Final Report for SPARC-Botswana

Carla Klehm, PI, with Chris Kiahtipes and Sarah Mothulatshipi, Co-PIs
SPARC collaborators: Adam Barnes, Katie Simon, Forrest Follett
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Overview of the Report

The purpose of this report is to provide an overview of the SPARC-Botswana project, the results, and how these were subsequently used in a 2017 National Geographic field season. After a summary of the SPARC-Botswana project and the BosLand paleoenvironmental field season, synergistic activities (areas of overlap) between the two are outlined. Under each collaborative aspect, I underline the main topic, and then provide further details. Separate publication and future research sections assesses the present and potential directions for continued collaborative efforts.

Bosutswe Landscapes Project Background

SPARC-Botswana is a complementary component to an archaeological project ongoing in east-central Botswana, called Bosutswe Landscapes (BosLand), led by Carla Klehm (PI). BosLand is a multi-year, multi-component project that integrates low-altitude aerial surveys and geophysical surveys with traditional survey and excavation to explore the long-term social and environmental dynamics at a precolonial African chiefdom, Bosutswe. Bosutswe (700-1700 CE) is located at the eastern edge of the Kalahari Desert, where it provided a crucial link to long-distance trade that spanned from across the Indian Ocean (i.e. to trade partners in India, the Middle East, China, Indonesia) to the Congolese Basin. Bosutswe's location near the Kalahari allowed it to regulate trade in ivory, salt, and animal skins coming from further within the African interior to points further south and east such as Mapungubwe in South Africa and Chibuene in Mozambique, respectively. Although the site of Bosutswe and other similar large, regional polities (e.g. Mapungubwe) have been extensively documented, what remains unexplored and undertheorized are the broader cultural and natural landscapes in which these polities were situated. Settlement patterns beyond the polities themselves, local social and political dynamics among these communities of various sizes, the subsistence strategies involved in supporting the population at Bosutswe, and the environmental impacts (and mitigation strategies) associated with a long-term sedentary settlement located in a marginal semi-arid landscape just four of many potential avenues of inquiry. I mention these four as they are the current areas of focus for BosLand: explored through a digitization of hinterland sites around Bosutswe, a predictive model that identifies additional sites in the local catchment area, excavations at smaller hinterland sites to see when they were occupied and what people were doing there, and sediment samples from these sites and nearby areas that might indicate soil health and anthropogenic impacts of peoples farming, herding, and cutting down wood for fires, houses, and for metal smelting.

Imagery Acquisition

Carla Klehm obtained a DigitalGlobe Foundation Imagery Grant in December 2016, which granted her access to 2500 sq km of multispectral imagery oriented around the site of Bosutswe (25km in every direction). 25km is well within the catchment area of agropastoralists such as those at Bosutswe, who would have ranged their livestock (e.g. cattle, goats, sheep) within a few day’s walk as part of seasonal variations in vegetation and water sources. This satellite imagery is of sufficient resolution (i.e. sub 5-meter) that archaeological sites of various sizes were expected to be visible. Triple coverage of the study area allowed for variations in seasonal vegetation (i.e. whether vegetation serves as a good indicator for archaeological sites, and therefore the more veg the better and summer rainy season with max vegetation provided the best data; conversely, if greater visibility on the surface allows archaeological sites and features to be more visible and therefore winter dry season offers the more optimal dataset) and among satellites (WorldView 2 and 3 imagery versus GeoEye).

SPARC-Botswana (National Science Foundation, DigitalGlobe Foundation)

<u>SPARC-Botswana:</u>

1. Attempted to identify characteristics associated with Iron Age archaeological sites in Botswana
2. Determined areas of interest that corresponded to the broader BosLand project’s research questions
3. Collated user knowledge about known archaeological sites
4. Explored methods that would be useful for identifying archaeological sites
5. Built predictive models for two areas of interest with the study region
6. Identified “prospective sites” in the Primary Area of Interest
7. Identified ISO values in MS imagery that may relate to archaeological sites

The SPARC-Botswana team, comprised of Adam Barnes, Katie Simon, and Forrest Follett, then worked with Klehm to analyze the imagery with the support of the National Science Foundation. As initially proposed, the goal of SPARC-Botswana was “to utilize the expertise of the CAST staff to prepare an integrative GIS with our various spatial imagery datasets…the CAST staff will utilize the satellite imagery obtained from the DigitalGlobe Foundation in anticipation of the 2017 BosLand field season…[to create] a predictive model and multi-faceted GIS database… A project GIS that integrates sites with local water systems and previously collected geophysical and close-range aerial data, and a predictive model for sites in other nearby areas will focus and greatly enhance the productivity of the field season…The GIS database would serve to aid the National Geographic field season by locating additional sites surrounding Bosutswe, identifying key vegetation signatures that may relate to site features, and pinpoint potential areas where soil coring could take place.”

The SPARC-Botswana team and Klehm prioritized these goals in the following order: 1) creation of a GIS shapefile of known archaeological sites and other visible features based on previous work in region, museum files, educated guess; 2) a predictive model of archaeological sites around Bosutswe; and, if time permitted, 3) digitization of geohydrological features and 4) integration of geophysical and drone datasets previously collected in the region. Klehm digitized known and potential archaeological sites in the Bosutswe region. Klehm followed with two excel databases” one that groups the imagery files into categories based on seasonality and satellite, and another associated with the GIS shapefiles of known archaeological sites in the area, grouped by degree of certainty that ID'ed anomaly is a site, name of site if known, type of site: hilltop, open air) Various softwares (i.e. ENVI, eCognition) were then used by Barnes, Simon, and Follett to identify spectral, shape, and size features that relate to these known archaeological sites. Consultation with all team members determined a “Primary Area of Interest” as an imagery subset of 5km around Bosutswe, as this was the area where the BosLand field team would be working this season. A “Secondary Area of Interest” followed the river escarpment southeast of Bosutswe, where a large, 3-4 ha hilltop site was visible, as well as the densest concentration of potential sites outside of the immediate vicinity of Bosutswe (i.e. the Primary AOI).

With the initial metrics set and background data in hand, the SPARC-Botswana team proceeded to build a predictive model for the Primary AOI (using ENVI and eCognition) and Secondary AOI (using eCognition) as well as a number of associated ArcGIS/Google Earth files and databases. This data included clipped MS/pan imagery for the Primary and Secondary AOIs, a SRTM 30m DEM, digitized streams that were extracted from the DEM, a topographic position index (TPI) raster, and, within the Primary AOI, 22 “prospective sites” in addition to those previously digitized. The SPARC-Botswana team produced a write-up of which satellite/seasonal imagery was used (WorldView rainy season data), how the site signatures were developed (using soils to identify, the PPI tool in ENVI to determine base spectra, an ISO unsupervised classification to determine relevant ISO classes within known archaeology sites, Jeffries-Matusita separability index to evaluate the relationship between spectra and sites), a manual of known and predicted archaeology sites in the Bosutswe region with GPS location, site boundaries, and the location of various ISO values within the sites illustrated. This accompanied shape files of the (known and predicted) archaeological sites, and three maps for field use: two of the Primary AOI, one with ISO values across the 10km study area, with the known and predicted sites marked; one of the Secondary AOI with shapes of potential archaeological sites outlined. Due to lack to time and resources, the lower priority objectives of digitizing geohydrological features and integrating geophysical and drone data were not pursued.

In preparation for field data collection, Katie Simon suggested the software AmigoCollect to input field data to a tablet and directly into shape files associated with the archaeological sites. AmigoCollect connects via Bluetooth to a small GPS unit (here, GarminGLO) and integrates the point of the user on any raster and vector data files that are inputted into a particular project. Walking with a tablet and Garmin in the field would hypothetically be a way to navigate within the Primary AOI towards prospective and known sites and collect the data in the field without using an intermediary recording method (e.g. written notes, an xls file to be later merged with the shape file).

Paleoenvironmental Project Background and Summary (DigitalGlobe Foundation, NSF):

<u>BosLand 2017:</u>

1. Served principally as a paleoenvironmental season exploring the anthropogenic use of the landscape.

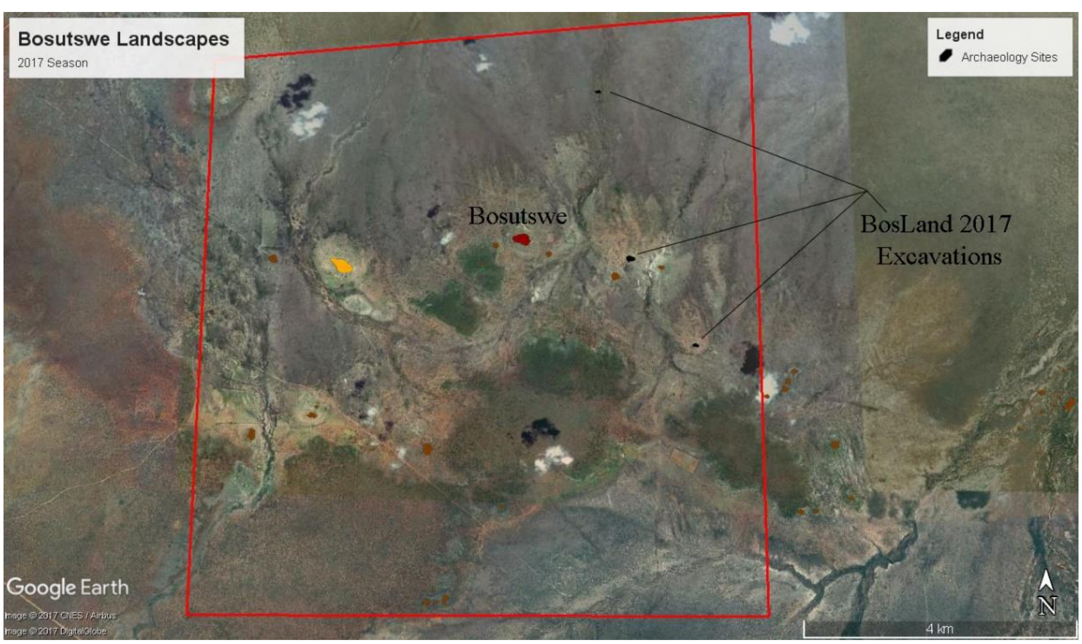
2. Tested three “hinterland” sites to sample the cultural materials within the Bosutswe region.

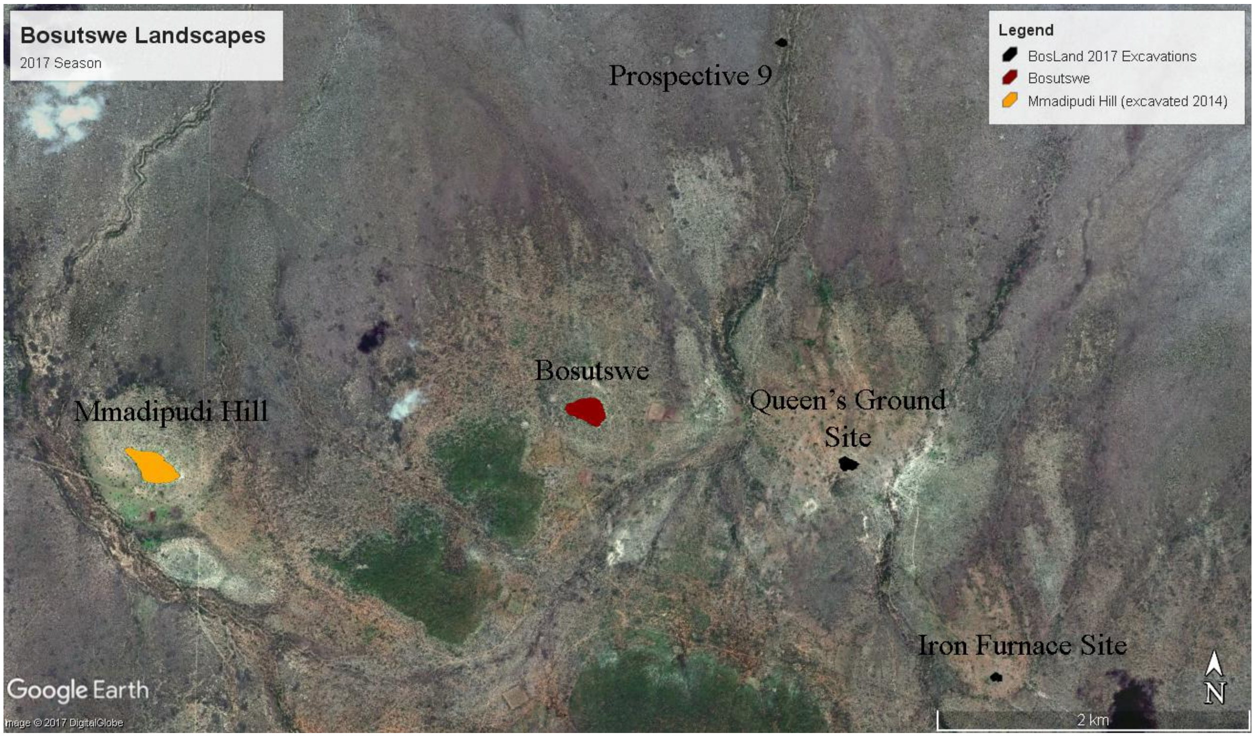
3. Sough to integrate these three new sites with other Bosutswe region sites excavated in previous (2011, 2014) campaigns to gain an understanding of the diversity of site types in the Bosutswe region, working towards a Bosutswe regional chronology of landscape use.

4. Sampled a series of alluvial terrace and paleosol features for sediments, as well as within excavation units, for macrobotanical and microbotanical remains. These samples will be used to infer vegetation composition over various periods.

The paleoenvironmental field project ("BosLand 2017"), led by Klehm as well as co-PIs Chris Kiahtipes and Sarah Mothulatshipi, sought to examine the environmental and archaeological evidence for African responses to the appearance of proto-global trade in the far reaches of this Indian Ocean trade network. Excavations at three small sites around the trade center of Bosutswe at the eastern edge of the Kalahari Desert along with sampling of paleoenvironmental records were to be used to question how urbanism and inequality in trade centers such as Bosutswe relates to cultural and ecological changes in satellite communities. Like the SPARC-Botswana project, BosLand 2017 focused efforts on the immediate vicinity around Bosutswe. Although we were interested in documenting the sites on the Bosutswe landscape and understanding the diversity of site types and activities therein, our core purpose was human-environmental dynamics: whether ecological issues associated with greater population densities and economic intensification such as resource scarcity, unpredictable rainfall, and land degradation impact the ways in which Bosutswe developed and operated have remained unaddressed.

We selected three sites in the Bosutswe region for excavation: two "open air" sites located on the basement basalt (Iron Furnace Site and Queen's Ground Site) southeast of Bosutswe, and a third "open air" site, Prospective 9, located between an alluvial fan and a seasonal stream north of Bosutswe. These smaller, potential more ephemeral sites might represent smaller homesteads responsible for tending to croplands and herding outpost or potentially temporary camps for traders and hunter-gatherers traveling to the Bosutswe region: precisely the sort of supporting sites that should glean a greater understanding of how people were utilizing the landscape.





Queen's Ground Site (approx. 1.5km SE from Bosutswe) had noticeable vitrified dung on the surface as well as a large (30m + diameter) kraal area with substantial rodent disturbance. At Queen's Ground, we established a datum at a high point adjacent to the vitrified dung, and set up a transect due south with 3 1x1m units every 10m from the datum. These units (10S 0E, 20S 0E, and 30S 0E) tested three different types of soil (white ashy soil associated with the kraal, mixed white ashy/greyish brown soil just off the kraal, greyish brown soil further from the kraal but still within an area with noticeable surface artifacts (i.e. ceramic sherds, lithic debris, animal bones). Two of these units (10S, 20S) were extended into a 1x2m and 1.5x1m unit, respectively, to collect a greater sample of cultural material (10S), to better see the stratigraphic profile (10S), and to accommodate the exhumation of a burial (20S).

Iron Furnace is located nearby Queen's Ground (about 1.5 km further SE from Bosutswe) smaller in kraal size and depth of deposit, and most notably more deflated/eroded versus Queen's Ground Site. Here, after a datum was established, three test units were placed in areas of interests (i.e. not along a transect due to vegetation and rodent disturbance issue). Again, one unit was placed in a kraal, another just off the kraal, and one further out; one of the units was opened to a 2x2m unit, and another a 1x2. Unit to collect a representative sample of the cultural material from the site.

Prospective 9 (P9) comprised the third site of excavations. While assessing some of the prospective sites, Chris determined P9 may be one of the more productive sites for test excavation: due to the amount of surface artifacts and the potential depth of cultural materials. Two 1x2m units tested out the depth of deposit, what materials might be present, areas for extended excavations, and charcoal samples to date the site. For publication, we will call this site

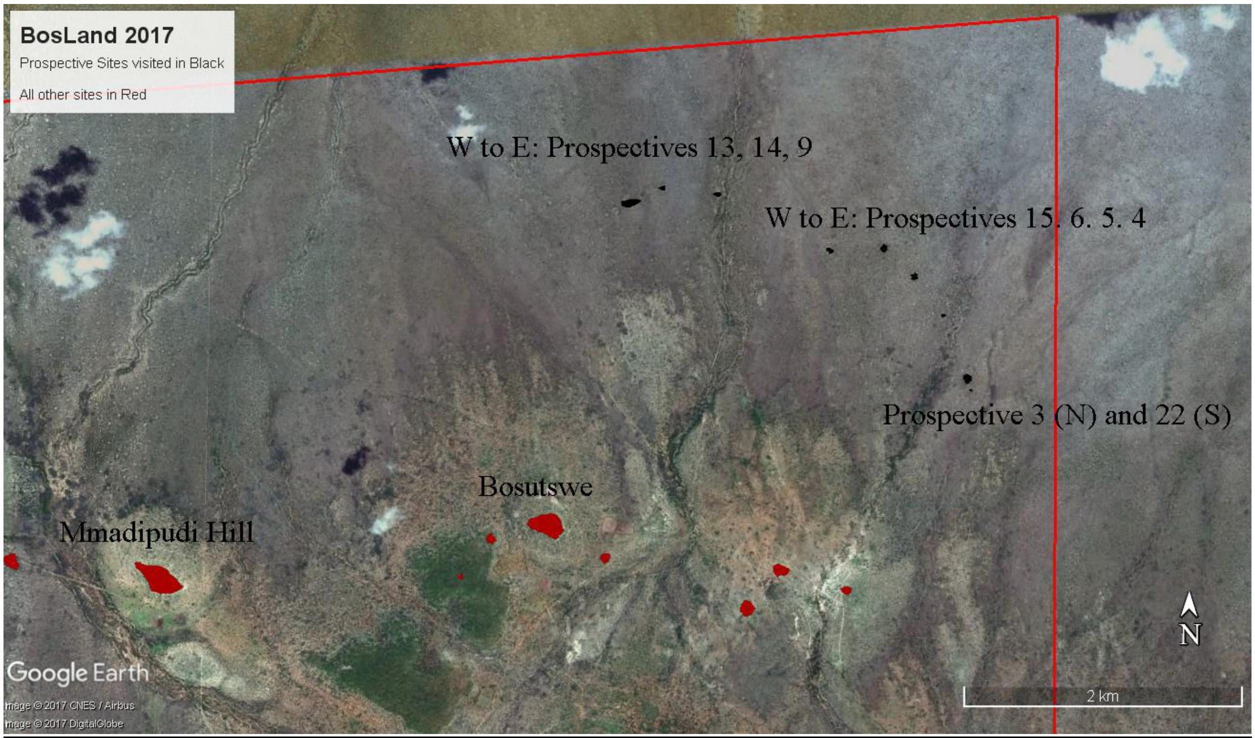
Letlalolanoga, or “Snakeskin,” as there’s a 2.5m skin from a black mamba from the season before at the site.

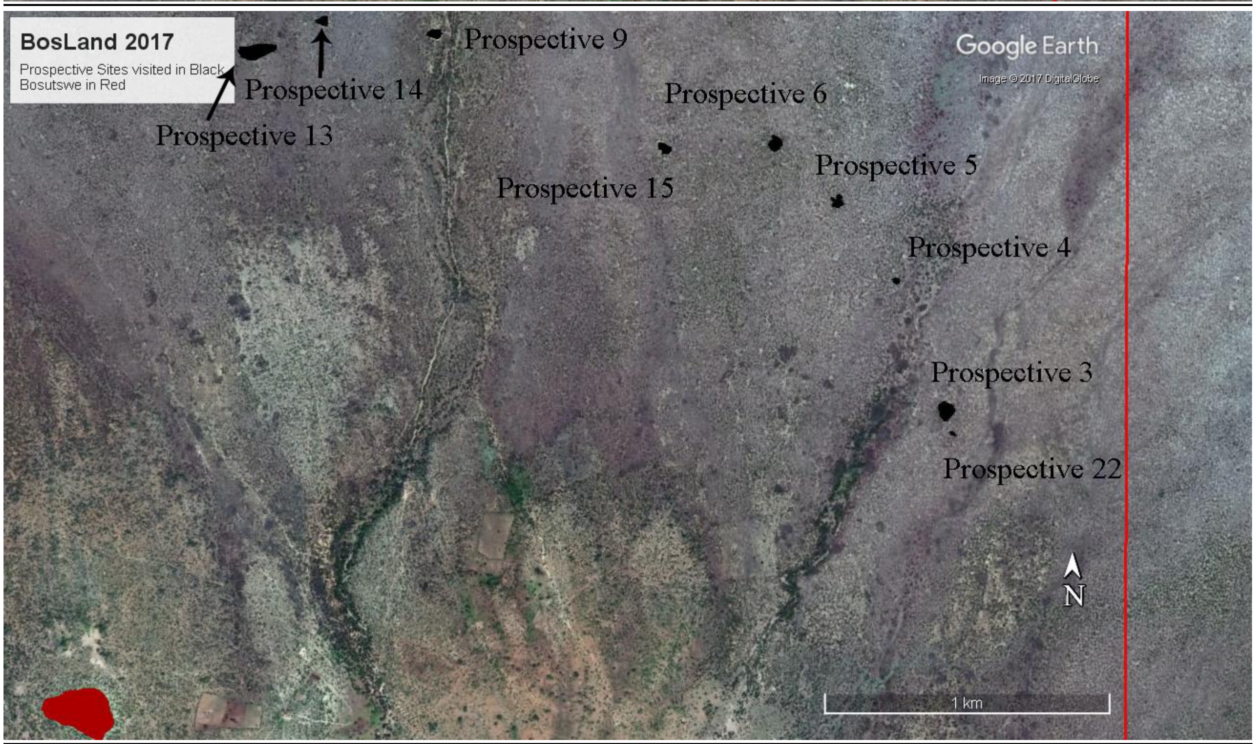
Additionally, Chris collected a series of sediment from on-site (i.e. within the excavation units) and off-site contexts. Soils from the excavations at Queen’s Ground and Prospective 9 were sampled in particular. Two transects of coring samples looked at deeper sediments located south and east of Queen’s Ground Site. Chris also augured a geological trench along a seasonal streambed just east of Prospective 9.

Synergistic Field Activities

Considerable overlap between SPARC-Botswana and BosLand 2017 existed in the field season. Although our efforts were principally concentrated on sampling a number of hinterland sites, and enabling Chris to collect samples from alluvial terrace features and paleosols, the SPARC-Botswana project factored directly and indirectly into our activities in the following ways:

1. <u>The paleoecological survey involved the use of satellite imagery to assess areas for sediment coring.</u> The satellite imagery gained from the DigitalGlobe Foundation grant, and processed by the SPARC-Botswana team for the project was useful to selecting locations on the landscape for prospecting. The ability to see where seasonal and more permanent streams, where alluvial fans were located, vegetation concentrations that may also relate to soils suitable for testing, helped Chris, the lead paleoecologist, determine where to survey. Two of Chris’s day-long prospects were along two north-south seasonal streams/drainages located north/northeast of Bosutswe, which he was able to prioritize because he knew of their presence and location.
   Changes to model: None needed.
2. <u>10 prospective sites from the SPARC-Botswana predictive model in the Primary AOI were visited.</u> Chris was interested in prospecting two seasonal streams in the NE Quadrant of the Primary AOI for sediment samples, and, since this areas coincided with a large concentration of prospective sites, Chris took the lead in ground-truthing various Prospectives as time permitted. Another advantage to the Prospectives in the NE Quadrant is that they are located in different environments than has been typically recorded and published on previously (i.e. the sites are on the alluvial plain and basement basalt, rather than on hilltops). The vegetation and soils (i.e. in opening of mopane woodlands, in black cotton soil areas BUT the soil composition changes slightly to brown, loosely compact loamy soil) are indicative of a class of sites (i.e. large hilltop, small hilltop, open-air) not previously investigated: these also fall under “open-air” sites, but are significantly less exposed and open than a site like QGS or IFS, often have less of a distinct “kraal,” and different soils associated with them. Chris’s initial survey of the western drainage (of the two streams) meant he and Sarah visited Prospectives 9, 13, and 14; a later survey of the eastern of the two stream had Carla investigate Prospectives 15 and 6; and Chris again to Prospective 3, 4, 5, 7, and 22.





Prospective 15: Site Confirmed. Notes: Clearing in mopane with no distinct change in soil type (brown, loosely compact), little ground cover. No visible Cenchrus ciliarus. Surface materials include ceramic sherds, lithics; OES bead visible.

Prospective 6: Site Confirmed. Notes: Low density, with less of vegetation clearing than P15. However, grinding stone located on surface, other stone feature (possible grain bin) also present, and approximately 20m of C. ciliarus suggests accumulation of cultural layers. Soil changes slightly from pure black cotton soil to brown, loosely compact soil as at P15.

Prospective 13: Site Confirmed. Notes: Ground stone and a few lithics, but no distinct kraal area. Perhaps not occupation site, but used for particular purpose (e.g. agricultural processing, due to close proximity to alluvial soils?).

Prospective 9: Site Confirmed. Notes: West of drainage, large open area/clearing of mopane trees with some vegetation interspersed throughout site area. Mopane off-site is very dense on both sides of the stream. Pottery, lithics, vitrified dung, beads, and bones all visible on surface.

Prospective 14: False Positive. Notes: Open grassy area in mopane wood, with an occasional ceramic sherd, but "artifact density" non-existent. Soil did not change from black cotton soil.

Prospective 3: Site Confirmation. Notes: Large site with open vegetation in mopane woodland east of the drainage. Clusters of ceramics on the surface as well as bone. Also, ostrich eggshell beads and ground stone present. Some recent grazing and burning is evident in a 50x50m area.

Prospective 22: False Positive. Notes: No archaeology, change in vegetation and soil morphology is subtle. Mixed grasses (not C. ciliarus) and mopane. Chris took soil probes to explore depth.

Prospective 4: Site Confirmation. Distinct opening in vegetation and light gray loamy soil with a pronounced mound. Artifacts present at low density (OES, ceramic, lithic scatter). Site is 40m in diameter at most. Drainage to the east is wide – 1.21m in depth.

Prospective 5: Site Confirmation. Distinct grassy opening in mopane woodland with low artifact density except for three small clusters of ceramic fragments (one cluster has a rim sherd, which is potentially diagnostic). Small mound visible, with acacia tree in the middle.

Prospective 7: Site Confirmation. Similar clearing in mopane woodland as P4 and P5, but artifact density is low (4 sherds per sq. meter) and there is no evidence of features. However, there may be subsurface cultural layers, as artifacts are coming out of rodent burrows, which are extensive on the site (at many ground sites, rodent burrows occur disproportionally on Iron Age archaeological sites, especially in kraal and midden areas).

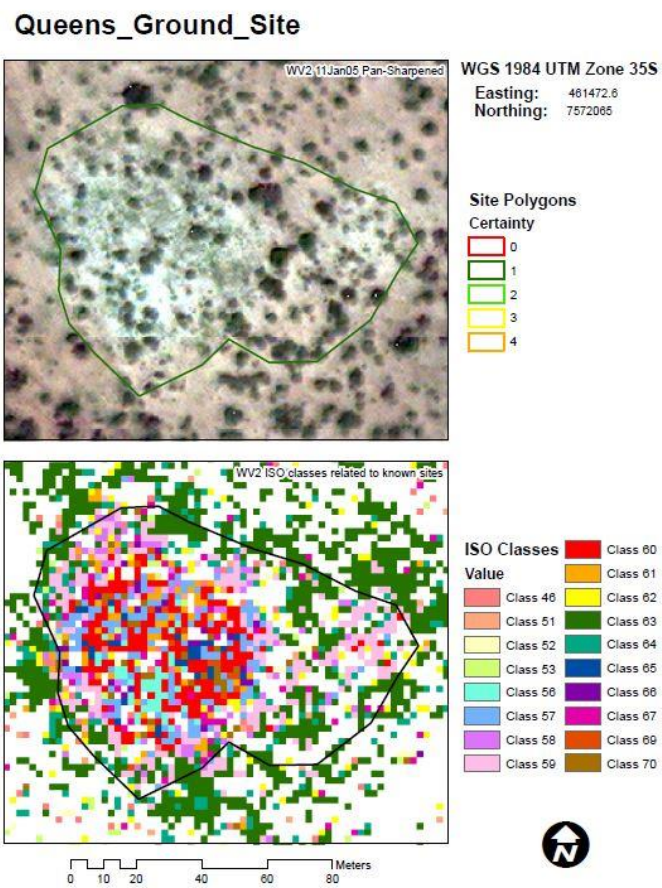
UNMARKED SITE (UM01): Site Confirmation??? Small opening in mopane woodland with some (about 1.3 per meter) ceramics and lithic artifacts. Dark clay-like soil. NEED GPS DATAPOINT FOR THIS.

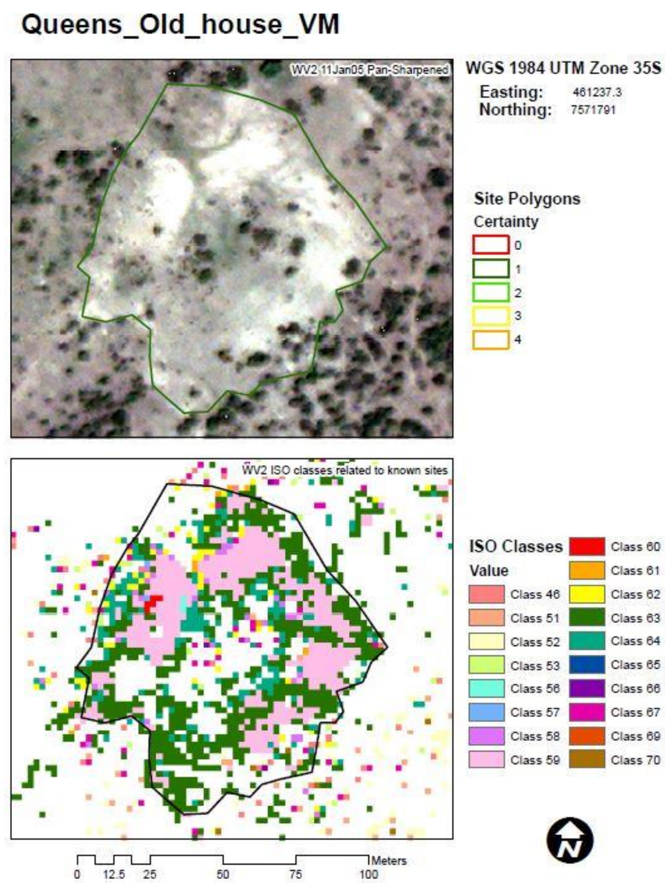
Changes to model: Prospectives 3, 4, 5, 6, 7, 9, 13, 15 are confirmed sites. Prospective 14, 22 are false positives (not sites).

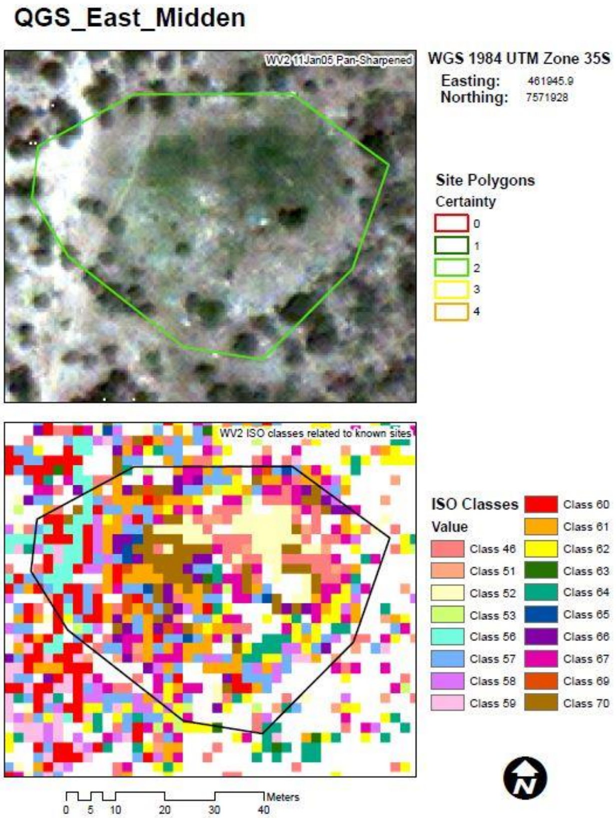
3. <u>Additional archaeological sites that Carla had digitized were also visited, some of which were confirmed (if they had not been previously) and others revised</u>. The BosLand 2017 first concentrated their efforts at Queen's Grounds Site for excavations and sediment

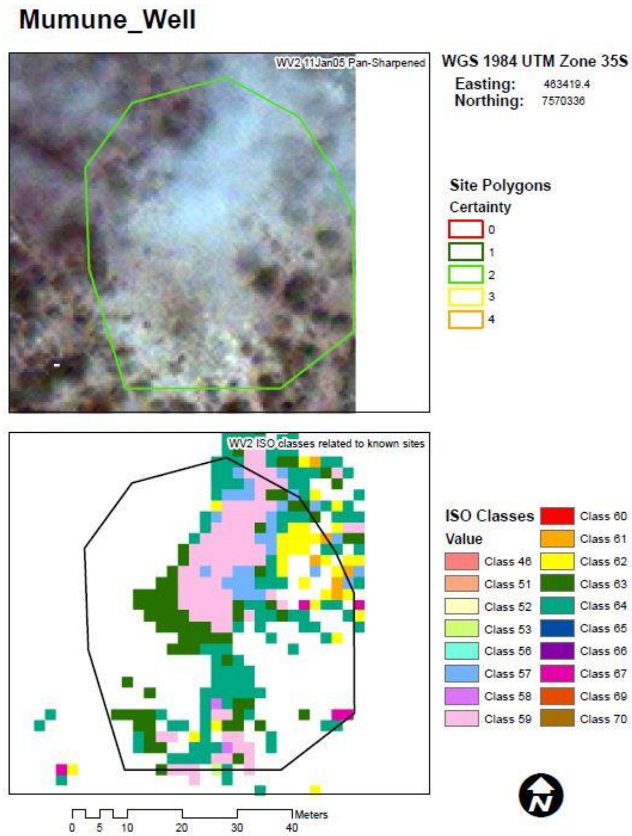
sampling. As this site was proximal to two other sites (Queens_Old_House_VM, QGS_East_Midden), Chris also checked these places. Neither qualifies as a site: the former is part of a continued, low density concentration of artifacts on the surface from Queens Ground Site, and is not a distinct site, settlement area, or even area of concentrated activity; East Midden had no artifacts visible on the surface. As the former was classified as a "Confirmed Site," and the latter a "Probable Site," and were therefore used in building the predictive model, these should be taken out of the model considerations. Queens_Old_House_VM does have 5 distinct clusters of ISO Class 59, however, which is a reoccurring ISO class in a number of other confirmed sites. Revisiting this area with a more high precision GPS that looks directly at ISO Class 59 may help further elucidate what this variable may be. The spectral analysis of QGS_East_Midden readily appears to have a "non-site" signature: that is, a scattering of intermixed ISO classes without distinct features. See image of the two sites below, appended from Adam's spectral breakdown of each site.

We also visited Mumune Well, a small hilltop site with significant deflation/erosion. This shifts its category from "Probable" to "Confirmed." Spectral breakdown and photo from site included below. The WV Jan imagery that was used has cloud cover and may have skewed the ISO classes.









Changes to model: Remove Queens_Old_House_VM and QGS_East_Midden from model considerations, site spreadsheet, although Queens_Old_House_VM may deserve further consideration. Mumune Well is now a "confirmed" site, but you may have to evaluate the ISO values in either the Dry/Winter season WV imagery or in GeoEye. Unknown if this will change what ISO values are picked up (testing of variations between the two seasons needed at a number of sites to evaluate!).

4. Prospective 9, which was previously unknown/undocumented, was chosen for test excavations by the BosLand team. In testing Prospective 9, we hoped to gather empirical evidence that would confirm that these prospective sites were associated with the Iron Age and therefore within Bosutswe's period of occupation. P9 had a fair amount of visible artifacts on the surface: ceramics, bones, shell beads, and even a glass bead. P9 was also located just west of a drainage that was good for Chris to augur (i.e. sufficient depth of sediment, artifacts visible in soil profile). This is the prospective site we chose to excavation.

   In the two test units, we were able to recover material culture such as decorated ceramics and glass beads that can date the site to the Iron Age, as well as charcoal for radiocarbon dating to provide another line of evidence. One of the decorated ceramics was exported for petrographic analysis, two glass beads for chemical analysis, and a charcoal sample. Prospective 9, then, will serve as an example for the model's success in identifying other Iron Age sites more than just surface observations. Site is roughly 67m x 42.5m at its greatest extent along NW and NE axes, respectively, which align fairly well with the original digitized shape. My guess is that the two units were placed in ISO 60 values, but will have to check after units are integrated into ArcGIS. One of the 1x2s was place along the north axis from the datum, the other along the east axis, with Datum at UTM Zone 35K 460989, 7574724. SW corner of the East Unit (1x2 orientated EW) 20m from datum due east, cultural layer depth to 30-35cm BS; SW corner of North Unit 21m (1x2 oriented NS), cultural layer depth to 20-25cm BS. More extensive notes, map of site and unit locations to come.

Image: Datum of Prospective 9, looking north.

Image: View of Prospective 9 from the southeast edge of the site.

Changes to model: Prospective 9 confirmed site, and we featured P9 in our first publication. We should merge the spectral analysis later with the datum/unit information.

5. Excavations at Queen's Ground Site might help with ISO analysis. This data needs to be uploaded, but QGS has a significant ring of vitrified dung (about 30m in diameter) in the center, which is slightly raised (by about 1m) above the material outside the ring (i.e. the vit. dung serves as a retaining wall for sediment inside that would otherwise succumb to erosional forces such as wind and rain that would move it further south. The datum (-21.9553965, 26.626882) was set 1.52 m due south off the vitified dung ring. The vitrified dung feature in the photo below is about 1.2m in width, 5.65m in length at a 70 degree angle from magnetic north; other exposed vitrified dung sections are also visible further northeast (if the vit. dung ring is a clock, this section is at the 6 o'clock position, and another exposed section at the 3 o'clock position. I need to map this, and integrate it into the GIS, but the size and shape of the feature may relate to particular ISO values, and as such may help us refine the search in the future.
   Changes to model: None yet, but will try to give a precise location of the dung feature.

Image: Vitrified dung at QGS. Base of measuring tape at datum, angled north.

Image: Queen's Ground site looking south, from vitrified dung to excavation unit 10S, 0E.

Image: View of eastern edge of vitrified dung ring at Queen's Ground, which is less distinct than the southern edge.

<u>Large site in Secondary AOI visited, confirmed</u>. In the Secondary Area of Interest, a large hilltop site was identified in Carla's initial assessment of the satellite data, Chris's independent look at Google Map, and Forrest's eCognition model. This site lies about 15km SE of Bosutswe, well within a day's walk of Bosutswe. The estimated size from the satellite imagery suggested it was 3-4 hectare in size, similar to Bosutswe and Mmadipudi Hill, the two other previously studied and major Iron Age sites in the region. Carla could not find any museum records of the site. Carla, Chris, Sarah Mothulatshipi and two other project members approached the site from the southeast. Road is visible outside Secondary AOI rectangle NE of the area. Road ended at major drainage east of the site; last 1.5km hiked to the site. Stopped to talk to local villagers

along road, site is named “Mohise,” which means “he/she/it burns.” Erosional material (vegetation, soil, rocks, cultural material) forms a large ring around the base of the site, and is visible on satellite imagery (looks like a “halo”). This is a similar pattern to that of Mmadipudi Hill. Mohise hilltop 70m in height, archaeological site mostly confined to center (clearing), and dense trees obscure site area until the clearing. Dense accumulation of artifacts on surface, and rise in kraal area suggests that there is >1m of cultural material (Carla’s guess is 2-3m in depth, based on her previous experience). Ceramic sherds, bones, lithics and utilized stones, metal, shell beads, vitrified dung. A couple decorated ceramics, a silcrete core, and a vitrified dung sample were all collected for potential analysis. The BosLand 2017 team discussed targeting this site for extensive excavations in future seasons, as given its size and prominence on the landscapes, it may play a key role in political dynamics in the Bosutswe region.

Image: from center of Mohise

Image: Mohise from the east

Changes to model: Perhaps confirm site in Secondary AOI? Otherwise, none.

6. <u>Difficulties with AmigoCollect</u>. Difficulties with the GPS and software made the AmigoCollect and GarminGLO Bluetooth package mostly unusable in the field. Although satellites had no problem locating the Garmin device (according to the lights on the Garmin), and the tablet bluetooth could find the Garmin, the AmigoCollect software had difficulties integrating the Garmin’s GPS location into its map. The majority of the time, it could not find it at all; the couple times it did, it took 20+ minutes of continually rebooting the software. Furthermore, the Garmin’s GPS location only showed up in

AmigoCollect in decimal degrees, making navigation via the tablet hard (i.e. you could not easily calculate the distance between the user and the target site). Because of these issued we did not use AmigoCollect and did not input new field data into the software.
Changes to model: None known.

7. Catalogued sites and prospective sites helped the BosLand team develop hypotheses of how the Bosutswe cultural landscape may have been utilized, both in terms of settlement layout and resource use. This will be written up in a "big picture" landscape archaeology article that synthesizes the projects in Summer 2018.
Changes to model: None requested at the moment.

Publications and Presentations

Klehm, Carla, Barnes, Adam, Follett, Forrest, Simon, Katie, Kiahtipes, Chris, and Sarah Mothulatshipi. 2019. "Toward Archaeological Predictive Modeling in the Bosutswe Region of Botswana: Utilizing multispectral satellite imagery to conceptualize ancient landscapes." *Journal of Anthropological Archaeology* 54: 68-83.

Klehm, Carla. 2019. Were the margins truly marginal? Geospatial and archaeometric approaches to examining inequality and globalization during the Iron Age in southern Africa. Department of Anthropology Brown Bag, Stony Brook University, February 8. Stony Brook, NY.

Klehm, Carla. 2018. From Geophysics to Building a Predictive Model of Archaeological Sites in the African Interior: Spatial archaeometric applications of the Bosutswe Landscapes Regional Survey, Botswana. Annual Meeting of the Society for American Archaeology, April 13. Washington, DC.

Future Directions

Multiple future directions exist. The refinement of the model based on the BosLand 2017 season is the first step. From the QGS excavations, we may also be able to narrow some of the ISO values associated with sites, especially with kraals/middens. Expansion of eCognition to the Primary AOI is another. "Negative testing," of using the prospective sites to reverse-find the known sites as another gauge of accuracy may also strengthen our knowledge of what the model is identifying. Expanding the model beyond the Primary AOI (i.e. to the Secondary AOI) is another possible direction. More experimentation with targeting different features (i.e. testing for vegetation rather than soil), various spectral bands, different seasons, and different satellites will provide a more robust understanding of the potential for multispectral satellite imagery. From a field-based perspective, returning to the Bosutswe region and testing the rest of the sites, with expanded test excavations/full excavations, high precision mapping of site boundaries and features within sites should help refine ISO values used in analysis. More closely identifying ISO values of interest will open up the imagery to explore "non-site" areas.