Central America tropical rainfall patterns varied through time

February 4 2013

Historic lake sediment dug up by University of Pittsburgh researchers reveals that oceanic influences on rainfall in Central America have varied over the last 2,000 years, highlighting the fluctuating influence the Atlantic and Pacific Oceans have on precipitation.

The Pitt study, published in the February print edition of the peer-reviewed journal *Geology*, shows that factors currently producing drier climates in Central America actually resulted in wetter conditions a few hundred years ago, providing a deeper understanding of drought cycles in that region of the Western Hemisphere.

The researchers analyzed lake sediment that had accumulated for 1,400 years in Lago El Gancho in Nicaragua to reconstruct climate patterns in the Central American country during the Medieval Climate Anomaly—a warm period roughly spanning the years 950 to 1250—and a 500-year, global cold spell known as the Little Ice Age that began around 1350.

Because of the extreme disparity in climatic conditions they represent, these two time periods contain clues for scientists looking to better understand climate change, said lead study author Nathan Stansell, who conducted the research as a graduate student in Pitt's Sedimentology and Sediment Geochemistry Labs led by Mark Abbott, Pitt associate professor of geology. Stansell earned his master's and PhD degrees in geology and planetary science from Pitt's Kenneth P. Dietrich School of Arts and Sciences in 2005 and 2009, respectively.

"We have a decent understanding of how those systems affect today's Central American climate, but we wanted to know if those systems operated in similar ways in the past," said Stansell, now a research fellow at The Ohio State University. "We found that the long-term trends we inferred from the data are not entirely consistent with our modern-day observations."

Sandwiched between the Atlantic and Pacific oceans, Lago El Gancho, which is near the city of Granada, became the research team's choice for examining the variability and influence of the North Atlantic Oscillation—a phenomenon that is the dominant mode of climate variability in the North Atlantic region. The researchers also examined the El Niño/La Niña Southern Oscillation pattern—a quasi-periodic climate pattern occurring every three to seven years or so in the Pacific Ocean.

Using layered mud found in the sediment cores collected in 2004, the team reconstructed past climatic conditions using the radiocarbon ages of charcoal to date the layers. They examined the calcium-carbonate shells of the ostracod crustaceans, small organisms living in lakes, to measure the oxygen isotope ratios commonly studied to identify wet and dry climate cycles.

The sediments revealed a dramatic change in climatic conditions brought on by the North Atlantic Oscillation. In our modern age, when the North Atlantic is in its "positive" phase, atmospheric pressure anomalies prevent colder Arctic air from plunging south into the lower latitudes of North America, leading to drier conditions in Nicaragua, while negative phases lead to wetter climates.

However, the Pitt team found that during the positive-phase Medieval Climate Anomaly, wetter conditions prevailed alongside the North Atlantic and La Niña patterns. Then, 150 years later, the Little Ice Age

chilled the region off, holding a negative North Atlantic phase, and an abrupt shift toward persistently drier conditions occurred. The impact of the El Niño/La Niña Southern Oscillation pattern did not change between the two periods.

How or why did this happen? "There are any number of possible scenarios," Stansell says. "Most likely, the Northern Hemisphere temperatures affected the atmospheric pressure across the North Atlantic while in a positive phase. When the Oscillation became negative, it would have pushed precipitation to the south, leaving it drier in Nicaragua.

"The main idea here is that the ability of the Atlantic Ocean to exert its influence on precipitation patterns in Central America varied in the past," Stansell adds.

Climatic Future

Scientists are currently working towards a better understanding of how precipitation patterns will change under a range of different scenarios.

Modern-day observations show drier conditions during positive whirls. However, Stansell's geologic record of the Medieval Climate Anomaly and Little Ice Age shows the opposite. Therefore, he said, the use of a geologic record to determine current conditions needs to be considered carefully.

"What this tells us is that more studies like ours need to be done in order to better predict how the tropical hydrologic cycle will operate in the future," said Stansell. "Our specific work in the tropics is to better develop that longer-term perspective of how the North Atlantic pressure anomalies play a key role in this region's water-resource availability."

Stansell stresses the importance of combining geologic evidence with modeling scenarios to reconstruct patterns of the past to more accurately discern a climatic future.

"If we can't accurately reconstruct past conditions in our modeling scenarios, then we can't rely on those models to predict future changes," Stansell said.

More information: The paper, "Lacustrine stable isotope record of precipitation changes in Nicaragua during the Little Ice Age and Medieval Climate Anomaly," was published online by *Geology* on Nov. 13 in addition to being published in the journal's February 2013 print edition.

Provided by University of Pittsburgh