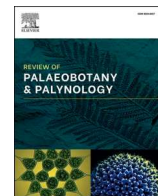




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Review paper

The '4.2 ka drought event' and the fall of the Harappan Civilization: A critical review

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ABSTRACT

The role of climate variability in the expansion and collapse of the Harappan Civilization in South Asia has been a subject of intense research and debate among archaeologists, Quaternary climate scientists, meteorologists, climatologists, historians, geographers, archaeobotanists, and anthropologists. Moreover, high-resolution palaeoclimatic studies have challenged the previous perspectives attributing societal collapses solely to socio-political and economic factors. These studies have revealed that periods of abundant rainfall, resulting from climate amelioration and/or due to seasonality: Winter vs. Summer precipitation, often coincided with the peak of socio-economic, cultural, and technological advancements in various civilizations. Conversely, abrupt climatic changes or rapid climatic changes, such as prolonged droughts, led to the destruction of irrigation systems, agricultural devastation, and widespread famines. These climatic disruptions triggered cultural adaptations, migrations, and sometimes even the collapse of entire civilizations. Climate forcing, particularly solar variability, played a primary role in repeated societal displacements, migrations, and deurbanization across different regions in the past. Additionally, the intensified El Niño-Southern Oscillation, a shift of the Indian Ocean Dipole to a strong negative state, and the southward migration of the Inter-Tropical Convergence Zone contributed to an extended period of weakened Summer Monsoons of South Asia and increased aridity. This depletion of water resources triggered the general demographic shift vis-à-vis the 4.2 ka event. The displacement was a response to a weakened Summer Monsoons of South Asia. In this research review article, we aim to understand the role of climate variability and explore the complex socio-climatological linkages in the mysterious displacement of once-thriving, highly advanced, widespread, and urbanized Harappan Civilization at the 4.2 ka.

1. Introduction

1.1. Holocene climate change vis-à-vis Harappan Civilization

Gaining a comprehensive understanding of climate change and its potential impacts on human societies during the Holocene presents one of the greatest scientific challenges of the 21st century. To explore climate change, a diverse range of data types derived from geological, biological, geomorphic, historical, and archaeological records are now employed. Archaeological studies, in particular, play a crucial role in uncovering the intricate relationships between climate and past human cultures. Paleocological evidence, such as pollen, phytoliths, and fire frequency, as well as geoarchaeological and geophysical analyses, provide valuable insights into human presence and their impact on

landscapes, including soil formation and sedimentation rates (O'Brien et al., 1995; Mayewski et al., 1997; Meeker and Mayewski, 2002; Mayewski and Maasch, 2006; Anderson et al., 2007). Multi-disciplinary research that combines multiple proxy records enables us to construct a more complete and nuanced understanding of the socio-cultural vs. climatological linkages, offering valuable insights into the complex interactions between human societies and their changing environment (Anderson et al., 2007).

The Holocene (~11.7 ka to Present; ka = calibrated kilo annum: thousand years ago: B.P.; cal kyr BP, where B.P. stands for Before Present, with present being the year 1950), has recently been divided by the International Commission on Stratigraphy (2018) into three Ages/Stages: Early Holocene (11.7–8.2 kyr BP), Middle Holocene (8.2–4.2 kyr BP), and Late Holocene (4.2 kyr BP to Present). The Holocene Epoch

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