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

American Public Health Association
For science. For action. For health.

Climate for Health
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
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 HUMAN POPULATION IS HEALTHIER THAN EVER BEFORE

BUT TO ACHIEVE THIS WE’VE EXPLOITED THE PLANET AT AN UNPRECEDEDENTED RATE

THE ECOLOGICAL PARADOX
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.
The Gordian Knot of Food Security

Transition to Western diets
Rising temperatures and variability
Water Scarcity
Arable land loss
Air pollution (ozone)
Loss of Pollinators
Changes in Nutrient content
Changes in pests and pathogens
More frequent and intense natural disasters
Changes in solar radiation?
Changes in soil microbes?

Population and Economic Growth
Biofuels
Surprises?

Fisheries Declines
Wildlife Declines
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).)
### Table 1: Characteristics of agricultural experiments

<table>
<thead>
<tr>
<th>Crops</th>
<th>Country</th>
<th>Treatments used</th>
<th>Years grown</th>
<th># of Replicates*</th>
<th># of Cultivars</th>
<th>CO₂ ambient/elev (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>Australia</td>
<td>2 water levels, 2 N treatments, 2 Sowing times, 1 Water level, 1 N treatment, 2 Sowing times</td>
<td>2007-10</td>
<td>4</td>
<td>8</td>
<td>382/546-550</td>
</tr>
<tr>
<td></td>
<td>Australia</td>
<td></td>
<td>2007-9</td>
<td>4</td>
<td>1</td>
<td>382/546-550</td>
</tr>
<tr>
<td>Field Peas</td>
<td>Australia</td>
<td>2 water levels</td>
<td>2010</td>
<td>4</td>
<td>4</td>
<td>382/546-550</td>
</tr>
<tr>
<td>Rice</td>
<td>Japan</td>
<td>1 N treatment, 2 warming treatments</td>
<td>2007-8</td>
<td>3</td>
<td>3</td>
<td>376-379/570-576</td>
</tr>
<tr>
<td></td>
<td>Japan</td>
<td>3 N treatments, 2 warming treatments</td>
<td>2010</td>
<td>4</td>
<td>18</td>
<td>386/584</td>
</tr>
<tr>
<td>Maize</td>
<td>U.S.</td>
<td>2 N treatments</td>
<td>2008</td>
<td>4</td>
<td>2</td>
<td>385/550</td>
</tr>
<tr>
<td>Soybeans</td>
<td>U.S.</td>
<td>1 treatment</td>
<td>2001, 02, 04, 2006-08</td>
<td>4</td>
<td>7</td>
<td>372-385/550</td>
</tr>
<tr>
<td>Sorghum</td>
<td>U.S.</td>
<td>2 water levels,</td>
<td>1998-99</td>
<td>4</td>
<td>1</td>
<td>363-373/556-579</td>
</tr>
</tbody>
</table>

* "# 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
Increasing CO₂ threatens human nutrition

Samuel S. Myers¹,², Antonella Zanobetti¹, Itai Kloog³, Peter Huybers⁴, Andrew D. B. Leakey⁵, Arnold J. Bloom⁶, Eli Carlisle⁶, Lee H. Dietterich⁷, Glenn Fitzgerald⁸, Toshihiro Hasegawa⁹, N. Michele Holbrook¹⁰, Randall L. Nelson¹¹, Michael J. Ottman¹², Victor Raboy¹³, Hidemitsu Sakai⁹, Karla A. Sartor¹⁴, Joel Schwartz¹, Saman Seneweera¹⁵, Michael Tausz¹⁶ & Yasuhiro Usui⁹

---

![Graph showing the impact of increasing CO₂ on the nutritional content of different crops.](image-url)
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 $C_3$ crops and will be placed at significant risk
- Baseline of 2 billion deficient 63 million LY lost
Rising CO2 likely to place between 150-200 million people at new risk of zinc deficiency while exacerbating existing deficiency in over 1 billion

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 4\textsuperscript{th}, 12\textsuperscript{th}, and 17\textsuperscript{th} 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

![Map showing additional health burden from pollinator removal](image-url)
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.
Climate Change and Global Fisheries
THANK YOU!

Biology
Land Use

Ocean Science/Program Mgt

Planetary Health

Science Policy

Atmospheric Chemistry

Climate Modeling

Veterinary Medicine

Agronomy-Rice

Marine Biology

Biogeo-science

Parasitology

Agronomy Maize/Soy

Envtl Science/Program Cdtr

Epidemiology

Marine Science

Nutritional Epidemiology

Earth Sciences

Ecology Modeling

Nutritional Epidemiology

Climate Science

Climate & Fisheries

Statistics

Plant physiology Health