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# Dynamics of Drought, Crisis and Resilience in Preindustrial Mediterranean Societies

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## Abstract

The Mediterranean is a semiarid region in large part, with a marked seasonal contrast in precipitation, a wet winter season characterized by intense rainfall events and an extended summer dry season of several months with little to no rain. Model-based projections of future climate change come to a rare consensus that the Mediterranean will become even drier in the future, with potentially exacerbating consequences for populations already strained by social conflict. But the Mediterranean is also a region where societies have successfully adapted to environmental change for millennia. Within the last 2000 years alone, the Mediterranean environment is marked by periods of remarkable climatic stability, multi-centennial scale climate change, and shorter-term climate variability, including extended megadroughts, pluvials, and climatic effects of volcanic eruptions. During this period, resilient societies manipulated local vegetation, diverted and stored water resources, and built inter-regional connections among agricultural, pastoral, and urban populations to combat environmental variability and long-term climatic changes. In contrast, Mediterranean history is also marked by the rise and fall of great empires, widespread land abandonment, and periods of cultural and technological regression. The characteristics of a society that made it either resilient or vulnerable to environmental change are hotly contested, perhaps no more famously than the more than two centuries of academic debate surrounding the decline and transformation of the Roman Empire. As such, there are few areas better provisioned for the study of complex interactions between people and their environment, over long time scales, changing social structures and times of climatic stability versus instability. To better understand the actual impact of environmental change on society, and the ability of a society to be resilient in the face of a changing environment, it is necessary to go beyond qualitative speculation. Recent developments in our ability to reconstruct paleoenvironmental change at high temporal resolution, e.g., with tree rings and other high resolution archives, combined with new techniques in numerical modeling of human-environment interactions, makes a quantitative investigation of the limits to resilience possible. In a series of ongoing studies, we are quantifying the way environmental variability and anthropogenic influence on the environment during critical periods for the Aegean kingdoms and the Roman, Byzantine, and Ottoman Empires. We hypothesize that social organization and technology play important roles in the sensitivity of a society to external environmental variability, e.g., cycles of

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drought. Periods with strong leadership, robust trade networks, and innovative technology allowed societies to manipulate their environment to feed populations during times of environmental stress. On the other hand, climate variability could have provided an ultimate cause for decline during times when societies were fragmented and leadership was weak. We test these hypotheses by modeling feedbacks between climate, land use, and productivity to provide local, quantitative estimates of environmental carrying capacity for humans. The model is driven by high-resolution paleoclimate reconstructions combined with historical and archaeological data synthesis on land use, societal organization, diet, technology, and trade. The model results are confronted with independent estimates of population size and dynamics, and ultimately provide evidence for the likelihood of certain trajectories of both societal and environmental change in the face of environmental variability.