

# Climate change and the adequacy of food and timber in the 21st century

William E. Easterling\*

Department of Geography and the Earth and Environmental Systems Institute, Pennsylvania State University, University Park, PA 16802

Edited by Susan Hanson, Clark University, Worcester, MA, and approved November 7, 2007 (received for review October 31, 2007)

One of the great challenges of the 21st century will be to increase the global food and timber supply to accommodate a world growing to 10 billion or more people while undergoing climate change. Success in meeting this challenge will require a steady stream of technical and institutional innovations to increase food and timber production while simultaneously adapting to changing climatic conditions.

Every five years since 1990, under the auspices of the United Nations, the Intergovernmental Panel on Climate Change (IPCC) assembles teams of highly respected researchers from an international pool of scientists to undertake a comprehensive assessment of the state of knowledge of climate change science, the potential impacts of and adaptation to climate change, and policy options for mitigating climate change. The assessment distills fundamental new insights about climate change and its effects on natural and human systems. Each assessment produces massive amounts of information that must be condensed into a single three-volume report. The condensation forces the omission of important information. In this special feature on “Climate Change and Food Security,” the lead authors of the chapter on Food and Forestry in the

recently released Fourth Assessment Report of the IPCC (1) amplify the findings of the assessment beyond what space limitations allowed in the Report. This permits the special feature to report new scientific synthesis on the consequences of climate change accompanied by rising atmospheric carbon dioxide concentrations ( $[CO_2]$ ) for food and forestry production.

This special feature begins with an assessment of the effects of climate change on the major food and forage crops of the world (2), with emphasis on plant response to elevated  $[CO_2]$ , interactions between climate change variables and air pollutants, impacts of increased climate variability and frequency of extreme events, the role of weeds and pests, disease and animal health, issues in biodiversity, and vulnerability of soil carbon pools. For the first time, the consequences of climate change for highly vulnerable small-holder farmers and fishers are considered (3). As the global consumption of fish protein continues to rise, pressures on the world's fisheries are amplified by climate change (4). Local extinctions of certain commercially important fish species are expected with high confidence. The global demand for forest products is expected to increase modestly over the next several decades (5). Forestry

production increases needed to meet this demand are likely to shift from low-latitude regions in the short term to high-latitude regions in the long term as the climate changes.

Because of the unrealized response of the climate system to historical greenhouse gas emissions, the planet is committed to at least as much warming over the 21st century as it has experienced over the 20th century ( $\approx 0.75^\circ C$ ) regardless of possible future actions to reduce emissions. Failure to slow the increase in atmospheric greenhouse gas concentrations only increases the warming. Adaptation to the anticipated warming is essential. Possible strategies for adapting food and forestry production to climate change are identified (6). Finally, the main drivers of global food security—food availability, stability, utilization, and access—are examined in the context of climate change (7). The joint effects of change in socioeconomic development and climate change on the numbers of people at risk of hunger over the 21st century are examined.

Author contributions: W.E.E. wrote the paper.

The author declares no conflict of interest.

\*E-mail: billeasterling@psu.edu.

© 2007 by The National Academy of Sciences of the USA

1. IPCC (2007) *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, eds Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (Cambridge Univ Press, Cambridge, UK).
2. Tubiello FN, Soussana J-F, Howden SM, Easterling W (2007) *Proc Natl Acad Sci USA* 104:19686–19690.
3. Morton JF (2007) *Proc Natl Acad Sci USA* 104:19680–19685.
4. Brander KM (2007) *Proc Natl Acad Sci USA* 104:19709–19714.
5. Kirilenko AP, Sedjo RA (2007) *Proc Natl Acad Sci USA* 104:19697–19702.
6. Howden SM, Soussana J-F, Tubiello FN, Chhetri N, Dunlop M, Meinke H (2007) *Proc Natl Acad Sci USA* 104:19691–19696.
7. Schmidhuber J, Tubiello FN (2007) *Proc Natl Acad Sci USA* 104:19703–19708.