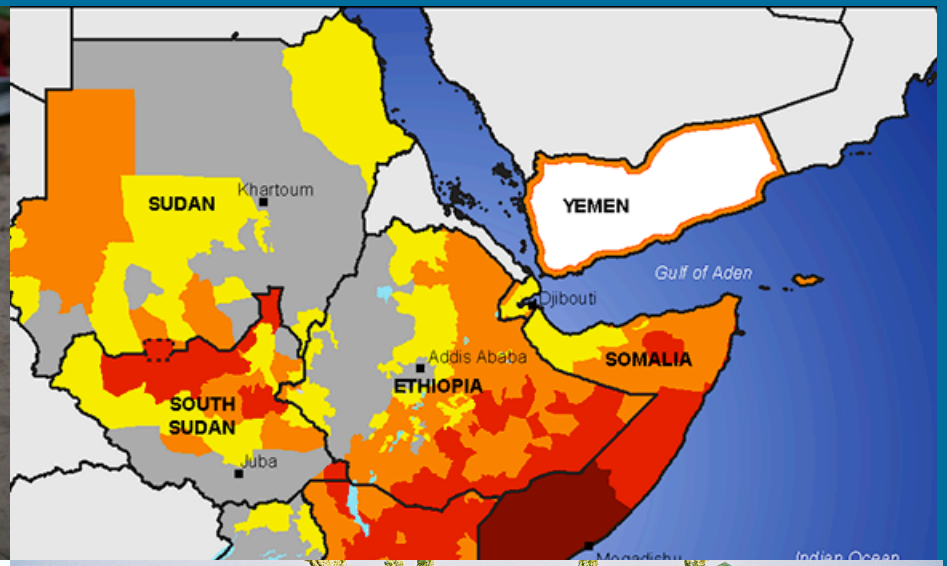
Mission 2019:
Global Food Security in the 21st century



Terrascope – Academic Structure

First Semester

- **Solving Complex Problems--Mission 20xx**

Second Semester

- **1.016**
- **Terrascope Field Experience (Spring Break)**
- **Terrascope Radio (SP.360, HASS, CI-H)**

Terrascope – Social Structure

First year learning community

You will develop friendships and bonds that last for your time at MIT and beyond

Terrascope Room 16-168: a place to study, hang out, interact, cook, eat, SLEEP, always someone around to talk to

Terrascope lunches: see calendar—eat, listen (or not), learn

Special activities: movie nights, special dinners, weekend trip, and ideas?

Solving Complex Problems

- Multidisciplinary, project-based learning experience
- Students work toward a solution to a interdisciplinary problem related to Earth's environment
- Each year's theme is different and referred to as "Mission XXXX", where XXXX refers to the graduation year of the class involved

Solving Complex Problems--Motivation

- To build in you the capacity to tackle the "big" problems that confront society
- To encourage you to take charge of the learning process
- To show you how to do independent research, to evaluate the quality of information sources, and to synthesize different information streams

Solving Complex Problems--Motivation

- To encourage you to think about optimal solutions rather than correct solutions
- To help you learn how to work effectively as part of a team
- To improve your communication skills using two media: the web site and the formal oral presentation
- To convince you of your potential!!

Past Missions

- Develop a viable plan for the exploration of Mars with the aim of finding evidence for life
- Design permanent, manned, underwater research laboratories and develop detailed research plans for the first six months of their operation
- Design the most environmentally sensitive strategy for hydrocarbon resource extraction from the Arctic National Wildlife Refuge and determine whether or not the value of the resource exceeds its financial and environmental cost

Past Missions

- To develop strategies for developing countries in the Pacific basin to cope with tsunami hazards and disasters. Due to the unique needs of each country, we specifically focused on developing plans for Peru and Micronesia.

- To develop a plan for the reconstruction of New Orleans and the management of the Mississippi River and the Gulf coast. The reconstruction of New Orleans and the management of the Mississippi River and the Gulf coast.

Past Missions

- To develop strategies to deal with the collapse of the global fisheries and the general health of the oceans
- To develop a plan to ensure the availability of fresh clean water for western North America for the next 100 years.
- **Propose an integrated global solution to the rapid rise in atmospheric CO_2 that will stabilize concentrations at an economically viable and internationally acceptable level.**

Subject Structure

Problem divided into approximately five to ten tasks; students divided into teams

Each team assigned an Undergraduate Teaching Fellow (UTF), Alumni Mentors, and have access to library staff

First few weeks-month is focused on smaller-scale group projects, with students taking more and more control by the middle of the term

Subject Deliverables

- Weekly individual journal entries
- Each team will communicate its progress to the rest of the class regularly throughout the term
- Mini-projects during first half of term
- The class describes and justifies its overall plan in a web site
- The class explains the design in a two-hour presentation before a panel of experts and a general audience; this presentation is also webcast around the world.

Mission 2018

(www.mission2018.com)

Our Energy Future

Our Mission

Our mission is to devise a global energy production portfolio for the next fifty years that will reduce the rate of increase in human produced greenhouse gas emissions and attempt to maintain a constant atmospheric concentration of CO2. Energy demand continues to grow in order to maintain or improve living conditions for an expanding population. Our goal is to meet growing global energy demand while improving standards of living and keeping the global CO2 concentration under 450 parts per million to avoid a 2 degree Celsius increase in global temperatures. Our proposed solution seeks to reduce CO2 emissions from industry, transportation, and electrical energy production. We explore the potential of energy sources besides fossil fuels such as nuclear, solar, wind, geothermal, biomass, and hydro/tidal power and how countries can transition from fossil fuels to these sources. We also outline possible methods of carbon capture and sequestration to remove the CO2 that is already in the atmosphere. Beginning by reducing fossil fuel usage in developed countries with high implementation abilities, we can reduce global emissions while still allowing developing countries to use fossil fuels to develop. We also aim to counteract increasing energy demand with increased efficiency and other efforts to actually reduce demand.

Energy Consumption

About 7 billion people live on planet Earth. People need food, water, clean air, and a good quality of life. Our civilization relies on large amounts of energy to achieve these goals. However, the consumption of today jeopardizes the living conditions of tomorrow. Developing countries have dramatically increasing energy needs which must be met in order to continue improving the standards of living. For this reason, it is important to find ways to meet growing energy demand in a sustainable manner. Figure 1 illustrates the relative usage of different energy sources over the past 25 years. The U.S. Energy Information Administration (EIA) reports that total global primary energy (energy that has not been through any conversion processes) consumption in 2011 was 152,000 TWh;[1] 81.2% was produced using fossil fuels.[2] Fossil fuels are limited and also emit greenhouse gases when consumed which can cause global climate change and environmental degradation. Global energy consumption is predicted to increase by 56% from 2010 to 2040[3] and our current methods of energy production and levels of consumption are unsustainable. If

re to meet the energy needs of the future, to protect our planet and our species, we must change our current energy portfolio.

A few words on the bigger picture…

"What I have learned is that passion, along with curiosity, drives science. Passion is the mysterious force behind nearly every scientific breakthrough. Perhaps it's because without it you might never be able to tolerate the huge amount of hard work and frustration that scientific discovery entails….

"For the next four years you will get to poke around the corridors of your college, listen to any lecture you choose, work in a lab. The field of science you fall in love with may be so new it doesn't even have a name yet. You may be the person who constructs a new biological species, or figures out how to stop global warming, or aging. Maybe you'll discover life on another planet. My advice to you is this: Don't settle for anything less."

Nancy Hopkins, a professor of biology at M.I.T., has been teaching since 1973.

Extracted from Op-Ed contribution in the New York Times, September 5 2009

A few words on the bigger picture…

"Better is possible. It does not take genius. It takes diligence. It takes moral clarity. It takes ingenuity. And above all, it takes a willingness to try."

Atul Gawande in *Better: A Surgeon's Notes on Performance*

"Vocation is the place where our deep gladness meets the world's deep need."

Friedrich Buechner

Meet the staff and UTFs!

Staff

Ari Epstein

Alumni Mentors – an invaluable resource

Bob Gurnitz, chief mentor

TA: Mike Eddy

UTFs

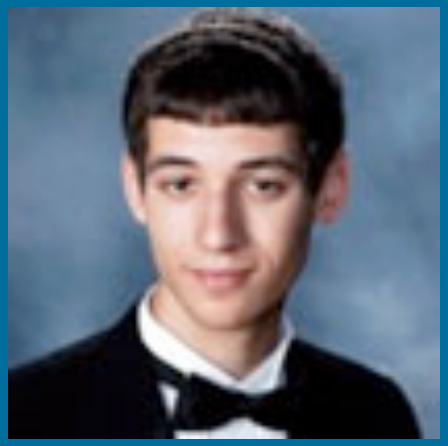
Judy Pu

Dirk Stahlecker

Ishan Meswani

Jake Burga

UTFs



Anthony Occidentale

Anna Jungbluth

Laurel Regibeau-Rockett

Important Contacts

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Daniel Sheehan, GIS specialist:
dsheehan@mit.edu

David McGee, Instructor & Director:
davidmcg@mit.edu

Subject Grading

Individual performance (30%)

Team performance (30%)

Class accomplishment (40%)

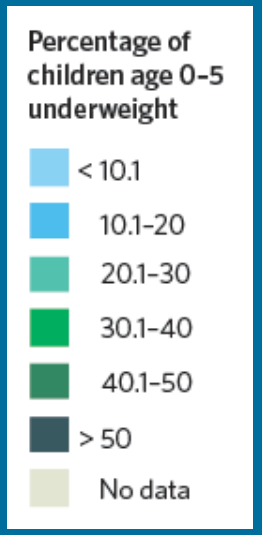
Mission 2019

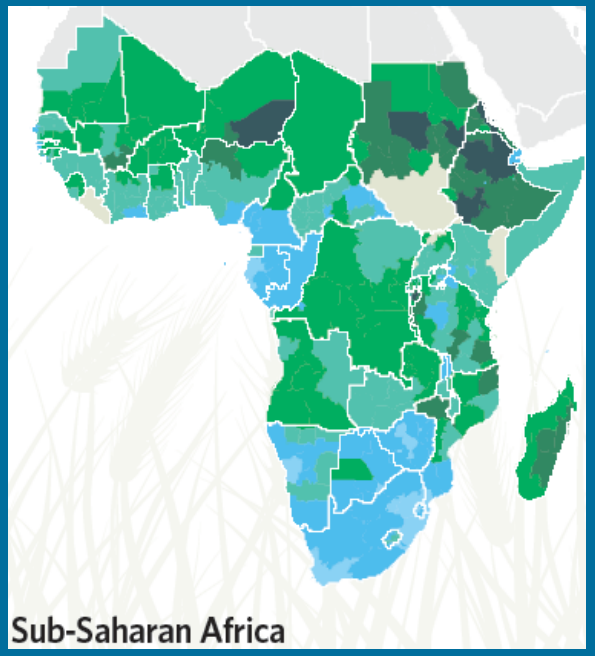
Your mission is to design a plan that will produce and distribute enough food to feed the planet over the next century, while ensuring that efficiency and equity are maximized and reducing agriculture's toll on the environment.

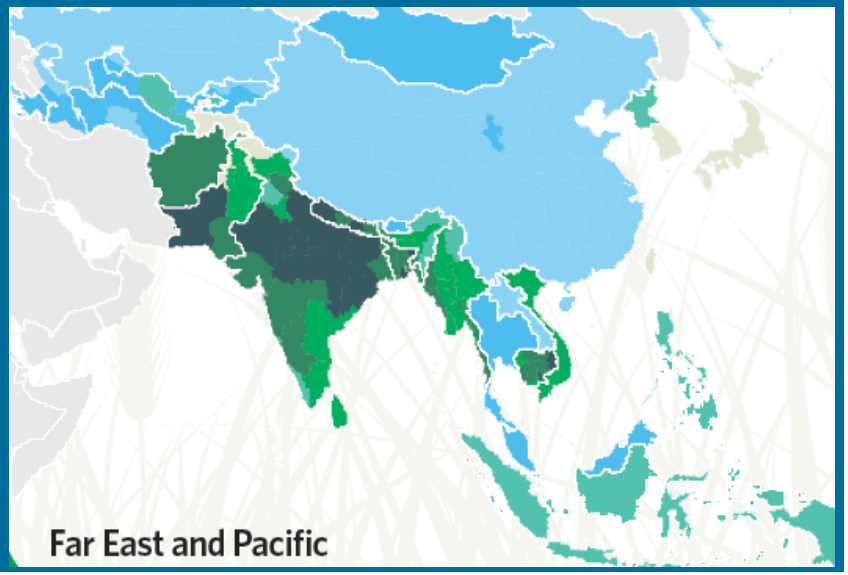
A four-part problem: Part 1

~800 million people are undernourished at present, even though global food production is greater than or equal to global food requirements.

Undernourishment tracks with poverty--not necessarily with lack of food.





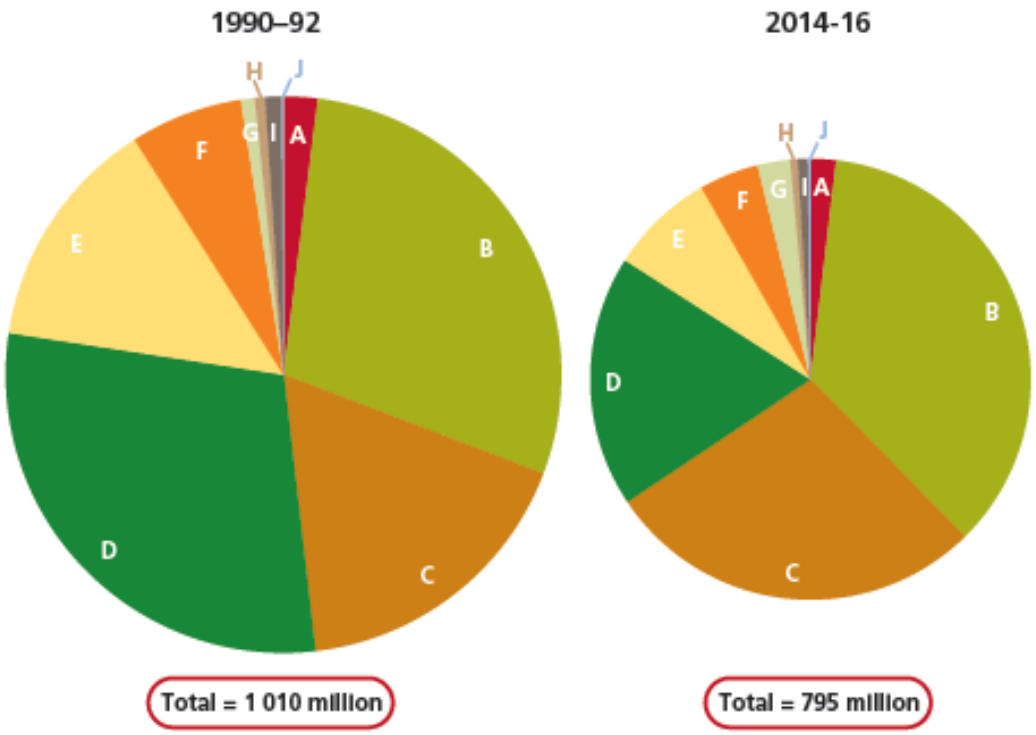


Nature 2010, v. 466, p. 546-547

Undernourishment tracks with poverty--not necessarily with lack of food.

FIGURE 2

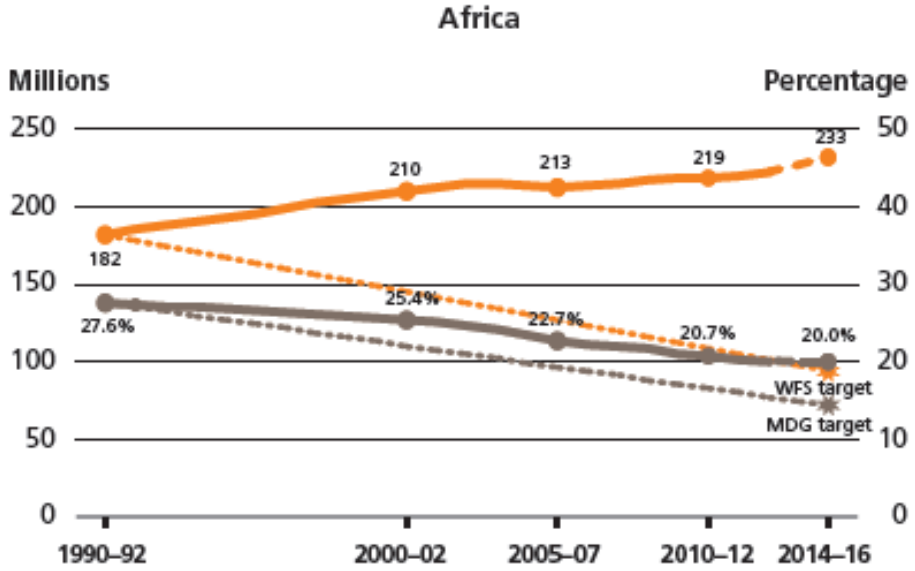
The changing distribution of hunger in the world: numbers and shares of undernourished people by region, 1990–92 and 2014–16

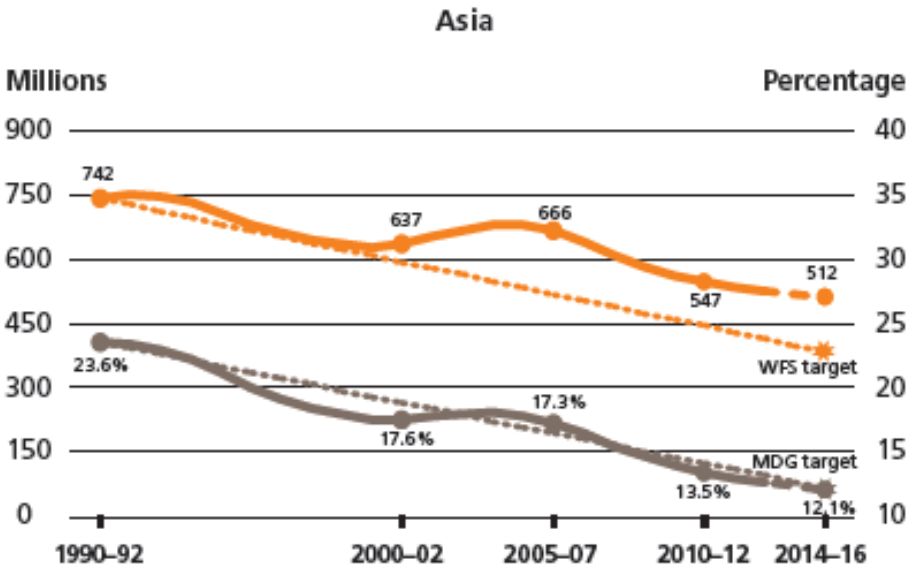


	Number (millions)		Regional share (%)	
	1990–92	2014–16	1990–92	2014–16
A Developed regions	20	15	2.0	1.8
B Southern Asia	291	281	28.8	35.4
C Sub-Saharan Africa	176	220	17.4	27.7
D Eastern Asia	295	145	29.2	18.3
E South-Eastern Asia	138	61	13.6	7.6
F Latin America and the Caribbean	66	34	6.5	4.3
G Western Asia	8	19	0.8	2.4
H Northern Africa	6	4	0.6	0.5
I Caucasus and Central Asia	10	6	0.9	0.7
J Oceania	1	1	0.1	0.2
Total	1 011	795	100	100

UN FAO, *The State of Food Security in the World 2015*

The number of hungry people has been dropping steadily for decades, but not in all regions





Orange: Numbers
Grey: Percentage

World Food Summit target: ½ of number of hungry by 2015
Millennium Development Goals target: ½ of percentage of hungry by 2015
(both relative to 1990 levels)

UN FAO, *The State of Food Security in the World 2015*

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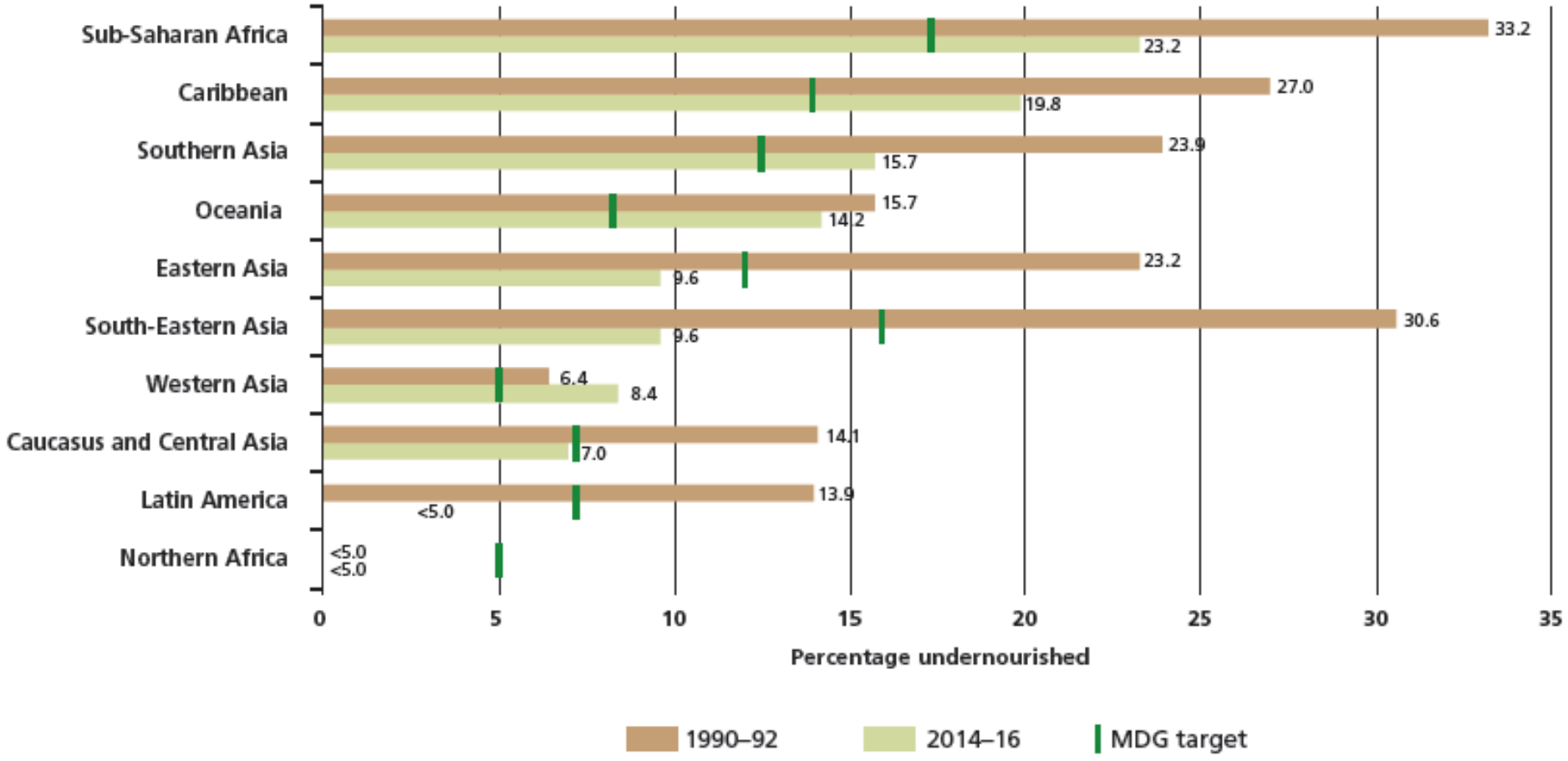


UN FAO, *The State of Food Security in the World 2015*

70% of the world's food is produced by smallholder farmers – i.e. those with <5 acres of land.

Most of the world's hungry are farmers.

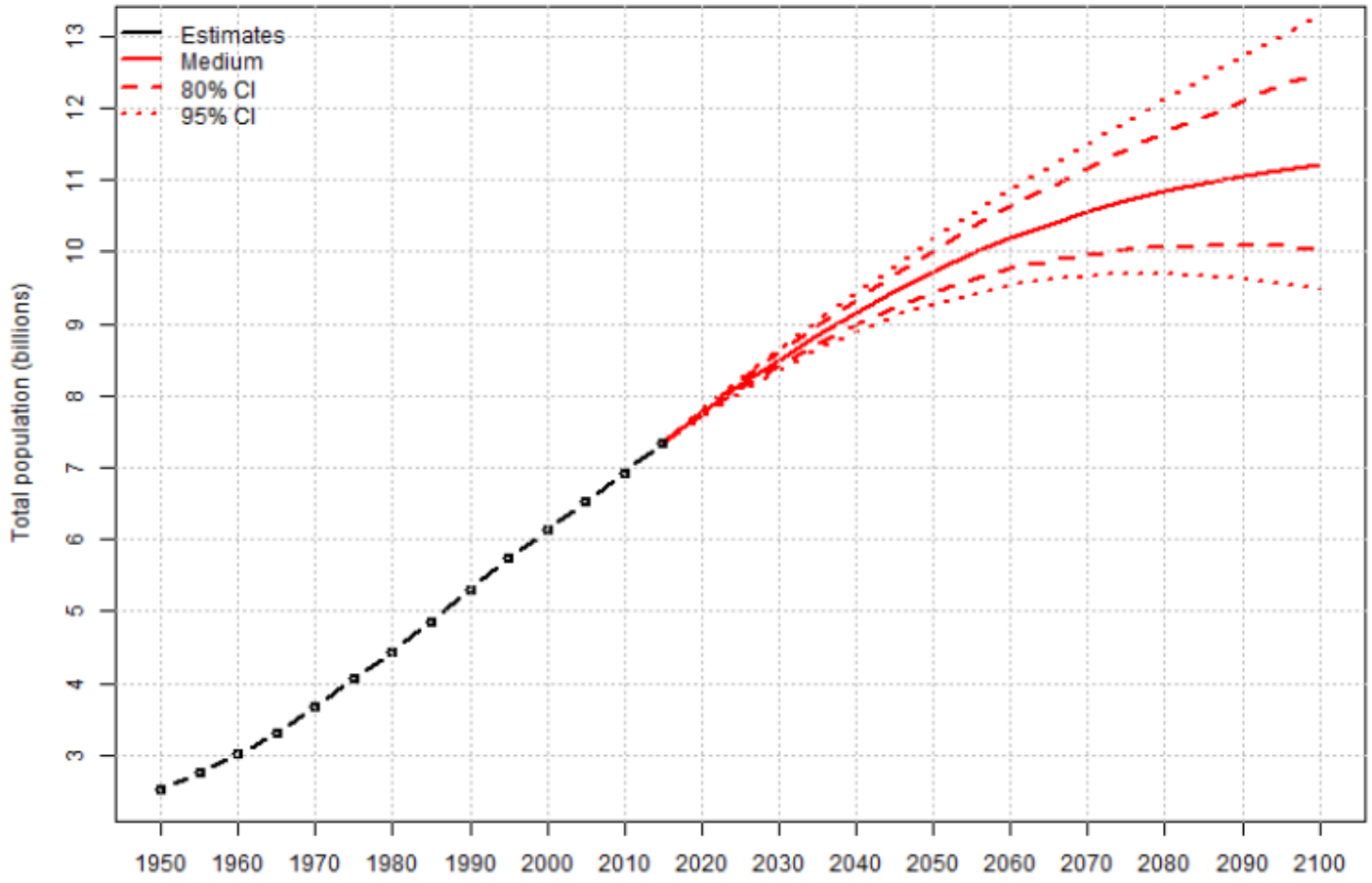
UN FAO, *The State of Food Security in the World 2015*

A four-part problem: Part 2

Population growth and increasing per capita demand require a ~60-100% increase in global food production by 2050.

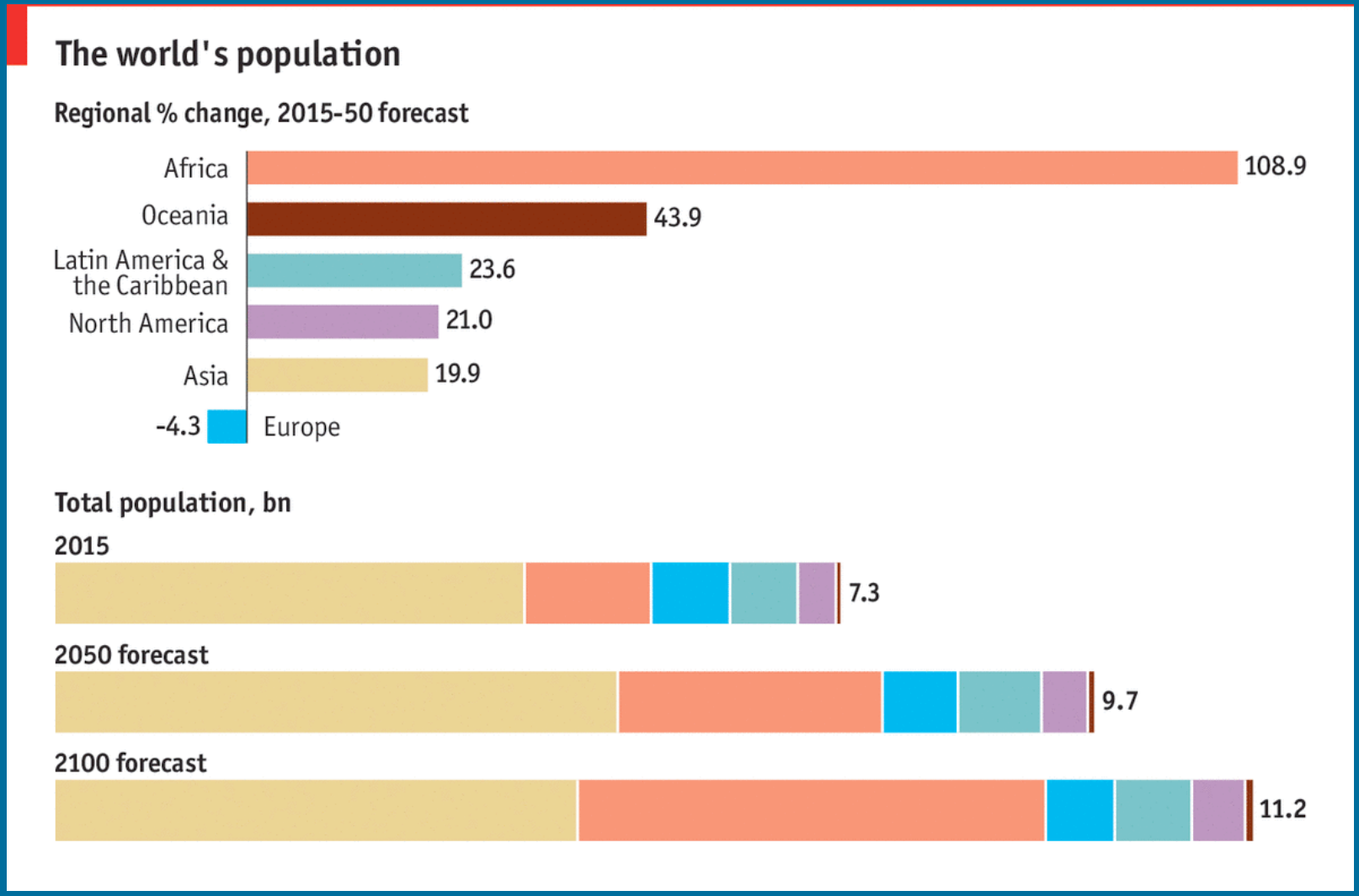
Population estimates: 11B people by 2100

Figure 2. Population of the world: estimates, 1950-2015, medium-variant projection and 80 and 95 per cent confidence intervals, 2015-2100



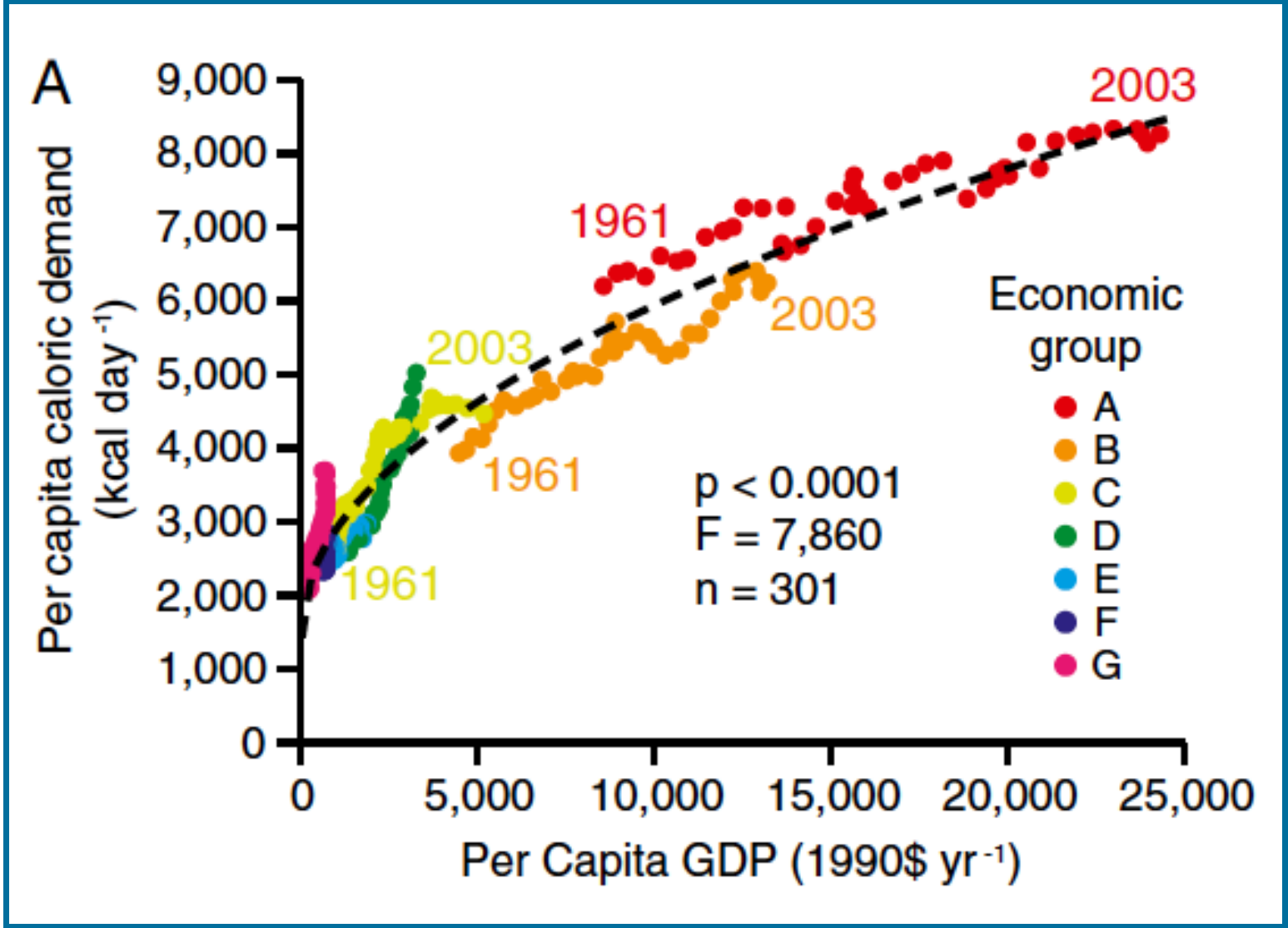
Source: United Nations, Department of Economic and Social Affairs, Population Division (2015). *World Population Prospects: The 2015 Revision*. New York: United Nations.

Most of this growth will be in Africa



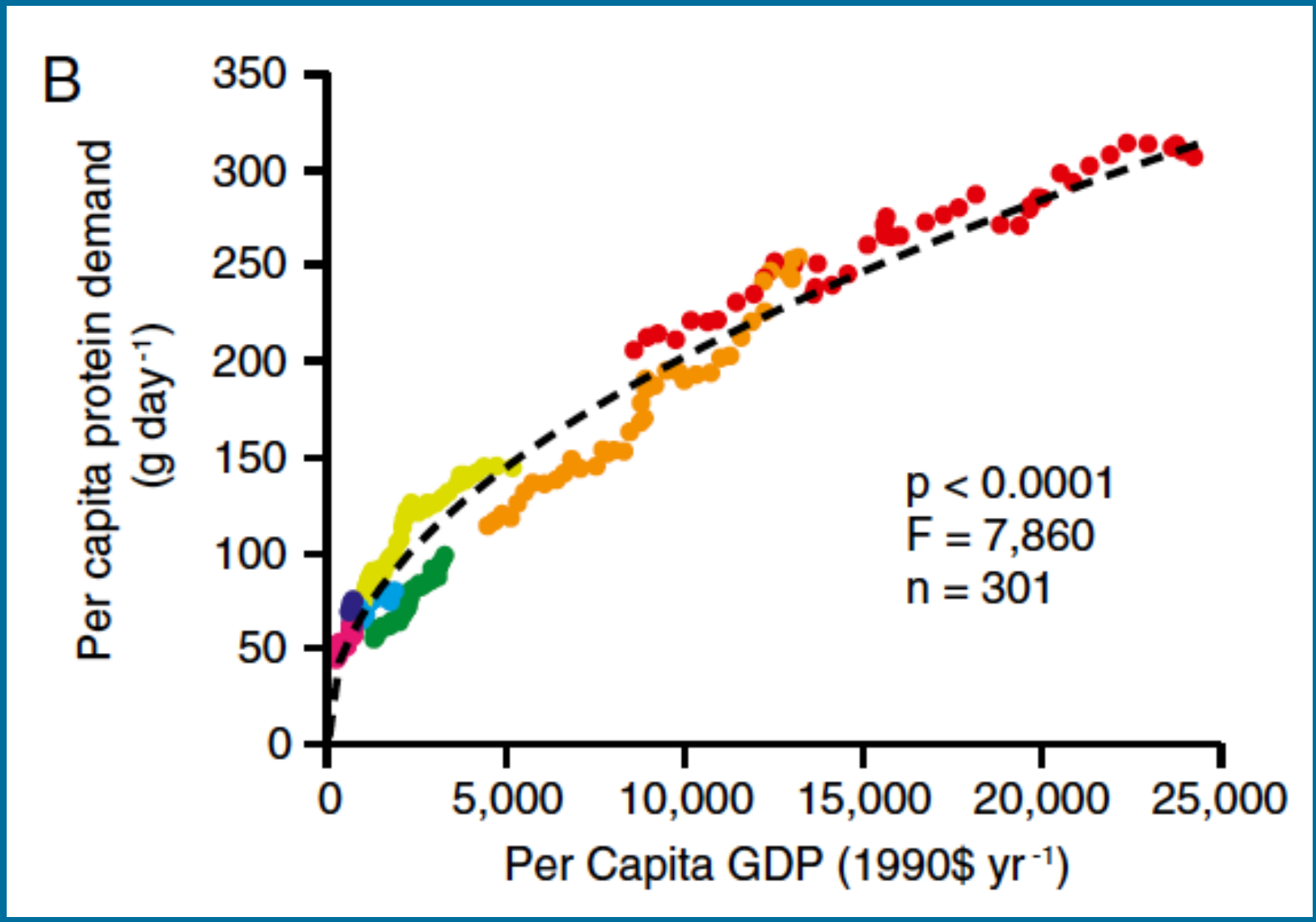
http://www.economist.com/blogs/graphicdetail/2015/08/daily-chart-growth-areas

Increasing food demand with rising GDP



Tilman et al., PNAS 2011

Increasing food demand with rising GDP



Tilman et al., PNAS 2011

A four-part problem: Part 3

Agriculture as currently practiced relies on unsustainable use of soil, water, fossil fuels and other resources.

A four-part problem: Part 3

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Agriculture's impacts

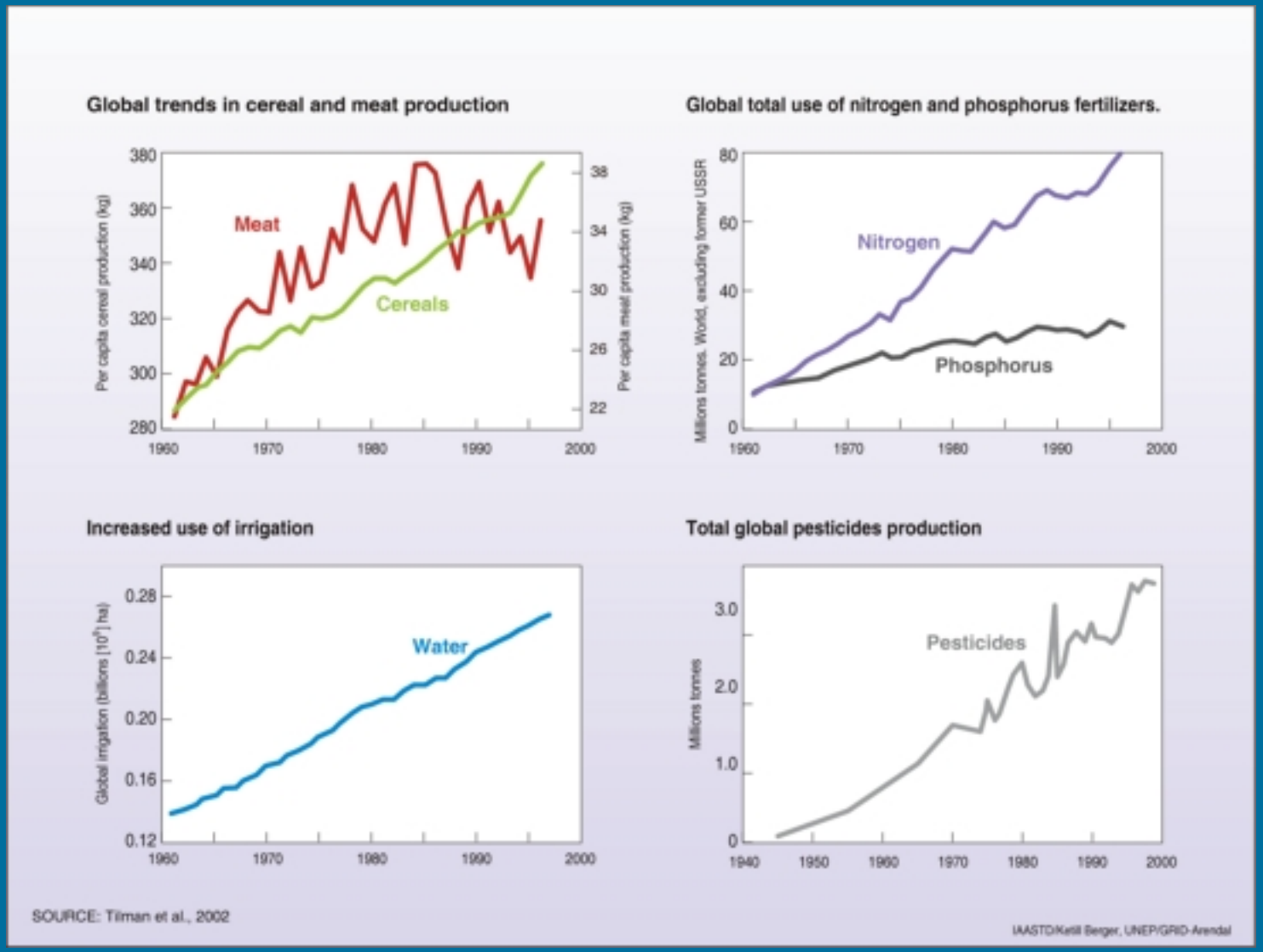
"Agricultural systems are...the single largest source of human-induced environmental change."

-J. Sachs, *The Age of Sustainable Development* (Columbia U Press, 2015)

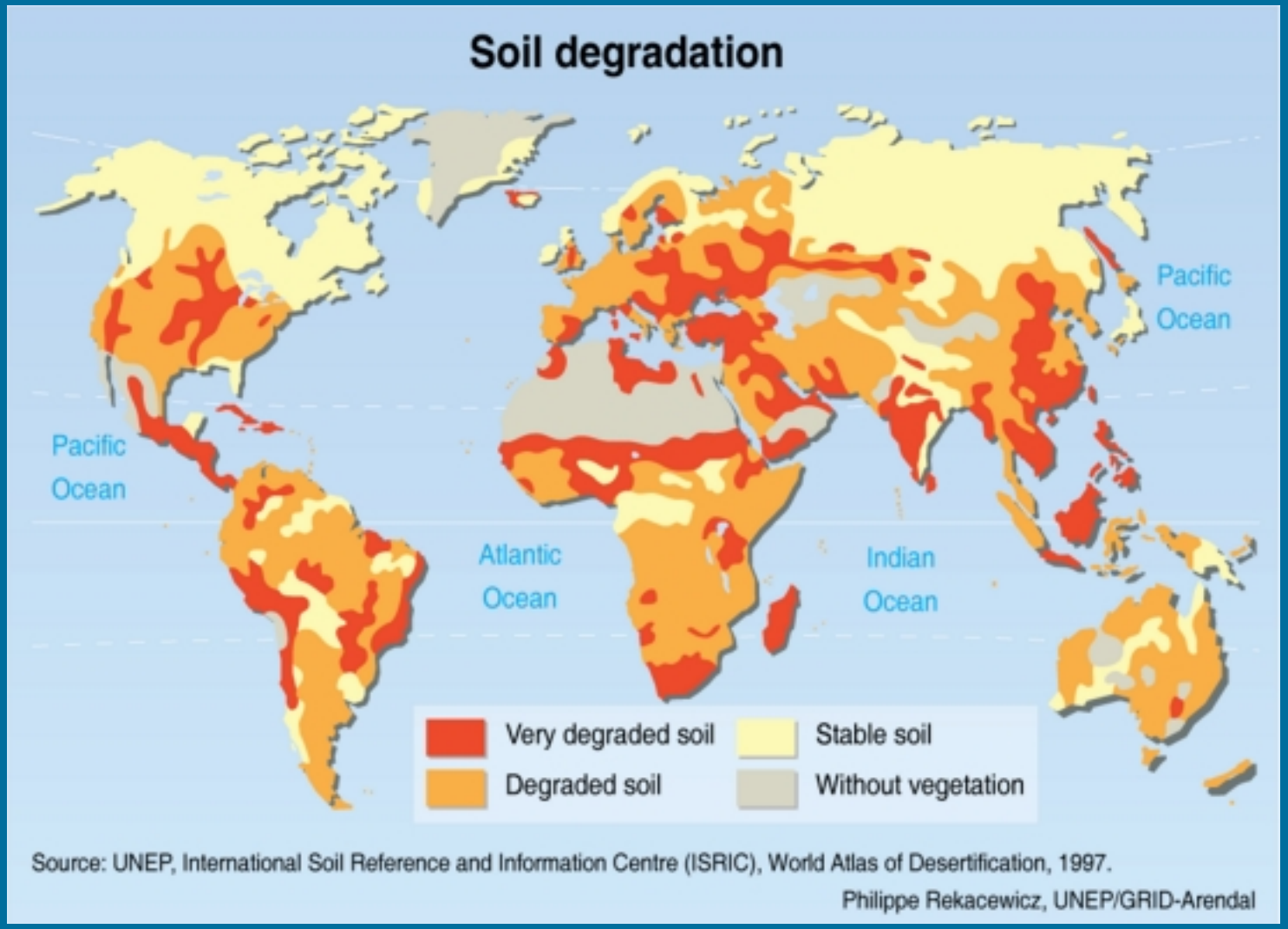
The anthropogenic footprint

~40% of all land not covered by ice is devoted to agriculture (UN FAO, 2013).

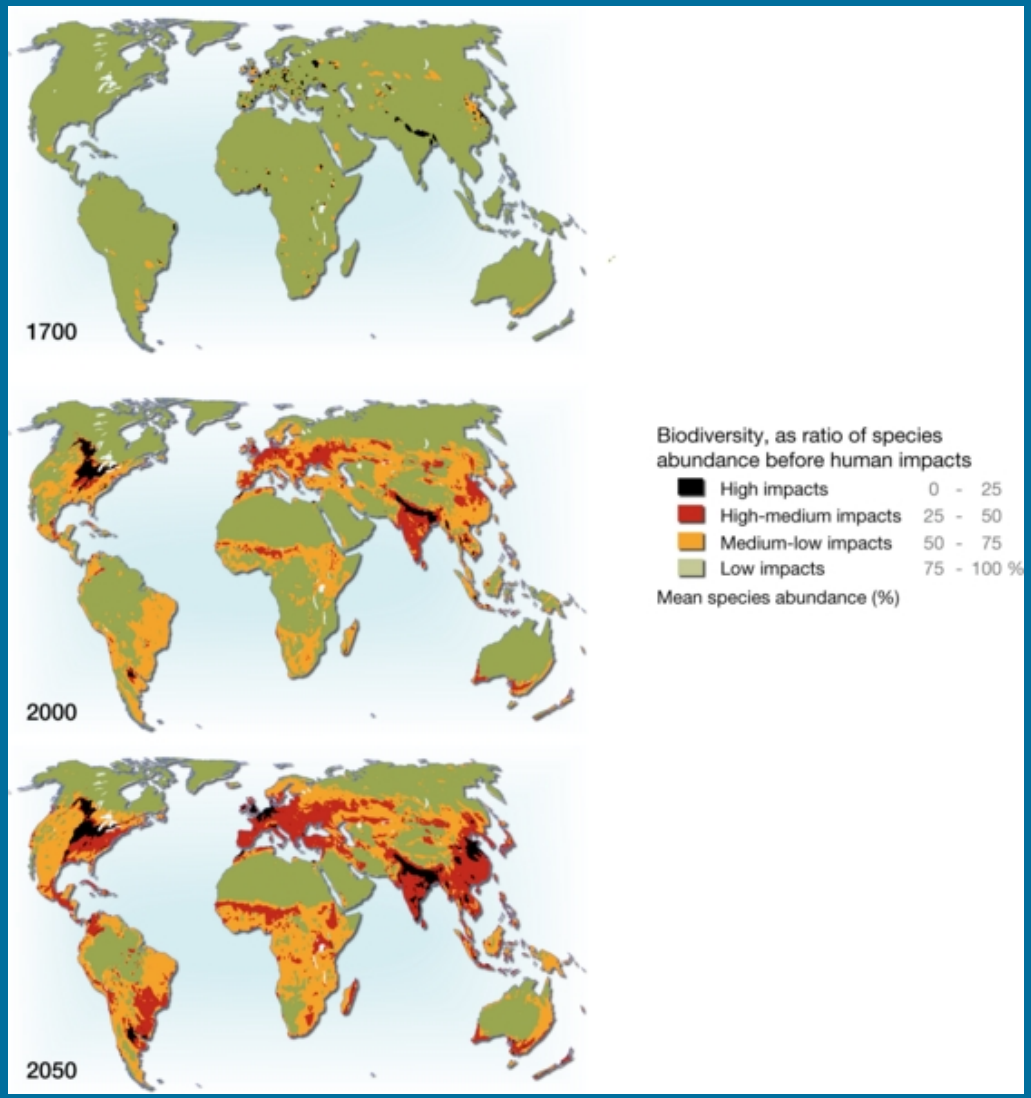
Reaching natural limits



Reaching natural limits



Reaching natural limits



The anthropogenic footprint

Suppose we put all humans on a scale,
then all domesticated animals,
then all wild terrestrial mammals.

Which would weigh the most?
What would be the relative proportions?

The anthropogenic footprint

Smil, V. *Harvesting the Biosphere*. Cambridge, MA: MIT Press, 2012.

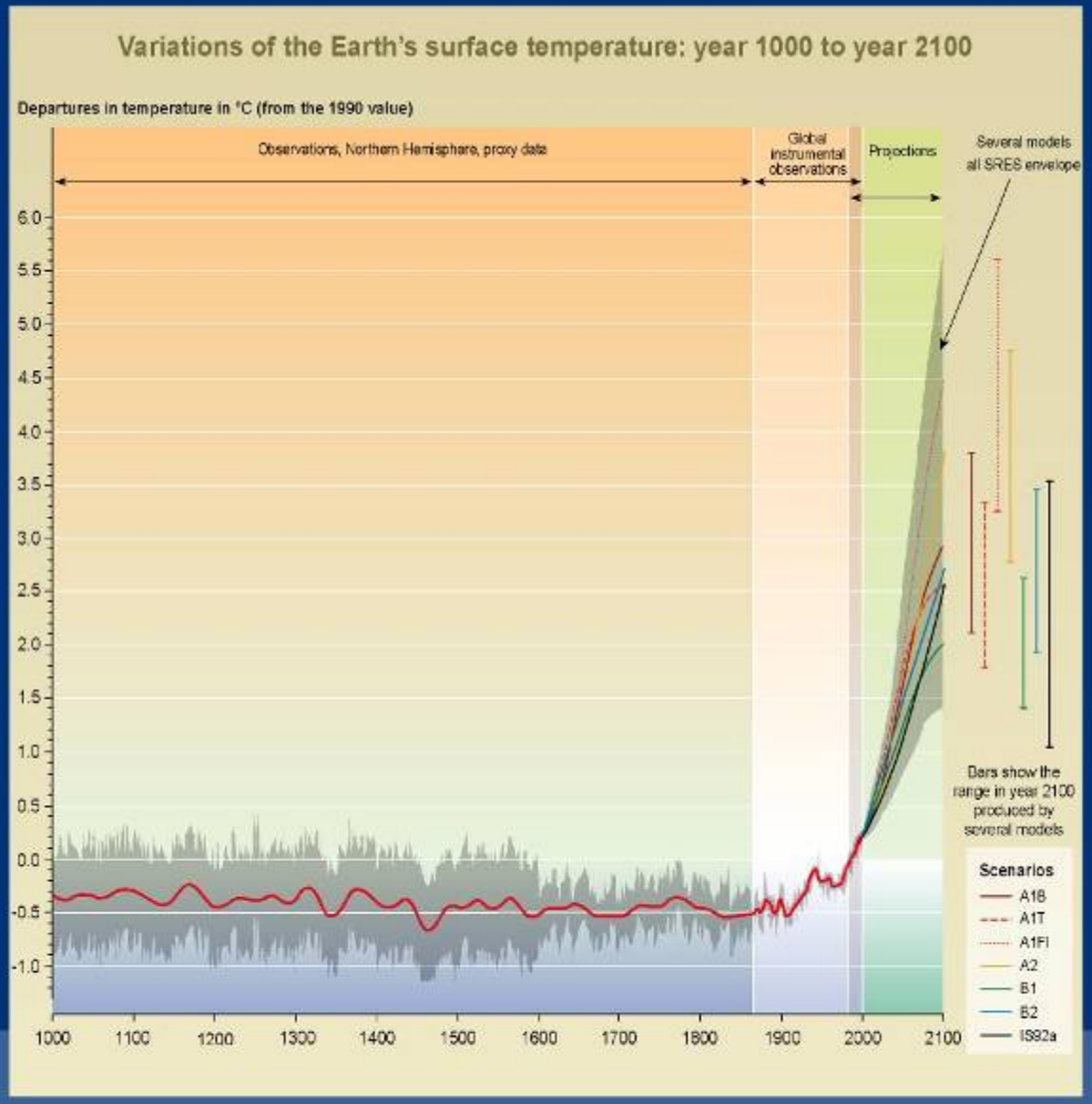
A four-part problem: Part 4

Climate change is projected to have negative impacts on food production, with particularly large impacts in areas with current food deficits.

Impacts of climate change on agriculture

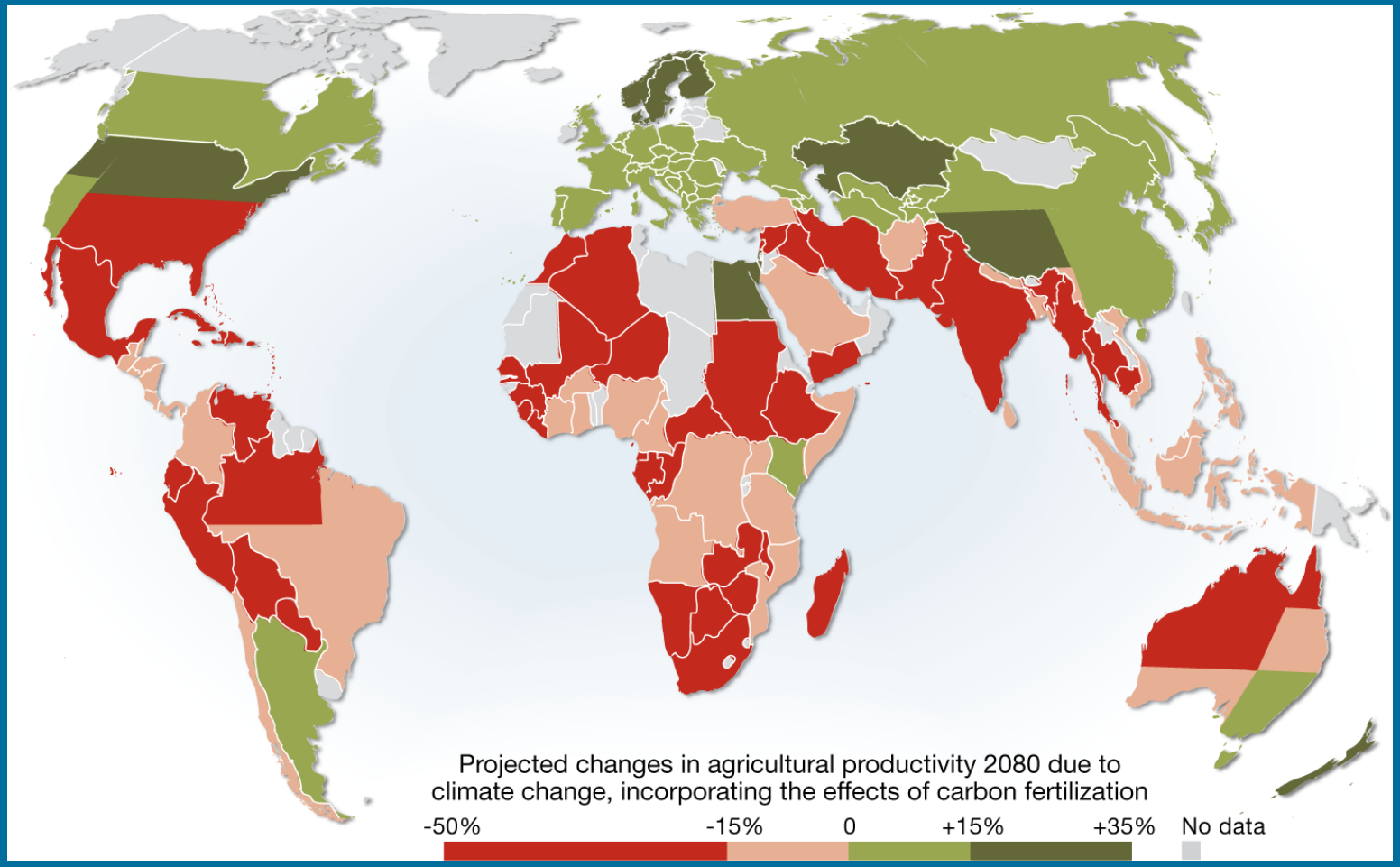
"Farm systems, more than any other human activity, are dependent on the climate and environment we know and have had for centuries."

-J. Sachs, *The Age of Sustainable Development* (Columbia U Press, 2015)



SYR - FIGURE 9-1b

Projected impact of climate change on agriculture



Cline, W. R. 2007. Global Warming and Agriculture: Impact Estimates by Country. Washington D.C., USA: Peterson Institute.

Class Structure

After a set of introductory exercises, we will brainstorm possible team roles and allow you to "self-organize"

- Each of you will be assigned to a team, and each team will be assigned at least one upperclass teaching fellow (UTF), a library liaison, and multiple alumni mentors
- Each team will be responsible for proposing to the class one or more options for its assigned part of the solution
- Teams will work independently and will be responsible for their own solutions, although mentors and volunteer faculty resources may be called upon as "sounding boards".

First Assignment (Due this Friday by 12 PM)

- Reading on Stellar site
- Answer questions in first assignment (also posted to Stellar)
- Hand in assignment via Stellar by Friday 9/11 at 12 PM

Meeting Places

- Class will meet in three different places, so consult the "Calendar" page before each class meeting to see where you will go
- THIS FRIDAY WE MEET in 3-270
- http://web.mit.edu/mission/www/m2019/
- https://stellar.mit.edu/S/course/12/fa15/12.000/index.html

New views of a planet we aren't changing