Boston Hurricane Frequency Over Last Millennium Linked To Ocean Surface Temperatures

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(PhysOrg.com) -- The frequency of hurricanes striking the Boston area has varied widely over the last millennium, with periods of lowest activity corresponding to cooler surface temperatures in the tropical North Atlantic Ocean, according to newly published research from the University of Massachusetts Amherst.

Sediments deposited in Lower Mystic Lake, which straddles Medford and Arlington, show that during some centuries Boston was struck by only two to three intense hurricanes. At other times, such as the 13th century, the area experienced the impact of up to eight extreme events.

“There is obviously concern about how hurricane activity might change in the future,” says post-doctoral researcher Mark Besonen of the UMass Amherst Climate System Research Center. “By studying how it has varied naturally in the past, we can better understand the underlying factors that affect hurricane development.”

Results were published online July 24 in *Geophysical Research Letters*. Additional researchers include Raymond Bradley, a UMass Amherst professor of geosciences, Manfred Mudelsee of Climate Risk Analysis in Hannover, Germany, Mark Abbott, a professor of geology at the University of Pittsburgh, and Pierre Francus, a research scientist at the Institut National de la Recherche Scientifique in Qu?bec, Canada.

According to Besonen, what is known about variations in hurricane activity is based on a very short record. Satellite observations used today began in the 1960s, and systematic aircraft reconnaissance of storms only started in the mid-1940s. The instrumental record goes back a bit farther, about 130 years, but historical records before that time are patchy. “Fortunately, we can turn to the geologic record to extend our understanding of hurricane activity further—looking back 1,000 years or more,” says Besonen.

The use of geologic records to create hurricane strike histories for a given area is a new field of research called paleotempestology that only started 15 years ago. Typically, scientists have focused on coastal ponds and marshes, looking for sand layers deposited by hurricane storm surges. However, Besonen focused his efforts further inland and used sediments in Lower Mystic Lake.

“Lower Mystic Lake offered a fantastic opportunity for a Boston area record because each year is represented by a discrete layer of sediment called a varve that accumulates at the bottom of the lake,” says Besonen. “You can count these varves like tree rings to go back in time.”

Within the Mystic Lake sediments, Besonen found occasional layers of coarse sediment that had washed into the lake during flooding events. By counting the varves, he was able to determine the year in which each of these sand layers was deposited. Using historical records as guidance, he ruled out spring freshets and Nor’easter storms as possible mechanisms for the flooding events, and recognized that the majority of these anomalies occurred in years when hurricanes were known to have struck the Boston area.

“A hurricane strike often causes vegetation disturbance and tree blow-down, which exposes lots of fresh, loose sediment,” says Besonen. “The intense precipitation associated with hurricanes picked up the sediment

and deposited it in the lake to form the graded beds containing coarser sediment that we see."

The Lower Mystic Lake hurricane record extends back to 1011 A.D., more than 600 years before the first European settlers arrived in the Boston area. The number of hurricanes striking the Boston area was lower in the 11th century and the 17th to 19th centuries, with higher activity noted in the 12th to 16th centuries. In general, periods of decreased activity corresponded to times when sea surface temperatures in the tropical North Atlantic were cooler, with increased activity corresponding to periods when sea surface temperatures are inferred to have been warmer.

Sea surface temperature is one of the parameters known to moderate hurricane activity today, but models of future change are uncertain. "Long-term records like those from Mystic Lake provide climate modelers with a way of testing if their understanding of changes in hurricane activity over time are correct," says Besonen. "If their models can reproduce the past record correctly, we have more confidence in their simulations of future changes."

However, Besonen cautions that a record from a single point, such as Mystic Lake, may not represent hurricane activity in the entire North Atlantic basin. "The scientific community is actively debating the importance of other factors, such as wind shear, that affect hurricane development on longer timescales," says Besonen. "We really need more records, like the one from Mystic Lake, from other areas to help answer these questions with confidence."

Provided by University of Massachusetts Amherst