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Title: Fudging maps at Jam

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Abstract

The minaret and archaeological remains at Jam, in central Afghanistan, were nominated as Afghanistan's first World Heritage site in 2002. The nomination was successful despite the International Council on Monuments and Sites (ICOMOS)'s reservations about the quality and completeness of the nomination document: in particular, ICOMOS was concerned about the rudimentary mapping and imprecise definition of the site, which has not been surveyed systematically or in detail. The extensive, but largely undocumented, looting of the site over the past two decades has further complicated archaeological investigations there.

The key goals of the fieldwork I coordinated at Jam in 2003 and 2005, therefore, included an 'on the ground' re-appraisal of the extent of the site and the mapping issues, and an assessment of the looting. In particular, I wanted to determine whether it was possible to utilize the robber holes as a source of information, both of localized sub-surface remains, and as an indication of the broader spatial limits of the site. This was based on the premise that looters only continue to dig in areas where they are finding sufficient artefacts to warrant their efforts. I also hoped to correlate the robber holes we documented on the ground with those visible in the high resolution satellite imagery of the site. This would enable us to study a larger area than it was practical to survey during our short field seasons given the mountainous terrain, and simultaneously to generate a base-line against which any further looting of the site could be monitored.

The fieldwork revealed that the base map used in the World Heritage Nomination document is flawed – the actual site is about a third of the size of that delineated on the map, and when the GPS points we took are plotted on the map, they often occur hundreds of metres from their actual location. A similar problem arose when we attempted to overlay the GPS points on the high resolution satellite image of the site. The latter problem was partially solved when we ortho-rectified the central portion of the image but the complex, deeply incised topography of the mountainous region limited the size of the area we were able to rectify. Since it is currently not possible to return to Jam to undertake a proper topographic survey of the site, the best way to 'fudge' the problems of integrating existing cartographic sources, the satellite imagery and a range of survey data from hand-held GPS and a Total Station survey, is to use GIS software. Although far from perfect, the resolution of some of these problems has enabled us to significantly refine the extent and nature of the site, and facilitate the development of a more comprehensive and practical cultural heritage management plan for the site.

Key words: Jam, Ghurids, Afghanistan, World Heritage

Author biography

D.C. Thomas; recently completed his Ph.D., entitled 'The ebb and flow of an empire – Afghanistan and neighbouring lands in the twelfth and thirteenth centuries' at La Trobe University, where he is now an Honorary Research Associate. David's first degree was in Archaeology and Anthropology at the University of Cambridge. After a couple of years of digging and teaching, he completed an M.Sc. in Computing and Archaeology (including GIS) at the University of Southampton in 1994. He then became the inaugural Computer Officer in the British Institute in Amman for Archaeology and History, before returning to Cambridge to work as a researcher on the Kilise Tepe and Abu Salabikh projects. The author of and contributor to numerous academic and popular articles, David now works as an archaeological sub-contractor in and around Melbourne, primarily for *Ochre* Imprints.

Introduction

The iconic minaret of Jam stands in a remote mountain valley in central Afghanistan, the finest surviving monument of the enigmatic Ghurid dynasty. The seasonally nomadic Ghurids rose to prominence ca 1150-51 when they devastated the capitals of their neighbours and erstwhile overlords, the Ghaznavids. Over the next sixty-five years, the Ghurids expanded their polity into central Asia and the northern Indian sub-continent, before succumbing to the Khwarazm-Shah in 1215 and then the Mongols in

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1222. Their summer capital of Firuzkuh, which is thought to be modern Jam (Pinder-Wilson 2001; Vercellin 1976), was abandoned and never re-occupied.

The re-discovery of the minaret in 1957 prompted renewed interest in the little-known Ghurid dynasty, and this has intensified since Jam became Afghanistan's first World Heritage site in 2002. The few studies that have been published, however, have primarily been architectural or historical; the archaeological remains at Jam have largely been unexplored and the site has suffered extensive looting in recent years. With this in mind, I went to Jam in 2003 as the archaeological field director of the Minaret of Jam Archaeological Project (MJAP), a small project operating under the auspices of the Istituto Italiano per l'Africa e l'Oriente (IsIAO). Our brief from UNESCO was to investigate the archaeological impact of a proposed road running through the site. Although we were able to determine that the proposed road route would have a minimal impact upon the archaeological remains, we also discovered that alarming reports of extensive looting at Jam (Stewart 2002) were no exaggeration. The looting clearly required more thorough investigation than we could manage during our initial two week stay.

A rebellion in the provincial capital in 2004 meant that we were unable to return to Jam until 2005, this time as an independent project, with a larger, international, multi-disciplinary team. We set out better equipped with maps, GPSs, satellite images and a Leica Total Station. Our surveying capacity, however, was constrained by several factors. Herberg and Davary's somewhat idiosyncratic 1976 site map, which appears in the World Heritage Nomination (WHN 2002) document, proved to be the most detailed map available at the time.[1] The variable nature of the satellite coverage, and prohibitive insurance costs, meant that the use of a differential GPS was not a practical option, so we opted for two hand-held Garmin Geko 301 GPSs. Our plans were further disrupted by the late withdrawal of our surveyor. His last-minute replacement, Danilo Rosati, could only join us for the middle week of the project due to other fieldwork commitments. The result was a far from ideal assortment of cartographic, GPS, survey and satellite imagery data which proved to be as difficult to integrate as might be expected.

Previous fieldwork at Jam

Few scholars have had the opportunity to work at Jam since the minaret's re-discovery was announced in the West in 1957 (Maricq & Wiet 1958; 1959). A brief season of fieldwork was carried out by Marc Le Berre in 1960 but it was not until over forty years later that these results appeared in print, published posthumously (Sourdel-Thomine 2004). Janine Sourdel-Thomine's book, like most studies, focuses on the minaret; the short section outlining Le Berre's fieldwork adds little detail to the observations published by Werner Herberg and Djelani Davary, following their brief surveys at Jam in the early 1970s. Herberg and Davary (1976) documented and photographed the principal structures Le Berre discovered, as well as a large cistern at the top of Kuh-i Khara, a mountain top rising 400 m above the minaret (Herberg & Davary 1976, pp. 61, 69, Lageplan Nrs 4, 9, 12). They also recovered more Judaeo-Persian tombstones from a cemetery ca 1.2 km to the south of the minaret, which was initially discovered by the architect Andrea Bruno (1963). The geographic spread of these finds, which Herberg and Davary appear to have plotted on Guido Fino's 1975 topographic survey map, is considerable and indicates that the site consisted of much more than just the minaret.

The decades of conflict following the Soviet invasion of Afghanistan in 1979 further curtailed the possibilities of conducting archaeological fieldwork at the site– in 1999, Andrea Bruno was only able to visit the site for an hour, having negotiated a truce between the Taliban and local Mujahideen who were entrenched on either bank of the Hari Rud (Bruno 2003, p. 11). The fieldwork that did take place focused on remedial structural works intended to prevent the leaning minaret from toppling (Najimi 2007).

2002 World Heritage Nomination

The push to nominate Jam as Afghanistan's first World Heritage site was in part motivated by a sense of collective remorse at the West's inability to prevent the destruction of the Buddhas of Bamiyan, and the need for a 'good news story' as the overthrow of the Taliban regime in 2001 failed to produce a quick return to peace and stability. The nomination document was "rushed and incomplete" (Walworth 2008, p. 32) and contains numerous small factual and typographic errors. The mapping of the site, and definition of core and buffer zones (Figure 1) is particularly problematic – in its assessment of the nomination, the UNESCO World Heritage Centre Technical Evaluation notes that two of the four core zones are "identified without any description; the

[1] We were unable until later to obtain a copy of the relevant sheet of the most accurate general map series of Afghanistan, the Soviet 1984-86 1:50,000 maps (Wiles 2007: 3), and in any case we subsequently discovered that these maps are not detailed enough to be of any great use for detailed survey work and have quality-related limitations (Gruen *et al*. 2004).

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hand-drawn (traced) map shows the limits of the core and buffer zone with lines which [sic] would be over 50m wide, passing through the middle of the described 'castles' and other archaeological sites" (cited in Walworth 2008, p. 29).

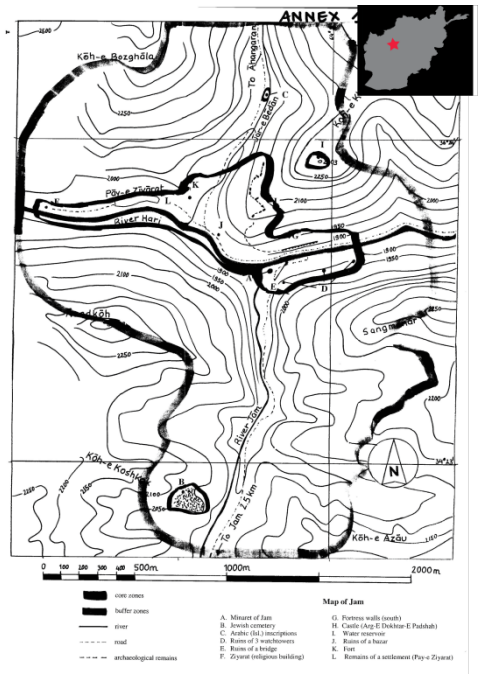

Figure 1. UNESCO World Heritage Nomination document map of Jam, with a thumbnail map inserted to show the location of the site within modern Afghanistan

These criticisms were later diluted in the International Council on Monuments and Sites (ICOMOS)'s official evaluation of the nomination, which states that "the map is at a somewhat unusual scale of c 1:86,000 and so it does not show a great deal of detail. It moreover omits any information concerning more recent or contemporary interventions in this area (including the route of the proposed new road). It would be desirable there for [sic] the State Party to provide more detailed cartographic materials to meet these deficiencies" (WHN 2002, p. 2). Despite these deficiencies, the Herberg / Davary map is still the only one of Jam available on the World Heritage Convention website.

2003 and 2005 MJAP fieldwork

Even today, the logistical challenges of reaching, let alone working at Jam are considerable – the 215 km drive from Herat took 18 hours by 4WD in 2003. We were, nevertheless, able to conduct two successful seasons of fieldwork there in 2003 and 2005, which among other things documented the extent of looting at the site for the first time, and established the site's southern and eastern limits (Thomas *et al*. 2004; Thomas *et al*. 2006; Thomas 2007; *inter alia*). We also discovered that the World Heritage Nomination dossier map and subsequent plans drawn by Bruno are incompatible with the survey data we collected – when we attempted to overlay GPS points on them, they appear up to two hundred metres from their actual topographic location, in some cases falling on the wrong side of the river valleys (by contrast, the GPS data appear in broadly the correct locations when imported into Google Earth although the current low resolution of the imagery precludes its use for publication purposes). The variable sizes of the errors suggest that the problem has not simply arisen due to the use of different projections. It became imperative, therefore, to find a way of integrating the existing spatial datasets with the various types of data we had collected, both in terms of presenting our findings and facilitating the cultural heritage management of the site.

Integrating spatial data in a GIS

In recent years, archaeologists have increasingly used a combination of satellite images and GPS data to gather, analyse and present survey data for large archaeological sites such as Merv in neighbouring Turkmenistan (Dare 2001), and to quantify looting at sites in the Near East (Contreras & Brodie 2010; Stone 2008; *inter alia*). The flat topography at many of these sites, however, significantly reduces the challenges of using remote sensing data in this way, compared to working with images of a deeply incised landscape such as that around Jam. Given the problems with the existing cartographic datasets, however, satellite imagery represents the best 'base map' on which to collate and plot the various spatial data in a GIS. I opted to use MapInfo (v.11) and

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Global Mapper (v.12) software to explore and integrate the spatial datasets – the survey data, data derived from analysis of commercially available high resolution satellite imagery and the existing cartographic data. Each of these datasets will be considered in turn below, although they are obviously interrelated and the process of integration was a non-linear, reflexive one.

Survey data

Detailed inspection of a composite photographic image of the steep valley slope opposite to the north of the minaret resulted in the preliminary identification of over 130 robber holes (Figure 2). The difficult terrain, density of robber holes and time constraints meant that we focussed on a 50 m-wide strip at the western end of the valley, stretching 225 m from the Hari Rud up to the fortress of Kasr Zarafshan. Although the hand-held GPSs we were using have a nominal accuracy of +/-6 m under optimal conditions, it soon transpired that the deep valleys and limited availability of satellites over Jam typically reduced the accuracy of GPS readings to ca +/-12 m. This level of imprecision negated hopes of using GPS points to correlate the larger robber holes we documented on the ground with those which are visible in the satellite image. Nonetheless, we took GPS points on most of the robber holes anyway as a quick (albeit imprecise) way of locating them.

Figure 2. Robber holes (red dots) visible in a composite image of the valley slope to the north of the minaret (image: Rosati, Rugiadi & Thomas, MJAP 2005).

The locations of the majority of the robber holes (98/121 – 81%) were surveyed using the Total Station during our surveyor's week-long stay. We used the accurate spatial data for these robber holes as an 'anchor' in MapInfo to fix the approximate locations of the remaining robber holes, which had either less accurate GPS locations (16 robber holes) or just field descriptions (7 robber holes). Although this 'fudging' of the spatial data is far from ideal, the GPS dataset proved to be internally quite consistent and relatively easy to overlay on the Total Station survey data.

By the end of the season, we had recorded 121 robber holes in the 50 m-wide strip of the valley side alone. Over forty per cent of the robber holes we recorded are larger than 3 m in diameter; when summed, the area covered by the robber holes amounted ca 1,245 m^2 (Thomas, in Thomas & Gascoigne 2006, pp. 159-160). This means that at least 11% of the valley slope we surveyed on foot had been looted. Despite not being able to correlate precisely the robber holes recording in the field with those visible in the satellite image, I estimate through a process of extrapolation that at least 360 robber holes are located on this 150 m long part of the valley side. The actual number is probably much greater, as many other robber holes may have been obscured by the spoil heaps.

The different attributes of the robber holes, such as volume of deposits removed, presence / absence of architecture and ceramic sherd counts, were displayed using the Thematic Maps option in MapInfo. This revealed, for example, that the architectural remains noted in nearly seventy per cent of the robber holes occur across the surveyed area, not just on the lower slopes. The distribution of architectural remains indicates that terraced, probably domestic structures, similar to those found in robber holes to the west of the minaret in 2003, extended all the way up to the fortress (Figure 3).

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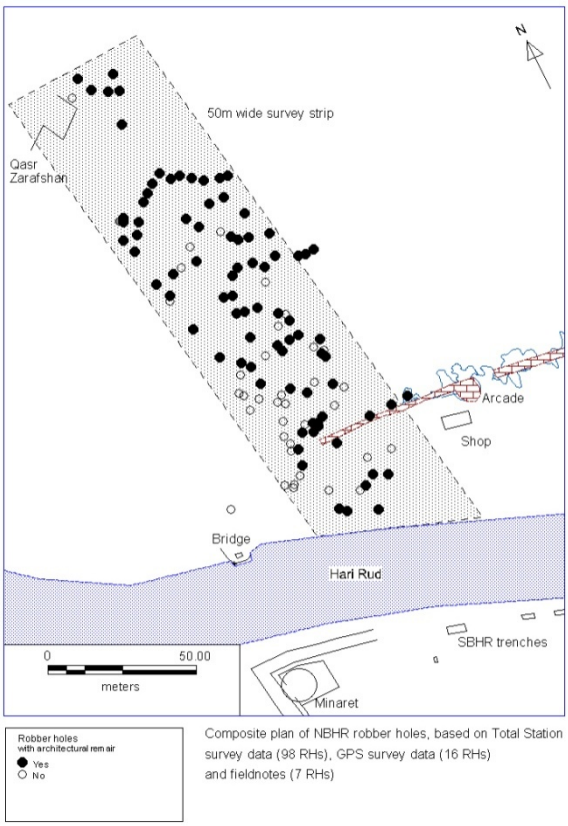

Figure 3. Distribution of architecture in robber holes in the surveyed valley slope at Jam

High resolution satellite imagery

The most detailed satellite imagery of Jam available in 2005 was a Quickbird image (taken on 17th July 2004), which required ortho-rectification due to the complex topography of the region. Over fifty GPS readings were taken on prominent topographical features to generate a series of Ground Control Points (GCP). Kevin White, MJAP geomorphologist, then used a 3rd order polynomial transformation to ortho-rectify a small central portion of the satellite image around the site (Figure 4). The GPS survey data we collected correlate well with the topography and our field observations when plotted on the ortho-rectified part of the image. Unsurprisingly, GPS points which fall outside this ortho-rectified area are up to a couple of hundred metres from where they should be.

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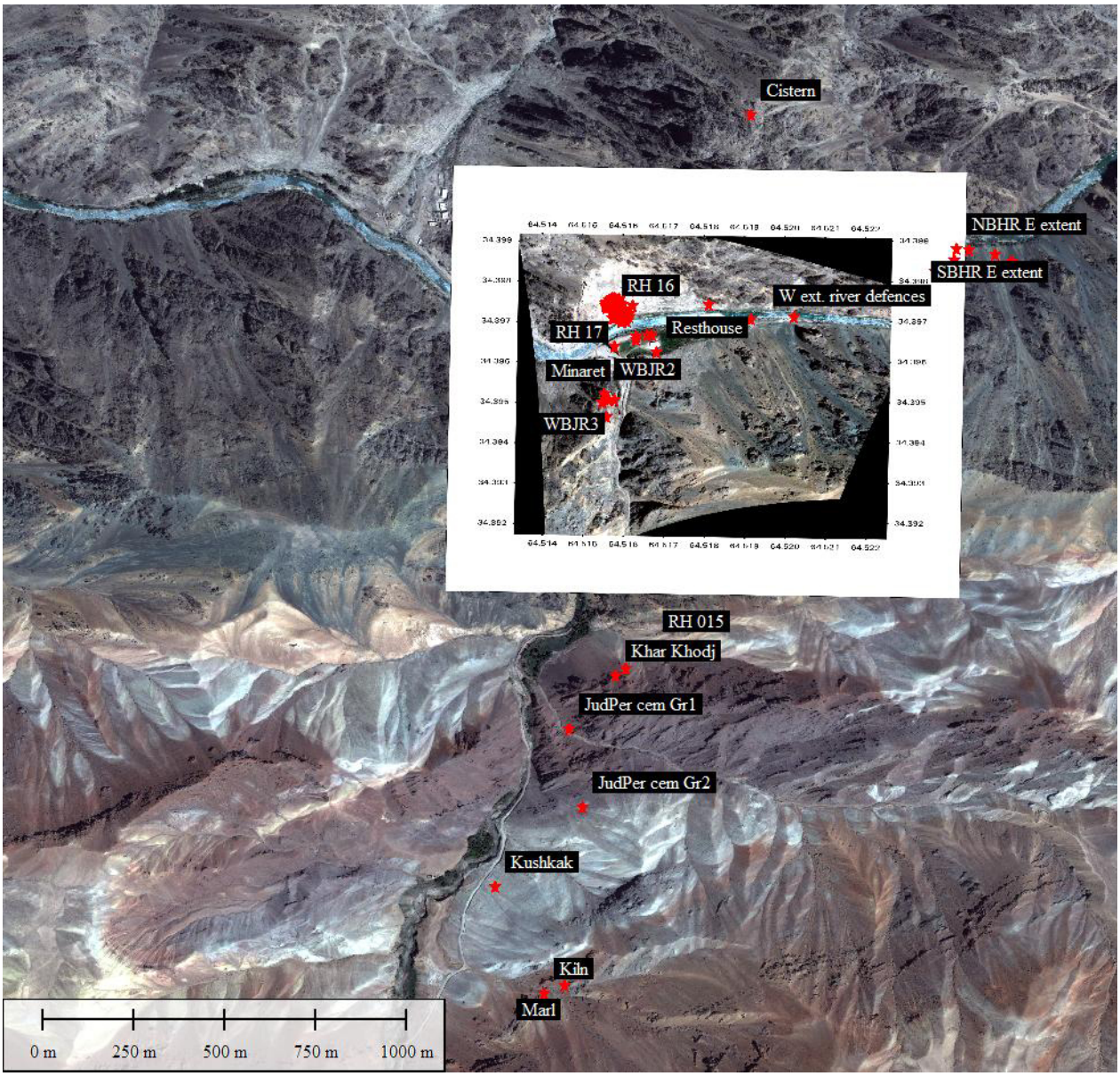

Figure 4. Ortho-rectified central portion of the Quickbird image of Jam, overlain on the unrectified image. Note the GPS points (red stars) within the rectified area are correctly located while those outside, in the unrectified area, are often a couple of hundred metres from their actual location and in some cases fall on the wrong side of rivers.

Despite not having the resources to ortho-rectify the whole area of the satellite image covering the site, the unrectified satellite imagery is still useful in that it is of sufficiently high enough resolution to allow us to identify individual robber holes and map the rough extent of looting. As Di Giacomo and his colleagues (2011, p. 2053, Fig. 2) and Contreras and Brodie (2010, p. 112, Fig. 5), among others, have noted elsewhere, the robber holes appear as small dark dots in the high resolution satellite image, surrounded by blurry white 'blisters' (the looters' spoil heaps). A total of over 1,100 individual robber holes have now been identified through a detailed study of the satellite image (Figure 5).

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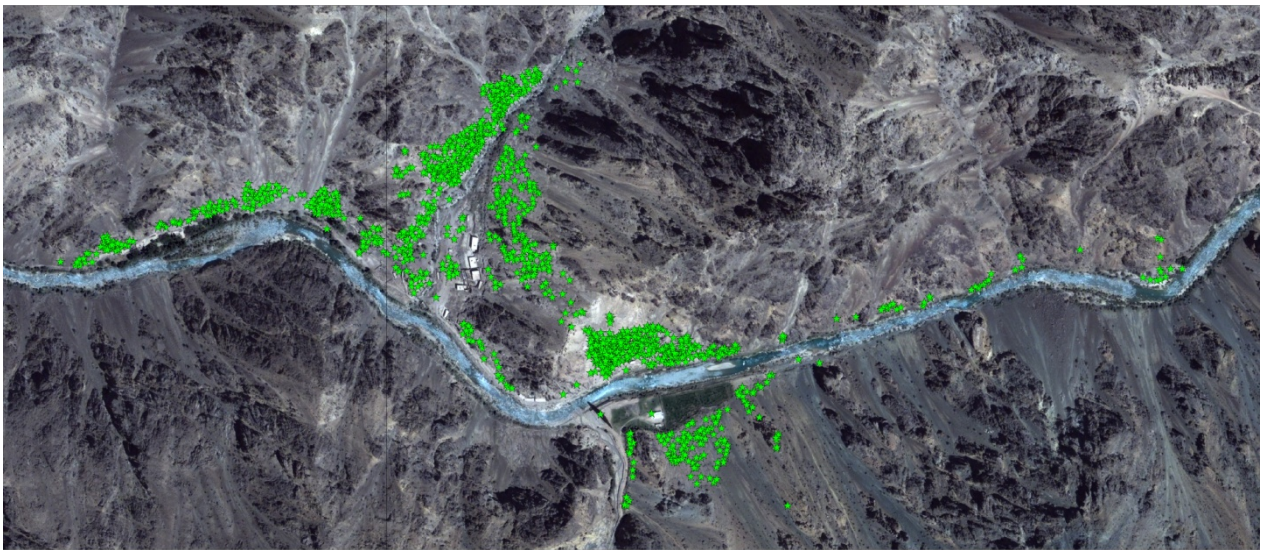

Figure 5. Robber holes (green stars) identifiable in the unrectified Quickbird satellite image of Jam

By using MapInfo to delimit areas on the Quickbird image which we know from field survey to have architecture, scatters of ceramic artefacts and / or to have been robbed, it is possible to estimate the total area of the site at around 195,000 m^2 (19.5 ha). Even allowing for the unrectified area to be approximately one third larger than it actually is due to the distortion in the satellite image, this re-calculated extent of the archaeological remains at Jam is markedly smaller than the 'Core Zones' delimited in the WHN dossier map, a fact that has considerable implications for the cultural heritage management of the site.

Cartographic data

The World Heritage Nomination dossier demarcates four core zones of the site, reputedly covering about seventy hectares, surrounded by a buffer zone of approximately six hundred hectares (see Figure 1 above; WHN 2002, p. 1, Annex 1). Having precise data about the size and location of these zones is obviously essential from a cultural heritage management point of view, particularly given the threats to the site and the restrictions that the zones impose on development projects such as the proposed road. Given the sparse archaeological information about the extent of the site available in 2002, the somewhat arbitrary demarcation of the buffer and core zones seems in part to have been designed to circumvent Afghanaid's proposed construction of a road and bridge close to the minaret (WHN 2002, pp. 13-14). This has created significant tensions at Jam, with a few of the more reactionary locals suggesting that if the minaret is an impediment to such projects, it should be blown up.

When the World Heritage Nomination dossier map was imported into Google Earth and geo-referenced using the coordinates on the map, the minaret appears 433.7 m from where it should be. Although it would be unwise to assume that the satellite images available through Google Earth are topographically accurate given the issues of terrain relief and other geometric distortions, a further discrepancy emerges when the polygon tool in Google Earth Pro is used to measure the demarcated zones – the core zones amount to an area of 61.25 ha and the buffer zone 480 ha.

The various zones in the World Heritage Nomination dossier map create an impressive, if somewhat erroneous, sense of the size and extent of the site, which may have helped strengthen the case for the site's nomination. In so doing, however, important components of the site which fall outside the limits of the imprecisely defined core zones are endangered, while potentially unnecessary restrictions are placed on activities which can be undertaken within the arbitrarily defined buffer zone. The revised site plan which I have mapped (Figure 6) provides a much more accurate representation of the extent of the site.

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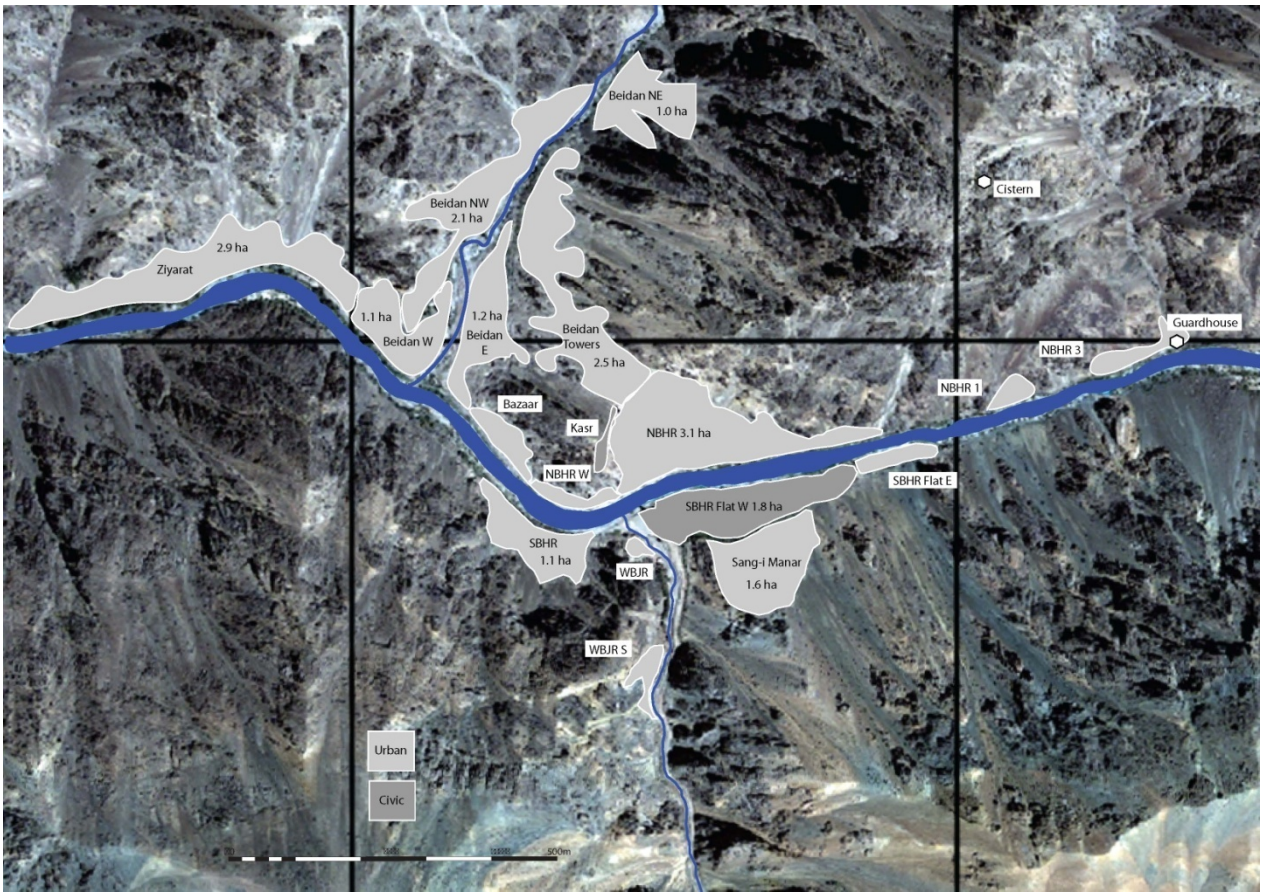

Figure 6. Revised site plan for Jam, overlain on Quickbird satellite image (note that it does not include the Judeo-Persian cemetery 1.5 km to the south of the minaret.

Conclusion

In this short paper, I have outlined the way I have used MapInfo GIS software to combine surface survey data with a detailed study of a high resolution satellite image, to generate the first empirical investigation of the extent of looting at Jam, and by inference, the minimum extent of the site – looters generally do not continue digging in an area unless they find something. The looting of the archaeological remains at Jam, which seemed to have stopped by the time of our second field season in 2005, has been as extensive and severe, if not more so, as anecdotal evidence from the early 2000s suggested. Although the integrity of the site has been compromised, however, it is important to appreciate that useful information can still be garnered from the robber holes – they merit detailed study, rather than being dismissed as destruction.

While the general extent of looting at Jam can be discerned in the high resolution satellite images, the currently available survey data and satellite images are not sufficiently precise or up-to-date to be used as a way of monitoring those parts of the site which have already been looted. The fact that many of the known archaeological sites at Jam are difficult or impossible to identify also renders the images of little use as a means of searching the landscape for other, undiscovered sites. What is urgently needed is more fieldwork and a detailed topographic mapping program. One possible approach to generating an accurate topographic map of the site would be to implement the strategy used by Armin Gruen and his colleagues (2004) at Bamiyan. They used a combination of a stereo-pair of SPOT images and B/W Geo level IKONOS image mosaic to produce a 5 m raster Digital Terrain Model and a high resolution ortho-images of the central portion of the Bamiyan valley around where the Buddhas stood. This is considerably more accurate than the ca 30 m DTM we were able to create for Jam from the freely available SRTM data. Significant resources and expertise, including fieldwork with a differential GPS, however, would be required to do this.

Although the revised site extent discussed in this paper is about one third of that delineated in the World Heritage Nomination dossier plan, it actually includes more of the archaeological remains at Jam than the original site plan – some of the architectural remains in the robber holes higher up the north bank of the Hari Rud towards Kasr Zarafshan, for example, fall outside the demarcated core zones of the site, as do the guardhouse and 150 m-long stretch of river defences discovered over 950 m to the east of the minaret. This more precise delineation of the archaeological site is timely as Prof. Peter Jansen, the archaeologist

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appointed by UNESCO as a consultant expert for the site, is due to give a paper on redefining the limits of the World Heritage Site at the forthcoming Experts Meeting on Jam in December 2012. It remains unclear what data he is basing his study upon.

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I am grateful to the Afghan and Western members of the 2003 and 2005 MJAP field teams, particularly Dr Kevin White for sharing his remote sensing expertise, and to my principal Ph.D. supervisor Dr Phillip Edwards. Prof. Dr Armin Gruen kindly took time to discuss his approach to mapping the Bamiyan valley. Any remaining errors or misunderstandings are obviously my sole responsibility.

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