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Notes on a Disappearing Past

Satellite-Based Monitoring of Looting and Damage
to Archaeological Sites in Syria

Jesse Casana

Mitra Panahipour

ABSTRACT

This article presents analysis of recent, high-resolution satellite imagery to document looting and damage to archaeological sites in Syria that have taken place as a consequence of the ongoing civil war. The effort relies on 2012 and 2013 GeoEye and WorldView imagery covering 30 key sites, alongside freely available imagery served on Google Earth and Bing Maps. Results reveal widespread damage to archaeological sites across the country, caused both by looting and military activities. Ongoing satellite-based monitoring provides a powerful method to document looting and destruction, and will ultimately prove helpful in structuring post-war damage assessment and reconstruction in Syria.

Following up on the recent *JEMAHS* Forum discussing cultural property crimes in the context of armed conflict (Kila 2013), this article presents an analysis of recent satellite imagery revealing patterns of looting and damage to archaeological sites in Syria that have taken place as a consequence of the ongoing civil war. As discussed by several contributors to the *JEMAHS*

Forum (e.g., Al Quntar 2013; Ali 2013; Cunliffe 2013), Syria has an extraordinarily rich archaeological heritage, as home to the world's first sedentary agricultural villages, thousands of major Bronze and Iron Age sites (Akkermans and Schwartz 2003), and some of the most spectacular Roman and medieval ruins in the world (Burns 2009; Butcher 2003) with six World Heritage sites listed and 12 others under consideration (UNESCO 2014). As in any conflict, these cultural resources come under threat of looting as well as more direct forms of damage from bulldozing, construction activities, or shelling and gunfire (Kila 2013). Since March 2011, when civil unrest began in Syria, access to most sites by either archaeologists or antiquities officials has been extremely limited. With little or no direct observation by trained professionals, most of our information regarding war-related damage to archaeological sites, monuments, and other cultural properties comes instead from journalists, as well as from reports, photos, and videos uploaded to social media sites. As this pilot study demonstrates, analysis of satellite imagery offers a powerful means to monitor war-related looting and damage to sites in Syria until archaeologists and antiquities officials are able to conduct ground inspections. Results suggest that damage to sites is quite widespread across Syria, but also shows that most looting is concentrated on later period sites (Roman–Early Islamic), while earlier Bronze and Iron Age tell sites are particularly vulnerable to damage from the construction of military garrisons.

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Background

The most widely disseminated reports of war-related destruction and damage to sites and monuments in Syria have been produced by journalists, and thus have understandably focused largely on historic buildings or monuments, such as the destruction of a minaret at the Umayyad mosque in Aleppo (e.g., Watson 2013), the burning of that city's historic *souq* (e.g., Weaver 2012), or the bombardment of the Crusader castle at *Krak des Chevaliers* (e.g., Al Jazeera 2013). However, these reports do not indicate how widespread such incidents are across the country and, in many cases, reports are based on photos and videos posted to social media sites by partisan actors in the conflict. Thus, the sources of information may be at least in part politically motivated.

In May 2012, Cunliffe published a study that attempted to use journalistic and social media sources to compile a more complete picture of the nature and extent of war-related damage (2012). She found credible evidence of damage at many World Heritage sites and candidate sites including Palmyra, Bosra, and Apamea, as well as at many of the so-called Dead Cities, the well-preserved Roman and late Roman ruins that dot the hills of western Syria. More recently, the Syrian government's Directorate General of Antiquities and Museums (DGAM) has begun releasing periodic reports that summarize their knowledge of looting and other damage to sites (e.g., Abdulkarim 2013; 2014). Unfortunately, many top DGAM officials were forced to leave the country over the past few years for both political and safety reasons, and those who remain in Syria are generally unable to inspect sites as travel to most areas of Syria remains dangerous. Thus, even DGAM reports rely, to a large extent, on second-hand information provided by non-specialists. In addition, DGAM summaries have been criticized as politically motivated propaganda because they report almost exclusively on damage to sites that are in opposition-held areas and lay all blame at the feet of rebels and thieves, meanwhile failing to report on well-documented cases of site damage and looting in Assad regime-held regions (Al Quntar 2013; Ali 2013).

In late 2012, high-resolution Quickbird imagery from April 2012 covering the Roman city of Apamea was posted on Google Earth and revealed a stunning degree of looting at the site, all of which had taken place over the preceding eight months (Trafficking Culture 2012). Apamea is a candidate to be a World Heritage site (UNESCO 2014) and is among the best preserved Roman-period cities anywhere in the world. The city was founded following the conquest of Syria by Alexander the Great, and soon became one of the principal urban centers of the region (Ball 2000; Butcher 2003). The city was occupied throughout the Hellenistic, Roman, and late Roman periods (ca. 330 BCE–614 CE); however, sometime during the seventh or eighth century, Apamea, along with most other contemporary settlements in the northern Levant, was largely abandoned. Settlement continued on the high, upper citadel, which was re-fortified during the medieval period and remains occupied today, but the remainder of the city remained largely abandoned, leading to its relatively good state of preservation. Apamea, now with its magnificent colonnaded street largely reconstructed, was among the top tourist destinations in Syria until the start of the current war.

Imagery revealed that between July 2011 and April 2012, about two-thirds of Apamea was intensely looted, appearing now as a pockmarked, almost lunar, landscape. The initial discovery of the looting on Google Earth-served imagery was soon picked up by news media around the world and became an exemplar of the dire cultural heritage situation in Syria. However, it remained unclear to what degree the kind of extreme looting visible at Apamea was widespread or if the site was a sad, but unusual, case. The example of Apamea nonetheless makes clear that analysis of recent high-resolution satellite imagery is a powerful way to monitor looting and site destruction remotely, as has been also demonstrated in Iraq (Stone 2008; Jahjah et al. 2007) and elsewhere (e.g., Contreras 2010). Furthermore, observations derived from satellite imagery provide an independent cross-check against less verifiable reports from media or government sources.

Methodology

Our first step in this project was to undertake an analysis of all archaeological sites within the areas that are covered in 2012 and later imagery on either Google Earth or Bing Maps, the two leading sources of freely accessible, high-resolution imagery. Our research team has been working for several years to develop a comprehensive archaeological site database for Syria and surrounding regions as part of a NASA-funded research project (Casana and Cothren 2013), and this dataset, including around 15,000 sites in Syria, provides a robust basis for analysis. Unfortunately, as of the writing of this study, there remains only a small area within Syria covered by recent imagery on free web mapping services. To expand our analysis, we also received an imagery grant from the DigitalGlobe Foundation, an organization that provides non-profit researchers up to 500 km² of archived

imagery. The foundation agreed to provide 25 scenes, and with this number we were able to obtain coverage of 30 key sites from across Syria (Fig. 1). We selected sites to yield a sample from all the different geographic regions of Syria and sites from all periods in an effort to determine whether there are any patterns in site looting and destruction, either geographically or chronologically.

Using both freely available Google Earth- and Bing Maps-served imagery alongside GeoEye-1 and Worldview-1 and 2 imagery provided by the DigitalGlobe Foundation, we then carefully compared the most recent images available to pre-war, high-resolution imagery of the same sites, looking for evidence of looting holes, bulldozing, construction, or other signs of damage. It must be noted that imagery-based analysis is unlikely to reveal damage to standing monuments or architecture, at sites now covered by modern towns and villages, and at sites obscured by dense vegetation. With these limitations,

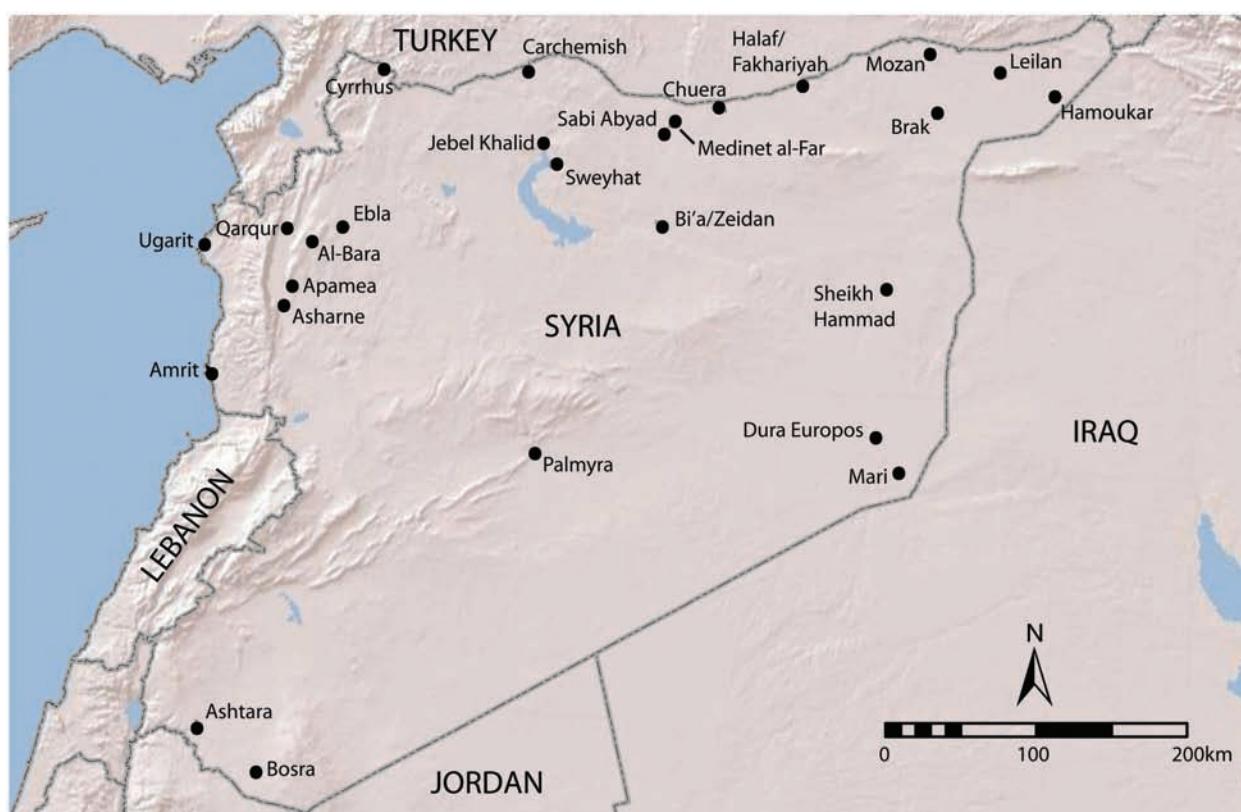


FIG. 1

A map of key archaeological sites in Syria covered by recent high-resolution satellite imagery provided by the DigitalGlobe Foundation. (Map from DigitalGlobe.)

it often reveals patterns of damage to sites with great clarity. Below, we present examples of damage we have been able to recognize, first focusing on two regions of Syria, the Orontes Valley and the lower Balikh Valley, where the largest amount of 2012 and later imagery is available. We then present findings at other individual sites throughout Syria, comparing major sites of the Roman through Early Islamic periods (ca. 150 BCE–1100 CE) to sites of the earlier Bronze and Iron Ages (ca. 3000–500 BCE). Finally, we offer an analysis of the general trends we have been able to identify, noting both limitations and recommendations for ongoing monitoring efforts.

The Orontes Valley

The Orontes River flows north through western Syria, from its headwaters in the highlands of Lebanon to its debouchment into the Mediterranean from the Hatay province of Turkey. Within the well-watered and fertile valley through which the river flows lie some of Syria's largest cities, including Homs and Hama, as well as a rich record of ancient settlement. Within this region, Google Earth currently provides some of the most extensive coverage from 2012 and later, including in the vicinity of Apamea.

Apamea

At Apamea, where extensive looting has already been well documented, analysis reveals a spatial pattern in the looting that has not been widely discussed in media reports. On the north of the site in particular, it is evident that looting activities are concentrated almost entirely on the eastern portion of the site that is owned and managed by the Syrian government (Fig. 2). As is common at very large sites like Apamea, much of the ancient settlement area, even that within the late Roman fortification walls, is privately owned and is cultivated annually. A road that cuts through the center of the site demarcates these privately held areas to the west from the government-owned areas to the east, and the April 2012 image shows that only four or five holes were placed in privately held areas. Our most recent GeoEye-1 image from November 4, 2012 shows that looting holes have begun to encroach

west of the modern road, but still remain largely concentrated on the government-owned heritage site (Fig. 3).

Media reports discussed by Cunliffe (2012) and Ali (2013) suggest that Assad-regime forces shelled Apamea and bulldozed part of the medieval citadel's walls in order to construct a road to better supply troops garrisoned at this strategic spot. The satellite imagery from 2012 offers confirmation of the continuing presence of Assad forces at Apamea, with the construction of a large military garrison on a small promontory at the center of the site. In this image, a building, the site of the former tourist restaurant, has been encircled by a bulldozed earthen bunker, with a tank emplacement on the eastern side. The looting trenches at Apamea are not small, metal detecting holes, but typically measure up to 3 m on a side. The size and sheer number of these holes, as well as the short period over which they were dug, indicates that they were either made using machinery, such as a backhoe or an excavator, or involved a small army of laborers, either of which would have been observed by military forces occupying the site. Comparing a Google Earth-served image from September 27, 2012, to a GeoEye-1 image from November 4 of the same year shows that looting continued during this six-week period, contemporary with the presence of Assad's military forces on the site, thereby suggesting that the military was either directly involved or at least tacitly complicit in the looting.

Tell Jifar

Expanding our search beyond Apamea reveals many other smaller sites in the vicinity that have been similarly impacted by looting and the construction of military garrisons. One of the most revealing is the small mound of Tell Jifar, located just 2.5 km east of Apamea, opposite a small reservoir. The April 2012 Google Earth-served imagery shows that the entire top of the small tell has been transformed into a military garrison (Fig. 4). Tanks, other vehicles, and artillery are positioned in bunkers that ring the top of the mound and several military tents have been erected on the upper mound as well as along its southern edge. The base of the mound on its southern, eastern, and western sides has been subjected to extreme looting, the size and character of which appears very similar to looting holes at Apamea. However, in this case, earlier imagery



FIG. 2

The north end of Apamea on July 19, 2011, and April 3, 2012. The government-owned portion of the site was severely looted over this eight-month period, while the privately held area west of the modern road was left largely untouched. (Map data ©2014 Google Earth and Digital Globe.)



FIG. 3

During the construction of an Assad-regime military garrison at Apamea in 2012 (left), looting continued to expand as illustrated in Google Earth-served images from April 3 and September 27, 2012, and a GeoEye-1 image from November 4, 2012. (Map data ©2014 Google Earth, DigitalGlobe, and DigitalGlobe Foundation.)



FIG. 4
Tell Jifar, 2.5 km east of Apamea, as seen on Google Earth-served imagery from April 2012, December 2007, September 2003, and on a CORONA image from July 1969. The 2012 image reveals extensive looting and military-related damage, but looting had begun at least ten years earlier. The CORONA image reveals an occupation below the main mound apparently being targeted by looters. (Map data ©2014 Google Earth and DigitalGlobe.)

from December 2007 shows that there was already extensive looting at that time with an even earlier image from September 2003 showing that looting had begun at the site more than a decade ago. Nonetheless, a comparison of looting from 2007 and 2012 shows that the size and extent of holes expanded considerably since the war began. Moreover, it seems likely that the looting expertise that developed at Tell Jifar over the past decade laid the foundation for the massive increase in scale that the imagery reveals took place after the war made it possible to do so. The close association between looting holes and the military garrison, with many large holes just a few meters outside of the tents, again suggests either direct or indirect involvement of military personnel in looting.

The fact that looting trenches at Tell Jifar are concentrated almost entirely at the base of the mound rather than on the mound itself is also revealing as to the looters' objectives. In western Syria, most mounded tell sites like Tell Jifar have long histories of settlement, particularly during the Bronze and Iron Ages (ca. 3000–500 BCE), while later settlements of the Hellenistic, Roman and late Roman periods (ca. 300 BCE–650 CE) are often located at topographically flat sites, dispersed in large numbers throughout the landscape (Casana 2007; 2012). Archaeological surveys reveal that it is quite common for tell sites to have late period occupations of Roman or medieval date off the main mound, and Tell Jifar is likely one such site. Declassified CORONA satellite imagery from July 1969 shows that there is a light patch of soil south of the main mound, generally indicative of anthropogenic soils associated with ancient settlement (Menze and Ur 2012; Wilkinson, Beck and Philip 2006). This area corresponds precisely to the area of intense looting as seen in Fig. 4. Thus, looters in this case are mostly likely specifically targeting a late period settlement, rather than the Bronze and Iron Age mound.

Tell Qarqur

Tell Qarqur, located about 35 km downriver from Apamea, has been the site of American Schools of Oriental Research (ASOR)-sponsored excavations since 1993 (Dornemann 2012a–b), and the author directed investigations at the site from 2005–2010 (Casana, Herrmann and Fogel 2008; Casana 2014). Tell Qarqur is located at the junction between the main north–south road through the Orontes Valley and one of the main east–west roads connecting

Aleppo and inland Syria with Latakiya and the coast. As such, the site today is and has been throughout much of 10,000-year occupational history situated in a strategic location. Archaeological evidence shows that the site was fortified many times in the past, going back at least to the early third millennium BCE and continuing through the Crusader period, so it is perhaps unsurprising that the site was chosen as a location for a large military garrison at the start of the current conflict.

The most recent Google Earth-served pre-war image available, dating to June 28, 2010, was acquired while the ASOR team was excavating the site and the open trenches, equipment tents, and team bus are visible in the image (Fig. 5). However, an image from July 2011 shows that by then the northern half of the site had been transformed into a military garrison with numerous tanks or other military vehicles lining the edge of the mound and several more guarding the road at the base of the site. Several military tents are also set up on the east and south sides of the main mound. The establishment of this Assad-regime military garrison was contemporary with the intense fighting that took place in the town of Jisr Shugur, just 5 km to the north, in June 2011 (Chulov, Weaver and Meikle 2011). The creation of large bunkers on sites like Tell Qarqur creates massive bulldozing scars, while the stationing of troops on the site inevitably leads to damage to open excavation trenches. A later image from September 23, 2012, shows the continued presence of at least two military vehicles or tanks on the site, but a GeoEye-1 image from November 4, 2012, shows that the military had abandoned the site, perhaps in response to the increasing domination of rebel forces in the region.

The kinds of damage illustrated above are quite widespread in recent satellite imagery from the region surrounding Apamea with numerous small sites garrisoned by regime forces, including Tell Baqalou, Tell Houash, Tell Braidij, and Tell Zajrit and several others subjected to intense looting including Tell Sheikh Sultan, Tell Salba, and Er-Rubba (Fig. 6). At Er-Rubba, severe looting predates the war as at Tell Jifar discussed above, but at all of the other sites damage is entirely war related. The patterns identified thus far suggest that as more imagery becomes available, it is likely the scope and severity of site destruction and looting in the region will increase.

The Balikh Valley

The region of Raqqa, at the confluence of the Euphrates and Balikh Rivers in northern Syria, also has recent high-resolution imagery available on Google Earth. Our study expands on this using recent images of a number of key sites further north up the Balikh Valley. Collectively, analysis of these data reveal several key trends, including the existence of widespread and sometimes extreme looting of sites that predates the current war, as well as the expansion of looting since the war, but concentrated primarily at later period sites.

The early prehistoric sites in our study, including Sabi Abyad, a major Pottery Neolithic (Halaf-related) site (Akkermans et al. 2006); Tell Zeidan with a long history of Late Neolithic and Chalcolithic settlement (Stein 2009); and Hammam et Turkman with major Ubaid, Late Chalcolithic, and Bronze Age occupations (Van Loon 1988), all show little evidence of looting or other damage in imagery from October 10, 2012 (Fig. 7). These sites, while all home to major excavation projects and quite well-known among archaeologists, do not appear to be (at this stage) the type of sites being targeted by looters. Likewise, analysis of the geographic distribution of military activity in Syria shows that the Balikh and surrounding regions have seen very little armed conflict (Syria Needs Analysis Project 2013), and thus mounds in this area appear, at least for the time being, much less likely to be garrisoned by military forces.

On the other hand, the 38-ha mound of Tell Bi'a, identified with the ancient city of Tuttul, shows intense looting damage, but only on one small area in the southwestern portion of the site (Fig. 8). Tell Bi'a is best known for its Early and Middle Bronze Age (third to mid-second millennia BCE) monumental architecture and cuneiform archives (Strommenger and Kohlmeyer 2000; Miglus and Strommenger 2007), but the site also sits adjacent to the extensive remains of the late Roman (fourth–seventh centuries CE) and Early Islamic (seventh–tenth centuries CE) city of Raqqa, most of which is now covered by modern buildings but is clearly visible in 1960s CORONA satellite imagery (Challis et al. 2004; Hritz 2013). The intensive looting at Tell Bi'a is concentrated almost exclusively on the small part of the site that was home to Hellenistic, Roman, and Byzantine settlement, while the large, excavated remains of the Bronze Age palatial architecture appear to be of little interest.

A similar phenomenon is evident at a large, predominantly late Roman/Early Islamic site known as Thoul Nayel just 500 m southeast of Tell Zeidan (Curvers 1991; Hritz 2013). The site, which is part of an extensive series of remains surrounding the late Roman city of Callinicum (modern Raqqa), has been intensely looted (see Fig. 7). In an October 2012 image, looting holes cover virtually the entirety of the site, but comparison with an April 2011 image shows that much of this damage predates the current civil war. A careful analysis reveals an expansion of looting between April 2011 and October 2012, but that is simply the continuation of a long tradition of looting in the region.

Further north up the Balikh River basin is the large Early Islamic settlement of Medinet al-Far, notable for its massive rectilinear fortification systems and well-preserved architectural remains (Wilkinson 1998; Walmsley 2007). The site was initially founded during the Early Islamic period as part of a series of border cities defending against the Byzantine Empire to the north (Eger 2012), and has been the site of Syrian-sponsored excavations for many years. Google Earth-served imagery from August 2010 shows already extensive looting damage across most of the 100-ha ancient settlement, while DigitalGlobe imagery from October 2012 shows that, like at other sites in the region, the number and size of looting holes has increased since the start of the war (Fig. 9).

Roman and Medieval Sites

Data from the Orontes and Balikh regions where more coverage by recent high-resolution imagery is available show a strong preference for looting at later period sites, particularly of the Roman, late Roman, and Early Islamic periods, and this picture is largely confirmed by a number of other sites in our study. In addition to those major late-period sites already discussed (e.g., Apamea, Medinet al-Far, and Thoul Nayel), we acquired imagery through DigitalGlobe for several other significant late-period sites including Amrit, Bosra, Cyrrhus, Al-Bara, Jebel Khalid, Palmyra, and Dura Europos. Many of these sites are reported to have suffered war-related damage, including media stories covering the encampment of refugees and rebel fighters within the tombs and stone buildings at Al-Bara and other Dead Cities, and Al-Bara

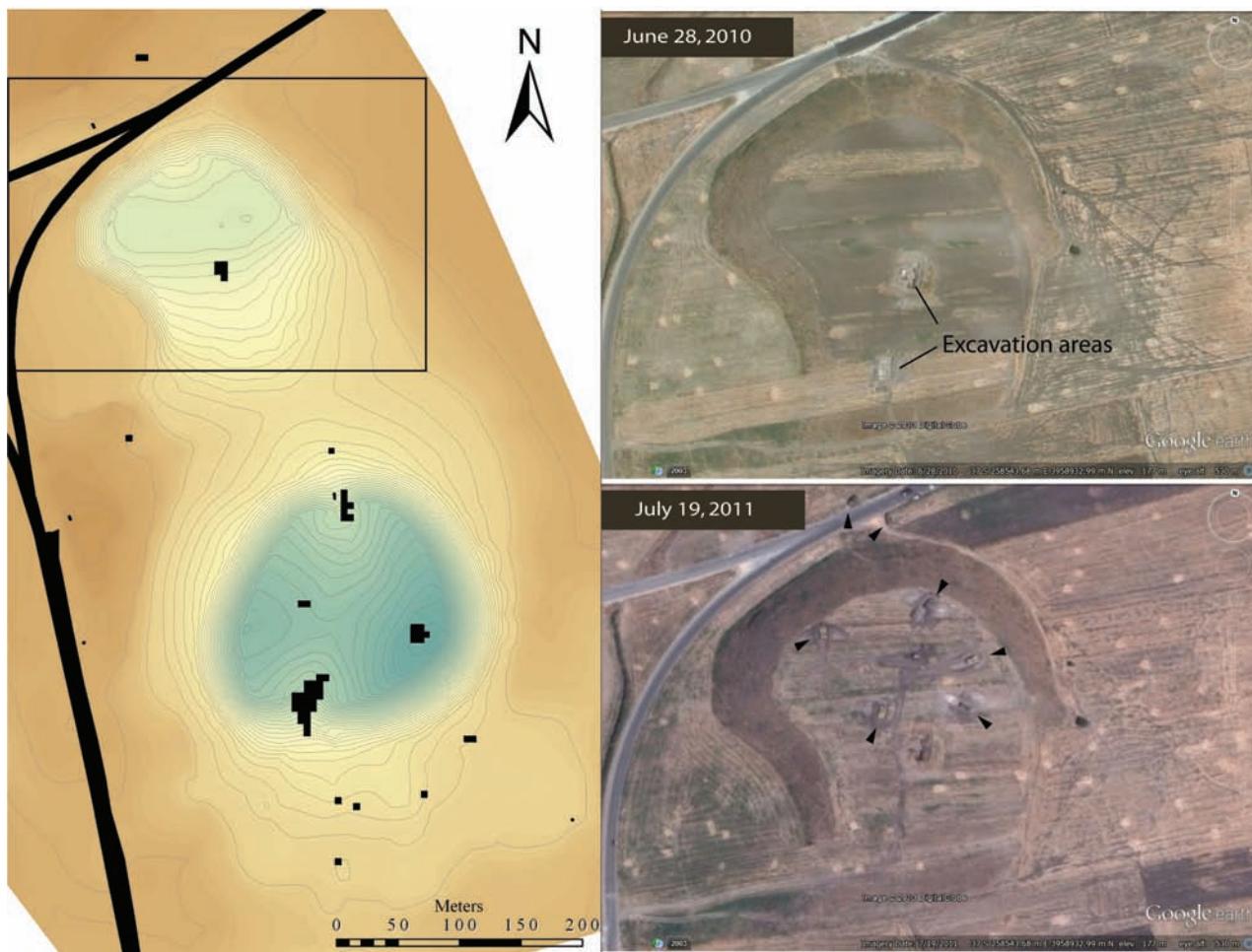


FIG. 5

A topographic map of Tell Qarqur and Google Earth-served images from June 2010 during excavations and July 2011 when the northern end of the site had been transformed into a military garrison. Tanks and other military vehicles are indicated with arrows. (Map data ©2014 Google Earth and DigitalGlobe.)

was specifically noted as the likely location of damage to historic monuments in Cunliffe's study (2012). More of such damage is reported in the most recent damage assessment by DGAM (Abdulkarim 2014). In November 2012, imagery of Al-Bara and its hinterland, where several other Dead Cities are located, the tree cover and modern buildings make recognition of looting or damage to the site quite challenging.

Similarly, at the site of Amrit, a large city founded on the Syrian coast during the Achaemenid period and notable for its well-preserved tombs and ritual buildings, dense vegetation prohibits obvious identification of looting. The same is true at Cyrrhus, a key Roman/late Roman city on the modern Syrian-Turkish border, and at

Bosra, a Roman city in far southern Syria that is largely obscured by a modern town. At Bosra in particular, a World Heritage site where intense fighting has taken place throughout the current war, there have been many reports of looting and shelling damage to monuments (Cunliffe 2012; Abdulkarim 2013), but these are difficult to see in our imagery. Reports are nonetheless credible and suggest that even while we cannot see it in satellite imagery, there has likely been significant damage at most of these sites.

At Dura Europos, a well-known Hellenistic-late Roman city in far eastern Syria, located on a high bluff above the Euphrates River, we are able to see significant looting in imagery from November 14, 2012 (Fig. 10). Ironically,



FIG. 6

Numerous other sites in the region of Apamea impacted by construction of military garrisons (Tell Braidij, Tell Baqalou, and Tell Houash) as well as severe looting (Tell Salba, Er-Rubba, and Tell es-Sheikh Sultan) visible in imagery from April 4, 2012. (Map data ©2014 Google Earth and DigitalGlobe.)

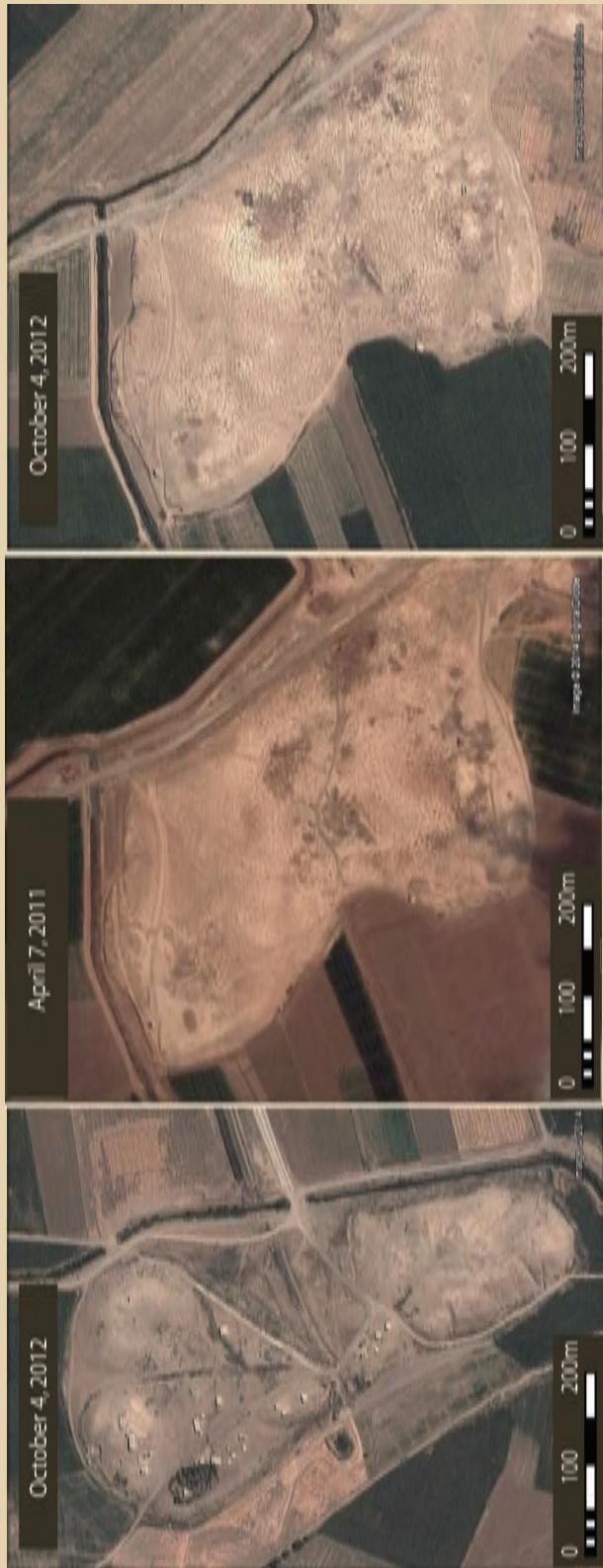


FIG. 7
Tell Zeidan (left), a Neolithic and early Chalcolithic site, has no evidence of looting as of October 2012. Thoul Nayal, a Roman and late Roman site 500 m to the southwest, was intensely looted prior to the war as seen in April 2011 (center) with expanded looting visible in October 2012 (right). (Map data © 2014 Google Earth and DigitalGlobe.)



FIG. 8

Tell Bi'a on a GeoEye-1 image from October 10, 2012, reveals dense looting on the southwestern corner of the site where post-Bronze Age settlement is concentrated. (Courtesy of the DigitalGlobe Foundation.)



FIG. 9

The square fortification on the northern end of Medinet al-Far, as seen on a GeoEye-1 image from October 10, 2012, revealing extensive looting across much of the site. (Courtesy of the DigitalGlobe Foundation.)

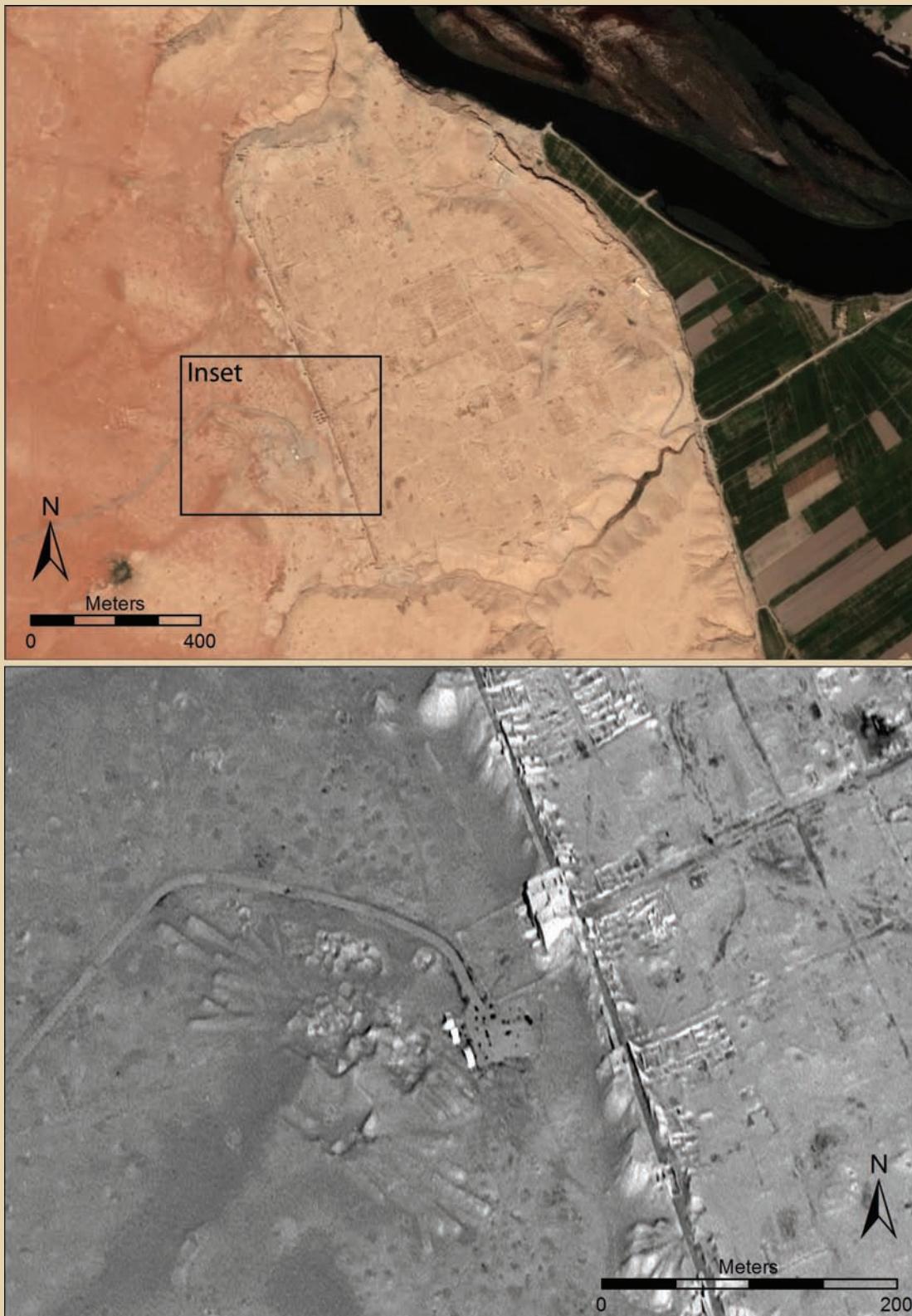


FIG. 10
Dura Europos in September 2007 imagery (top). Extensive looting, mostly predating the war, is visible in the area just outside the Palmyrene Gate, seen here (inset) on a GeoEye-1 image from November 14, 2012.
(Map data ©2014 Google Earth and DigitalGlobe.)

Dura Europos originally came to archaeological attention through Breasted's publication of late Roman frescoes that were exposed by the construction of military bunkers at the site during the lead-up to the Arab Revolt of 1920–1922 (Breasted 1924). Imagery predating the current war from September 2007 shows that, like at many other major late-period sites, looting was already widespread long before the war with hundreds or possibly thousands of looting holes visible both inside and outside the fortification walls. Our imagery from November 2012 shows that since the war, the number of looting holes has continued to increase, although in practice it would be somewhat of a challenge to find somewhere not already looted in recent years.

For two other major late-period sites in our study, Palmyra and Jebel Khalid, the most recent archived imagery available is too old (dating to July 2010 and April 2011) to reveal war-related damage. They nonetheless confirm the suggestion from other sites in the study that looting was already quite widespread prior to the war, with many looting holes visible at both sites. The longstanding tradition of looting at these sites makes it likely that given the breakdown of government authority, such activities have already intensified and will continue to increase in scale in the future.

Bronze and Iron Age Sites

Several of the images supplied by the GeoEye Foundation target major Bronze and Iron Age (ca. 3000–500 BCE) sites found throughout different parts of Syria, including Ugarit (Ras Shamra), Tell Asharne, Ebla (Tell Mardikh), Tell Ashtara, Tell es-Sweyhat, Carchemish, Tell Chuera, Tell Halaf, Tell Fakhariyah, Tell Brak, Tell Mozan, Tell Leilan, Hamoukar, Tell Sheikh Hammad, and Mari (Tell Harriri). Most of these sites have been the subject of decades-long excavation campaigns by European and North American archaeologists, and several including Ebla and Mari were reported to have been damaged by looters in government reports (Abdulkarim 2013; 2014). Our analysis found relatively little visible evidence of looting or destruction at most of these sites, suggesting that at least at the time our images were acquired, the sort of extreme looting evident at sites in the Orontes and Balikh Valleys as well as at later period sites

throughout Syria is not widespread at these sites; however, many may have suffered damage from the war.

Ebla (Tell Mardikh)

The ancient city of Ebla (modern Tell Mardikh) has been home to Italian-sponsored excavations since the 1960s that famously uncovered a large palace and cuneiform archive dating to the Early Bronze Age IV (late third millennium BCE) (Matthiae and Marchetti 2013). The archive, found in the structure dubbed Palace G, along with a wealth of archaeological evidence spanning the mid-third to mid-second millennia BCE, has made Ebla one of the best resources for the history, politics, and material culture of the Near East during this period. Reports of looting at Ebla began to surface on social media in 2012, and the site is highlighted as one damaged by looters in July 2013 and January 2014 reports by DGAM.

However, a GeoEye-1 image of Ebla dated November 4, 2012 does not reveal evidence of significant looting at the site (Fig. 11a). Of course, we would be unable to see damage to the ancient building remains, which have been well documented (Ali 2013; Abdulkarim 2014). There are some reports that looters may be digging tunnels into the side of the site's central mound (Cunliffe, pers. comm.), which would also be unlikely to appear in imagery. It is also possible, as with any of our images, that looting and other kinds of damage have taken place since the image was acquired. The one major change we can see at Ebla during 2012 is the creation of what appears to be a military camp inside the site (Fig. 11b). A dense cluster of military tents surrounded by a fortification bunker is evident adjacent to one of the Italian excavation areas on the northwestern part of the site. The massive ancient earthen walls of Ebla, preserved to 20–30 m in height, create a natural defensive feature now as they did during the Bronze Age (Fig. 11c). As seen in the Orontes Valley discussion above, the presence of military installations on the site does not bode well for its future.

Tell Chuera

Tell Chuera is a major Bronze Age city in north-central Syria and has been the subject of several German-sponsored excavation projects going back to the 1950s

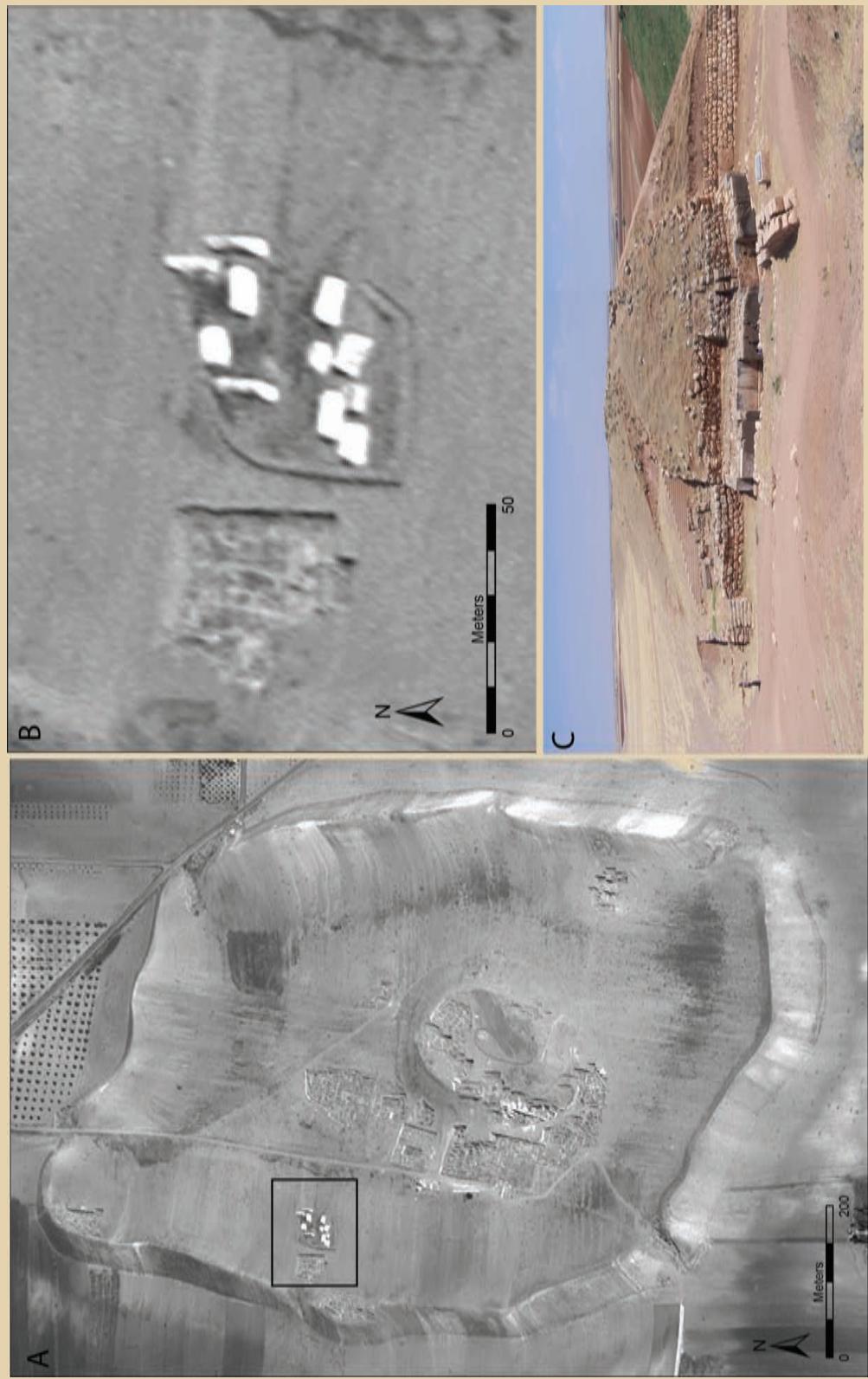


FIG. 11
Ebla (Tell Mardikh) on a GeoEye-1 image from November 4, 2012 (a), revealing the construction of a military installation inside the Bronze Age fortification walls of the ancient city (b). The ancient walls, pictured here at the excavated southwestern city gate (c), offer an easily defended location. (Black-and-white photos courtesy of the DigitalGlobe Foundation and color photo by J. Casana.)

(Meyer 2010). The site is best known for its massive Early Bronze Age (third millennium BCE) settlement, comprising a high central mound surrounded by two circular, concentric fortification systems. The site was also home to a key administrative center during the Middle Assyrian period in the late second millennium BCE.

Analysis of a GeoEye-1 image from September 2013 shows little evidence of looting or damage to the main Bronze Age portions of the site (Fig. 12). However, a large number of looting holes similar in size to those at Apamea are visible just outside the fortifications to the north, with a smaller number outside the site to the west. These were dug sometime between the time our image was acquired and September 2012, the most recent image available on Bing Maps. While archaeological investigations have not documented the nature of archaeological remains in these off-site areas, it is possible that they may contain extra-mural cemeteries contemporary with the main phases of occupation at Tell Chuera. On the other hand, a 1968 CORONA satellite image shows that the looting holes are concentrated on an area of light-colored soil which, again, is often indicative of anthropogenic soils associated with ancient settlement. If looters are targeting an occupation rather than a cemetery or other off-site feature, its position vis-à-vis the main mound suggests it would be a chronologically distinct component of the site and thus possibly a late-period settlement, perhaps of Roman or late Roman date. While we cannot be certain of the specific target of looting at Tell Chuera, a focus on a late-period settlement would fit the patterns we observe across the country.

Tell Ashtara

Tell Ashtara is a large mounded site in far southern Syria, close to the modern Jordanian border, and was likely the ancient city of Aštaroth, depicted in an eighth-century BCE relief from Nimrud (Bryce 2012: 79). The site was excavated by a Syrian expedition in the 1960s, revealing a massive Iron Age fortification system as well as earlier occupations in the Middle and Late Bronze Age. A WorldView-1 image of the site from August 27, 2013, shows that between that date and the most recent Bing Maps image from August 2011, the top and northern sides of the mound have been severely damaged by large holes (Fig. 13). The strong shadows on several holes at the top of the mound suggest they are of substantial depth, possibly 2–3 m. The holes at Tell

Ashtara are quite different in appearance from the looting holes recognized at many other sites in our study, as they are often of oblong shape and scattered across the mound in unusual configurations. They are also, however, distinct from the defensive garrisons created by Assad's military forces, which are typically built using bulldozers and excavators and appear quite orderly. Tell Ashtara is located in one of the regions of Syria most securely held by the Free Syrian Army (Syria Needs Analysis Project 2013), and thus the large holes at the site may be best interpreted as military bunkers for opposition forces.

Synthesis

This pilot study, relying on a small sample of donated imagery alongside freely available Google Earth- and Bing Maps-served imagery, has successfully identified worrisome patterns of looting and damage to archaeological sites across Syria. Of the 30 major sites for which we acquired imagery from the DigitalGlobe Foundation, our analysis recognized ten sites that have suffered relatively severe war-related damage, either from looting or the construction of military garrisons (Table 1). In addition, in areas where recent, high-resolution images are freely available, such as in the middle Orontes Valley, looting and damage appears quite widespread at many smaller sites. Moreover, at numerous major sites including Bosra, Cyrrus, Mari, and Palmyra where the date of available imagery or ground cover prevent identification of war-related damage in our analysis, credible media or government reports show extensive damage to ancient buildings or monuments. Thus, imagery analysis considered alongside ground-based observations suggests that the Syrian civil war is having quite a severe impact on the archaeological heritage of the country.

While available imagery is still too inconsistent in geographic and temporal terms to provide quantifiable data regarding trends in looting or other damage, we are still able to recognize patterns in the types of sites that appear to be most at risk. In general, in regions that had well-established traditions of looting predating the war, like those around Raqqa and Apamea, the intensity of looting has increased considerably in recent years. Throughout all parts of Syria, we also find a strong preference for looting of sites dating to the Roman, late Roman, or Early Islamic periods. At every major late period site covered



FIG. 12
Tell Chuera on a GeoEye-1 image from September 2013 reveals extensive looting of an area outside the Bronze Age city walls to the northeast, likely the location of a later period occupation adjacent to the main mound. (Courtesy of the DigitalGlobe Foundation.)



FIG. 13
Tell Asntara in far southern Syria on a WorldView-1 image from August 27, 2013, revealing many large holes across the top and sides of the mound dug since the start of the war. (Courtesy of the DigitalGlobe Foundation.)

TABLE 1 SUMMARY OF DAMAGE TO ARCHAEOLOGICAL SITES THAT ARE PART OF THIS STUDY

Site	Imagery Date	War-Related Reported Damage	Pre-War Observed Damage	War-Related Observed Damage
Al-Bara	Nov. 2012	Encampment of refugees; shelling damage; looting		
Amrit	Aug. 2013			
Apamea	Nov. 2012	Bulldozing; shelling damage; looting		Extreme looting; military garrison
Tell Asharne	Jan. 2013		Extensive urban development	
Tell Ashtara (Aštaroth)	Aug. 2013	Looting		Severe trenches or looting holes
Tell Baqalou	April 2012			Military garrison
Tell Bi'a (Tuttul)	Oct. 2012		Severe looting	Gradual expansion of looting
Bosra	Oct. 2013	Looting; shelling damage	Extensive urban development	
Tell Braidij	April 2012			Military garrison
Tell Brak	Feb. 2013			
Carchemish	Oct. 2013			
Tell Chuera	Sep. 2013			Looting
Cyrrhus	Aug. 2012	Looting; shelling damage		
Dura Europos	Nov. 2012	Looting; vandalism		Gradual expansion of looting
Ebla (Tell Mardikh)	Nov. 2012	Looting; vandalism		Military garrison
Er-Rubba	April 2012		Severe looting	Expansion of looting
Tell Fakhriyah	Feb. 2013			
Tell Halaf	Dec. 2012		Extensive urban development	Expansion of cemetery on mound
Hamman et-Turkman	Oct. 2012			
Tell Houash	April 2012			Military garrison
Hamoukar	Aug. 2012			
Jebel Khalid	July 2010		Occasional looting	N/A
Tell Jifar	Nov. 2012		Severe looting	Severe looting; military garrison
Tell Leilan	April 2013			
Mari (Tell Hariri)	June 2012	Looting; vandalism		
Medinet al-Far	Oct. 2012	Looting	Severe looting	Expansion of looting
Tell Mozan	Feb. 2013			
Palmyra	April 2011	Shelling damage	Occasional looting	N/A
Tell Qarqur	Nov. 2012			Military garrison
Sabi Abyad	Oct. 2012			
Tell Salba	April 2012			Severe looting
Tell Sheikh Sultan	April 2012			Looting
Tell es-Sweyhat	Oct. 2012			
Sheikh Hamad	Jan. 2012			
Thoul Nayel	Oct. 2012		Extreme looting	Expansion of looting
Ugarit (Ras Shamra)	May 2013	Vandalism		
Tell Zeidan	Oct. 2012			

Note: "Reported Damage" is that known from media or government reports, while "Observed Damage" is that documented on satellite imagery.

in our study where imagery could reasonably be expected to reveal looting (i.e., excluding those where vegetation or modern buildings obscure the ground), large numbers of looting holes were identified. Most of these sites, particularly those in more remote regions such as Dura Europos and Medinet al-Far, show severe looting damage that predates the war, and, in many cases, most notably at Apamea and smaller sites in its vicinity, the scale of looting has increased dramatically since the war. The preference for looting of late-period sites could be driven by several factors, including what kinds of antiquities are easier to sell, such as mosaics or sculptural fragments. Some preference for late-period sites may also be related to the much greater abundance of gold, silver, and other metals generally found at such sites, if looting is driven by metal detecting.

In contrast, very little evidence of looting can be found at early prehistoric, Bronze, or Iron Age sites in the study. At Bronze Age sites where we do see looting, as at Tell Bi'a, Tell Chuera, and Tell Jifar, it seems to almost exclusively target areas off or adjacent to the main mounds, and thus is most likely focused on late-period components of these sites. However, prominent Bronze and Iron Age mounds are being damaged quite severely in many cases by the construction of military garrisons on top of them. Large tell sites often occupy naturally strategic points and frequently form some of the most obvious high points in the landscape, thus being attractive to military commanders. Our study has found severe damage related to military activities at numerous sites including Tell Qarqur, Tell Jifar, Ebla, and Tell Ashtara, and we can expect that many other mounded sites are being similarly impacted. The damage resulting from such activities is not limited to direct bulldozing and trenching, but also from the strewing of

bullet casings, ordinance, and trash, creating challenges for archaeological excavations at these sites long into the future. Geographically, the areas shown to have the most intense conflict, such as northwestern Syria, are also those where the most military-related site damage appears to be taking place. Future studies might therefore target areas that have seen the most military conflict for new imagery acquisition.

Finally, it is important to note the temporal limitation of our current study, as in general, the more recent the available image is, the more likely it will reveal looting or damage. For example, at Tell Chuera, a relatively recent Google Earth-served image from September 2012 shows no evidence of damage to the site, while imagery from a year later reveals extensive looting. Thus, efforts like those presented here to monitor looting and damage to sites across Syria should be ongoing until the conflict ends and archaeologists and antiquities officials are able to return and conduct ground assessments of damage.

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