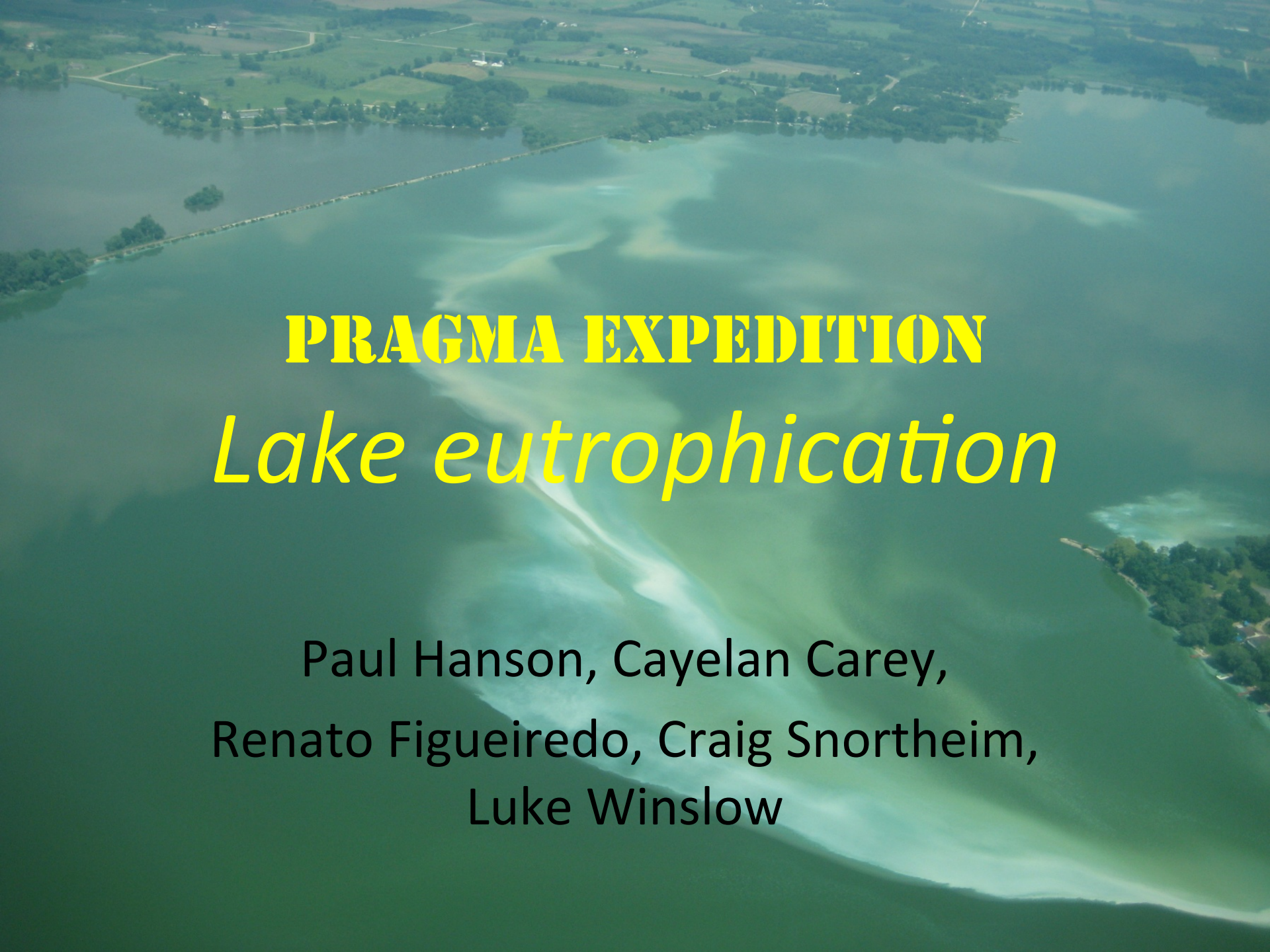
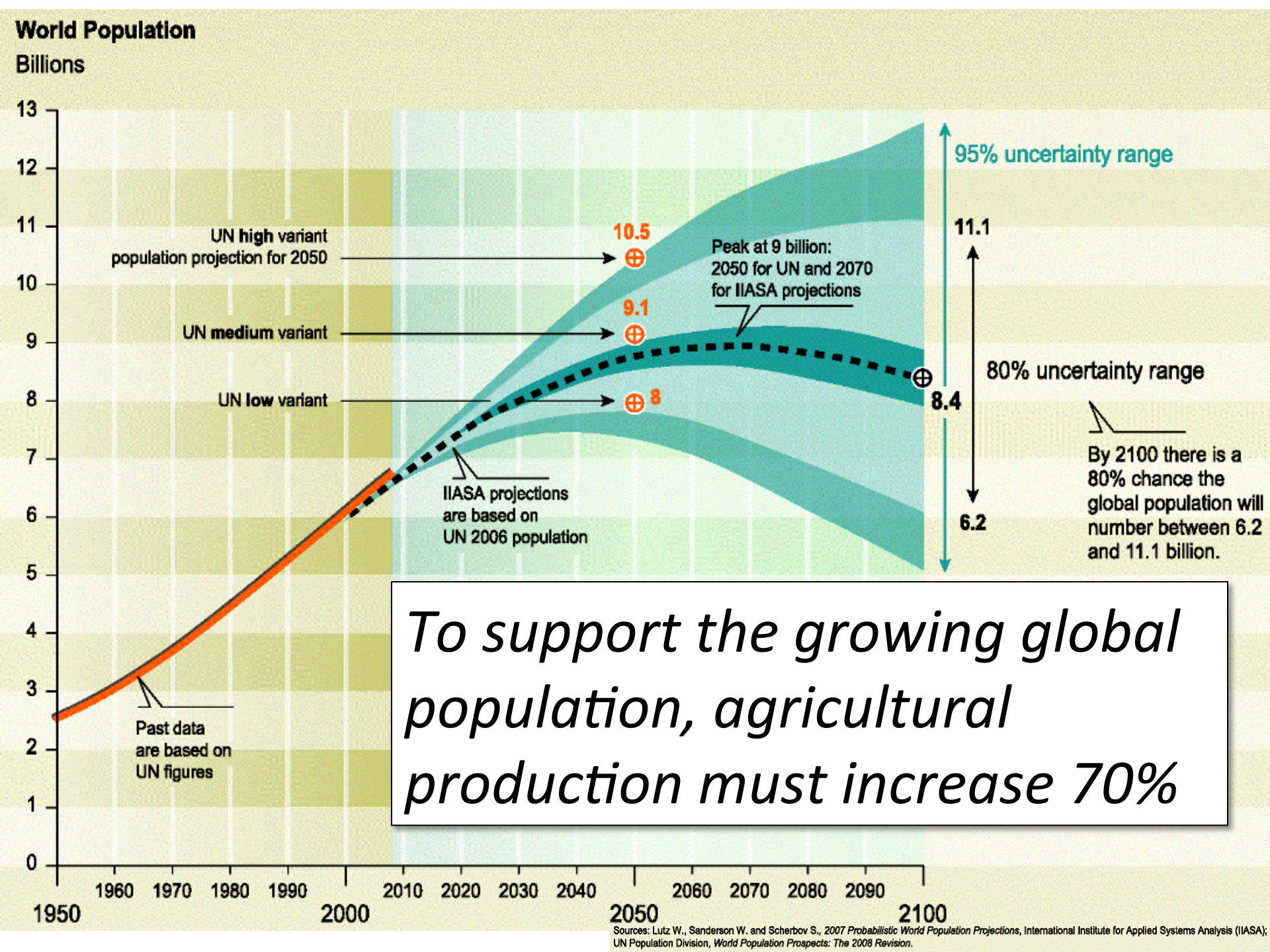


PRAGMA EXPEDITION

Lake eutrophication

Paul Hanson, Cayelan Carey,

Renato Figueiredo, Craig Snortheim,
Luke Winslow


World Population
Billions
13
12
11
10
9
8
7
6
5
4
3
2
1
0
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
UN high variant
population projection for 2050
10.5
UN medium variant
9.1
UN low variant
8
Peak at 9 billion:
2050 for UN and 2070
for IIASA projections
95% uncertainty range
11.1
8.4
6.2
80% uncertainty range
By 2100 there is a
80% chance the
global population will
number between 6.2
and 11.1 billion.
IIASA projections
are based on
UN 2006 population
Past data
are based on
UN figures
To support the growing global population, agricultural production must increase 70%
Sources: Lutz W., Sanderson W. and Scherbov S., 2007 Probabilistic World Population Projections, International Institute for Applied Systems Analysis (IIASA);
UN Population Division, World Population Prospects: The 2008 Revision.

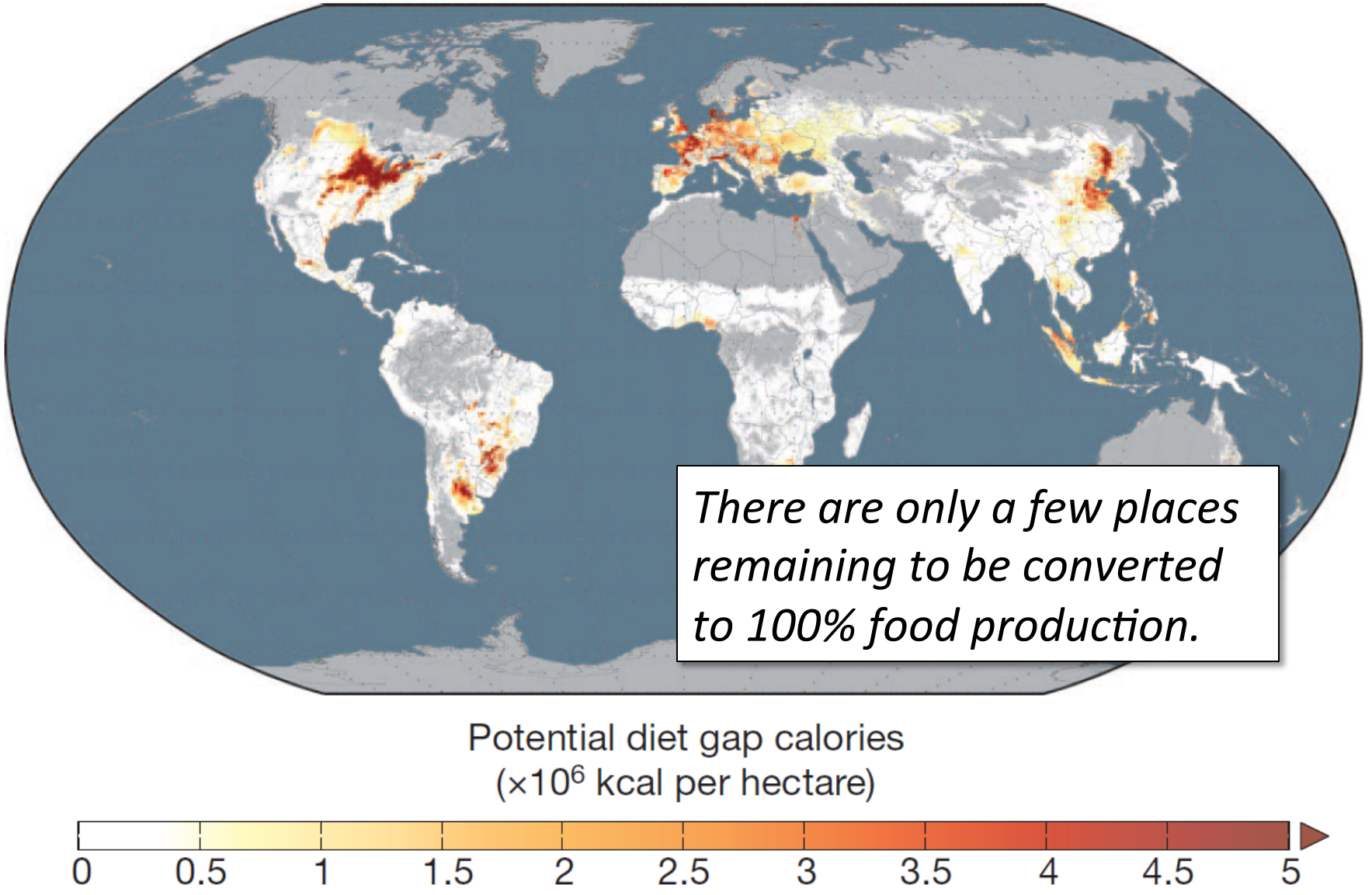


Figure 4 | Closing the diet gap. We estimate the potential to increase food supplies by closing the 'diet gap': shifting 16 major crops to 100% human food and away from the current mix of uses (see Fig. 1) could add over a billion tonnes to global food production (a 28% increase for those 16 crops), the equivalent of $\sim 3 \times 10^{15}$ kilocalories more food to the global diet (a 49% increase in food calories delivered).

Higher food production requires more water and more nutrients.

An unintended consequence is eutrophication (excess nutrients that degrade water quality).

Eutrophication leads to…

- Poor water clarity
- Loss of macrophytes
- Bad smell
- Toxic water conditions
- Dead fish
- Reduced ecological and economic value

Confronting even a narrow slice of this global issue requires:

- New data, rapidly becoming available
- New models for natural systems
- Expertise from multiple disciplines – natural sciences, computer science & technology

Expedition:

Discover the rules controlling phytoplankton community dynamics and water quality

Goals

- Create a collaborative human and technological infrastructure that supports distributed team
- Obtain new data from GLEON to confront models
- Calibrate a new hydrodynamic-water quality model, GLM-FABM-AED, to Lake Mendota, Wisconsin (USA).
- Investigate whether the model can reproduce the observed lake physical-biological features of interest
- Consider a different set of rules that govern biological communities in lakes
- Expand research to additional lakes and broader research community

Accomplishments

- Data for L. Mendota have been obtained
- Lake model has been partially calibrated
  - Default parameters transferred from literature
  - Physics calibrated
  - Water quality calibration begun
- HTCondor implementation
  - "R" code wrapper written for the model
  - Works for physics, now need the water quality
- Overlay network (Florida, Virginia Tech. Wisconsin) installed and in use
- Expansion to other sites, Australia and New Zealand, has commenced
- Simulations for science
  - Just beginning!!

Exciting outcomes are being realized:

1. Demonstration of harmonized distributed resources – people, data, technologies
2. Working phytoplankton emergence model
3. Management of thousands of scenarios
4. Visualizations of complex predictions and observations
5. Students trained in the science and cyber-infrastructure
6. Engaged GLEON++ community
7. Contributions to water quality and eutrophication knowledge (papers!)