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Maritime Cultural Heritage, Coastal Change and Threat Assessment in Syria

Kieran Westley[1] · Nicolas Carayon[2] · Jafar Anbar[3,4] · Colin Breen[1] · Lucy Blue[5]

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Abstract
Syria's coastal and nearshore zone contains a significant, but under-researched, record of maritime cultural heritage (MCH) ranging from prehistory to the present. This is exemplified by a lack of underwater investigations, but also limited investigation of key onshore maritime sites such as ports and harbours. There is also a lack of specialist in-country management regarding maritime cultural heritage research and protection. This situation has been worsened by the ongoing conflict (since 2011), which has reduced (already limited) field investigation. To assist in the advancement of Syrian maritime archaeology, this paper presents a baseline assessment which makes use of a geospatial database generated from satellite imagery as well as both published and grey literature. This assessment reviews past coastal environment changes affecting the Syrian littoral, and then highlights past disturbances and potential future threats impacting the MCH. This is done through analysis of all coastal/nearshore sites documented to date and showcased in more detail using two case studies: Tabbat al-Hammam and Ras Ibn Hani. This enables discussion of the current state of Syrian maritime archaeology and suggests ways forward for its future management and investigation.

Keywords Maritime archaeology · Remote sensing · Satellite imagery · Historic environment management

Introduction

The Syrian coastal zone has a rich cultural heritage with archaeological sites ranging from Palaeolithic flint scatters to Bronze and Iron Age occupation mounds (tells) and from Crusader fortifications to Ottoman buildings (Riis et al. 2004; Burns 2009). This

✉ Kieran Westley
kl.westley@ulster.ac.uk

1 School of Geography and Environmental Sciences, Ulster University, Coleraine, UK

2 Ipso Facto, Marseille, France

3 Aix Marseille University, CNRS, CCJ, Aix-en-Provence, France

4 National and Kapodistrian University of Athens, Athens, Greece

5 University of Southampton, Southampton, UK

area played a major role in trade and seafaring from at least the Bronze Age onwards with ancient textual records describing seaborne military or commercial activity involving ports and harbours on the Syrian coast. Archaeological evidence of these activities also exists as the material remains of port facilities, ranging from modified natural harbours to man-made structures such as moles and quays (Carayon 2008).

In 1992, the Syrian Navy officer, Hussein Hijazi published the results of his extensive fieldwork, conducted over twenty years, on the Syrian coastline in his book *Ancient Ports, Harbours and Anchorages Along the Syrian Coast.* This was the first systematic mapping and recording of the ports, harbours, shipwrecks, and settlements on the Syrian coastline based on detailed field observations and architectural descriptions (Hijazi 1992). However, aside from this study, the maritime aspects of this cultural heritage remain under-researched. One illustration of this is the lack of underwater archaeological work (Haldane 1993; Kampbell 2013) compared to the extensive shipwreck, harbour and (to a lesser extent) submerged landscape investigations conducted elsewhere in the eastern Mediterranean (Demesticha 2018; Galili et al. 2018; Harpster 2018; Semaan 2018; Demesticha et al. 2019). Onshore, a few coastal sites have been subject to detailed investigation, such as Tell Tweini, Ras Shamra, and Ras el-Bassit (Schaeffer 1929; Courbin 1986; Yon 2006; Bretschneider and van Lerberghe 2008; Al-Maqdissi et al. 2010; Beaudry 2014; Bretschneider and Jans 2019), but many more ancient coastal settlements still need to be investigated (Carayon 2008). Moreover, the emphasis has often been on the land-based settlements associated with ports rather than the physical form and infrastructure of the ports themselves or, with the exception of Ras Ibn Hani (Marriner et al. 2012) and Tell Tweini (Al-Maqdissi et al. 2007; Baeteman and Bogemans 2019), port development in response to landscape and environmental change. This vacuum has historically extended to heritage management. Typically, maritime features, such as ports, harbours or shipwrecks, are not specifically identified in the Syrian Law of Antiquities (1963), which also only has a passing reference to the offshore remit of the Directorate-General for Antiquities and Museums (DGAM) in relation to issuing archaeological prospection licences. At the time of writing, Syria had not ratified the UNESCO (UNESCO 2001) Convention on the Protection of the Underwater Cultural Heritage (United Nations 2021). Information from former members of the DGAM also indicated that there had not been a concerted effort to engage with the management of maritime cultural heritage or establish a dedicated maritime archaeology unit (Al-Maqdissi pers. comm.). The lack of maritime archaeological research and management has undoubtedly been hindered by the Syrian conflict, ongoing since 2011, which has prevented relevant capacity building efforts like those that have taken place elsewhere in the eastern Mediterranean over the last decade (Blue and Breen 2019; Demesticha et al. 2019).

Since 2011, much of Syria has been devastated by the ongoing conflict. Over much of the country, violence and illegal looting has had disastrous impacts on cultural heritage (Casana and Laugier 2017; Danti et al. 2017; Kanjou 2020). In contrast, the coastal governorates of Tartus and Latakia have remained under government control during the conflict and largely escaped the worst fighting (Mohamed et al. 2020). Even so, other potential threats exist in these coastal areas, for instance population pressure and land use change driven by growing populations of Internally Displaced Persons (IDPs) (Hammad et al. 2018; Mohamed et al. 2020; Mohamed 2021) and, over the coming years, increased flooding and coastal erosion as a result of anthropogenic climate change (Reimann et al. 2018; Westley et al. 2021). In all cases, the impact of these threats will be exacerbated by the breakdown and loss of support for already limited management efforts (Kanjou 2020).

To assist in the development of a framework for future investigation and protection of Syria's maritime cultural heritage, this paper presents an up-to-date baseline assessment. It incorporates a review of past climate and environmental changes affecting the Syrian coast, heritage documentation through remote sensing, and a threat assessment exercise following the methodologies of the Maritime Endangered Archaeology (MarEA) project (Andreou et al. 2020) as well as an initial assessment funded by the Honor Frost Foundation (HFF) (Westley et al. 2018). Two case studies (Tabbat al-Hammam, Ras Ibn Hani) are presented and followed by a discussion on the present state of Syrian maritime archaeology and the outlook for its future management and investigation.

Coastal Climate and Environmental Change

Past environmental changes along the Syrian coast are integral considerations in heritage management, relevant to site prospection, archaeological interpretation and addressing long-term coastal changes which impact the future management of heritage sites.

Physical Geography and Geology

The Syrian coastline is approximately 200 km long and characterized by a narrow plain running between the sea and the Jabal an Nusayriyah Mountains and which rarely extends inland by more than 1 km except for the Jableh and Akkar Plains (Fig. 1). The plain consists of Quaternary fluvial, colluvial, and marine sediments that accumulated against the western foothills of the mountains which themselves are mainly uplifted Jurassic and Cretaceous carbonates with Cretaceous ophiolites (the Baer-Bassit Massif) and Pliocene basalts to the north and south, respectively (Brew et al. 2001; Dodonov et al. 2008).

The tidal regime is microtidal (~0.3 m range), and coastal geomorphology is accordingly wave-dominated: zones of beachrock and unconsolidated sediment alternate with low rocky shores. Small pocket beaches, bays, promontories, headlands, and estuaries also occur intermittently. Dunes are present on the Akkar Plain and south of Latakia. High coastal cliffs are located in the north where the Baer-Bassit Massif reaches the sea. There are few offshore islands, the largest of which, and only inhabited example, is Arwad Island off the coast of Tartus (Bird 2010; Wolff et al. 2018).

Past Relative Sea-Level (RSL) Change

During the Pleistocene, global sea-level rose and fell by up to 120 m, relative to the present day, in response to the growth and melting of ice sheets (Rohling et al. 2009). In Syria, this signal was modified by tectonically driven crustal displacement. Consequently, former shorelines and marine terraces have been uplifted to 5–190 m above present sea-level (asl) (Fig. 2A). Their chronology is not yet confirmed, but the lowest terraces probably date to Marine Isotope Stage (MIS) 5 (~85–130 ka) and higher examples to one of several highstands ranging from MIS 7 to MIS 11 (~190–420 ka) (Besançon et al. 1994; Bridgland et al. 2008; Dodonov et al. 2008). Although global sea-level fall undoubtedly exposed large swathes of Syria's continental shelf, evidence of this now submerged palaeolandscape is minimal, probably due to a lack of research. One possible exception is at Ras Ibn Hani where a peat layer representing a former terrestrial landscape now lies buried ~4 m below present sea-level (bpsl) and has been radiocarbon

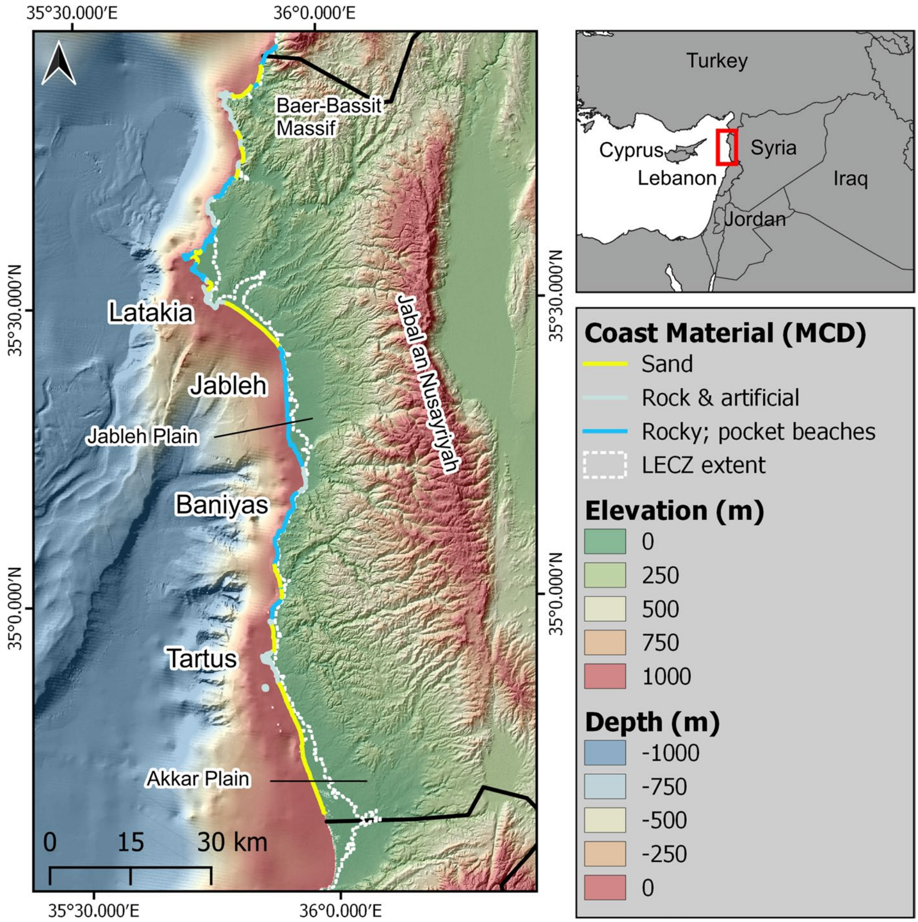


Fig. 1 Onshore topography (SRTM 30 m elevation model), offshore bathymetry (EMODNET 2020 elevation model) and constituent material of the Syrian coast (Mediterranean coastal database; Wolff et al. 2018). LECZ refers to the Low Elevation Coastal Zone (land < 10 m elevation and in hydrological connection to the coast)

dated to 10.4–9.9 ka cal BP (Marriner et al. 2012). Also, at Ras Ibn Hani are potential undated palaeo-channels which have been identified from high-resolution bathymetry (Westley 2021). Outside here, there is no published evidence of relative sea-level (RSL) change or submerged landscapes from the Syrian shelf (Benjamin et al. 2017).

RSL change and shoreline movement continued into the Holocene as shown by radiocarbon-dated material (bioconstructions, vermetids, shells) from uplifted erosion platforms, beachrock and fossilized coastal dunes. In general, Holocene coastal change comprised three main aggradation phases resulting from increased fluvial sediment input (estimated to be at 5000 BC, 2000 BC, and 1200 AD) and separated by erosive and/or retreat phases and two episodes of coastal uplift in about 1400 BC and 1000 AD. The precise causes of aggradation remain unclear, but could either result from climate changes or human actions, as argued by Ras Ibn Hani (see below) (Sanlaville et al. 1997).

This general pattern masks a degree of local complexity caused by tectonic movements and sediment supply. These local changes are exemplified by coastal progradation which either created or removed natural harbours. For example, at Amrit the Hellenistic quay and harbour basin are now 800 m inland (Al-Maqdissi 1993; Carayon 2008)**.** Another potential infilled natural bay can be identified from declassified Corona spy satellite imagery at Arab al-Milk, close to the site of Tell Daruk, but has yet to be investigated in detail (Westley et al. 2018). Conversely, at Ras Ibn Hani, port development was enabled during the Bronze Age when the formation of a tombolo created a sheltered anchorage. In this case, the increase in sediment supply which enabled tombolo formation has been linked to enhanced soil erosion caused by a combination of Bronze and Iron Age agricultural practices and possibly a phase of climatic aridification (Marriner et al. 2012).

Documentation Results

An essential resource for historic environment management is a digital geospatial database of archaeological sites. There has historically been no such database for Syrian maritime sites (Al-Maqdissi pers. comm.). Therefore, a maritime archaeology-focussed database was compiled in 2017–18 by the HFF-sponsored Syria Benchmarking project (Westley et al. 2018). This complemented pre-existing and simultaneous documentation in the coastal lowlands by the Endangered Archaeology of the Middle East and North Africa (EAMENA) project (Rayne et al. 2017). Since 2019, additional documentation has been undertaken by MarEA (Andreou et al. 2020). All these projects used the same method: a combination of literature review and satellite imagery assessment to identify archaeological sites and assess threats and disturbances. All results have been uploaded to the open access EAMENA database hosted at the University of Oxford (https://database.eamena.org/). Key data sources included:

(1) Published literature (Braidwood 1940; Besançon et al. 1994; Riis et al. 2004; Kampbell 2013)
(2) Unpublished material (Carayon 2008; Anbar 2020)
(3) Geological/geoarchaeological reports (Sanlaville et al. 1997; Marriner et al. 2012).
(4) Recent Very High-Resolution (VHR: < 1 m) satellite imagery hosted on Google Earth (2009–2020).
(5) High-resolution (~ 3 m) declassified Corona spy satellite imagery (1968–70) hosted by the open access Corona Atlas (http://corona.cast.uark.edu/).

This paper considers only sites located offshore, within the Low Elevation Coastal Zone (LECZ: land less than 10 m elevation and in hydrological connection to the coast) or within 500 m of the present coastline. This definition was chosen to capture all documented archaeological material on the seabed, the low-lying coastal plain, and also on elevated land close to the sea (e.g. coastal cliffs, steep slopes). This area contains a total of 290 documented sites. It is unlikely that this represents the full distribution of Syrian maritime heritage given the limitations of satellite remote sensing for archaeological prospection coupled with the lack (or publication) of research, particularly for offshore areas. Nevertheless, it gives a sample of the range of evidence on the Syrian littoral.

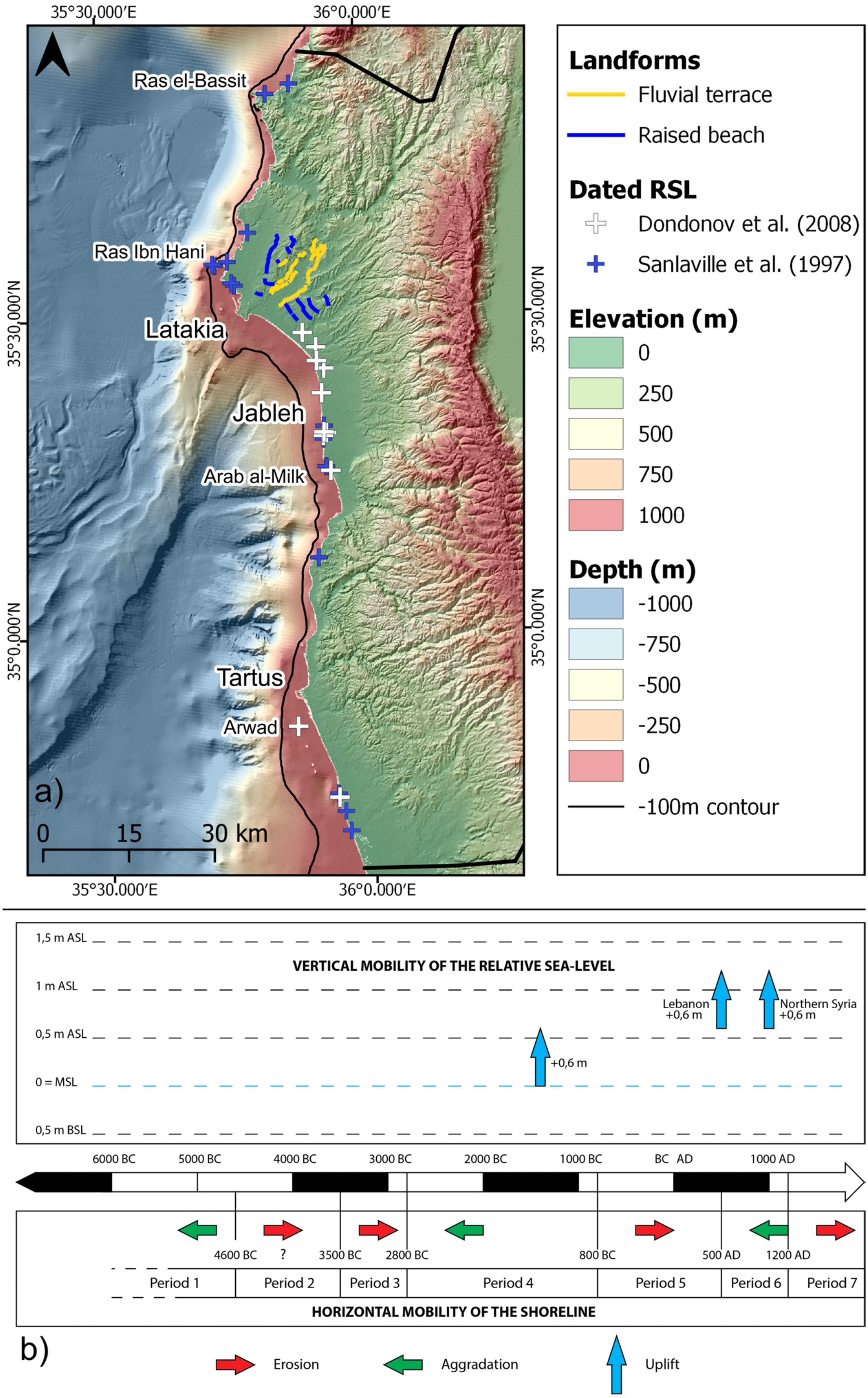
Documented sites concentrate in three main clusters—Tartus-Akkar Plain, the Jableh Plain, and the Ras Shamra area (Fig. 3a). There are several reasons for this pattern. Firstly,

Fig. 2 **a** Distribution of dated RSL evidence and identified Pleistocene raised beaches and fluvial terraces ▶ in Syria. RSL evidence has been dated by U-series (Dondonov et al. 2008) or ^{14}C (Sanlaville et al. 1997). Raised beaches and fluvial terraces are from Bridgland et al. (2008). The - 100 m contour has been superimposed to give a rough sense of continental shelf exposure during maximal RSL lowstands. **b** Holocene RSL changes and principal phases of shoreline movement along the Syrian coast (after Sanlaville et al. 1997)

it is the focus of previous research. For example, the Tartus-Akkar Plain contains a number of well-known Phoenician colonies and harbour cities; Arwad (Arados), Antarados (Tartus), Marathos (Amrit) and Tabbat Al-Hamman (Renan 1864; Braidwood 1940; Frost 1966). The Jableh Plain was subject to a comprehensive landscape survey in 1958–63 (Riis et al. 2004), whilst Ras Shamra contains Ugarit, the capital of a Bronze Age kingdom and one of the best-studied sites on the Syrian coast (Yon 2006). Secondly, topography probably also influenced past settlement. The three clusters occur where the coastal plain is extensive. In contrast, the steep slopes north of Ras Shamra and, to a lesser extent, between Tartus and the Jableh Plain were less suitable for settlement. Nevertheless, areas with few documented sites highlight potential areas for future survey, particularly when they appear otherwise amenable for settlement, such as the low-lying plain south of Latakia. With regard to chronological distribution, Classical-period sites dominate and reflect the focus of much previous research during the Roman or Hellenistic periods (Fig. 3c), and the often well-preserved remains from these times. There is also a relatively high proportion of Bronze Age and Iron Age sites, again reflective of research interests in Ugarit, Phoenicia, and a general focus of investigation on tell sites which often contain material from these periods (Riis et al. 2004; Yon 2006; Bretschneider and Jans 2019).

The documented record contains a wide range of archaeological site types but is dominated by a few categories (Fig. 3b), the most common being quarry sites. These generally comprise regular to rectilinear features cut into coastal and foreshore bedrock and which are identifiable on satellite imagery. They cluster near Jableh, Latakia, Arwad, and Ras Ibn Hani where low sandstone or limestone platforms are exposed. Some, but not all, of these features have been identified from ground survey (Riis et al. 2004; Yon 2006), but detailed investigation seems to be rare. Their locations may have been chosen to take advantage of exposed rock platforms and also facilitate transport of excavated blocks by ship. Their foreshore locations also could either indicate that they served a dual role, first functioning as quarries and then later repurposed for salt production or fish tanks (hence the high proportion of salt processing interpretations: Fig. 3b); or were submerged by RSL rise. Either interpretation would require ground investigation to confirm.

Settlement sites and tells are also common, as would be expected if the coastline was occupied during antiquity, whilst high numbers of ports and harbours have also been identified. This includes known ancient harbours (e.g. Arwad, Minet el-Beida, Tabbat al-Hamman: Carayon (2008)), as well as sheltered bays (including now-silted up examples) which could represent potential natural harbours. However, relatively few sites have built harbour infrastructure (represented in Fig. 3b by the Pier/Jetty/Wharf/Quay category). These are mainly known from previous research (e.g. Braidwood 1940; Carayon 2008; Marriner et al. 2012), and the low numbers could be reflective of either the general lack of maritime archaeological research in Syria or even the ready availability of natural harbours in certain locations. The Jableh Plain is for example characterized by numerous small bays and creeks that offer sheltered anchorages and shelving beaches for landing (Riis et al. 2004), whilst the reef at Arwad creates an extensive natural anchorage (Anbar 2020). The range of other common site types is reflective of general human activity in the coastal zone, for instance cemeteries, bridges, and fortifications, and are not necessarily maritime specific.


35°30,000′E
36°0,000′E
Ras el-Bassit
Ras Ibn Hani
Latakia
Jableh
Arab al-Milk
Tartus
Arwad
a)
0 15 30 km
35°30,000′N
35°0,000′N
35°30.000′E
36°0.000′E
Landforms
Fluvial terrace
Raised beach
Dated RSL
Dondonov et al. (2008)
Sanlaville et al. (1997)
Elevation (m)
0
250
500
750
1000
Depth (m)
-1000
-750
-500
-250
0
-100m contour
1,5 m ASL
VERTICAL MOBILITY OF THE RELATIVE SEA-LEVEL
1 m ASL
Lebanon +0,6 m
Northern Syria +0,6 m
0,5 m ASL
+0,6 m
0 = MSL
0,5 m BSL
6000 BC
5000 BC
4000 BC
3000 BC
2000 BC
1000 BC
BC AD
1000 AD
4600 BC
?
3500 BC
2800 BC
800 BC
500 AD
1200 AD
Period 1
Period 2
Period 3
Period 4
Period 5
Period 6
Period 7
HORIZONTAL MOBILITY OF THE SHORELINE
b)
Erosion
Aggradation
Uplift

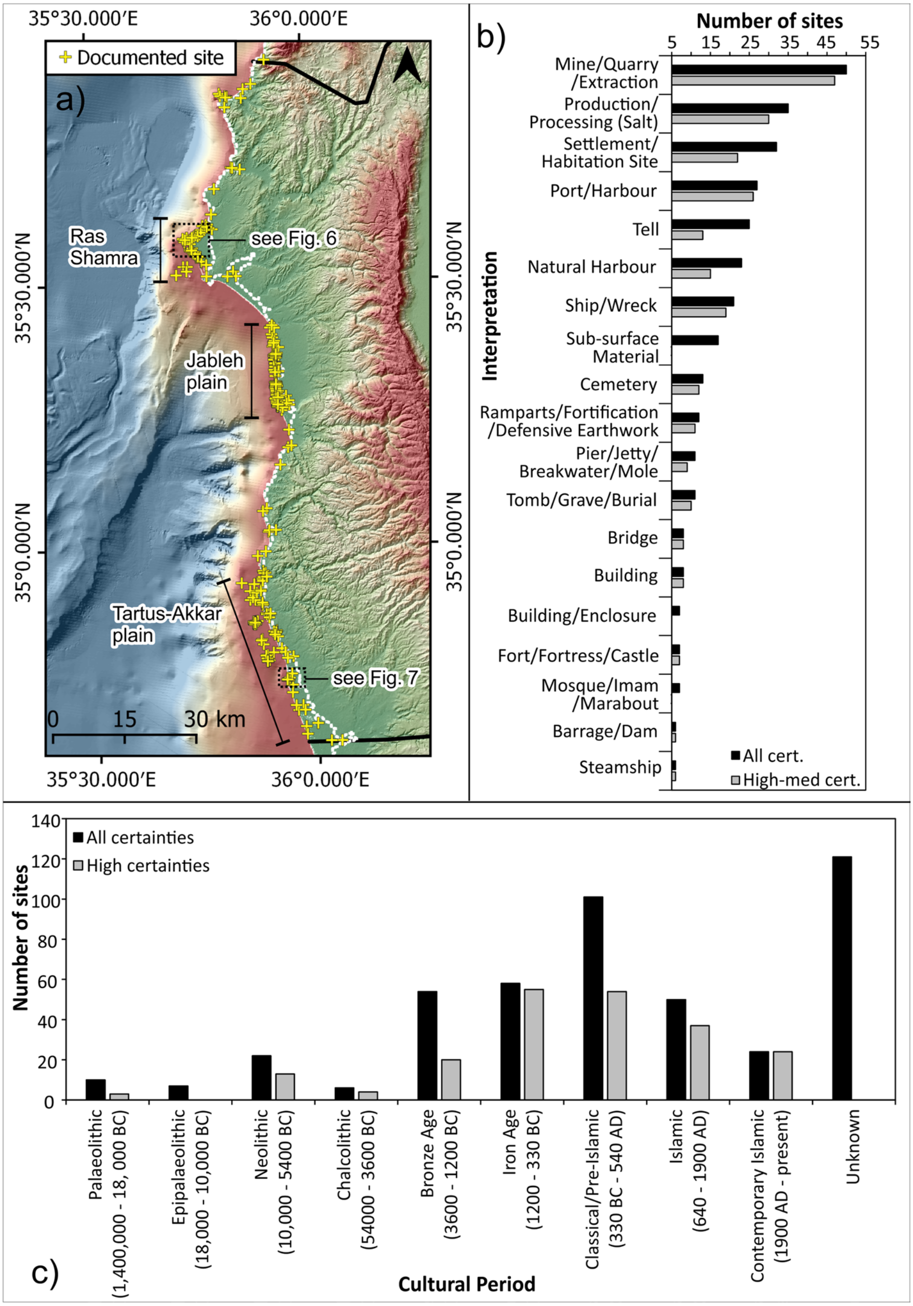


Fig. 3 **a** Spatial distribution of documented sites. **b** Bar chart showing number of occurrences of interpreted site types using all certainty qualifiers (black) and only high (definite, high, medium) certainty qualifiers (grey). Only categories with > 5 documented occurrences are shown. **c** Bar chart showing number of occurrences of cultural periods using all certainty qualifiers (black) and only high certainty (Definite, Probable) qualifiers (grey). Note that the totals for B and C are more than the number of documented sites (290) because individual sites can have multiple interpretations and cultural periods. All terms used and age ranges are as per the EAMENA database controlled vocabulary

In total, 27 shipwrecks were identified. However, only five of these are demonstrably ancient (Classical period up to 12-13th C AD: Murai et al. 1988; Kampbell 2013) and at least three are represented by dispersed cargo scatters rather than wreck structures and/or amphora mounds. The majority of documented wrecks are late 19th to mid-20th century AD vessels and include several large, probably metal, shallow water, intertidal wrecks with unknown construction or loss dates and which are visible on satellite imagery (Westley et al. 2018; Wrecksite.eu 2020). Again, this is evidence of a lack of active underwater archaeological investigation (Haldane 1993; Kampbell 2013). If so, given the presence of numerous ancient ports and harbours, it suggests a strong possibility that many ancient shipwrecks are still to be discovered in Syrian waters.

Threat and Disturbance Assessment

Disturbance assessments were conducted primarily by comparing satellite imagery from multiple timesteps to identify impacts which have damaged sites or their surroundings. Threat assessments were then produced by extrapolating from the disturbance patterns (Rayne et al. 2017; Andreou et al. 2020). For instance, a site located on the foreshore that has previously been affected by coastal erosion would then also have coastal erosion identified as a future threat. Similarly, a site located in a field with crops would have ploughing identified as a potential threat. For both threats and disturbances, certainty qualifiers (definite, high, medium, or low for disturbances; possible or probable for threats) are used to add additional nuance to the interpretation.

A general picture of past disturbance and future threat can be obtained by using general overarching categories (Fig. 4). This clearly shows that, unlike elsewhere in Syria (Danti 2015; Casana and Laugier 2017; Danti et al. 2017; Kanjou 2020), the coastal strip has largely escaped direct conflict-related disturbances to cultural heritage. Instead, by far the most common identified disturbance and threat category is natural processes. However, there are also strong indications that human activities, most clearly related to agriculture, building, infrastructure and domestic use, have also impacted many sites and will likely continue to do so.

The specific causes of disturbance or threat within these categories can also be examined in more detail (Fig. 5). The most common identified cause of disturbance process is construction (Fig. 5a). This relates principally to the urbanization and development of the Syrian coast which has occurred mainly in the last 30–40 years (e.g. Hammad et al. 2018). The next most common disturbance cause is water action, a generalized term which encompasses a series of effects caused by the flow and movement of water. The high numbers for this cause are because it is a generalized term which is used when the precise cause cannot be determined. It is therefore applied to sites clearly located within the wave or tidal zone, and which, by dint of their position are often (and sometimes continually) impacted by processes such as waves, tides, and surges, but for which more precise impacts, such as coastal erosion, cannot be determined.

Significantly, the next most common disturbance categories are anthropogenic. The category road/track relate again to urbanization and infrastructure expansion, whilst vegetation/crops/trees and ploughing are clearly linked to agricultural practice which also appears to have intensified in the last few decades. For example, comparisons of recent and Corona satellite images show that many fields have been given over to orchards since the early 1970s, potentially resulting in root damage to archaeological material, or its removal in

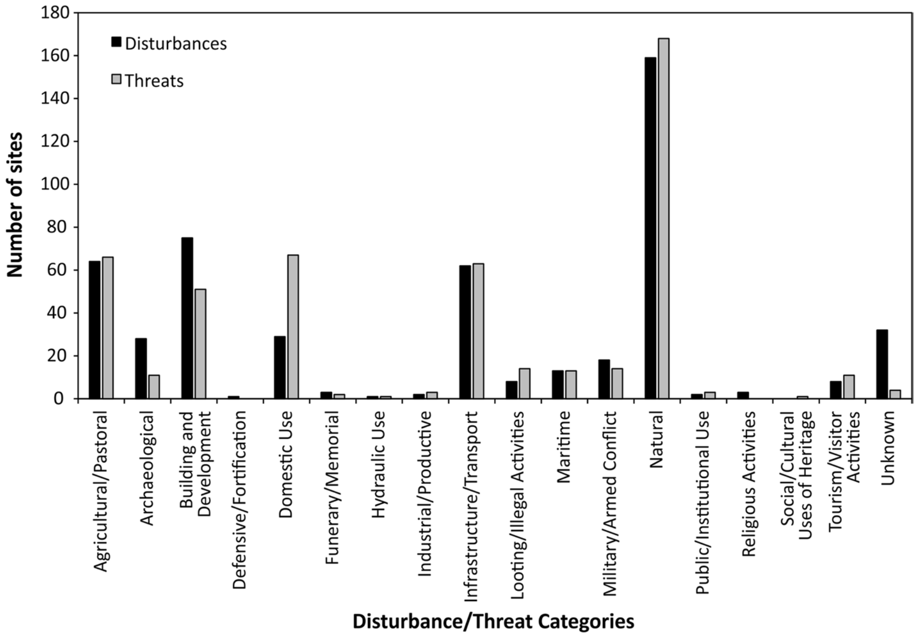


Fig. 4 Bar chart showing number of occurrences of generalized categories for identified past disturbances (black) and potential future threats (grey). Note that totals are more than the number of documented sites (290) because individual sites can have multiple threats and disturbances

advance of planting, whilst other fields have had polytunnels constructed over them. Other high frequency disturbances are occupational and continued use, which reflects the fact that people are living on and around archaeological sites. Excavation (unclassified) and clearance (bulldozing/levelling) would be another cause. In many cases, the latter two causes reflect preparation of land in advance of construction. Few direct impacts from violent conflict were identified.

The most common cause of threat is water action, relating to the prevalence of coastal sites (Fig. 5b). Although this is generally the result of natural coastal processes, impacts associated with it, such as flooding or erosion, may well increase in the near future with anthropogenic climate change (Reimann et al. 2018; Brooks et al. 2020; Westley et al. 2021). This is also evidenced by the fact that a relatively high number of sites are identified as potentially being affected by coastal erosion and retreat, albeit with lower (i.e. possible) certainties because the precise rate and extent of coastal change has yet to be ascertained at a site level. It should also be remembered that coastal processes can be altered by human interference, such as construction activities which modify natural sediment dynamics and shift the location of zones of erosion versus deposition, or variation in fluvially supplied sediment caused by changing land use inland (Mohamed 2021; Hzami et al. 2021).

The second most common threat is occupation/continued use and is the result of numerous documented sites lying within urban or agricultural areas which are actively used by the present population. The high numbers for this category are also the result of more specific threats that cannot be identified beyond the fact that people will continue to live and work on, or adjacent to, archaeological sites. The next common categories (excepting coastal erosion/retreat; discussed above) also relate to human activity; specifically, construction, vegetation/crops/trees, road/track and ploughing. These again likely reflect

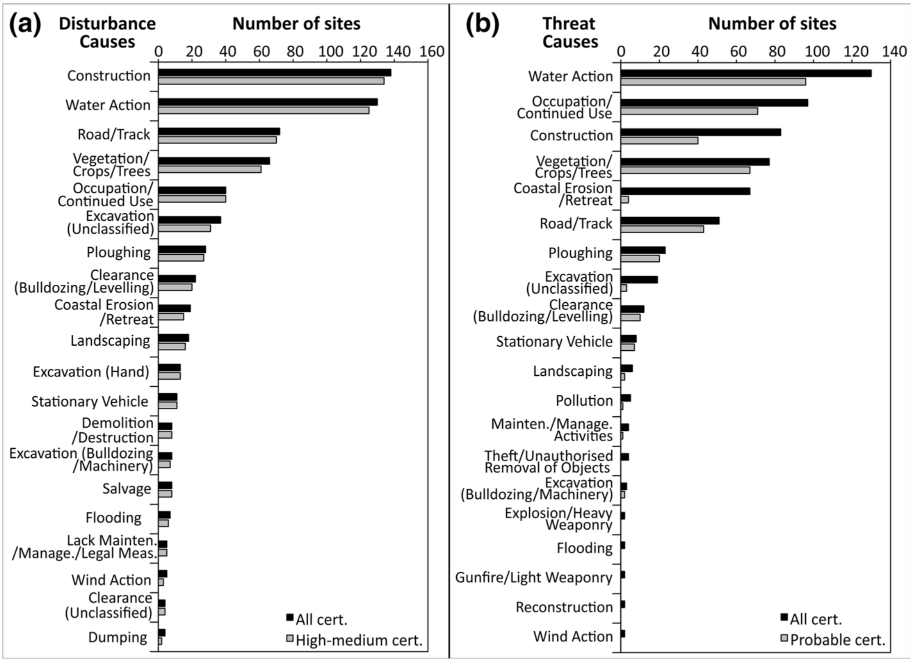


Fig. 5 Bar chart showing the 20 most common occurrences of **a** disturbances and **b** threat causes. Both sets of causes are presented with all certainty qualifiers (black) and only high certainty qualifiers (grey; Definite-High-Medium for disturbances; Probable for threats). Note that totals are more than the number of documented sites (290) because individual sites can have multiple threats and disturbances

continuation of the trends of urban and infrastructure development and agricultural intensification which are visible from the satellite imagery. In some cases, the impact on archaeological material may be minimal or absent (i.e. possible rather than probable certainty). In other cases, particularly with regard to infrastructure or urban expansion, impacts could be destructive unless appropriately mitigated.

Case Studies

Two case studies are presented below which illustrate representative examples of coastal sites, the disturbances they have experienced, and the potential threats they face.

Ras Ibn Hani/Ras Shamra

The coastal plain north of Latakia contains several important archaeological sites, not the least of which is Ras Shamra/Ugarit, inhabited from the Neolithic onwards and capital of a Bronze Age kingdom which flourished between 1800 and 1200 BC. Ras Shamra is located 1 km inland and was served by the port of Minet el-Beida, situated in a sheltered bay (Yon 2006). Southeast of Ras Sharma lies the Ras Ibn Hani Peninsula. This area also contains a

Ugaritic settlement, but which survived the collapse of the Ugaritic kingdom and continued to be occupied through the Iron Age and Classical periods (Bounni et al. 1979).

The anchorage and harbouring opportunities in this area may have been a key reason for its settlement. Not only did Minet el-Beida offer a naturally sheltered harbour, but so too did Ras Ibn Hani after a tombolo formed in about 3500 to 3000 BP (i.e. 1500–1000 BC). This linked a small island to the mainland resulting in the creation of two sheltered bays. Evidence for harbour installations includes a series of small quays or jetties, possibly of a Late Bronze Age or Iron Age date, located on either side of the Ras Ibn Hani Peninsula (Fig. 6a; Marriner et al. 2012). Conversely, Minet el-Beida lacks archaeological evidence

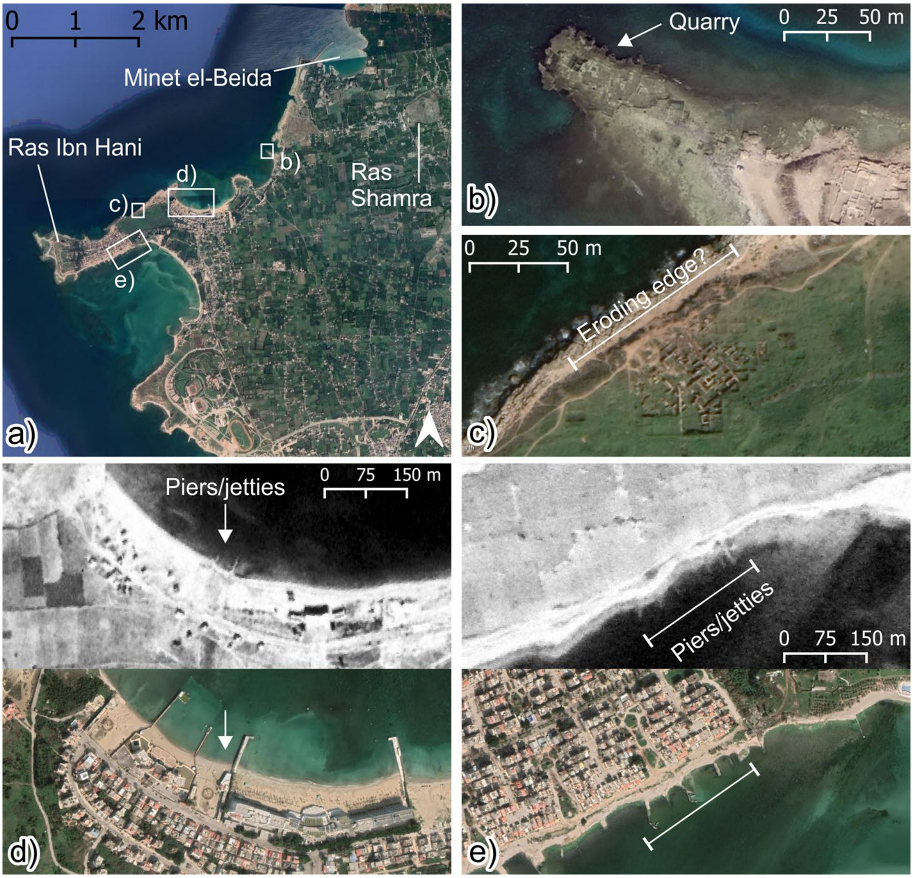


Fig. 6 Archaeological evidence around Ras Ibn Hani. **a** Overview satellite image showing locations of key sites and place names. **b** Quarries cut into foreshore bedrock platforms. **c** Possible eroding edge of the coastal backshore scarp which threatens the archaeological site at Ras Ibn Hani. **d** Top: Corona image (20/11/1968) showing probable Late Bronze Age or Iron Age piers faintly visible in the northern bay at Ras Ibn Hani. Bottom: Recent satellite image showing the same location but with the ancient piers removed or covered by recent construction. **e** Top: Corona image (02/12/1970) showing probable Late Bronze Age or Iron Age piers faintly visible in the southern bay at Ras Ibn Hani. Bottom: Recent satellite image showing the same location but with the ancient piers removed, covered or modified by recent construction. (All recent satellite images are from Google Earth and Maxar; A, C, D, E: 23/02/2019; B: 08/11/2016; Corona images are from the Corona Atlas: https://corona.cast.uark.edu)

of harbour infrastructure apart from warehouses, though ancient texts imply the presence of a quay or wharf (Carayon 2008).

Outside the harbour areas, the foreshore rock platforms have extensive evidence of quarrying visible on very high resolution (VHR) satellite imagery, at least some of which were previously recognized (Al-Maqdissi et al. 2010). In contrast to the rich onshore and coastal material, offshore evidence is lacking and again highlights the lack of underwater investigation, even in well-studied areas. There are hints of a submerged palaeo-landscape represented by buried peat layers, and a potential palaeo-channel (see Sect. 2; Marriner et al. 2012; Westley 2021), but definitive wreck material is lacking. For instance, although up to 43 stone anchors (or fragments) are known from Ras Ibn Hani, Ras Shamra and Minet el-Beida, these were found on land rather than underwater and may have been votive offerings. This is suggested by a collection of 17 anchors in the Temple of Baal at Ras Shamra, and the fact that the majority do not appear to have been used in the sea (Frost 1969; Warburton 2020).

A range of disturbances have impacted these sites. For example, Corona spy satellite imagery shows that Ras Ibn Hani was largely uninhabited in the late 1960s to early 1970s and suggests two piers or jetties in the northern bay and at least five in the southern bay. By 2004, extensive settlements covered the peninsula, the shores of both bays, and encroached on the archaeological sites. This development included the addition of modern jetties in close proximity to the ancient structures**.** In the northern bay, at least one northern jetty was still present in 2008 (Al-Maqdissi et al. 2010), and possibly as late as 2016 (based on VHR satellite images). Since then it appears to have been removed entirely or could be buried under the beach (Fig. 6d). In the southern bay, piers are still visible on recent imagery, but it is not clear if these are the original Bronze or Iron Age structures or whether they have been compromised by the recent development (Fig. 6e). In terms of threat, it is notable that the archaeological site at Ras Ibn Hani includes material on, or close to, an unconsolidated backshore scarp (Bounni et al. 1998). This is precisely the type of location that will be at risk from erosion triggered by twenty-first century sea-level rise driven by anthropogenic climate change.

Tabbat al-Hammam

Tabbat al-Hammam comprises a large coastal occupation mound (tell) which contains archaeological evidence dating from the Neolithic to the Hellenistic periods (Braidwood 1940; Hole 1959). It was originally excavated in 1938. This expedition identified a breakwater immediately adjacent to the mound and probably constructed in the eighth or ninth century BC. This consisted of an L-shaped structure built partly out of ashlar blocks, and extending up to several tens of meters offshore to create a sheltered harbour in the bay to the north (Frost 1972; Carayon 2008; Anbar 2020; Fig. 7a). A submerged scatter of ashlar blocks was also discovered approximately 200 m south of the breakwater and suggests the possibility of an additional southern harbour. The remains of both these latter installations were also observed and documented by Hijazi (1992). A stone quarry situated on the western side of the mound has been interpreted as the source of the blocks used for the breakwater. Remains of the breakwater were still present in the 1930s, albeit heavily eroded, and possibly into the early 1970s, based on Corona imagery (Fig. 7b). However, this has since been destroyed or buried beneath a modern breakwater which was constructed in 1992 or 1993. The mound itself and surrounding landscape have also been directly impacted by human activities since the late 1960s or early 1970s. Several paths or tracks presently cross the mound, and extensive housing developments

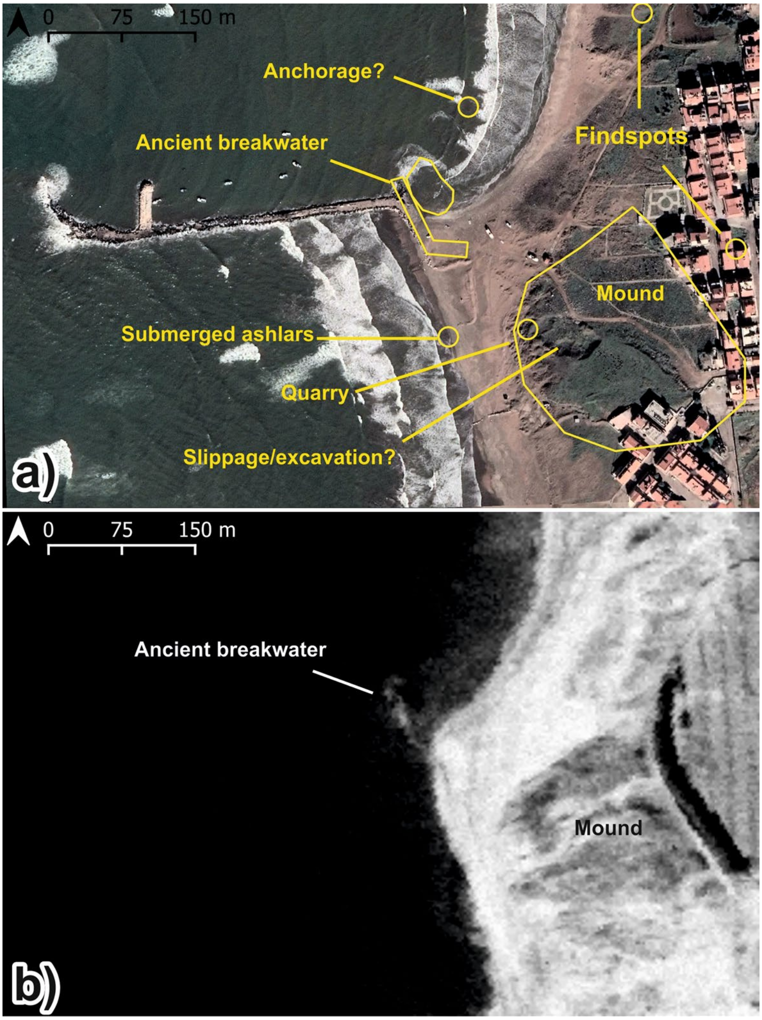


Fig. 7 **a** Tabbat al-Hammam showing archaeological evidence identified by Braidwood (1940) overlaid onto recent (25/12/2017) satellite image (from CNES and Google Earth). Note the modern breakwater and also recent impacts from paths and housing. **b** Corona image (02/12/1970) showing the mound and possibly the ancient breakwater (image from the Corona Atlas:: https://corona.cast.uark.edu)

now encroach directly on it from the south and east (Fig. 7A). Recent VHR satellite images also show collapse on one side of the mound which could be either from natural slippage or illicit excavation. The submerged ashlar blocks south of the breakwater cannot be identified by recent imagery; therefore, it is unclear if they are still present, but buried, or have been removed.

Discussion

The above baseline assessment can be used to develop a series of thematic and chronological observations, identify key threats and pressures, and suggest ways to advance maritime archaeology in Syria. Nevertheless, we recognize that this contains significant generalizations which are heavily conditioned by the limited amount of research and investigation conducted to date on Syria's maritime cultural heritage. As such, we stress that the discussion and observations presented in this paper should be seen as a 'first-pass' overview made on the basis of the present evidence and which can be modified or refined as new information generated by further research becomes available.

Thematic Observations

The most immediately obvious gap is the lack of underwater archaeological research. Shipwrecks are present, but the majority of documented examples are quite recent. However, even the limited underwater projects to date have discovered ancient wrecks or cargoes (Murai et al. 1988; Kampbell 2013). Submerged landscape investigation is almost non-existent and is hindered by a lack of marine geological data which could inform studies of RSL and palaeo-geographic change, taphonomic conditions and preservation potential. This contrasts with the extensive offshore surveys and submerged landscape research that have taken place elsewhere in the Levant (Galili et al. 2017, 2020). Coastal geoarchaeological work is also relatively limited with the only examples being from Ras Ibn Hani and Tell Tweini (Al-Maqdissi et al. 2007; Marriner et al. 2012; Baeteman and Bogemans 2019). Again, this contrasts with parts of the Levant; for example, in Lebanon where multiple detailed geoarchaeological studies of ancient harbours have been undertaken (Marriner et al. 2006, 2008a, b; Marriner and Morhange 2008; Carayon et al. 2011b, a).

Chronologically, it is clear that much work has focused on the Bronze and Iron Ages and, to a lesser extent, the Classical period. Earlier periods (i.e. Palaeolithic and Neolithic) are not well researched along the Syrian coast, beyond a handful of landscape survey projects (Besançon et al. 1994; Riis et al. 2004). Later periods (e.g. the Islamic period) appear to receive relatively little archaeological attention. This has no doubt been influenced by the obvious and accessible nature of the Classical period and Bronze and Iron Age evidence, such as ruined structures and distinctive tell sites. This is manifested in long-running investigations at key sites, such as Ras Shamra.

With regard to ports and harbours, it is evident that despite the high number of documented Classical period sites, there is a lack of built harbour infrastructure from this period. For example, the infrastructure at Tabbat al-Hammam, Arwad Island and Ras Ibn Hani is usually regarded as dating from the late Bronze Age to Iron Age (Braidwood 1940; Bounni et al. 1979; Carayon 2008; Marriner et al. 2012; Anbar 2020). Possible exceptions are the buried quay at Amrit and the mole at Ras-el Bassit, both of which are regarded as Hellenistic (Courbin 1986; Al-Maqdissi 1993; Carayon 2008). Several reasons for this can be suggested, but which need further investigation to confirm. For instance, the changing location of maritime hubs, such as the abandonment of Ugarit and subsequent concentration of Classical-period maritime activities at Arwad, Latakia and Tartus. At these latter two sites, investigation has been hindered by recent urban development and port expansion. This has in all probability destroyed or, in a best-case scenario, covered the relevant evidence although Latakia does have an excavated port basin which is as yet undated (Carayon

2008). Even at sites which have been investigated, port development and harbour infrastructure appears to have only been examined to a relatively small degree (e.g., Amrit, Ras el-Bassit), particularly compared to work on the adjacent settlement sites. This could be due to either a lack of interest or expertise, particularly since much of the relevant evidence is either buried or submerged and hence more difficult to access by non-specialists. Nonetheless, even without evidence of major built infrastructure, it is clear that maritime activity continued into the Classical period as evidenced by Syrian exports found elsewhere. This includes distinctive north Syrian mortaria produced at Ras El-Bassit and which are found across the Eastern Mediterranean and occasionally further afield (Hayes 1967). Therefore a, final possibility is that some of this maritime activity relied on opportunistic ports without built infrastructure, as described for Cyprus (Leidwanger 2013).

Challenges and Threats

Fortunately, and in contrast to areas inland, Syria's maritime heritage has been minimally affected by violent conflict. The risk assessment above (Sect. 5) has highlighted the increasing development of the Syrian coast in the last half-century with urban expansion and agricultural intensification prevalent. It is also possible that the coastal area, having escaped the worst of the conflict, is placed under increased pressure by increasing numbers of internally displaced people who have fled areas of fighting (Hammad et al. 2018; Mohamed 2021) and resulting in increased and even unplanned, development. For instance, satellite imagery shows that coastal development did not stop during the conflict. Active construction and land reclamation has taken place northwest of Latakia since 2015, construction of a ring road around Jableh was initiated in 2016, and the final stages of seafront redevelopment at Tartus took place between 2010 and 2013. In some cases (e.g. Tabbat el-Hammam, Ras Ibn Hani), anthropogenic activities have clearly impacted the maritime heritage. Given the lack of maritime specialism within the DGAM (Kanjou 2020), the level of heritage protection is probably minimal, in particular for the coast and seabed. If development continues apace, particularly if increased financing comes in post-conflict, there will be a clear need to meet this challenge via enhanced capacity for maritime archaeological management.

Natural threats, principally resulting from waves and storms, are also present. Definite coastal retreat has also been noted at several locations (e.g. Arab al-Milk: Westley et al. 2018). Without further study, it is unclear whether such threats will be exacerbated by modification of coastal sedimentary regimes caused by human actions such as seawall construction, harbour expansion, sand mining, or upstream reduction of sediment supply, as elsewhere in the Mediterranean (Hzami et al. 2021). However, there is also a strong likelihood that twenty-first century anthropogenic climate change will result in enhanced threat levels, principally as a result of sea-level rise, more frequent flooding, and accelerated coastal erosion (Vousdoukas et al. 2018, 2020; Westley et al. 2021). Particularly vulnerable sites are those situated at or close to the water's edge and with archaeological material embedded in or built on top of unconsolidated sediments. Tabbat al-Hammam and Ras Ibn Hani are examples of such sites, and there are others, such as Tell Sukas. Fully submerged archaeological material, particularly within dynamic shallow nearshore waters will also be subject to potentially destructive processes, such as storms, waves, and currents. For instance, sites can be rapidly uncovered as a result of storm activity, with formerly buried material exposed or re-worked, and later re-buried. Whilst this is often part of the natural dynamic equilibrium which submerged sites reach with their surrounding environment (Quinn et al. 2016; Majcher et al. 2021), there are suggestions that this could be variably altered on a site-by-site basis as future climate change affects storm frequency and intensity (Wright 2016).

Future Outlook

The clear lack of material offshore requires further research to confirm if there is genuine absence of evidence or if there is more material to be discovered. This could include initiation of 1) Underwater archaeological prospection for shipwrecks using geophysical techniques and targeted at areas with known wrecks, potential harbours and submerged coastal sites; 2) Marine geological research on past sea-level change, taphonomic conditions along with submerged palaeo-landscape preservation and 3) Liaison with local museums, fishermen, or divers to ascertain the existence of unrecorded or unreported archaeological material. For example, the bay of Bassit reportedly contains more unrecorded wrecks identified by local fishermen (Kampbell 2013; see Beaudry (2014) for mention of an intact amphora recovered from this bay in 2002). In addition to underwater sites, it is also clear that elements of the coastal and foreshore archaeological record are also worthy of investigation, for instance geoarchaeological investigation of potential harbours and less well-studied coastal sites (Carayon 2008). It seems that some efforts were steered in this direction in the 2000s (Al-Maqdissi et al. 2010), but with the exception of Ras Ibn Hani (Marriner et al. 2012), results have not come to fruition, presumably stalled by the conflict.

Syria is now emerging from a period of intense conflict and the post-conflict reconstruction of economy and society has commenced. Such strategies need to deal comprehensively with environmental and heritage resource protection. In terms of the country's marine cultural heritage, there is a pressing need to consolidate a baseline survey of the resource. This will include a programme of field mapping, supported by Syrian professionals who have the capacity to undertake such work, as well as the development of a comprehensive plan for site and landscape protection to ensure the continued survival of the resource. Central to this will be the involvement of coastal communities and the development of stewardship programmes that contribute towards coastal sustainability. The successful advancement of maritime archaeology in Syria depends on enhancing local capacity, so that there are community specialists with the skills and knowledge to investigate and manage the resource appropriately. This is being tackled on a small scale by recent HFF scholarships awarded to two Syrian archaeologists to undertake post-graduate masters of science research in maritime archaeology at the University of Aix-Marseille. The foci of the individual research theses were ancient Ugarit and Arwad Island (Anbar 2020). The latter has now been taken forward in the form of doctoral research. Further capacity development projects could aim to encourage more in-country partnership, including groundtruthing and documentation of remotely identified sites and enhanced aerial survey.

Conclusion

This assessment has consolidated a baseline understanding of Syrian maritime heritage, a significant step considering the general lack of maritime archaeological investigation in the country. The 290 documented sites analysed here range from Palaeolithic lithic scatters to modern shipwrecks and some sites—e.g. lithic/ceramic scatters—have no explicit 'maritime' function, but are included because of their proximity to the coast. However, many other sites have a genuine maritime function—e.g. shipwrecks, ports and harbours. Importantly, this includes evidence for previously unrecorded or poorly recorded coastal activity in the form of possible foreshore quarries and potential harbour sites. The review of RSL change has also highlighted the complexity of palaeo-geographic change along the Syrian coast with implications for both submerged landscapes and harbour evolution. The disturbance assessment has revealed that, despite the ongoing conflict, there has been minimal direct impact from violent action. Identified primary disturbances relate to anthropogenic actions such as construction, agricultural activities, and infrastructure development. That said, these are all impacts which can be exacerbated by reduction of historic environment management capacity caused by the conflict. Natural processes, particularly water action related to coastal and marine processes, have also played a role. However, in many cases the precise effects are unclear other than contribution to long-term deterioration of foreshore or submerged sites. Threat assessment has revealed a similar pattern with sites on or immediately landward of the shoreline vulnerable to coastal or marine processes including erosion, particularly in light of future anthropogenic climate change-induced sea-level rise, and storm surges. In many cases, anthropogenic pressures remain prevalent. For instance, continued use or occupation of areas on or around archaeological sites and also construction, which clearly did not stop despite the conflict. Given the possibility of conflict-related internal migration and post-conflict financing, these threats could well increase in the future. The assessment has also identified distinct gaps, notably with respect to underwater investigation and integration of geological and geoarchaeological research. However, the most pressing need is that of in-country capacity. Local expertise is needed to conduct field assessments which can consolidate, update, and maintain this baseline, largely generated through remote sensing, and equally important is that it can also lead effective management strategies to counter the multiple threats facing Syria's irreplaceable maritime cultural heritage.

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