Cooperation Reveals Legacy of **Ancient Land Use**

Dr. Nicholas Brokaw and Dr. Sheila Ward

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Dr. Nicholas Brokaw and Dr. Sheila Ward of the University of Puerto Rico recently conducted a multidisciplinary study with collaborators from around the United States to decipher how and to what extent ancient Maya land use affects land management and the environment today.

Nicholas Brokaw by S. Eshleman

This project is multidisciplinary and many people were involved. How did the project come together?

Fortunately for us, archaeologist Stan Walling invited us to his study area in the Rio Bravo Conservation and Management Area (RBCMA), Belize, to look at the present abundance of some tree species used by the ancient Maya. He thought the present distribution and abundance of those species might reflect ancient rituals. Stan also introduced us to archaeologist Marisol Cortez-Rincon, and geo-archaeologists Tim Beach and Sheryl Luzzadder-Beach, who study the impacts of the ancient Maya on topography, soil, and hydrology. We realized that we had the inter-disciplinary team to look at how the Maya used the land (archaeology), how that land use changed topography and soil for the long term (geo-archaeology), and how those long-term topography and soil changes still affect the present forest (ecology).

The team needed access to landscapes that had been used and shaped by the ancient Maya to conduct your research, and you worked on the Rio Bravo Conservation and Management Area. What was it like working with them and was it at all difficult to get permission for land access?

That was the easy part. The RBCMA is owned and managed by Programme for Belize (PfB), a Belizean NGO whose mission is to manage and conserve their 100,000 ha reserve through research and sustainable uses. Our work is part of the research agendas of the Programme for Belize Archaeology Project, In the RBCMA, and the Maya Research Program (MRP), nearby. PfB and MRP make our work logistically possible.

The RBCMA is a great place to look at the effect of the ancient Maya on the present forest. It has: 1) a large area, to take in variation of landscape and topography, 2) a great variety and number of ancient Maya features – temples, house mounds, causeways, reservoirs, terraces – the variation that we want to relate to variation in the present forest, and 3) mostly old-growth forest undisturbed (except for some light logging for mahogany and Spanish cedar) since the departure of the Maya in about 900 AD. So there is little subsequent disturbance to obscure the direct effects of Maya land use. It's also great fun to work in this big, wild area. Working in the field Last summer we saw a puma and a jaguar.

Did you have difficulty getting funding for the project, or experience any major obstacles to securing funding?

Our work is supported by the US National Science Foundation (NSF) and through university field courses. Our timing has been good. NSF has been funding more interdisciplinary work and work on nature/human interactions, and NSF likes collaborations among diverse institutions. That is what we proposed and NSF funded. Also, everyone is fascinated by the ancient Maya and by the tropical forest. We put all that together.

Did any other complications arise during your research?

A complication is the nature of the Maya forest "experiment". Widespread ancient Maya land use and subsequent forest regrowth amount to a large-scale, long-term experiment on biodiversity. Like a normal experiment we have experimental results, in this case the present forest. But unlike a normal experiment we do not know what the experimental treatments were, in this case the ancient Maya land uses a thousand years ago. So the archaeological and geo-archaeological work is to reveal the treatments, and the ecological research is to describe the details of the results, that is, the tree species composition of the present forest. Also, there are no places we can be assured were never cleared by the ancient Maya, to serve as experimental controls. Thus our method is to compare present forests in areas of different ancient land uses.

Another "complication" is that the field work can be pretty grueling. There are heat, rain, sharp spines, mosquitos, botflies. But the forest is so beautiful and interesting, and the camaraderie is so good. Those keep you going.

Communicating with the Past through the Forest

A multidisciplinary group of archaeologists, geo-archaeologists, and ecologists are working together to study the impact of the ancient Maya on the modern environment. To succeed, they need to account for culture, land use, and the environment.

Sheila Ward by N. Brokaw

WORKING TOGETHER

Archaeology and ecology study the same things, sometimes, because their search for evidence often lead them to far-off, remote places where the environment has been relatively untouched by human hands, at least recently. In this case, Dr. Nicholas Brokaw and Dr. Sheila Ward travel to the 100,000 hectare Rio Bravo Conservation and Management Area (RBCMA) in Belize to study how the ancient Maya affect the environment there to this day. The Maya civilization has long impressed and puzzled scientists. How did they grow enough food to feed their high populations and support an elite class who oversaw the building of temples, the development of astronomy, and other achievements? Why did the Maya decline so quickly and what were the long-term environmental consequences of their land use? By visiting the RBCMA, the researchers are able to "speak" to these ancient people about their lives using the evidence they left behind. Though it provides some interesting challenges, working as a team, rather than apart, ultimately allows the archaeologists, geo-archaeologists, and ecologists to better understand the Maya and the tropical forest of the RBCMA.

MAYA ENVIRONMENTAL HISTORY

The RBCMA is now covered largely with old-growth tropical forest, having been selectively logged for mahogany and Spanish cedar but little disturbed otherwise. But at one time it was home to many types of Maya structures: cities, villages, reservoirs, terraces, canals and more. The forest is underlain by porous limestone and surface water is rare in the uplands of the RBCMA. Despite this, annual rainy seasons have created a tropical forest of many broadleaf tree species, palm trees, thick vines, and large herbs.

In the Maya area humans entered the picture around 7,000 BC, and by 1,000 BC, the Maya civilization began, peaking at a high population in about 900 AD. Scientists note that fossil pollen, carbon-13 isotopes, and lake-bottom sediments all suggest that agriculture became prominent and the forest began declining at around 3,000-1,000 BC. When the Maya declined, following about 900 AD, the forest returned.

To support their impressive cities and high population the Maya must have been masters of agriculture. Their probable farming methods

could have included swidden (shifting or slash-and-burn) agriculture and probably larger-scale, intensive farming of annual crops. Of special interest was agriculture that may have included trees and from which the modern forest may have developed. Possible household gardens near dwellings would have contained a variety of useful trees and other plants. Patches of land further away may have been used to grow specific types of fruit trees, while other forest patches may have been allowed to grow more naturally but with selective cultivation and harvest of certain tree species and other products. Forests in remote areas or areas bordering Maya city-states were perhaps left partly untouched.

Only a multi-disciplinary team can evaluate the long-term impacts of this ancient land use. The archaeologists study the ancient structures that remain today to suggest ancient land uses. The geo-archaeologists study how that land use changed topography and soils, while the ecologists view the same sites with different eyes, seeing the effects of the past on the present and future forest. Together, they are working to answer the question: Did Maya land use decrease tree species diversity and productivity of the regrown forests? Or rather, did the Maya use of the land enrich diversity and productivity? Since the RBCMA's forest, once home to a thriving Maya civilization, dates from the time of the Maya collapse, it is a perfect laboratory for this study.

TREE DISTRIBUTIONS TODAY: CURRENT ENVIRONMENT? ANCIENT CULTIVATION?

Brokaw, Ward and their collaborators believe that the ancient Maya did have a major impact on the modern forest. First, the archaeologists have shown that the Maya erected many different types of structures, which created long-lasting, novel substrates for the regrown forest. Second, a record of erosion and deposition due to land use, uncovered by the geo-archaeologists, showed that the Maya inadvertently moved tons of soil permanently downslope. That probably exaggerated the substrate difference between uplands, with drier, thinner soil, versus lowlands, with wetter, thicker soil. Early results from Brokaw and Ward's study show that many tree species at the RBCMA have preferences for distinctive soil characteristics. Therefore, this soil movement from uplands to lowlands could have had a large impact on the present, post-Maya distribution and abundance of tree species.

The distribution of the ramón tree *(Brosimum alicastrum),* for example, shows that it prefers the calcium-rich soil in natural uplands and on Maya temples constructed with calcium-rich limestone blocks.

While the evidence suggests that ancient land management had lasting effects on the future forest, the researchers are not yet able to determine whether Maya tree cultivation affected the distribution of tree species in the modern forest of the RBCMA. The hypothesis is that the Maya would have preferred certain tree species to others, and they would have planted and protected those species. Would the effect be large enough to still influence the spatial distribution and abundance of the descendants of those species today, 1000 years after the Maya decline and forest regrowth? There are many species useful to humans in the forest of the RBCMA. Many researchers see that as evidence that the Maya cultivated those tree species so effectively that they enriched the species composition of the current forest. Unlike researchers at some other sites, The University of Puerto Rico team has not yet found evidence in the RBCMA to support that conclusion. Of course, future research could provide new insights.

FUTURE OF THE FOREST

Ward and Brokaw hope that by using information available about the past, it is possible to make the present and future a better place. However, it is not certain what aspects of Maya agriculture and deforestation are a useful analogue for modern civilization. The research team points out that, although some archaeologists believe Maya agriculture was ultimately unsustainable, its variety did support a populous civilization for hundreds of years, and thus adaptations of their methods might enhance sustainability today. Also, although the Maya likely deforested a large area of Mesoamerica, there probably were many interspersed patches of regrowth and uncut forest, in which most forest species survived, unlike in the larger cleared areas lacking patches of regrowth today. The Maya might teach us how to supply humanity with the resources it needs and teach us why we should not clear the forest far and wide. They could light the way forward in a time of great global change and environmental risk. Brokaw and Ward will soon have more conclusions and yet more questions from analysing the data already in hand, "then it's back to the forest".

Researcher Profile

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Dr. Nicholas Brokaw was educated at Princeton University and the University of Chicago. He now teaches environmental science at the University of Puerto Rico. His research focuses on tracking and understanding long-term changes in tropical forests, and his work has been published in *Trends in Ecology and Evolution and Encyclopedia of the Ancient Maya.*

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Dr. Sheila Ward received her PhD in Ecology at the University of California-Davis. She was awarded a Fulbright Fellowship for forest science research and has been published in *Environmental Conservation* and *Forensic Science International: Genetics.* She researches tropical forests, focusing on tree improvement and the relationship between the environment and forest dynamics.

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