Layers of the Past

Combining data from two centuries' worth of images creates a new view of the ancient Near East

by Eti Bonn-Muller

Archaeologists have long been frustrated by their inability to visualize how ancient sites and their environs once looked. But this is no longer a problem with CAMEL—the snappy acronym for the Center for Ancient Middle Eastern Landscapes at the University of Chicago's Oriental Institute—a souped-up version of the "virtual globe" idea. CAMEL draws from a giant pool of three types of images: topographic maps dating from the mid-19th century to the present, pioneering aerial photographs taken by archaeologists between the 1920s and 1950s, and remote-sensing data such as satellite imagery. It then merges these components to create pictures of on-the-ground features such as archaeological sites that show how the landscape of the Middle East—broadly defined by CAMEL's researchers as extending from Greece to Afghanistan to the Horn of Africa—has changed over the past two centuries. The resulting image is a dense jumble of varying pixel sizes and colors, but digitally peeling away its layers is like unearthing a rich, virtual trove of information.

This data is invaluable, especially to scholars studying the Middle East. Before the mid-20th-century advent of mechanized farming techniques, deep plowing, urban development, and modern warfare, this landscape had remained relatively untouched for thousands of years. Through composite CAMEL images, it is now possible to follow everything from the course of ancient rivers and patterns of vegetation growth to the emergence of recent looters' holes and the damage sustained to millennia-old mud-brick palaces during the latest wars in Iraq and Afghanistan. CAMEL is also revolutionizing the way archaeologists approach fieldwork in the region. "For the first time, we can actually see sites as part of a broader archaeological landscape of topography, ancient agriculture, herding systems, and roads," says Oriental Institute (OI) director Gil Stein, who used CAMEL data at Tell Zeidan, the sixth- to fifth-millennium B.C. site in Syria where he directs excavations. "This is one of the single best resources in existence for doing landscape archaeology in the Near East."

Using a composite CAMEL image of the area surrounding Tell Zeidan, Stein and his team were able to reconstruct an ancient river terrace system and locate 64 possible archaeological sites, which they then mapped and surveyed for surface finds. "We can now start to understand Tell Zeidan's role as a regional center dominating a hinterland of small surrounding agricultural villages," he says. "In three weeks, we were able to do work that would otherwise have taken us three months."

CAMEL team members under the direction of Scott Branting, an assistant professor of archaeology at the OI, work with Geographic Information Systems (GIS) to combine the three types of images. They usually start with two—preferably one that contains a good deal of spatial information, such as a satellite image, and another with less information, such as an old, hand-drawn map—and match their coordinates. The computer then stretches and fits, or "georectifies," the images. With them aligned one on top of another, it is possible to begin layering other types of images, including aerial photographs, on top of the georectified one. Among the myriad benefits of the resulting image is the ability to overlay real-time GPS data on it, so archaeologists in the field using a tablet PC can actually see themselves on the image.

CAMEL overlays multiple maps and images of the same area taken at different times to investigate changes to ancient sites and landscapes. The high-resolution Quickbird-2 satellite image (above) shows Persepolis, the ancient capital of the Persian Empire during the Achaemenid Dynasty (550–330 B.C.). Taken in 2002, it has been rendered as an infrared false-color composite over a detailed topographic model obtained by the U.S. space shuttle *Endeavor* so that certain features, such as vegetation surrounding the site, are clearly visible.

By superimposing additional layers of images, CAMEL is also able to show features that have disappeared over time. On top of the 2002 image (detail at right, bottom) is a declassified 1960s U.S. spy satellite image (middle) and a 1937 photograph (top) taken by Erich Schmidt, a pioneer of aerial archaeological survey, from the Oriental Institute. A digital composite of these images helped researchers see that an ancient water system (line of dots in the foreground of the top image) had been obscured by modern development.

The CAMEL "lab," as the university calls it, is the brainchild of geographer-turned-archaeologist Tony Wilkinson, formerly an associate professor at the OI and now a professor at Durham University in the United Kingdom. In 1996, Wilkinson realized the importance of developing tools to work with Cold War–era spy satellite imagery, which had just begun to be declassified. So the following year, he began to amass these images. The OI now houses some 1,200 declassified spy satellite images, one of the largest collections in the world alongside the U.S. Geological Survey. Working out of a cramped room in the basement of the OI, Wilkinson started looking for other visual materials that might augment them.

Today, the 12-year-old lab is well equipped. Since 2004, it has been under the direction of Branting, who expanded on these ideas by digitizing thousands of maps and photographs from the OI's collection and ramping up the purchase of more recent satellite images. The team, including current graduate students and CAMEL associate directors Joshua Trampier and Robert Tate, is made up of about two dozen students and volunteers. One of its main goals is to make the information accessible to the public in an online archive. For now, the team provides information to researchers upon e-mail request (http://oi.uchicago.edu/research/camel). A potential problem is that data could fall into the hands of looters, but Branting is optimistic that CAMEL may also be able to help the good guys. "If somebody has the wherewithal to know that he should use remote-sensing imagery to loot, he's going to be able to purchase very high-resolution stuff anyway," says Branting. Making the information available, he argues, and developing partnerships throughout the region with local agencies such as Egypt's Supreme Council of Antiquities, "at least puts them on an even playing field to try and stop it."

CAMEL images of the Egyptian 5th Dynasty pyramid complex of Abusir revealed that portions of its ancient funerary zone and harbor (visible 90 years ago) had disappeared beneath expanding fields and sprawling modern villages. From top to bottom: photograph taken from an airplane in 1920 by Oriental Institute founder James Henry Breasted, 1937 map produced by the British War Office, declassified U.S. spy satellite image taken in 1969, and Quickbird-2 satellite image taken in 2007.

James Henry Breasted, founder of the Oriental Institute, took aerial photographs of archaeological sites while on expeditions throughout the Middle East. Here, he poses with his camera in front of the Royal Air Force biplane used for his flight over Egypt in 1920, when he captured the photo shown at the top of the stack of images above.

Branting's team is working with researchers at the University of Arkansas to develop a way to automate the labor-intensive process of georectification for the declassified spy satellite imagery; for the time being, they do it by hand. In 2009, the team finished digitizing the OI's collection of more than 4,500 maps, but it will be another three-plus years before all of the thousands of aerial photos are digitized. In addition, new satellite images continue to be reproduced (and declassified) every year. Branting has also started to reach out to overseas research centers, including the Albright Institute in Jerusalem, to digitize their map collections so researchers don't need to travel to Israel to access them. "Ideally, we'd like to create a very deep temporal landscape," says Branting. "This will probably always be an ongoing project to a certain extent." And, undoubtedly, an invaluable one. "We can now reconstruct the earliest urban landscapes in the world," adds Stein. "It's incredible." ■

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