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# A reassessment of the impact of drought cycles on the Classic Maya

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ABSTRACT

The study reported here challenges the widely discussed hypothesis that cyclical droughts had a major impact on the Classic Maya. This hypothesis was developed by Hodell et al. (2001, 2005) on the basis of the results of time series analyses of cores from Lake Chichancanab in the Yucatán peninsula. Hodell et al.'s analyses indicated that the Maya region was affected by two drought cycles during the 1st millennium CE, one with a periodicity of 208 years and another with a periodicity of 50 years. The timing of the droughts was such, Hodell et al. argued, that they were likely responsible for several important sociopolitical events, including the collapse of Classic Maya society. In our study, we investigated two potentially important problems with Hodell et al.'s analyses: their use of interpolation to make their data regularly spaced, and their reliance on radiocarbon point estimates to generate age–depth models. We found that interpolation biased Hodell et al.'s results and that when it is avoided there is no evidence for a 208-year drought cycle in the Lake Chichancanab dataset. We also found that when the errors associated with the relevant radiocarbon dates are taken into account, there is no evidence for *any* drought cycles in the Lake Chichancanab dataset. Together, our analyses indicate that both the 208-year drought cycle and the 50-year drought cycle identified by Hodell et al. are methodological artifacts. The corollary of this is that the drought cycle hypothesis lacks an empirical basis and needs to be treated with skepticism.



## 1. Introduction

This paper reports a reassessment of an influential hypothesis concerning the impact of climate change on Classic Maya society. The traditional territory of the Maya-speaking people is located close to the middle of the isthmian portion of the North American continent (Fig. 1). Mayanists usually divide this area into three loosely defined regions (Sharer and Traxler, 2006). The *Highlands* is formed by the Chiapas highlands of Mexico and the elevated part of Guatemala. The *Southern Lowlands* consists of the southern portions of the Mexican states of Campeche, Quintana Roo, the Petén of northern Guatemala, and Belize. The *Northern Lowlands* comprises the rest of the Yucatán Peninsula. The Classic period of Maya history began around 250 CE and ended about 900 CE (Sharer and Traxler, 2006). Conventionally, the Classic period of Maya history is divided into the Early Classic (ca 250–600 CE), Late Classic (ca 600–800 CE), and Terminal Classic (ca 800–900 CE) (Sharer and Traxler, 2006).

The Classic Maya have attracted the interest of archaeologists, art historians, epigraphers, and linguists for several reasons. First, their socioeconomic system was among the most complex in prehispanic North America. They engaged in intensive agriculture, specialized craft production, and long-distance trade, and they lived in city-states ruled by divine kings (Coe, 2011). Classic Maya city-states normally comprised several civic-ceremonial centers and a large number of villages that were connected by a road network and, in some cases, causeways (Chase and Chase, 2001). Second, the material culture of the Classic Maya is unusually rich. They constructed large stone step-pyramids, built elaborate temples and palaces, and erected ornately carved stone stelae (Coe, 2011). They also created high-quality polychrome pottery, intricate jade funerary masks, and fine lithic artifacts, including a range of what seem to be primarily esthetic or ceremonial objects (Coe, 2011). Third, the Classic Maya had one of the few well-developed writing systems in the Americas (Houston et al., 2001). Their writing has been deciphered, and the texts and inscriptions that

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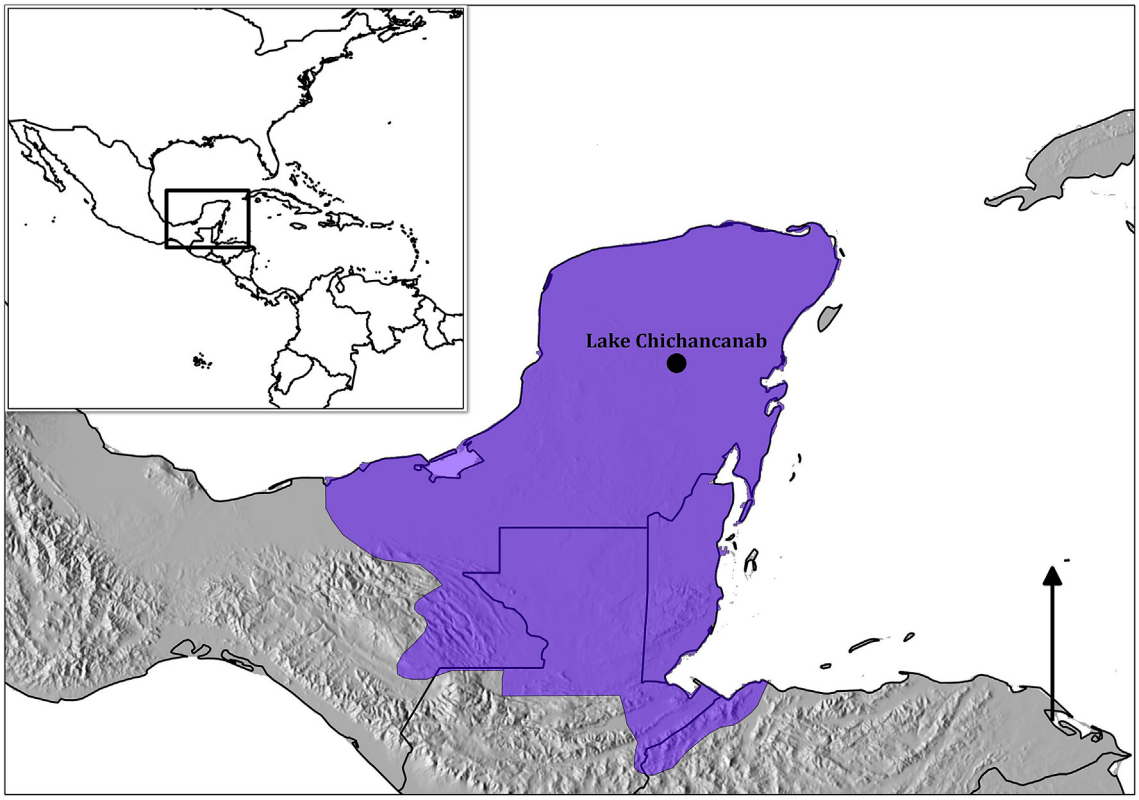


**Fig. 1.** Map of the Lowland Classic Maya region.

have been translated provide an often remarkably detailed history of political events, conflict, and mythology (Martin and Grube, 2008). Lastly, the Classic Maya developed a sophisticated system of calendars based on celestial movements (Rice, 2007).

The hypothesis we tested concerns the impact of drought on the Classic Maya. There is a long tradition of invoking drought as a cause of the disappearance of the distinctive traditions of the Classic Maya between 900 and 1100 CE—an event that is often referred to as the "Classic Maya collapse" (Gunn et al., 2002; Demarest et al., 2004). Today, most Mayanists accept that drought was involved in the collapse, but opinions differ about the number of droughts involved, and the causal relationship between drought and collapse (Aimers, 2007; Turner and Sabloff, 2012; Iannone, 2013). Some authors have argued that the Maya region was subject to a series of intense droughts that placed stress on resources, rapidly lowering the carrying capacity of the environment (Haug et al., 2003; Kennett et al., 2012). The reduction in carrying capacity caused a decrease in population from starvation and migration to less-affected areas, and this in turn led to the decline of the most affected lowland cities. Others have argued that a "mega-drought" was responsible for the collapse (e.g. Gill, 2000; Faust, 2001). First outlined by Gill (2000), this hypothesis posits that between 800 and 1000 CE the Maya lowlands were affected by a severe drought that peaked around 922 CE. The great length and severity of the mega-drought brought about thirst, famine, and disease, killing the majority of the lowland Maya. Still other authors have argued that drought's role in the collapse was mediated by ideological change (e.g. Lucero, 2002; Lucero et al., 2011; Moyes et al., 2009). One of the obligations of the divine kings was to ensure good harvests by correctly performing rituals and currying favor with supernatural forces. Another of their obligations was to maintain a certain level of peace and prosperity for their subjects. When the droughts occurred, crops failed and water stores were depleted leading to food stress and increased conflict between polities. Consequently, the system of divine kingship was perceived to have failed, leading people to abandon it along with other Classic Maya traditions. Lastly, some authors have placed more emphasis on environmental mismanagement by the Maya, which made Classic Maya society unsustainable and less resilient to the effects of drought (e.g., Culbert, 1973; Diamond, 2005; Dunning et al., 2012; Iannone et al., 2013). According to these models, the Classic Maya expanded into marginally productive areas to cope with population increase. The expansion involved clear-cutting and more intensive agricultural practices, which caused soil erosion and nutrient loss. Then, when drought occurred, the already fragile, unsustainable agricultural system could no longer support the population and consequently society collapsed.

The hypothesis we tested also posits that drought caused the collapse of Classic Maya society, but differs from the foregoing hypotheses in that it views the collapse as only one of a number of sociopolitical events that were caused by drought. Developed over the last 20 years by David A. Hodell and his collaborators (Hodell et al., 1995, 2001, 2005; Yaeger and Hodell, 2008) on the basis of results of analyses of sediment cores from lakes in the Yucatán peninsula, the hypothesis contends that the Maya region was subject to two drought cycles during the 1st millennium CE. The primary cycle was driven by solar activity, and had a periodicity of around 208 years. Droughts in this cycle caused the site abandonments that preceded the emergence of the Classic Maya at 250 CE, the temporary decline of the important centre of Tikal around 670 CE, and the collapse of Classic Maya society between 900 and 1100 CE. The second drought cycle had a periodicity of about 50 years. These higher-frequency droughts governed the tempo and pattern of the collapse. The collapse began in the Southern Lowlands with the onset of drought conditions around 900 CE, ebbed for roughly 50 years when a drought was skipped, and then continued in the Northern Lowlands as the 50-year drought cycle reengaged.