New study refutes claims of drought-driven declines in plant productivity, global food security

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A new, comprehensive study by an international team of scientists, including scientists at Boston University in the US and the Universities of Viçosa and Campinas in Brazil, has been published in the current issue of *Science* (August 26, 2011) refuting earlier alarmist claims that drought has induced a decline in global plant productivity during the past decade and posed a threat to global food security.

Those earlier findings published by Zhao and Running in the August 2010 issue of *Science* (Vol. 329, p. 940) also warned of potentially serious consequences for biofuel production and the global carbon cycle. The two new technical comments in *Science* contest these claims on the basis of new evidence from NASA satellite data, which indicates that Zhao and Running's findings resulted from several modeling errors, use of corrupted satellite data and statistically insignificant trends.

The main premise of Zhao and Running's model-based study was an expectation of increased global plant productivity during the 2000s based on previously observed increases during the 1980s and 1990s under supposedly similar, favorable climatic conditions. Instead, Zhao and Running were surprised to see a decline, which they attributed it to large-scale droughts in the Southern Hemisphere.

"Their model has been tuned to predict lower productivity even for very small increases in temperature. Not surprisingly, their results were

preordained," said Arindam Samanta, the study's lead author. (Samanta, now at Atmospheric and Environmental Research Inc., Lexington, MA, worked on the study as a graduate student at Boston University's Department of Geography and Environment.)

Zhao and Running's predictions of trends and year-to-year variability were largely based on simulated changes in the productivity of tropical forests, especially the Amazonian rainforests. However, according to the new study, their model failed miserably when tested against comparable ground measurements collected in these forests.

"The large (28%) disagreement between the model's predictions and ground truth imbues very little confidence in Zhao and Running's results," said Marcos Costa, coauthor, Professor of Agricultural Engineering at the Federal University of Viçosa and Coordinator of Global Change Research at the Ministry of Science and Technology, Brazil.

This new study also found that the model actually predicted increased productivity during droughts, compared to field measurements, and decreased productivity in non-drought years 2006 and 2007 in the Amazon, in contradiction to the main finding of the previous report. "Such erratic behavior is typical of their poorly formulated model, which lacks explicit soil moisture dynamics," said Edson Nunes, coauthor and researcher at the Federal University of Viçosa, Brazil.

The new study indicates that Zhao and Running used NASA's MODIS satellite data products, such as vegetation leaf area, without paying caution to data corruption by clouds and aerosols. "Analyzing the same satellite data products after carefully filtering out cloud and aerosol-corrupted data, we could not reproduce the patterns published by Zhao and Running. Moreover, none of their reported productivity trends are statistically significant," said Liang Xu, coauthor and graduate student at

Boston University.

In any case, the trends in plant productivity reported by Zhao and Running are miniscule—a 0.34% reduction in the Southern Hemisphere offset by a 0.24% gain in the Northern Hemisphere for a net decline of 0.1% over a ten-year period from 2000 to 2009. "This is the proverbial needle in a haystack," said Simone Vieira, coauthor and researcher at the State University of Campinas, Brazil. "There is no model accurate enough to predict such minute changes over such short time intervals, even at hemispheric scales."

Any investigation of trends in plant growth requires not only consistent and accurate climate and satellite data but also a model suitable for such purposes. "The Zhao and Running study does not even come close," said Ranga Myneni, senior author and Professor of Geography, Boston University. "Their analysis of satellite data is flawed because they included poor quality data and do not bother to test trends for statistically significance. Our analyses of four different higher-quality MODIS satellite vegetation products that have been carefully filtered for data corruption show no statistically significant trends over 85% of the global vegetated lands."

Provided by Boston University