The Geography of Collapse

Using Subjective GIS to Illustrate one of the Great Historical Struggles between Humans and their Environment

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Abstract

History undoubtedly repeats itself; engaging with the past to inform the present is often necessary in addressing some of the greatest challenges to a globalized world. Historical scholars are beginning to embrace geography as a means to connect the past with the present, and increasingly engaging in the use of GIS to do so.

Jared Diamond's book, *Collapse*, calls upon the examples of great ancient civilizations that crumbled under the destructive impacts of deforestation, unsustainable agriculture, and overpopulation in order to place in context the similar environmental problems we face today. Mapping these examples so that they can be explored in a more interactive way engages the minds of a wider audience than historians or climatologists. A GIS-based illustration of historical societal "collapse" can encourage public awareness of current threats to regional and global environmental security, and on some level a resistance to a similar fate.

The objectives of this project are (1) to apply current methods of GIS-based historical geography and literary analysis to the discussion of Chaco Canyon in Jared Diamond's book, *Collapse,* (2) to create an animated map that will geographically and historically represent the evolution of the food, water and timber resources consumed by the Ancient Puebloans at Chaco Canyon that ultimately caused their own demise through unsustainable growth and consumption, and (3) to provide an educational resource that provides insight into the past and therefore the future of global climate change, overpopulation and unsustainable resource management.

Introduction

The most famous stories of societal collapse seem to come from far-away cultures, such as the people of Easter Island, the Mayas, or the Aztecs. In northwestern New Mexico, Chaco Canyon remains a popular tourist attraction, but few Americans realize that the downfall of the Chaco Culture around the mid 13th century marked an equally catastrophic period in North American pre-history (Diamond 2005).

Looking upon the site remains, one may wonder why the Ancient Puebloans, after thousands of years of migrating across North America, would have chosen to settle in such a precarious, barren landscape. Archaeological finds in this region have revealed, however, that the dry and listless landscape we see today at Chaco Canyon once flourished with pinyon and juniper woodlands (Diamond 2005). It is a combination of unsustainable water resource use, deforestation and gradual drying of the local climate that are largely attributable to the sudden breakdown of the most extensive, complex society in pre-Columbian North America at its time, complete and abrupt abandonment of Chaco Canyon, and the seemingly wasted landscape its inhabitants left behind. Facing similar problems across the world today, we would do well to appreciate the story of Chaco Canyon.

The core of this project can be defined as the translation of historical representational space to the representational space of a map. When dealing with centuries of history for which we now have only glimpses of facts, this becomes particularly tricky. Literary and historical GIS attempt to combine both quantitative and qualitative data together in an attempt to present a story in such a way that orients the reader's mind and hopefully, better guides him or her through a series of seemingly disconnected details. As writer Eric Bulson so eloquently stated, "Literary (and in my opinion, Historical) maps give readers something that novels do not: an image, a structure, a way to visualize form and narrative design." (Bulson 2007)

Source: National Park Service

Pueblo Bonito was the largest (1 ha) community center in Chaco Canyon, containing approximately 600 chambers at the peak of Chaco Culture. Construction began in 1070 and was finished by 1115. it was also the center of religion and long-distance trade, having great political influence on the other community "houses" of Chaco Canyon

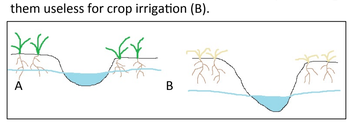
Lessons from History: What did the Ancient Puebloans get wrong?

The Illusion of Abundance: Chaco's Fickle Climate

Chaco Canyon was created by the erosion of the Chaco Wash River, cutting through the Northwestern region of the Colorado Plateau. The canyon floor is mostly sand, and despite the obvious evidence of fluvial landscape morphology, water doesn't last long in Chaco Canyon. Rain visits more seldom now than it did in the first and second millennia AD, but even then every drop of rain mattered to the Ancient Puebloans. As a result of this arid climate, growth rates of the surrounding juniper and pinyon woodlands are slower than those of more humid climes. (Diamond 2005, Price and Feinman 2010). The combination of slow forest recovery, inconsistent annual rainfall patterns proved to be a deadly combination for the Ancient Puebloans. The larger their population became, the larger the risk of widespread famine, in even a few years of drought (Diamond 2005).

Technological Blunder: Irrigation Canals

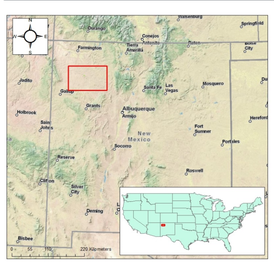
The Ancient Puebloans relied on floodwaters from occasional thunderstorms to provide a reliable water source for as much cropland area as possible. They constructed complex canal systems that would connect to ephemeral streams that drained into the Chaco Wash River. When rain did come, runoff would be diverted into the fields, raising the water table to irrigate crops (A). They did not take into account, however, that the erosive flow of runoff through narrow canals would widen and lower them, thus lowering the water table below the root zone, eventually rendering them useless for crop irrigation (B).



Pushing the Boundaries: Timber

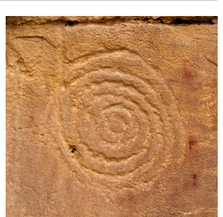
Timber was an important resource for fuel and housing at Chaco Canyon. The early settlers were surrounded by woodlands of juniper as well as pinyon pine, whose nuts provided an important protein source. As the Puebloans grew in number, so did their demand for timber. Not only did the loss of these woodlands to roof beams eliminate nuts as well as deer from the region, but it also left the soil lacking regenerative nutrients that the trees had provided for woodland regrowth. At peak population, the Puebloans were having to travel great distances to retrieve the timber they needed.

Methodology



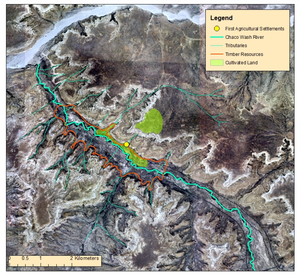
The Ancient Puebloans had no writing of their own; all we have are smatterings of archaeological evidence of Chaco Canyon's story. Therefore, I have taken the liberty to, through my interpretation of the chapter, "The Ancient Ones: The Anasazi and their Neighbors" of Jared Diamond's book, Collapse, as well as other resources, employ GIS to illustrate the progression of resource use at Chaco Canyon between 0-1200 AD. I pursued this objective using the following:

- Publicly Available Digital Orthophotos (University of New Mexico, to provide surface detail (Projection: Universal Transverse Mercator, Zone 13)
- Publically Available Hydrographic Layers (NOAA), for the digital representation of the Chaco Wash River
- Buffer Layers based on timber resource use as described in Collapse
- Creation of Shapefiles representing likely farmland and canal systems

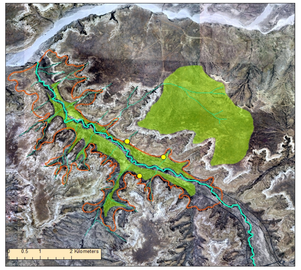


A petroglyph on a Chaco Canyon Wall

Engaging GIS

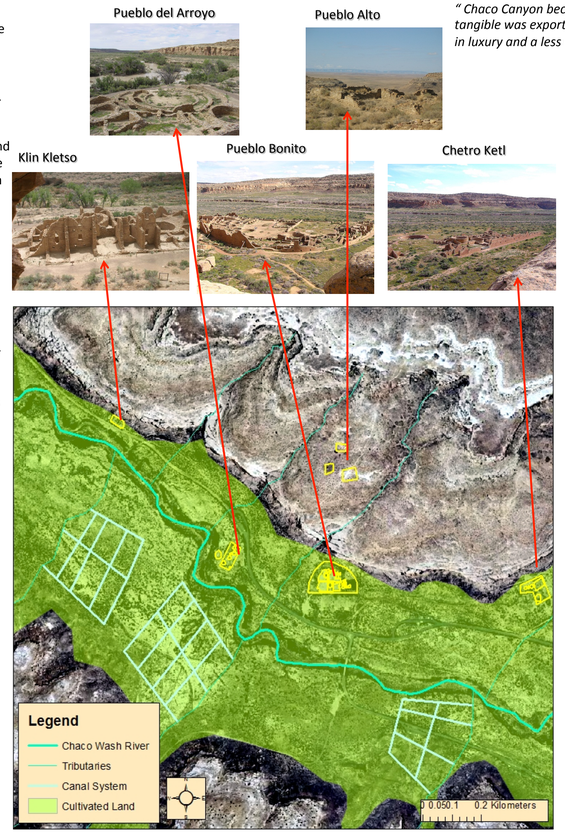


1 AD - 500 AD
The first sedentary dwellings of the Ancient Puebloans show up in the archaeological record around 100 AD (Price and Feinman 2010), on the upper mesas of Chaco Canyon. These communities introduced dryland agriculture to Chaco Canyon, cultivating corn, beans, and squash. However, the diet of these early settlers was largely reliant on the gathering of pinyon nuts and the hunting of small rodents and deer.



500 AD – 700 AD
In the second half of the first century AD, the construction of more permanent structures, as well as specialized architecture for dwellings (pithouses), food storage rooms, and round religious or community gatherings (kivas). This suggests that there was a large enough population at this time for significant investments in labor. The area of cultivated land as well as the land used for timber expanded during this initial period of growth.

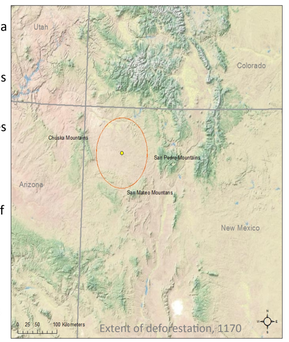
700 AD – 1000 AD
As population and also construction expanded between 700 and 1000 AD, the species of timber used to buid Chaco Canyon's impressive architecture changed from pinyon and juniper, which were locally available, to spruce and Douglas fir, which only grow at higher elevations. This suggests that the land area used for timber resources was rapidly expanding beyond Chaco Canyon's walls when construction began on a large scale.

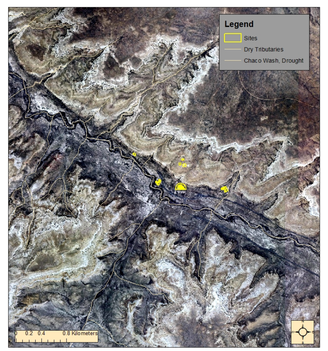


" Chaco Canyon became a black hole into which goods were imported but from which nothing tangible was exported…Chaco society turned into a mini empire, divided between a well-fed living in luxury and a less well-fed peasantry doing the work and raising the food." (Diamond, p. 149).

1000 AD- 1200 AD
Between 1020 and 1100, Chaco Canyon reached it's peak population and spatial extent. The images to the left are of the remains of Chaco Canyon's most populated centers, Pueblo Bonito being the largest. However, this was a very different people than the hunter-gatherers and subsistence farmers that preceded them. The people of Chaco Canyon engaged in a regional trading network over 53,000 sq.km (20,500 sq. mi), exchanging goods such as shell trumpets, copper bells, precious stones and macaw feathers from the west coast and Mesoamerica (Price and Feinman 2010). However, having exhausted local timber resources, increasingly scarce rainfall, and an overwhelming number of mouths to feed, The Ancient Puebloans grew increasingly reliant on their trade networks for food and fuel

According to archaeological record, the last tree used as a roof beam was cut in 1170. Dendrochronology and strontium isotope dating tells us that at this point, spruce trees and corn were being imported from up to 56 miles outside of Pueblo Bonito, in the Chuska, San Mateo, and San Pedro Mountains to the west, east, and south of Chaco Canyon. Because all of their local resources had been utterly depleted, the Ancient Puebloans had irreversibly turned themselves into a society dependent on the resources of far away lands.





In 1175, cycles of intermittent droughts lasting decades at a time began to plague the Ancient Puebloans. These would not have been enough to destroy the Ancient Puebloans 500 years earlier, when they were much smaller in number. Climate change became the straw that broke the back of Chaco Canyon civilization.

Without fuel, vegetables, animal protein, or water, the great kivas of Pueblo Bonito had already began to receive the brunt of violence that appeared during Chaco's final decades as the largest and most complex society of Pre-Columbian North America. Findings of complete decapitated rat bodies in human coprolites, as well as strong evidence for cannibalism suggest that these were desperate times. By 1200 AD, Chaco Canyon had been abandoned completely, its survivors migrating northward over the Colorado Plateau.

Informing the Present…and the Future

"All of us moderns – house-owners, investors, politicians, university administrators, and others – can get away with a lot of waste when the economy is good. We forget that conditions fluctuate, and we may not be able to anticipate when conditions will change. By that time, we may already have become attached to an expensive lifestyle, leaving an enforced diminished lifestyle or bankruptcy as the sole outs" – Diamond, p.156

With the benefit of hindsight, it is clear that the collapse of Chaco Canyon Culture in the 13th century originated in human environmental impacts. The Ancient Puebloans settled Chaco Canyon as self-subsistence farmers, needing only local timber and the combination of dryland agriculture, hunting and gathering to sustain their initially small populations. As populations grew, so did the human demand on the landscape, whether it be water, timber, or food. The story of Chaco Canyon's collapse is chillingly similar to the conditions faced by societies worldwide. Swept in a globalized economy, the way one nation manages its own resources will have widespread impacts. Integrating stories such as that of the Ancient Puebloans into our modern concerns about sustainable use of global food and water resources can encourage us to make better economic, social, and political decisions that will prevent our very own "Collapse".

References

- Bulson, E. (2007). Novels, Maps, Modernity: The Spatial Imagination, 1850-2000. New York: Routledge.
- Cooper, D., and Gregory, Ian N. (2010). Mapping the English Lake District: a literary GIS. *Transactions of the Institute of British Geographers*, 36, 89-108.
- Diamond, J. (2005). The Ancient Ones: the Anasazi and their Neighbors. *Collapse: How societies choose to fail or succeed* (136-156). New York: Viking Press.
- Feinman, T.G. and Feinman, G. (2010). Native North Americans. *Images of the Past* (266-319). New York: McGraw Hill.
- Gregory, I.N., 2005, A Place in History: A Guide to Using GIS in Historical Research. Centre for Data Digitisation and Analysis, Queens University, Belfast, 1-112
- Mau, I., Stewart, Hornsby, K.S., and Bishop, I.D. (2007). Modeling Geospatial Events and Impacts Through Qualitative Change. Lecture Notes in Computer Science 4387, 156-174.
- Pictures from the National Park Service: www.nps.org
- For more interactive maps of Chaco Canyon, see hwww.traditionsofthesun.org/viewerChaco

Acknowledgements

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