

A catalog of change



“Our task was to see if the temperature changes we’ve been seeing are affecting the natural world.”

Cynthia Rosenzweig
NASA Goddard Institute
for Space Studies

by Katherine Leitzell

Lake Tanganyika, the second-deepest lake in the world, is dying. Since the late 1970s, fish catches in the East African lake have declined by a third or more, and scientists say that the problem is a direct result of climate change. Catherine O’Reilly, an aquatic ecologist at Bard College

who studies the lake, said, “As Lake Tanganyika warms up, the water density changes and it doesn’t mix as easily. That means fewer nutrients are moving up to the surface of the lake, so there is less food available to the entire food web.”

Lake Tanganyika is not the only place where climate change has manifested its effects. All over



Piles of sardines await buyers in a market near Lake Tanganyika. Thousands of people in East Africa depend on fish from the lake for protein. However, fish catches in Lake Tanganyika are declining because of the effects of global climate change on the lake. (Courtesy C. O’Reilly)

the world, researchers have documented changes in physical and biological systems that they attribute to rising temperatures. In the Rocky Mountains of North America, marmots emerge from hibernation more than a month before they used to. Worldwide, birds have changed their migration patterns, reaching their summer destinations in Europe and North America earlier in the spring. Plants in Canada, the United States, and Europe are flowering sooner. Meanwhile, shrinking Arctic sea ice, thawing permafrost in Canada and Siberia, and retreating glaciers around the world show the impact of climate change on the physical world.

Researchers are now working to catalog and understand those changes. In 2007, a group of scientists, led by NASA scientist Cynthia Rosenzweig, compiled information on climate change effects into a comprehensive database of more than 600 studies on organisms and physical systems around the world. Scientists hope that this information will help define how climate change is affecting the planet, and how the natural world and the people who depend on it might respond to increased warming in the future.

Compiling the impacts

The Observed Climate Change Impacts Database started as an effort by scientists involved with the 2007 Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report. Rosenzweig was the Coordinating Lead Author for the first chapter, focusing on detecting observed impacts of climate change. She said, “Our task was to see if the temperature changes we’ve been seeing are affecting the natural world.” Rosenzweig and her colleagues compiled the database from hundreds of

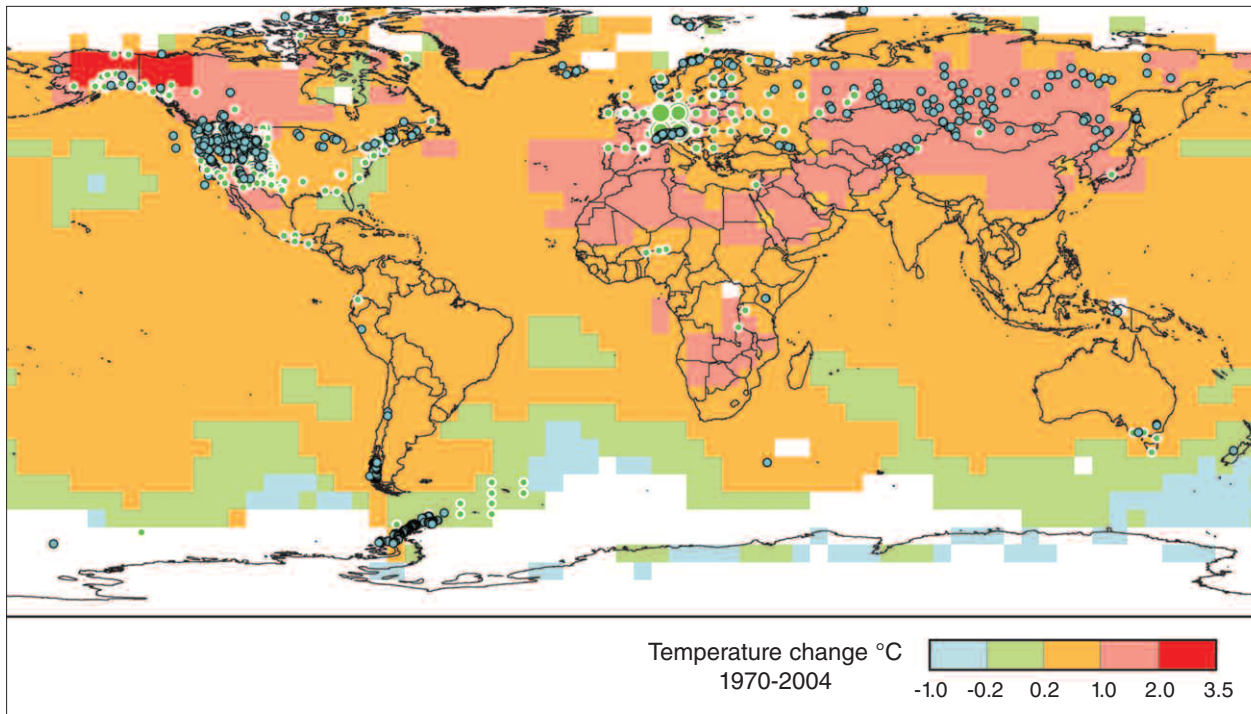


Yellow-bellied marmots in Colorado's Rocky Mountains now emerge from hibernation about a month earlier than they used to. The change is just one of the impacts identified in the IPCC Observed Climate Change Impacts Database. (Courtesy A. Schaefer)

scientific studies connected to climate change, such as those of Lake Tanganyika, analyzing each study to determine whether the observed effect was actually caused by global warming.

The database serves as a starting point for research into current and future impacts of climate change. The data are freely available to the public through the IPCC Data Distribution Center, a joint service of the NASA

Socioeconomic Data and Applications Center (SEDAC), the British Atmospheric Data Centre, and Germany's High Performance Computing Centre for Climate and Earth System Research (Deutsches Klimarechenzentrum). “The data can be used in many ways,” Rosenzweig said. International agencies can use the database to explore the global impacts of climate change. Government leaders can learn how climate change is affecting their country



The Observed Climate Change Impacts Database catalogs climate-related impacts ranging from changes in bird migration patterns to receding glaciers. On the map above, blue circles represent documented changes in physical systems, and green circles show changes in biological systems. Blocks of color show regional temperature change from 1970 to 2004; blue indicates cooling of up to 1 degree Celsius (2 degrees Fahrenheit), green denotes regions with less than 0.2 degrees Celsius (0.4 degrees Fahrenheit) change, and yellow and red indicate warming up to 3.5 degrees Celsius (6.3 degrees Fahrenheit). (Courtesy IPCC)

or region. And scientists can use the data to understand how climate change is affecting the planet both now and in the future.

“People often want to know what changes are happening where they live,” Rosenzweig said. “With our database, you can explore the physical and biological changes that have occurred and whether they are responding in the direction of temperature changes. Researchers can also see where there are data gaps, and we hope that this will encourage future work in the lower latitudes and developing countries, where more studies are urgently needed.”

Is it really climate change?

In building the Observed Climate Change Impacts Database, IPCC scientists first had to determine whether each specific change was caused by global warming, or whether there was another explanation. Other factors, such as changes in land use, increased pollution, invasive species, and the urban heat island effect—warmth generated in cities and suburbs—can also lead to changes consistent with climate change.

To demonstrate a significant link to climate change, a study must not only show that warmer temperatures could account for the change, but

also that no other explanation was sufficient. Cynthia Rosenzweig and her team examined each study in the database to assess how likely it was that a specific impact, such as a change in animal behavior or a shrinking glacier in the Swiss Alps, was related to climate change. The IPCC scientists asked whether the study authors had ruled out other explanations for the changes, and whether or not they were in the direction expected with warming. They then related the changes to gridded temperature trends from a global temperature data set.

After careful examination of each study in the database, Rosenzweig and her group were surprised to find how many impacts were closely linked to climate change. Rosenzweig said, “By far, out of the hundreds of cases, only a handful of the impacts might actually be caused by something else.”

Warming hits home

By themselves, scattered changes in bird migrations or water temperature may not seem alarming. “What the database shows is that ecosystems are responding to climate change. In essence they’re doing what they’re supposed to be doing; they are re-acclimating. Whether that’s good or bad is a human judgment, and it has to do with the values that we place on our natural world,” Rosenzweig said. “However, we have seen widespread changes with just the 0.7 degrees Celsius [1.3 degrees Fahrenheit] of warming, and this is just a fraction of what is expected. Eventually, the rate of change will outstrip the species’ phenotypic and genetic adaptive capacity, and then some serious problems might arise.” Also, since humans rely on the natural world for food, water, and resources, changing ecosystems can cause serious problems for human health and economies.

Rosenzweig and O'Reilly point out that the impact of climate change may prove to be especially damaging in the regions with the scarcest data—primarily tropical and subtropical areas in Latin America, Africa, and Asia, where fewer scientists have studied the effects of climate change. O'Reilly said, “Some of the ecosystems humans depend on most heavily are the ones that we have the fewest and shortest data sets for.” In the region surrounding Lake Tanganyika, for example, the combination of decreasing fish catches and increasing human population means that hunger and malnutrition may not be far behind. O'Reilly said, “In Africa, around this lake, it’s going to lead to a huge problem which hasn’t really been realized or planned for.”

Researchers and policy makers all over the world are now working to understand how climate change will affect people where they live. How will climate change impact water supplies for growing populations? How will cities respond to sea level rise? How will farmers deal with environmental changes that affect their crops? The United States Global Climate Change Research Program recently reported on observed and potential regional impacts of climate change within the United States. The report emphasized that many changes have already occurred, and that climate change will have some impacts, whether or not people reduce carbon emissions in the future. O'Reilly said, “We’re at the point right now in human society where we need to be thinking about adaptation to climate change.”

To access this article online, please visit
http://nasadaacs.eos.nasa.gov/articles/2009/2009_climate.html.



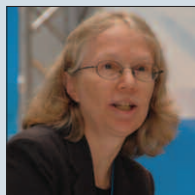
About the data used

Data set	IPCC Fourth Assessment Report (AR4) Observed Climate Change Impacts Database
Parameter	Physical and biological impacts of climate change
Data center	NASA Socioeconomic Data and Applications Center

About the scientists



Catherine O'Reilly is an assistant professor of biology at Bard College in Hudson, New York. She studies aquatic ecology, particularly in tropical systems, climate change, and biogeochemical cycles. The National Science Foundation and the United Nations Development Programme Lake Tanganyika Biodiversity Project provided funding for her work on Lake Tanganyika. (Photograph courtesy Bard College)



Cynthia Rosenzweig is an agricultural scientist at the NASA Goddard Institute for Space Studies (GISS). Her research focuses on interdisciplinary methods for assessing the impacts of global environmental change. Rosenzweig was the leader of the 2007 Intergovernmental Panel on Climate Change (IPCC) Working Group 4. NASA funded her research. (Photograph courtesy NASA)

References

- O'Reilly, et al. 2003. Climate change decreases aquatic ecosystem productivity of Lake Tanganyika, Africa. *Nature* 424: 766–768.
- Rosenzweig, C. 2008. Warming climate is changing life on global scale.
http://www.giss.nasa.gov/research/briefs/rosenzweig_02
- Parry, M., O. Canziani, J. Palutikof, P. van der Linden, and C. Hanson, eds. 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. Cambridge, UK: Cambridge University Press.
- Rosenzweig, C., et al. 2008. Attributing physical and biological impacts to anthropogenic climate change. *Nature* 453: 353–357.
- United States Global Climate Change Research Program. 2009. Global climate change in the United States.
<http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts>

For more information

- NASA Socioeconomic Data and Applications Center (SEDAC)
<http://sedac.ciesin.columbia.edu/index.html>
- IPCC Fourth Assessment Report (AR4) Observed Climate Change Impacts Database
<http://sedac.ciesin.columbia.edu/ddc/observed/index.html>
- Catherine O'Reilly
<http://www.bard.edu/academics/faculty/faculty.php?action=details&cid=1554>
- Cynthia Rosenzweig
<http://www.giss.nasa.gov/staff/crosenzweig.html>
- United States Global Change Research Program
<http://www.globalchange.gov/about>