Study Links Warming of Indian Ocean to Decreased Rainfall in Africa

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(PhysOrg.com) -- A study led by a team of geographers from the University of California, Santa Barbara, suggests that warming of the Indian Ocean — a direct result of climate change — is to blame for a steep decline in rainfall over the eastern seaboard of Africa, which has serious implications for the region's food security.

The interdisciplinary study revealed that over the past 20 years, rainfall in that part of Africa has declined by as much as 15 percent per year. The study also indicates that if the decline continues at its current rate, the population of undernourished individuals in the region could increase by more than 50 percent by 2030. The researchers's findings are published in the current issue of the *Proceedings of the National Academy of Sciences*.

"Our work suggests that greenhouse gas emissions, which have come mostly from the wealthy, developed countries, already constitute an example of dangerous climate change," said Chris Funk, an associate researcher with the UCSB geography department's Climate Hazards Group and the article's lead author. The Climate Hazards Group specializes in applying climatology to problems of food security. The group works closely with governmental institutions to improve the scientific research, capacity building, and application components of initiatives such as the Famine Early Warning System Network, which is funded by the United States Agency for International Development.

In addition to Funk, the research team included Joel Michaelsen, a

professor of geography at UCSB, and representatives from the United States Geological Survey (USGS); Scripps Institution of Oceanography; NASA; and the University of Massachusetts, Lowell. The four-year project was funded by the United States Agency for International Development's Famine Early Warning System Network, the USGS, NASA's Precipitation Monitoring Mission, and the National Science Foundation.

According to records from ground stations and satellites, rainfall during eastern and southern Africa's main rainy seasons — March through May and December through February, respectively — have shown steady declines since the 1980s. Analyzing historical data of seasonal rainfall over the Indian Ocean and Africa's eastern seaboard from 1950 to 2005, the team found decreasing rainfall in Ethiopia, Kenya, Tanzania, Zambia, Malawi, and Zimbabwe that was linked to increases in rainfall over the ocean.

Statistical analyses indicate that the increased rainfall over the Indian Ocean, caused by rising sea surface temperatures, produces anomalies in moisture transports between the ocean and land. This reduces main growing season rainfall in parts of Africa. Presumably, the energy released by this maritime convection reduced onshore flows of moisture and brought dry descending air down over the African continent.

Matthew Barlow, a professor of environmental, earth, and atmospheric science at the University of Massachusetts, validated this hypothesis using an atmospheric model from the National Center for Atmospheric Research. The combination of empirical and model-based evidence strongly suggests that increases in rainfall over the ocean tend to create atmospheric conditions that inhibit moisture from being transported onshore.

Next, guided by Michael Dettinger, a USGS scientist working in the

Climate Research Division of the Scripps Institution of Oceanography at UC San Diego, the team examined 11 climate models produced by the Intergovernmental Panel on Climate Change (IPCC) to simulate future rainfall changes. Of the 11 models, 10 indicated that through 2050, precipitation over the Indian Ocean would continue to increase and thereby deprive the eastern seaboard of Africa much needed rainfall.

"The models agree that anthropogenic warming has occurred over the past 50 years and will occur over the next 50 years," said Funk. "We show that this warming has caused and likely will cause main-growing-season drought in the world's most food insecure countries."

However, according to Funk, the team's food-balance modeling, which uses historical data related to population, rainfall, seed, fertilizer, and cultivated area, showed that "modest" increases in agricultural capacity could result in a 40 percent reduction of undernourished people.

"Many of the farming techniques used now are inadequate, and there has been very little support for agricultural development," Funk said. "There's very little use of fertilizer or farm machinery. That means there's a strong potential to increase farm production. Modest improvements in per capita agricultural capacity could substantially alleviate undernourishment, making Africa agriculturally self-supporting in 30 years. Even with declining rainfall, Africa can be self-sufficient."

Provided by University of California, Santa Barbara