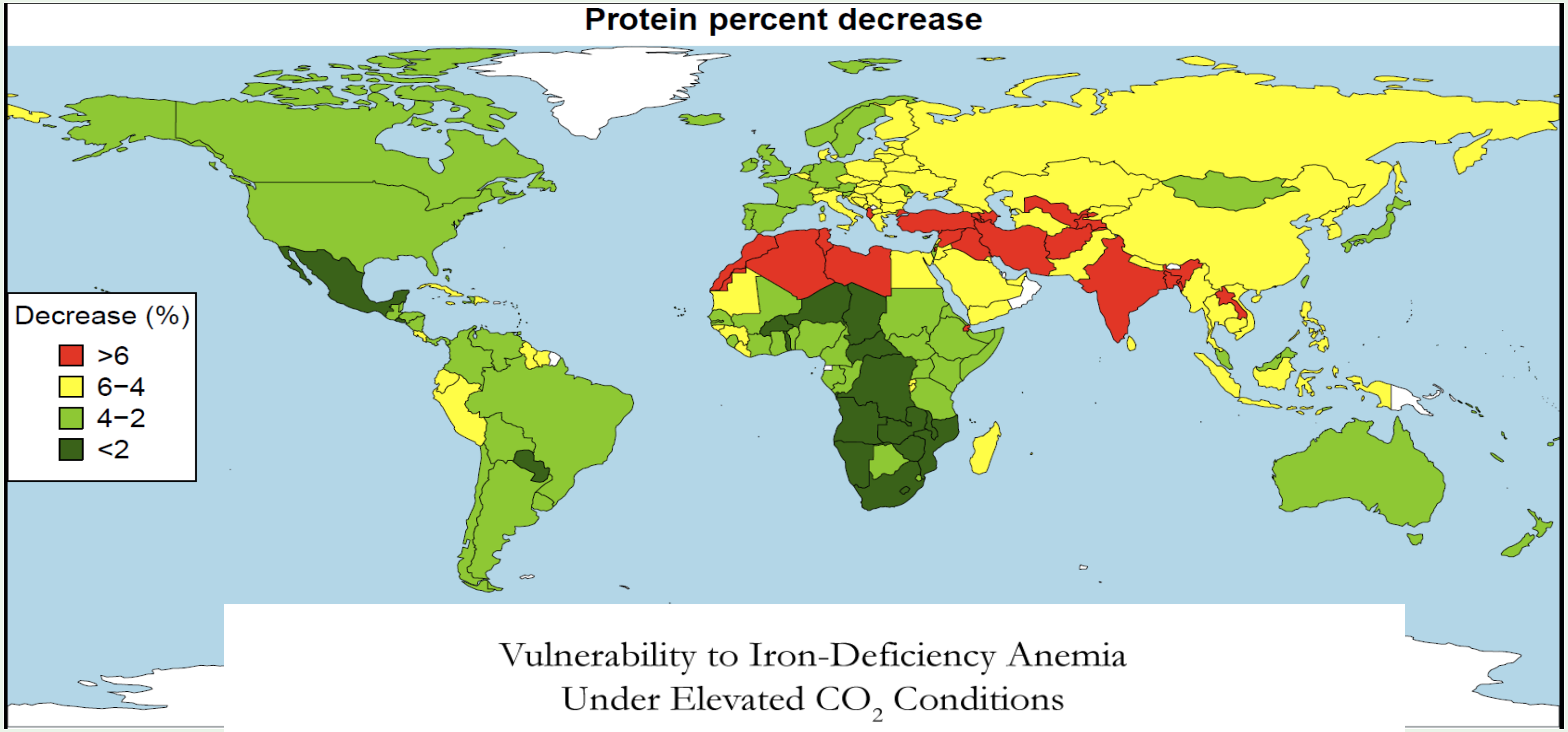


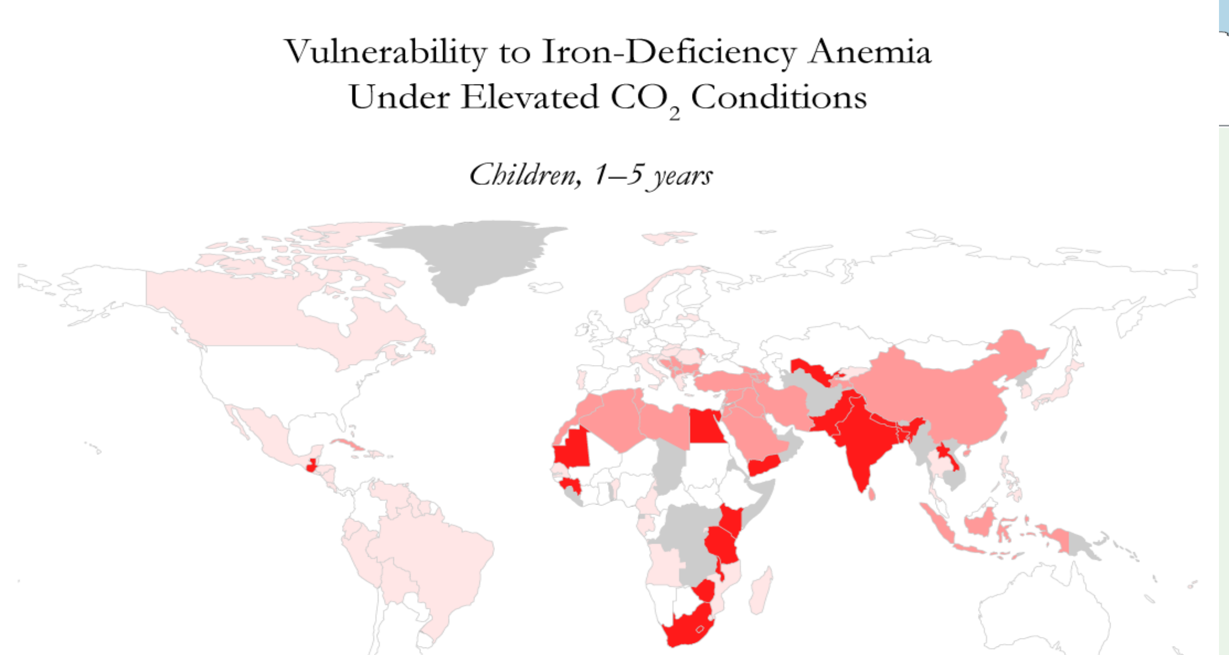
Figure 1: Absolute percentage increase in risk of zinc deficiency in response to elevated atmospheric [CO_2]

Rising CO2 likely to place between 150-200 million people at new risk of zinc deficiency while exacerbating existing deficiency in over 1 billion

From *Myers, SS, et al, Effect of increased concentrations of atmospheric carbon dioxide on the global threat of zinc deficiency: a modelling study. The Lancet Global Health, July 16, 2015*

What about protein and iron?





Health Impacts of Global Pollinator Declines

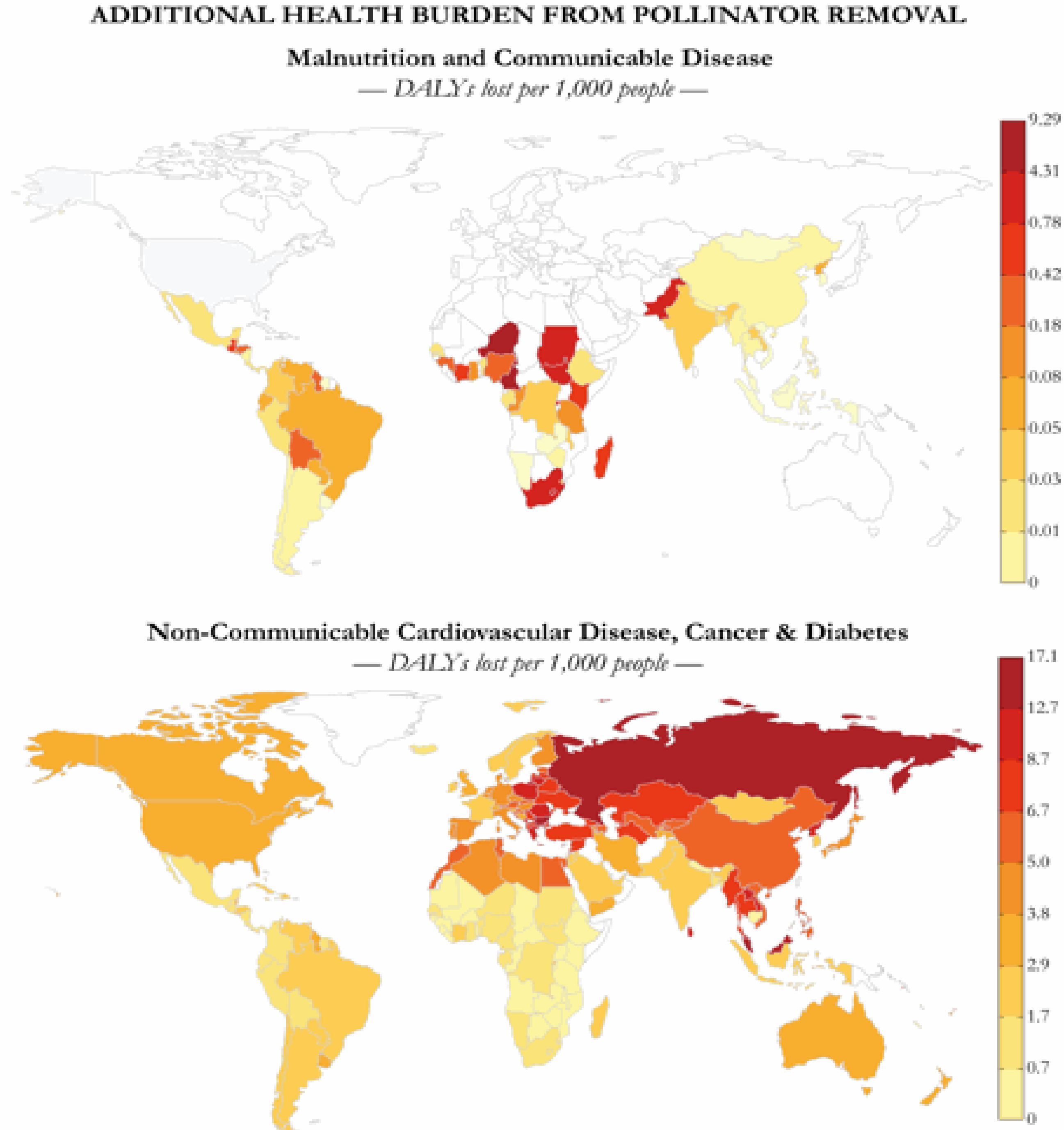
- Pollinators declining globally, and pollinator-dependent crops provide large shares of calories and nutrients
- At risk populations: near thresholds of deficiency, receive significant nutrients from pollinator-dependent crops
- Low intake of fruits, nuts and seeds, and vegetables are 4th, 12th, and 17th largest risk factors for global burden of disease



Study Design

- What people eat and what is in it
- Pollinator dependence of each food crop
- Scenario analysis for pollinator declines
- EAR for micronutrients and GBD for food groups





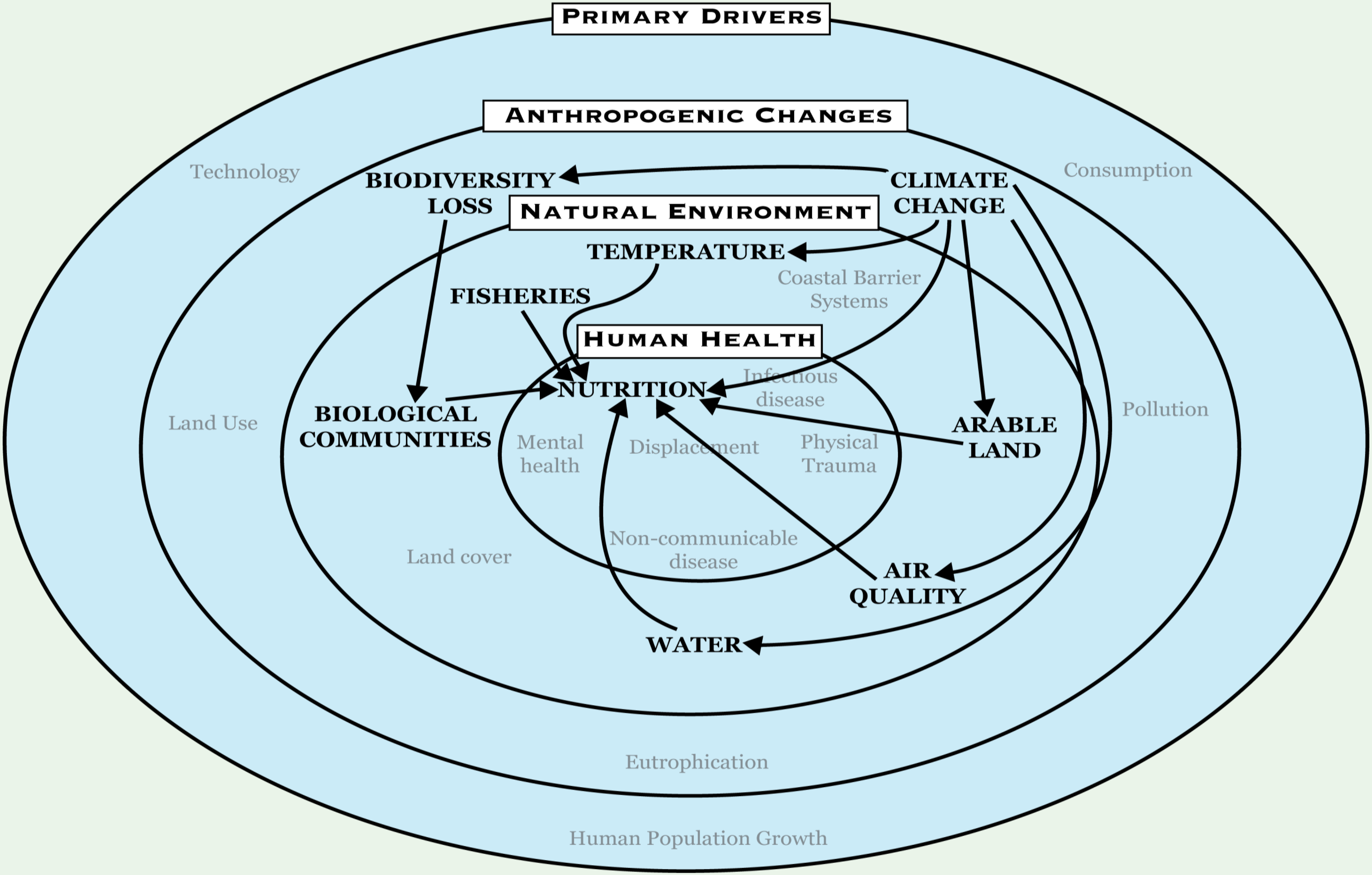
Smith, MR, Singh, GM, Mozaffarian, D and Myers SS. 2015. *The Lancet*.

Our Findings

- Vitamin A deficiency—71 million
- Folate deficiency -173 million
- Full pollinator service loss: *1.42 million additional deaths per year from non-communicable and malnutrition-related diseases, equivalent to a 2.7% increase in total yearly deaths.*
- Greatest vulnerability: eastern Europe, and central, eastern, and south-east Asia
- 82% of all pollinator-related DALYs that are lost were associated with *indigenous* production.

www.thelancet.com Published online July 16, 2015 http://dx.doi.org/10.1016/S0140-6736(15)61085-6

Climate Change and Global Fisheries


PRIMARY DRIVERS
ANTHROPOGENIC CHANGES
Technology
Consumption
BIODIVERSITY LOSS
CLIMATE CHANGE
NATURAL ENVIRONMENT
TEMPERATURE
Coastal Barrier Systems
FISHERIES
HUMAN HEALTH
Infectious disease
NUTRITION
BIOLOGICAL COMMUNITIES
Land Use
Mental health
Displacement
Physical Trauma
ARABLE LAND
Pollution
Land cover
Non-communicable disease
AIR QUALITY
WATER
Eutrophication
Human Population Growth

Mental Health?

THANK YOU!


Biology
Land Use


Ocean Science/
Program Mgt

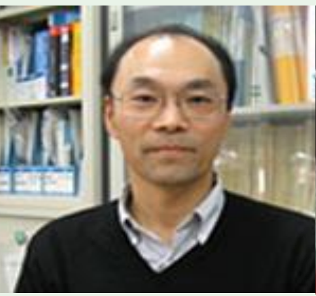

Planetary
Health


Science
Policy


Atmospheric
Chemistry


Climate
Modeling


Veterinary
Medicine


Agronomy-
Rice


Marine Biology


Biogeoscience


Parasitology


Agronomy
Maize/Soy


Envtl Science/
Program Cdtr


Epidemiology
Statistics


Marine
Science


Nutritional
Epidemiology


Earth Sciences


Ecology
Modeling


Nutritional
Epidemiology


Climate
Science


Climate &
Fisheries


Statistics


Plant physiology
Health