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New research shows link between volcanic eruptions, Nile flooding and revolt in ancient Egypt

Study advances knowledge of how sudden climate changes from volcanic eruptions impacted past societies

Research has implications for current debate on how societies will respond to future climate change

** Dr Francis Ludlow is available for interview **

Dublin, Tuesday, October 17, 2017 – Major revolts in ancient Egypt's famous Ptolemaic era may have been triggered by volcanic eruptions that resulted in the suppression of the Nile summer flooding. This is according to new research which combines evidence from ancient Egyptian writings, polar ice-core records and climate modelling.

The research, which was led jointly by historians in Trinity College Dublin and Yale University, also helps us better understand how climate systems function and how societies respond to short-term climate shocks. The study is published in leading international journal *Nature Communications* today.

Famed for cultural and material achievement, rulers such as Cleopatra, and home to the great city of Alexandria, the prosperity of Egypt's Ptolemaic era (305-30 BCE) was renowned, and ultimately directly tied to the river Nile with the annual summer flooding of the river a critical support to the region's agriculture.

Because the Ptolemaic era is one of ancient Egypt's most richly documented periods, historians have long known the dates of major political events. These include revolts against the ruling Ptolemaic family and the cessation of major inter-state wars conducted by the Ptolemies against their rivals, the great Seleukid Empire. However, the specific factors triggering these events has remained unclear.

In the study the researchers drew on evidence from climate modelling of large twentieth century eruptions, annual measurements of Nile summer flood heights from the Islamic Nilometer in Cairo, as well as descriptions of Nile flood quality in ancient writings. The authors show that large volcanic eruptions disrupted the African summer monsoon and reduced Nile river flow. This helped to trigger economic and political instability, in particular acting to trigger revolts against Ptolemaic rule of Egypt and limiting the Ptolemaic state's ability to wage warfare.

The authors also provided evidence of further social stresses through the increased sales of family-held land following eruptions. This has been abundantly documented

in the period's surviving records, and likely to have occurred because families were unable to meet state taxation demands after failed harvests.

"It is very rare in science and history to have such strong and detailed evidence documenting how past societies responded to sudden hydroclimatic shocks. Because the Ptolemaic era is so richly documented, the dates of major political events are known with some confidence," explained Dr Francis Ludlow, Marie Skłodowska-Curie Individual Fellow in Trinity's School of Histories and Humanities, who jointly lead the study.

"What is often less clear from the ancient writings is what specific factors triggered events like revolts. This study, however, has been able to show a repeated close timing between these events and the dates of major volcanic eruptions known from polar ice-core measurements of the atmospheric fallout of volcanic sulfate."

"To fully understand how sudden environmental pressures could act to destabilise society, the historical context is key, and in this case included pressures from high levels of taxation and ethnic tensions that likely coalesced to trigger revolt at times of agricultural failures from insufficient floodwaters."

Joseph Manning, the William K. & Marilyn Milton Simpson Professor of History and Classics at Yale, who co-lead the study with Ludlow, added: "Egypt and the Nile are very sensitive instruments for climate change, and Egypt provides a unique historical laboratory in which to study social vulnerability and response to abrupt volcanic shocks. Most premodern history is descriptive and static, but when we combine precisely dated climate data with our historical texts, we have a window into how societies respond to short-term climate shocks. This kind of short-term climate change triggers human responses. With volcanic eruption dates fixed precisely in time by the ice-cores, we can see society in motion around them. This is the first time for ancient history that we can begin to talk about a dynamic understanding of society."

The study, according to the authors, also has significant implications for current debates about how societies will respond to future climate change, and about how the nations that depend upon the summer floodwaters of Nile might manage under the impact from the next big volcanic eruption.

"High resolution, chronologically precise, paleoclimate records, which are being generated now almost daily, are going to change forever how historians work. Something that is often lost in public debates about climate change is that palaeoclimatology is undergoing a real scientific revolution. This is altering not only our perception of historical climatic changes on various scales, from short term shocks to slower moving long term changes, but it is also revolutionizing our understanding of human societies and how the forces of nature influenced them in the past," explained Professor Manning.

Dr Ludlow added: "A lot of volcanoes erupt each year but they are not affecting the climate system on the scale of some past eruptions. There hasn't been a truly large eruption affecting the global climate system since Mount Pinatubo in the Philippines in 1991. Sooner or later we will experience a large volcanic eruption, and perhaps a sequence of them, that will act to exacerbate drought in sensitive parts of the world. Our research points to the need for further study into the effects of volcanic climate disturbances on modern societies worldwide."

The research was led jointly by historians in Trinity College Dublin and Yale University with important contributions from climate scientists Alexander Stine (San Francisco State University) and William Boos (University of California, Berkeley), ice-core scientist Michael Sigl (Paul Scherer Institute, Switzerland) and paleoenvironmentalist Jennifer Marlon (Yale University).

** Press-only copy of the journal article is available from this link: https://www.dropbox.com/sh/l8nworebwyj5ntx/AADhOcQIBQzeuaAUjWMtF2c2a?dl=0

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