Yale

Humanities/Humanity Faculty Workshop, Whitney Humanities Center

Collapse! What Collapse?
Societal adaptations to abrupt climate changes before global warming.

A workshop at Yale October 20-22, 2017.

Harvey Weiss, organizer **Limited seating by reservation.**

Co-sponsors:

Yale Institute for Biospheric Studies, Franke Program in Science and the Humanities, Council on Archaeological Studies, Yale Environmental History, Yale University Tell Leilan Project

Faculty sponsors:

Richard Burger (Anthropology), Michael Dove (Anthropology, F&ES), Joseph Manning (History, Classics), Robert Mendelsohn (F&ES, Economics), Harvey Weiss (Environmental Studies, F&ES)

Pieter Bruegel the Elder, Tower of Babel. 1563. "So God scattered them from there over all the earth, and they stopped building the city." Genesis 11: 8.

Present global warming is rapid and anthropogenic, the product of industrial age greenhouse gas (GHG) emissions. This global warming is projected by scientific researchers and political leaders to threaten the continued viability of (1) global coastal communities, (2) traditional agriculture in Asian, African, and South American regions, 3) industrialized agriculture in European and North American regions, and 4) health, morbidity, and mortality in both industrialized and industrializing nations. In consideration of the rapidity and magnitude of GHG climate-change effects, global scientific and political communities have developed and encouraged two kinds of strategies: (1) mitigation strategies to reduce GHG emissions and their effects and (2) adaptation strategies that allow threatened global nations and communities to adapt in response to 21st and 22nd century GHG climate changes (IPCC 2014; Mendelsohn, Dinar, Williams 2006). The expectation is that mitigation and adaptation may provide for minimization of climate change effects to a level that ensures the sustainable resilience of nations and communities.

Will these strategies be adopted and prove effective? This is a question that drives much current social and economic science research on climate change (IPCC, 2014; Hsiang, et al. 2017). However, the fundamental investigation into and exploration of societies and global warming, resides within history and archaeology and anthropology (Barnes et al 2013; Dove, ed. 2014). How was sustainable resilience accomplished *in the past*?

Pre-industrial climates and climate changes were not anthropogenic, of course, but exclusively natural. Their abruptness, magnitude, and duration, however, varied considerably and regionally, and often exceeded the extremes projected for present GHG climate change. Hence the history of societal adaptations to pre-industrial climate change is the necessary guide to adaptive creativity, receptivity, and effectiveness. That history can be qualified and quantified: How have societies adapted in the past and with what "success"?

Two kinds of records document the climate changes of the past. The instrumental record contains temperature and precipitation values that define climate and prominent climate changes, such as the northern hemisphere's Medieval Warm Epoch and the Little Ice Age, ca. 1300–1850 BC (Mann et al. 2009; Bradley, Warner, & Diaz 2016). The paleoclimate record utilizes climate proxies derived from marine, lake, glacial, and speleothem cores and tree rings that reflect climate values derived from proxy transfer functions. Moreover, the paleoclimate record documents natural climate changes from 12,000 years ago through the eighteenth century (Bradley 2014).

Together, these two kinds of past climate records define both regional and global climate changes, many abrupt in onset and termination, that challenged societies' sustainable resilience and forced adaptive responses at historically significant junctures. It is these climate changes and adaptive responses that have drawn wide academic attention and intense research efforts, because in some historically significant cases the climate changes are (1) only known in low-resolution and (2) the adaptive societal responses are defined without consensus from different historical and archaeological perspectives—that is, was the response collapse or adaptive success, or is collapse in fact adaptation in some historical situations?

The purpose of this two-day Yale faculty workshop is to examine six well-known yet most debated and historically consequential episodes of past climate change and adaptive societal responses:

1. **2200 BC global megadrought and societal adaptations in East Asia and West Asia;**
2. **Maya collapse and regional abandonment at 8th century AD droughts;**
3. **Ancestral Pueblo collapse and migration at the 13th century AD "Great Drought";**
4. **Little Ice Age (16th to 19th centuries AD) European agricultural failure, depopulation, revolution, and rebirth;**
5. **West Asian Little Ice Age and Ottoman collapse in the 17th century AD;**
6. **Andean Medieval Climate Anomaly, Little Ice Age climate changes mid-16th to early 18th centuries AD, and Inka expansion.**

The workshop will offer participants two sets of data for each episode: (1) the most recent instrumental or paleoclimate records presented and analyzed by leading scientists from US universities, and (2) the most recent archaeological and historical records, presented and analyzed by leading societal response investigators, including several Yale faculty.

The workshop is being structured as (1) pre-workshop reading of invitees' suggested articles, (2) two or three workshop presentations each morning and afternoon, (3) each followed by Yale faculty participants' analysis and discussion, (4) with a concluding summary discussion of outstanding issues and research problems.

Northeast Syria, dry-farming harvest transport, view East from Tell 'Aid (H. Weiss, July 1981).

<u>October 20</u>: Introductory Dinner: an open discussion of climate change / collapse issues

<u>October 21</u>:

Morning:

1. **What we need to work on: a continued workshop open discussion**
2. **d'Alpoim Guedes: Tibetan plateau adaptations at 2200 BC climate change**
3. **Weiss: West Asia adaptations at 2200 BC climate change**

Lunch.

Afternoon:

4. **Lachniet: Pre-modern mega-drought in Mesoamerica**
5. **Demarest: Maya collapse complexities**
6. **Kohler: Ancestral Pueblo adaptations to 13th century AD "Great Drought"**
7. **Cook: Pre-modern and 21st century California megadrought**

Drinks, dinner and summary of workshop issues and analyses.

<u>October 22</u>:

Morning:

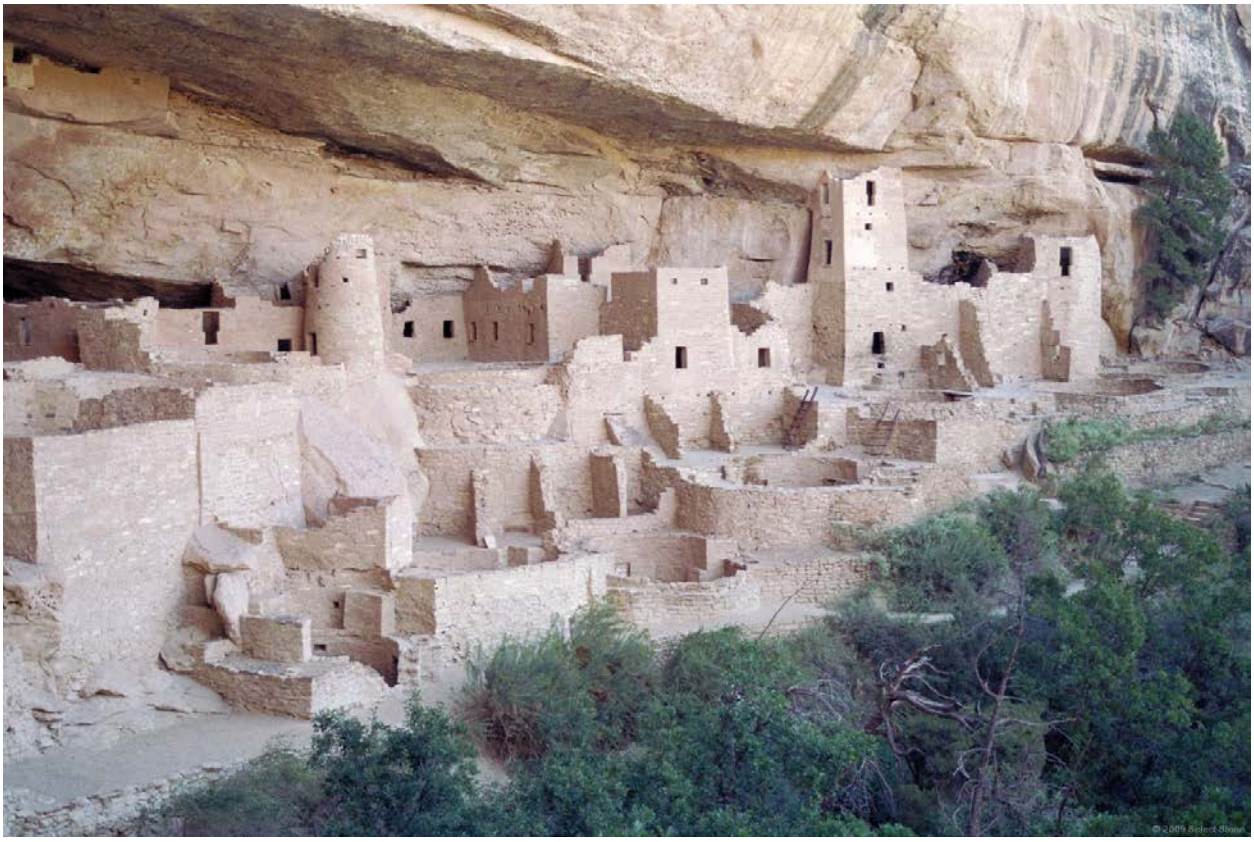
8. **Anchukaitis: Little Ice Age climates northern hemisphere**
9. **deGroot: European adaptations to LIA climates**
10. **White: Ottoman adaptations to LIA**

Lunch.

Afternoon:

11. **Vuille: Climate Anomalies and the Little Ice Age in the Andes**
12. **Sandweiss: El Nino and Collapse across the Andes**
13. **Tung: Drought, Wari and Warfare**
14. **Summary discussion of Europe and the Andes in the late Holocene**

Drinks, dinner and closing summary of workshop issues and analyses.



Mesa Verde, Colorado, constructed ca. 1190 AD, abandoned ca. 1280, excavated 1910.

Workshop issues summarized:

The 4.2 ka BP global megadrought is documented in all varieties of paleoclimate records for the period 2200-–1900 BC. The visibility of this megadrought has forced recognition of the event as the global middle-late Holocene boundary. In West Asia the event was characterized by a 30-50% reduction in precipitation, such that rainfed agricultural societies were forced to collapse, abandon territories, and migrate to riverine, swamp, or karst-spring refugia (Weiss 2015, 2016). There is "a marked decrease in human activity" on the Tibetan plateau during the 4.2 ka BP megadrought, with changing regional locations and crop choices an apparent resilient strategy (d'Alpoim Guedes, Manning, Bocinsky 2016; Wang et al. 2016). Were the responses in West Asia and East Asia similar?

Ancestral Pueblo societies of the US southwest Four Corners region inhabited famous settlement sites such as Mesa Verde and Chaco Canyon, among others. Decades-long droughts at the end of the 13th century AD, "The Great Drought," recorded in regional series of tree rings, reduced agricultural viability and contributed to the abandonment of the region and habitat-tracking before an eventual revival (Bocinsky and Kohler 2014). Controversy remains, however, about the relationship of the Great Drought to regional abandonment. Have coincident cultural forces provided the essential causal linkages for abandonment (Glowacki 2015)? Are these cultural data analyzable? What is the relationship of the The Great Drought to the current megadrought in California (Cook, Ault, Smerdon 2016)?

The Maya peoples of the central lowlands in Guatemala inhabited expansive cities with elite rulers, priests, and scribes, dominated by major public buildings--both temples and palaces--and sustained by intensive agriculture. Since 1995, major paleoclimate research in both high-resolution lake sediment cores and speleothem cores has revealed a succession of major drought events coincident with the abandonment of major Mayan cities and settlement areas (Lachniet et al. 2017). This Terminal Classic Collapse commenced in 2-stages at AD 660 and continued through multi-decadal droughts between AD 800 and 900 (Kennett et al 2012). Were the Maya increasingly susceptible to drought because of emerging political and societal forces, or were the droughts physically impossible to withstand (Douglas et al. 2016)? Why did the Maya not return to the central lowlands in the post-drought period?

The Little Ice Age in Europe is a highly contested period, with varieties of claims made for demographic and political decline and rebirth in the 17th century AD (deVries 1980). Fundamentally, there is the problem of defining the Little Ice Age climatically (Mann et al 2009; Anchukaitis et al 2017). Then there are the variety of claims made for climate-change generated politico-economic and social disturbances. For instance, "[Parker] claims that the Little Ice Age caused famines that led to the starvation of millions, and, via the 'fatal synergy' of famine interacting with war and rebellion, resulted in a reduction of Eurasia's population by one-third" (deVries 2014). Can European Little Ice Age climate changes be linked to quantifiable evaluations of European economic conditions (deVries 2008)?
The Little Ice Age in Ottoman West Asia was marked by repeated famines, warfare, rural flight, and political devolution. White (2011) has compiled the massive historical data and instrumental records, now confirmed by sediment core data from the Ottoman borders in Syria (Kaniewski, van Campo, and Weiss 2012). Can we measure the difference between western European and Anatolian Little Ice Age conditions? What made the Ottomans more vulnerable to Little Ice Age climate changes than the western Europeans?

In the Andes, the Medieval Climate Anomaly, AD 850–1250, was a warm and moist period, while a dry climate prevailed 1250–1550. During the Little Ice Age, a wet phase AD 1550–1750 was followed by a cold and dry phase 1750–1899 (Bustamente et al. 2016; Kanner et al. 2013). El Nino frequencies also dominate the regional Andean climates. How did these variable, often violent, climate alterations affect Andean societies, drive imperial formation or collapse, and socio-political strife? (Tung 2012; Sandweiss and Quilter 2008; Sandweiss et al. 2009).

The driest phase of the Medieval Climate Anomaly occurred between 1250 and 1400, when "extreme drought dominated climatic conditions from the equator to the southern Andes" (Ledru et al. 2013). This last period is marked by the Inka expansion. The relationship between extreme drought and Inka imperial expansion has not been explored in the light of recent Andean paleoclimatology.

References

Anchukaitis, K., et al. 2017. Last millennium Northern Hemisphere summer temperatures from tree rings: Part II, spatially resolved reconstructions. *Quaternary Science Reviews* 163: 1-22. http://dx.doi.org/10.1016/j.quascirev.2017.02.020

Barnes, Jessica, et al. 2013. Contribution of anthropology to the study of climate change. *Nature Climate Change* 3: 54–544. doi:10.1038/nclimate1775

Bocinsky, R. Kyle, and Timothy Kohler. 2014. A 2,000-year reconstruction of the rain-fed maize agricultural niche in the US Southwest. *Nature Communications* 5: 5618.

Bradley, Raymond S. 2014. *Paleoclimatology*. New York: Elsevier. 3rd ed.

Bustamante, M.G., F.W. Cruz, M. Vuille, et al. 2016. Holocene changes in monsoon precipitation in the Andes of NE Peru based on $\delta^{18}O$ speleothem records. *Quateernary Science Reviews* 146: 274-28.

Cook, Benjamin I., Toby R. Ault, and Jason E. Smerdon. 2016. Unprecedented 21st century drought risk in the American Southwest and Central Plains. *Science Advances* 12 Feb 2015: Vol. 1, no. 1, e1400082. doi: 10.1126/sciadv.1400082
d'Alpoim Guedes, Jade, Sturt W. Manning, and R. Kyle Bocinsky. 2016. A 5,500-Year model of changing crop niches on the Tibetan Plateau. *Current Anthropology* 57: 517–522.

deVries, Jan. 1980. Measuring the impact of climate on history: the search for appropriate methodologies *J. Interdisciplinary History* 10: 599–630.

de Vries, Jan. 2008. *The Industrious Revolution: Consumer Demand and Household Economy, 1650 to the Present.* NY: Cambridge University Press.

deVries, Jan. 2014. The crisis of the seventeenth century: the Little Ice Age and the mystery of the "Great Divergence." *J. of Interdisciplinary History* 44(3): 369–377.

Douglas, Peter M. J., Arthur A. Demarest, Mark Brenner, and Marcello A. Canuto. 2016. Impacts of climate change on the collapse of lowland Maya civilization. *Annu. Rev. Earth Planet. Sci.* 2016. 44: 613–45. doi: 10.1146/annurev-earth-060115-012512

Dove, Michael, ed. 2014. *The Anthropology of Climate Change*: *an historical reader*. NY: Wiley-Blackwell.

Glowacki, D. M. 2015. *Living and Leaving: A Social History of Regional Depopulation in Thirteenth-century Mesa Verde*. Tucson: University of Arizona Press.

Hsiang, Solomon, R. Kopp, A. Jina, J. Rising, M. Delgado, S. Mohan, D.J. Rasmussen, R. Muir-Wood, P. Wilson, M. Oppenheimer, K. Larsen, T. Houser. 2017. Estimating economic damage from climate change in the United States. *Science* 356: 1362-1369.

IPCC 2014. *Climate Change 2014: Synthesis Report. Contributions of Working Groups I, II and III Intergovernmental Panel on Climate Change.* Ed. R. K. Pachauri and L. A. Meyer. Geneva: IPCC.

Kaniewski, David, Elise van Campo, and Harvey Weiss. 2012. Drought is a Recurring Challenge in the Middle East. *Proceedings of the National Academy of Sciences* 109: 3862–3867.

Kanner, L.C., S. Burns, H. Cheng, L.R. Edwards and M. Vuille, 2013: High-resolution variability of the South American summer monsoon over the last seven millennia: Insights from a speleothem record from the central Peruvian Andes. *Quat. Sci. Rev.* 75: 1-10.

Kennett, Douglas, Sebastian F. M. Breitenbach, Valorie V. Aquino, et al. 2012. Development and disintegration of Maya political systems in response to climate change. *Science* 338: 788–791. doi: 10.1126/science.1226299

Kohler, Timothy and Mark Varien. 2012. *Emergence and Collapse of Early Villages: Models of Central Mesa Verde Archaeology*. Berkeley: University of California Press.

Lachniet, M. S., Y. Asmerom, V. Polyak, and J.P.Bernal. 2017. Two millennia of Mesoamerican monsoon variability driven by Pacific and Atlantic synergistic forcing. *Quaternary Science Reviews* 155: 100-113.

Ledru, M.-P., V. Jomelli, P. Samaniego, M. Vuille, S. Hidalgo, M. Herrera, and C. Ceron. 2013. The Medieval Climate Anomaly and the Little Ice Age in the eastern Ecuadorian Andes. *Clim. Past* 9: 307–321. doi:10.5194/cp-9-307-2013

Mann, Michael E., Z. Zhang, S. Rutherford, R.S. Bradley, M.K. Hughes, D. Shindell, C. Ammann, G. Faluveg, and F. Ni. 2009. Global signatures and dynamical origins of the Little Ice Age and Medieval Climate Anomaly. *Science* 326: 1256–1260. doi: 10.1126/science.1177303

Mendelsohn, R., A. Dinar, and L. Williams. 2006. The Distributional Impact of Climate Change on Rich and Poor Countries. *Environment and Development Economics* 11: 1-20.

Sandweiss, D.H., R. Shady S., M.E. Moseley, D.K. Keefer, and C.R. Ortloff. 2009. Environmental change and economic development in coastal Peru between 5,800 and 3,600 years ago. *Proceedings of the National Academy of Sciences* 106:1359-1363.

Sandweiss, D.H. and J. Quilter. 2008. Climate, Catastrophe, and Culture in the Ancient Americas. In *El Niño, Catastrophism, and Culture Change in Ancient America*, ed. By D. H. Sandweiss and J. Quilter, pp. 1-11. Washington DC: Dumbarton Oaks.

Tung, Tiffiny A. 2012. *Violence, Ritual and the Wari Empire*. Tampa: Univ. Press Florida.

Tung, Tiffiny A., M. Miller, L. De Santis, E.A. Sharp, and J. Kelly. 2016. Patterns of violence and diet among children during a time of imperial decline and climate change in the ancient Peruvian Andes. In A. VanDerwarker and G. Wilson, eds. *Food and Warfare*. NY: Springer. Pp. 193-228.

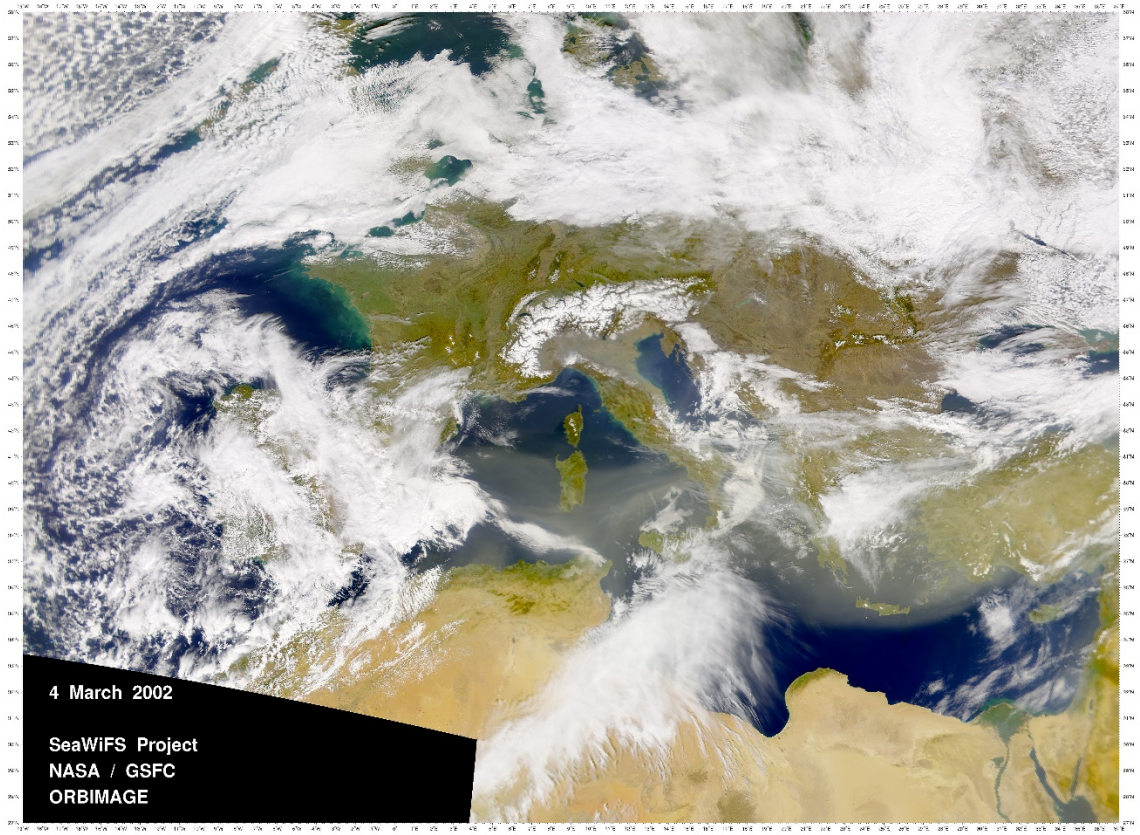
Wang, Jianjun, Liguang Sun, Liqi Chen, Libin Xu, Yuhong Wang, and Xinming Wang. 2016. The abrupt climate change near 4,400 yr BP on the cultural transition in Yuchisi, China, and its global linkage. *Nature Scientific Reports* 6: 27723. doi: 10.1038/srep27723

Weiss, Harvey and Raymond Bradley. 2001. What Drives Societal Collapse? *Science* 291: 609–610. doi: 10.1126/science.1058775

Weiss, Harvey. 2016. Megadrought, societal collapse and resilience at 4.2–3.9 ka BP. *PAGES (Past Global Changes)* 4.2: 62–63. doi: 10.22498/pages.24.2.62

Weiss, Harvey, ed. In press. *Megadrought and Collapse*. NY: Oxford University Press.

White, Sam. 2011. *The Climate of Rebellion in the Early Modern Ottoman Empire*. NY: Cambridge Univ. Press.



North Atlantic cyclogenesis and Mediterranean westerlies (NASA, 4 March 2002).

Yale University faculty sponsors:

Prof. Richard Burger, Dept. Anthropology
http://anthropology.yale.edu/people/richard-l-burger
Prof. Michael Dove, Dept. Anthropology and F&ES.
http://anthropology.yale.edu/people/michael-dove
Prof. Joseph Manning, Dept. History and Dept. Classics.
http://history.yale.edu/people/joseph-manning
Prof. Robert Mendelsohn, F&ES and Dept. Economics.
https://environment.yale.edu/profile/mendelsohn/
Prof. Harvey Weiss, Environmental Studies and F&ES
https://environment.yale.edu/profile/harvey-weiss/

Other Yale faculty engaged within this research seminar's effort:

Prof. Fabian Drixler, Dept. History, early modern Japanese history, the great divergence
Prof. Alexey Fedorov, Dept. Geology and Geophysics, Climate dynamics
Prof. Rod McIntosh, Dept. Anthropology, West African archaeology
Prof. Alan Mikhail, Dept. History, Egypt and Near Eastern environmental history
Prof. Peter Perdue, Dept. History, environmental history of China
Prof. Paul Sabin, Dept. History, environmental history of North America
Prof. Anne Underhill, Dept. Anthropology, archaeology of China

Gruta Carlos Pacheco, Mexico; Juan Pablo Bernal climbing (K. Christensen, 3 June 2011).

Invited participants' contributions in the areas the workshop will explore:

Prof. Kevin Anchukaitis, Schl. Geography and Development, Univ. Arizona.
Paleoclimatology, dendrochronology, Holocene climate dynamics.
https://geography.arizona.edu/user/kevin-anchukaitis

Prof. Ben Cook, NOAA/NASA, Columbia Lamont Earth Observatory.
Drought history of US Southwest, California megadrought.
http://www.ldeo.columbia.edu/user/bc9z

Prof. Arthur Demarest, Dept. Anthropology, Vanderbilt University.
Lowland Classic Maya archaeology, Classic Maya collapse
https://as.vanderbilt.edu/anthropology/bio/arthur-demarest

Prof. Jade d'Alpoim Guedes, Dept. Anthropology, Univ. California San Diego.
Environmental archeology; ethnobiology; Tibet archaeology
http://anthro.ucsd.edu/people/faculty/faculty-profiles/jade-guedes.htm

Prof. Dagomar deGroot, Dept. History, Georgetown University
European economic history, 17th-18th centuries, Little Ice Age adaptations.
http://explore.georgetown.edu/people/dd865/

Prof. Timothy Kohler, Dept. Anthropology, Washington State University.
Ancestral Pueblo societal adaptations to the "Great Drought," ca. AD 1280
https://anthro.wsu.edu/faculty-and-staff/tim-a-kohler/

Prof. Matthew Lachniet, Dept. Geosciences, University of Nevada, Las Vegas.
Speleothem geochemistry, paleoclimatology, North America, Mesoamerica.
https://www.unlv.edu/people/matthew-lachniet

Prof. Daniel Sandweiss, Climate Change Institute; Dept. Anthropology, University of Maine.
Paleoclimates and archaeology, Peruvian Andes
https://umaine.edu/anthropology/faculty-staff/dr-daniel-h-sandweiss/

Prof. Tiffiny Tung, Dept. Anthropology, Vanderbilt University.
Bioarchaeology, imperialism, Peruvian Andes
https://as.vanderbilt.edu/anthropology/bio/tiffiny-tung

Prof. Matthias Vuille, Dept. of Atmospheric/Environmental Sciences, SUNY Albany.
Andean climate changes at Medieval Climate Anomaly and Little Ice Age.
http://www.atmos.albany.edu/facstaff/mathias/

Prof. Sam White, Dept. History, Ohio State University.
West Asia environmental history, Ottoman Empire, Little Ice Age.
https://history.osu.edu/people/white.2426