EGU22-12080, updated on 16 Aug 2022
https://doi.org/10.5194/egusphere-egu22-12080
EGU General Assembly 2022

Explosive Volcanism Drives Bumper North Sea and Grand Banks Fish Catch, 1600-1850 CE

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Research that twins data from human (written) archives with data from natural environmental archives represents a rapidly advancing frontier in understanding the ecosystem and linked societal impacts of climatic change. The study of explosive volcanic eruptions, capable of inducing severe short-term climatic anomalies, provides a proving ground in which to develop the methodologies required to combine these disparate sources of evidence, and for showcasing the insights that can be achieved. Volcanic influences on the oceans are becoming increasingly understood, through advances in marine palaeoenvironmental proxies and more sophisticated Earth system modelling. At the same time, growing concern exists over the impacts of present and projected climatic changes on marine ecosystems and important higher trophic level species (Cod, Herring) exploited by commercial fisheries. Here we examine the impact of major explosive volcanism on North Atlantic sea-surface-temperatures (SSTs) using the Norwegian Earth System Model, and on North Sea Herring (1600-1860 CE) and Grand Banks Cod (1675-1827 CE) populations, using rigorously reconstructed catch volumes from contemporary documentation. We show that volcanic eruptions, identifiable through elevated sulfate levels in polar ice cores, impacted ocean temperatures and triggered population booms in both species during the first post-eruption decade. We also show this response to be consistent with expected increases in plankton productivity (a key food source for Cod and Herring) under lower SSTs in the North Sea and higher SSTs in the Grand Banks, respectively. We complement our historical analyses with Cod and Herring population modelling, similarly predicting a population boom in the first decade following a positive ecosystem disturbance (e.g., increased food availability for Cod and Herring, promoting increased survivorship). Lastly, we employ historical Herring price data to examine market responses post-eruption, observing an increase in prices in the first two post-eruption years, thus indicating an increased demand for Herring as a substitute for terrestrial agriculture likely to have been impacted by volcanic climatic anomalies. Our results will help improve fish population projections for the North Atlantic after the next big eruption. This work has been funded by the ERC NorFish (ID 669461) and 4-OCEANS (ID 951649) projects.