Investigating Mobile Pastoralist Landscapes in North East Iran: The Contribution of Remote Sensing

Kristen Hopper and Hamid Omrani Rekavandi

Introduction

The Gorgān Plain, located in the province of Golestan in northeast Iran, encompasses several different environmental zones. Rainfall averages 800 mm per year in the foothills immediately to the north of the Ālborz mountain chain, and decreases significantly to circa 200 mm per year as one moves north into the steppe near the Ātrak River (Khormali and Kehl 2011: 111). The Gorgān River, dissecting the plain from east to west, represents a rough natural boundary between the well-watered primarily agricultural landscape of the southern half of the plain, and the increasingly arid steppe in the north. In the Sasanian Period (AD 224–250) this natural frontier was supplemented by a *c.* 175 km long defensive wall likely built to control trade, facilitate taxation, and deter raids by groups living north of the wall. Field survey and remote sensing of historical and modern satellite imagery carried out by members of the Gorgān Wall Project (Wilkinson *et al.* 2013), along with data from surveys undertaken between the late 19th century and the present day, have identified hundreds of archaeological sites dating from the Neolithic to the Islamic Periods in this region (Abbasi 2011; Arne 1945; de Morgan 1902; Kiani 1982; Schmidt 1940; Shiomi 1976; 1978; Wilkinson *et al.* 2013; see Figures 7.1 and 7.2). Taken together these surveys have demonstrated the intensity of *tappehs* (mounded sites), fortifications, and irrigation works in the southern portion of the plain, while reinforcing the lack of sedentary settlement or

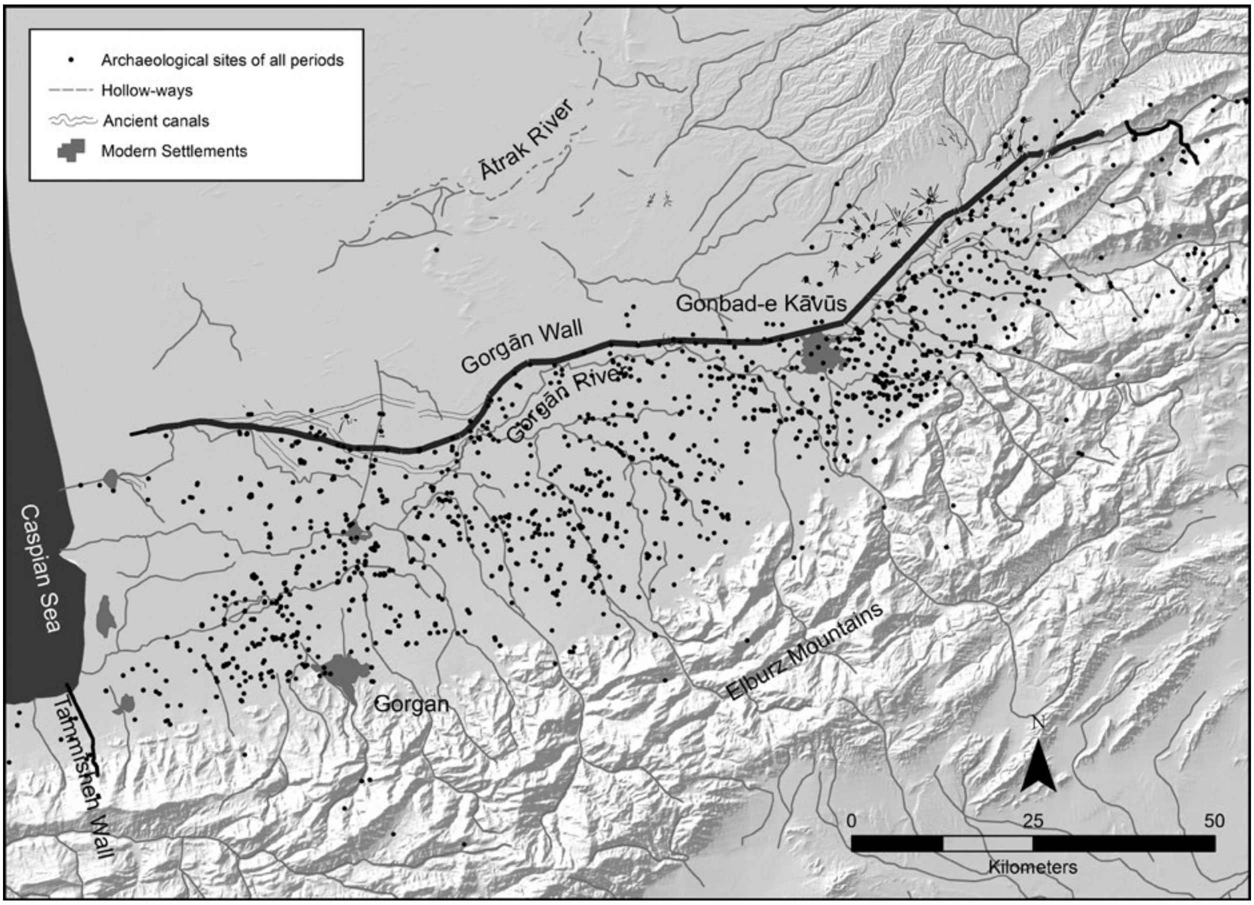

Figure 7.1. Map of Gorgān Plain — distribution of sites, canals, hollow ways, and other archaeological features from all periods in the Gorgān Plain. Note the density of settlement in the southern half of the plain as compared to the northern half. Base map — SRTM 90 m — data available from the US Geological Survey.

agricultural investment in the northern portion of the plain in most periods. This pattern is in part due to the intensity of survey to the south of the Gorgān River, as compared to the north. However, the few surveys that have covered the northern portion of the plain, and the remote sensing of the CORONA satellite imagery seem to indicate that it also reflects a real difference in land-use and settlement patterns.

Signature landscapes

Signature landscapes are defined by a package of activities that represent a dominant land-use strategy of a coherent time frame (Wilkinson 2003: 11, 214–215). The dominant signatures in the Gorgān Plain, characterised by dense sedentary occupation and intensive agriculture, are a landscape of tells in the prehistoric periods, and a landscape of dispersal with increasing investment in irrigation systems in the later periods. The former signature is represented by the sheer number and density of Neolithic, Chalcolithic, and Bronze Age *tappehs* recorded by archaeological survey. The latter signature landscape is clearly detectable in the Sasanian Period, and in the more ill-defined Iron III/IV Period in the Gorgān Plain, where absolute and relative dates have established relationships between settlements/fortified sites and massive irrigation systems (Sauer *et al.* 2013). Along with these dominant signatures are the imprints left by land use strategies associated with mobile pastoralism. The traces of these activities are not invisible (for the long running debate on the visibility of nomads in the archaeological record see Cribb 1994: 65–83; Finklestein 1992; Finkelstein and Perevolotsky 1990; Potts 2014: 1–46; Rosen 1992), but depending upon the type of activity and the environment could leave a much lighter imprint on the landscape (Wilkinson 2003: 173). Signature landscapes associated with dense sedentary occupation, agriculture, and irrigation will generally obliterate traces of less robust activity that preceded it.

Mobile pastoral activity is usually easier to detect in more marginal landscapes or landscapes of preservation, such as desert, steppe, or highland, which are naturally too arid to support intensive rain-fed cultivation, but are often exploited for grazing or episodic settlement (Alizadeh and Ur 2007; Wilkinson 2003: 41–43). The traces of such activity are characterised by features such as tent bases, enclosures, and temporary structures, which can be detected by intensive pedestrian survey or, increasingly, through the analysis of high resolution satellite imagery, as demonstrated in the Negev desert, highland areas of Turkey, and the desert fringes in Jordan (Hammer 2012; Kennedy 2014; Rosen 2010: 68). While investigating these landscapes is key to finding direct remains of mobile pastoral activity, it is important to note that we are only viewing the traces of the exploitation of one kind of environment. However, bearing this in mind, landscapes of preservation offer us a view on an important piece of the whole.

The contribution of remote sensing

Aerial photography and satellite imagery are useful for detecting mobile pastoral activity for several reasons. First, we can benefit from an aerial perspective to elucidate patterning and morphology of often ephemeral structures that might be missed in ground-based survey (Kennedy 2011: 1287). Second, we can more quickly investigate landscapes that would take considerable amounts of time to survey utilising traditional methods, or which may be difficult to access. We can also use the results of such exercises to guide field survey. Thirdly, historical images can offer us a perspective on landscapes that may have been altered by modern development. This is particularly significant as traces of mobile pastoral activity are often rather ephemeral and are easily erased by more robust activity. For example, an analysis of CORONA imagery of the Mughan Steppe by Alizadeh and Ur (2007) allowed them to identify Shahsevan mobile pastoralist camps through depressions constructed for corralling animals. The CORONA images had fortuitously caught the landscape at a time when the visible signature was that left by mobile pastoralism. However, while these features were visible in different environmental zones on the historical CORONA, they were not as easily detectable in arable lowland zones during field survey due to modern agriculture.

The archaeological landscape of the southeast Caspian coastline

The usefulness of declassified CORONA spy satellite photography for detecting archaeological sites and features has been demonstrated for landscapes throughout the Near East (Casana and Cothren 2013; Philip *et al.* 2002; Ur 2003; 2013a; 2013b). The CORONA satellite images of the Gorgān Plain taken in the 1960s and 1970s are no exception, with hundreds of archaeological sites and features visible (see Figure 7.2).

Systematic analysis of the CORONA imagery revealed far fewer archaeological sites, from all periods, to the north of the Gorgān River than to the south of it. This is not surprising given the semi-arid nature of the northern plain. This landscape was historically not intensively cultivated and until the mid-20th century had not sustained significant alterations due to modern agriculture. Exploitation of the semi-arid steppe for sedentary settlement and cultivation appears only to have occurred periodically as attested by recent survey and by excavations at Qelich Qoineh. This circa 80 ha site, located to the north of the Gorgān River, has been dated to sometime between the 8th and 5th centuries BC, being occupied for no less than 100, but no more

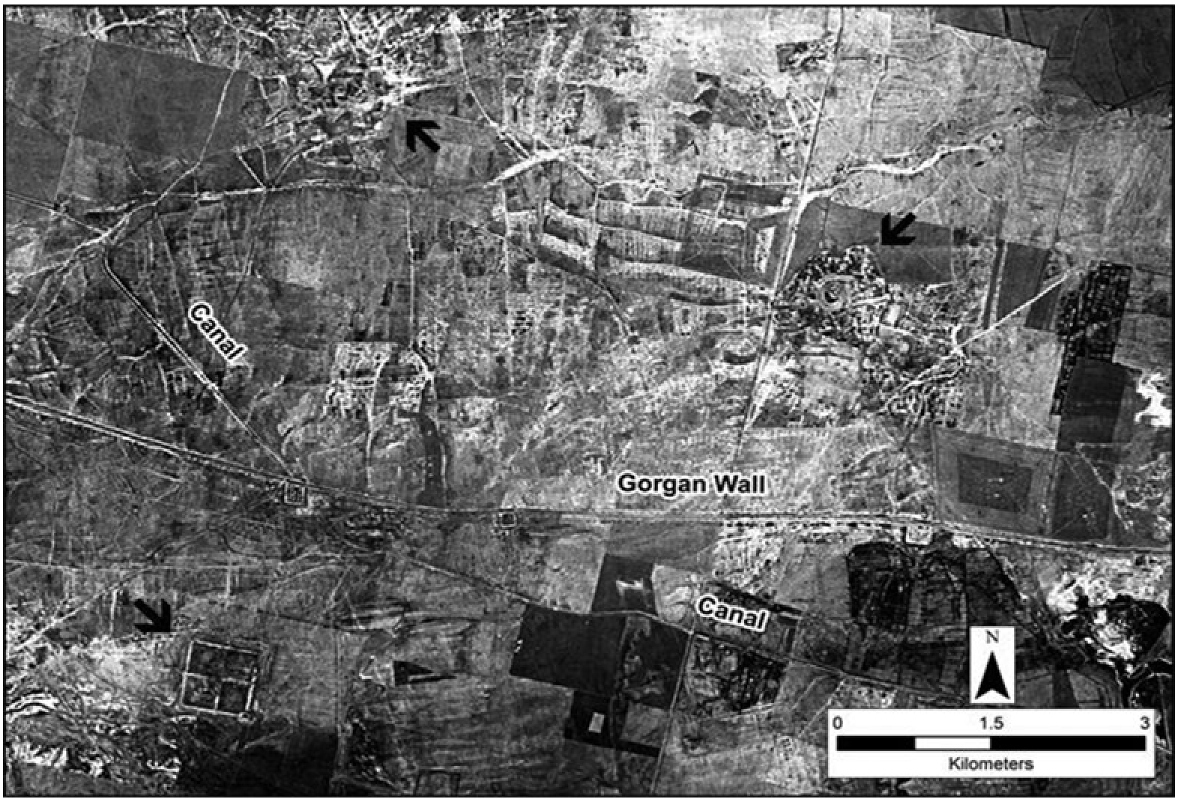

Figure 7.2. Archaeological sites and features on the Gorgān Plain visible on CORONA imagery. Imagery available from the US Geological Survey.

than 300 years. Morphologically similar sites with pottery contemporary to, or slightly later than Qelich Qoineh are common in the steppe, but most appear to have fallen out of use by the Sasanian Period (circa 3rd century AD) (Hopper 2017; Wilkinson *et al.* 2013). However, the traces of activities one might expect from seasonal use of the area in subsequent periods as attested by historical and ethnographic sources, such as animal pens or tent bases, are not visible on the CORONA images.

Imagery from the GAMBIT satellite taken in January 1966, on the other hand, is of higher resolution and of a similar date but due to the nature of the original programme rather limited in coverage. A window of this imagery covering a roughly north–south strip along the Caspian coastline was also analysed and revealed a number of distinct, but ephemeral features either barely visible, or not present on the CORONA imagery, which are possibly associated with less intensive land-use practices.

Remotely sensed features

Features that were mapped on the GAMBIT images have been classified based upon their shape, size, location, relationship to other features, and their 'signature' (or detectable imprint) on the satellite imagery. Some are clearly representative of known landscape features such as canals, qanats, or archaeological sites. Others, mainly a group of circular and sub-circular features, present a new and distinct category. The area over which these features occur is roughly 65 km², and approximately 7 km inland from the modern Caspian coastline. The southern end of the cluster is found about 8 km northeast of Gomīshān, and the northernmost limit is located 5.5 km south of the modern Iran-Turkmenistan border.

Feature types

Circular and Sub-circular Enclosures

This category comprises 220 circular, sub-circular, and ovoid features with an internal length between 13 m and 332 m at the widest point. Despite this large size range, their appearance on the satellite imagery, location, and relationship to similar features singles them out as a discrete category.

The morphology of these features is very distinctive (see Figure 7.4). Each roughly circular feature is best described as an enclosure. The perimeter of the feature gives the effect of a raised dashed line, lighter than the surrounding soil. Each of the segments of the 'dashed line' measures between 5 m and 15 m. There appears to

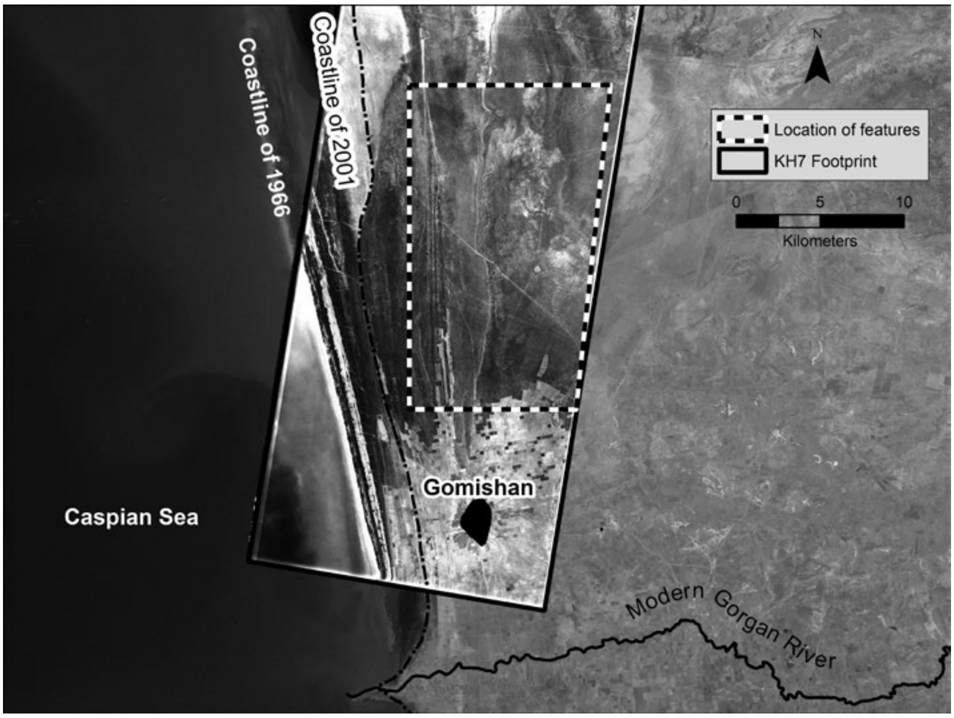

Figure 7.3. Location of circular enclosures and small circular features and coverage of the GAMBIT imagery. Basemap Landsat. Imagery available from the US Geological Survey.

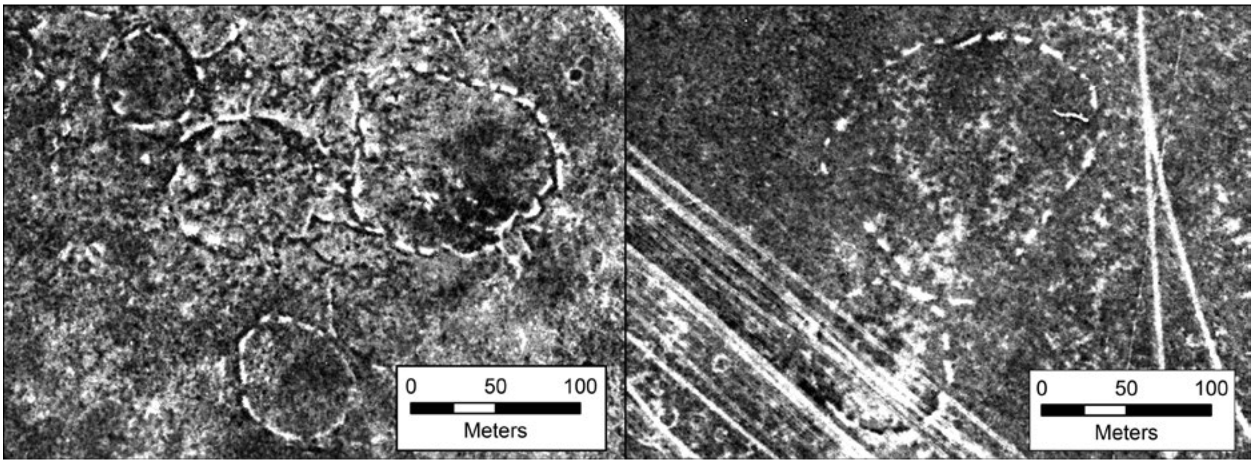

Figure 7.4. Circular and sub-circular enclosures — examples of enclosures visible on the GAMBIT imagery. Note the disturbance of the features in the right image by later tracks. Imagery available from the US Geological Survey.

be no difference in the appearance of the soil inside and outside the 'dashed line', though some of the enclosures appear to have internal features (usually smaller circular features which will be discussed below). Half (50%) of these features fall between 60 m and 120 m in internal length and 95% are between 13 m and 200 m. The average size is 105 m internal length. The graph below (Figure 7.5) illustrates a concentration of feature size between 80–99 m, with the size decreasing rather steadily between 80–13 m, and 100–220 m. There are few features above 200 m.

26% of the circular features are attached to another circle, while internal divisions, and lines of smaller uniform circular features (~5–10 m in diameter) are found in association with 9% of the circular features. Figure 7.5, below, illustrates that there appears to be no distinctive relationship between size or characteristics, and specialised function.

Small circular Features

Small circular features are distinguished from circular and sub-circular enclosures both by their size and their

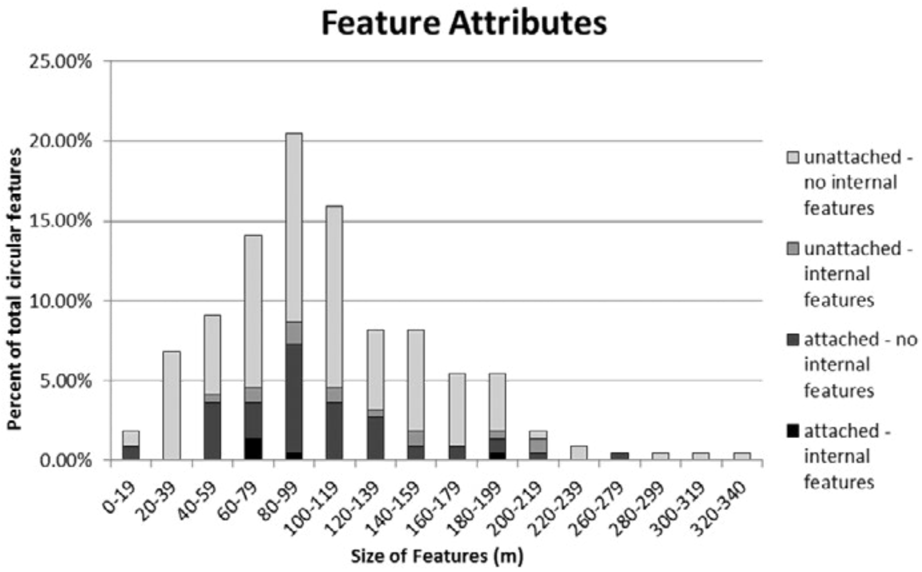

Figure 7.5. Attributes of circular and sub-circular enclosures — this table demonstrates that there is no clear relationship between the size of the features and special attributes such as attachment to other features, internal divisions, and relationships with smaller circular features.

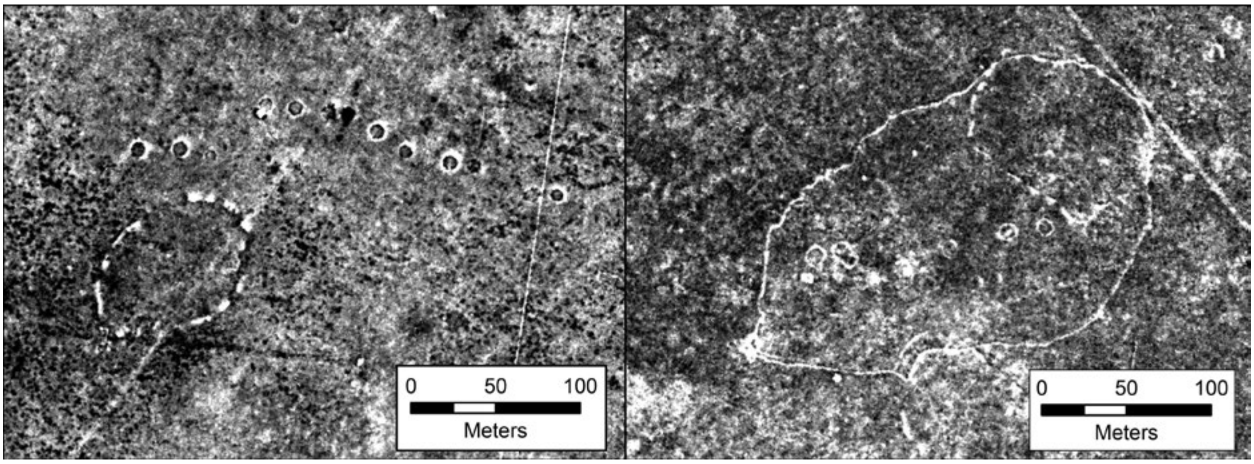

Figure 7.6. Small circular features — these features are generally found in close proximity to the larger circular and sub-circular enclosures and are either found in linear arrangements or clusters of up to fourteen. Imagery available from the US Geological Survey.

signature on the imagery. Smaller (~5–10 m), and more uniform, they generally occur in lines or clusters of two to eight with a few groupings of up to 14. They are located within the same area as the larger circular and sub-circular enclosures. Several clusters occur in the immediate vicinity of the enclosures while others sit within the enclosures (See Figure 7.6).

Several groups exist in lines or clusters along an old shoreline of the Caspian Sea. These are similar in morphology but are much more poorly preserved. The poor preservation of these features can be explained through their relationship with these relict coastlines (see discussion below).

Comparisons of Historical and Modern Imagery

When discussing the location of this feature type it is important to address the issue of visibility. Because the GAMBIT imagery only covers a very limited area, this could affect the perceived distribution of these features. In order to determine if they are in fact limited to this area, other imagery of different resolutions and dates were also viewed to see if the same features were present. This included CORONA imagery from 1968 and 1969, and imagery available on Google Earth from 2013. In total 241 circular features were located. Of these, over half (60%) were only detectable on the GAMBIT imagery, 27% were visible on both the GAMBIT and the imagery used by Google Earth, and 7% were located on all three image types. Small percentages were only located on either the CORONA imagery (<1%) or the imagery on Google Earth (5%).

As the GAMBIT image is of a higher resolution than the CORONA, it is not surprising that while these images are from relatively similar dates (1966 and 1968/1969, respectively) there is a significant difference in the visibility of the circular features. In many cases the circular features that are visible on the CORONA were easy to overlook unless one knew where they were located. The imagery used by Google Earth is also high resolution (circa 0.5 m), but is much more recent. As such, 27% of the circular features are detectable on both the GAMBIT and imagery and imagery on Google Earth. However, the discrepancy in the number of features in this case appears to have less to do with the resolution of the imagery, and more to do with the survival of the features. A significant portion (nearly 50%) of the ovoid/circular features that once existed north east of Gomīshān have been erased due to modern agricultural or building programmes (see Figures 7.8 and 7.9).

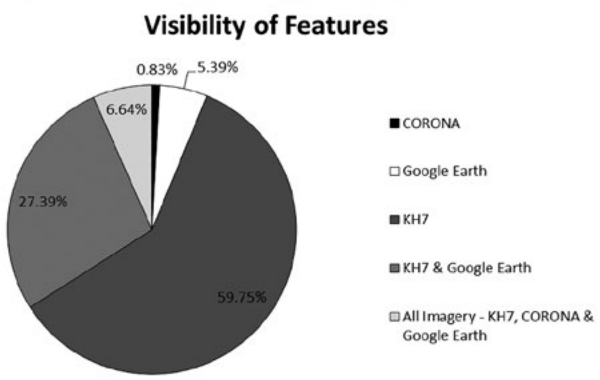

Figure 7.7. Visibility of Features — this graph indicates the percentage of features that are visible on one or more types of imagery with different resolutions and dates.

Despite a lower rate of recovery for the circular features on the imagery on Google Earth, the distribution of those that were detected is significant. The area between the edge of the GAMBIT footprint and an arbitrary line 10 km to the east was examined to determine if these features extended further to the east on the other two imagery types. A further six circular features were located to the east. They were widely dispersed and none was more than 5 km from the edge of the GAMBIT image. It appears that this grouping of circular features does not extend much beyond the limits of the GAMBIT image.

The dynamic sea

Since undertaking this research we have been unable to return to Iran to conduct further field survey. Therefore, other avenues of dating and interpretation have been sought: A hypothesis as to the date and function of these features has been proposed based on their relationship with dated high stands of the Caspian Sea, and historical and ethnographic accounts of land use in this area.

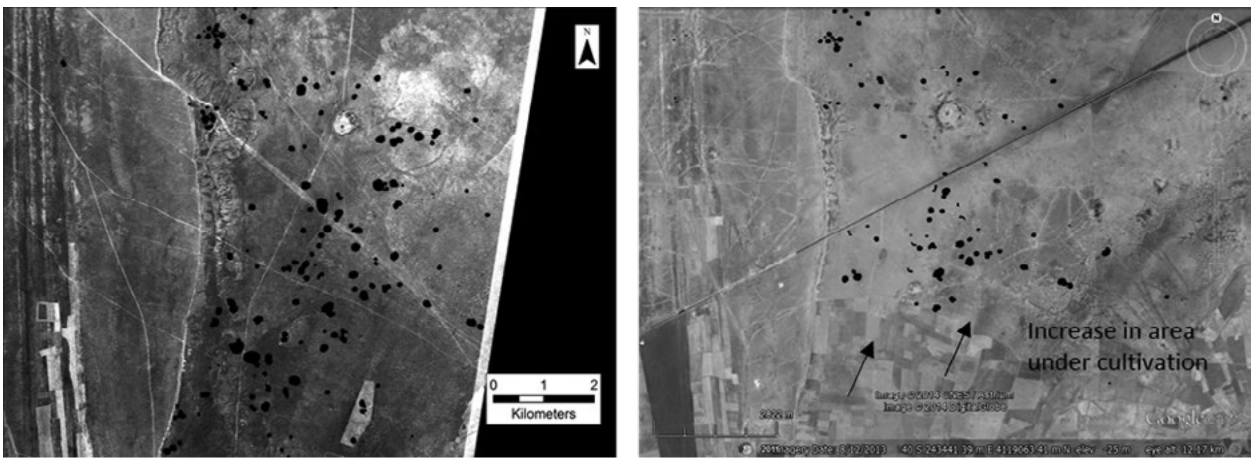

Figure 7.8. Feature distribution on GAMBIT (imagery available from the US Geological Survey) and imagery on Google Earth (© CNES/Astrium and Digital Globe 2014). Note the increase in the area under cultivation in the right hand image from 2013, which has destroyed many of the features that were visible on the left hand image from 1966.

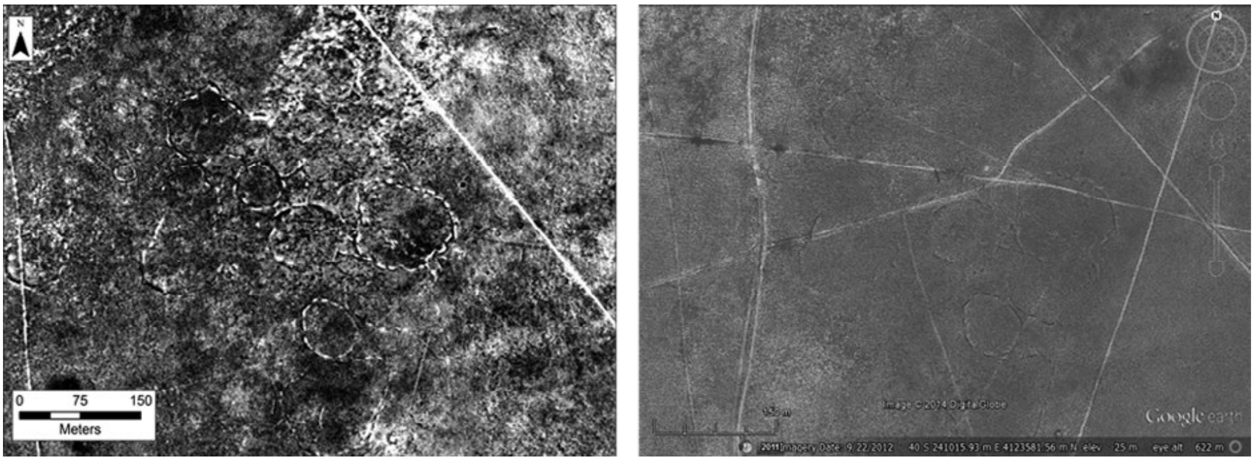

Figure 7.9. Visibility of features on GAMBIT imagery from 1966 (available from the US Geological Survey) and imagery on Google Earth from 2012 (© DigitalGlobe 2014).

Holocene oscillations of the Caspian sea

The study of oscillations in the level of the Caspian throughout the Pleistocene and Holocene has been spurred on by contemporary worries about the environmental impacts of sea level change (Dolukhanov *et al.* 2010; Dumont 1998; Kakroodi *et al.* 2012; Kaplin and Selivanov 1995; Kislov and Toporov 2007; Kroonenberg *et al.* 2007; Lahijani *et al.* 2009; Mamedov 1997; Rychagov 1997). Each of these studies emphasises the incredibly dynamic nature of the sea (which is in fact not a sea, but the world's largest lake), but there is little consensus as to the timings of major transgressions and regressions prior to historical records, with many studies criticised for their sampling strategies and dating techniques, and reliable records on sea level change having only been kept since 1837 (Kakroodi *et al.* 2012; Kroonenberg *et al.* 2007).

A recent review of published evidence for Caspian Sea level oscillations in relation to the archaeology of the region noted the significance of the Derbent regression (covering at least a 1000-year span between 2600 and 300 years BP) on levels during the Sasanian Period (Wilkinson *et al.* 2013: 33–36). A minimum of at least 32 m below sea level (bsl) is attested (Kakroodi *et al.* 2012: 94). This means that during a considerable period of time, which comfortably encompasses Late Antiquity, the sea level would have been significantly lower than at present (circa 27 m bsl). This is supported by the identification of part of the Tammīsheh wall (constructed during the Sasanian Period) located in the Caspian Sea below present sea level (Wilkinson *et al.* 2013: 35).

Taking into consideration a much longer timescale, Kakroodi *et al.* (2012) have recently combined previously published data, with data from new samples taken near the southeast corner of the Caspian Sea to establish an updated sea level curve for the last 10,000 years. This study reinforces interpretations of the Derbent regression, but adds further information on the dating of high sea level stands proposed to have occurred during the Holocene, around 2600 BP, and 280–240 BP obtained through radiocarbon dating of lagoonal deposits (Kroonenberg *et al.* 2007: 140–141). Other research focusing more specifically on the South Caspian coast in Central Guilan — East Mazanderan further suggests high stands at 2500, 900, and 500 BP (Lahijani *et al.* 2009: 67).

Three broad periods of consensus can be drawn from the above mentioned data: 1) a high stand in the 1st millennium BC (Kroonenberg *et al.* 2007; Lahijani *et al.* 2009), the Derbent Regression in which sea levels dropped, generally dated sometime between the 1st millennium BC and the 17th century AD (Kakroodi *et al.* 2012; Karpychev 2001; Kroonenberg *et al.* 2007; Lahijani 2009; Rychagov 1997); 3) an increase in sea levels sometime between the 12th and the 19th century (Karpychev 2001; Lahijani *et al.* 2009; Rychagov 1997).

Actual measurements of the Caspian Sea level began in the mid-1800s and confirm that sea levels oscillated around 26 m below sea level, decreasing slightly between 1900 and 1930, before dipping dramatically between 1930 and the late 1970s, reaching a level of 29.4 m bsl. (Kakroodi *et al.* 2012: fig. 2).

Historical accounts of caspian coastline change

C. E. Yate, travelling through the region in the late 19th century, remarked on the variable nature of the coastline and the traces of ancient monuments (including the Gorgān Wall), both well inland and a considerable distance out to sea:

> 'The marks of this wall for some distance to the east of Gomish Tappa have now vanished, and it is said that they were washed away by the sea, which at one time extended inland ... On the other hand, there was a report that bricks were to be found under the water some distance out in the sea, and that, if true, would seem to show that dry land at one time extended even farther west than it does now' (Yate 1900: 273).

Yate's account clearly illustrates the visible remains of regressions and transgressions of the Caspian prior to the early 20th century. Mustawfi (trans. Lestrange 1902: 741) writes of a sea level rise that engulfed the island of Abaskun, sometime prior to 1340. Abaskun, a port in the south east corner of the Caspian was likely founded under Kavad in the Sasanian Period (Frye 1972: 267), further reinforcing the idea of a sea level rise between Late Antiquity and the 14th century. Other increases in sea level are recorded in the 17th and early 19th century (Dumont 1998: 45). However, as the 19th century progressed there are several accounts of another sea level dip. Muraviev (1871: 16) writing in 1819–20, indicates that while currently a part of the mainland, Gomish Tappeh (in the vicinity of Gomīshān) had been an island up until about ten years before his visit. Sykes (1915: 28–29) further emphasises this by saying that at Chikishlar (modern Chikishlyar, Turkmenistan located circa 60 km north of Gomīshān) 'ships have to lie 3 miles further out than they did 5 years ago.'

Shorelines on historical imagery

Examination of the GAMBIT and CORONA imagery have shown that the farthest inland example of a relict coastline is nearly 13 km from the coastline as it was in 1966. Organic material from a spit of one of these archaic shorelines (circa 10 km from the modern shoreline) was dated during excavations undertaken by the Gorgān Wall Project (Sauer *et al.* 2013). This spit exists near the visible termination of the Gorgān Wall overlying a Sasanian brick kiln (see Figure 7.11). Sauer *et al.* (2013: 152) note that the spit consisted of marine shells overlain by 'c. one metre of weakly bedded mottled clay build up, with thin lenses of pale brown find sand ... These are the types of sediments typically deposited in lagoons, mudflats or a shallow embayment of the sea.' On top of these deposits there is evidence of drying (equated with a regression) and a further thin layer of deposition (equating with another albeit shorter transgression). These shells were dated to between AD 1344–1460 cal. at 95.4% confidence.

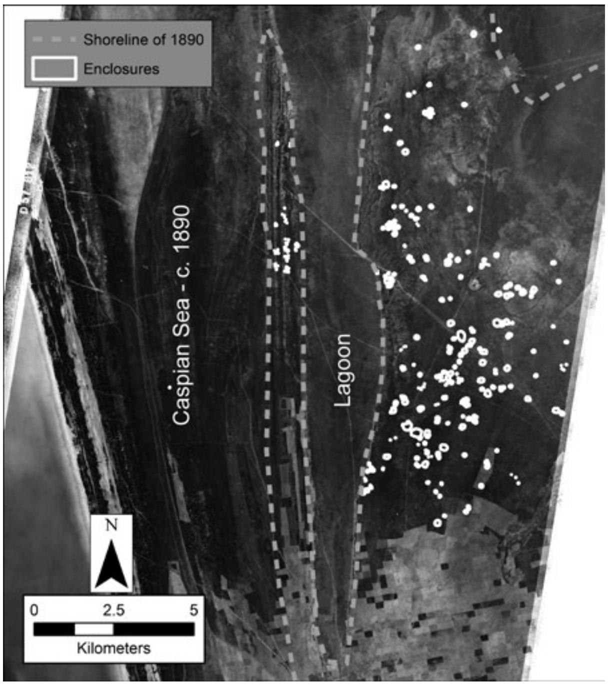

Figure 7.10. Shoreline of circa 1890 in relation to circular enclosures — this image demonstrates the relationship of the enclosures and small circular features with the coastline in 1966 and in 1890. Note that the features appear to respect the coastline of the late 19th century and the limits of the now extinct Hassan Gholi Bay (top right hand of image). Imagery available from the US Geological Survey.

Radiocarbon dates have been obtained from cores for organic material deposited in other transgressions of the Caspian by Kakroodi *et al.* (2012). Several of these, taken at circa 5 km and circa 20 km from the modern shoreline, have revealed dates similar to the material from the brick kiln overlay, further backing up the assertion that sea levels were considerably higher in the 13th–15th centuries than they are today. Kakroodi *et al.* (2012) also compared historical maps with shorelines visible on Landsat and ASTER imagery and reconstructed the location of the shoreline in 1890. European travellers' maps from the 1876–1881 (e.g. Baker 1876; Napier and Ahmed 1876; see Figure 7.11) also suggest a general consensus on the location of the shoreline in the late 19th century.

Discussion

Dating archaeological features by Caspian sea coastline change

Three absolute dates therefore confirm that the shoreline of the Caspian Sea was considerably higher than today at some point during 13th to 15th centuries AD. Furthermore, it reached a point significantly further inland than the features located on the GAMBIT image. Due to the ephemeral nature of the circular

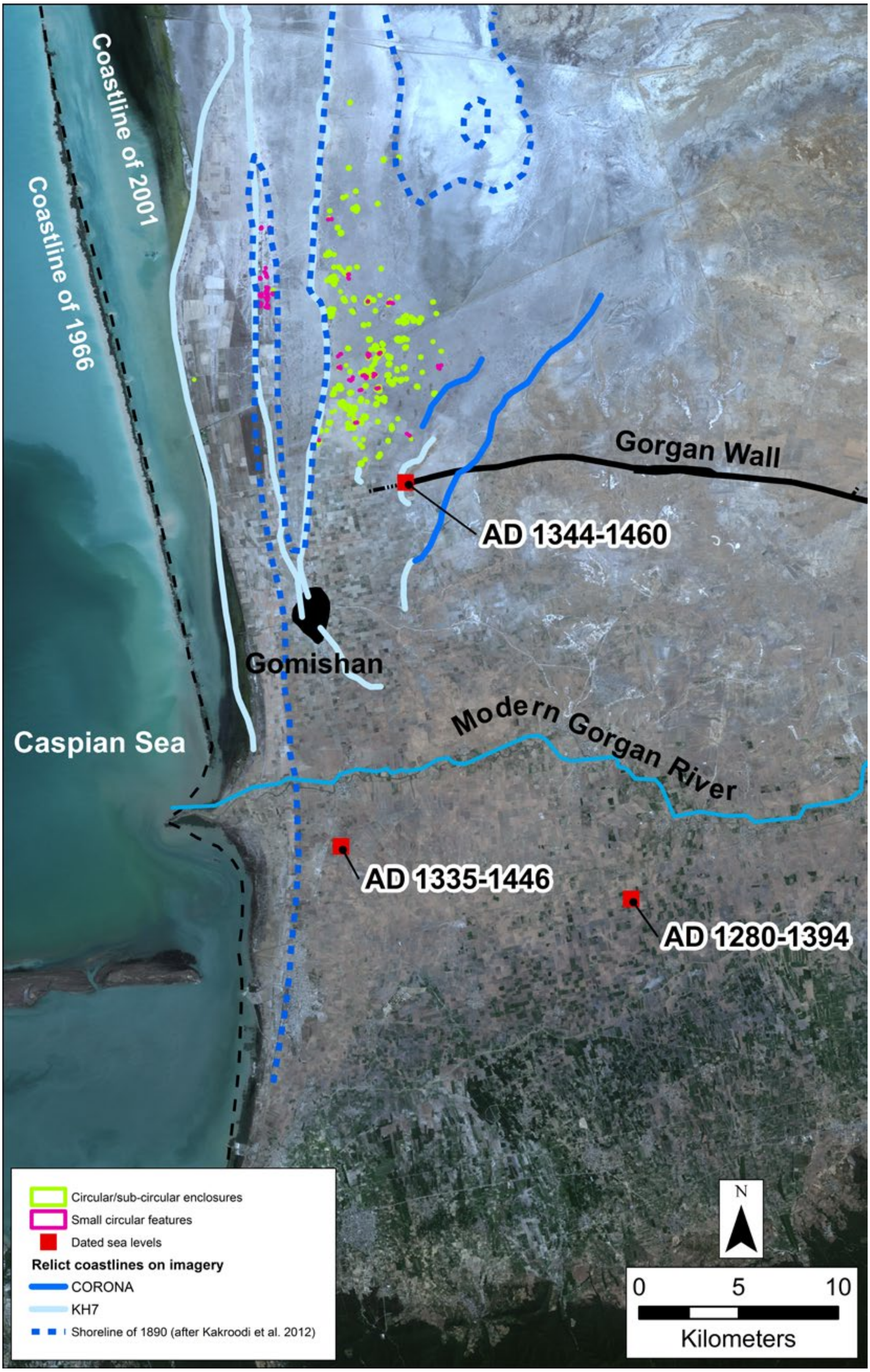

Figure 7.11. Map of the southeast Caspian coastline showing relict coastlines visible on KH7 GAMBIT and CORONA imagery, and dated transgressions/regressions of the Caspian Sea (data from Kakroodi *et al.* 2012; Sauer *et al.* 2013). Base map Landsat-7 from 2001, data available from the US Geological Survey

enclosures and associated features it seems unlikely that they could have been constructed before this date, and survived periods of engulfment by the Caspian. It is therefore likely that they date from after this time.

Two possibilities as to the *terminus ante quem* of these features can also be posited. Firstly, it is possible that they are roughly contemporary with the 19th century coastline, which they appear to respect, including the boundaries of the southern part of the now extinct Hassan Gholi Bay — known to have dried out in the early 20th century (Kakroodi 2012: 96). According to historical data, the sea level appears to have been relatively stable from 1840 or 1850 to the 1920s, roughly at the level indicated on Figure 7.10 and Figure 7.11 (Dumont 1998: 85; Kakroodi *et al.* 2012: fig. 7.2; Muriaviev 1871).

Secondly, these features could also pre-date this coastline. The decreased visibility of the features on the spit of land to the west of the lagoon, and the traces of a succession of relict coastlines on the spit might indicate that these features have been affected by changes in sea level. If this is so then there is a possibility that more of these features could be found underneath the area of the lagoon.

In summary, it would then seem likely that this group of features relate to activity taking place between the 13th and late 19th/early 20th centuries AD. Furthermore, because they appear to be so well preserved on the GAMBIT imagery, it seems likely that they date toward the later end of this range.

Historical land use

Important to the interpretation of the features detected on the imagery is an understanding of historical land use practices in the region. Mobile pastoralism appears to have been an important subsistence strategy in the steppes north of the Gorgān River from at least the late 1st century BC, through the Islamic Period (see Strabo: Falconer 1903; al-Tabari: Bosworth 1989). More recently, ethnographic and historical sources indicate that this area was used for grazing and some dry farming by nomadic and semi-nomadic Turkmen groups (Fraser 1825; Irons 1969; 1971; 1974; Le Strange 1905; Muraviev 1871; Napier and Ahmed 1876; Yate 1900).

Writing in 1825 James Baillie Fraser (1825: 261) notes that from the Caspian sea to the eastern parts of the Gorgān Plain, and from Astrabad in the south to the Ātrak in the north, the area was occupied by one half of the Yomut Turkmen tribe. Muraviev (1871: 9–10), detailing his journey to the southeast Caspian coast in 1819–20, also says that the entire area between the ‘White Hill’ (located north of Chikishlar and Hassan Gholi Bay) and the ‘Silver Hill’ (Gomish Tappeh) were inhabited by the Turkmen, who were also engaged in maritime trade in salt and naptha along the Caspian coast. He goes on to describe encampments both on the northern and southeastern banks of Hassan Gholi Bay (Muraviev 1871: 19).

Further historical accounts tell us that alterations of the Ātrak River along the Perso-Russian boundary in the 1880s resulted in the drying up of a southern branch of the river which provided fresh water to the Turkmen inhabiting the southern shore of Hassan Gholi Bay resulting in the abandonment of the area.

> ‘There is not a single Persian Yamut now anywhere on the river from Saikh Nazar’s little obah near Gudri, where I camped, right down to the sea at Hasan Kuli Bay, and the course of the river having changed, there is nothing to show where the boundary is. The soil along the river is said to be salt and unfit for cultivation, so the land is not of much value except for grazing in summer. In the winter the grazing is best to the north of the river, and the few Persian subjects there have been in the habit of taking their cattle to graze there.’ (Yate 1900: 268–269).

Yurts, enclosures, camp organisation, and location

Having established the land-use traditions of the area, it therefore seems likely that these features are associated with the activities of mobile, or semi-mobile, Turkmen groups engaged in herding and small-scale agriculture through seasonal use of this landscape. Likely features associated with this type of activity noted in other parts of the Near East include circular features of varying sizes used for tent bases, huts, corrals, or even burials (Müller-Neuhof 2014; Wilkinson 2003: 174).

The smaller circular features (measuring between 5 m and 10 m in diameter) resemble the signature that might be left by a yurt, the ubiquitous tent used by nomadic groups across Central Asia. The domed tent or yurt-like tent appears to have its roots in Iran and Central Asia, with references in classical sources to the royal tents in the Achaemenid and Parthian Periods, and similar constructions observed by travellers in the 12th and 13th centuries (Wilber 1979: 130; Wright 1958: 158).

The size of a yurt can vary. Wright (1958: 95) indicates that an average tent has a diameter of approximately 5.5 metres. Fraser (1825: 282) echoes these dimensions, with estimates of tents ranging between 15 and 20 feet in diameter (~4–6 m), while O’Donovan (1882: 42) records that yurts are generally 15 feet in diameter and 12 feet high. Ethnographic examples of larger tents erected for special occasions or by richer members of the community have been recorded with diameters of up to 12 m (Wright 1958: 98).

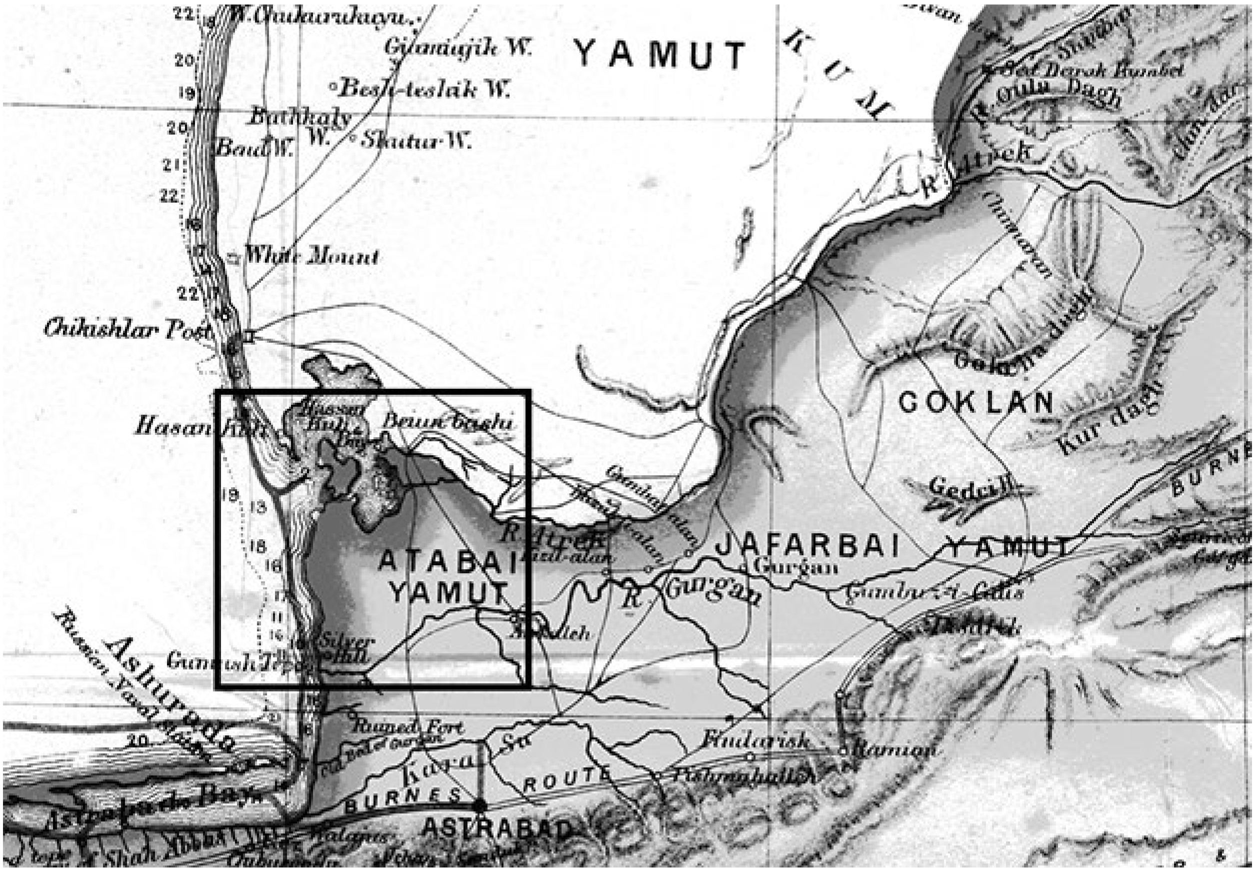

Figure 7.12. Map of Gorgān region after Baker 1876 — the black box indicates the area of interest.

Mud ramparts are said to have been used to insulate and shore up the yurts in winter (Wright 1958: 103). This practice could have left the type of raised bank that can be seen on the satellite imagery.

Wright (1958: 106) describes camps formed of six to eight yurts in a rough east–west line, with their doors generally facing south. These camps form part of a larger group, or *ōba*, which have a shared common territory of up to 20 square miles in the dry season, and 120 square miles in the wet season; when a larger area is utilised for pasture. During the latter season, journeys of up to 10 miles can be accomplished in a day in search of pasture. Camps generally had 50 to 60 tents, but large encampments (numbering 600 to 800 tents) were recorded in the area of Gomīshān in the 19th century (Wright 1958: 106).

Fraser (1825: 283) describes an alternative camp arrangement that consists of yurts, facing towards each other, arranged in a large square creating an enclosed area. Furthermore, 'the more important encampments are often surrounded by a fence of reeds, which serves to protect the flocks from petty thefts'. This description suggests the use of reeds embedded in the earth to construct paddocks or enclosures around a group of yurts to protect flocks. The large circular features on the imagery (with an average diameter of 105 m) may, therefore, represent corrals or pens. The lack of surface stone in the area would necessitate this type of construction.

In late 2014, the location of one of the groupings of large circular features discussed above was visited. Locating the exact anomalies found on the GAMBIT imagery was difficult, however, several modern reed enclosures (or their remains) were found. A discussion with a local Turkmen resident indicated that circular or semi-circular reed structures are used to offer sheep and goats shelter from the wind. The enclosures appear to be made from several shorter lengths of reed fencing. Short sections of reed fence used to construct larger enclosures could be one possible explanation for the dashed-line appearance of the features on the GAMBIT imagery. Currently, only hired shepherds accompany the flocks to the area in the autumn and winter. In the recent past, however, whole Turkmen families camped in the area while grazing their flocks. Furthermore, it was indicated that the flocks were much larger than today, perhaps numbering as many as 500 animals per family grouping. These modern reed structures, while adapted to the modern socio-economic needs of the

Figure 7.13. Photograph of yurt on the Gorgān Plain (Kristen Hopper 2009).

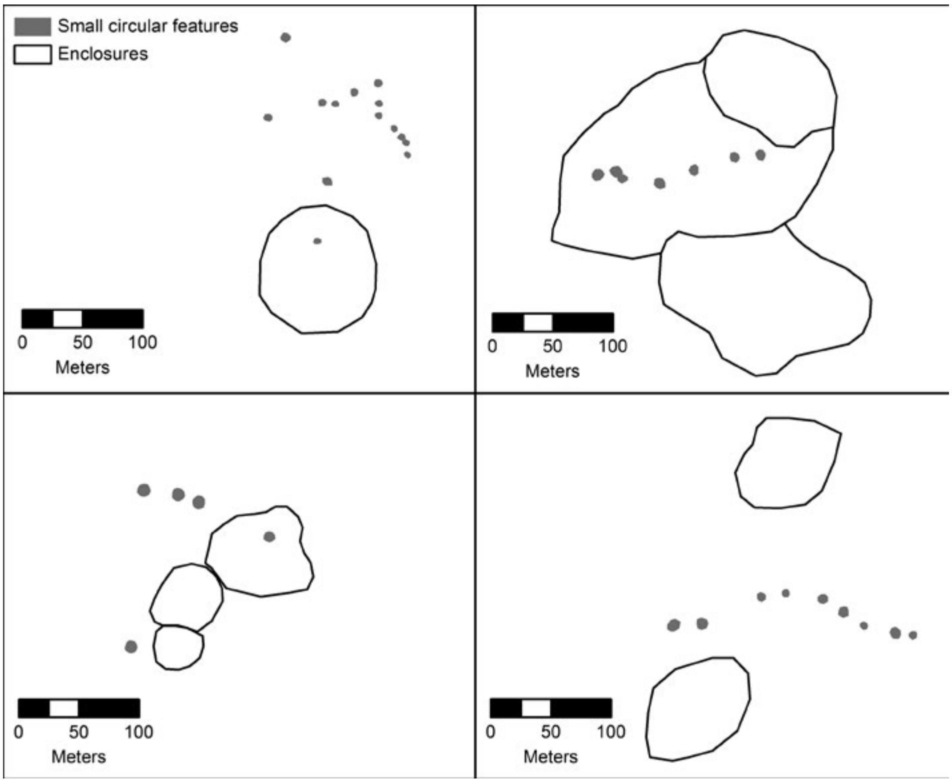

Figure 7.14. Line drawing of circular enclosures and small circular features — the small circular features are usually found in close proximity to the larger enclosures and are either found in a linear or clustered arrangement.

Figure 7.15. Modern reed structures in the area of the remotely sensed features (Andrea Ricci 2014).

Turkmen, demonstrate a long-tradition of structures relating to mobile pastoral activity in the region.

Conclusion

Compared to the wealth of evidence for settlement patterns and land use strategies of agricultural communities in the archaeological record, direct traces of mobile pastoralist activities are scarce. This does not mean that they are altogether absent. Features associated with nomadic, mobile pastoral, and agro-pastoral communities, while likely occurring in a range of environments, are more easily detected in less-agriculturally optimal landscapes or landscapes of survival. In these regions (semi-arid steppe, desert, or highland) the package of features associated with mobile groups such as corrals, tents bases, and circular enclosures etc., make up a distinct landscape signature.

This signature can be found in the northern semi-arid steppe of the Gorgān Plain. In this case, the use of satellite imagery has helped with detecting and mapping a range of features likely associated with pastoral activities. Further field survey of a larger sample of these features is planned and might allow us to confirm or deny these interpretations, however fieldwork in Iran has been difficult in the last few years highlighting the increased importance of remote sensing. Furthermore, the destruction of archaeological sites and features by modern land use and building smes increases the need for the use of historical imagery to look at landscapes that may no longer exist. New ways of dating and interpreting these features also need to be sought. Linking the archaeology with environmental data on Caspian Sea level change and its effect on the local landscape has enabled us to suggest a range of dates for the use of these features (circa 13th–early 20th century AD). Equally, the use of appropriate historical and ethnographic information on land-use practices can help with interpreting the role of these features within their local landscape.

Acknowledgments

This paper stems from work undertaken for the first author's PhD as part of the *Gorgān Wall Project* and the *Persia and its Neighbours Project* at Durham University under the supervision of Tony Wilkinson. We are grateful for the inspiration and guidance that Tony provided for this and many other aspects of our research. We would also like to extend our thanks to Andrea Ricci for visiting some of the remotely sensed features discussed in this paper.

Bibliography

Abbasi, Qurban

2011 *Final Report of the Archaeological Excavations at Narges Tappeh, Gorgan Plain, Iran*. Gorgan: Golestan Cultural Heritage Organization and Golestan Higher Education Institute.

Alizadeh, Karim; and Jason Ur

2007 'Formation and destruction of pastoral and irrigation landscapes on the Mughan Steppe, north-western Iran.' *Antiquity* 81: 148–160.

Arne, T. J.
1945 *Excavations at Shah Tepe*. Gothenburg: Elanders Boktryckeri Aktiebolag.
Baker, Valentine
1876 *Clouds in the East: Travels and Adventures on the Perso-Turkman Frontier.* London: Chatton and Windus.
Bosworth, Clifford E., trans.
1989 *The History of al-Ṭabarī (Ta'rīkh al-ruṣūl wa-al-mulūk). Vol. 30, The ʿAbbāsid Caliphate in Equilibrium*. Albany: SUNY Press.
Casana, Jesse; and Jackson Cothren
2013 'The CORONA Atlas Project: Orthorectification of CORONA satellite imagery and regional-scale archaeological exploration in the Near East.' In *Mapping Archaeological Landscapes from Space*, edited by D. Comer and M. Harrower, 33–44. New York: Springer.
Dolukhanov, Pavel; Andrei Chepalyga; and Nikita Lavrentiev
2010 'The Khvalynian transgressions and early human settlement in the Caspian basin.' *Quaternary International* 225: 152–159.
Dumont, H. J.
1998 'The Caspian Lake: History, biota, structure, and function.' *Limnology and Oceanography* 43(1): 44–52.
Falconer, William, trans.
1903 *The Geography of Strabo*. London: Bell.
Finkelstein, Israel
1992 'Invisible nomads: A rejoinder.' *Bulletin of the American Schools of Oriental Research* 287: 87–88.
Finkelstein, Israel; and Aviram Perevolotsky
1990 'Processes of sedentarization and nomadization in the history of Sinai and the Negev.' *Bulletin of the American Schools of Oriental Research* 279: 67–88.
Fraser, James B.
1825 *Narrative of a Journey into Khorasan in the Years 1821 and 1822*. London: Longman, Hurst, Rees, Orme, Brown and Green.
Frye, Richard N.
1972 'Byzantine and Sasanian trade relations with northeastern Russia'. *Dumbarton Oaks Papers* 26: 263–269.
Hammer, Emily
2012 'Local landscapes of pastoral nomads in southeastern Turkey.' Ph.D. diss., Harvard University.
Hopper, Kristen
2017 'The Gorgan Plain of northeast Iran: a diachronic analysis of settlement and land use patterns relating to urban, rural and mobile populations on a Sasanian Frontier.' Ph.D. diss., Durham University.
Irons, William
1969 'The Turkmen of Iran: A brief research report.' *Iranian Studies* 2(1): 27–38.
1971 'Variation in political stratification among the Yomut Turkmen.' *Anthropological Quarterly* 44(3): 143–156.
1974 'Nomadism as a political adaptation: The case of the Yomut Turkmen.' *American Ethnologist* 1(4): 635–658.
Kakroodi, A. A.; S. B. Kroonenberg; R. M. Hoogendoorn; H. Mohammd Khani; M. Yamani; M. R. Ghassemi; and H. A. K. Lahijani
2012 'Rapid Holocene sea-level changes along the Iranian Caspian coast.' *Quaternary International* 263: 93–103.
Kaplin, Pavel, and Andrew Selivanov
1995 'Recent coastal evolution of the Caspian Sea as a natural model for coastal responses to the possible acceleration of global sea-level rise.' *Marine Geology* 124: 161–175.
Khormali Farhad, and Martin Kehl
2011 'Micromorphology and development of loess-derive surface and buried soils along a precipitation gradient in Northern Iran.' *Quaternary International* 234: 109–123.
Kiani, M. Y.
1982 *Parthian Sites in Hyrcania: The Gurgan Plain.* Berlin: Reimer.
Kislov, Alexander, and Pavel Toporov
2007 'East European river runoff and Black Sea and Caspian Sea level changes as simulated within the Paleoclimate modelling intercomparison project.' *Quaternary International* 167–168: 40–48.`
Kennedy, David
2014 ''Nomad villages' in north-eastern Jordan: from Roman Arabia to Umayyad Urdunn.' *Arabian Archaeology and Epigraphy* 25: 96–109.
Kennedy, David, and Bishop M. C.
2011 'Google earth and the archaeology of Saudi Arabia. A case study from the Jeddah area.' *Journal of Archaeological Science* 38: 1284–1293.
Kroonenberg, S.B.; G. M. Abdurakhmanovb; E. N. Badyukovac; K. van der Borgd;
A. Kalashnikove; N. S. Kasimovc; G. I. Rychagovc; A. A. Svitochc; H. B. Vonhoff; and F. P. Wesselingh
2007 'Solar-forced 2600 BP and Little Ice Age highstands of the Caspian Sea.' *Quaternary International* 173–174: 137–143.
Lahijani, Hamid Alizadeh Ketek; Hossain Rahimpour-Bonab; Vahid Tavokoli; and Muna Hosseindoost
2009 'Evidence for late Holocene highstands in Central Guilan–East Mazanderan, south Caspian coast, Iran.' *Quaternary International* 197: 55–71.
Le Strange, Guy
1902 'Description of Persia and Mesopotamia in the year 1340 AD from the Nuzhat-al-Ḳulūb of Ḥamd-Allah Mustawfi, with a summary of the contents of that work.' *Journal of the Royal Asiatic Society of Great Britain and Ireland* Oct. 1902: 733–784.
Le Strange, Guy
1905 *Lands of the Eastern Caliphate*. Cambridge: Cambridge University Press.

Mamedov, A. V.
1997 'The Late Pleistocene-Holocene history of the Caspian Sea.' *Quaternary International* 41/42: 161–166.
Morgan, Jacques de.
1902 *La Délégation en Perse du Ministère de l'Instruction Publique 1897 à 1902.* Paris: Ernest Leroux.
Müller-Neuhof, Bernd
2014 'A 'marginal' region with many options: the diversity of Chalcolithic/Early Bronze Age socio-economic activities in the hinterland of Jawa.' *Levant* 46(2): 230–248.
Muraviev, Nikolai
1871 *Journey to Khiva through the Turcoman Country, 1819–20*. Translated from Russian by Philipp Strahl and from German by W.S.A. Lockhart. Calcutta [Kolkata]: Foreign Department Press.
Napier, G. C.; and Kazi Syud Ahmed
1876 'Extracts from a diary of a tour in Khorassan, and notes on the Eastern Alburz tract; with notes on the Yomut Tribe.' *Journal of the Royal Geographical Society of London* 46: 62–171.
O'Donovan, Edmund
1882 *The Merv Oasis: Travels and Adventures East of the Caspian during the Years 1879–80–81*. New York: G. P. Putnam's Sons.
Philip Graham; Danny Donoghue; Anthony Beck; and Nikolaos Galiatsatos
2002 'CORONA satellite photography: an archaeological application from the Middle East.' *Antiquity* 76: 109–118.
Potts, Daniel T.
2014 *Nomadism in Iran: From Antiquity to the Modern Era*. Oxford: Oxford University Press.
Rosen, Steve A.
1992 'Nomads in archaeology: A response to Finkelstein and Perevoltsky.' *Bulletin of the American Schools of Oriental Research* 287: 75–87.
2010 'The camel and the tent: An exploration of technological change among early pastoralists.' *Journal of Near Eastern Studies* 69(1): 63–77.
Rychagov, G. I.
1997 'Holocene oscillations of the Caspian Sea, and forecasts based on palaeogeographical reconstructions.' *Quaternary International* 41/42: 167–172.
Sauer, Eberhard, H.; Omrani Rekavandi; Tony J. Wilkinson; and J. Nokandeh
2013 *Persia's Imperial Power in Late Antiquity: The Great Wall of Gorgan and Frontier Landscapes of Sasanian Iran*. Oxford: Oxbow Books.
Schmidt, Erich
1940 *Flights over Ancient Cities of Iran.* Chicago: The University of Chicago Press.
Shiomi, H.
1976 *Archaeological Map of the Gorgān Plain, Iran No. 1.* Hiroshima University Scientific Expedition to Iran. Hiroshima: Denshi Insatsu Co. Ltd.
1978 *Archaeological Map of the Gorgān Plain, Iran No. 2.* Hiroshima University Scientific Expedition to Iran. Hiroshima: Denshi Insatsu Co. Ltd.
Sykes, Percy M.
1915 *A History of Persia, Vol. 1*. London: Macmillan and Co.
Ur, Jason
2003 'CORONA satellite photography and ancient road networks: A Northern Mesopotamian case study.' *Antiquity* 77: 102–115.
2013a 'Spying on the past: Declassified intelligence satellite photographs and Near Eastern landscapes.' *Near Eastern Archaeology* 76(1): 28–36.
2013b 'CORONA satellite imagery and ancient Near Eastern landscapes.' In *Mapping Archaeological Landscapes from Space*, edited by D. Comer and M. Harrower, 21–32. New York: Springer.
Wilber, Donald N.
1979 'The Timurid court: Life in gardens and tents.' *Iran* 17: 127–133.
Wilkinson, Tony J.
2003 *Archaeological Landscapes of the Near East*. Tucson: University of Arizona Press.
Wilkinson, Tony J.; Hamid Omrani Rekavandi; Kristen Hopper; Seth Priestman; K. Roustaei; and Nikolaos Galiatsatos
2013 'The Landscapes of the Gorgān Wall.' In *Persia's Imperial Power in Late Antiquity: The Great Wall of Gorgān and Frontier Landscapes of Sasanian Iran*, edited by E. Sauer, O. Rekavandi, T. J. Wilkinson, and J. Nokandeh, 24–132. Oxford: Oxbow Books, Oxford.
Wright, G.R.H.
1958 'Tents and Domes in Persia.' *Man* 58: 159–60.
Yate, Charles E.
1900 *Khurasan and Sistan*. Edinburgh: Blackwood.