Reconstructing a Ring Ditch with Palisade Wall

Introduction

The physical structures that people build say a lot about the priorities, values, and experiential realities of their human designers and occupants. The shelter and protection that a given structure provides, for instance, articulates the presumed challenges that might be faced by the people who are living and building in that environment. Intervening in the natural landscape by collecting, measuring, and modifying resources to build a functional construct is a fundamental component of the human experience. Built structures, then, embody and can codify sentiments and desires likely held by the people involved in the building. Taking this relationship between people and the world as a given, we can reverse engineer the form of the physical built environment to try to see how even the remnants of a structure or altered landscape record and display human events that may have taken place on that land. The built environment, in some small way at least, reflects its creators’ knowledge, technology, engineering abilities, values, and aesthetic principles. Thus, the spaces that people create can serve as a rich deposit of their history and culture.

I apply this theory of built structures as a window into the lived reality of other people of the past. The community of interest is the Baures people in the Bolivian Amazon, an indigenous group that formerly populated the pre-Columbian landscape. The goal of this study is to synthesize data from landscape archaeological research to be able to digitally reconstruct a part of the Baure built environment. Collecting the appropriate information entailed a review of field surveys, historical accounts, and scholarly discourse. Once the relevant material was compiled, I
needed to identify key quantitative measurements for the digital reconstruction. In applying the strictly objective information to the virtual model, I needed to set aside personal notions about how a given structure might be built. In choosing to model a built intervention in the Amazonian landscape, I hope to contribute to a more compelling reconstruction of what life was like for this region’s former inhabitants – for the people who designed, built, and inhabited the physical structure.

I researched and modeled the ring ditch (Figure 1). Ring ditches are a particular class of earthworks, also known as monumental built environments in the landscape. As the name suggests, “Ring ditches are archaeological sites enclosed by continuous or near continuous ditch, with the excavated earth piled on the inside and/or outside as adjacent low berms” (Erickson 2010:623). These specific pre-Columbian monumental ring ditches, also known as causewayed-enclosures, geoglyphs, *zanjas, fosos*, or *trincheras*, are found in the Bolivian Amazon, particularly in the Baures region (Erickson 2010:623). The archaeological and historical record also suggests that these ring ditches may have been accompanied by palisade walls that were constructed along the inner berm of the ditches. Based on the contextual information, maps, photographs, measurements, and scale drawings in publications (Erickson 2006, 2008, 2009, 2010, Erickson et. al. 2008), I was able to collect the necessary information about ring ditches and palisade walls for this reconstruction project. Some of the primary information needed for this endeavor related to the size and form of the ring ditches and palisade walls, and the materials used to construct them. Before discussing the modeling process, it is important to share background information about ring ditches and palisade walls.
Contextual Information

These landscape architectural features have been located by researchers in Acre, Xingu, and Tapajos regions of Brazil (Erickson 2009:211). The form and scale of ring ditches is diverse. These earthworks have been found in “octagonal, hexagonal, square, rectangular, ‘D’ and ‘U’ shapes, as well as clusters of ring ditches and concentric ring ditches” (Erickson 2010:623) (Figure 2). Located “on forest islands or bluffs overlooking savannas, wetlands, and rivers,” ring ditches take up a considerable amount of land area (Erickson 2010:620). In the Baures region specifically, “these earthworks are found on forest islands within the savanna” (Erickson 2010:623) (Figure 3). Forest islands are elevated plots of land that are raised so as to protect the flora and human structures on them from potential damage in a highly flood-prone region. Field surveys and analyses of satellite imagery show that “Most ring ditches have diameters of 100–300 m and ditches of up to 4.5 m deep and 10 m wide, often with steep sidewalls” (Erickson 2010:625) (Figure 4). Researchers report that “Many ring ditches are built over a substrate of rock. In many cases, the last 0.5 to 1 m of the 3–5m deep ditch was cut into rock that required considerable extra labor for the project” (Erickson 2010:630).

The second main component of these structures may have been palisade walls that were built along the inside perimeter of the ditches (Figure 5). Erickson and his colleagues report that the palisade walls would have been constructed from trees that were felled from the land contained within the ditch, as well as from the land immediately surrounding the earthwork (Erickson 2010:643) (Figure 6). A survey of the landscape in the Amazon suggests that local trees used to source wood for the posts would have had diameters at breast height (DBH) of between 25cm and 37cm (Erickson 2010: 635). These dimensions are supported by other research, which took into account historical eyewitness accounts. Trees that fit within these diameters “closely [match] the descriptions of palisade posts of the Guarani (as ‘thick as a man’
and as wide as ‘man and a half at the waist’)’” (Erickson 2010:635). The full height of a standard post was probably around 5.5m, based on calculations using the local types and reasonably-sized DBH trees, as well as firsthand historical accounts from people who saw these constructs when they were still standing. Erickson writes that “Although palisade heights are not given in the chronicles for Baures, Schmidt’s eyewitness descriptions of Guarani palisades, thick tree trunks were buried 1.67 m below the ground and stood 2.73 m above the ground or a total length of 4.4 m. In a second account, posts were buried 1.67m deep and towered 4.91 m above the surface or a total length of 6.58 m” (Erickson 2010:635).

Several other elements of the palisade posts are important to take into consideration. The presumed placement of the palisade posts on the inner circumference of the ring ditch is important to note, as this conjecture lends support to the presumed defensive functionality of the earthworks. Researchers write that “Based on the Colonial period descriptions and to be most effective for defense, palisades were constructed on top of the inside berm created by the excavation of the ring ditch. Palisades would be more effective, intimidating, and aesthetically pleasing if all posts were of similar diameter, length, hardness, and resistance to decay” (Erickson 2010:634). The posts were also likely installed close to one another with little space between posts (Erickson 2010:635). This tight spacing also supports the hypothesis that ring ditches with palisade walls were meant to keep unwanted visitors out. These hypothesized structural features of ring ditches and their accompanying palisade walls is in line with historical accounts; “The Jesuits described these features as forts with deep moats and palisades (Anonymous 1743; Eder 1985)” (Erickson 2009:210). In addition to the above historical eyewitness account, other “Early explorers described villages that were protected by wooden palisades and moats” (Erickson 2008:170). One last thing to mention in regard to the structure of ring ditches with palisade walls is that “The Colonial period descriptions of ring ditches in the
Baures region describe retractable bridges across the ditches, doorways, gates, and baffled or irregular narrow corridors to control access” (Erickson 2010:635). Again, the themes of controlled access and outright restriction of passage into these earthworks is highlighted in the way openings in the wall were designed. Palisade walls would have been constructed to be nearly impermeable, with only narrow openings to facilitate ordered, directed movement.

Based on the archaeological record, a ring ditch with a palisade wall was a multipurpose construct, an environmental intervention that could be used to contain and protect a variety of communal resources. This structure may have had a vital role in defense, rituals, cemeteries, surrounding elite residences, protecting a community from wild animals, supporting the establishment and growth of settlements at large, protecting sacred crops, and embodying community pride (Erickson 2010:620) (Figure 7). Ring ditches had these kinds of functional roles with the help of palisade walls built along the circumference (Figure 8). The combination of a ditch and wall suggests that one of the primary reasons these large earthworks were made was to protect community assets – people, homes, communal spaces, ritual sites, graves, and/or sacred crops. The physical structure of these landscape interventions “would have been excellent barriers against enemies” (Erickson 2006:259). Researchers have also examined how ring ditches may have been designed in relation to the surrounding environment, as opposed to only creating a barrier against it. Landscape archaeologists note that “Many of the larger ring ditch sites are the nodes of radiating networks of straight causeway and canal, [further] suggesting functions as population, political, and ritual centers” (Erickson 2006:259).
Modeling Process

Based on the sources, some of the key dimensions necessary for my modeling are that ring ditches typically have diameters of between 100 and 300m, are up to 4.5m in depth, and are 10m wide. Frequently, the bottommost 0.5 to 1m of the ditch are cut into rock. Using sources from the Colonial period, researchers have determined that palisade walls were probably built along the top of the inner berm of a ring ditch. The posts were likely relatively consistent in diameter and length. Based on a survey and study of trees in the region, the diameter of the tree trunks used as posts were likely between 25 and 37cm. The length of a palisade post has been estimated to be 5.5m, with approximately 1.67m buried in the ground, and the remaining amount above the surface. Palisade posts were probably placed together with little gap between them to deny entrance to and from the enclosed space.

With these quantitative measurements and observations collected, I was able to begin synthesizing them to create a virtual reconstruction of a ring ditch with a palisade wall. My original plan for the modeling process was to create a series of static 3D Maya models of a ring ditch with a palisade wall exclusively using Maya software, which would be designed to be seamlessly integrated into a virtual landscape using the Unreal Game Engine software. These multiple models would be different drafts of the same earthwork, progressively more complete (i.e. with a ditch dug out around half of the perimeter, and then the whole perimeter, or with some palisade posts standing, and then with all of them erected) as the ditch and wall got built up digitally. The idea behind having multiple models was to be able to populate the Unreal landscape with a series of earthworks that could collectively show the stages of construction. Ultimately, I did not end up using Maya, nor did I create discrete earthwork models. However, I still completed a three-dimensional digital reconstruction of one fully built-up ring ditch with a palisade wall, using a couple of computer-aided design programs that are employed for
architectural modeling (AutoCAD 2017 and Rhinoceros 5). For this particular project, these programs are more appropriate, since they are widely used for modeling architecture and terrain.

To start, I selected one of the ring ditches (San Carlos 1) (Erickson et al. 2008) that seemed representative of these earthworks. The San Carlos 1 ring ditch was also illustrated with scale plan (Figure 9) and section drawings (Figure 10). After importing the plan and section drawings into AutoCAD, I used the spline tool to precisely trace over the linework in the two drawings (Figures 11-12). With the spline tool, I added control points at close intervals along the underlaid drawings of the plan and section curves. The software then created a continuous, smoothly-curving line (which is red in the figures) between these control points, for both the plan and section drawings, and which matched the contours of the reference images’ curves.

After creating these digitized line drawings in AutoCAD, I exported the drawings, still linked to the underlaid reference images, into Rhino. In Rhino, I scaled the drawings and linework to their real-life dimensions (Figure 13). Scaling is crucial for easing the addition of this static ring ditch model into the Unreal landscape. After scaling the linework, I measured the horizontal length of the section cut, so that I would know how much to offset the plan curve. After determining how wide the cross-section of the ditch was, I offset the plan curve from itself by that distance (Figure 14). Using the offset command in Rhino created a second bounding curve with the same formal qualities as the initial curve. Once I had the two plan curves that were concentric with each other, and followed the same profile, I inserted the section curve between the two plan curves. Then, using the Sweep2 command, I was able to revolve the section curve around the two plan curves, thus creating a three-dimensional U-shaped surface (Figure 15). This surface followed the profile of the ditch in section and was contained within the edges of the ditch’s perimeter in plan. However, the ditch profile needed more work, because the “raw” section cut I was modeling had a misleading depth, since its walls included
the erosion and compiling of sediment from the 400-500 years during which the earthworks were abandoned. I stretched the section profile of the ditch in the vertical direction to be 4.5m deep. While I changed the profile of the measured San Carlos 1 ring ditch, this alteration was a reasonable move to make, because the goal of the project is to show this kind of landscape architectural structure as it may have been hundreds of years ago. Once the ditch form was created, I selected the inner plan curve and used the PlanarSrf (Planar Surface) command to make a single-plane surface fill on the inside of the full model (Figure 16). I also offset the outer plan curve by 10m, and again used the PlanarSrf command to fill in the space between this curve and the outer edge of the ditch, to create a single-plane horizontal surface. Having this horizontal surface on the perimeter will allow the model of the earthwork to more easily be added into the Unreal landscape. Once the modeling for the ring ditch ground elements was finished, I made sure that all of the ring ditch terrain surfaces were on their own layer.

I also used Rhino to create a second layer for modeling the palisade posts. Based on the measurements from the previously mentioned publications, the average of the smallest and largest post diameter dimensions (25cm and 37cm, respectively) was 31cm, so I use this measurement for modeling. I made a cylinder with a diameter of 31cm and a height of 5.5m, for the palisade post length. After creating this base cylinder, I offset the bottom circular surface 1.67m, to delineate the approximate point at which the post should intersect with the ground line (Figure 18). I then copied and pasted this cylinder around the entire inner plan curve, leaving minimal space between each post on top of the inner berm (1,092 posts in total). Once I had copied and pasted the posts so that they completely covered the inner perimeter of the ring ditch, I returned and deleted several posts in a few places along the perimeter, to create small passage openings. After all of the posts were in place from a plan perspective, I manually dragged all of the posts up and down within a range of 60cm (so the top of the post could be as low as 30cm
beneath the initial top height, or as high as 30cm above the initial top height) to create randomized variation in the heights of the posts (Figure 19). The last step in the modeling process involved adding cone-shaped tops to all palisade posts to accurately capture the form of tree trunks that would have been felled by people.

Once this modeling was completed (Figures 20-24), I converted the Rhino model to the IGES file format, which is compatible with Maya software. I had planned to have multiple iterations (and, therefore, models), of the ring ditch with palisade wall, to show the earthwork at varying stages of construction, but I ultimately exported a single model. I spent approximately 10 hours working on the final project model.

Conclusion

With this digital model, I was able to construct a virtual three-dimensional monumental earthwork structure in the Bolivian Amazon, using measurements and descriptions about form, size, and materials from archaeological and historical information, as well as aerial imagery. The model makes this kind of landscape feature come alive, emphasizing how much labor, time, energy, and labor organization was mobilized for their construction. While this particular modeling project does not include people, which is a key component of this course, it will still contribute positively to a digital landscape that is already populated with people. This model can serve as a component of the Unreal virtual world that expresses the capacity of the indigenous Baures people to construct large, monumental structures in the environment. The ring ditch model can be placed in a manner that engages with other built structures (homes, gardens, path, orchards, cemeteries) and landscape interventions (causeways, canals, fish weirs, and fish ponds). In a way, though, ring ditches are in and of themselves “humanized” and can be understood as “anthropogenic or engineered landscapes” (Erickson 2009:205). This model
captures the result of human action on and in the environment. Ideally, the model will also contribute to a fuller understanding and more engaging experience of seeing how the indigenous Amazonian people of the Baures region lived in the past.

Quantitative and qualitative observations about an altered landscape can convey a tremendous wealth of knowledge about the former human occupants of that environment. As pieces of evidence that remain, often in situ because of their scale and materiality, the components and forms of physically-built structures can embody the stories of the lives of the people who made them. The built environment reflects methods that people used to adapt to the challenges of the space. Identifying and studying the deliberate restructuring of the form of the landscape can reveal the fundamental ways in which a society may have ordered itself, thereby signaling through the spatial organization of the physical world the composition of a community that has long since passed.
References Cited

Erickson, Clark L.


Erickson, Clark L., Patricia Álvarez, and Sergio Calla M.


Erickson, Clark L.


Erickson, Clark L.


Erickson, Clark L.