Ancient Maya solutions to water and food insecurity: Low technology lessons for contemporary development

Ezgi Akpinar Ferrand and Vernon L. Scarborough
Southern Connecticut State University and University of Cincinnati, United States

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The authors argue that the application of ancient Maya water management systems could support contemporary water security. They show that man-made or natural ponds, known as *aguadas*, could be a low technology, sustainable solution for communities living in the ancient Maya landscape today.

Keywords: Maya; aguada; water security; low technology solutions; development.

Human civilizations exist over periods of environmental change and can cause large-scale environmental alterations, but how these changes affect civilizations is a matter of contentious debate. Beginning with the Neolithic Revolution, we have witnessed numerous human societies affected, and even brought to their knees, by natural and human-made environmental change. Civilizations such as the ancient Maya flourished in the difficult landscapes of Central America starting from 1000 B.C. until the Terminal Classic in the 10th century A.D. Scholars debate their demise, but two environmental changes occurred contemporaneously: climate change (prolonged droughts), and soil erosion and sedimentation[1,2,3]. Warfare also seems to have increased in the decades before the end of the Terminal Classic, which may or may not have been related to stresses associated with these changes[4,5].

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Interestingly, the regions in which the ancient Maya inhabited by the millions, such as Petén, Guatemala, were never again occupied at the same densities after their downfall[6,7]. After a century of continuous study, assessments of land-use, food production, water management systems, and environmental change have provided a better understanding of the reasons behind ancient Maya successes and failures within this environment—one limited by thin soils, low availability of surface water (karst geology), a marked dry/wet climatic regime, and periodic droughts.

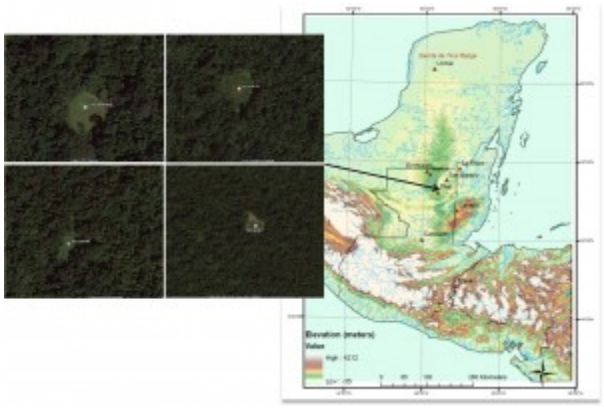

Figure 1. Aguadas in Maya Lowlands, Central America. Source: Akpinar Ferrand (2011) and Google Earth.

At the turn of the 21st century, water and food security issues remain among the most pressing concerns globally, not dissimilar to what the ancient Maya experienced a millennium ago—if only at a regional scale[8]. A number of today's prima facie technologically advanced solutions, such as genetically modified seeds, large-scale water developments like the GAP Project in Turkey or the Three Dams Project in China, and the complex practices of the "Green Revolution", present a series of environmental and societal concerns[9,10,11,12]. Scientists and governments are now paying close attention to ancient and traditional low technology agricultural and environmentally sound land-use practices[13]. Significantly, the livelihood of two-thirds of humanity still depends on traditional agricultural techniques and their local agricultural output[14]. In the least developed and developing nations of the subtropics, we observe a dependence on rainfall for water security which also defined the water storage practices of the ancient Maya[15]. It is our hypothesis that the application of ancient Maya water management systems may present sustainable low technology solutions to increase water and food security among present-day populations living in the same ancient landscape as well as in those nations in comparable geographic areas. One area of interest and great promise in applying ancient Maya water management best-practices involves the use of natural and human-made ponds, known as *aguadas*[16].

Across a wide swath of the interior Maya lowlands, the ancient Maya exploited sinkholes and natural depressions. Where nature did not provide, the Maya utilized quarried depressions for water retention. The karst nature of the landmass and a highly seasonal distribution of rainfall made the

capture and storage of rainwater a necessity. Collectively, thousands of *aguadas* are found wherever the ancient Maya resided in the seasonally parched interior parts of the peninsula[17]. Archaeological evidence suggests that the ancient civilization spent a considerable amount of effort modifying and maintaining their *aguadas*[16].

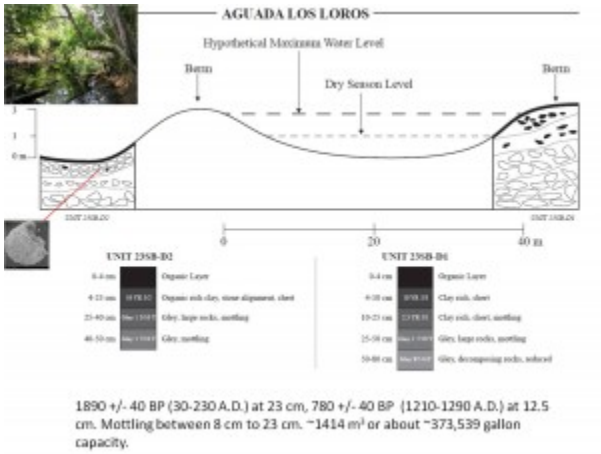

Figure 2. Aguada Los Loronos, Petén, Guatemala. Source: Akpinar Ferrand et al. forthcoming.

Ancient Maya modified and constructed *aguadas* utilizing different techniques. Some of these techniques involved lining the *aguadas* with impermeable clay, stone or plaster lining, building stone-lined wells called *buk'te* to preserve water (in the deepest part of the *aguadas)*, and constructing silting tanks at their entrances (to filter water)[16,18,19]. We also know that endemic plant species of *Nymphaea ampla*'s (water lilly) pollen were commonly found in the ancient sediments of *aguadas* from paleoenvironmental investigations[17]. *Nymphaea ampla* is known to grow in clean and still water—as an *aguada* plant it was likely useful in preventing excess evaporation and reducing organic waste[15,20,21].

Further evidence from *aguada* investigations demonstrate that the ancient Maya increased *aguada* capacities by building berms and dredging. Over the years, investigations of *aguadas* have revealed that *aguada* volumes usually range between 2,500 and 10,000 m^3 [17]. Weiss-Krejci and Sabbas (2002) demonstrate that a small depression with 57m^3 capacity could have supported forty-seven people with 4.8 liters daily water per capita using precipitation and evaporation data from Belize [22]. If we consider that most *aguadas* were much bigger in volume, we can begin to imagine the immense water storage capacity of these features for modern populations of the interior Maya Lowlands currently facing water scarcity.

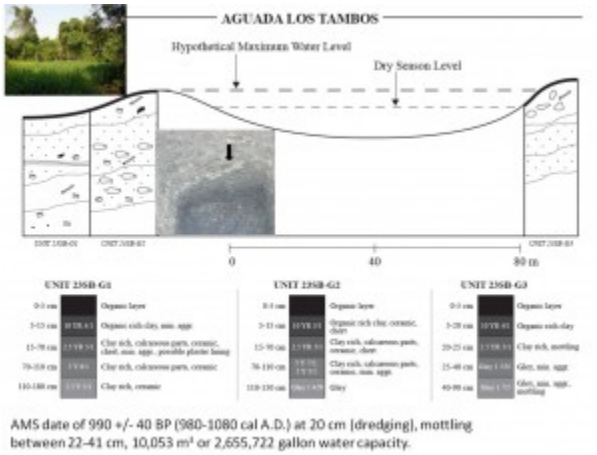

Figure 3. Aguada Los Tambos, Petén, Guatemala. Source: Akpinar Ferrand et al. forthcoming.

Lastly, *aguadas* may prove essential in increasing the food security of the interior Maya Lowlands. Corroborating *aguadas'* potential for agriculture is the ancient pollen recovered repeatedly within *aguada* sediments, including cultigens that broadcast pollen over relatively short distances (e.g. manioc, cotton, and maize) [16,23,24,25]. Ancient Maya were likely using *aguada* water for pot irrigating proximate fields or agricultural terraces. Furthermore, modern experiments are showing the potential of *aguadas* for aquaculture in the Yucatan Peninsula [26,27]. Arredondo et al. (1982) described the placement of 18 g of tilapia fry in a seasonal shallow water *aguada* in central Mexico (0.8 fish/m²) with a resultant 450 kg/ha tilapia yield requiring no additional feeding[26]. The placement of native fish species is recommended for sustainable development purposes based on the unfavorable results of studies analysing the introduction of non-indigenous species to *aguadas* [28].

In conclusion, easy to adopt, low-end technologies, derived from tried and true solutions of ancient civilizations may prove invaluable beginning points for sustainable development projects in developing nations today. Based on the paleoenvironmental, archaeological and aquacultural investigations of *aguadas,* scholars now know rainwater water collection in *aguadas* can increase the water and food security of present-day regions formerly occupied by the ancient Maya. Looking further afield, the ancient Maya example provides lessons for comparable regions of the globe.

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About the author(s)

Dr. Ezgi Akpinar Ferrand is a visiting assistant professor in the Department of Geography at Southern Connecticut State University. Akpinar Ferrand conducts research on paleoenvironments, geoarchaeology, sustainable development, and water and food security in Belize, Guatemala and Mexico. She has also worked in Turkey. Professor Vernon L. Scarborough is a Distinguished Research Professor and Charles P. Taft Professor in the Department of Anthropology at University of Cincinnati. Scarborough's research and fieldwork on hydrology and water management systems has been conducted primarily among pre-Columbian Maya civilization sites in the Maya lowlands of Guatemala and Belize. Scarborough also worked on water management systems at site locations in Sudan, Pakistan, Indonesia, Greece and the American Southwest, among others. This article is partly based on an original piece of research awaiting publication in the Journal of Ancient Mesoamerica titled 'Use of Aguadas as Water Management Sources in Two Southern Maya Lowland Sites.' Dr. Akpinar Ferrand can be contacted at: *akpinarfere1@southernct.edu*.

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