Bulletin of Old Pueblo Archaeology Center
Tucson, Arizona

Old Pueblo Archaeology

August 2015[1]
Number 75

Archaeology's Deep Time Perspective on Environmental and Social Sustainability

Allen Dart, RPA

What good is archaeology except to dig up and show off troves of trinkets? Does this so-called social science have any relevance to modern society, to making our lives better?

Well, yes. About a decade ago my colleagues Brian Kenny and Vince Murray, discussing the relationship between modern Maricopa County, Arizona, residents with that area's archaeological heritage, wrote "The organic or indigenous past may not be theirs, but the past can add meaning, value, context and perspective to their lives. It can be adopted and cherished in preserved neighborhoods and landscapes, and it can be fostered through lifestyle engagement, historical learning, and the telling and sharing of stories."

In a presentation I developed for Arizona Humanities (see left box below), I suggest that archaeology and its related disciplines can do even more for modern humankind. The deep time perspective that archaeology provides on natural hazards, environmental change, and human adaptation not only is a valuable supplement to historical records, it sometimes contradicts historical data that modern societies use to make decisions affecting social sustainability and human safety.

What can be learned from archaeological evidence that virtually all ancient Native American farming cultures in Arizona and the Southwest eventually reached a threshold of unsustainability, which probably was a

Continued on page 3

What is Arizona Humanities?

Arizona Humanities (formerly the Arizona Humanities Council) is a 501(c)(3) nonprofit organization and the Arizona affiliate of the National Endowment for the Humanities. Its mission is to build a just and civil society by creating opportunities to explore our shared human experiences through discussion, learning and reflection. For more information visit http://www.azhumanities.org/.

Old Pueblo Archaeology Center's mission is to educate children and adults to understand and appreciate archaeology and other cultures, to foster the preservation of archaeological and historical sites, and to develop a lifelong concern for the importance of nonrenewable resources and traditional cultures.

Also in this issue:

Sahuaripa Update: What a Difference an Additional Season Makes! *by John Carpenter* 2

Upcoming Activities 15

Membership Application Form 17

[1] Issue no. 3 for the 2013 membership year. Due to production difficulties this issue was not actually published until 2015.

Sahuaripa Update: What a Difference an Additional Season Makes!

John Carpenter, Ph.D.
Centro INAH Sonora

[Editor's note: In the April 2015 issue of *Old Pueblo Archaeology* (no. 74: http://www.oldpueblo.org/about-us/publications/), archaeologist Dr. John Carpenter wrote about recent investigations of ancient sites that he has been leading in the Río Sahuaripa area of eastern Sonora, Mexico. On May 27, 2015, he emailed us this update and the accompanying photos.]

Al,

I am somewhat chagrined, though elated to report that much of my report of the first season's results in Sahuaripa was erroneous. We recently documented large habitation sites of 20+ room roomblocks enclosing up to three plazas with double cobble alignments, much evidence of shell exchange, including *Glycymeris* bracelets, *Pecten* and *Chama* pendants, and *Olivella*. Obsidian is now ubiquitous. A single turquoise bead. A much greater assemblage of decorated wares, including Ramos and Carretas polychromes, Madera Black/red, Arivechi Red/Purple-on-brown/grey series, unidentified red-on-buff, along with plain brown and red wares.

Long-distance exchange is reflected by a pectoral of *Pinctada mazatlanica* and an enigmatic figurine fragment, both of putative West Mexican origin. Exotic items extend into the Bacanora valley to the west. What a difference an additional season makes! Tentatively planning on implementing five weeks of testing in October/November/December.

Saludos,

John

Dr. John Carpenter Slavens
Sección de Arqueología
Centro INAH Sonora
Jesús García final y E. Sarmiento
Colonia La Matanza
Hermosillo, Sonora 83080
(662) 213-1234, 217-2580 (FAX)
Casa/Oficina (662) 272-3061
https://inah.academia.edu/JohnCarpenter

Chama shell pendants

Pectoral

Scale for all photos

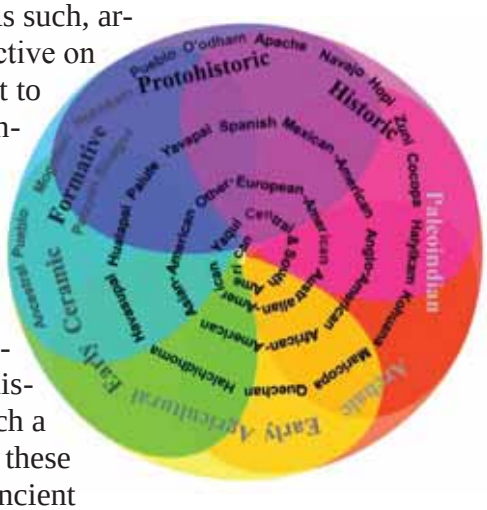
Figurine

Archaeology's Deep Time Perspective on Environment and Social Sustainability

Continued from page 1

factor in the ultimate collapse or reorganization of their societies? Could the disastrous damages to nuclear power plants damaged by the Japanese tsunami of 2011 have been avoided if the engineers who decided where and how to build those plants had not ignored prehistoric archaeological, geological, and historical evidence of tsunamis?

In my Arizona Humanities "Archaeology's Deep Time Perspective on Environment and Social Sustainability" presentation I note that archaeology is a science that studies past human cultures by analyzing the material remains – artifacts and living sites – that people left behind. As such, archaeology and some of its related disciplines provide a "deep time" perspective on environmental change and human adaptation that is a valuable supplement to written historical records. Archaeological evidence often can be used to confirm and supplement written histories, but sometimes archaeological findings can contradict historical information that modern societies use to make decisions affecting social sustainability and human safety.



Cycles of Change in Southwestern Societies graphic by Allen Dart

Archaeology identifies cycles of change over the lifespan of a society. It therefore extends scientific observation of stability and transformation beyond all social memory. Prehistoric evidence records a fuller range of environmental dynamics, such as natural hazards and climate change, than historical records do. Because archaeology and related disciplines provide such a deep time perspective that we are not likely to see in written histories, these areas of inquiry can help us learn how to adapt to the present by studying ancient peoples.

In the next few pages are a few case studies of how archaeology and other "deep time" disciplines can provide guidance for modern mankind.

Model of Ventureño Village, a display in the Museum of Ventura County; photograph by David J. McLaughlin, used with permission

Case Study 1: Long-Term Effects of Exposure to Natural Chemical Hazards

By the late 1700s, there were as many as 20,000 Chumash Indians living off the California coast on the Channel Islands. In a 2011 study, anthropologists Sebastian Wärmländer and colleagues[2] measured and analyzed archaeological skeletal remains of 269 male and female Chumash adults who lived over a span of 7,500 years. The study showed that average cranial volume shrank about 6 percent between the 6500-600 BC and AD 1150-1782 periods.

[2] **Error! Main Document Only.**https://www.academia.edu/898415/Could_the_Health_Decline_of_Prehistoric_California_Indians_be_Related_to_Exposure_to_Polycyclic_Aromatic_Hydrocarbons_PAHs_from_Natural_Bitumen

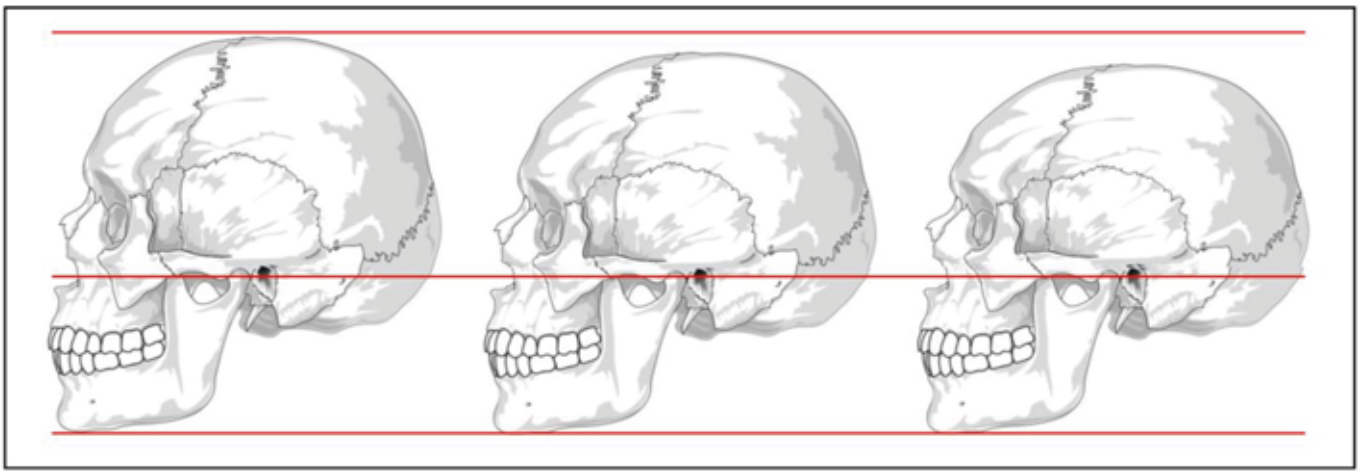
Left: Natural bitumen seep at La Brea Tar Pits, Los Angeles, California;
center: Abalone shells with their breathing holes plugged with bitumen, possibly used as food containers;
right: Chumash hopper mortar with residues of bitumen used to adhere the hopper basket;
left photo by Daniel Schwen from Wikipedia Commons; center and right photos courtesy of the Santa Barbara Museum of Natural History

Modern reconstruction of a Chumash bitumen-sealed tomol plank canoe; photo courtesy of the Santa Barbara Museum of Natural History

One of the most important natural resources of the Chumash was bitumen – natural asphalt – which they gathered from seeps on the islands and used as an all-purpose glue. Chumash ancestors who lived on California's Channel Islands in ancient times must have thought they had a valuable resource in bitumen because they used it to water-proof their canoes, line baskets used as water vessels, and plug holes in shells they used as food containers. They even chewed it. Wonderful, no?

Wärmländer and his coauthors also examined naturally occurring bitumen tar from the Channel Islands, and found that it contains polycyclic aromatic hydrocarbon (PAH) toxins. Exposure to PAHs is associated with major health problems" cancer, damage to internal organs, and reproductive impairment. The tar toxins may have contaminated Chumash individuals through skin contact, ingestion, or inhalation, compromising their health. The study concluded that daily exposure to bitumen tar toxins contributed to declining health of prehistoric California Indians and to the gradual reduction in skull volume over several thousand years.

Today bitumen is used mainly for building roads, as a sealant in roofs, and for waterproofing and soundproofing. As a petroleum by-product, however, the Chumash study of archaeological and historical populations provides insights into what future generations may experience from exposure not only to similar chemical toxins in oil spills, industrial burning, cigarette smoke, and even plastic water bottles; but perhaps even to some materials normally found in nature.



A normally proportioned human skull (left) and progressive illustrations of how the volume in the cranium (the upper part of the skull) might be reduced relative to unchanged proportions in the skull's lower part

Case Study 2: Agricultural Techniques

An archaeological perspective is valuable for examining long-lived agricultural societies, to provide insights into sustainable farming.

When we examine most modern agriculture, we find that it focuses on large-scale farming involving extensive, deep plowing. In contrast, farming by ancient societies was simpler, primarily involving simple casting of seeds, or using a digging-stick to plant them in the ground. Generally, the greatest land disturbance in prehistoric southwestern fields was not plowing, but just manipulation of earth and rocks to conserve soil and moisture for plants grown in the fields.

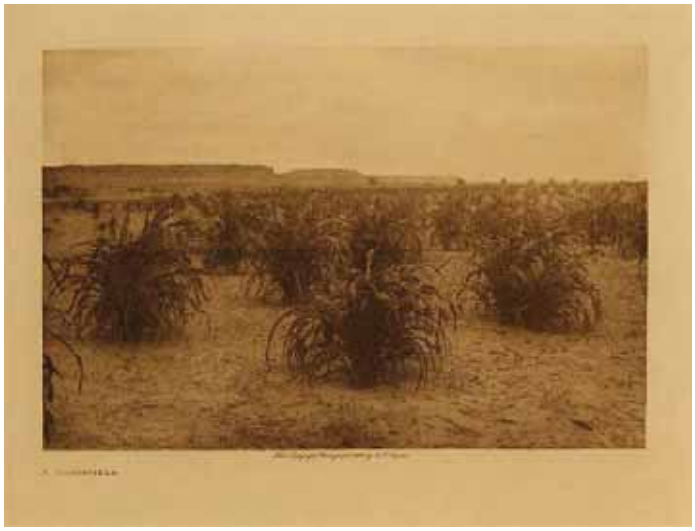
As a result of this relatively minimal disturbance, the natural biological diversity of field areas around most prehistoric and historical native villages was basically maintained, ensuring the availability and viability of the area's naturally occurring plant and animal species.

Modern tractor plowing a field;, from ok.gov, State of Oklahoma

"A Farmer Sowing Seed" from Aunt Mary's Primer: Adorned with One Hundred and TwentyPretty Pictures; anonymous, 1851; Project Gutenberg, www.gutenberg.org/files/11065/11065-h/11065-h.htm

Willard Leroy Metcalf, "Zuni Planting Scene"; 1882, gouache on paper, 13⅜ by 15½ inches; collection of the New Mexico Museum of Art. Museum acquisition, 1965 (1880.23D)

Contrast the minimally invasive southwestern Native American fields in the photos on page 6 with the "amber waves of grain" fields one often sees in the American heartland. Extensive land leveling and plowing destroys soil and most of an area's natural habitat, and modern farmers often replace the former natural variety of plant species with single-species crops. The introduced, large stands of crops all of one kind are more susceptible to plant-specific diseases and pests. But as illustrated on page 7, something can be done about this. Farming's impact on species diversity can be reduced by rotating crops seasonally and planting different varieties in the same field, as ancient peoples did and as the USDA Natural Resources Conservation Service recommends today.



Contrast the minimally invasive southwestern Native American fields in the photos on this page with the "amber waves of grain" fields one often sees in the American heartland. Extensive land leveling and plowing destroys soil and most of an area's natural habitat, and modern farmers often replace the former natural variety of plant species with single-species crops. The introduced, large stands of crops all of one kind are more susceptible to plant-specific diseases and pests.

But as illustrated on page 7, something can be done about this. Farming's impact on species diversity can be reduced by rotating crops seasonally and planting different varieties in the same field, as ancient peoples did and as the USDA Natural Resources Conservation Service recommends today.

Left: photos showing traditional southwestern, minimally invasive farming methods

Left top: "A Cornfield" (Hopi sand-dune field)
U.S. Library of Congress photo by Edward S. Curtis dated 1925

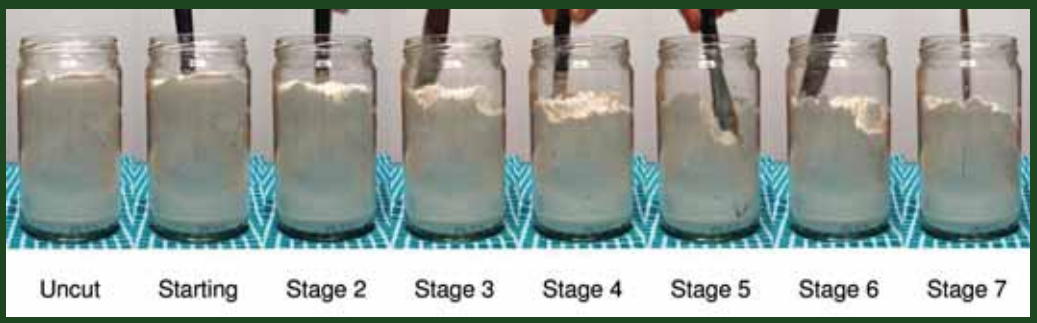
Left center: a Tohono O'odham field in Big Fields, Arizona, beside a checkdam of mesquite poles and brush erected to slow the flow of water and spread it out over the field; poles are located across a shallow, wide wash; note the native herbaceous plants that were encouraged to grow around the field;
Arizona State Museum, University of Arizona photo by Helga Teiwes, August 15, 1977

Left bottom: "Zuñi Gardens"
U.S. Library of Congress photo by Edward S. Curtis dated 1925

Right: example of America the Beautiful's "amber waves of grain";
USDA Natural Resources Conservation Service photo

A Helpful Kitchen Hint, but Not So Good for Farming

Need a way to get more flour into your jar or canister when it's too full to hold more? Here's a hint: You can slice back and forth through the flour with a knife to compact it and lower its height, as shown in these sequential photos.



This will make room in the container for more flour to be added.

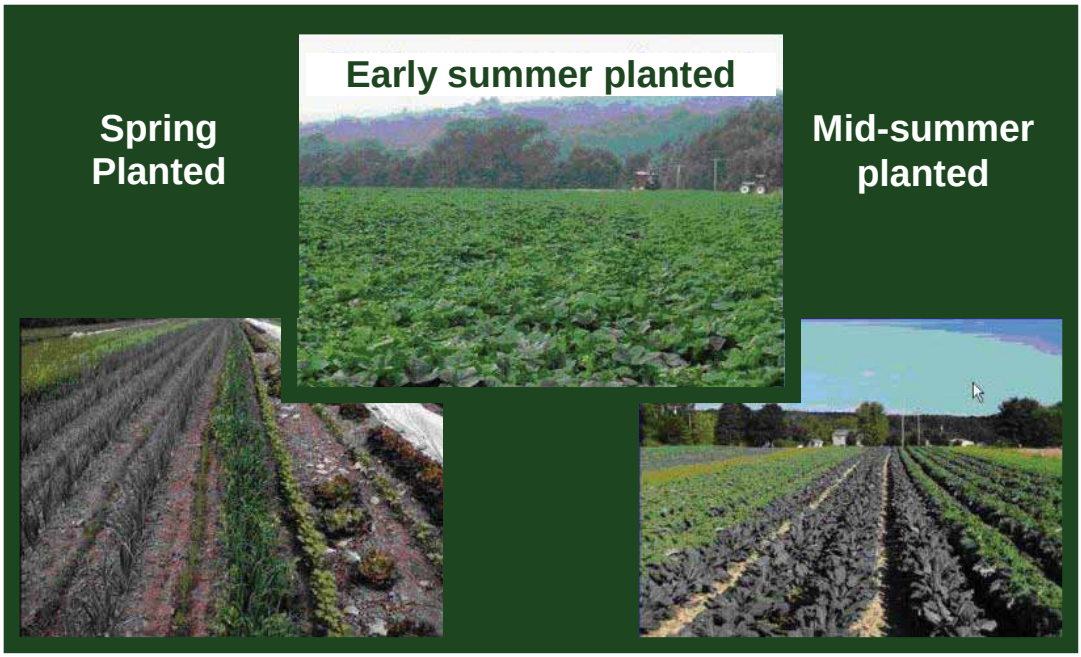
Why did I go off on the kitchen-hint tangent above?

Because, just as flour gets compacted by cutting through it, deep plowing for agriculture compacts the soil, making it denser and creating an underground "hardpan." Plowing therefore makes it more and more difficult for water to percolate deep into the soil, and this prevents plants from forming deep roots.

The U.S. Department of Agriculture reports that even one year of tillage greatly damages soil structure. This increases erosion and impairs water infiltration and soil health. Also, plowing mixes carbon throughout the plow layer, removing some of it from the surface, where it is important for holding plant nutrients and water.

Planting huge expanses with a single agricultural species makes the crop highly susceptible to widespread infestations of such pests as bacterial leaf streak (left) and locusts (right). The susceptibility can be reduced by rotating crops periodically and by planting different kinds of crops successively in the same field.
Bacterial leaf streak photo by Marcia McMullen from North Dakota State University Extension Service via Creative Commons creativecommons.org/licenses/by-nc-sa/3.0/;
locusts photo: black locusts climbing grass stalks, from dreamstime.com dreamstime_xl_10998149.jpg

U.S. Department of Agriculture



NRCS Helping People Help the Land

Crop rotations and diversity photos by Charles L. Mohler, USDA Natural Resources Conservation Service

No-till machine planting soybeans in wheatfield stubble near Newllton, Louisiana; USDA Natural Resources Conservation Service photo by Stephen Kirkpatrick

Some no-till planting machines have disks that can cut as little as ¼-inch into the ground for planting seeds USDA Natural Resources Conservation Service photo from an NRCS presentation by Dave Lightle

An alternative to deep-till plowing is "no-till" farming. In the no-till planting process, the stems, stalks, and leaves from a newly harvested crop are left in the field. Then when the next crop is planted, instead of plowing or tilling, a machine cuts very small grooves or punches holes in the soil, sometimes no more than ¼ inch deep, and plants the seeds in the grooves or holes. This keeps most of the old stems, stalks, and leaves (crop residue) intact on the soil surface to protect the soil while the new plants are growing.

Benefits of no-till planting are that it protects the soil from erosion by wind and rain; reduces water runoff from the field during rains and irrigation, thus conserving water; adds organic matter to the soil; reduces labor, fuel, and equipment wear; provides habitat for wildlife; and reduces release of carbon gases.

No-till farming is similar to what we see archaeologically – planting seeds in small grooves or holes dug with simple digging sticks.

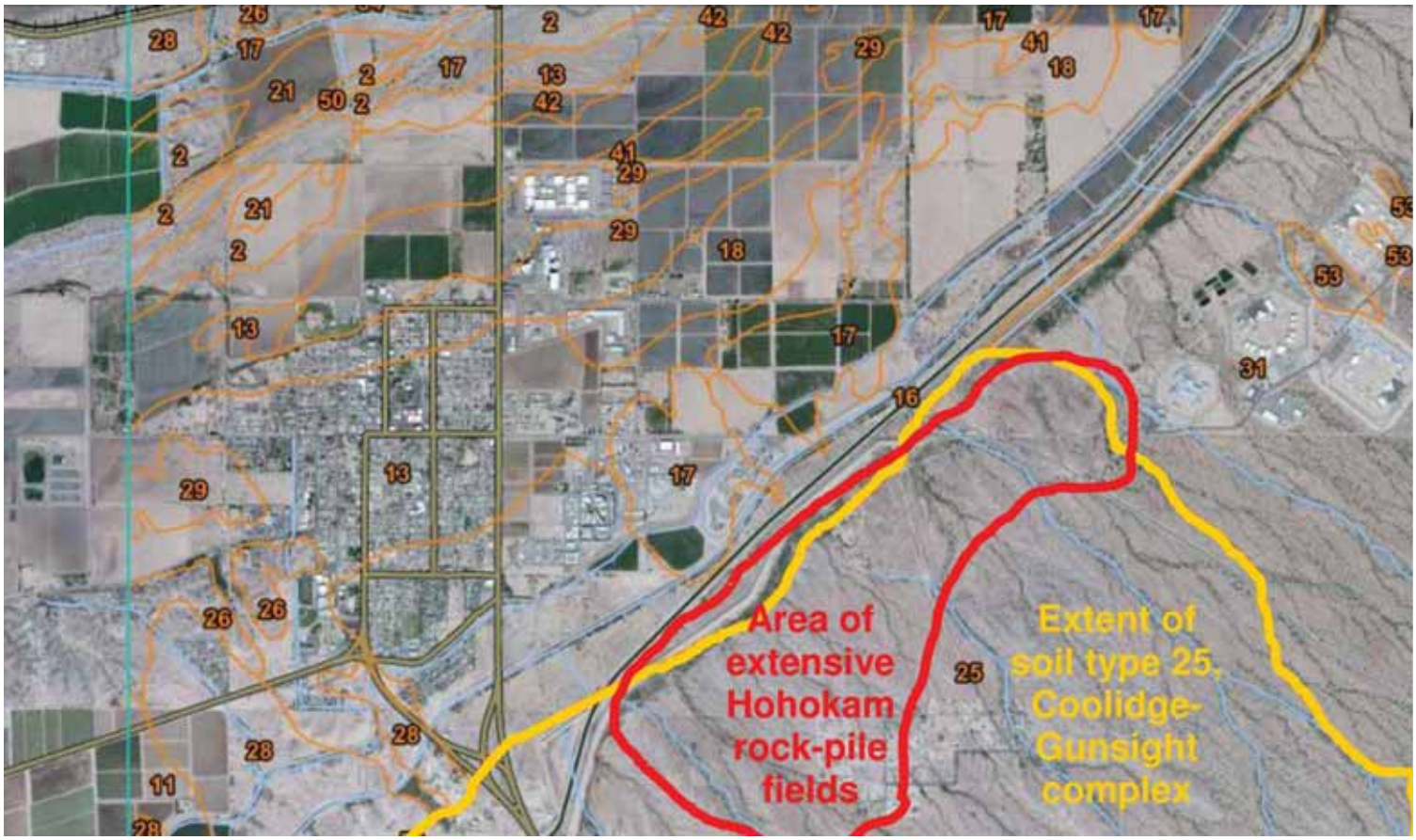
Case Study 3: Some Early Southwestern Farming Methods Worth Considering

Many modern farmers, and even some government soil survey reports and maps, consider desert land that cannot be easily irrigated, or land that is relatively rocky, to be unarable (unusable for farming). For example, in the soil map on page 9 provided by the USDA Natural Resources Conservation Service (NRCS) on-line Web Soil Survey, soil type 25 outlined with the heavy yellow line on the lower-mountain-slope alluvial fans east of Florence, Arizona, is identified as "Coolidge-Gunsight complex, 1 to 5 percent slopes." The NRCS soil survey notes that the Coolidge and Gunsight soils are sandy loam to gravelly sandy loam and calls the complex "Not prime farmland." There have been no farm fields on this complex historically.

In contrast, archaeological and ethnographic studies have found that ancient and historical Native Americans in the Southwest developed simple yet sophisticated agricultural intensification methods, mostly by simply manipulating rocks, earth, and brush, to tame supposedly "unarable" land in places such as the gravelly upland slopes surrounding the Gila, Verde, Santa Cruz, and San Pedro River valleys. Hundreds of thousands of these agricultural features in the prehistoric Southwest attest that it is possible to utilize many areas that today's farmers consider unarable. For example, as shown on the soil survey map, southern Arizona's ancient Hohokam Indian culture created extensive rock-pile fields in the rough, gravelly upland areas overlooking the Gila River east of Florence, Arizona. Other agricultural intensification were used in other parts of the Southwest, as shown in photos on pages 9 and 10.

Would you like to subscribe to **Old Pueblo Archaeology**?

If you are not currently an Old Pueblo Archaeology Center member, please consider becoming one so that you can receive future issues of the *Old Pueblo Archaeology* bulletin. See membership information elsewhere in this issue.



Above: Soil types identified in the vicinity of Florence, Arizona (the developed area in left-central part of this aerial photograph); type 25 soil is "Coolidge-Gunsight complex, 1 to 5 percent slopes" classified by NRCS as "Not prime farmland"; soil survey map downloaded from USDA Natural Resources Conservation Service Web Soil Survey website, June 6, 2015

Center right: Hohokam rock-pile field on Tumamoc Hill, Tucson; photo by Allen Dart

Lower right: Hohokam checkdams on Tumamoc Hill, Tucson; photo by Allen Dart

Old Pueblo Archaeology Center's Board of Directors
as of August 2015

President: Monica Z. Young
Vice President: Samuel Greenleaf
Secretary: Patricia Wiedhopf

Other Board Members:
Alexander Cook, Lynda Klasky,
Paul Virgin, Gwendolyn Wooddell

Executive Director (Volunteer): Allen Dart, RPA

Editor of this Issue of Old Pueblo Archaeology: Allen Dart

Left: checkdam in Hovenweep National Monument, Utah; right: Hohokam contour terrace on Tumamoc Hill, Tucson; photos by Allen Dart

"Walled Gardens at Middle Mesa" (Hopi)
U.S. Library of Congress photo by Edward S. Curtis, 1921

A modern Hopi sand-dune cornfield after harvest;
photo by Allen Dart, April 23, 2014

Case Study 4: Weeds

The herbicide glyphosate, commonly known by its trade name, Roundup, is the primary choice of the U.S. agricultural industry to fight weeds that grow in cotton, corn, and soybean fields. But now there are ten "noxious" agricultural weed species in the U.S. that in the past few years have evolved the ability to withstand an ordinarily lethal dose of glyphosate.

One of these ten, *Amaranthus palmeri* (Palmer amaranth, commonly known as pigweed and careless-weed) has become one of the most prolific and intractable agricultural field weeds. This species has been called "the Paul Bunyan of weeds," able to grow a stalk as thick as a baseball bat and tough enough to disable a combine that has the misfortune to encounter it. In its herbicide-resistant form, "it's about the closest thing out there to a weed we can't control," wrote Purdue University's Thomas T. Bauman in a 2011 *Scientific American* article. "[I]t germinates all season," Bauman stated, "so after you think you've killed it off, it comes up again the next time it rains. Some cotton growers have had to abandon their fields where pigweed has taken hold. Others have turned back the clock on agriculture by a century and are sending crews into their fields to whack at it with hoes." This plant's presence in modern fields makes it extremely difficult for cotton farmers to make a profit.

Yet archaeological and ethnographic studies of human populations over the centuries have shown that some kinds of amaranth, including *A. palmeri*, were used extensively for food because their seeds are edible and can be ground into a nutritious flour, and some of the leaves are nutritious greens.[3] In fact, common spinach is a plant in the Amaranth Family.

Ancient southwestern Native Americans actually encouraged the growth of amaranth and other kinds of "weeds" in and around their corn and bean fields, apparently not just to add to their diet but also to enhance the natural diversity and viability of the areas around the fields. Doing so not only provided additional resources because many of the encouraged wild plants have other economic uses, but their diversity also attracts huntable animals.

Shouldn't we consider some of the "alternative agriculture" techniques?

Amaranthus palmeri photographs courtesy of T. Beth Kinsey, The Firefly Forest: www.fireflyforest.com

Edible amaranth seeds
ID 45906289 © HandmadePictures | dreamstime.com

Globe mallow, a "weedy" species used in traditional medicine by some Arizona Native Americans; photo by Allen Dart

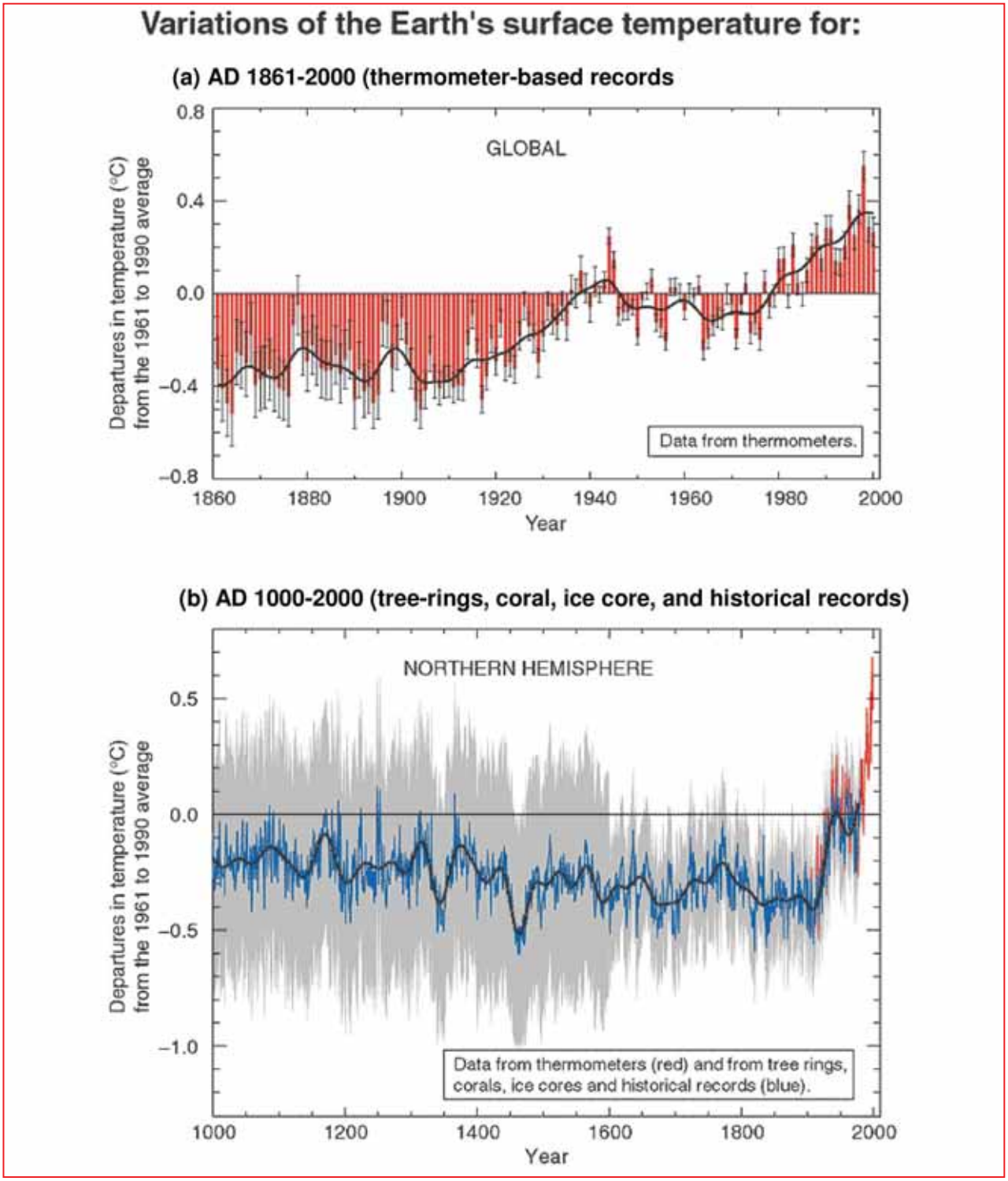
Case Study 5: Dendrochronology and Dendroclimatology

Average annual temperatures measured with thermometers since 1861 (our earliest consistent thermometer records) show that temperatures rose markedly starting between 1905 and 1940, and accelerated significantly beginning in the 1970s. But without good written records of temperatures prior to 1861, how can we tell whether similar extreme-temperature variations also occurred before 1861, or whether the past century's gradual rises in temperatures really are unusual?

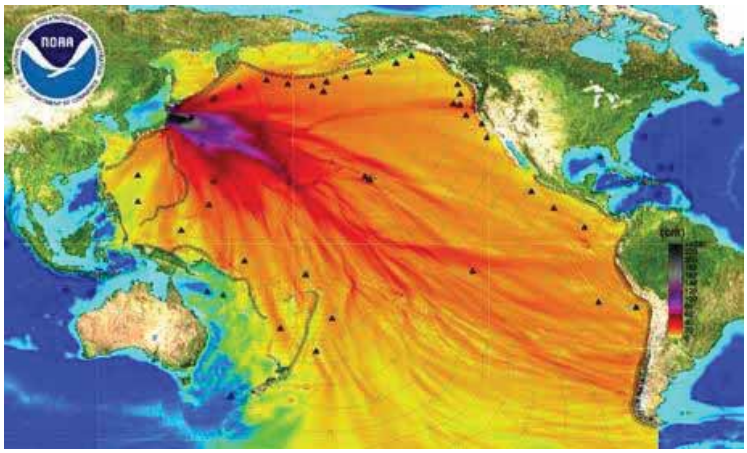
Fortunately, early in the twentieth century, astronomer A. E. Douglass recognized that tree-ring patterns can tell us a lot about past climatic conditions because certain kinds of trees grow thicker annual rings during rainier years and thinner ones or no new growth rings in drought years. By matching the ring patterns of living trees with those of wood samples cut from older, dead ones, Douglass created a "dendrochronology" – a tree-ring time chart – that shows how tree growth in the Southwest reflects environmental conditions in any particular year. With help from archaeologists, who provided older and older samples of wood from archaeological sites, this dendrochronology now has been extended back to at least 322 BC, almost 2,200 years earlier than all historical records of thermometer-based temperatures.

[3] Note that carelessweed and some other amaranths can concentrate nitrates in its leaves when grown in soils high in nitrogen, such as those polluted by agricultural runoff or where nitrogen fertilizers have been used. Such high nitrates are unhealthy, so the leaves should only be used when the plants are found growing in low nitrogen soils and in nitrogen fertilizer-free areas.

How do the tree-ring and thermometer climatic records compare? The deep time environmental record archived in tree rings indicates that the past century's trend of markedly increasing temperatures is unprecedented during the past 1,000 years. Is this something we need to be concerned about? Considering that a significant percentage of the Earth's surface water is currently frozen in polar ice caps, glaciers, and icebergs, continuing average temperature increase will cause sea levels to rise several meters in the next 50 years. So yes, I think warming temperatures are something we should worry about.



Variations of the Earth's surface temperature: AD 1861-2000 from thermometer-based records (shown in red) vs. AD 1000-2000 from tree rings, corals, ice cores, and historical records (shown in blue), adapted from Climate Change 2001: The Scientific Basis by J. T. Houghton, Y. Ding, D. J. Griggs, M. Noguer, P. J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (2001, Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, London)



National Oceanic and Atmospheric Administration energy map showing intensity of the 2011 tsunami

Case Study 6: Deep Time Records of Environmental Shifts and Environmental Hazards

The "deep time" perspective also suggests that if we want to sustain our modern global society and economy, resilience strategies alone are not enough to maintain our way of life and the social order. We also need to pay heed to deep time records of environmental shifts and environmental hazards.

A case in point is the earthquake-generated tsunami that devastated eastern Japan just a few years ago. On March 11, 2011, Japan was rattled by the 9.0-magnitude Tohoku earthquake, the most powerful one in that country's history, followed by a tsunami (tidal wave) that devastated much of the country's east coast. These catastrophic events claimed over 22,000 lives and left thousands of other people missing. The giant tsunami waves deluged cities and rural areas alike, sweeping away cars, homes, buildings, a train, and boats, leaving a path of death and devastation in their wake.

Shortly after the quake, cooling systems in one of the reactors at the Fukushima Daiichi nuclear power station in Fukushima prefecture failed, causing a nuclear crisis. The initial reactor failure was followed by explosions and eventual partial meltdowns in two reactors, then by a fire in a third, which released radioactivity directly into the atmosphere. The nuclear troubles were not limited to the Daiichi plant; three other nuclear facilities also reported problems. More than 200,000 residents were evacuated from affected areas.

Not long after the disaster it was reported that the engineers who designed and sited the Fukushima Daiichi plant had believed the plant was sufficiently protected from damage by tsunamis. Tokyo Electric Power Co. (TEPCO), the plant's builder, had erected seawall defenses at Fukushima high enough to protect the nuclear reactors from waves up to 17 feet high. Was the 17-foot wall high enough? No – The tsunami crested at 23 to 27 feet high, destroying nearly everything in its path.

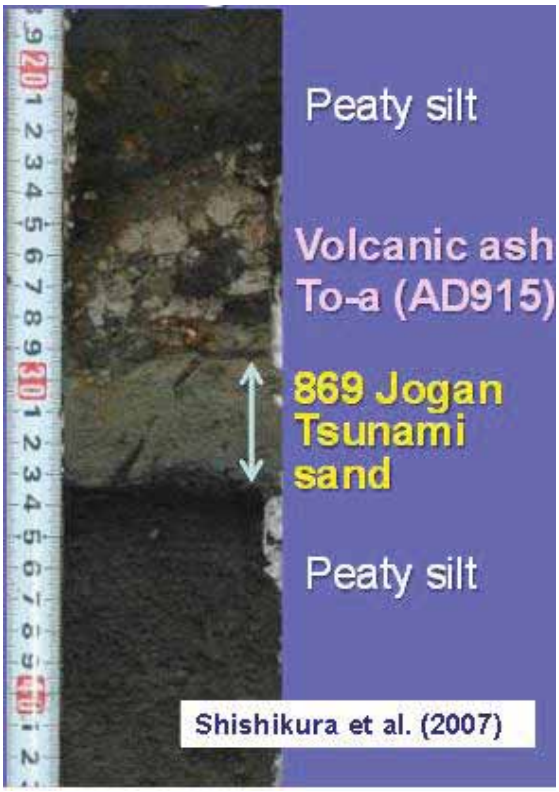
In late March 2011, an Associated Press investigation[4] showed that TEPCO had dismissed important scientific evidence, and all but disregarded 3,000 years of geological history when the company planned the Fukushima nuclear plant defense against a killer tsunami. Geologic records (which in many cases go even deeper into "deep time" than the archaeological record of human events) indicate that tsunami waves had struck the northeastern coast of Japan before, and that it could happen again along a fault line that runs offshore about 220 miles east of Fukushima.

In postulating the worst-case earthquake and tsunami that the Fukushima Daiichi complex might face, TEPCO's engineers decided not to factor in quakes earlier than 1896. That meant they excluded a major quake that occurred more than 1,000 years ago and that was followed by a powerful tsunami that hit many of the same locations as the 2011 disaster. Written history of Japanese tsunamis shows that the Jogan Tsunami of AD 869 brought waves nearly 26 feet high at Soma, just 25 miles north of the plant. Farther north, the geological record shows that a surge from the sea swept sand more than 2.5 miles inland across the Sendai plain. (The 2011 tsunami pushed water at least about 1.5 miles inland.)

Geologists also had found two additional layers of water-swept sand in the region, and concluded that these layers were deposited by two additional "gigantic tsunamis" that had hit the area in the past 3,000 years, both presumably comparable to Jogan. Radiocarbon dating couldn't pinpoint exactly when the other two tsunamis had hit, but the study's authors put the range of the earliest layer of sand between 670 and 910 BC, and the second layer between 140 BC and AD 150.

TEPCO engineers purposely chose to ignore the deep time perspective that was available to them. The result was one of the world's worst nuclear disasters. TEPCO "absolutely should have known better," said Dr. Costas

[4] Source of AP investigation data: *Nuclear Plant and Tsunami Risk: 3,000 Years of Geological History Disregarded* by Yuril Kageyama and Justin Pritchard (2011, coastalcare.org)

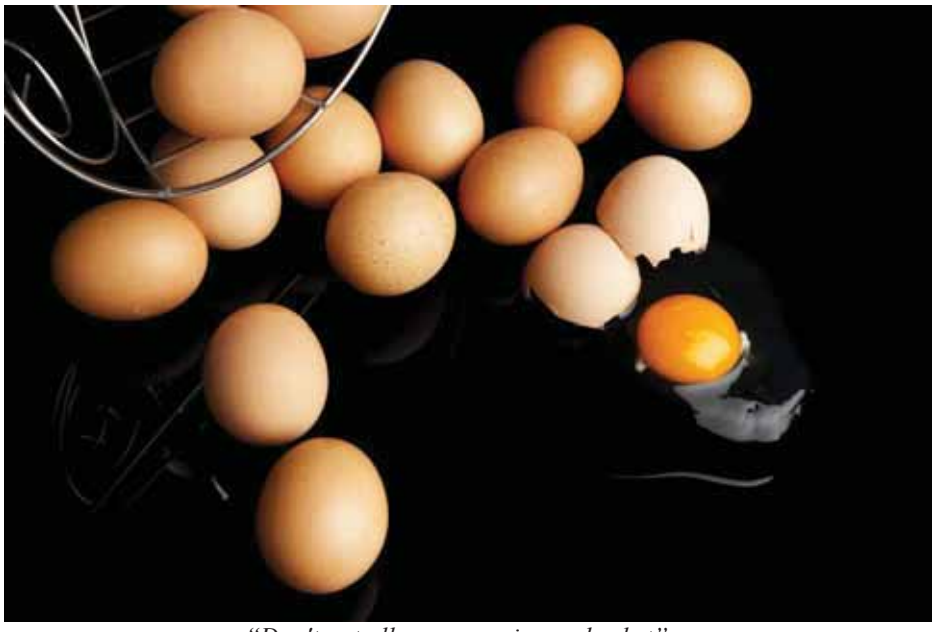


Evidence of 869 Jogan tsunami: left, Japanese historical document; right, geological profile showing sand layer deposited by the tsunami; from "Evaluation of Magnitude of Past Tsunami by Geological Records" by Masanobu Shishikura (2013, PowerPoint file for Geological Survey of Japan paleotsunami workshop, Taiwan)

Synolakis, a leading American expert on tsunami modeling and an engineering professor at the University of Southern California. "Common sense," he said, should have produced a larger predicted maximum water level at the plant.

So What Lessons We Can Apply from "Deep Time" Interpretations of Past Cultures and Events?

To conclude, archaeology and related "deep time" disciplines can help modern society make more informed decisions for planning how to address environmental change, population growth, agriculture, and unanticipated adversities. Some lessons that can be learned from these lines of inquiry include:



"Don't put all your eggs in one basket"
© Eyewave - Dreamstime.com - All Eggs In One Basket Photo

- The perspectives that archaeology and other "deep time" sciences provide on human adaptation, environmental change, and natural hazards are essential supplements to historical records.
- We should pay attention to the archaeological and geological records and interpretations of past earth events and human cultures in addition to relying on historical records.
- Diversity in such things as agriculture and energy sources may be a key to long-term survival and social cohesion. In other words, we should not "put all our eggs in one basket."

In addition to sources in the photo credits I acknowledge and thank Gary Huckleberry for providing the inspiration for this study.

Upcoming Activities

ONGOING:

OPEN3 simulated archaeological dig, OPENOUT in-classroom education programs, and archaeological site tours for children

OTHER ACTIVITIES MAY HAVE BEEN ADDED!

Contact Old Pueblo Archaeology Center
for updates & details

info@oldpueblo.org
520-798-1201
www.oldpueblo.org

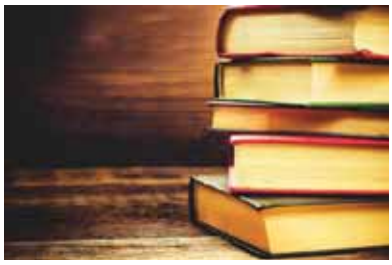
Saturday & Sunday September 5 & 6, 2015 ►►
"Labor Day Weekend Archaeological Excavations at Creekside Village"
in Tularosa Canyon, New Mexico, sponsored by Jornada Research Institute:
David Greenwald, dgreenwald@tularosa.net*

◄◄ September 17, 2015 **"Third Thursday Food for Thought" dinner & "Solar-Petroglyph Interaction at Casa Malpais" presentation by Thomas P. Robinson** at Dragon's View Asian Cuisine, Tucson: info@oldpueblo.org

Saturday September 19-Sunday Sept. 27, 2015 ►►
"Archaeological Excavations at Sevilleta Pueblo"
sponsored by
Jornada Research Institute in Sevilleta, New Mexico:
Michael Bletzer, michael.bletzer@gmail.com*

◄◄ September 21, 2015 **"The Archaeology of the Human Experience"** free presentation by archaeologist Michelle Hegmon at the Arizona Archaeological and Historical Society meeting, Tucson:
John D. Hall, jhall@sricrm.com*

September 23, 2015 ►►
"Autumnal Equinox Tour of Los Morteros and Picture Rocks Petroglyphs Archaeological Sites" with archaeologist Allen Dart in Marana, Arizona:
info@oldpueblo.org



◄◄ September 26, 2015
"ASM Library Benefit Book Sale" at the Arizona State Museum, University of Arizona, Tucson: Darlene Lizarraga, dfl@email.arizona.edu*

Fridays October 2-December 11, 2015 ►►
"Prehistory of the Southwest Class: The Hohokam Culture of Southern Arizona" with archaeologist Allen Dart at Old Pueblo Archaeology Center, Tucson:
info@oldpueblo.org

* Not an Old Pueblo Archaeology Center-sponsored program. For information contact the sponsoring person or organization directly.

Upcoming Activities (Continued)

◄◄ October 2-4, 2016
"Arizona Archaeological Society Annual Meeting"
at Springerville Heritage Center, 418 East Main Street, Springerville, Arizona: Carol Farnsworth, farnsc570@gmail.com*

October 3, 2015 ►►
"Arrowhead-making and Flintknapping Workshop"
with flintknapper Sam Greenleaf at Old Pueblo Archaeology Center, Tucson: info@oldpueblo.org

◄◄ October 7, 2015
"Set in Stone but Not in Meaning: Southwestern Indian Rock Art"
free presentation by archaeologist Allen Dart at Maricopa County White Tank Library, Waddell, Arizona:
PattyDennehy@mcldaz.org*

October 9, 2015 ►►
"Hohokam and Mimbres Archaeology, Art, and Ideology" adult education class with archaeologist Allen Dart for OLLI-UA Green Valley members at Pima Community College, Green Valley, Arizona: https://ce.arizona.edu/olli*

◄◄ October 15-18, 2015
"Southwest Kiln Conference" at Eastern Arizona College, Safford:
http://www.swkiln.com/*

October 19, 2015 ►►
"Navajo Rugs and Textiles" lecture and hands-on interactive demonstration sponsored by Desert Foothills Chapter, Arizona Archaeological Society, at Good Shepherd of the Hills Church, Cave Creek , Arizona: Mary Kearney, maryk92@aol.com*

◄◄ October 26-30, 2015
"The Rustic Border Region of Arizona and New Mexico"
Arizona Pathfinders coach tour departing from Arizona Historical Society Museum, 949 E. Second St., Tucson:
azpathfindersahs@gmail.com*

October 31 is the deadline to get tickets for the November 13, 2015 ►►
"Fundraising Raffle of a 2015 Ford Mustang - 50th Anniversary Edition"
by Tucson's Jim Click Automotive Team & Old Pueblo Archaeology Center:
info@oldpueblo.org

◄◄ October 31 also is the deadline to get tickets for the November 13, 2015 **"Old Pueblo – Young People" fundraising raffle** to benefit Old Pueblo Archaeology Center's children's education programs. The grand prize is a 66 by 37 inch Navajo rug-saddle blanket appraised at up to $800: info@oldpueblo.org

* Not an Old Pueblo Archaeology Center-sponsored program. For information contact the sponsoring person or organization directly.

Upcoming Activities (Continued)

January 16, 2016 ►►
"Charlie Bell Canyon Petroglyphs and Archaeology Tour" with Rick and Sandi Martynec in Cabeza Prieta National Wildlife Refuge west of Ajo, Arizona; depart in car caravan from Pima Community College, 401 N. Bonita Ave., Tucson; or Cabeza Prieta National Wildlife Refuge (CPNWS) headquarters, 611 N. 2nd Ave., Ajo: info@oldpueblo.org

Archaeology Opportunities **Membership/Old Pueblo Archaeology Subscription Application Form**

Whichever membership level you choose,
your membership fee supports Old Pueblo Archaeology Center's educational programs.

Name (Mr., Ms. Mrs.) _____

Address _____

City, State, Zip _____

Area Code & Phone ( ) _____

Email address _____

I am submitting the following payment for:

Archaeology Opportunities membership $ ____

Category:* _____

Old Pueblo Archaeology subscription only $ ____

Donation to Old Pueblo Archaeology Center $ ____

TOTAL ENCLOSED $ ____

Membership categories and rates:

❑ Individual	$40	* Categories and rates shown at left include Old Pueblo Archaeology electronic bulletin annual subscription (4 issues), provide discounts on publications and some activities, and provide opportunities to participate in Old Pueblo Archaeology Center's member-assisted field research programs such as archaeological excavations and surveys.		
❑ Household	$80			
❑ Sustaining	$100			
❑ Contributing	$200	❑ Friend	$25	Provides 1-year Old Pueblo Archaeology bulletin subscription (4 issues) & discounts on publications & some activities; does not provide participation in member-assisted field research programs.
❑ Supporting	$500			
❑ Sponsoring	$1,000	❑ Subscriber	$10	Provides 1-year subscription to the Old Pueblo Archaeology electronic bulletin (4 issues); does not provide discounts or participation in member-assisted field research programs.
❑ Corporation	$1,000			

Please complete this section only if paying with credit card:

Please charge to my: ❑ Visa ❑ MasterCard ❑ Discover ❑ Diners Club

Name on credit card _____

Account # on front of card _____ Expiration date (Month/Year) ____ / ____

Signature _____ Date signed _____

Please return this form, with check payable to "OPAC" or with credit card information completed, to the address below:

Old Pueblo Archaeology Center
PO Box 40577
Tucson AZ 85717-0577

Questions? Contact Old Pueblo at 520-798-1201 or info@oldpueblo.org

Thank you for helping teach and protect the Southwest's heritage!

Old Pueblo Archaeology Center
PO Box 40577
Tucson AZ 85717-0577

Apply Postage Here for Mailing

Old Pueblo Archaeology

Bulletin of Old Pueblo Archaeology Center

Located at 2201 W. 44th Street in the Tucson Unified School District's Ajo Service Center
Mailing Address: PO Box 40577, Tucson AZ 85717-0577
www.oldpueblo.org 520-798-1201 info@oldpueblo.org

Old Pueblo Archaeology Center's *Archaeology Opportunities* Membership and Discounts Program

Archaeology Opportunities is a membership program for persons who wish to support Old Pueblo Archaeology Center's education efforts and perhaps even to experience for themselves the thrill of discovery by participating in research. Membership is also a means of getting discounts on the fees Old Pueblo normally charges for publications, education programs, and tours. Members of *Archaeology Opportunities* at the Individual membership level and above are allowed to participate in certain of Old Pueblo's archaeological excavation, survey, and other field research projects, and can assist with studies and reconstruction of pottery and other artifacts in the archaeology laboratory. Membership benefits include a 1-year subscription to the **Old Pueblo Archaeology** electronic quarterly bulletin, opportunities to participate in Old Pueblo's member-assisted field research programs, discounts on publications and archaeology-related items, and invitations and discounts for field trips and other events.

Old Pueblo Archaeology is the quarterly bulletin of Old Pueblo Archaeology Center, a 501(c)(3) nonprofit corporation. Questions, comments, and news items can be addressed to editor Allen Dart at info@oldpueblo.org or 520-798-1201, or by mail to Old Pueblo Archaeology Center, PO Box 40577, Tucson AZ 85717-0577. For more information please visit our web site: www.oldpueblo.org. Your membership helps support Old Pueblo's children's education programs.

Disclosure: Old Pueblo Archaeology Center's Executive Director Allen Dart is a USDA Natural Resources Conservation Service cultural resources specialist who volunteers his time to Old Pueblo. Views expressed in Old Pueblo Archaeology Center communications do not necessarily represent views of the U.S. Department of Agriculture or of the United States.