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Archaeological research in Lebanon often focuses on settlement from the Bronze Age to Roman periods, while surrounding landscapes, earlier and later periods are under-represented. Large datasets collecting information from all periods and site types, such as the Endangered Archaeology in the Middle East and North Africa (EAMENA) database, address this imbalance. EAMENA predominantly uses satellite imagery to identify archaeological sites and the threats posed to them, leading to the recognition of many previously unpublished sites, including abandoned buildings and agricultural terraces. Here we explore how such data can be used to trace patterns of settlement and landscape use. Transects running from coast to uplands in northern and southern Lebanon are compared: the results show profound differences between north and south, and between coastal and inland zones. The importance of large, holistic datasets for previously understudied site types and periods in piecing together past patterns of land use, subsistence economies, burial traditions and change over time are demonstrated.

Keywords Lebanon, remote sensing, heritage database, landscape archaeology

Introduction

As is common in the archaeology of southwest Asia, archaeological research in Lebanon has often focused on settlement sites dating from the Bronze Age to the Roman periods. In contrast, the surrounding landscapes, as well as earlier and later periods, remain under-represented. Pioneering work by researchers such as Copeland and Wescombe (1965; 1966) in the 1960s and, more recently, by Copeland *et al.* (Copeland and Yazbeck 2002; Garrard and Yazbeck 2008; Yazbeck 2004) on prehistoric sites helped to address this imbalance; yet much of the work carried out in Lebanon since the 1990s has still largely been focused on the excavation of settlement locales and sites dating to the post-Neolithic to Antique periods. These disparities are now being addressed by a variety of new field surveys in the region, which are documenting multi-period landscapes and features (e.g. Bradbury *et al.* in press; McPhillips *et al.* in press; Ten Harkel *et al.* 2019). Large datasets collecting information from all periods and site types, such as the Endangered Archaeology in the Middle East and North Africa (EAMENA) database, can also help to fill in the remaining gaps and allow researchers to identify large-scale patterns and distributions which, in turn, open up new research questions and agendas.

As discussed in more detail by Ten Harkel *et al.* (forthcoming), the EAMENA project mainly uses satellite imagery to identify previously undocumented archaeological sites, which has led to the recognition of large numbers of unpublished (potential) sites in the MENA region. This evidence is integrated with aerial photographs and published data, for example from ground surveys. Satellite imagery is also used to assess the sites for their archaeology and condition (disturbances and threats), and all information is recorded in an Arches database (database.eamena.org; eamena.org/database; Ten Harkel and Fisher forthcoming). The main aim of the EAMENA project is to aid in recording and

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mitigating threats to archaeological sites across the MENA region. The database, however, also contains a wealth of data which are useful for archaeological research. Moreover, as the database has been designed and implemented by academic researchers, in collaboration with heritage practitioners and stakeholders from the MENA region (e.g. Mubaideen *et al.* forthcoming), both the heritage management and the archaeological research angles have been important factors for the EAMENA project and its database development.

The aim of this paper is two-fold. Firstly, to test the use of large heritage management datasets, specifically the EAMENA database, for research purposes. Specifically, the usefulness of data collected predominantly from satellite imagery, without adding detailed information that would not normally be an integral part of the EAMENA workflow is tested. The questions asked are: 1) Can the data be used to test existing hypotheses? 2) Can new research avenues be identified? and 3) what are the limitations of a dataset (largely) derived from satellite imagery analysis?

The second aim is to increase knowledge of Lebanese archaeology, specifically addressing questions about site types, settlement patterns, and landscapes in under-represented periods and regions. Can a basic spatial analysis of archaeological sites, alongside additional landscape data, add to the current understanding of this region? The focus on Lebanon arises from the authors' own research interests, but also from the fact that the region shows great potential for this kind of spatial analysis, in part due to the very different environments, its variable climate, and differences in land use over relatively short distances. In this context, the following questions are asked:

1) Are there differences in site type and site density between different environmental zones? Patterns of current land use, differences in precipitation, and differences in terrain can reflect that different areas were used differently in the past, but this has not yet been widely tested in Lebanon. The coastal zone is compared with the hills and the mountains.
2) Is there a difference between the north and south of the country? This is related to the first question, as the environment in the south differs from that in the north. The history of research is also different between the areas; it will be interesting to see if an apparent difference in archaeology is likely to be related to physical or cultural factors, or is (partly) caused by a research bias — for example an accessibility bias, potentially remedied through the application of remote sensing.
3) From a heritage perspective, what is the condition of the sites, and are there differences between different environmental areas and between north and south? How might these differences relate to human-driven processes?

Methods

Study area

Covering an area of just under 11,000 km^2, Lebanon is composed of four broad topographical units, two of which are part of the study area. The first, a narrow coastal strip less than a kilometre wide in places, reaches its widest point near Tripoli (*c.* 15 km), in the north of Lebanon. Beyond this zone, to the east, lie mid-high mountain ranges, whose elevation increases steeply, especially in the north, where peaks of >3000 m exist (e.g. Qornet es-Sawda). In the south this increase in elevation is more gentle; from a narrow coastal plain, to hills further inland (Fig. 1a). Beyond these areas (and excluded from this study), elevation drops as you move eastwards into the Bekaa Valley before rising again into the Anti-Lebanon mountain range (FAO 2008: 1). Lebanon is characterized by a Mediterranean climate, with almost all precipitation falling during the mild winter months. Modern temperature and precipitation values vary between micro-regions (e.g. see Marfoe 1979: 3 for the Bekaa), although precipitation is, on average, *c.* 700–1000 mm per annum near the coast and increases to as much as 2000 mm in the mountains in the north (Fig. 1b).

This paper focuses on several environmental coast–inland transects, from the coastal strip in the west to the first mountain range in the east, both in the north and south of Lebanon (Fig. 1; Table 1; Supplementary Material Table S2; Supplementary Fig. S1). In the north this includes multiple environmental zones from coast, to hills, to high mountains; in the south the landscape changes less dramatically as the elevation only reaches around 800 m asl. Our study area covers the coastal strip (north and south), the northern central mountains, and the slopes and uplands south of the Nahr al-Litani (South Lebanon and Nabatiyya districts). In the north, we are covering areas with higher elevation and (partly because of that) higher rainfall than the south, although the whole study area is well above the minimum requirement of *c.* 300 mm mean annual precipitation for cereals (Fig. 1).

In the south we have analysed two EAMENA grid squares (see Fradley *et al.* forthcoming for an

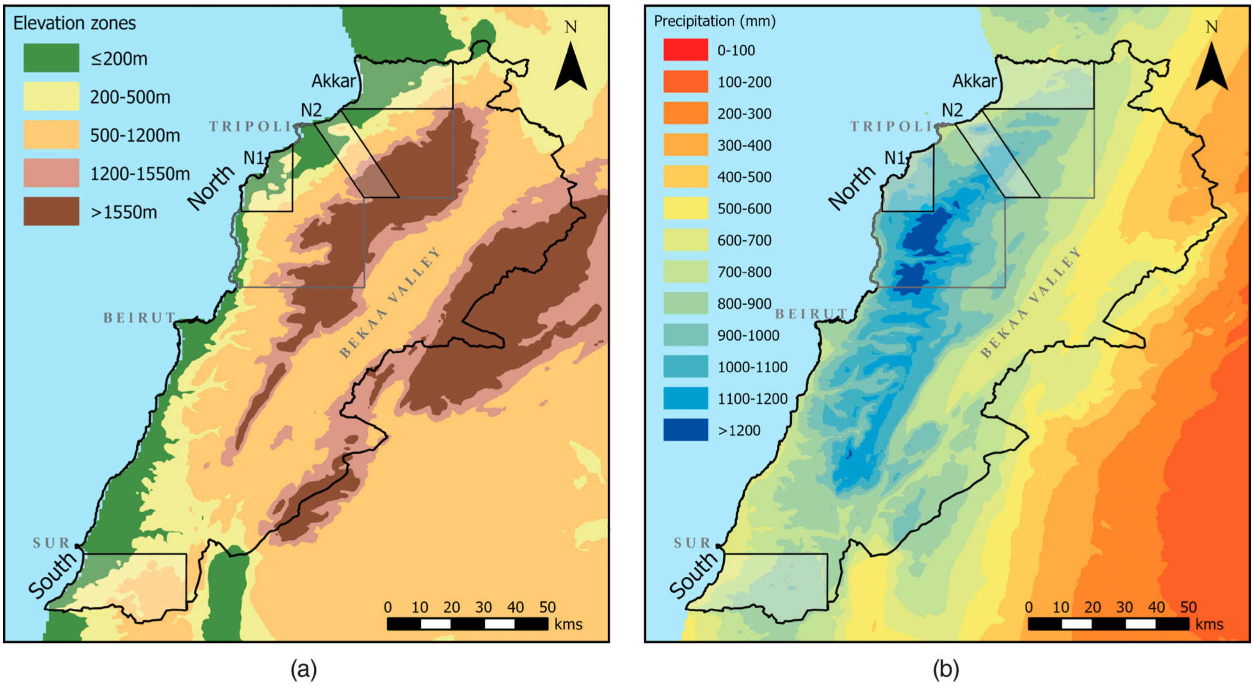

Figure 1 Lebanon, the north and south study region (grey lines), and transects 'N1', 'N2', and 'Akkar' in the north (black line) with a) elevation zones in m asl (colours correspond to coast, hills, mountains, and above the treeline, respectively) (data from DIVA GIS), and b) annual precipitation in mm (data from WorldClim 2.0). For additional places mentioned in the text, see Fig. 3 and Supplementary Fig. S1.

Table 1 Analysed area and potential heritage places for each grid square (wider study region) and transect (detailed analysis subset)

EAMENA-grid number	Land area in Lebanon (km^2)	Google Earth survey	Archaeological assessment[1]	Condition assessment[2]
E35N33–11	127	88	88	88
E35N33–12	433	293	290	293
E35N34–21	284	531	99	98
E35N34–22	640	379	379	13
E35N34–23	71	228	228	228
E35N34–24	523	733	352	338
E36N34–13	638	309	47	46
E35N34–42	29	13	13	13
E36N34–31	340	175	175	175
Total	3085	2745 (some sites in two grid squares)	1667	1288
Selected transect subsets for full analysis				
South transect	560	381	378	381
Transect N1	196	414	414	393
Transect N2	227	214	200	194
Akkar transect	369	188	188	188

[1]The presence of an archaeological assessment was based on the database field for interpretation.
[2]The presence of a condition assessment was based on the database field for overall condition.

explanation of grid squares), equating to one transect, containing around 380 potential 'sites'. Both the forms and archaeological interpretations, as well as the condition of potential archaeological features were recorded for all these locations. In the north, a larger area of seven EAMENA grid squares was analysed for the presence of archaeological remains. As this area was very large, a subset of three coast–mountain transects with in total 816 potential sites was analysed in the same detail as the southern study area (Table 1; Fig. 1). This divergence between north and south was, in part, due to the more varied landscape regions covered in the northern sector of the study, as well as the fact that some of this digitization was carried out in preparation for a field survey in the region (see the 'data collection' section for further discussion). The study was carried out by the EAMENA Oxford team and does not include any data collected by Lebanese (or other) trainees during the EAMENA training programme (see Ten Harkel *et al.* forthcoming for an explanation of this training programme).

Data collection

The whole study area was systematically surveyed for potential archaeological remains using Google Earth Pro. DigitalGlobe (Maxar Technologies) and CNES Astrium imagery of multiple, sometimes dozens of, different dates was available, ranging from 2003 to 2019, with a relatively high resolution (up to 0.3 m). Site identification was supplemented by using overview publications and toponyms from historical maps and site gazetteers (e.g. Crowley 2016; Lehmann 2002; Marfoe 1978; Skeels and Skeels 2001), as well as, where available, information from published ground surveys and excavations (e.g. Bartl 1998; 2002; Copeland and Wescombe 1965; 1966; Copeland and Yazbeck 2002; Garrard and Yazbeck 2008; Thalmann 2006). During the data entry phase, the information was 'homogenized', i.e. everything was 'translated' into the controlled vocabulary of the EAMENA database. Whilst in some cases this reduces the level of detail for any given location, importantly, it allows the data to be comparable (for further details see Rayne *et al.* 2017: 8).

Following initial site identification, satellite imagery, alongside any published data, was again used for the archaeological and condition assessment of the potential heritage places. The use of remote sensing to identify and assess archaeological sites has now become a well-tested approach for the MENA region (e.g. Casana and Laugier 2017; Deadman and Al-Jahwari 2016; Hritz 2014; Kennedy and Bishop 2011; Menze and Ur 2012; Philip *et al.* 2002; also see Wilkinson 2003: 33–37 on the limited use of this prior to the 2000s). While this is much quicker than visiting these places on the ground, the process is nonetheless time-consuming, and thus data collection is ongoing (compare the numbers of Google Earth pins with the numbers of archaeological and condition assessments in Table 1). For the south and all three north transects, full analysis was, however, completed. This paper therefore, presents basic data for the whole study region, alongside a fuller analysis of a representative subset of data (south study area and three transects in the north study area). Each transect (subset) was selected to encompass areas from coast to inland (thus covering the main environmental/climatic/topographic zones of interest) as well as equal areas in the north and south. In order to test whether the chosen transects could be used as representative samples for large extrapolations, additional data from outside the transects was added to the database, with these datasets then confirming the existing patterns and making no significant changes to the outcome of the comparative analyses. The numbers used in this study are from datasets available in the database on 1 May 2020; with data entry ongoing, the total number of records, as well as the number of enhanced records, will continue to increase.

The integration of information from publications and ground surveys is essential (and a well-accepted methodology) for assessing the success rate of remote sensing surveys (e.g. Congalton and Green 2008; Rayne *et al.* 2017) and to fill in information which is not usually derivable from satellite imagery, such as the dating of the sites: it is worth noting that such information was available mainly for the northern area. The northernmost transect, covering the Akkar region, relied heavily on published surveys and even excavation data (e.g. Bartl 1998; Thalmann 2006). To the south of the Akkar (Batroun and Tripoli latitudes), analysis relied primarily on satellite data, but was supplemented by several published surveys and other publications (e.g. Copeland and Wescombe 1965). In contrast, in the southern area, travel and research have been restricted, with much fewer available and accessible legacy and published data. To allow a comparison between north and south without this potentially distorting factor, the location of one of the transects in the north was specifically selected for this study due to no survey or extensive publication data being available to the authors for the area (Transect N2: Fig. 1, Table 1).

Data collection and remote sensing analyses (potential site identification, archaeological assessment, and condition assessment), as well as data entry, were carried out for separate areas by the three authors, all of whom have experience of working on the ground in Lebanon. Cross comparisons were then made between the data entry standards in order to assess the robustness of using standardized vocabularies and methodologies, and to avoid differences resulting from different working practices or research backgrounds.

Analyses

After the remote sensing analyses of the identified potential sites were completed in the database, the

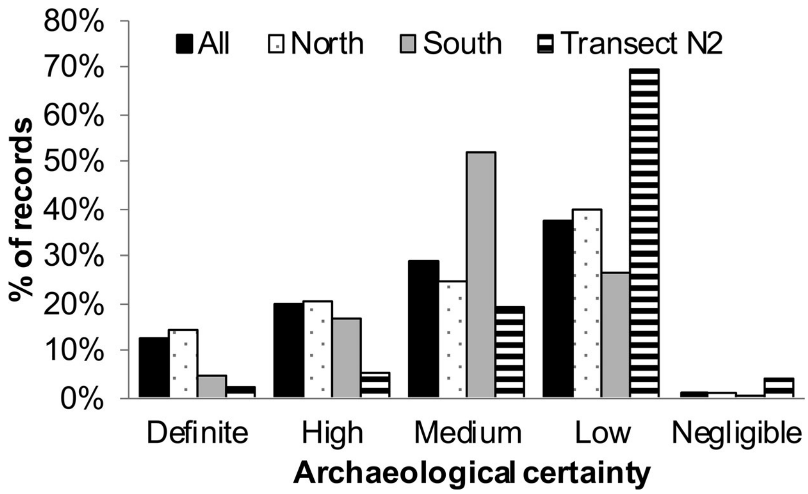

Figure 2 **Archaeological certainty of sites in the whole study area (black), the north (white and dotted), the south (grey), and, for comparative reasons, transect N2 (striped). The south and transect N2 are mostly based on remote sensing analysis.**

dataset was assessed for its quality (e.g. archaeological certainty). Subsequently, spatial comparisons were conducted using both the EAMENA database advanced search function and GIS (both QGIS and ArcGIS were used). Except for 'north' and 'south', analytical zones within each area were determined on the basis of elevation (derived from DIVA GIS (DIVA GIS 2020)). Precipitation, temperature, soils (i.e. erosion), water availability and land use/vegetation are all either affected by, or indirectly reflected in, changing elevation, at least within the current study area: for the purposes of this paper elevation is presented as a proxy for land use. It has the advantage that distance from the coast is also included into this one variable. The underlying analyses also directly considered precipitation (from Worldclim 2.0, Fick and Hijmans 2017) and land cover (ESA CCI Land Cover Project 2017) and we would recommend taking into account variables such as soil depth, slope, aspect, and so on, for any future, detailed work. The elevation bands used are <200 m asl for the coastal strip, 200–500 m asl for the foothills, 500–1200 m asl for the hills, 1200–1550 m asl for mountains below the tree line (north only), and >1550 m asl for mountains above the treeline (north only) (Fig. 1; Supplementary Material Table S2). Although these divisions are somewhat arbitrary, they generally correspond to different environmental and land use zones and combine the different factors mentioned above.

Results and interpretation

On 1 May 2020, there were 3571 Lebanese heritage places in the EAMENA database, 2745 of which fell within the study area (Table 1). Many of these were (potential) heritage sites, newly identified through remote sensing. All summary data presented below are available in the Supplementary Material.

Nature of the data

Archaeological certainty

An assessment was made of the archaeological certainty of 2313 of the identified potential sites in the wider study area. Following EAMENA terminology (see Ten Harkel *et al.* forthcoming; EAMENA project 2020; Supplementary Material Table S3), five levels of certainty, ranging from 'definite' (archaeological evidence observed on the ground, i.e. based on published resources) to 'negligible' (extremely uncertain) were used (see Rayne *et al.* 2017: fig. 5 for examples). A combination of remote sensing and published information was used to assess the likelihood of the remains being both human made/modified and dated to a period prior to the mid-20th century CE (the archaeological cut-off date used by the EAMENA project). Of these 2313 assessed sites, 292 had 'definite' certainty (13%), 453 'high' (20%), 672 'medium' (29%), 871 'low' (38%) and 25 'negligible' (1%) (Fig. 2; Supplementary Material Table S3). The high percentage of low certainties (39% 'negligible' or 'low') partly reflects the nature of remote sensing studies, in which it can be hard to be certain if remains were in use/constructed prior to 1950. For example, it might be very clear that there is an abandoned structure, but very hard to ascertain when it was constructed or abandoned. These wider patterns are comparable with results from the transect analysis. For example, the relatively low numbers of

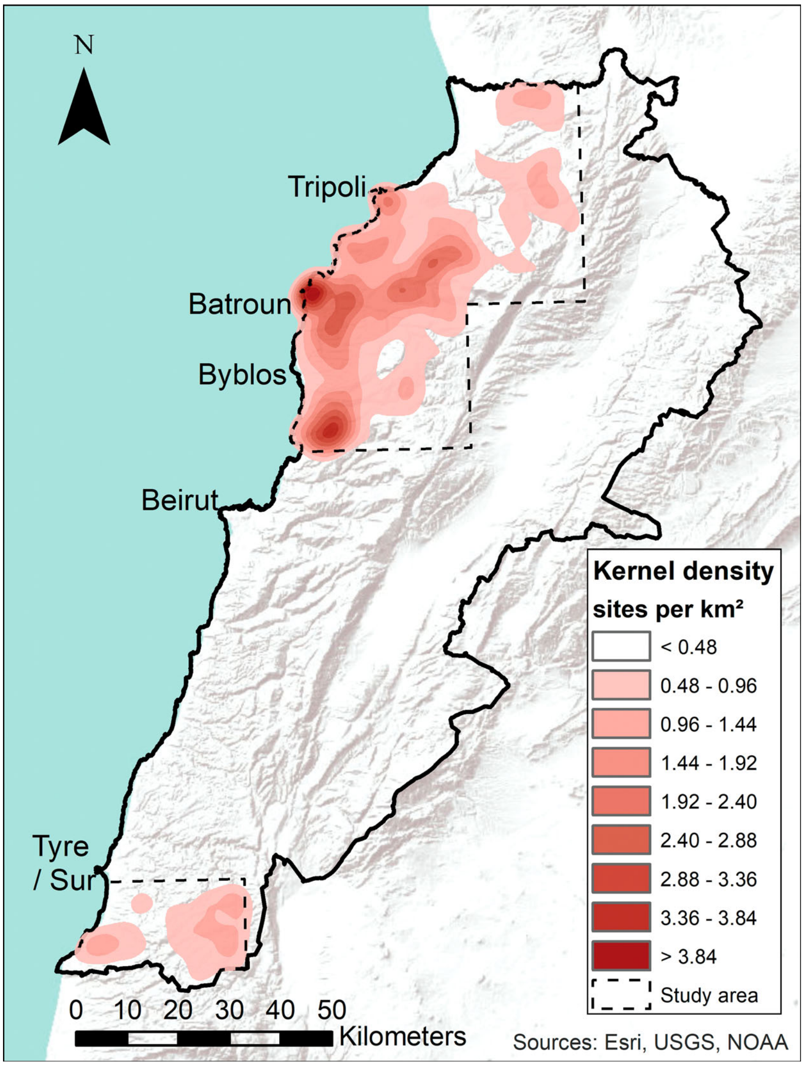

Figure 3 **Site density per km^2 for the whole study area (study area outline indicated, dashed line). Generated in ArcMap 10.8, using the kernel density function with a cell size of 100m.**

heritage places with ‘definite’ and ‘high’ certainties in the south, and especially within transect N2, reflect the fact that most of these records were based on remote sensing analyses (Fig. 2).

Cultural period

The difficulties of determining precise chronology from remote sensing also means that information on the cultural period of sites with a high(er) archaeological certainty is not available in the vast majority of cases. For 90% of heritage places the cultural period is ‘unknown’, while for only 10% it is ‘possibly’, ‘probably’, or ‘definitely’ known (Supplementary Material Table S4). This is comparable to the rest of the database, where 83% of heritage sites have a cultural period indication of ‘unknown’. Consequently, and because cultural period information is for a large part tied to ground survey and other published data, and therefore heavily skewed towards certain areas (e.g. Akkar), it is not useful to systematically compare site distribution by period for this paper.

For future research, systematic extrapolations based on known and ground-checked features may be possible (e.g. Lawrence *et al.* 2012: 354–55). For purposes of this paper, general inferences were made based on the morphology and associated (/proximate) dated remains. While all periods are represented, partly due to the inclusion of ground survey data including, for example, Palaeolithic and later prehistoric studies (e.g. Copeland and Westcombe 1965; Garrard and Yazbeck 2008), the dataset appears to contain mostly remains from the Chalcolithic and onwards (e.g. tell and other settlement sites). In particular, the study has recorded an abundance of sites and features probably dated to the Ottoman period and early 20th century CE, a subject which will be returned to later.

Site density

Looking closer at the data from the transect surveys, and as shown in Fig. 3, the distribution of heritage places is not even across the study area (see also Supplementary Material Tables S1 and S2). In some cases, the densest clusters are a consequence of these regions having been the subject of ongoing research projects, representing a research bias rather than an archaeological pattern (e.g. near Byblos and Batroun). Preservation also probably plays a role. For example, the site cluster in the hills south-east of Tripoli may actually reflect the long-term preservation of this landscape, with many regions being 'abandoned' during the late 19th and early 20th century CE through processes of de-ruralization and emigration (e.g. Tabar 2009: 4–5).

Conversely, some low-density areas on the map may actually have had higher numbers of sites. For example, coastal sites are less visible on the imagery due to ongoing modern development, as well as a continuity in occupation, i.e. many archaeological structures may still be in use (e.g. old houses with roofs are not clearly distinguishable as 'archaeology' on the imagery, whereas ruined houses are). Vegetation coverage can also distort potential patterns, and it is likely that in densely vegetated upland areas and river valleys, site densities are actually even higher than this study would suggest.

Other patterns are perhaps more intriguing. For example, despite being the focus of several excavations and surveys (e.g. Bartl 1998; Thalmann 2006), the density of potential archaeological sites in the Akkar region is relatively low and is specifically clustered within upland regions or areas set back from the coastal plain. This may, in part, be due to the way in which 'sites' have been categorized and counted in these areas. For example, during survey in this region Bartl (1998: 178) observed the large clusters of rock cut-tombs and necropoli recorded in the hilly regions to the south and east of the Akkar plain which, when found in isolation, would have been recorded as discrete sites.

Settlement, habitation and activity patterns

Site types

In the EAMENA database, site function (e.g. 'agricultural/pastoral', or 'religious'), interpretation (e.g. 'field system', or 'temple'), and feature forms (e.g. 'wall', or 'structure') are recorded using controlled vocabularies (Supplementary Material Tables S5–S7; EAMENA project 2020). Together, these form the database framework for the type of site being recorded. The most common site function in the study area is 'agricultural/pastoral', which in most cases reflects an agricultural rather than pastoral function (as is, for example, clear from the most common interpretation, which is 'field system'), although 'enclosures' for livestock are also common[3] (Figs 4–6). This is followed by 'domestic' (interpretations such as settlement and building). Conversely, 'funerary/memorial' remains only form 4% of the total, while this is 27% for the EAMENA database as a whole (see the discussion section).

While the overall pattern is similar between north and south, a clear difference is that in the south, as many as 75% of the sites are identified as 'agricultural/pastoral', while in the north the sites are more diverse in function and interpretation (Figs 4–5). Both in the north and south there is a clear relative increase in 'agricultural/pastoral' sites with increasing elevation, and an accompanying decrease in other site types (with the exception of 'domestic' sites in the north which are relatively stable except for being almost absent at very high altitudes) (Fig. 4b–c).

The prevalence of agricultural remains is partly a reflection of the larger space they cover and the way in which these features are recorded: for example, a village would be classed as a single heritage locale, whilst fields associated with this village, especially if dispersed, may be recorded as several different heritage places or 'sites'. It also reflects visibility and preservation. Terraced field systems, in particular, are easily identifiable on satellite imagery, while the recent, 20th-century CE abandonment of agricultural areas means that many of the remains are well-preserved and not yet fully overgrown by vegetation.

The differences between north and south, and between the coastal strip and other zones have multiple explanations. Firstly, the higher diversity of site types in the northern zone and especially in its coastal strip is probably partly a reflection of the higher reliance on publications and ground surveys. This is particularly clear when comparing the different northern transects: Transect N2, which, like the southern transect, relies almost solely on remote sensing analyses has a considerably higher percentage of 'agricultural/pastoral' sites than the north overall (66% compared to 41%), while the Akkar transect, where the 'enhanced' records are almost all based on publications, only had 5% (Supplementary Material Table S5). Secondly, the observed patterns are likely

[3]Note that the interpretation 'enclosure' is used for any structure that was unroofed; the combination of 'agricultural/pastoral' and 'enclosure' is often used for animal pens, but could also refer to, for example, a walled garden.

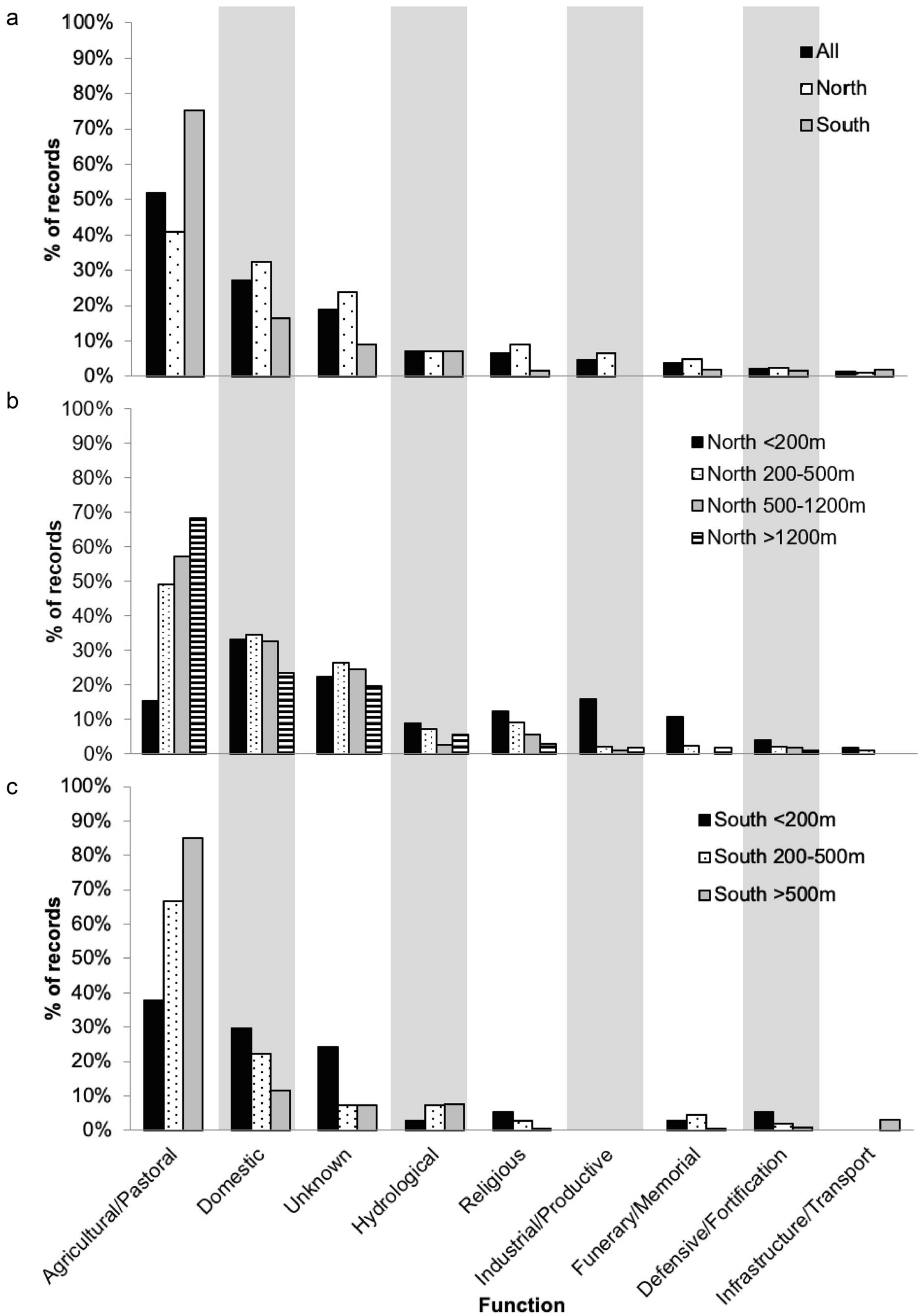

Figure 4 Site type defined by site function for the study area, a) comparing north and south, b) comparing by elevation in the north, and c) comparing by elevation in the south.

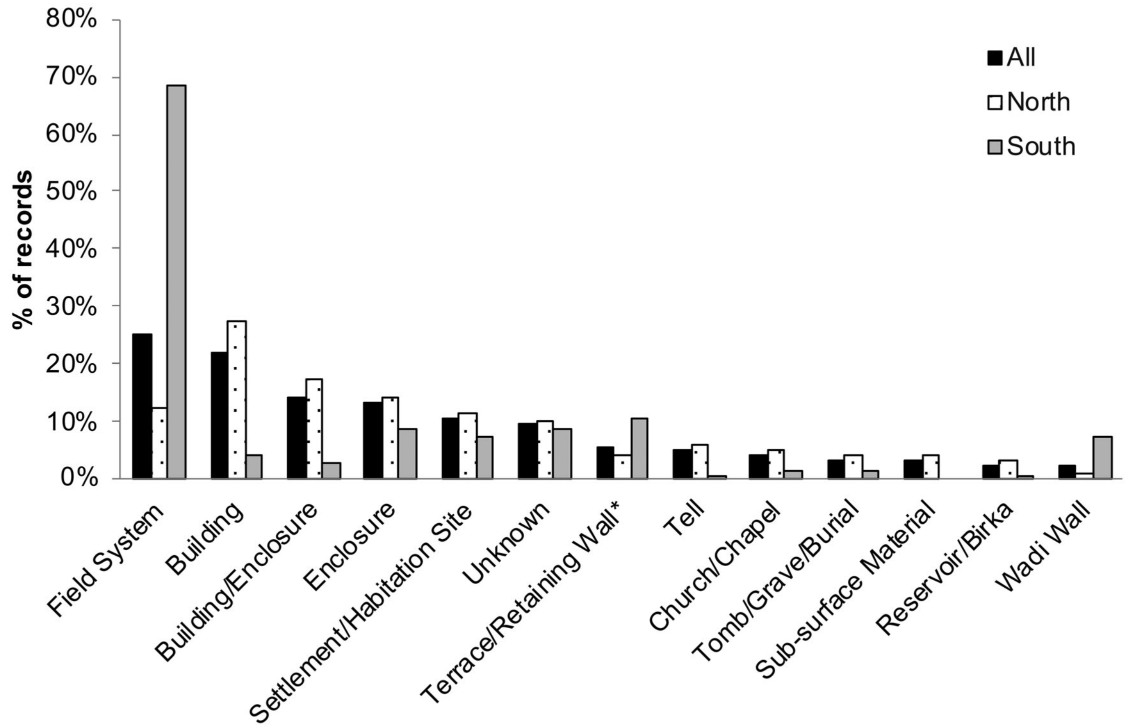

Figure 5 Site type defined by site and feature interpretation for the study area, comparing north and south.

to be a reflection of a zone of archaeological preservation (Wilkinson 2003: 41–43), with preserved and visible remains relatively more often present in the south, and in both the north and south in upland areas. This is linked to current land use: owing to increased settlement density and development in the north, many ancient, or at least pre-20th century CE, field systems have been destroyed or disturbed by ongoing activities there. Moreover, as we record abandoned fields only, areas with continued use of ancient field systems are also less likely to be recorded.

Nonetheless, the diversity probably also reflects an actual archaeological pattern. For example, the coastal strip, with its important towns, ports and routes, probably always had a more diverse use. There are certain types of activities that are necessarily confined to the coast. For example, the distribution of 'industrial/productive' sites, predominantly representing salt pans, attested in the region since at least the Ottoman period (Panayot Haroun 2015: 398), is largely limited to the north and mainly alongside the coast between Batroun and Tripoli, probably because the underlying geology of this coastline was particularly suitable (Fig. 7).

Finally, the majority (70%) of recorded feature forms are 'positive/built' features (structures, walls, banks) (Supplementary Material Tables S7–S8). Other archaeology is obviously likely to be present, but is not always picked up as easily by remote sensing methodologies (e.g. Rayne *et al.* 2017: 10–11, although see Philip *et al.* 2002 for a discussion of the use of Corona imagery for the identification of flat surface scatters). Variations in the recorded forms may point towards underlying differences in land use, construction technique, and settlement patterns. Of particular interest here is the high occurrence of 'bank/wall' in the south, which is not so frequently recorded in the north. As suggested in the discussion, this is partly a result of researcher bias, but also an archaeological difference.

Condition

Most sites are in 'good' or 'fair' condition (60%) with only a small percentage in a 'very bad' or 'destroyed' state (7%) (Fig. 8a; Supplementary Material Table S9). The situation is slightly worse in the south than in the north. Both in the north and south (Fig. 8b–c), and most pronouncedly so in the south, the coastal area has fewer sites in a 'good' or 'fair' condition, and more that are in a 'very bad' condition or 'destroyed'. This can probably be explained by reference to the construction boom that has taken (and is still taking) place across the entire coastal strip.

Despite the destructive effect of development, the most common disturbances and threats fall in the 'natural' and 'agricultural/pastoral' categories (49% and 29% of sites affected, respectively;

Figure 6 **Typical site types as observed during remote sensing analysis: 'buildings' (previously roofed) and/or 'enclosures' (never roofed) associated with terraces (top left, Oct. 2010), 'buildings' (previously roofed) typical for the 19th–20th century CE (top right, Dec. 2015), 'enclosures' possibly used as animal pens (bottom left, Oct. 2014) and Qal'at Tibnin (bottom right, July 2015). Imagery by Maxar Technologies via Google Earth Pro. Varying scales.**

Supplementary Material Table S10).[4] There are more heritage places affected by 'agricultural/pastoral' activities in the south than in the north, probably because the southern sites are largely fields, and current land use remains predominantly agricultural. 'Natural' and 'agricultural/pastoral' disturbances are not necessarily very damaging. For example, the 'natural' category is, for a large part, comprised of 'vegetation' (49%); while this can cause substantial damage to structures (especially through root action), such damage is less far-reaching than, for example, construction, whereby whole areas might be bulldozed or landscaped and any historic remains entirely destroyed. The 'agricultural/pastoral' group is more varied, and consists of high-impact disturbances like landscaping or bulldozing for the making of new terraces or fields or ploughing, but also agricultural crops, the effect of which varies (from low-impact annuals that need ploughing, to potentially higher-impact trees).

Discussion

As outlined at the beginning of the paper, one of the aims in carrying out this work was to assess whether the patterns that could be distinguished in the data were of use for academic research and/or for research feeding into heritage management strategies. Could the collation of data into a single database system reveal patterns that are worthy of further investigation, or do they merely reflect researcher bias?

Explaining the patterns: data reliability

Over the past decade there has been a wealth of literature on the role of 'big data' within the humanities and social sciences, with the emerging disciplines of data science starting to shape, enhance and offer new opportunities for archaeological studies (e.g. Bradbury *et al.* 2015; Casana 2014; Cooper and

[4]Note that one heritage place (or site) can have multiple disturbances.

Figure 7 Distribution of units classified as 'industrial/productive' (top left) with examples of salt pans from the ground (right), with 20th-century CE structural alterations (bottom right), and on satellite imagery (bottom left; Google Earth, Maxar Technologies, April 2009).

Green 2016; Huggett 2020; Levi 2013; Menze and Ur 2012, amongst many others). Issues of 'certainty' and data 'reliability' can certainly be interrogated and analysed within a small dataset and, due to the broad patterns that are being identified and analysed, become arguably less of an issue when working at the scale of 'big data' (here used to refer to the scale of the whole EAMENA database, although we acknowledge that the 'scale' of archaeological big data is small in comparison to other disciplines) (although see Huggett 2020 for alternative suggestions). However, when these analyses are reduced to a 'medium scale' (i.e. several grid squares within a country, as in this study) these issues become more problematic and challenging. A relatively low percentage of false or inaccurate records is much more likely to distort the patterns within a 'medium' scale dataset than within a 'small' (i.e. where unreliable data can be easily identified) or 'big' dataset (i.e. where a few unreliable records are unlikely to change any major patterns and observations). The reliability of the data at this scale, then, becomes more of an imperative, as does recording the nature of the original data (Atici *et al.* 2013).

The assessment and mitigation of these challenges within the EAMENA database (Rayne *et al.* 2017) and other similar projects (e.g. Lawrence *et al.* 2012) has been extensively discussed elsewhere and therefore

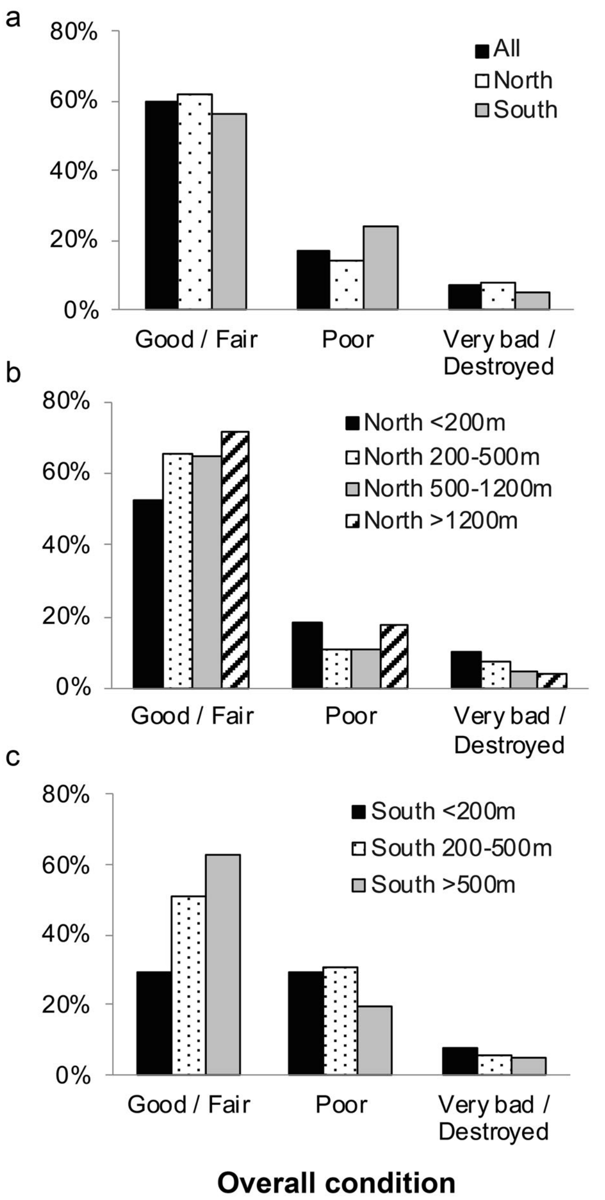

Figure 8 Recorded overall site condition for the studied transects, a) comparing north and south, b) comparing by elevation in the north and c) comparing by elevation in the south.

will not be repeated in detail here. Whilst human subjectivity certainly comes into play, studies have demonstrated that having some sort of controlled vocabulary and ways in which to express 'certainty' can help mitigate inconsistencies in large datasets (Rayne *et al.* 2017). As already discussed, certainties are recorded within the database for the majority of fields (e.g. archaeological certainty, form and interpretation certainties, disturbance certainties), which can be taken into account in the analyses and used to filter the data. For example, one could leave out everything with only a low or negligible certainty. For this paper, we have deliberately chosen to include and analyse the full dataset. This is, in part, to allow us to identify patterns which may not be visible given a more limited subset of data. In the future, with a larger dataset, comparative analyses should be conducted to compare results between different levels of certainty (e.g. leaving out all archaeologically 'negligible' and 'low' sites, or only using 'high' and 'definite' sites). In the current dataset, however, this would mean that almost all field systems would not make the cut: we simply do not have the chronological data to assess whether individual field systems existed and were in use prior to the mid-20th century CE.

This being said, it is clear that there are multiple explanations for each of the observed patterns. Firstly, as already discussed, research biases can skew the data. In our study area, the north was more intensively researched than the south, and within the north (bar transect N2), the data contained published survey and excavation data (e.g. Bartl 1998: 178). This is not something that is unique to this database, or to the EAMENA methodology, and is something that can be dealt with during data analysis and interpretation, as long as it is clear that this is the case. When using data from the EAMENA database, it is recommended that people familiarize themselves with where the data comes from (this is recorded and detailed in the database).

Secondly, as previously noted, visibility is important. Again, this is not something that is unique to this dataset, but often has a larger effect on data derived from remote sensing than field-derived data. While certain features are more easily detected using remote sensing than on the ground (e.g. Philip and Bradbury 2010: 148), many types of archaeological sites are less visible, or at least less easily classified (e.g. Lawrence 2012: 62–63) from remote imagery. The effect of this on this current dataset is clear, with the large majority of recorded features being positive/standing remains and field systems (mostly with standing walls). In addition, vegetation or modern construction can cover remains, which might skew data towards certain areas where these are absent. This might, for example, partly explain why a higher proportion of sites were located in some upland areas. The vegetation issue can to some extent be avoided by including imagery from the summer and early autumn months, when it is at its lowest (in this study such imagery was available).

Thirdly, the varied preservation (condition) of archaeological remains is an obvious issue that feeds into heritage management strategies and is one of the key objectives of the EAMENA project. When all of these factors are taken into account, the remaining pattern is that of the actual past.

Explaining the patterns: existing hypotheses

Keeping these factors in mind, the effectiveness of the EAMENA database for research purposes can be evaluated by examining existing hypotheses and considering how well the data from the study area support or refute these. The topics of focus here — upland areas and burial archaeology — reflect current themes in Mediterranean and MENA region archaeology.

Between the coast and mountains: elevation and changing land use

Although the uplands or mountainous regions of Lebanon and the wider Eastern Mediterranean are often seen as (too) challenging for habitation, recent decades have seen the beginnings of interest in the archaeology of these areas (e.g. Chaaya 2015; 2016; Fischer-Genz *et al.* 2018; Given 2007; Harfouche 2017; Nacouzi 2004; 2018). Although surveys and excavations in Lebanon have often focused on the coastal plains, questions about past mobility, the interconnectivity between coast and uplands, and the role of mountainous regions are key to many aspects of Lebanese archaeology. One would expect to see more sedentary, agricultural communities at lower elevations, with transhumance and pastoralism occurring at higher elevations (e.g. Abdi 2003: 402), but it is also known that these communities did not exist in complete isolation and that village-based transhumance was (and still is) practised. The sheer extent, nature and chronological distribution of settlement, habitation and exploitation of upland regions over the longue durée, is something yet to be fully addressed for many areas within Lebanon and the wider MENA region, and it is here that the EAMENA data can be of use, although limitations do exist.

One of the key questions pertaining to upland regions is the nature of exploitation and habitation within these areas, and how practices may have varied over time and space. Evidence for exploitation of the Lebanese mountains during the Roman and Post-Antique periods is attested by textual and epigraphical material (e.g. Fischer-Genz *et al.* 2018: 259; McPhillips *et al.* 2019) and is also starting to be documented archaeologically (e.g. Chaaya 2015; 2016; Fischer-Genz *et al.* 2018; Gatier and Nordiguian 2005; Harfouche 2017; McPhillips *et al.* 2019; Nacouzi 2004; 2018; Ten Harkel *et al.* 2019). Attaining this level of detail is difficult based on remote sensing alone (the function of structures and buildings can be difficult to assess), but when looking at the data collected by the EAMENA project, it is, nevertheless, worth highlighting that a substantial percentage of the possible heritage sites recorded by the project are located at elevations above 500 m asl (55% in the north and 61% in the south; Supplementary Material Table S2), emphasizing the sheer scale of upland activity and the potential for future work in these regions.

It is also possible to start exploring the types of activities occurring in these upland regions. One limitation here — in addition to the difficulty of identifying site function from satellite imagery — is that the terms used in the database are rather broad. This is necessary across a region as large as that covered by the EAMENA database, to enable broad cross-comparisons, speedy recording, and to keep things at a level useful for heritage management. As such, the term ‘agricultural/pastoral’ encompasses both sites related to sedentary agriculture, such as farms, field systems and villages, as well as sites potentially related to pastoral nomadism, like animal pens (‘enclosures’). There are, however, some other terms and combinations that we can use. For example, it is telling that the number of ‘domestic’ sites across the whole study area decreases above 1200 m, and above 1550 m (treeline) consist exclusively of what appear to be seasonal camps. In the south, domestic sites decrease gradually from coast to inland, with the land elevations here not reaching more than 1000 m asl (Fig. 4). In the north, a slightly different pattern is observed, with no gradual decline between the designated elevation categories (domestic sites in the <200 m, 200–500 m and 500–1200 m categories all account for roughly 30%) but rather a drop-off once the over 1200 m asl elevation is reached (to 20%). In addition, if the occurrence of ‘buildings’ (roofed) is compared with ‘enclosures’ (unroofed), it is clear that in mountainous areas buildings are often absent, while enclosures that can be associated with pastoralism are more common (Fig. 9). It is also possible, from the spatial and elevation data, to identify a general pattern in the north in terms of the elevation at which structures seem to switch from ‘buildings’ to ‘enclosures’ (Fig. 9) that might point towards wider patterns of land use and land exploitation. This is not a product of differential classifications by different researchers, as confirmed by the fact that the study area in which this pattern occurs was recorded by a single researcher. Beyond these broad observations, this pattern also

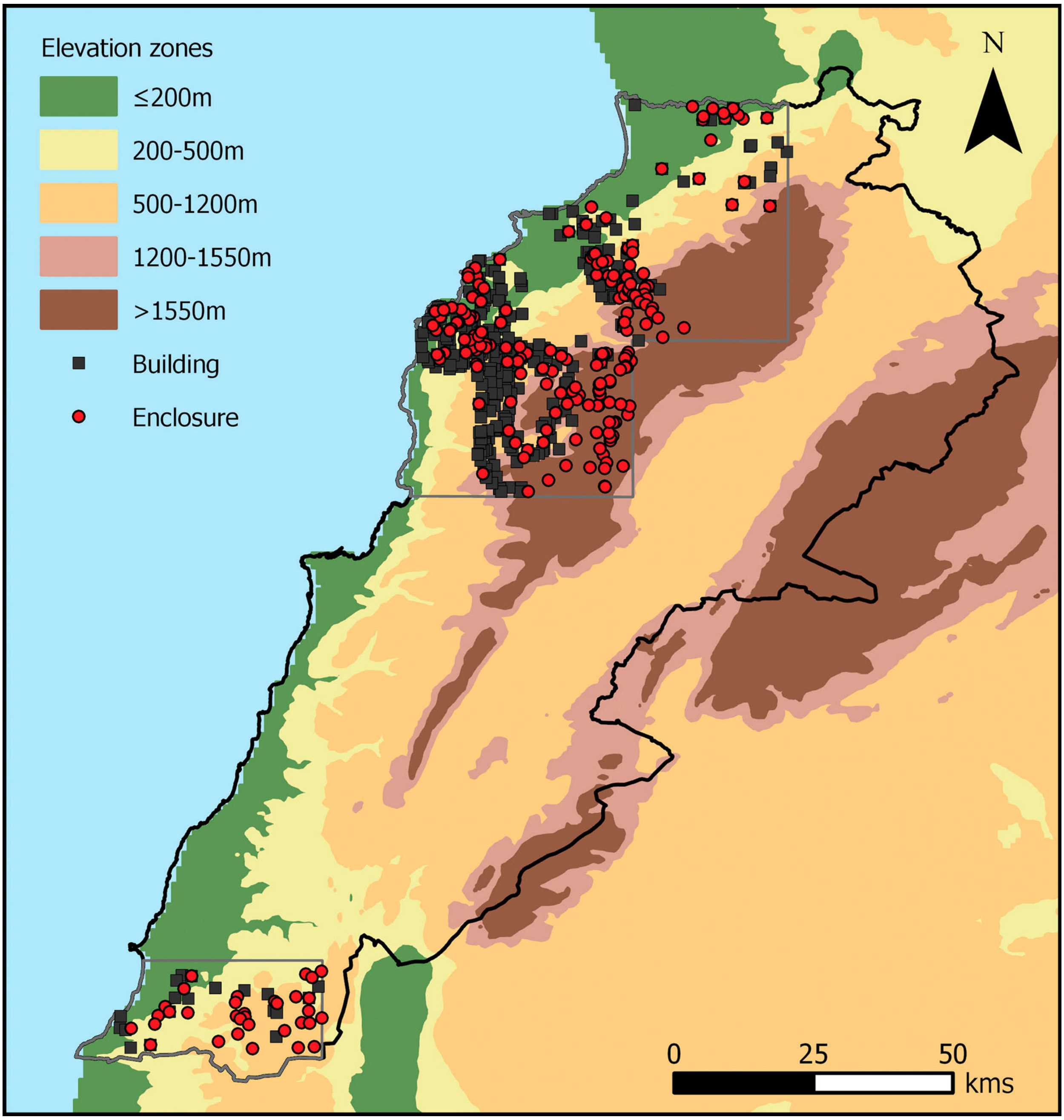

Figure 9 Pattern of 'enclosures' and 'buildings' by elevation.

illustrates several key differences between the ways in which occupation, activity and settlement patterns may have occurred in the north versus south of Lebanon. Many of the patterns require further investigation but they do suggest that settlement and activity in both the north and south are tied to, or at least influenced by, factors reflected by changing elevation (i.e. terrain, climate, vegetation, etc). This is only part of the story, however, and brings us back to the issue of diversity of site forms and functions identified, and whether the more limited range of feature types identified in the southern transects is simply a result of a lack of ground data and published materials.

Stone burial monuments: absence or invisibility?

Over the past few decades substantial work has been carried out on the distribution of stone burial monuments, including cairns and dolmens, across the wider Levant and Arabia. Numerous publications have explored the relationship between these features and different population groups, as well as their potential dating, interpretation and socio-cultural function (e.g. Abu-Azizeh 2013; Abu-Azizeh *et al.* 2014; Bradbury

2011; 2016; Bradbury and Philip 2011; Steimer-Herbet 2000; 2004a; 2004b; Steimer-Herbert and Braemer 1999). Remote sensing has been a key tool in trying to understand and map their wider distribution and landscape location (e.g. Abu-Azizeh 2013; Bradbury 2011; Bradbury and Philip 2011; Deadman 2012; Deadman and Al-Jahwari 2016), as well as being used to document and monitor their current state and preservation (e.g. Rayne *et al.* 2017: 18–23).

Despite the widespread recognition of these features in neighbouring areas in Jordan and Syria, what is remarkable is the very limited presence of these features within Lebanon (Bradbury 2011: 163; Fig. 4). Several clusters of monuments are known in the north and south of the country (Steimer-Herbet 2000; Steimer-Herbet *et al.* 2018; Tallon 1958; 1959). Furthermore, Marfoe's (1995: 82) work in the Bekaa Valley makes reference to the presence of dolmens and tumuli in the foothills of this area, although he provides very few details concerning the nature or wider distribution of these moments across the region. Nonetheless, even with new data being generated through ongoing survey work, the numbers of stone monument clusters known from Lebanon remain very small, especially in contrast to the hundreds and, in some cases, thousands of structures documented in surrounding regions (e.g. Bradbury and Philip 2011).

As discussed above, much of the research carried out in Lebanon has tended to focus on the coastal strip, with investigations in mountainous areas and foothills of the Lebanon and Anti-Lebanon mountains only taking place more recently. As such, part of the issue re the lack of stone monuments documented to date might relate to researchers and scholars not looking in the right areas. Based on their distribution elsewhere across the Levant, the lithology of these mountainous and upland regions (predominantly cretaceous, neogene or miocene limestones, with basalt flows in the extreme north and south-east of the country (e.g. Dubertret 1975)) is clearly suitable for the construction of monuments. The findings of the present study challenge this explanation. Based on the current distribution of funerary monuments and cairns it is clear that the remote sensing work carried out by the EAMENA project (Fig. 10) emphasizes the previously known distributions of stone monuments in Lebanon. These patterns are confirmed by ongoing survey work in some of the upland areas south of the Koura and Akkar regions during which no cairns or stone monuments have been recorded (e.g. Nahr al-Jawz region and Shekka Plateau, Bradbury pers. comm. 2020).

Several hypotheses can be put forward. Firstly, due to the substantial scale of landscape transformation that has occurred in some parts of northern and southern Lebanon, even beyond the coastal plain, it is possible that stone burial monuments were once a feature of this landscape but have since been destroyed. Additional remote sensing work using historical imagery would help to address and assess this possibility. Alternatively, these may be features that, due to their lithological background, are very difficult to detect via remote sensing. Furthermore, present day tree cover in many of the upland regions may be obscuring and hindering their identification using remote sensing. This does not, however, fully explain the limited numbers of these features recorded via ground survey. It is possible, therefore, that stone burial monuments were simply not an accepted way of disposing of, or memorializing, the dead within this region. Given the material connections between Lebanon and the wider Levant during the periods in which these monuments may have been used, this is an intriguing possibility. The dating of stone burial monuments, including cairns and dolmens, is fraught with difficulties and, as many researchers have demonstrated, their use spans millennia (e.g. Bradbury 2016). This being said, many of the stone monuments documented to date in Lebanon are broadly dated to the late 4th and 3rd millennium BCE (e.g. Steimer-Herbet 2000; Steimer-Herbet *et al.* 2020). Knowledge of Lebanese burial practices, particularly during the 4th millennium BCE, is still limited, with the sites of Byblos and Sidon Dakerman standing out as well documented, yet unusual jar burial assemblages (Genz and Sader 2007: 258–59). In contrast to these coastal locations, it may be that within the deeply incised uplands, rather than the megalithic or cairn burials known from further north and the Bekaa Valley, caves, crevices and rock-cut tombs were a much more common way of disposing of the dead; one of the only other Early Bronze Age I (4th millennium BCE) burials documented from Lebanon to date, is a looted rock-cut chamber tomb (Genz and Sader 2007: 259). Further work on this question is clearly required.

New research avenues and understudied areas

A landscape of terraces

Having demonstrated the application of the EAMENA database to existing hypotheses and

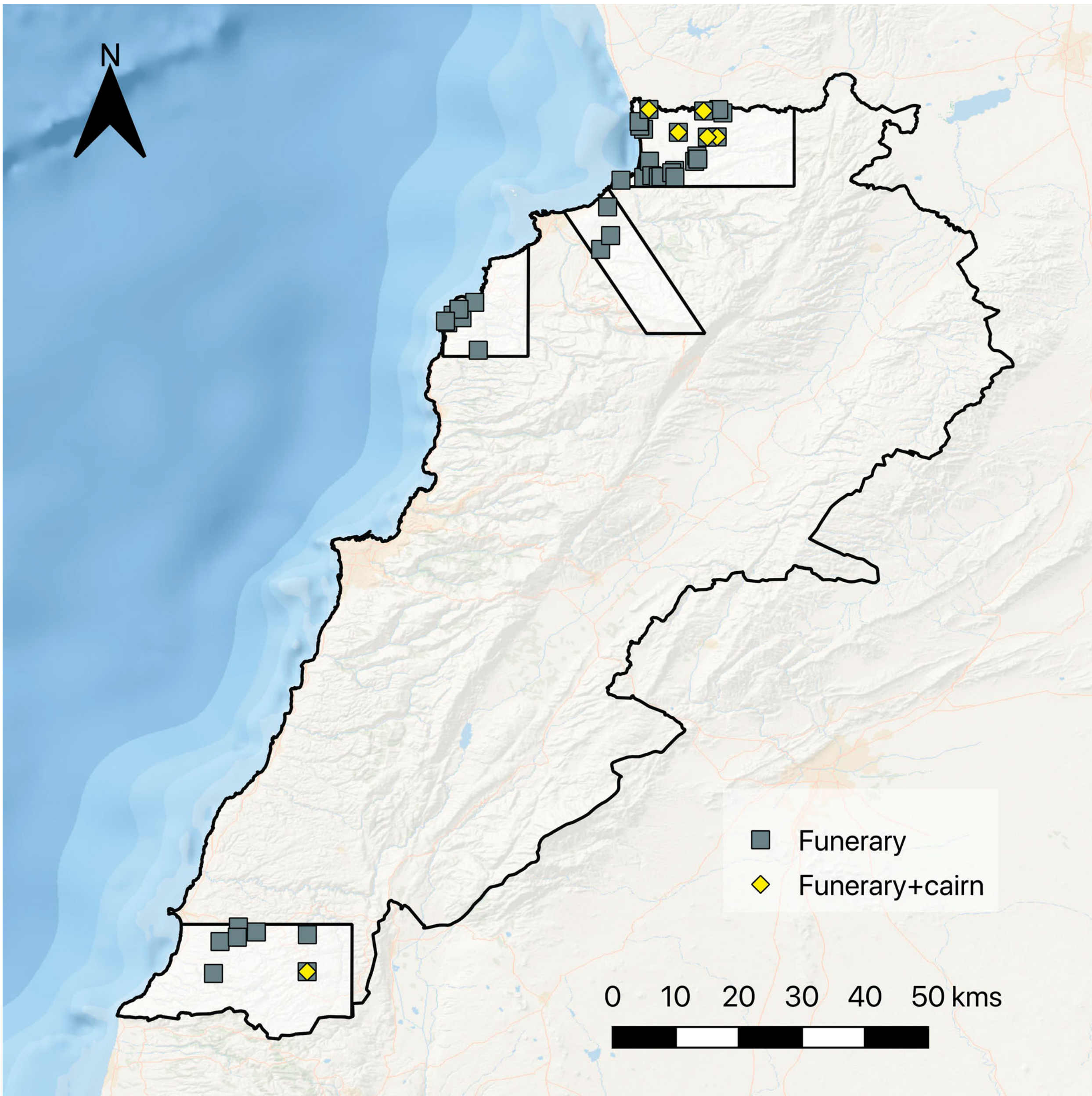

Figure 10 Cairns and burial monuments recorded in the studied transects.

studies in the sections above, we now turn towards two understudied themes: agricultural landscapes and Ottoman–20th-century CE remains.

As discussed, the large majority of identified potential heritage places were assigned as having an 'agricultural/pastoral' or 'domestic' function. The majority of these are field systems, predominantly terraces. Looking into the evidence in more detail, these systems, especially in the north, are often associated with buildings and other structures (for example, enclosures). While the majority of locales of this type are in the database as undated (period 'unknown'), and consequently the archaeological certainty is often 'low', it is likely that a lot of these were at least in use during the Ottoman period and early 20th century CE, and that some may have much older origins still (e.g. Bradbury *et al.* in press; McPhillips *et al.* in press; Ten Harkel *et al.* 2019). The terraces too, although much harder to date, may have older origins. Their continued use, in some cases into the 21st century CE, also raises issues of how we classify and record 'living archaeology' (i.e. archaeological structures that are still in use) using remote sensing. For the field systems, in particular, one of the factors allowing us to propose a pre- to mid-20th-century CE date was their (temporary) abandonment. The dataset could, therefore, be missing large areas of terracing that, whilst constructed prior to the 1950s, are still actively exploited and planted. A similar issue affects historic houses, which — as stated above — are almost impossible to identify from satellite imagery if they are well maintained and still inhabited.

From travellers' reports, ethnographic studies and archives (e.g. Burckhardt 1822: 177; Cresswell 1970; Lewis 1953), we have references to extensive terracing activities in the uplands of Lebanon, with such features being used to transform unproductive areas into extensive agricultural systems (Lewis 1953: 2; McPhillips *et al.* 2019: 205). Due to emigration, deruralization and the mechanization of agriculture, terraces were increasingly abandoned from the 19th and into the early 20th centuries CE onwards in Lebanon, as well as throughout the wider Mediterranean (Cresswell 1970: 26; Lewis 1953: 7; Palmer *et al.* 2010: 66). This abandonment leads to erosion (recorded for 20% of the field systems in our dataset), with eventual stabilizing vegetation recolonization (49% of field systems show this to some extent; see Supplementary Material Table S12). As Cresswell (1970: 28) noted in the 1970s, ruined and abandoned terraces could cause significant problems for owners of downslope plots, often leading to whole slopes being abandoned, rather than just sections of terraced land. The timing and length of abandonment is almost impossible to determine via remote sensing, although future work combining historical mapping, historical satellite imagery and an assessment of current vegetation cover might provide some chronological indicators, allowing us to distinguish between recently and historically abandoned areas. Ground surveys can, again, add to our understanding here. Within the wider Levant and Mediterranean, patterns in the vegetative recolonization of abandoned terraces have been used to examine the length of abandonment and the rapidity (in the case of this study 20–60 years) of vegetation succession, which has obvious implications for the labour and investment required for the re-use/rehabilitation of previously abandoned terraces (Palmer *et al.* 2010). Further south-east, in Jordan, OSL and radiocarbon dating have been used to propose a dating schema, spanning the beginning of the 1st century CE through to *c.* 800 CE, for the extensive agricultural terracing surrounding Petra (Beckers *et al.* 2013). Finally, terraces in the Nahr Ibrahim area in central Lebanon were recently dated, based on their soil profiles, to as far back as the Early Bronze Age, with the Iron Age, Classical and medieval periods also represented (Harfouche and Poupet 2017).

Whilst the EAMENA database does not distinguish between different types of field systems, we can find some clues in the forms that are recorded. As discussed above, there are clear differences between field system records in the north and south. For example, out of the 158 units classified as field systems in the north, nearly 50% (76 out of 158 units) were recorded in association (i.e. intersected/were within 50 m) with other features, such as enclosures, buildings or settlements. If we increase the distances involved, *c.* 73% (115 out of 158) were found within 500 m of other structure/features. Without dating and further remote sensing or ground survey work, the relationship between the field systems and other noted features cannot be fully determined. In contrast, in the south *c.* 80% (208 units in total) of the 258 recorded field systems were entered as discrete entities (i.e. were not even within 500 m of a potentially associated enclosure, building or settlement).

The high occurrence of 'bank/wall' in the south also seems to be an archaeological difference, rather than (only) a researcher bias. When this variation was first noted by the authors, it was assumed that this was a product of different researchers classifying features noted from satellite imagery in two different ways (i.e. the original data entry was carried out by one individual in the south and two individuals in the north; see Atici *et al.* 2013 for further discussion of classification and researcher bias). Subsets of data were, therefore, selected from the south and north as test case studies and revised feature assessments were carried out by the authors. Rather than completely challenging the existing data entry forms, these revised assessments partly confirmed them, suggesting an observable difference between the forms of terraces and field systems in the south and the north of the study region (Fig. 11, see also Fig. 6a). In the south, those recorded as 'banks' tended to be earthen banks, whereas those recorded as 'bank/wall' tended to be broad linear stone divisions (which could either be stone-built banks or collapsed walls). Moreover, there seems to be a greater range of field system forms in the south, with a range of rectilinear and radial field systems also being recorded, in addition to walled and banked terraces. These observations were further confirmed by a brief reference from the 1950s to terrace systems in the south as 'divided by sloping earth banks' (Lewis 1953: 4). These variations seem to be directly related to the differences in terrain (and geology) between the north and south (Lewis 1953). As work in the wider Eastern Mediterranean has demonstrated, however, variations can also be a result of underlying socio-cultural

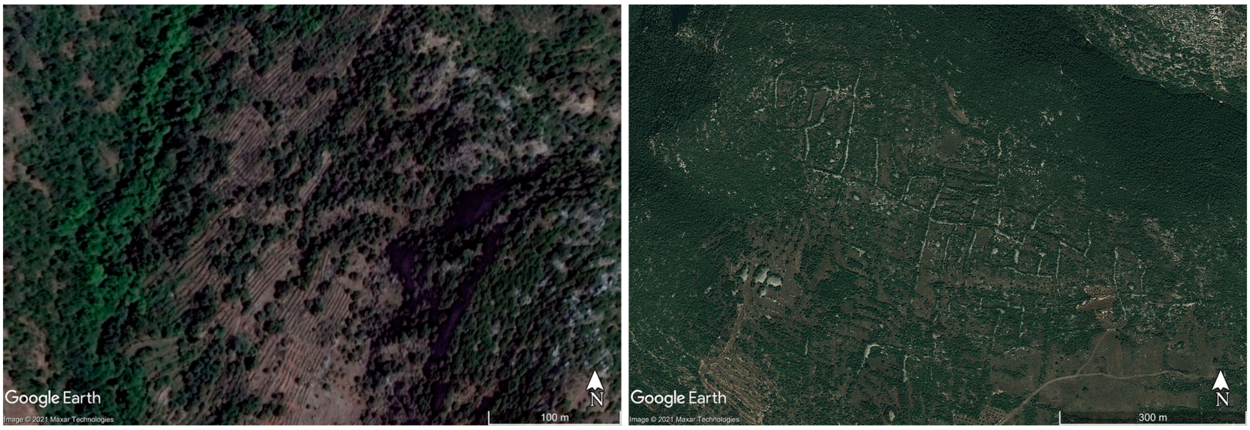

Figure 11 A typical field system in the north (left, image date 26/06/2017) and in the south (right, image date 14/10/2011) of Lebanon. Maxar Technologies via Google Earth Pro. Note the different scale.

variations, as well as being reflective of local social structures and the localized organization of agro-pastoral practices and exploitation (e.g. Cresswell 1970; Palmer *et al.* 2010: 66). Whilst further work is needed in order to unpick the implications of these differences, it does highlight the potential of investigating previously under-explored landscape features on a broad scale. The latter is obviously worth further exploration, especially in relation to the different cycles of re-use and abandonment, as well differential crop use across these two regions over the past few centuries. Patterns and variations, observable from satellite imagery or aerial photography, in the forms, preservation and morphology of terraces and field systems may also allow us to start to map cycles of use and abandonment in these upland areas, as well as suggesting preliminary classifications which, when combined with ground survey results, may enable the building of a regional, chrono-morphological map.

Ultimately, these landscape features have a multiplicity of values, as tangible archaeological features, as well as material representations of the intangible skills involved in their construction, maintenance, organization and use. When maintained they can be an effective method for conserving soil and water, whilst abandoned terraces can lead to increased soil erosion, which in turn leads to a loss of biodiversity (Lewis 1953: 14; Palmer *et al.* 2010: 66, 72, 76). In this sense, the vegetation often observed growing over the abandoned terraces in our study is a positive, as it will decrease these processes, with species diversity potentially also increasing, although not necessarily returning in the same form as it was before management of the landscape, after a longer period of disuse (e.g. Palmer *et al.* 2010: 76–77). With several biospheres in Lebanon now promoting biodiversity, reforestation schemes and sustainable farming practices (e.g. Association for the Protection of Jabal Moussa (APJM) 2020; Berrahmouni *et al.* 2015: 77–78), terraces, as an ubiquitous feature of Lebanese landscapes, are important case studies from an historical and archaeological perspective. They represent the interplay between human and non-human agents, as well as the continuing and dynamic relationship between human needs, heritage and sustainability practices.

Conclusion

This paper set out to illustrate the potential of analysing basic archaeological patterns, largely derived from remote sensing, alongside additional landscape data, such as elevation, in this case used as a proxy for land use, and environmental/landscape zones. In doing so it also sought to ask a series of questions that can now be answered. First, differences in site type and density between different environmental zones can be identified, with more variety in site types along the coastal strip, but also a surprising density of agricultural and pastoral sites in the uplands. This points towards the necessity of further archaeological work and investigations in some of these more neglected regions. Some of these patterns persist until the present day, with the coastal strip still more heavily subjected to ongoing development for a variety of purposes than mountainous and hilly inland regions. As such, the differences are clearly a combination of 'real' differences in the past and issues of preservation in the present. Second, there are differences between the north and south of the country, which, to a large degree, can be explained by reference to a difference in research history (or at least the availability of published research). To some extent, however, these differences are archaeologically 'real' as well, most notably in the case of the different forms of field systems, which may reflect not only differences in terrain and geology, but also wider socio-cultural traditions. Third, there are differences in site condition, most clearly between the coastal and inland regions, with sites along the coast being more often recorded as poor or destroyed. Whereas the coastal areas, therefore, require much archaeological attention to record the endangered archaeology in the face of the development boom, the inland regions hold much potential to further our understanding of past agricultural and subsistence practices.

As this paper has demonstrated the EAMENA database holds promise, not only as a heritage management tool, but also within an archaeological research framework. Our work has shown the potential for large and medium-scale datasets collated by EAMENA and similar projects to inform and test existing hypotheses. Due to the holistic nature of data collection (i.e. the aim to record every potential heritage feature), projects such as this also have the potential to shed light on under-represented periods or research areas, pointing towards avenues for future investigation and analysis. Multiple scales of analysis and data interrogation are possible (at local, national and regional levels), although certain limitations and factors have to be kept in mind. As with any large project, researcher or analyst subjectivity is something that has to be factored in. Whilst the database has mitigated this through the use of controlled vocabularies, large-scale analyses need to take this possibility into consideration, especially when exploring the use of the database for large-scale archaeological reconstructions. Additional challenges are posed by visibility or preservation biases, and variations in data entry detail and enhancement. These are, however, not challenges unique to the EAMENA database and are faced by any archaeological project; our work, therefore, will be of use to researchers from other projects, especially those who are contemplating how to best combine heritage management and archaeological research practices.

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Supplementary material

Supplementary material can be accessed here: https://doi.org/10.1080/00758914.2021.1968114.

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