

# Did volcano eruptions alter the trajectories of the Roman Republic and the Ptolemaic Kingdom? Moving beyond black-box determinism

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McConnell et al. (1) suggest that the eruption of Alaska's Okmok volcano in 43 BCE strongly affected historical events in the late Roman Republic and the Ptolemaic Kingdom.

This interpretation is problematic, first because classical sources can plausibly be interpreted in completely different ways. The handling of natural disasters and phenomena by ancient authors often has to be seen in a religious context: Calamities were interpreted as precursors, concomitants, and aftermath of incisive events like military defeats or the death of an emperor. From this perspective, unusual events such as the death of Iulius Caesar result from an interruption of balance between gods and human beings—manifested in a huge number of incidents like speaking animals, destructive flashes, and apparitions and also the often-mentioned comet (2, 3). Of course, some of these effects might be the result of actual events, such as the eruption of Aetna and so on, but the selection of single incidents to prove “significant vulnerability to hydroclimatic shocks” is more than doubtful: Ancient authors, for instance, made no difference between an imaginable darkening of the sun and apparent fictional stories as the resurrection of a sacrificed cow in the temple (2). Also, even if extreme climate effects were unambiguously recorded, this is far from establishing a solid link to the long-term political transformation from republic to empire.

Second, as a consequence, a detailed analysis of integrated socioenvironmental mechanisms would be indispensable to overcome “black-box determinism” (4) by identifying the sociopolitical effects of an environmental shock (5). Both qualitative and quantitative approaches might be useful here.

Qualitative approaches, for instance, may investigate environmental shocks as “revelatory crises” (6), which may expose the contradictions inherent to the prevailing sociopolitical configuration [e.g., the Chernobyl disaster in the Soviet Union (7)]. Crucially, environmental variables have to be balanced against sociopolitical variables (8)—as exemplified by the end of the Ptolemaic Kingdom: Cleopatra VII's main interest at first was to prevent Egypt from taking the “wrong side” in the Roman civil war. Certainly, bad harvests might have contributed to her not supporting Cassius or later Octavian, but the political interest was arguably essential. Obviously, she had very close links to the Caesarians (her son of Caesar), so it might not surprise that she eventually tried to support them with her fleet (9, 10). Similarly, the claim that “Egypt's own capacity to defend against Rome was diminished by the famine” (1) neglects that Egypt already was a Roman client kingship with little sovereignty.

Quantitative approaches demonstrate how thresholds in the underlying system variables may engender nonlinear change and cascading feedbacks. Note that for systems with self-organizing criticality, invariance between forcing mechanisms and system output makes causal inferences nearly impossible—tracing large-scale societal events back to environmental shocks, then, is futile: “Any event of any scale might have acted as the trigger” (ref. 4, p. 309).

Overall, a superficial correlation between climatic and social events cannot substantiate the purported effects. Butzer's critique of the “continuing failure to appreciate the complexity of [human–nature] interrelationships,” therefore, still appears topical (ref. 5, p. 3633).

**1** J. R. McConnell et al., Extreme climate after massive eruption of Alaska's Okmok volcano in 43 BCE and effects on the late Roman Republic and Ptolemaic Kingdom. *Proc. Natl. Acad. Sci. U.S.A.* **117**, 15443–15449 (2020).

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**3** H. Sonnabend, *Naturkatastrophen in der Antike: Wahrnehmung – Deutung – Management* (Verlag J.B. Metzler, Stuttgart, 1999).

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