THE CENTER FOR ANCIENT MIDDLE EASTERN LANDSCAPES (CAMEL)

Emily Hammer

The Center for Ancient Middle Eastern Landscapes (CAMEL) is a GIS laboratory that carries out landscape archaeology, historical geography, and cultural heritage research projects. CAMEL's research aims to collaboratively develop innovative methods and approaches within the field of Near Eastern landscape archaeology. Through work-study positions, research assistantships, and courses, CAMEL trains students to answer questions about diachronic change and spatial patterns in modern and historical cultural and environmental phenomena and provides them with technical skills that are useful for both academic and professional careers in a variety of disciplines. In 2016–2017, CAMEL staff advanced a number of ongoing research projects, including three highlighted below: the Afghan Heritage Mapping Project, the Desert Kites of Eastern Jordan and Egypt Project, and the Anatolian Atlas Project. Additionally, CAMEL served the Oriental Institute (OI) and the broader academic community by making a significant portion of its data archives available for public search and download and by making new fieldwork equipment available to OI projects.

The Afghan Heritage Mapping Partnership

The satellite imagery analysis methods used in landscape research are an important way to continue archaeological research and to monitor cultural heritage preservation in conflict zones across the Middle East and Central Asia. Since 2015, CAMEL has devoted most of its research efforts toward cultural heritage projects concerning the sites and monuments of Afghanistan. This work is generously funded by an institutional grant from the US Department of State to the Oriental Institute (2015–2018), titled "The Afghan Heritage Mapping Partnership" (AHMP). The first two years' award for this grant, received last year, was just under one million dollars. The Partnership draws on satellite imagery and other geospatial datasets to build a comprehensive GIS database of identifiable archaeological sites across Afghanistan. The goals in creating this database are to inventory and map known and previously unknown archaeological heritage sites, especially in areas threatened by future mining development, urban expansion, and looting; to document the current state of archaeological site preservation and analyze spatial and temporal patterns in looting; to create a planning tool that will allow heritage protection to be incorporated into mining, economic, and urban development projects; and to train a cohort of Afghan information technology specialists and heritage professionals in the use of GIS technology for cultural heritage management.

Database Development

The backbone of the AHMP database development has been the visual confirmation, correction, and enrichment of metadata for sites listed in the 1982 *Archaeological Gazetteer of Afghanistan* (authored by Ball and Gardin). From 2014–2016, we had built a GIS database of the 1284 sites in that *Gazetteer*. The spatial data published in the *Gazetteer* was produced before

Figure 1. Afghan Heritage Mapping Project staff with Warwick Ball, author of the original 1982 Archaeological Gazetteer of Afghanistan. *Ball visited CAMEL in October 2016 to share information concerning sites discovered since 1982 and to seek CAMEL's help with preparing maps for an updated version of the* Gazetteer

From left to right: Rebecca Seifried, Anthony Lauricella, Warwick Ball, Emily Hammer, and Kathryn Franklin

civilian use of GPS for mapping and has long been known to be inaccurate. Each of the *Gazetteer* sites' coordinates was located in modern DigitalGlobe satellite imagery and more precisely mapped using both points and polygons to represent the sites' center points and areal extent. In 2016–2017, we expanded the database beyond the original *Gazetteer* to include other survey datasets generated by our own project and others'.

In collaboration with Warwick Ball, the author of the original gazetteer, CAMEL has worked to include major sites discovered since 1982 into its AHMP database. Ball is in the process of preparing an expanded, updated version of the *Archaeological Gazetteer of Afghanistan* for publication by Oxford University Press and has generously provided CAMEL with lists and descriptions of new sites. CAMEL staff are working to precisely locate and map these new sites using satellite imagery and to produce new maps for the forthcoming volume. This will aid Ball in publishing the new gazetteer and also assists CAMEL in expanding its own database (fig. 1).

The original *Gazetteer* only included a selection of the most important sites known at that time in Afghanistan, but archaeological surveys have recorded many more. Further, for the sake of expediency, the *Gazetteer* frequently listed multiple sites that are located close to one another under a single name. For the purposes of our cultural heritage analyses and mapping, it is important to include the full results of archaeological surveys, with all known sites listed and individual sites or site components listed individually. For this reason, we have returned to the original publication of East Bactria Survey, completed by a French team in the 1970s. Jean Claude Gardin contributed a selection of these sites to the *Gazetteer* that he co-authored with Warwick Ball, but the original survey publication is allowing CAMEL to incorporate all of the mapped sites into its database.

In collaboration with Mitchell Allen, an archaeologist who is in charge of publishing the results of William Trousdale's Helmand-Sistan survey from the 1970s, CAMEL worked to digitize and geo-reference large numbers of hand-drawn maps, aerial photos, lists of surveyed sites, and information from field notebooks. This archival data is allowing us to help Allen reconstruct the survey data within GIS, which in the future will assist him with publication of the survey results and allow for spatial analysis of the survey data. The sites newly studied by the Helmand-Sistan Survey that were not already included in the 1982 *Gazetteer* will now be incorporated into the AHMP's site database (fig. 2).

Another group of scholars, David Thomas and Fiona Kidd, have also generously shared the results of their 2004 satellite imagery survey of a part of the Registan Desert with CAMEL. This data has also expanded our AHMP site database, as have the results of several other "remote surveys" undertaken by CAMEL, all discussed in greater detail below.

CAMEL also added to the AHMP database by inventorying sites marked on 1:50,000 Soviet topography maps dating to the early 1980s, which record the location of standing archaeological mounds, ruin fields, and pastoral nomadic campsites. This inventory work would take a long time to achieve for the entirety of Afghanistan, as the Soviet topography series is composed of 1,644 maps in total. To begin, CAMEL has added sites to our database from Soviet maps covering the Dusar Sha'ida study area discussed below as well as from maps covering areas that have been affected by urban expansion in Afghanistan's ten largest cities (Kabul, Kandahar, Herat, Mazar-i Sharif, Kunduz, Jalalabad, Ghazni, Balkh, Baghlan, and Farah) (fig. 3).

Figure 2. Mitchell Allen (right), an archaeologist involved in the Helman-Sistan Survey in southwest Afghanistan in the 1970s, collaborates with CAMEL to digitize and reconstruct unpublished data from his original fieldwork. In May 2017 he worked with Afghan Heritage Mapping Project staff members Anthony Lauricella (center) and Rebecca Seifried (left)

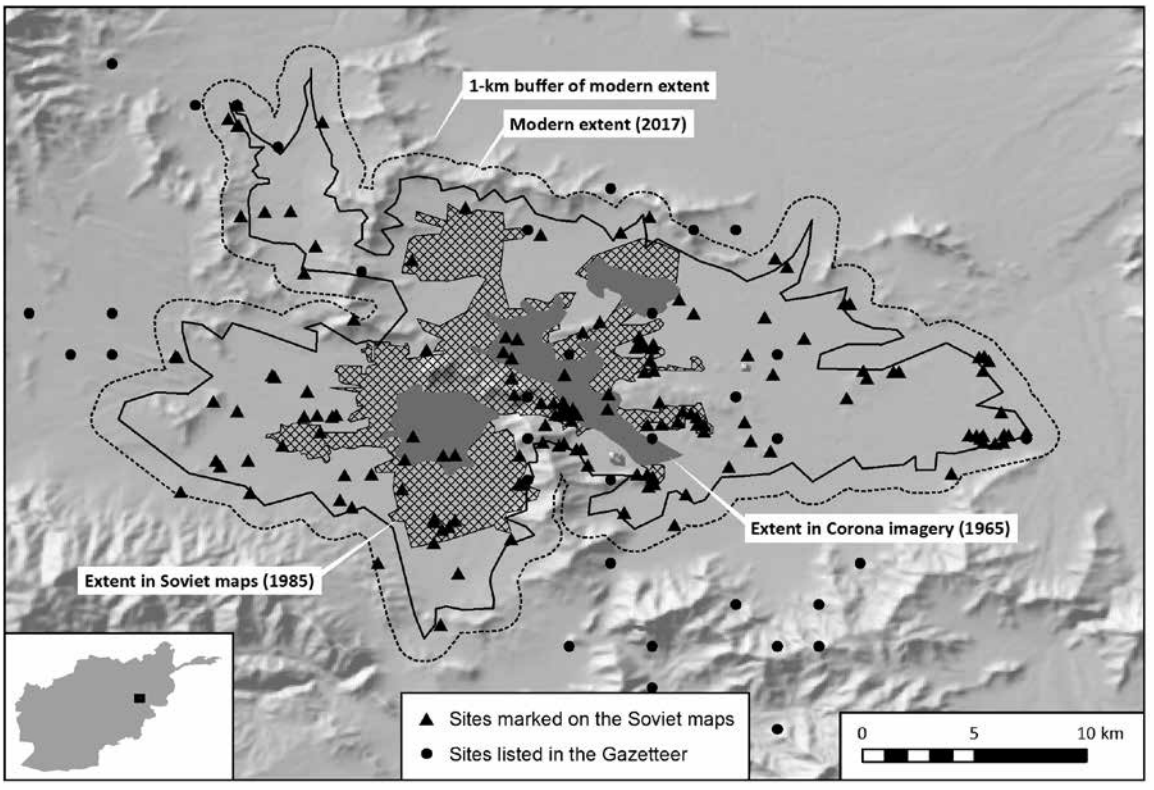

Figure 3. Urban growth in Kabul, Afghanistan, as documented in 1960s CORONA imagery, 1985 Soviet topography maps, and 2017 DigitalGlobe imagery. This urban growth has engulfed a variety of archaeological sites cataloged from the 1982 Gazetteer and 1985 Soviet maps. Future growth of the city (modeled with a 1 km buffer around the current extent) could imminently threaten additional sites.(image: Rebecca Seifried and AHMP staff)

Remote Site Discovery

The second component of our database development and grant research identifies previously unmapped archaeological sites using both maps and satellite imagery. We pursued site discovery in several different areas of the country including in the Dusar Sha'ida mining area of Herat Province, the area around Herat City itself, the Balkh Oasis, the area around Kandahar City, and the area around Spin Boldak at the southeastern corner of the Registan Desert. These areas were chosen for remote survey on the basis of their potential to yield important previously unmapped sites and on the basis of information suggesting sites in those locales have been/will be threatened by looting, urban growth, intensive agriculture, and/or mining. Our methods of "remote survey" involved placing a 1 × 1 km grid over high-resolution satellite imagery captured by the DigitalGlobe Corporation. CAMEL staff members examined the landscape square by square, marking all visible archaeological sites and recording their general type (e.g., mound, standing architecture, fortification). These results were then checked and streamlined by a senior member of the project.

Future mining activities may threaten archaeological sites on a broad scale in Afghanistan. It is for this reason that CAMEL targeted an area identified as high priority for future mining by the USGS for one of our first site discovery projects. The Dusar Sha'ida Copper and Tin Region in Herat Province was "remote surveyed" last year. The results of this survey were presented in a synthetic article about ongoing and potential future damage to archaeological sites (E. Hammer, R. Seifried, K. Franklin, and A. Lauricella. 2018, in press. "Remote Assessments of the Archaeological Heritage Situation in Afghanistan." *Journal of Cultural Heritage*) and incorporated into the AHMP site database.

Urbanization and other forms of development threaten archaeological sites much more immediately and on a larger scale than potential future mining activities. In order to investigate the effects of urbanization on site preservation, we focused on a 60 sq km area centered on the city of Herat. All archaeological sites and features in this zone were recorded in order to quantify the potential impact of urbanization on the heritage landscape. An analysis of these sites was the topic of a successful MA thesis by a Center for Middle Eastern Studies student and CAMEL staff member, Gwendolyn Kristy (G. Kristy 2017. The Impact of Urbanization on Cultural Heritage in Herat, Afghanistan: A GIS Analysis. MA thesis, The University of Chicago Center for Middle Eastern Studies). Gwendolyn also presented the results of this study in a poster at the American Schools of Oriental Research (ASOR) and

Figure 4. CAMEL staff member Gwendolyn Kristy (left) and Associate Professor Donald Whitcomb (right) discuss Gwendolyn's MA thesis research, which examined the effect that unplanned urban growth has had on cultural heritage sites in the vicinity of the city of Herat, Afghanistan, at a student research poster fair held on campus in March 2017. Gwendolyn presented a similar version of this poster at the ASOR Annual Meeting in November 2016 and the SAA Annual Meeting in April 2017.

Society for American Archaeology (SAA) Annual Meetings (November 2016 and April 2017, respectively) (fig. 4).

Military activity is another type of activity that affects many archaeological sites in Afghanistan. CAMEL documented the effects of military activity on sites surrounding Kandahar City in southeast Afghanistan and this dataset was the subject of a successful Bachelor's honors thesis by an Anthropology student and CAMEL staff member, Emily Boak (E. Boak 2017. Militarized Landscapes and Cultural Heritage in Kandahar, Afghanistan, 2001–2014. BA thesis. University of Chicago, Departments of Anthropology and Geography).

Two other "remote surveys" CAMEL conducted last year in the Spin Boldak region of southeastern Afghanistan and in the Balkh oasis in northern Afghanistan were analyzed and prepared for final publication this year. Kathryn Franklin and Emily Hammer submitted a publication on "remote survey" methodology, drawing on the results of CAMEL's work in the Spin Boldak region (K. Franklin and E. Hammer. 2018, in press. "Untangling Palimpsest Landscapes Using Remotely Sensed Techniques in Spin Boldak, SE Afghanistan." *Journal of Field Archaeology* 43/3). Archival map data, dated satellite imagery, and the AHMP's site database provided ways of resolving issues of chronology that typically plague such "remote surveys." In particular, the article discusses methods for dating three types of sites found in Spin Boldak: fortified enclosures, caravanserai, and pastoral campsites. The Spin Boldak dataset was also presented at the ASOR Annual Meeting (November 2016). Anthony Lauricella and Emily Hammer submitted a publication on fortification and settlement patterns in the Balkh oasis of northern Afghanistan (E. Hammer and A. Lauricella. [submitted]. "The Land of a Thousand Cities: Fortified Mounds of the Balkhab River Valley [Northern Afghanistan]." *Antiquity*). Data on over 2,000 sites mapped in the Balkh area using satellite imagery were presented at the Oriental Institute's "Limits of Empire in Ancient Afghanistan" conference (October 2016) and the ASOR Annual Meeting (November 2016).

Monitoring Destruction of Sites

The third component of the project aims to diachronically document destruction of archaeological sites through looting, development, and other processes. We used time-series of DigitalGlobe imagery, made available to us through State Department-provided access to an online repository, to record types and severity of destruction at over 1,000 significant sites from the 1982 *Gazetteer* (fig. 5). A publication was prepared on the results of the damage assessment: "Remote Assessments of the Archaeological Heritage Situation in Afghanistan" (E. Hammer, R. Seifried, K. Franklin, and A. Lauricella. 2018, in press. *Journal of Cultural Heritage).* In this publication, we argue that systematic looting of archaeological sites in Afghanistan already occurred before Taliban related conflicts, that there has been little increase in systematic looting in Taliban controlled areas post-2001, that the greatest increases in looting have occurred in Afghanistan's northern oases in areas that are not Taliban strongholds, and that the most pressing threats to Afghanistan's heritage sites come from development activities, including agricultural expansion, urban growth, and future mining. The focus of cultural heritage groups and media reports on both looting and destruction events by the Taliban thus does not address the most urgent cultural heritage concerns for Afghanistan. The data from this study was also presented at several conferences: the ASOR Annual Meeting (November 2016) and the Neubauer Collegium's "Past for Sale: Antiquities as Global Contraband" Symposium (May 2017).

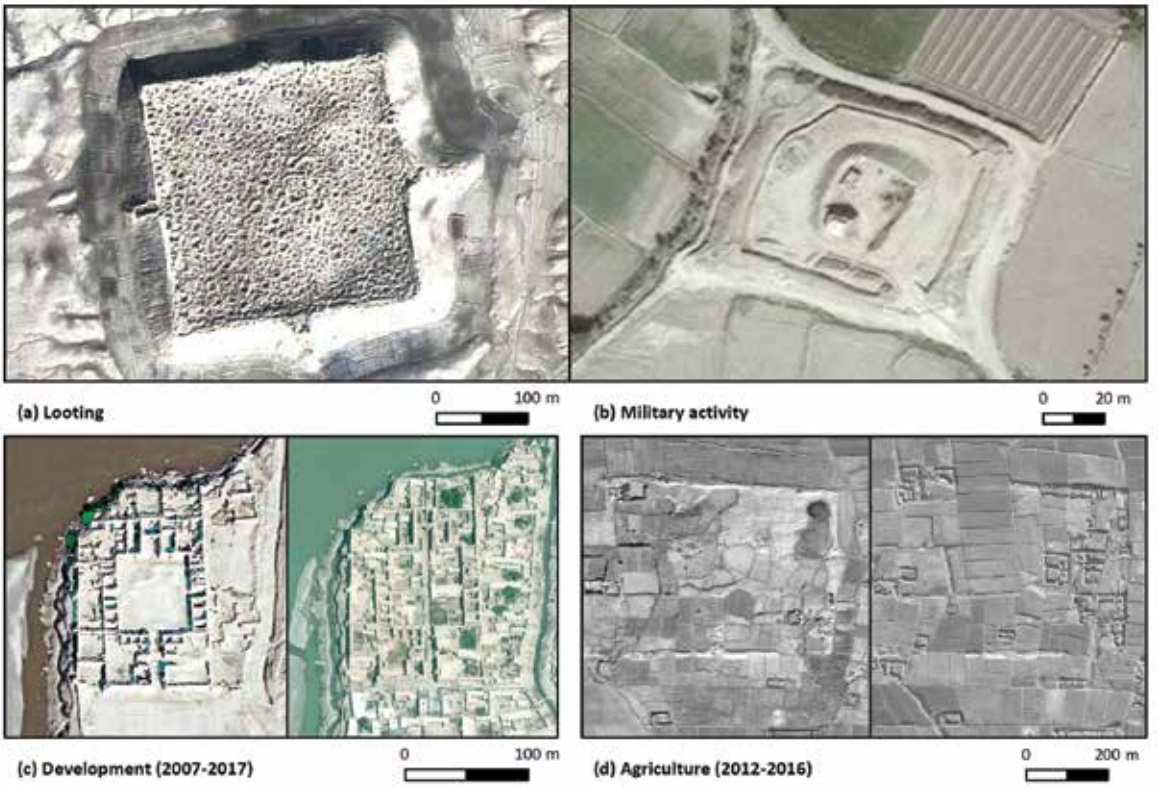

Figure 5. Examples of different types of damage to archaeological sites in Afghanistan as seen in DigitalGlobe imagery (images: DigitalGlobe; Rebecca Seifried and AHMP staff)

a) Looting at Abu Huraira in Balkh Province
b) Military activity at Gur Tepe in Kunduz Province
c) Development-related damage at Lashkari Bazar in Helmand Province
d) Agricultural-related damage at Kafir Qal'a in Kunduz Province

Graduate students Anthony Lauricella and Joshua Cannon, former CAMEL director Scott Branting, and current CAMEL director Emily Hammer had an article accepted to the journal *Antiquity* that details a new method to automatically detect looters' pits on the surfaces of sites in Afghanistan and its application to the site of Ai Khanoum (Alexandria-on-the-Oxus, Takhar Province in northeastern Afghanistan) (Lauricella, A., J. Cannon, S. Branting, and E. Hammer. 2017. "Semi-Automated Detection of Looting in Afghanistan Using Multispectral Imagery and Principal Component Analysis." *Antiquity* 91/359: 1344-1355).

GIS Training for Afghan Professionals

The State Department grant also funds a GIS training program for archaeologists and cultural heritage specialists in Afghanistan. In July 2016, Emily Hammer, Gil Stein, and Steve Camp traveled to Kabul to arrange the details of this training program, which has been carried out in collaboration with the GIS faculty of Kabul Polytechnic University (KPU). The training program commenced in October 2016 under the direction of Jessica Giraud with a "teacher training" for KPU faculty, who are experts in GIS and Geodesy but needed information on how these methodologies are applied in the fields of archaeology and cultural heritage (fig. 7). The training program continued in January–February 2017 under the direction of Jessica Giraud

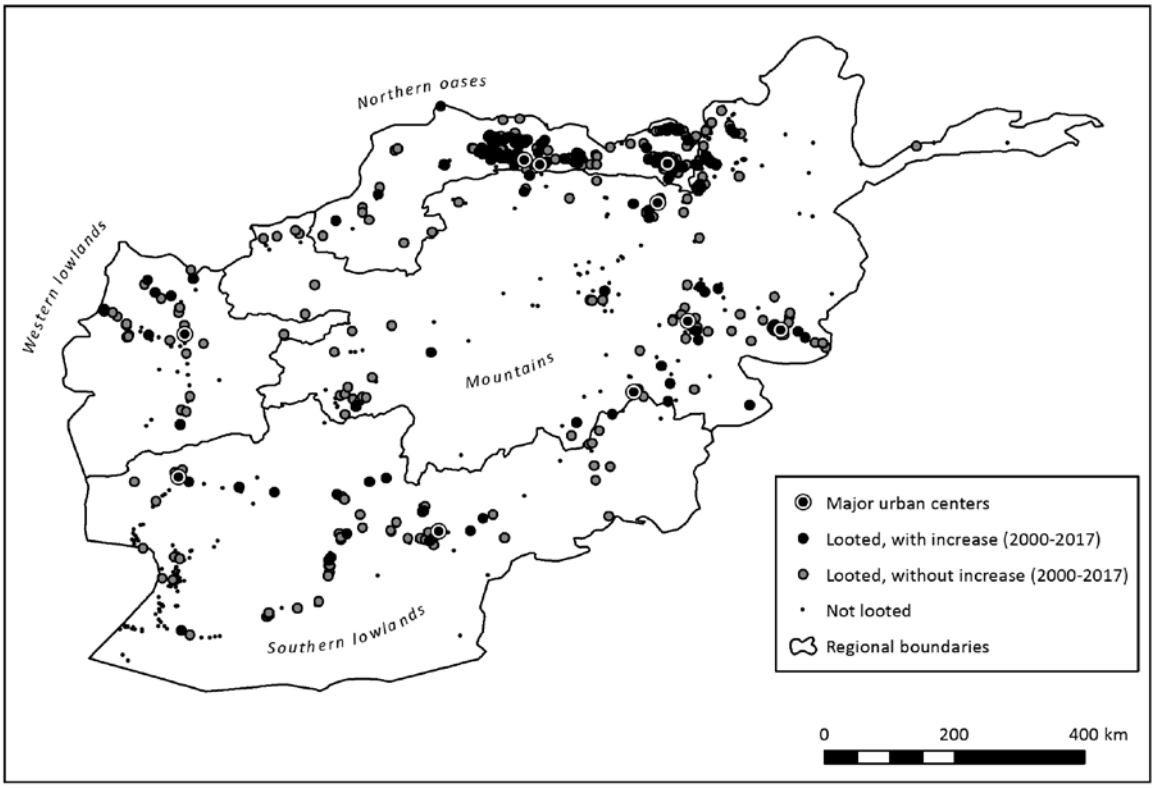

Figure 6. Distribution of the 474 looted sites across Afghanistan studied by CAMEL, 173 of which showed an increase in looting 2000–2017, in relationship to four major geographical zones. Note the major concentration of looted sites in the northern oases. 1,002 sites total were analyzed (image: Rebecca Seifried and AHMP staff)

Figure 7. Jessica Giraud carries out the "Applications of GIS for Archaeology and Cultural Heritage" training for faculty at Kabul Polytechnic University in October 2016 (photo: Alejandro Gallego)

and the KPU faculty. Twenty-two professionals and students from the Afghan Institute of Archaeology, the Ministry of Monuments, Kabul University, and KPU received seven weeks of GIS instruction. CAMEL director Emily Hammer worked with Giraud on the development of course syllabi and activities throughout both of the training periods.

Mapping Desert Kites

Outside of Afghanistan, CAMEL's research efforts were devoted to regional archaeology projects investigating the distribution, form, and environmental context of mass-kill hunting traps found in eastern Jordan, southern Egypt, and other parts of the Near East and Central Asia. Aerial mapping of these traps has been central to their study because many are too large and/or faint to be seen from the ground. CAMEL's projects were designed to draw on new sources of historical aerial imagery.

Kites in Eastern Jordan

The black basalt desert of eastern Jordan (*harra*) preserves an astonishing density of archaeological features that represent massive long-term human investment in what is now an inhospitable landscape. The most intensively studied of these features are large hunting traps called "desert kites" due to their shape — an irregular polygon enclosure with long tails. While a number of influential studies were able to map limited numbers of kites throughout the 1970–80s, the availability of free high-resolution satellite imagery through Google Earth in the last decade has enabled systematic mapping of kites and led to an explosion in the number of kite studies. Over the past two years, CAMEL students and staff have been using new sources

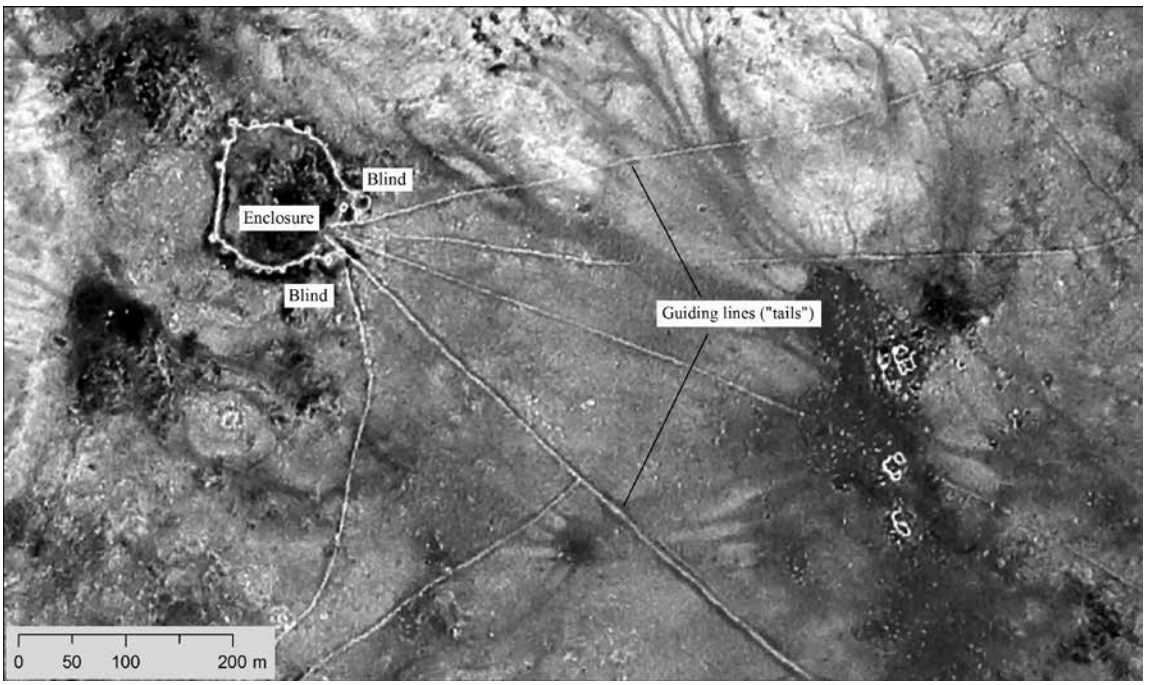

Figure 8. Major components of a desert kite in Eastern Jordan, U2, January 1960 (image: Emily Hammer and Anthony Lauricella)

of high-resolution declassified military intelligence imagery to systematically map kites and their surrounding features. U2 planes captured high-resolution aerial photos in which kites and other stone features appear very clearly. This historical view can therefore provide information on structures that have been destroyed in the last decades with agricultural expansion, development projects like roads, and bulldozing for oil prospection.

We systematically mapped kites and all other archaeological features by laying a 1 × 1 km grid and examining U2 imagery from January 1960 and modern imagery square by square. Thus far, we have mapped a total of over 13,500 features in systematically surveyed squares. The majority of these mapped features are corrals, campsites, and "wheel" features of unknown function. Only 546 are kites (another 344 kites have been mapped in targeted areas).

Our systematic mapping allows us to examine the scale of the desert kite phenomenon in Jordan and to assess spatial patterns. Several different estimates exist for the total number of kites in the Jordanian *harra*, ranging from around 500 to over 1,000. Through both systematic and targeted mapping, we have already identified 890 kites across the Jordanian *harra*, and our study is not yet complete. This indicates that the higher estimates for the total number are more likely to be reflective of the actual total. A number of kites we have identified do not appear in the most recent distribution maps of other projects like Global Kites (http://www.globalkites.fr/). Because of recent destruction, we expect that our use of historical imagery will result in the identification of a larger number of kites than that identified by projects using only modern imagery.

Scholars have long observed that the majority of kites in the *harra* form linear chains that can stretch for tens of kilometers. Individual kite enclosures in these chains are connected by long guiding lines, and mapping these guiding lines has allowed previous surveys to define kite chains and even propose relative dating for different components of these chains. Following our systematic mapping, we used kernel density estimates to examine clusters of kites and how these relate to chains. These statistics highlight the fact that the vast majority of the large number of kites in the Jordanian *harra* are part of much larger, regional-scale structures (91%). A small but significant minority of kites (9%) were probably constructed for use on their own.

As the project moves forward, we plan to employ environmental GIS analyses to better understand the positioning of these traps and settlements in relationship to the landscape. The preliminary conclusions of our work, including more data on the arguments explained above, have recently been published: E. Hammer and A. Lauricella, "Historical Imagery of Desert Kites in Eastern Jordan." *Near Eastern Archaeology* (2017) 80 (2, Repopulating the Badia): 74–83.

Kites in Egypt and the Sudan (contributed by Émilie Sarrazin)

Desert kites are also found in other parts of the Middle East. In Egypt, they are particularly prominent in the Western Desert between southern Egypt and northern Sudan. Such structures have been recorded following extensive surveys and/or analysis of satellite imagery of the Aswan-Kubbaniya and el-Hosh regions in Upper Egypt, the region between the First and Second Cataract in Lower Nubia, the Third Cataract region of Upper Nubia, and the Kurgur and Dungul oases. Some have even been observed far away from the Nile Valley and oases, in the dunes of the Great Sand Sea of the Western Desert. These features have been published with an inconsistent degree of detail and accuracy, and have never been studied as a coherent ensemble. The first phase of this project, now completed, consisted of mapping the published kites in GIS, in order to both regroup this scattered dataset and also provide updated

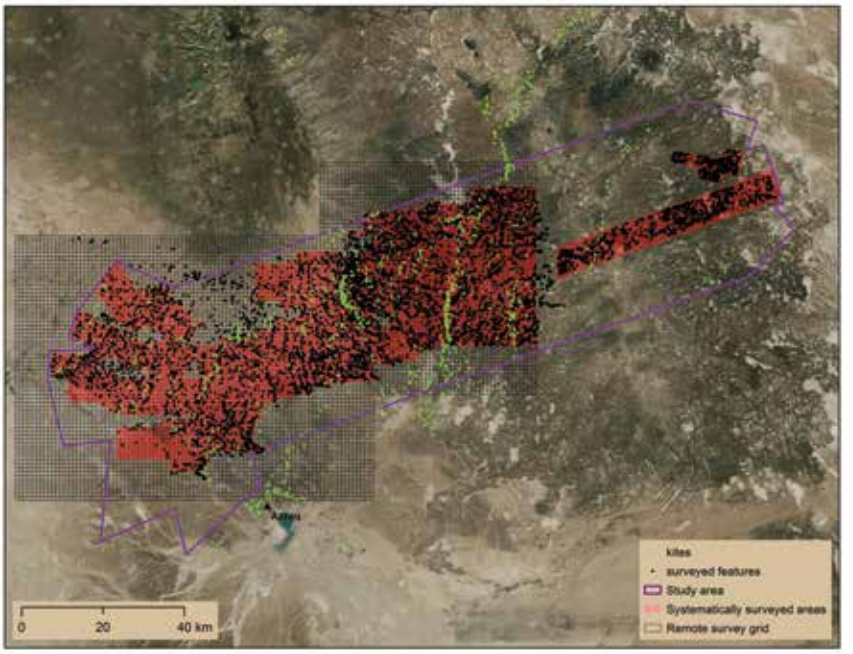

Figure 9. Extent of CAMEL's systematic mapping in Eastern Jordan with the locations of features and kites (image: Emily Hammer and Anthony Lauricella)

georeferenced drawings of these structures. The second phase of this project, currently in progress, consists of expanding the study of satellite imagery beyond these surveyed areas, in order to obtain complete coverage of the region. Such a comprehensive survey, based on a grid system, is essential in order to properly study the spread of these game traps and their relationship with the surrounding landscape. If possible, the positioning of ancient remains such as circular camps and cairns will also be taken into account. Once such a systematic examination has been performed, Digital Elevation Model (DEM) and Difference Vegetation Index (NDVI) maps will be used to study how slope, elevation, the presence of wadis and soil humidity have influenced the location of these features. The end goal of this project is to further contribute to the discussion concerning the use and the spatial and chronological distribution of these puzzling structures.

GIS and Historical Geography: The Anatolian Atlas Project (contributed by Joshua Cannon)

GIS has useful but underutilized applications in the field of historical geography. Graduate student Joshua Cannon and undergraduate researcher Rolland Long are creating a website that displays geographic and bibliographic data on central Anatolian archaeological sites together in order to highlight and re-assess debates in historical geography literature for the Hittite period. In 2016–2017 they digitized the locations, chronology, characteristics, and sources of information for 400 sites, mostly dating to the second millennium BCE. They also have generated digital maps of the route taken during the celebration of the Hittite AN.TAḪ.ŠUM festival, drawing on Hittite texts describing the festival, the locations of sites documented by archaeological surveys, and freely available topography data. The festival route is mapped out day by day with pathways that were identified through GIS modeling and with archaeological sites that are likely matches for the historical cities visited during this

festival. Each archaeological site is accompanied by metadata that details the argument for why that site has been associated with a textually attested city. The interactive online version of the Anatolian Atlas, along with a comprehensive bibliography for Hittite archaeology and geography, are now available to the public via the CAMEL website: https://oi.uchicago.edu/research/camel/anatolian-atlas. Joshua and Rolland presented the preliminary results of their digital mapping of the Hittite AN.TAḪ.ŠUM festival at the ASOR Annual Meeting (November 2016).

Online Repository of Maps and Geospatial Data

Over the last two decades, CAMEL has greatly benefitted from its ever-expanding database, which now contains around 20,000 georeferenced maps, satellite images, and other spatial datasets relevant to the archaeology and history of the Middle East. Since 2014, we have been working to make this data available to the whole OI and to the public by transitioning towards use of the Oriental Institute's Integrated Database (IDB). In September 2016, a significant subset of CAMEL's holdings (over 9,000 datasets) became available for online public search and download via the IDB for the first time. The major strengths of our online collection are digitized and georeferenced versions of historical maps held by the Oriental Institute, historical aerial photographs of particular archaeological sites and landscapes, and georeferenced historical satellite imagery covering large swaths of the Middle East, primarily from the Cold War-era Corona spy satellite program.

To use CAMEL's online repository, look for the "CAMEL" option under the "Search All" dropdown box at http://oi-idb.uchicago.edu/. Once you have located a georeferenced dataset of interest using keywords and other filters, an interactive map with up-to-date satellite imagery embedded in the dataset's page allows you to see the spatial coverage of the dataset. CAMEL Assistant Director Anthony Lauricella and IDB project manager Anne Flannery presented on this new resource at the Chicago Colloquium on Digital Humanities and Computer Science (November 2016).

Figure 10. A UAV camera (drone) enabled Emily Hammer to collect aerial photography over the site of Ur in southern Iraq in April 2017; the camera captured photos in the hours following a rare spring rainstorm, and the differential absorption of moisture in the soil shows buried mudbrick architecture

New Equipment For Fieldwork

In the past several years, CAMEL has earned a significant amount of income from grants and from contract work. These funds enabled the purchase of new fieldwork equipment for Oriental Institute projects, including a Bartington Grad601-2 magnetic gradiometer (for subsurface mapping), a Leica TS06+ total station (for excavation and survey), and a DJI Phantom 4 UAV camera (for aerial photography). The Phantom 4 had its first use during a new survey that Emily Hammer began at the southern Mesopotamian city of Ur in April 2017, a project detailed further in her individual research report (fig. 10).

Acknowledgments

Many staff members made our research and grant work possible, and we thank them for their commitment and energy throughout the year. Our student staff for general laboratory projects included Anthony Lauricella (Assistant Director), Thomas Chiodini, Sarah Mace, and Justin Reeve. Émilie Sarrazin carried out research on the desert kites of Egypt and Nubia. Joshua Cannon and Rolland Long carried out all work on the Anatolian Atlas project. Anthony Lauricella (Assistant Director) took primary responsibility for developing and testing the web interface of the Integrated Database project alongside IDB project managers Foy Scalf and Anne Flannery. The efforts of Kathryn Franklin and Rebecca Seifried (Heritage Analysts) as well as those of Anthony Lauricella (Assistant Director) were essential to all of our Afghan grant-related database-building and research projects. Our other Afghanistan grant staff included Emily Boak, Shaheen Chaudry, Emily Hansen, Michael Johnson, Gwendolyn Kristy, Jim Meierhoff, Madeline McCann, and Oren Siegel.