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Landscapes of Mobility and Movement in North-West Arabia: A Remote Sensing Study of the Neom Impact Zone

Michael Fradley [1,*] and Sarah Gyngell [2]

[1] School of Archaeology, University of Oxford, Oxford OX1 3TG, UK
[2] Department of Archaeology & History, La Trobe University, Melbourne, VIC 3086, Australia
* Correspondence: Michael.Fradley@arch.ox.ac.uk

Abstract: The historic environment of north-west Saudi Arabia is likely to be severely impacted by the construction of the Neom mega-city complex and the development of the city's hinterland. This region, located east of the Gulf of Aqaba, has only been subject to limited archaeological survey in the past, limiting any assessment of this negative impact. This paper presents data collected through a remote sensing survey of the region undertaken by the Endangered Archaeology in the Middle East and North Africa (EAMENA) project, independent of the Neom project. It is argued that this data reflects a landscape of movement between north and south, with evidence of structures and monuments from at least the Bronze Age through to the pre-Islamic period, but little evidence of permanent settlement or agriculture. This should not be dismissed as a peripheral landscape, but one that contains rich archaeological evidence of concentrated activity, suggesting that some areas have held long-term significance to the people inhabiting and moving through this region.

Keywords: remote sensing; GIS; landscape archaeology; Neom; mobility; Saudi Arabia

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1. Introduction

Optical analysis of satellite imagery is a widely used technique for the rapid assessment of archaeological landscapes in the Middle East. Use of this methodology has been expanded geographically by the Endangered Archaeology in the Middle East and North Africa (EAMENA) project to locate sites and assess surviving structural evidence, current disturbances and the condition of the sites and threats to those sites throughout the region. The area surveyed was selected due to the expected impact of the multi-faceted Neom development in north-western Saudi Arabia, one of the largest planned urban and hinterland projects in the region. The scale of this development makes a remote sensing approach vital, as previous targeted surveys have not provided the necessary extensive cover to assess this development impact and the present study covers all but the eastern extent of the proposed Neom footprint. In addition to providing an assessment of the likely impact on the archaeology of the construction zone, the resulting data also feeds into broader archaeological research questions about connectivity across supposedly 'peripheral' landscapes in northern Arabia.

2. Materials and Methods

2.1. Background

The study area (Figure 1) is bounded by the Jordanian border to the north and the Gulf of Aqaba and the Red Sea to the west and southwest. To the east, the survey runs as far as 36 degrees longitude and 27 degrees latitude to the south. Within the survey area, the western and southern sections are dominated topographically by a mixed band of granite mountains (Figure 2). A band of Umm Sahm and Ram sandstone plateaus runs down the centre of the study area, with the start of the Tawil sandstone formations to the east, including the western part of the Tabuk valley. The modern climate is relatively cool but dry when compared to central Arabia [1].

Figure 1. The Neom survey area in regional context.

This remote sensing survey was an opportunity to better understand this peripheral landscape between the more commonly studied landscapes of western Saudi Arabia and southern Jordan, improving our understanding of the endangered archaeology of the region in light of the Neom development (Figure 3). Neom, its name combining the Greek

word for 'new' and the Arabic for 'future,' has been designed as a future-facing sustainable mega city and is part of the wider Vision 2030 concept of the Kingdom of Saudi Arabia (https://www.Neom.vision2030.gov.sa/ (accessed on 13 July 2022)). The development will include Oxagon, an industrial city built on the coast of and out over the Red Sea with a population of 90,000 by planned 2030 (https://www.Neom.com/en-us/regions/oxagon (accessed on 13 July 2022)) and The Line, a multi-level, part subterranean development intended to house one million (https://.Neom.com/en-us/regions/whatistheline (accessed on 13 July 2022)), as well as extensive recreational development of the mountainous region east of the Gulf of Aqaba (https://www.Neom.com/en-us/regions/trojena (accessed on 13 July 2022)). However, independent reporting of the development has questioned the sustainable claims of the Neom scheme, the detrimental impact on local communities affected by the project and the nature of the architectural design [2–4].

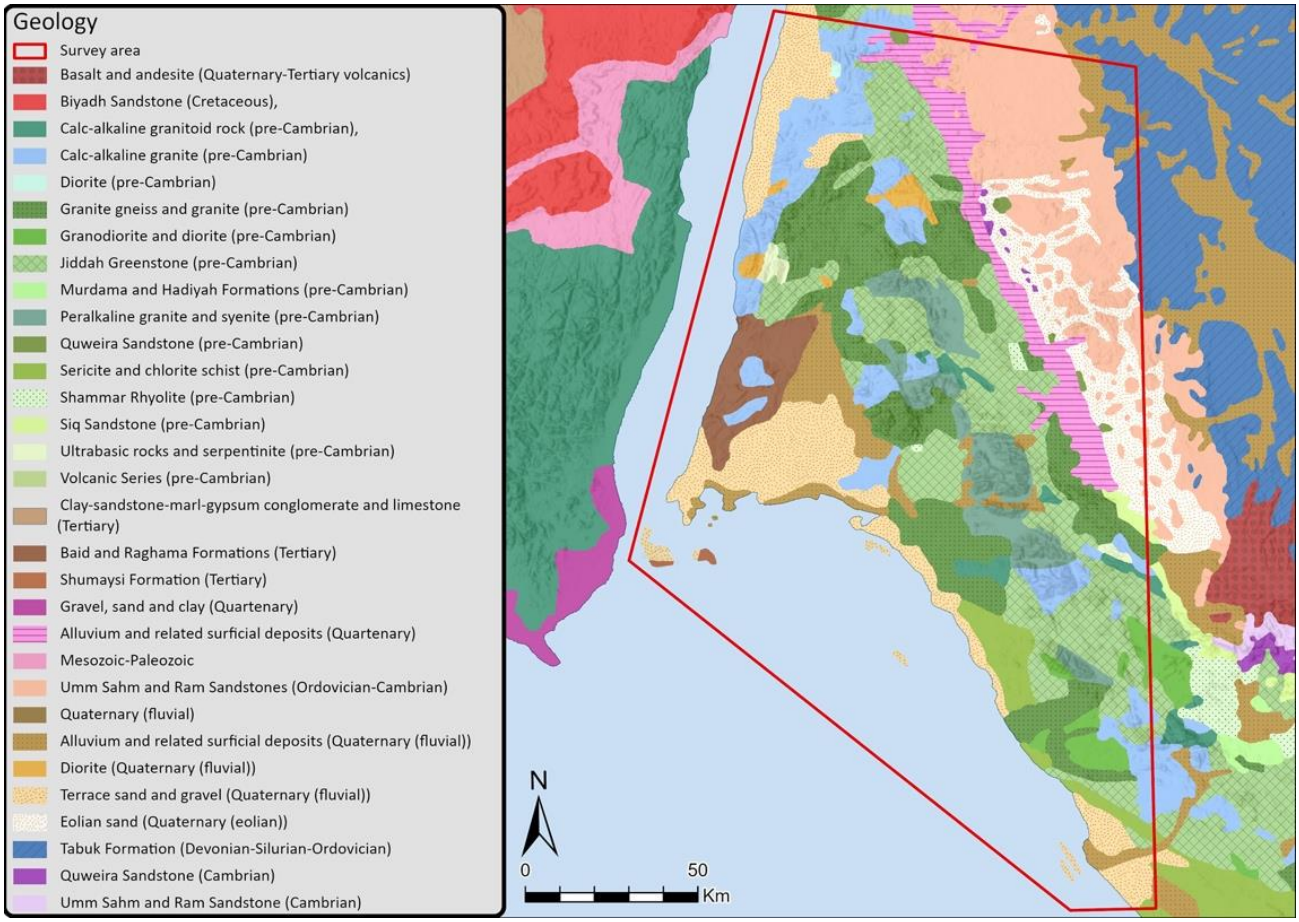

Figure 2. Highlighting the Neom impact areas based on published plans. The red line relates to the Line development.

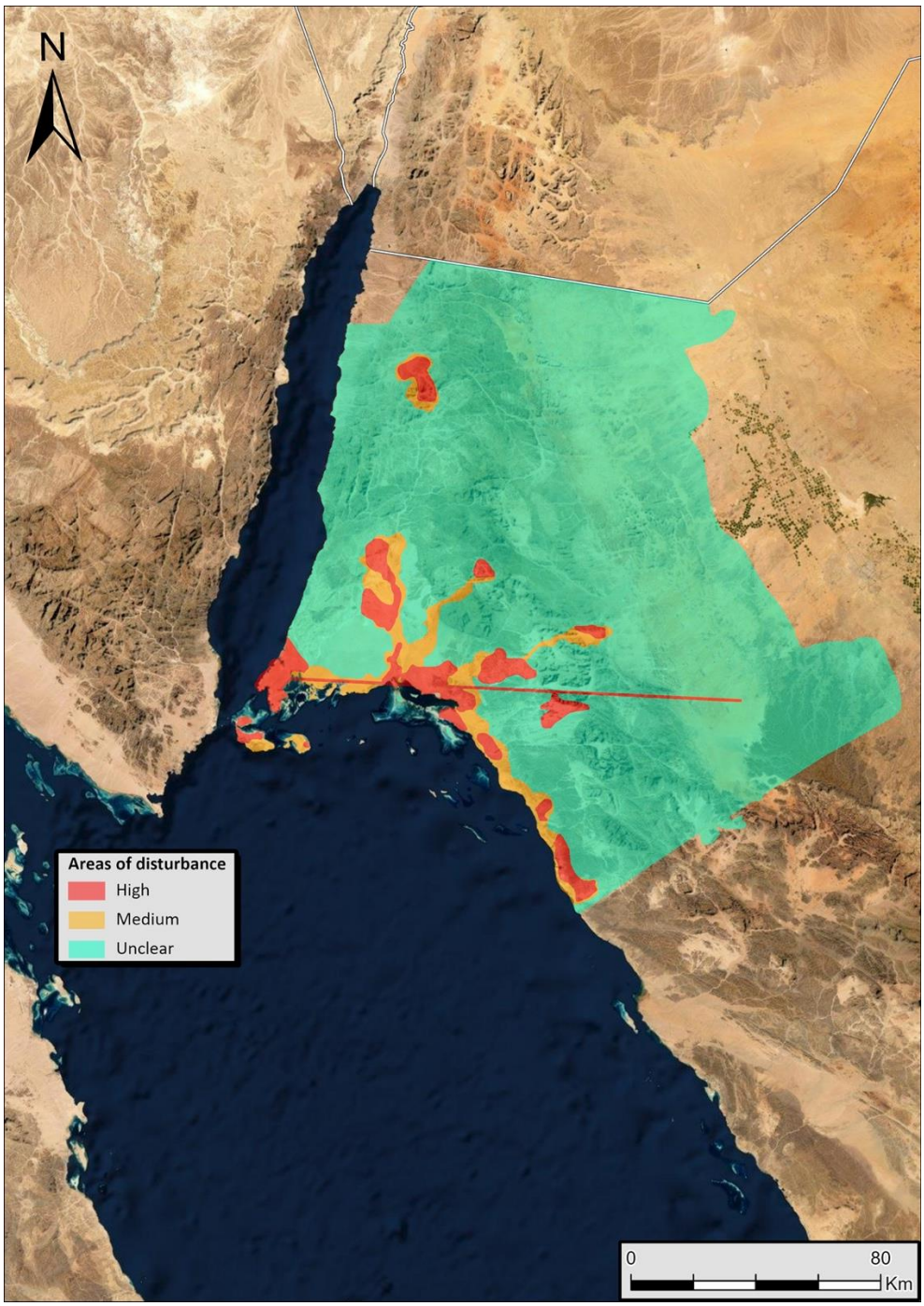

Figure 3. The geology of the survey area, adapted from [5,6].

Archaeologically, a general reconnaissance survey of the wider region of north-western Saudi Arabia and unrelated to the Neom development was undertaken over 40 years ago to set a baseline understanding of the area's archaeological heritage [7]. This published ground survey identified a range of site types, but it was not geographically comprehensive and did not produce accurate mapping of identified sites. Since this first survey, the area has only been subject to limited archaeological survey and investigation. This is particularly notable in comparison to investigations in the south of Jordan in areas such as Wadi Rum and Wadi Faynan [8–11] and more recent investment in heritage research around Khaybar and Al Ula in Saudi Arabia [12,13].

Recent years have seen surveys investigating palaeolithic evidence from across the coastal zone of the survey area, designed to better understand early hominids' dispersals out of Africa [14]. More broadly, the 'Tabuk corridor' to the east of the survey area has been identified as a probable route of hominid dispersal into the Arabian Peninsula [15].

Investigations have taken place immediately west of the survey area at Qurayyah where a substantial settlement and agricultural landscape supported by complex water-management systems was established by the 2nd millennium BCE [16,17]. The latter site has been seen as part of a wider tradition of walled oasis sites including Tayma, Dumat al-Jandal and Khaybar continuing to the west and south-east, potentially beginning in the late 4th or early 3rd millennium BCE and possibly influenced by broad settlement forms coming down from the Levant region [18].

Over the past decade, research by the Saudi-Polish mission has focused on the port of al Khurayba/Aynuna, especially the Nabatean ruins set back from the coastline [19]. This site has been frequently linked to the maritime settlement of Leuke Kome, mentioned by Strabo in relation to the campaign of Aelius Gallus in 25–24 BCE and in the *Periplus Maris Erythraei* likely written in the first century CE [20]. However, the precise location of Leuke Kome remains under debate, with arguments still resting heavily on interpretations of historical writing about the geographical position of the port and feeding into wider discussion on the navigability of the Gulf of Aqaba [20–22]. To the north-west of al Khurayba/Aynuna, a detailed ground survey has also been undertaken at al Bad' and surrounding areas, linked to historical Madyan, has provided a wealth of detailed information about that settlement's history of occupation [23].

Cumulatively, with the exception of the coastal adjacent settlements of al Khurayba and al Bad', these surveys have produced only a limited amount of data, which has served to reinforce the perception of the wider region as a 'peripheral' archaeological landscape, so there is a clear need to undertake further archaeological survey as a means of understanding and mitigating damage to monuments in the region.

2.2. Methodology

The remote sensing survey employed the rapid systematic survey methodology developed by the EAMENA project, where satellite imagery is optically surveyed manually by project surveyors and drawing on the early pioneering work of Professor David Kennedy [24,25]. The imagery is systematically analysed, with any feature or group of features that are interpreted as being at least potentially archaeological recorded as a geospatial point. Features were primarily identified on the basis of site types (Figure 4) identified by previous studies and often investigated on the ground in both Jordan and Saudi Arabia [12,13,24,26]. It was not possible to conduct any ground survey within the confines of the present project which focuses on the cost-effective use of satellite remote sensing, but based on earlier fieldwork it is possible to be confident in the identification of morphologically distinct archaeological features. The method assesses land coverage via a grid system using grids measuring 0.25×0.25 of a decimal degree, each covering an area of approximately 625 km^2. The survey encompassed 44 grids, although many of these included large sections of open maritime waters and parts of Jordanian territory to the north.

Imagery was viewed and geospatial data recorded in the first instance primarily on Google Earth Pro, including the use of historical imagery housed on that platform, only exploring alternative imagery tiles if there was any ambiguity in the identification or interpretation of the site. In some cases, imagery hosted on Bing Maps or Apple Maps was consulted where no usable imagery was available for an area on Google Earth Pro. Imagery on all of these platforms was used as presented, with no additional processing or manipulation. Sites were classified according to interpretation terminology adopted by the EAMENA project. All data collected was subsequently uploaded to the EAMENA database, at which stage additional data categories were added and additional imagery was consulted to monitor the changing condition of the potential sites.

Figure 4. Satellite images of principal site types recorded (clockwise from top left: A V-shaped kite and clusters of enclosures; A ringed tomb and adjacent triangle structure; A possible mustatil structure and clusters of enclosures; A group of pendant structures. Source: Google Earth.

Data was then analysed in ArcGIS, exploring the spatial nature of data with relation to the topography, environment and geology of the region. Importantly, it was also assessed in terms of the impact of provisional planning of the Neom development on the heritage landscape recorded by this remote sensing survey. The available formal planning designs were relatively limited at the time of the survey and it is assumed that details will change as construction proceeds (https://Neom.resortx.com/Neom-saudi-arabia/?page=7 (accessed on 13 July 2022)). It is also assumed that they provide a broad indication of key development zones on which an impact assessment can be made. Areas of urban development were classed as having a high impact, as was the route of The Line, although the exact impact of the latter is unclear depending on whether excavation and construction is predominantly subterranean. Areas of agricultural development were classed as medium impact, while the rest of the development zone was classed as unclear and it is assumed these latter areas remain at risk of negative impact.

3. Results

A range of site types were identified by the remote sensing survey (Figures 4–6). As with many surveys based on the use of remote sensing, it is acknowledged that this dataset is heavily biased toward larger, stone-built structures that are observable on a satellite image. Other site forms, such as surface scatters of material culture, rock art sites and caves with occupational evidence would almost certainly be missed by the survey. However, the results presented remain valid as a broad impression of areas of the landscape utilised in the past that can be built on by ground surveys in the future.

The most commonly recorded features were simple sub-circular stone-walled enclosures, generally in small groups but in a few cases as part of large, adjoining clusters. These crude structural forms are found across large parts of the Middle East and are near-impossible to date morphologically on the basis of satellite imaging and could potentially be from any date stretching back from the 20th century to the prehistoric period. It seems probable that many of these structures were related to transhumant livestock management. These structural forms were found across most parts of the survey area.

Stone cairns and more complex cairn-form structures were also recorded across much of the survey area. These occurred most commonly as simple circular stone mounds, either

individually or in small groups which were broadly dispersed across the project study zone. More complex ringed cairns (also termed as 'ring tomb' or 'bullseye'), with a concentric circular bank surrounding a central cairn, were recorded across the southern and western sides of the study area, with a single outlier recorded to the north-eastern section. In the southern tip of the survey area some of the ringed cairns were paired with triangular stone enclosure structures, the only part of the survey area where these triangle features were recorded. Pendant cairns, with a large cairn at its head and a linear bank or row of cairns leading away, were also recorded to the south and west of the study area, similar to the ringed cairn distribution, but without the comparable concentration of sites to the south.

An important combination of the enclosure and cairn features were also recorded across parts of the survey area, consisting of a circular or oval stone enclosure with one, or occasionally more than one cairn built into the line of the enclosure wall. In some examples, the enclosure had a single square notched structure, seemingly instead of a cairn structure. While many of these enclosures were relatively small, comparable to the size of many ringed cairns, some examples were very large with a radius of more than 100 m. Morphologically comparable examples of the smaller forms of this type have been identified over a wide geographical area, such as a group documented north of Gebel Ataqah to the west of Suez in Egypt [27] and in areas west of Riyadh. However, the larger examples, which in some cases were recorded in small clusters, appear to be a regionally distinct form recorded in this research area. Given the presence of a cairn, it is possible that these structures had a funerary or memorial function, although ground investigation is required to verify this conjecture. The overall form is comparable with the ringed cairn, with the cairn offset from the centre and the overall enclosure generally oval rather than circular. For the purposes of the present paper, this distinct structural form will be termed 'ringed enclosures'.

Small numbers of other structures were also recorded as part of the survey. Probable V-shaped kites (n = 32) of the Sinai-Negev tradition, stone structures that are widely accepted to have been devices for hunting game such as gazelle, were documented primarily on the eastern and western sides of the band of Umm Sahm and Ram sandstone running down the eastern side of the survey area. A single possible example was also recorded further west alongside a wadi running down into the Gulf of Aqaba. Two small groups of possible mustatil features, a stone-built form of monumental ritual installation that have been dated to the late Neolithic, were also documented and are the most northerly examples of this type of feature so far recorded in the Middle East [12,28]. Two small examples, c.50m in length, were recorded on the eastern side of the granite mountain range. The two structures were located c.850m apart from each other, with the northerly example surrounded by a large cluster of stone enclosures. A second possible cluster was identified further north on the eastern side of the sandstone band, just 10 km south of the Jordanian border. At least six small mustatil-type structures were recorded in this area, measuring just 10–25 m in length.

Settlement complexes were recorded on the Red Sea coast to the north of al Kuraybah and to the east of Sharma, the former being the well-studied site linked to the historically documented settlement of *Leuke Kome*. A single, distinct rectangular structure was also recorded in the north-western part of the survey area (Figures 7 and 8). The stone-built structure measures c.20m long and 15m wide, with the interior possibly divided into nine cells.

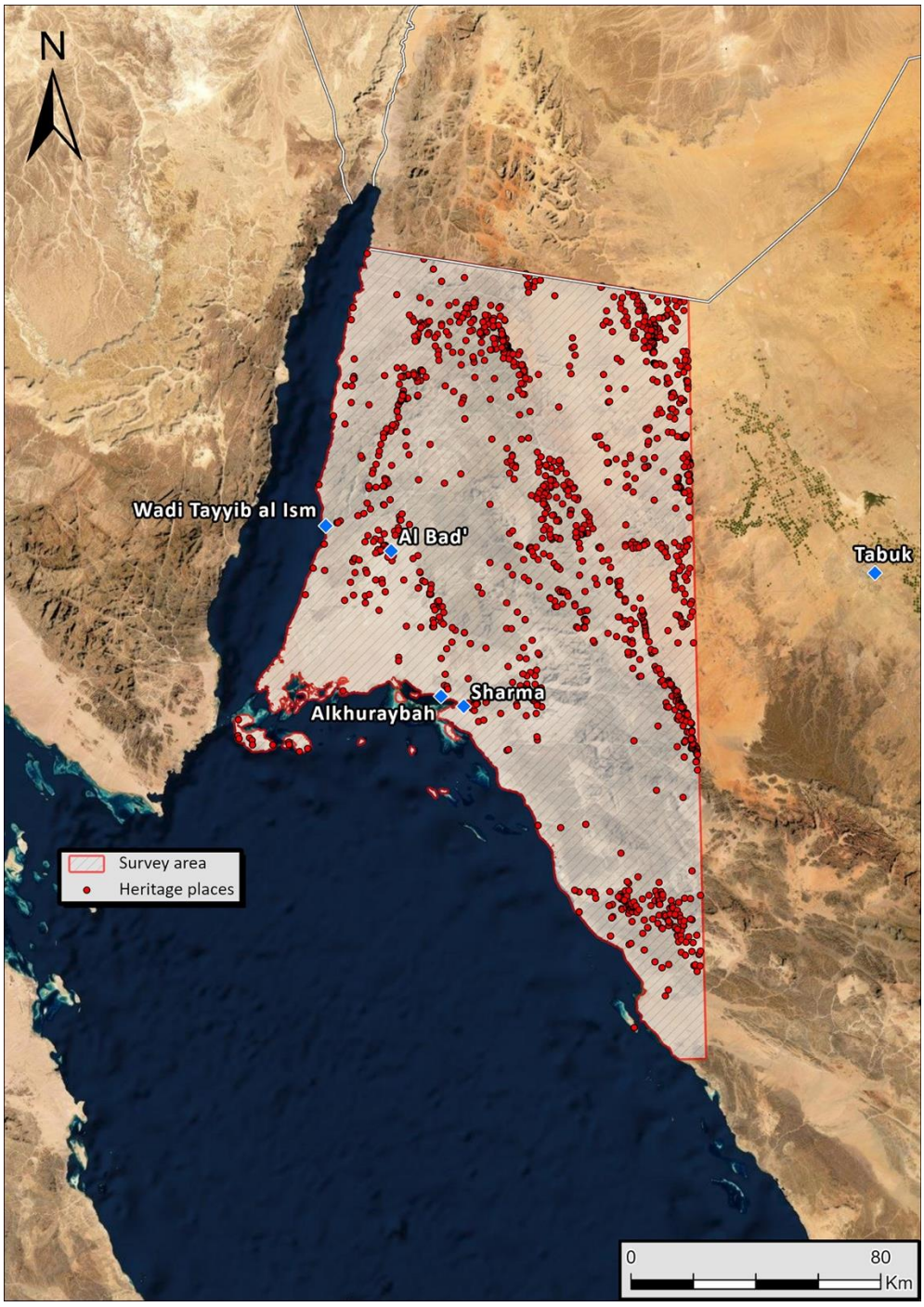

Figure 5. Distribution of all potential sites recorded via remote sensing survey.

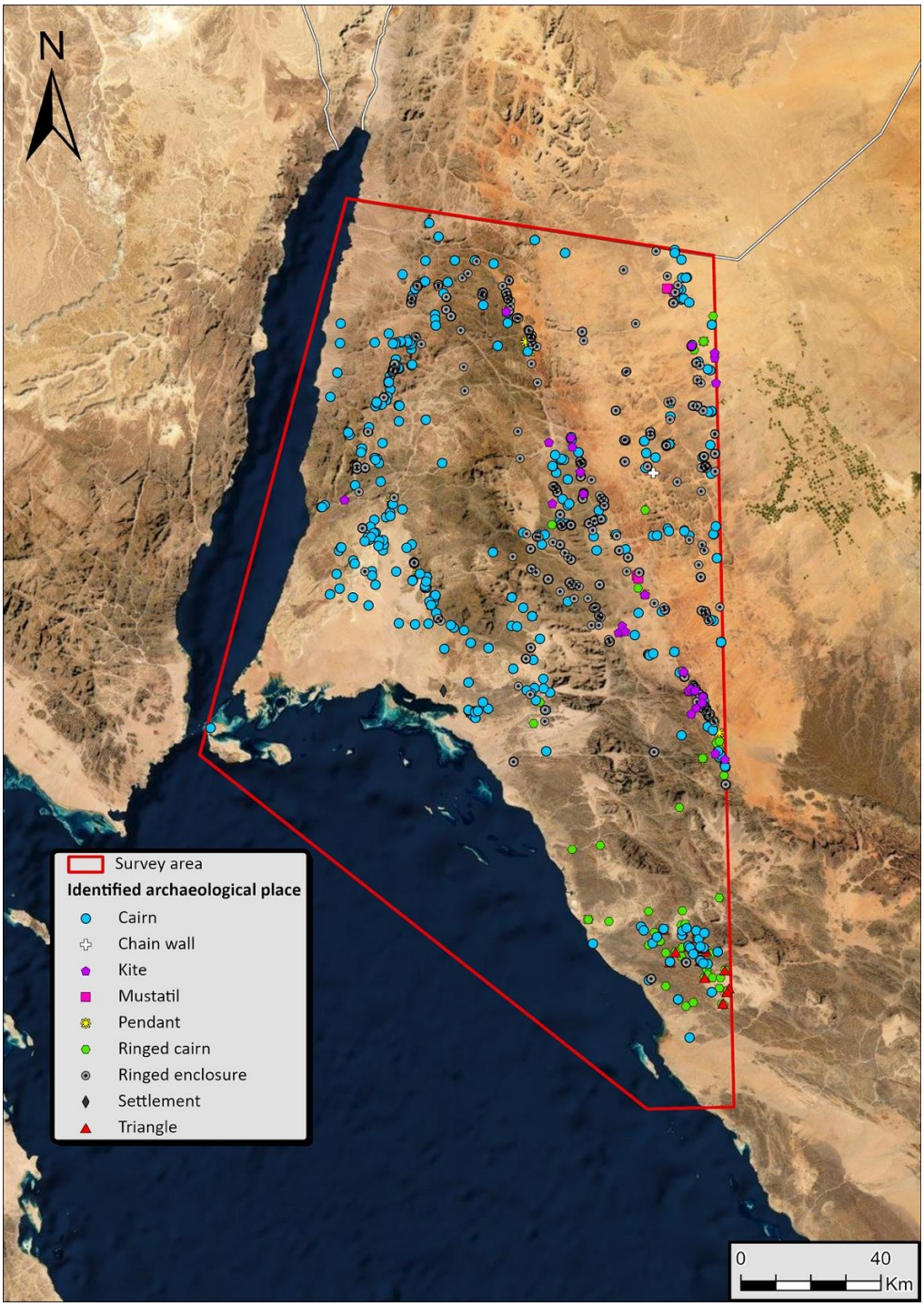

Figure 6. Main site types' distribution.

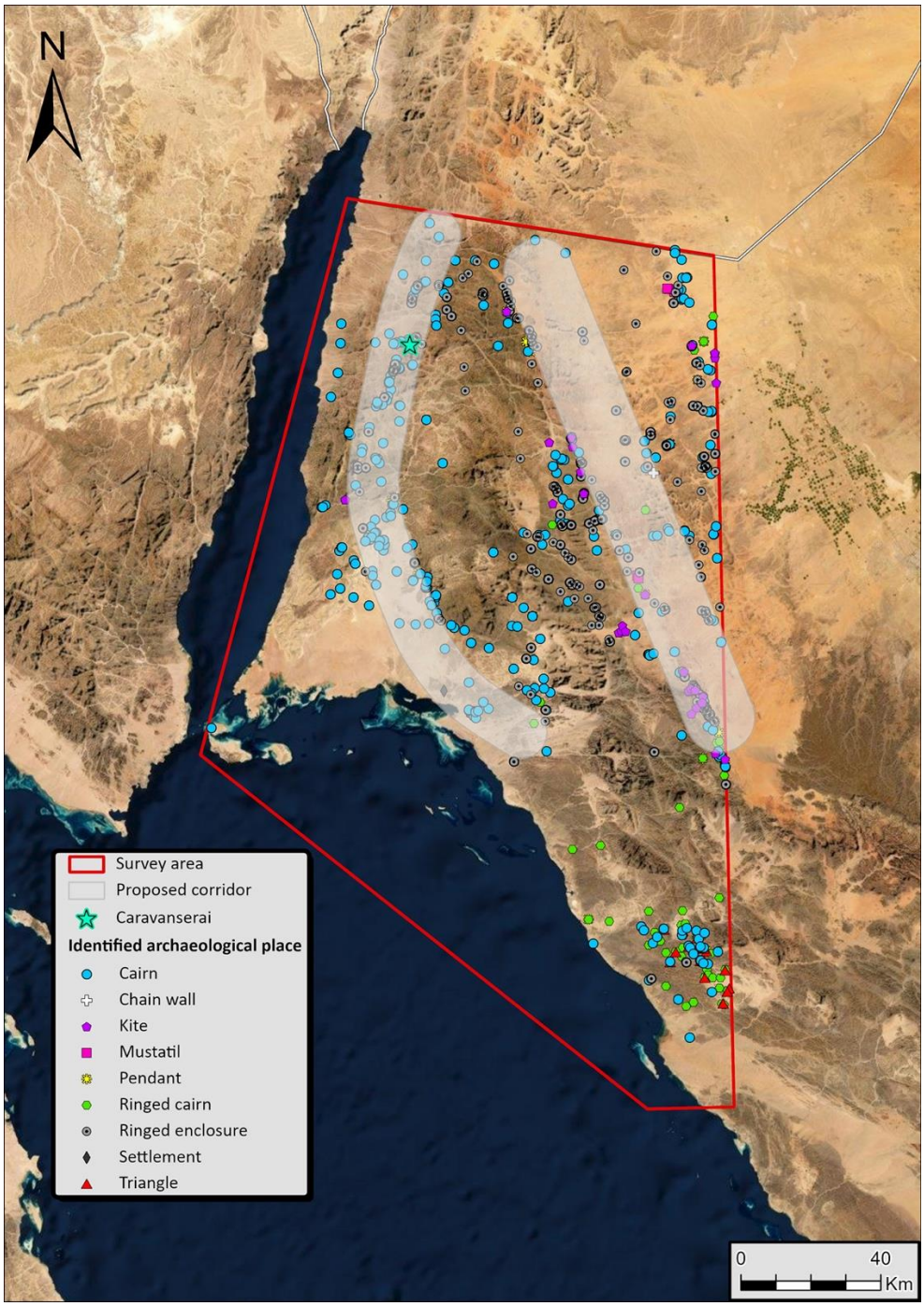

Figure 7. The east and west site 'corridors'.

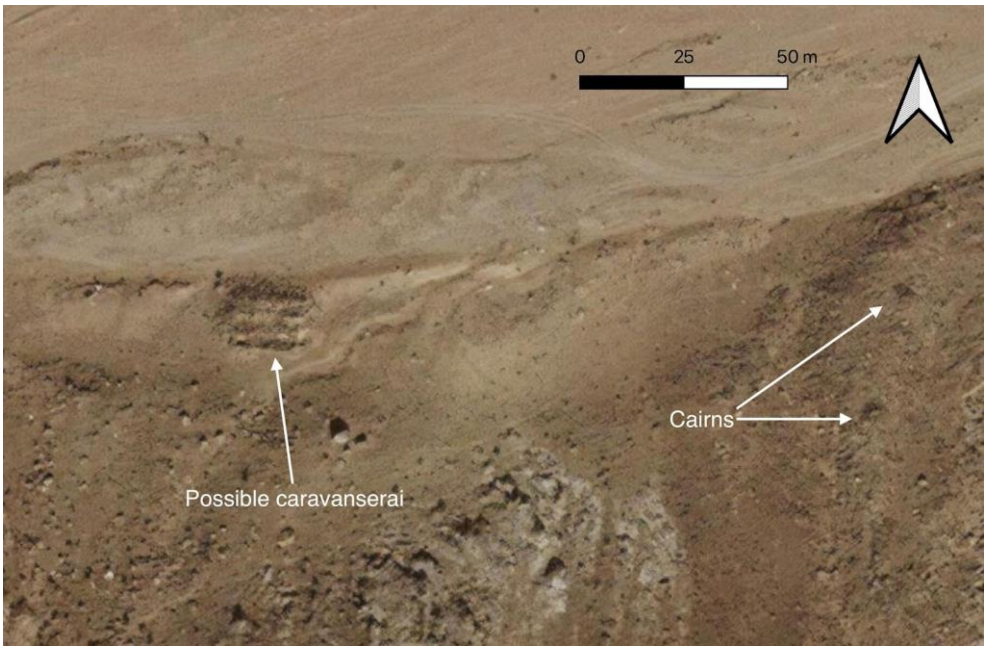

Figure 8. Satellite image of possible caravanserai site and nearby cairns. Source: Google Earth.

4. Discussion

At a broad level, the results of this remote sensing survey demonstrate a relatively clear linear patterning of data on several variations of north–south alignments. In the eastern section of the survey area, there is a concentration of sites along the flanks of the broken Umm Sahm sandstone formations on a broad NNW–SSE alignment, connecting the southern Levant to western Arabia. Further west into the granite mountains is a second alignment of sites running through the mountains on a NNE–SSW alignment, fanning out across the coastal zone and connecting it again to the southern Levant in the north. It should be noted that these two distinct distributions are not absolute and there is some deviation, including a distinct concentration of sites running north through the mountains from the coastal zone to the eastern 'corridor', while the two corridors converge at their northern end close to the modern Jordanian border.

The structures recorded are predominantly made up of basic stone enclosures, possibly corrals for small-scale pastoralism and various cairn form structures that may have had multiple functions in demarcating, controlling and signposting the landscape. That few of the structures identified could be interpreted as clear evidence of permanent settlement, that is with clusters of household-scale units, is suggestive that this was a landscape of movement between north and south where we have a range of evidence of territoriality in the form of cairn monuments but little evidence of fixed occupation. It is only possible to tentatively make this interpretation based on this remote sensing derived dataset and only possible to speculate on its links to nomadic or sedentary pastoralism, or longer-scale movement related to trade, this broad understanding places this landscape within the sphere of existing studies of pastoralism in the Near East [29] and broader understandings of the archaeology of movement [30].

4.1. A Pre-Islamic Caravanserai?

Supporting this perception of the project area being a landscape of movement is the general absence of clear settlement evidence across the survey area. The only identifiable structural settlements were recorded in the south-western area in the coastal zone, consisting of the multi-period settlement focus at Madian, the settlement complexes at al Khurayba and the smaller morphologically comparable complex east of Sharma. These sites have been subject to a relatively detailed level of study [19–21,23], but a possible

addition and an exception to this coastal focus is the large structure identified in a remote location 50 km north of Madian.

A notable exception is the identification of a single large rectangular structure in the north-western section of the survey area (Figure 8). In terms of the visible ground plan a comparison can be drawn between this structure and what has been interpreted as a caravanserai at the site of Kh. el-Khalade in southern Jordan. The latter structure measures approximately 32 m by 22 m, with internal rooms surrounding a small internal courtyard and is located a short distance from a larger fort structure and a series of cisterns [31]. The site is associated with evidence of Nabataean and Roman occupation, situated alongside the Via Nova Traiana and believed to be the documented site of a Praesidium, although there is no definitive evidence on whether either fort or caravanserai originated in the Nabataean period, or whether the interpretation as a caravanserai is correct. The term praesidium is understood to be a broader regional term for a military police post [32].

However, the broad interpretation of the smaller structure at Kh. el-Khalade as some form of roadside station could also be conjectured for the similar site recorded in the Neom zone. We can infer that this structure also consisted of eight small rooms surrounding a small, central courtyard. It also potentially situates the site chronologically within periods of possible Nabataean or Roman activity. However, an early Islamic date cannot be discounted completely and fits within the wider conjecture of Juchniewicz [21] of a watering station at modern al Sharaf, 10 km south-west of the possible station on a route leading north to Aqaba and long-distance routes such as the road later formalised as the *Via Nova Traiana* [33], although there is no evidence of an ancient surfaced road in the current survey area and the wider distribution of sites would support a view that there was not a single, defined route of movement through this landscape. In spite of the station being located so remotely, there is no evidence of the associated fort as has been recorded at Kh. el-Khalade.

In terms of its wider landscape, this possible station is located along the eastern alignments of structures, principally made up of cairns and ringed enclosures, with at least one cairn identifiable 150 m east of the station. This would seem to support the suggestion of a land-based trade route running parallel to the Gulf of Aqaba, with the station operating as some form of caravanserai along that route, potentially connected to overland routes linked to the South Arabian incense trade, or even a stage in a longer maritime connection to the Indian Ocean. While it is difficult to assign a basic cairn structure and the ringed enclosures identified in this study to a defined chronological period, it seems probable that the latter at least, and possibly both structural forms would pre-date the Nabataean/Roman date inferred for the station. The implication is that this station may have been, perhaps unsurprisingly, situated within a long-established prehistoric route although the absence of pendants and only a single ringed tomb that may more convincingly be dated to the Bronze Age [24,34] limits how assertively this argument can be made. That this route may have been so potentially long-lived also supports the perception that the Gulf of Aqaba was a difficult navigational option for maritime traffic across history and a land-based route was deemed more viable [21]. While the dispersal of cairns and enclosures would suggest that routes were moving north towards Aqaba and south toward Madian and al Khurayba, a small number of cairns located along Wadi Tayyib al Ism may suggest a minor branch route leading to a small bay opening out onto the Gulf of Aqaba.

4.2. Landscapes of Movement

The emphasis on movement is a dominant factor across much of the survey area and the wider datasets encourage the concept that any possible pre-Islamic trade route was formed along the line of long-established routes through the survey area, although this is likely to have always been less relevant than mobile pastoralism in terms of the archaeological record of these areas. There is little clear evidence of permanent settlement outside of the coastal zone to the south-west, or the developed settlement and agricultural systems recorded to the east of the survey area at Qurayyah [16,17], as well as the ancient sites of Tayma and Hegra further to the south-east. However, this should not be taken

as evidence that this landscape was therefore peripheral as the density and diversity of sites recorded suggest a rich and potentially contested region, particularly when compared, for instance with the relatively empty regions east of the Tabuk corridor. While this would appear to be a landscape primarily occupied by pastoralists and also possibly those involved in long-distance trade overland via the South Arabian incense trade or even the Indian Ocean maritime routes, there was significant investment in monuments particularly of a funerary or memorial nature expressing and inscribing notions such as place, control and ancestry across this region.

The activities of pastoralism in the region are probably most clearly represented by the presence of sub-circular and irregular stone-walled enclosures identified across much of the survey area. It is possible that such features have been built and used from prehistory through to the 20th century. In most cases these features were recorded as single enclosures or in small, clustered groups of two to five at the base of hills and steep-sided plateaus, suggestive of small-scale pastoral activity. It is potentially relevant that many of the larger, more complex clusters of enclosures were identified in the vicinity of two possible mustatil structures on the western side of the Umm Sahm and Ram sandstone band which while topographically and geologically indistinct, may have been the foci of more intense activity in the past.

The presence of V-shaped kites of the Sinai-Negev tradition running along both east and west sides of the band of Umm Sahm and Ram sandstone would suggest the localised exploitation of wild game. These simple structures, understood to have been used to lead game such as gazelle into a trapping or killing area were mainly found on the lower slopes of mountains. Chronological dating of this kite form remains problematic and while a broad phase of use from the 5th–3rd millennium BCE has been proposed based on fieldwork in the Negev [35], further dating samples are required to support this understanding. While the new dataset recorded in the present survey cannot add anything to that discussion, even in terms of relative chronology, it has provided a geographical link between known distributions in the southern Levant and those recorded more recently further to the south-east in western Saudi Arabia [36,37].

The two broad alignments of site distributions were also found to include a range of cairn-form structures, which are likely to have performed a funerary or memorial function and may be related to pastoral or trading communities. Topographically these structures were often built in prominent locations around hilltops and visible slopes, suggesting that they were intended to operate as highly visual locales. The most common morphology recorded were basic, circular stone cairns, distributed across much of the survey area. These structures are also difficult to define in terms of chronological period and could potentially have been built or actively re-used at any stage from the neolithic through to the pre-Islamic [28,38]. A far lower number of pendants and ringed cairns were recorded across the survey area, while a large concentration of ringed cairns in association with triangular enclosures is discussed in more detail below. Excavation of pendants and ringed cairns elsewhere has indicated a more probable Bronze Age period date of construction for these monuments [13].

Far more distinct within the survey area was the identification of large numbers of what are termed here, albeit blandly, 'ringed enclosures' (Figures 9 and 10). While the larger form of this site type is found outside of the survey area, particularly to the south-east, it appears that nowhere else are they found at the scale and in such large clusters as recorded in the current survey. At this stage, it is only possible to speculate on the function of these sites. The majority are located on bare hillslopes and the contrast with the scale of probable livestock corrals identified elsewhere would support an argument that these structures were not used simply for holding small livestock herds. The recurring addition of a single cairn or comparable structure and the high visible locations would suggest that the function may be linked to the probable funerary or memorial role of cairn-form structures recorded elsewhere in the landscape. It is possible that they acted as some form of formal gathering point, although this would not explain why some occur in large clustered groups. However,

the scale and number of these structures is clearly the result of significant communal investment. Chronologically it can only be inferred that the presence of cairns and the relatively amorphous shape of the large enclosures suggests that they are likely to belong broadly to prehistoric periods of activity in this region. At this stage only field investigation will improve understanding of these culturally distinct structures and potentially explain why this region was the centre of their regional distribution.

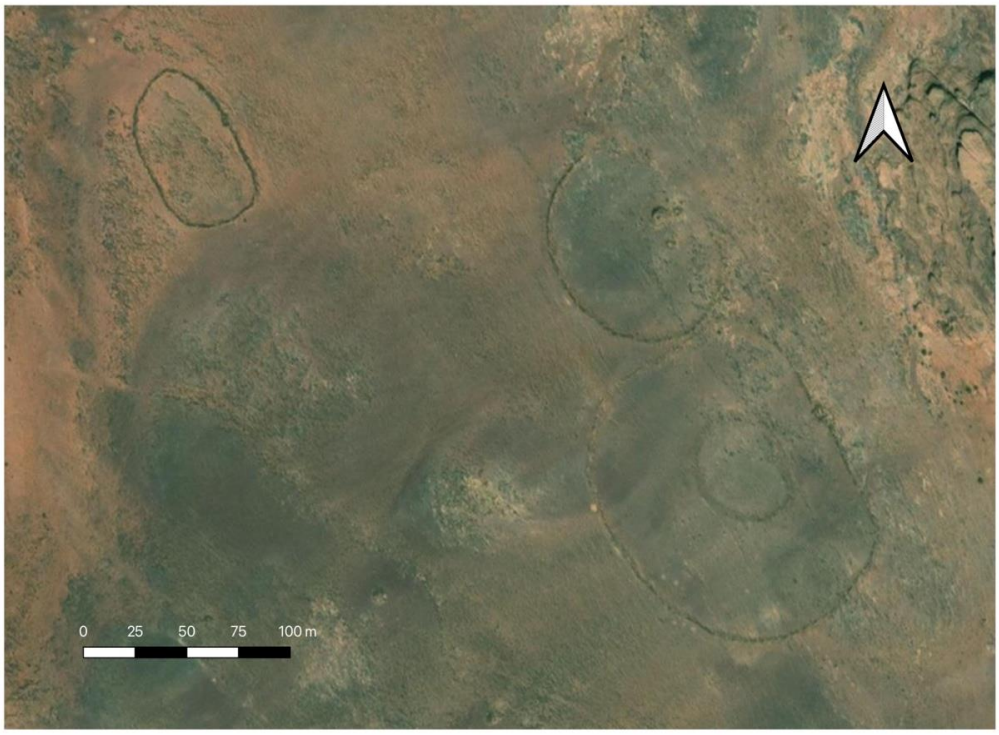

Figure 9. A cluster of 'ringed enclosure' structures. Source: Google Earth.

These various site forms suggest a range of cultural periods and functional uses, while their broad distribution across two linear corridors running from north to south would seem to attest to the long-term relevance of these land routes connecting the Levant and the Arabian Peninsula. More specifically, they appear to connect Aqaba and the region around Wadi Rum to both the northern Red Sea coast and the area around Harrat ar Rahah to the south-east. It is also notable that both of these corridors do not appear to be a single route through a landscape, but highlight a range of activity spread across a number of possible routes through a range of wadi systems and broken plateau landscapes.

4.3. Cultural Bounds

Although at a general level it is argued that this is a landscape of movement between north and south, there are a number of architectural types, primarily those more prevalent in the Arabian Peninsula, whose distribution appears to come largely to an end in the survey area and are not found currently in the Levant. For instance, the ringed-enclosure form of monument discussed in this paper, particularly in their larger, clustered form seem to be a regionally distinct morphology. Sample survey of the area north of the Jordanian border identified two small, isolated ringed-enclosures in the area between Rashidiyah and Tutun which would support the suggestion that this monumental form peters out to the north. Comparable sampling of the areas to the south and east of the survey area suggests that these monuments are still found in areas to the south-east and that examples are still found in the sandstone plateau's of Khaybar, although not clearly on the same scale as such notable clustered groups. At present, the highest concentration, by some distance, of ringed-enclosures is found in the current survey area.

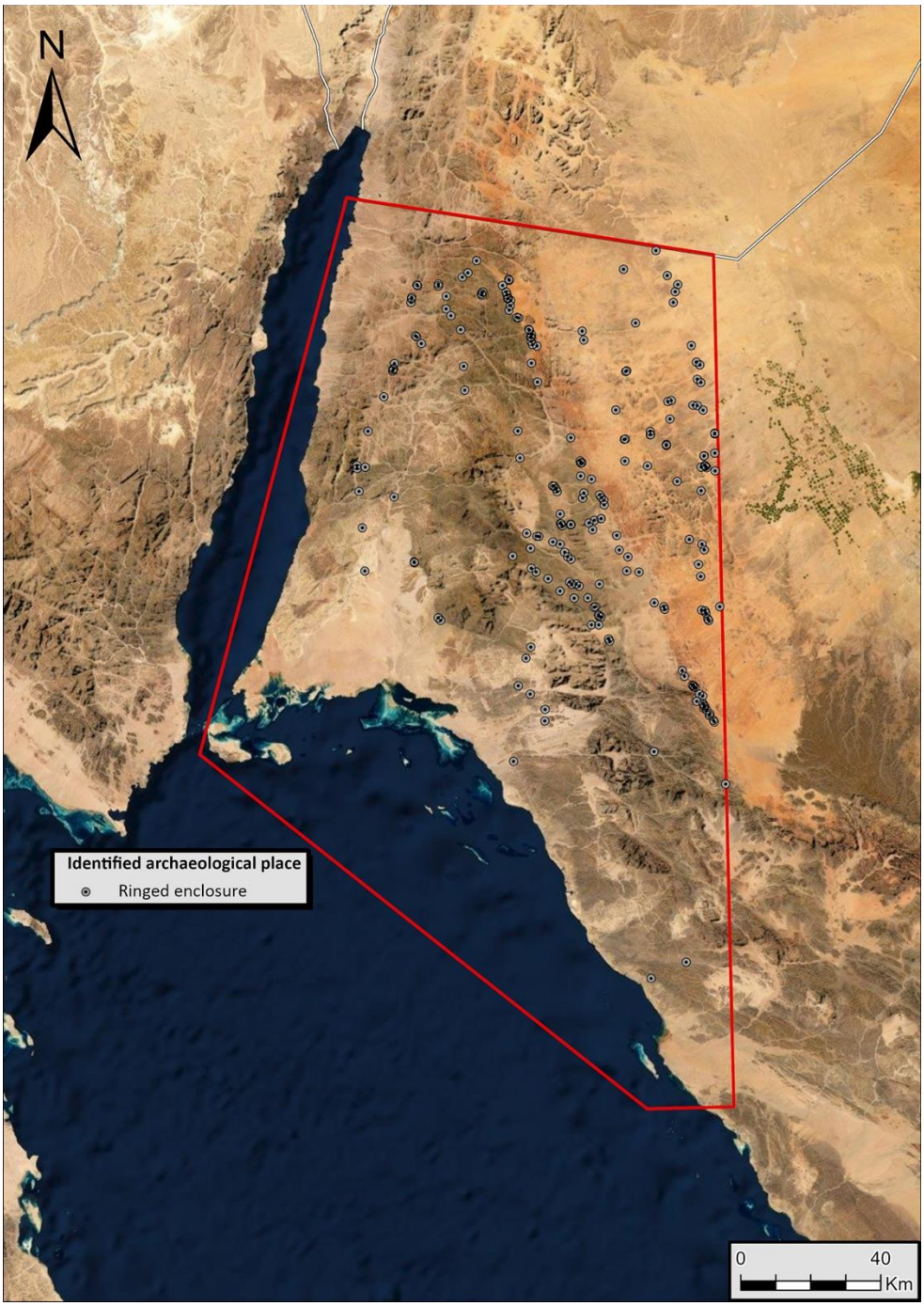

Figure 10. Distribution of 'ringed enclosure' structures.

Another even more distinct geographical limit can be seen in the distribution of triangular enclosures in association with ringed cairns (Figure 11). These are only found in the southernmost section of the survey area, where they occur in a relatively large cluster, but no examples were recorded further north. Ringed cairns without triangular enclosures and pendants are found across other parts of the survey area, although in relatively low densities compared to areas of Saudi Arabia to the south and east. Sample survey of areas to the east of the survey area would seem to confirm that the extent of triangular enclosures is limited to the extent identified at the southern end of the current survey area and from there south of a line heading north-west toward the city of Tabuk.

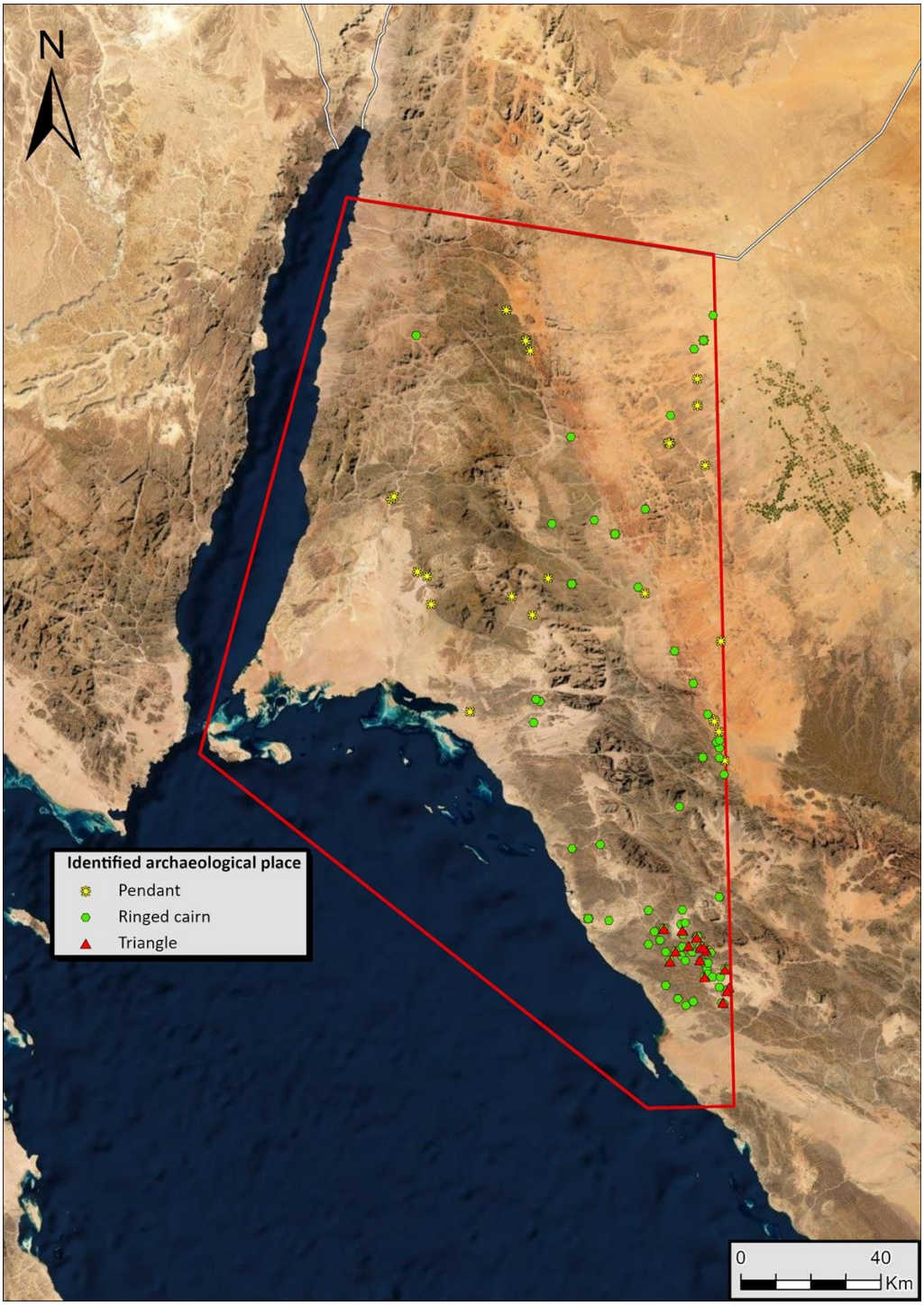

Figure 11. Distribution of ringed cairns, triangles and pendants.

Finally, the two possible mustatil structures represent the most north-westerly examples of these in the Arabian Peninsula (Figure 4). Excavations of mustatil structures south of the Nafud desert have produced late Neolithic dates in the late sixth or early fifth millennium BCE [12,28]. While the exact function of the mustatil monuments remains unclear, they were a significant form of monumental expression in central Arabia during the later Neolithic. These potential outliers on the edge of the monument's overall distribution offer an interesting opportunity to investigate these features on the edge of the Levant.

4.4. Predicting the Impact of the Neom Development

The construction of urban infrastructure and other planned developments for Neom will no doubt have a significant impact on the archaeological sites discussed in this paper (Figure 11). The limited availability of detailed plans for the city makes it difficult to investigate which sites may be at most risk. However, several low-resolution plans for the city are available, making it possible to predict likely areas of impact. According to the Regional Structure Plan (https://Neom.resortx.com/Neom-saudi-arabia/?page=7 (accessed on 13 July 2022)), construction will be concentrated on areas along the coast, with the central core of the city in the southwest of Tabuk. The Line, a 170 km linear city running from the Red Sea to the Hejaz Mountain range in northwest Saudi Arabia, will also be a significant element of the megacity.

The areas of disturbance in the figures below are projected according to the Regional Structure Plan and information published on the Neom website. Areas of urban development and the footprint of the Line were identified as areas of high disturbance and the surrounding "urban growth" areas were identified as areas of medium disturbance. It can be expected that the construction of major urban infrastructure, including an underground rail network, will result in significant impact to the landscape and any archaeological places within it. A 10 km buffer around the footprint of the Line has also been included, as significant disturbance to the surrounding landscape can be expected during the construction of the Line. Due to the small-scale and visibly insubstantial nature of many of the sites identified, it is likely that unless heritage management plans are in place any archaeological sites within these areas will be severely damaged or destroyed during construction. On the basis of the dataset presented in this paper, the potential caravanserai and the clusters of large ringed enclosures are sites that warrant preservation and further investigation on the ground. The ringed cairn/triangle combinations and possible mustatil are also worth consideration in this group as the most northerly-identified features of these site types, at an interface between the Arabian Peninsula and the southern Levant.

Two relatively intact archaeological landscapes consisting of dense concentrations of archaeological sites have been identified along the Line and are at particular risk of demolition. In the southwest of Neom, including the core city on the coast, over 80 cairns, 10 ringed enclosures, four pendants, three settlements and two ringed tombs are located within the predicted high and medium areas of disturbance. Similarly, in the southeast of Neom over 20 cairns, 18 ringed enclosures, 11 kites, three pendants and two ringed tombs, are located within 10 km of the Line. The high number of the "ringed enclosures" within this area of impact is a concern for future investigation of this newly identified site type.

The construction plans for the areas surrounding the city core area of Neom are less clear(Figure 12). The inland areas of the region have been reserved for agricultural or biodiversity development. The impact of this kind of development will likely be less than that of the construction of urban infrastructure. However, the development of agricultural land would still likely require significant land clearing, leading to possible damage or destruction of archaeological sites.

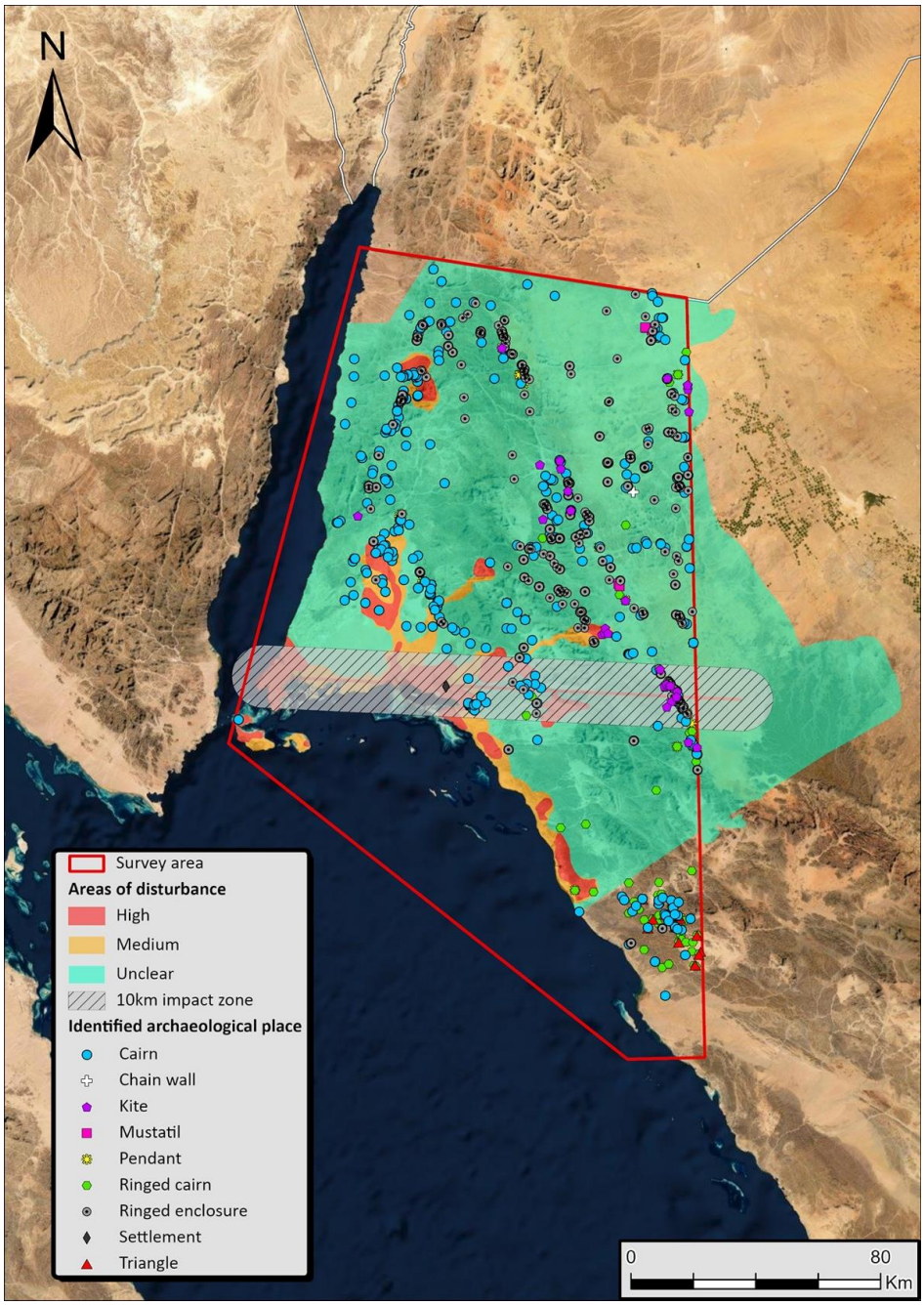

Figure 12. Neom development impact overlaying the distribution of main site types recorded. A 10 km buffer zone has been added to the Line development.

5. Conclusions

The remote sensing survey across the Neom impact zone has produced a broad understanding of a rich archaeological landscape. The principal benefit of this method is that it provides an overview of the region beyond the capacity of more detailed, but geographically restricted, ground surveys. This landscape is tentatively interpreted as one of movement and mobility, driven mainly by nomadic pastoralism but also affected to a lesser extent by the development of long-distance trade routes, with sites mainly distributed along two distinct north–south corridors and with little evidence of permanent settlement or cultivation outside of the southern coastal zone. However, this does not mean that the sites recorded should be dismissed as peripheral, but rather as important nodes along these long-lived communication routes. The presence of a possible caravanserai is a particularly

distinct element and the abundance of ringed-enclosures is a significant aspect requiring more detailed field investigation and preservation as part of the Neom development. This landscape also sits at the border of different cultural manifestations, as visible in the wider distribution limits of mustatil and ringed cairn/triangular enclosure pairs recorded in the survey area. As such, the corridors identified are a record of long-distance connectivity between and through such regionally distinct provinces.

While it is certain that more detailed survey will reveal further archaeological sites particularly non-architectural sites that are not easily identified via satellite remote sensing, this dataset has provided an opportunity to assess the impact of the Neom development based on the provisional visualisations of the new city and its hinterland. While acknowledging that the planned development may change or be mitigated during the construction phase it is clear that Neom's impact on the heritage environment will be significant. The protection, study and access to heritage sites across the survey area may spare those sites that are deemed to have the necessary value to warrant protection, there is however a risk that the process would break up the historic links across the landscape and elements dismissed as 'minor' could be lost without more detailed study. It is hoped that this survey supports the development of a more robust understanding of this landscape before the irreversible impact of the Neom development takes effect.

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