

The Historic Fur Trade and Climate Change

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Why did the Dutch come to the North American shores 400 years ago? Was it wanderlust, expansionist policies, or simply money? The earliest western explorers were the Vikings who, in the 1100s, were able to sail beyond Iceland and Greenland to Newfoundland, because they did so during the Medieval Warm Period. English explorer Henry Hudson, on the other hand, could not find a northern passage to China because the early 1600s were the coldest part of the Little Ice Age and the northern seas were frozen over (Figure 1).

After Hudson's third voyage, Dutch merchants contracted several sailors to establish trading posts for beaver pelts in the Americas. Among them was Adriaen Block, who built the first western settlement on the island of Manhattan (New York) after a fire on his ship forced him to over-winter there in 1614 [Varekamp and Varekamp, 2006]. His 1614 'figurative map' shows Long Island Sound as an estuary, and introduced for the first time the name 'Nieu Nederlandt' (New Netherlands).

Historical documents provide insight into the development of this colony, while Long Island Sound sediments recorded the environmental impact of these early settlers. The Dutch fur trade and resulting beaver eradication may have been driven by climate change, whereas the worldwide beaver eradication may have been a driver of climate change itself. When the early Europeans tried to keep themselves warm with fur, they may have contributed to global cooling.

The New Netherlands Colony and Climate Change

The Dutch settled on Manhattan, along the Hudson River, and on western Long Island [Shorto, 2005], trading for beaver pelts, as did the French in Canada. The British, who settled in Plymouth (Massachusetts) in 1620, clashed with the Dutch in the Americas as well as in eastern Indonesia (Banda Islands), where the spice trade was of major importance to the Dutch trading empire. The British were dug in on the island of Run, and attacked the spice-laden ships that left from the Dutch Banda Islands. With the final version of the Treaty of Breda in 1667, the Dutch traded New Amsterdam and the New Netherlands colony to the British in exchange for full ownership of the Banda Islands and Surinam in South America.

The Dutch sailed thousands of miles in small boats just to trade beaver pelts, and climate history provides some insight as why they did this. The early 1600s were the coldest part of the Little Ice Age, and fur-lined

coats (especially beaver pelt) were well suited to keep the middle and upper classes warm in winter in Europe. The beaver furs possibly were more than a fashion statement in the severely cold climate of the times (Figure 1) and the European beaver fur trade may not have flourished in the Americas if the European climate had been as warm as it was during the Medieval Warm Period. The beaver pelt trade also fed the thriving hatmaking industry in Europe. Felt-making involved soaking fur with mercury (Hg) nitrate, poisoning many hatters (giving the phrase 'mad as a hatter').

Danbury (Connecticut) became the New World's center of the hatmaking industry as beavers slowly returned to Connecticut in the early 1800s after the earlier onslaught of hunting waned. Upland sediment from former hatmaking factories, strongly contaminated with Hg even today, is flushed into Long Island Sound during extreme rainfall and floods [Varekamp et al., 2003, 2005]. Sediment with high concentrations of 'historic hatmaking mercury' was deposited in Long Island Sound during the floods of the 1900s and 1950s in Connecticut (Figure 2).

Landscape Evolution in Southern New England in Colonial Times

Beaver dams modify watersheds through retention of water, sediment, and organic

debris [e.g., Naiman et al., 1988]. The ponds provide an important hydrological buffering capacity to the landscape, and the effects of extreme weather events and longer wet periods are dampened through water storage and evaporation from the ponds and enhanced water infiltration. The removal of hundreds of thousands of beavers during early Dutch and English colonial rule led to the extensive desiccation of wetlands in New England. The Long Island Sound sediment may show a record of these changes brought about by the beaver pelt trade, although contemporaneous forest clearing and agricultural development also affected the landscape.

Sediment cores in western Long Island Sound show increasing sediment and carbon accumulation rates since the late 1600s. The removal of the beaver dams led to increased sediment export, with enhanced transport of particulate organic carbon. The increase in marine carbon accumulation rate as derived from carbon nitrogen (C/N) ratios and total organic carbon measurements suggests enhanced nutrient export from the post-beaver watersheds, possibly creating a preindustrial eutrophication pulse (Figure 3a).

Paleosalinity and paleotemperature records, based on stable isotope data and magnesium/calcium (Mg/Ca) analyses from foraminiferal carbonates (ongoing work), show gradual changes from 0 to 1600 A.D., but steep salinity 'lows' occur in more recent times (Figure 3b). The sharpness of these salinity dips can be interpreted to be a result of landscape changes that removed the hydrological buffering capacity, such as beaver dam removal and

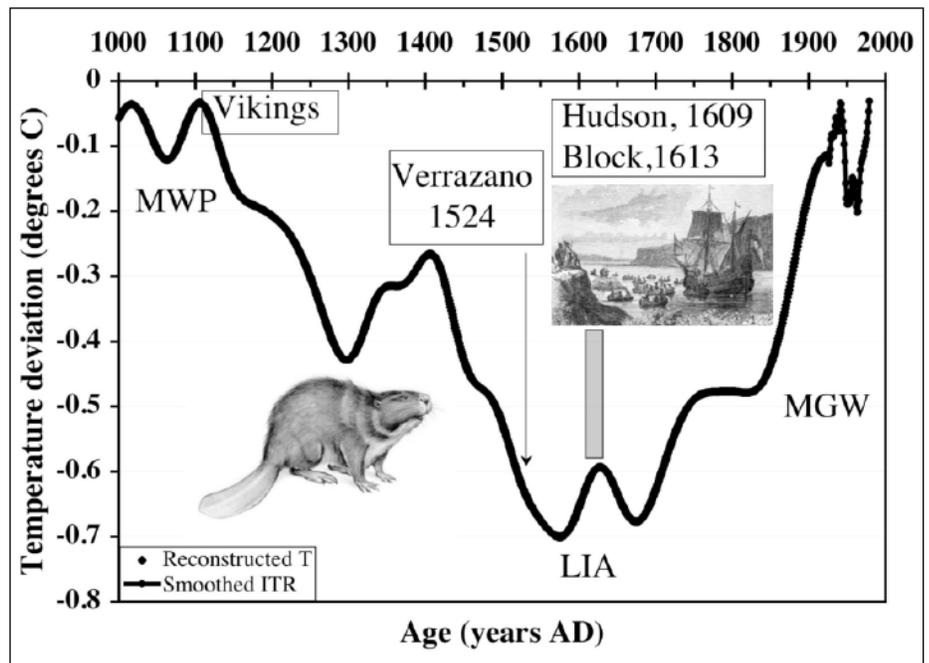


Fig. 1. Explorers of the North American east coast with reconstructed temperature record. The bold curve shows the temperature deviation from the mean temperature of 1961–1980 [Moberg et al., 2005]; the dotted segment is the instrumental temperature record (ITR). MWP, Medieval Warm Period; LIA, Little Ice Age; MGW, Modern Global Warming. Data is modified from a National Research Council [2006] report that reviewed global climate over the past 2000 years.

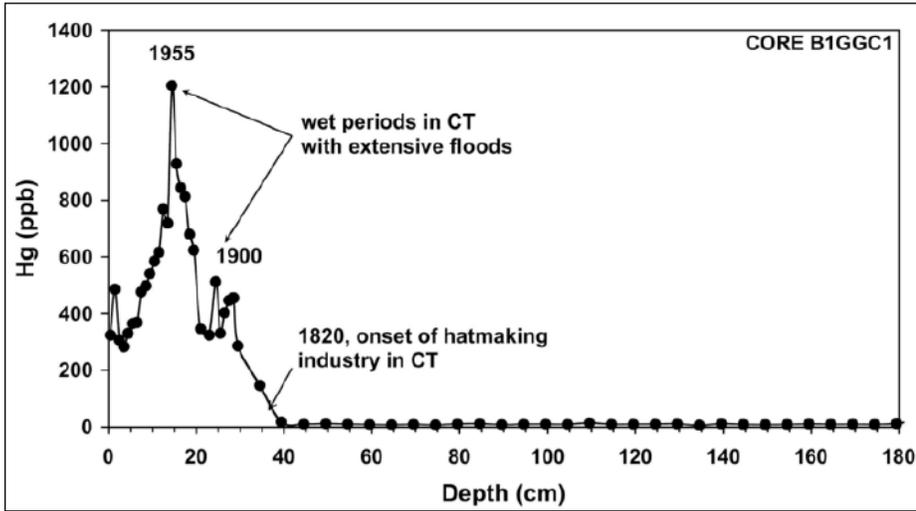
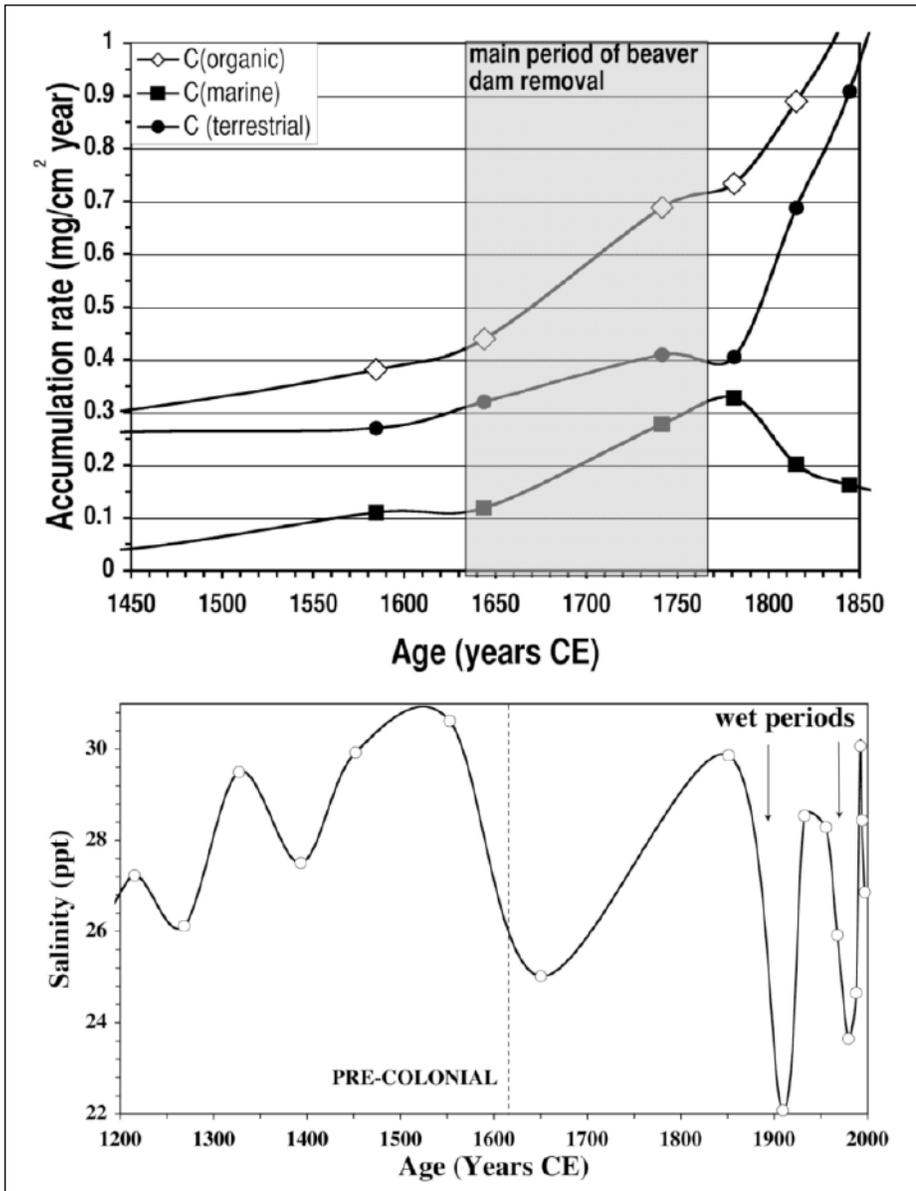


Fig. 2. Mercury (Hg) in a Long Island Sound sediment core in the delta of the Housatonic River, Conn., showing the presence of old 'hatting Hg' deposited in two peaks during the floods of the early 1900s and 1955 wet periods [Varekamp et al., 2005]. Common Hg contamination in LIS sediment rarely exceeds 600 parts per billion Hg.



changes from old growth forest to agricultural land. The low salinities in Long Island Sound waters coincided with the wet periods of the 1900s and mid-1970s in Connecticut [Varekamp et al., 2005], suggesting enhanced runoff during these periods compared with precolonial times.

Climate Change and the Global Fur Trade

The coldest epoch of the Little Ice Age created a commercial incentive for the beaver fur trade in Europe, and as such may have guided the course of history. A glut of beaver furs and the looming extinction of beavers may have led to the Dutch retreat from the Americas, but the disappearance of the beavers already had caused a dramatic local environmental change in landscape. The worldwide reduction in beaver ponds that started much earlier even may have affected the severity of the Little Ice Age as a result of reduced methane and carbon dioxide (CO₂) production from beaver-impounded wetlands. The global beaver eradication (possibly 50 million killed in North America alone) may have significantly decreased the methane and CO₂ flux from ponds, which would, together with possibly already reduced atmospheric CO₂ concentrations at the time [vanHoof et al., 2006], have led to a diminished greenhouse effect. Industrial society often is blamed for severe environmental damage, but the ideas presented here suggest that even during colonial times human actions may have strongly affected local environments and possibly even global climate.

Oddly enough, the path in life of this author mimics this history: a Dutch scientist who settled in Connecticut while working on the volcanoes of the Spice Islands [Vroon et al., 1994], and who now studies the swamps and sediment of Long Island Sound, tracing the Hg flux from local historic hat-making industries.

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Fig. 3. (top) Organic carbon accumulation in Long Island Sound core A1C1 (near Norwalk, Conn.), showing total organic carbon, marine carbon, and terrestrial carbon. Note the pulse in terrestrial and especially marine carbon accumulation rates from about 1650 on. Eutrophication of Long Island Sound during the later industrial period has a much greater magnitude. (bottom) Paleosalinity record from core A1C1 showing two sharp low-salinity spikes in the last century that correlate in time with two wet periods of the Connecticut climate record.

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Author Information

Johan C. Varekamp, Earth and Environmental Sciences, Wesleyan University, Middletown, Ct.; E-mail: jvarekamp@wesleyan.edu

NEWS

NASA's Plans for Moon Base

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As part of NASA's Global Exploration Strategy, the agency announced on 4 December that the United States will begin sending astronauts to the Moon again in around 2020 and plans to establish a permanent base there sometime around 2024. However, the agency has yet to determine key details of the plan, including cost and what science will be conducted.

Scott Horowitz, associate administrator for NASA's Exploration Systems Mission Directorate, said, "A lunar base will be the central theme in our...plan for going back to the Moon in preparation for going to Mars and beyond."

NASA received input from more than 1000 individuals and 14 space agencies in the development of its Global Exploration Strategy. The agency used this input as it identified 180 potential objectives within six overall themes: extending a sustained human presence on the Moon; preparing for future human and robotic missions to Mars and other destinations; international collaboration; the Moon's usefulness as a unique laboratory; economic advancement and technological innovation; and public engagement.

NASA Deputy Administrator Shana Dale explained that in the agency's first round of planning—a second round will take place in 2007—NASA used the first two themes in its decision to pursue an outpost on the Moon, mostly likely at a polar location, instead of

sorties. A polar location, such as the edge of Shackleton Crater at the South Pole, has several advantages: thermal stability, short periods of night that would allow for initial use of solar power, and the potential for finding oxygen, hydrogen, or other volatiles.

Data from upcoming lunar missions, such as the Lunar Reconnaissance Orbiter scheduled to launch in October 2008, will be used in planning the location and design of the Moon base, Horowitz said.

Jeff Volosin, of NASA's Lunar Exploration Architecture Team, who spoke at a 14 December AGU Town Hall, said that NASA probably will begin sending people to the Moon around 2020, starting with daylight missions and moving to nighttime missions and then a sustained presence over the next several years. Rovers able to carry people distances of up to 50 kilometers may be developed. However, he cautioned that none of this is yet finalized.

Dale said that under U.S. President George W. Bush's Vision for Space Exploration, which was announced in 2004, the program is intended to be sustainable and affordable, "one in which we go as we can afford to pay." Dale added that NASA expects to receive no money specifically for exploration of the Moon and plans to use the funds now spent on the shuttle for Moon exploration after the shuttle is decommissioned.

Volosin noted that NASA did not include science in its first phase of planning for exploration of the Moon because the two

main avenues for input from the science community—the NASA Advisory Council's (NAC) Science Committee and a U.S. National Research Council (NRC) committee—are in the middle of their respective processes.

The NAC Science Committee will hold the "Workshop on Science Associated With the Lunar Exploration Architecture" from 27 February to 2 March 2007 in Tempe, Ariz. (details are available at <https://www.infonetic.com/tis/lea/>). NAC Science Committee member Brad Jolliff, who spoke at the AGU Town Hall, said that at the workshop the NAC Science Committee hopes to develop a synthesis of key science activities, prioritize them, and determine what can and cannot be done under the current lunar architecture plan. The NAC will then use the results of the workshop as it makes recommendations to NASA.

The NRC committee is carrying out an independent assessment of the scientific priorities at the Moon, explained NRC committee Co-chair Carle Pieters, who spoke at the AGU Town Hall. The committee released its first report, "The Scientific Context for Exploration of the Moon: Interim Report" (available at <http://books.nap.edu/catalog/11747.html>), earlier this year, and it will issue a final report in May 2007. Pieters said that the committee currently is soliciting white papers and "thoughtful ideas" on priorities from members of the scientific community.

Horowitz said that NASA is listening to all of the stakeholders, including the scientific community, as the agency develops the capabilities and planning for exploration of the Moon. As those plans develop and become more detailed, he said, "We want to make sure we do not preclude any of the science."

—SARAH ZIELINSKI, Staff Writer