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## Volcanic Impacts on Climate and Society in First Millennium BCE Babylonia

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This paper capitalizes upon the recent availability of much-improved ice-core chronologies of explosive volcanism for the first millennium BCE in combination with the remarkable record of meteorological data preserved in Babylonian astronomical diaries, written on cuneiform tablets spanning 652-61BC and now housed in the British Museum. These diaries comprise systematic economic data on agricultural prices, weather observations at an hourly resolution, river heights for the Euphrates and other phenomena. Our initial results reveal strong correspondences between multiple previously unrecognized accounts of solar dimming, extreme cold weather and major ice-core volcanic signals. We also observe anomalously high spring floods of the Euphrates at Babylon, following major tropical eruptions, which is consistent with climate modelling of anomalously elevated winter precipitation in the headwaters of the Euphrates and Tigris in northeastern Turkey. With the astronomical diaries also providing systematic meteorological information (unparalleled in resolution and scope until at least the Early Modern period) ranging from wind direction and intensity, to the level of cloud cover and references to atmospheric clarity (clear vs. dusty skies), to the general conditions (temperature and precipitation) for all seasons, these sources can in combination with natural archives such as ice-cores open an unprecedented window into the Middle Eastern climate of the first millennium BCE.

Nor are these or other written sources from the region silent on the societal consequences of extreme weather and other climatic shocks. We will thus finish our paper with a brief case study of responses to the climatic impacts of explosive volcanism during the reign of Esarhaddon, ruler of Assyria, who's reign from 672 BCE suddenly became a troubled one. Contemporary prophecies indicated a loss of cattle, the failure of dates and sesame and the arrival of locusts. Such prophecies were often descriptions of events already occurring and along with predictions dated to 671 of 'darkness in the land', crop failure and famine, there is definite evidence that Esarhaddon resorted to the ritual of placing a substitute (sacrificial) ruler on the throne for 100 days. This did not, however, resolve the dangers perceived by the Assyrian ruler and he repeated the ritual in 670, along with apotropaic rituals against malaria and plague. That year, nevertheless, saw revolt. Herdsmen refused to supply oxen and sheep to the government officials, who could not travel the land without armed escort. Regional governors appropriated revenues and construction workers halted brick production. Esarhaddon acted decisively in late 670, early 669, executing a large number of rebellious Assyrian nobles. 669 and 668 remained troubled, however, with prophecies of locusts and plague among cattle and humans, while in 667 Egypt revolted against Assyria in the

context of possible shortages of barely and straw.

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