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Harbour and Coastal Archaeology in Syria A Review of the Past and the Recent Archaeological and Geoarchaeological Surveys

Article 4

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HARBOUR AND COASTAL ARCHAEOLOGY IN SYRIA
A REVIEW OF THE PAST AND THE RECENT ARCHAEOLOGICAL AND GEOARCHAEOLOGICAL SURVEYS

ABSTRACT

[AR] الآثار الساحلية والمرافئ في سوريا: مراجعة للمسوحات الأثرية والجيو أثرية الماضية والحديثة

تتميز الآثار الساحلية السورية بإرث تاريخي غني يعود تاريخه إلى العصر البرونزي، والذي يتمثل في مدن الميناء البارزة مثل أوغاريت (رأس شمرا حاليًا)، وأرواد، وعمريت، وجبلة، وتبة الحمام. لعبت هذه المدن الساحلية أدوارًا محورية في ربط الحضارات القديمة في المنطقة بعالم البحر الأبيض المتوسط الأوسع، وشهدت أنشطة بحرية نابضة بالحياة تشمل التجارة والملاحة البحرية وبناء السفن. على الرغم من محدودية الأبحاث الأثرية البحرية على طول الساحل السوري منذ الستينيات، والتي تفاقمت بسبب الاضطرابات الشديدة منذ عام 2011، فقد شهدت السنوات الأخيرة جهودًا جديرة بالثناء للقيام بمهام أثرية تحت الماء. تركز هذه المساعي، على الرغم من التحديات العديدة، على توثيق التراث الثقافي الساحلي وتحت الماء في سوريا. وبالاعتماد على أحدث الأعمال الميدانية الأثرية. تسلط هذه الدراسة الضوء على الاكتشافات المهمة في شعاب أرواد الواقعة على الامتداد الجنوبي للساحل السوري مقابل مدينة طرطوس الحديثة. وقد وفر التوثيق المنهجي للبقايا الأثرية المرتبطة بميناء أرواد والتحصينات الساحلية فهمًا شاملاً للتطور المعماري للمدينة القديمة. وهذا يساهم بشكل كبير في المعرفة الأوسع فيما يتعلق بتقنيات البناء السائدة في منطقة البحر الأبيض المتوسط. علاوة على ذلك، فإن التسجيل الأثري للبقايا القديمة المغمورة وجدران التحصينات الساحلية قد أسفر عن رؤى جديدة حول التغيرات البيئية. هذه التغيرات، المرتبطة ارتباطًا وثيقًا بالتقلبات النسبية لمستوى سطح البحر والنشاط التكتوني، تقدم منظورًا جديدًا للعوامل المؤثرة على تطور الجزيرة، مما يشير إلى أن الجزيرة شهدت هبوطًا أدى إلى غمر البقايا الأثرية. في جوهره، يثري هذا البحث فهمنا للماضي البحري في سوريا، في ظل التحديات المعاصرة، ويسلط الضوء على كل من التطور المكانية والبيئية في سياق البحر الأبيض المتوسط.

[EN] Syrian harbour and coastal archaeology have a rich historical legacy dating back to the Bronze Age, exemplified by prominent harbour cities such as Ugarit (modern-day Ras Shamra), Arwad, Amrit, Jableh and Tabbat al-Hammam. These harbour cities played essential roles in connecting the region's ancient civilizations with the broader Mediterranean world, witnessing diverse maritime activities encompassing trade, seafaring, and shipbuilding. Despite limited maritime archaeological research along the Syrian coastline since the 1960s and severe disruptions since 2011, recent years have witnessed commendable efforts to undertake underwater archaeological missions. These endeavours, despite several challenges, focus on documenting Syria's coastal and underwater cultural heritage. Drawing upon the latest archaeological missions, this study highlights significant discoveries at Arwad reef, situated on the southern stretch of the Syrian coastline opposite the modern city of Tartous. Systematic documentation of archaeological remains associated with Arwad's harbour and coastal fortifications has provided a holistic understanding of the ancient city's architectural development. This contributes substantially to broader knowledge regarding construction techniques prevalent in the Mediterranean region. Moreover, the archaeological recording of submerged ancient remains and submerged coastal fortification walls has yielded new insights into environmental changes in the region. These changes, intimately linked with relative sea level fluctuations and tectonic activity, offer a new perspective on factors influencing the island's development, suggesting that the island has experienced subsidence resulting in the submergence of the archaeological remains. In essence, this research enriches our comprehension of Syria's maritime past, even amid contemporary challenges, shedding light on both spatial evolution and environmental dynamics in the Mediterranean context.

KEYWORDS: Arwad island, coastal fortification, construction techniques, harbour and coastal archaeology, harbour infrastructure, Syrian coastline, relative sea level change.

I. INTRODUCTION

Syria has a relatively short coastline in the eastern Mediterranean, which stretches for about 200 km between Turkey from the north and Lebanon from the south. Geographical features are characterised by sandy beaches, alternating with rocky headlands and low cliffs. The coast is surrounded from the east by a coastal mountain range (Mount Lattakia), reaching up to 1500 meters above the present msl**.** The Syrian coastline has a rich history with evidence of various civilizations such as Phoenicians, Greeks, Romans, and Byzantines that have flourished along the coast over thousands of years. These cultures have left their marks on Syrian maritime history including important Bronze Age harbours, well-known coastal settlements, Classical to Medieval period harbours and finally potentially well-preserved shipwrecks of all periods. Ancient epigraphic and literary sources described maritime trade and military activities that were hosted from at least the Bronze Age onwards. Ugarit Kingdom at Ras Shamra in the north and the Phoenician harbours of Arwad, Amrit and Tabbat al-Hammam in the south, could be among the earliest examples of the development of ports and harbours on the Syrian coastline[1].

Coastal and maritime archaeological research in Syria is still very limited, because there is a lack of systematic archaeological documentation and underwater archaeological fieldwork. Moreover, few geological and geoarchaeological research has been conducted on the Syrian coast which is also creating a gap when it comes to the interpretation of submerged archaeological sites. However, in recent years, despite the challenges, several surveys and archaeological fieldworks were performed on the Syrian coastline. The submerged reef of Arwad in the southern part of the Syrian coastline was the main target of underwater research during the last five years.

The archaeological coastal sites located along the reef are so steeped in history, already heavily occupied since the Bronze Age and possess diverse archaeological remains. Nowadays, these sites are facing severe threats such as coastal erosion, relative sea-level rise, and environmental changes caused by climate change and anthropogenic impacts. Therefore, these surveys have aimed for detailed archaeological documentation of the harbour sites and the development of strategies for future preservation and research.

II. OBJECTIVES

One of the main objectives of this paper is to establish a foundational understanding of the existing knowledge in harbour and coastal archaeological research on the Syrian coastline, both in terms of historical investigations and recent underwater archaeological surveys. Secondly, the paper aims to consolidate and illustrate the results of the only two underwater archaeological missions carried out on the southern part of the Syrian coastline since 1960s[2]. The first mission was started in 2019 by a Syrian-Russian archaeological team. The second was conducted in 2021-2022 and was used in the framework of my PhD thesis at Aix-Marseille University, which aimed

[1] El-Amarna letters (EA 98, EA 101, EA 104, EA 105 & EA 149). The epigraphic documents at Ras Shamra. ARNAUD 1992: 180-182, PSEUDO-SCYLAX (2015): Journey, § 104, mid. 4th c. BC. STRABO (1924): Geography 16.2, 20 BC – 23 AD. Https://topostext.org/texts Accessed on (01/10/2023).

[2] Honor frost has performed the first systematic underwater archaeological fieldwork in 1964-1966.

mainly at the systematic archaeological documentation of the harbour sites along Arwad Reef, focusing on the harbour structures and their geomorphological environment.

It is important to note that the accessibility to the recent Syrian-Russian archaeological mission surveys is very limited, especially the survey at the archaeological site of Amrit. Therefore, this paper will mainly focus on the documentation results of the archaeological surveys conducted at Arwad Island. Finally, by presenting the outcomes of these missions, the paper aims to contribute to the overall understanding of Syrian maritime and underwater archaeology building upon the pioneering work of Honor Frost.

III. A Review of the Previous Harbour and Coastal Archaeological Research on the Syrian Coast

Early Travellers and Exploration Campaigns

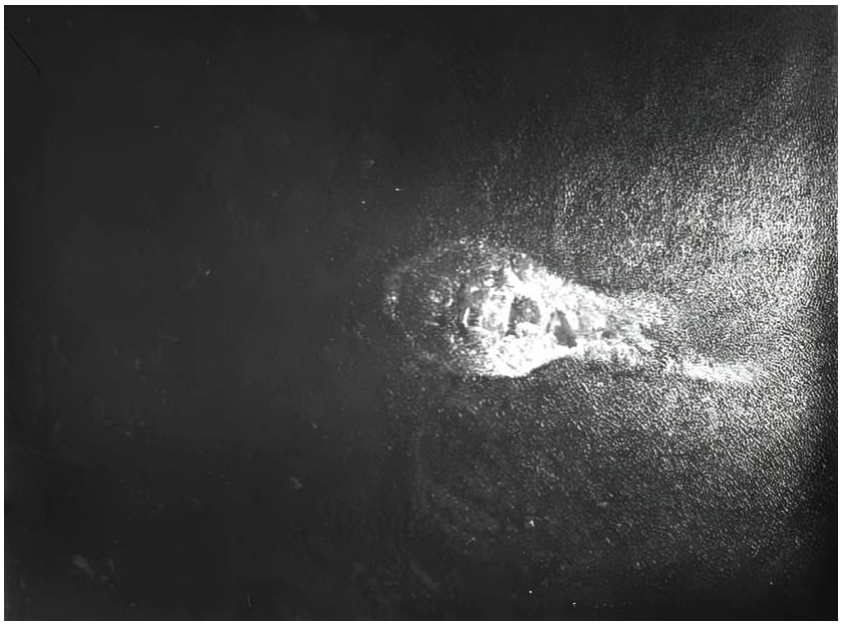
Back in the late 17th century, many travellers and geographers started their explorations on the eastern Mediterranean coastline. Their campaigns resulted in valuable descriptions, illustrations and freehand sketches of the archaeological remains of the harbour sites along the coast. In 1697, H. Maundrell described the main ancient harbour sites such as Lattakia, Arwad island and Amrit[3]. Later, in 1743 Pococke focused on the general features of the coastal cities from Tartous to Tripoli including Tartous (Antaradus), Amrit (Marathus) and the island of Arwad and its harbour and coastal fortification[4]. Ernest Renan's archaeological studies in 1864 were confined to the documentation of the southern part of the Syrian coast[5]. Gretille J. Chester, a member of the Royal Archaeological Institute, has published an article titled «*Notes on Ruad (Aradus) and Adjacent Places in Northern Syria*». He described the topography of the island and the general features of the coastal fortification[6]. Finally, in 1896 René Dussaud travelled along the Syrian coastline and produced some topographic notes and archaeological records during the first half of the 19th century[7].

Archaeological Surveys and Excavations

During the first half of the twentieth century, archaeological surveys accompanied by photographic documentation revealed valuable archaeological documentation of ancient harbour and coastal sites. In 1916, Savignac identified the remains of ancient monuments on Arwad during a short stay on the island. He recorded some archaeological features of the harbour and the coastal fortification[8]. Later, in the 1920's Sauvaget mentioned some ancient harbour remains in Lattakia[9]. In 1940 an archaeological excavation was initiated at the archaeological site of Tabbat al-Hammam

[3] Maundrell 1749: 19-22.
[4] Pococke 1743: 202-204.
[5] Renan 1864: 20-42.
[6] Chester 1875: 218-227.
[7] Dussaud 1927: 116-146.
[8] Savignac 1916: 567-577.
[9] Sauvaget et al. 1934: 87.

by Robert J. Braidwood[10]. At the same time, between 1918 and 1945, aerial photographs were taken by the French Army and by R. Poidebard[11] **[FIGURE 1]**. Furthermore, ancient harbour remains in Lattakia, Tel Tweini, Tel Sukas and Paltos were mentioned between the 1950's-1960's, by members of the Danish Carlsberg expedition in Syria.[12]



[FIGURE 1]: Syria, Tartous governorate, Jableh region, the Maraclea tower, vertical aerial view 29-05-1935. French Institute of the Middle East (IFPO), French Army, (HAL open science. Https://hal.science/hal-02479410. Accessed on (22/11/2022).

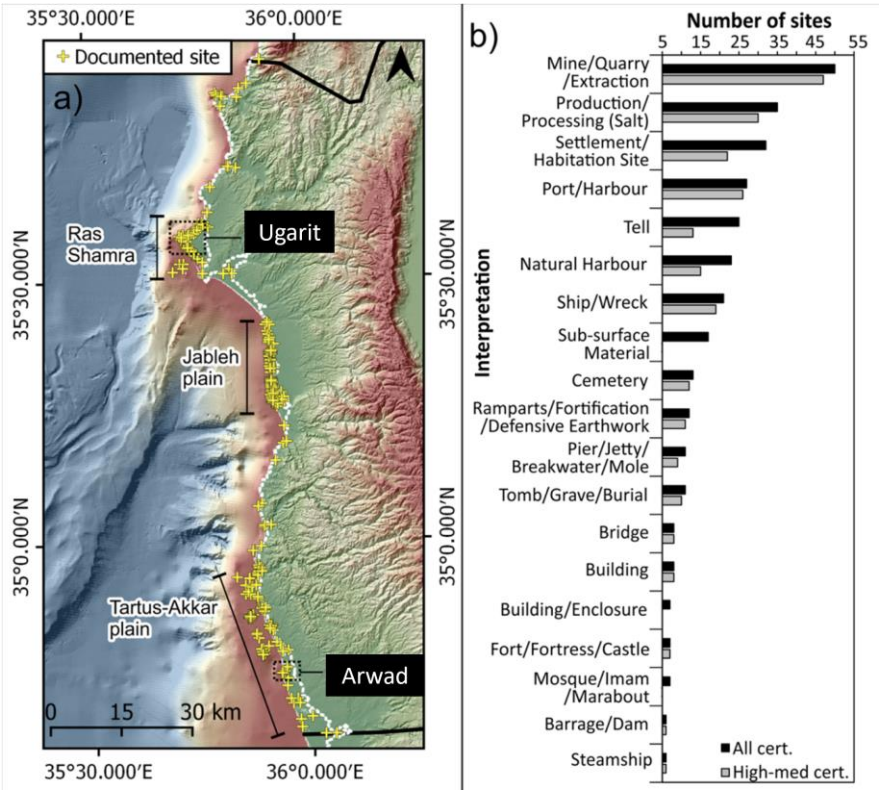
In the 1960s, Honor Frost was the first archaeologist to perform systematic underwater archaeological fieldwork in Syria introducing underwater archaeology. On the Syrian coast, she focused on the Phoenician harbours of Arwad, Amrit, Machroud and Tabbat al-Hammam[13]. Concerning other harbour installations, Courbin referred to harbour remains during excavation campaigns at al-Bassit in the 1970's[14]. Later, in 1978, the Tartous Department of Antiquities followed up the work of archaeological excavations on the archaeological site of Amrit; these works are still ongoing, aiming at the research of the area of the temple and the surrounding archaeological remains. In 1992 rescue excavations focused on the archaeological remains of the harbour of Amrit. These excavations revealed the harbour installations dating from the Hellenistic period.

One excavation was performed at the extension of the installations revealing several warehouses and a long quay[15]. Hussein Hijazi, a Syrian Navy officer, published the results of his extensive fieldwork in 1992, conducted over twenty years on the Syrian coastline, in his book *Ancient Ports, Harbours and Anchorages Along the Syrian Coast*. This book was the first systematic attempt at mapping and recording the ports,

[10] BRAIDWOOD 1940: 204-208.
[11] POIDEBARD & CAYEUX 1939: PL.XXVII; POIDEBARD et al. 1951: PL.XV.
[12] RIIS 1960: 111–132; 1965: 75–82; 2004: 15-16; OLDENBURG et al. 1981: 116.
[13] FROST 1964: 67-74; FROST 1966: 13-28; FROST 1970: 63-71; FROST 1995: 8-13.
[14] COURBIN 1986: 176.
[15] AL-MAQDISSI 1993: 448.

harbours, shipwrecks, and settlements on the Syrian coastline based on detailed field observations and architectural descriptions[16].

In 2008 N. Carayon focused his research on the identification of the geomorphological setting of the harbour sites and their infrastructures in the framework of his PhD research «*Les ports Pheniciens et Puniques geomorphologie et infrastuctures*»[17]. Recently, a comprehensive study «*the Syrian Benchmarking Report 2018*» initiated by the Honor Frost Foundation was the first concise desk-based approach to systematically gather, correlate and analyse all identified and potential sites and settlements on the Syrian coastline[18]. Finally, a comprehensive assessment that reviews past coastal environmental changes affecting the Syrian coastline was conducted in the framework of EAMENA and MarEA[19] **[FIGURE 2]**.



[FIGURE 2]: Spatial distribution of all identified and potential sites and settlements on the Syrian coastline. WESTLEY et al. 2022: 361.

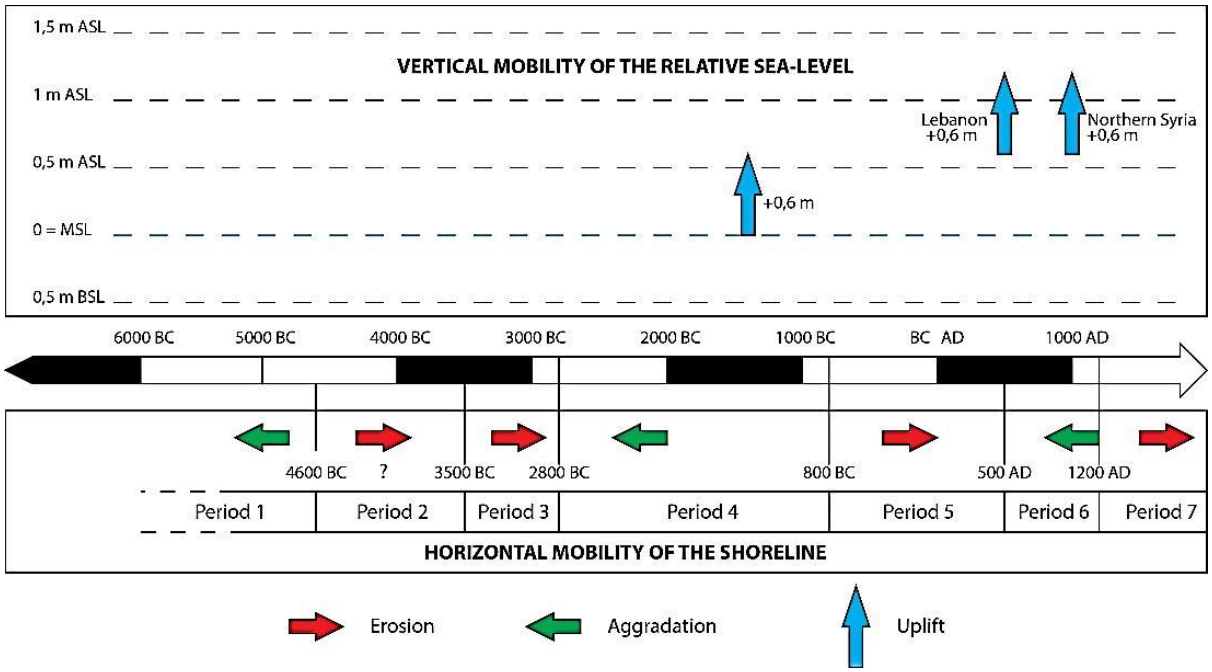
A Review of Previous Maritime Geoarchaeological Research in Syria

Understanding the main factors influencing coastal morphology is essential for comprehending the evolution of the harbour sites, where terrestrial and marine forces converge. The identification of the geomorphological settings requires a thorough understanding of the geological characteristics and topographical features of the coastal zone. Concurrently, tectonics and changes in sea level, whether natural or anthropogenic, linked to global climate change, contribute significantly to the harbour's

[16] HIJAZI 1992: 39-81.
[17] CARAYON 2008: 236-249.
[18] WESTLEY et al. 2018: 41-52.
[19] WESTLEY et al. 2022: 353–373.

coastal evolution. Sea level studies are also integral to harbour and coastal archaeology, providing a foundation for archaeological interpretations.

Relative sea-level change research has been relatively limited on the Syrian coastline[20]. Regional disparities were illustrated by these geomorphological and palaeo-environmental studies due to complex tectonic uplift and subsidence, in addition to horizontal movements controlled by sea level change, fluvial sedimentation, littoral drift and anthropic pressure. Nevertheless, two uplifted coastlines have been identified and dated on the Syrian coastline. The first occurred around c. 1400 BC and the second around c. 1000 AD in North Syria[21] **[FIGURE 3]**.

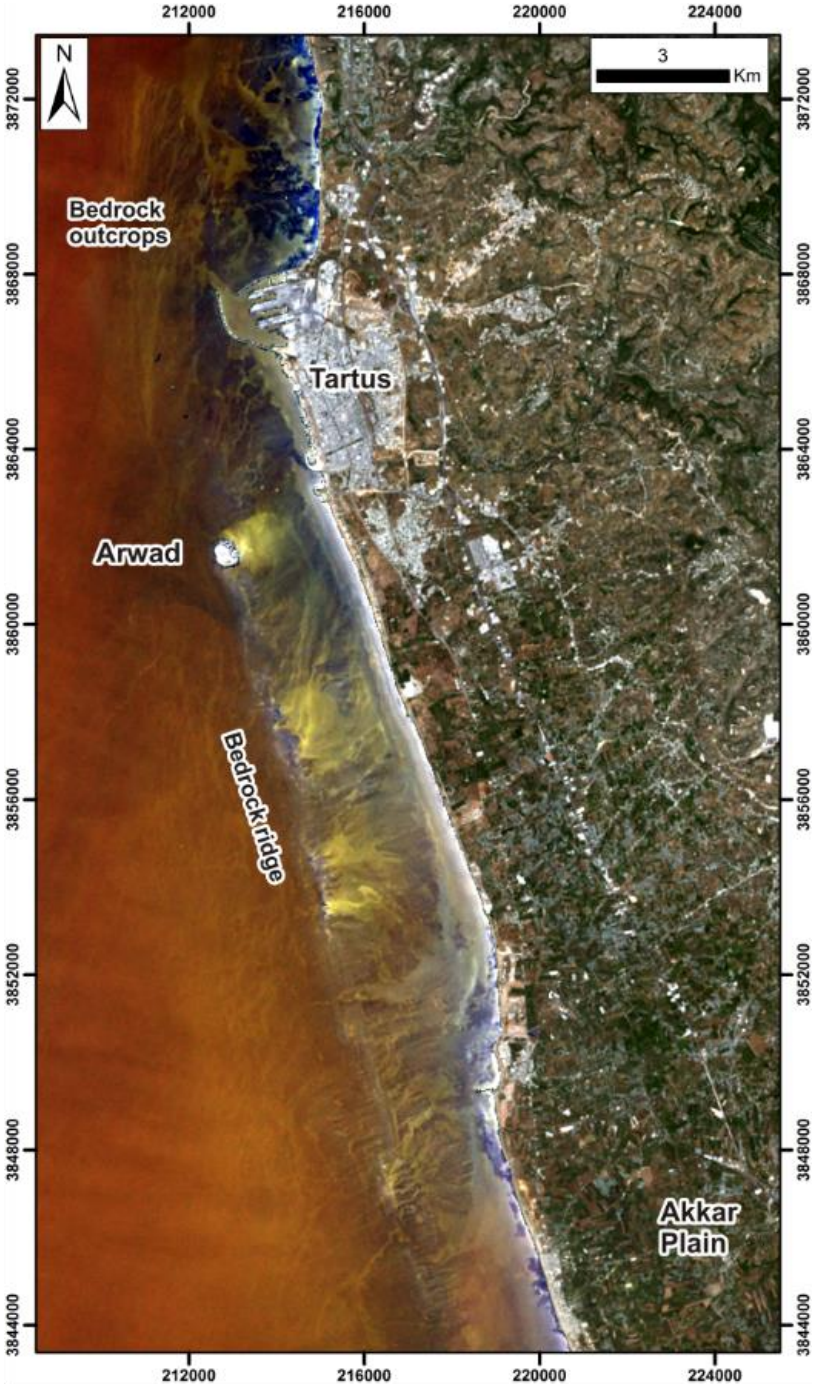


[FIGURE 3]: Relative sea level changes and principal phases of horizontal mobility along the Syrian coast during the Holocene. SANLAVILLE et al. 1997: 360; WESTLEY et al. 2022: FIG.7.

Recent Archaeological Surveys on Arwad Reef

After over 50 years, two underwater archaeological missions were carried out on Arwad reef where the Phoenician harbour sites of Arwad, Amrit and Tabbat Al-Hammam are located. The Syrian coast opposite Tartous is characterized by an underwater mountain range that forms a rocky seabed parallel to Tartous shoreline. This reef extends for about 15 kilometres towards the south starting from Arwad island which is its northern extremity. Arwad island and the other four islets (Al-Abbas, Abu-ᶜAli, Abu al-Faris and Machroud from north to south) are the only parts of this submerged bedrock ridge that have emerged. Machroud island lies about 8.5 km to the south and it is the last emerged islet of this reef **[FIGURE 4]**.

[20] DALONGEVILLE et al. 1993: 47; SANLAVILLE et al. 1997: 386-387; MARRINER et al. 2012: 46.
[21] SANLAVILLE 1997: 386-387; MARRINER et al. 2012: 46.



[FIGURE 4]: Shallow-water seabed geomorphology (<-20 to -30m) off Tartus. WESTLEY et al. 2018: 10.

Historically, Arwad island served as a major trade harbour, connecting the ancient Near East with the Mediterranean world. As a result of its strategic location at the crossroads of major trade routes on the Levantine coast, it witnessed extensive maritime activities, including trade, seafaring, and shipbuilding. In the Late Bronze Age, Arwad was a connecting harbour between the Egyptian, Hittites, and Mesopotamian civilizations. Arwad was mentioned in several epigraphic and textual ancient sources, such as in the El-Amarna letters of the 14th c. BC and the epigraphic documents at Ras Shamra, where Arwad has been described as one of the main harbour cities in the maritime trade route linking Ugarit and Egypt[22]. During the Iron Age, Arwad was an

[22] ARNAUD 1992: 192.

integral part of the successive Empires that ruled in the Middle East: Assyrian, Neo-Babylonian, Persian, Greek, and Roman[23]. Moreover, at the battle of Salamis in 480 BC, warships from Arwad were also part of the Persian navy that faced the Athenians.[24] Finally, in the late Iron Age, it was suggested that the territory of Arwad on the mainland extended north until Al-Mina near the estuary of the Orontes River[25].

The Syrian-Russian Archaeological Mission [2019-2021]

In late 2019, an archaeological mission was initiated under a collaborative agreement between the Directorate General of Antiquities and Museums (DGAM), the Syrian Ministry of Culture and the Russian University of Sevastopol. The research was carried out within the framework of the project of the development program of Sevastopol State University.

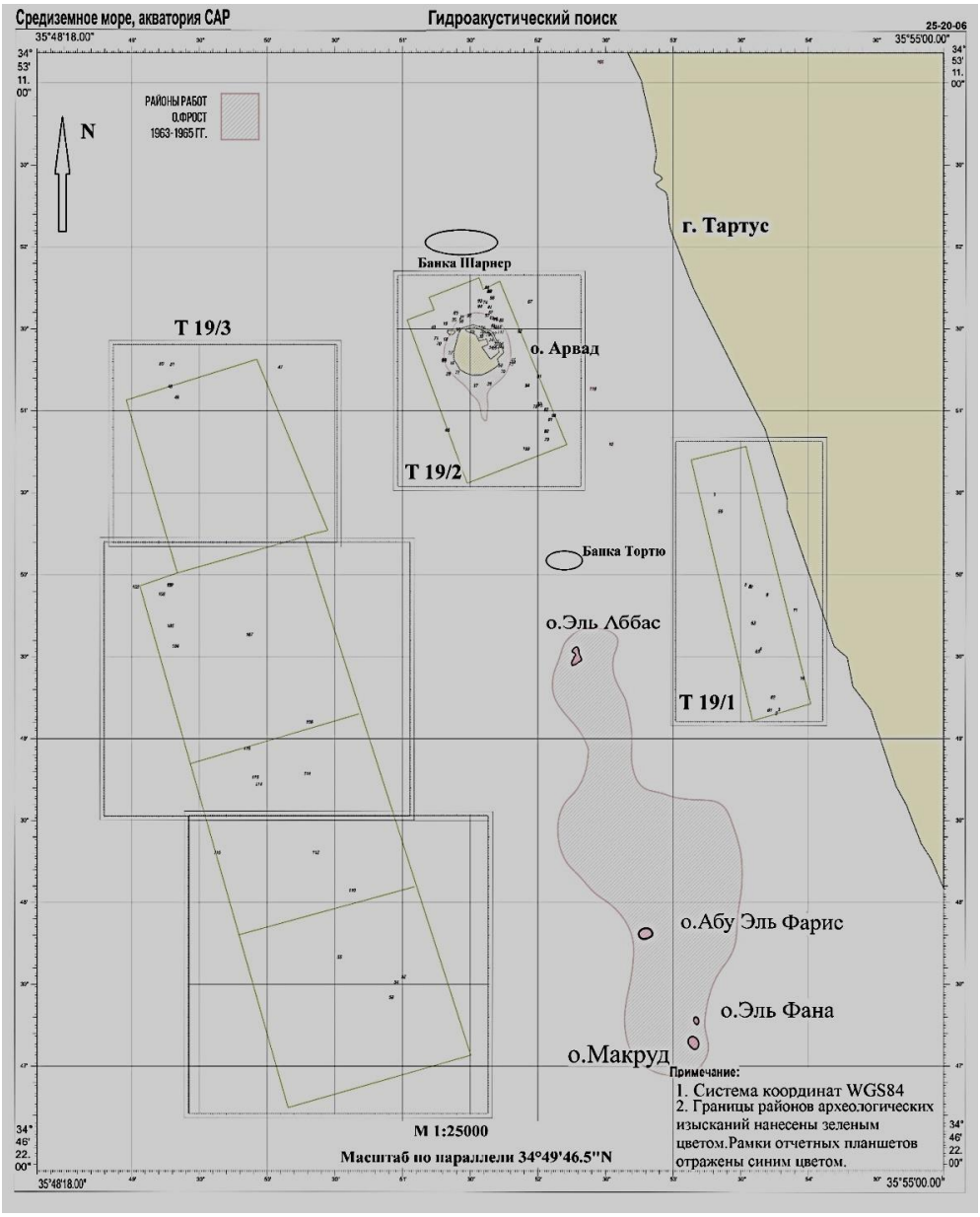
The main objectives of the mission are the monitoring and documentation of underwater archaeological remains including ancient shipwrecks along Arwad reef by using a mobile hydroacoustic sonar system (Side Scan Sonar). The activities included a three-dimensional laser survey and a photogrammetric survey of part of the submerged reef of Arwad island in addition to the fallen ashlar blocks of the fortification walls underwater. Moreover, areas around the small islands adjacent to Arwad island from the southern side were also surveyed. A geo-radar survey was conducted on part of the beach of the archaeological site of Amrit. Based on the 2019 survey data, a total of 119 promising targets and objects of archaeological interest were identified around Arwad island and offshore near the archaeological site of Amrit **[FIGURE 5]**. Noteworthy, findings include the detection of three shipwrecks, with one presumed to be of modern date. Additionally, Medieval port installations were identified in close proximity to the modern port of Tartous. Finally, the underwater destruction zone of the Arwad ancient fortification was identified as a focal point of interest[26].

[23] ANET 1969: 276-284; DIODORUS, (1933) 16.40: 41-42, https://topostext.org/texts. Accessed on (01/10/2023); QUINTE-CURCE (1861) :vol.4, 1, HTTP://BCS.FLTR.UCL.AC.BE/CURTIUSIV. Accessed on (01/10/2023).

[24] HERODOTUS, § 7.98, 430 BC. (1890), https://topostext.org/texts. Accessed on (01/10/2023).

[25] REY-COQUAIS 1974: 149-152; RIIS 2004: 66-88.

[26] LEBEDINSKI et al. 2020: 68-81.



[FIGURE 5]: Overview map of surveyed areas of the submerged reef of Arwad by the Syrian-Russian mission. LEBEDINSKI et al. 2020: FIG.2: 74.

Later in 2020 and 2021 the archaeological surveys were carried out by a team of divers, coupled with ROV surveys. Several archaeological targets were documented underwater near Arwad island and the tower of Maraclea (i.e. a structure measuring 16 m by16 m at a depth of -0.5 to -1.5 meters below present sea level **[FIGURE 1]**. Finally, on the south-eastern side of the island, at a depth of -4 to -5 meters below present sea level, a fortification wall was recorded. The wall has been traced for over 80 meters and is constructed with huge ashlar blocks **[FIGURE 6]**, which have different sizes ranging from 3.4 to 1.5 meters[27].

[27] LEBEDINSKI et al. 2022: 68-81.

[FIGURE 6]: A submerged fortification wall at the south-east corner of Arwad island. LEBEDINSKI et al. 2022: FIG.5: 60.

Back to Arwad in the Footsteps of Honor Frost 2021-2022 Surveys

A systematic archaeological documentation of the southern part of the Syrian coastline from Arwad island to Tabbat Al-Hammam took place for my PhD thesis at Aix-Marseille University 2020-2024. The PhD research concerns the maritime archaeological and geo-archaeological study of the Phoenician harbour sites (Arwad, Amrit - ancient *Marathous* and Tabbat Al-Hammam). The first coastal and underwater archaeological fieldwork was performed in May 2021 focusing on Arwad island, while the second fieldwork covered the ancient harbour site of Amrit in December 2022.

Objectives and Methodology of Documentation

The first survey at Arwad indicates that the island has a wealth of archaeological remains along its coastline in the south, west and north, presenting different construction techniques and different phases of construction. Moreover, the eastern side of the island creates a protected harbour basin from the west, south-west and north-west prevailing winds. The main objectives of the survey are to undertake a systematic documentation of all archaeological and geoarchaeological features, to perform a coastal change assessment of Arwad's harbour landscape, and to identify the construction techniques of the harbour structures and the coastal fortifications.

Methodologically, the archaeological fieldwork on Arwad island involved a combination of surveying, mapping and documentation techniques:

A. Architectural and 3D topographical documentation with total station provided by the archaeological department of Tartous of the Syrian Ministry of Culture. The topographic data was collected in a local coordinate system established on the present biological mean sea-level recorded by observing vermetids bioconstructions at Arwad ± 10 cm.

B. 3D photogrammetric documentation through high-resolution georeferenced aerial drone survey and on-land recording was done on the archaeological remains. Additionally, Digital Elevation Models (DEMOs) of the archaeological structures have been created and linked with the present biological mean sea-level recoded on the island.

C. Desk-based evaluation and data integration of published and non-published archaeological sources.

D. Aerial remote sensing analysis to record the coastal changes on the island during the last 100 years. Data used in this analysis: a) low-attitude aerial mapping performed in the field which provided very high-resolution (~2cm), b) recent high-resolution satellite imagery (<1 m) hosted on Google Earth (2009–2020), c) high-resolution (~3m) declassified Corona spy satellite imagery (1968–70) hosted by the open access Corona Atlas (http://corona.cast.uark.edu/)

E. Finally, we proceeded to the creation of a subsequent GIS database to facilitate the analysis and visualization of the documentation results and to enhance the management of maritime cultural heritage resources on Arwad reef by integrating diverse interdisciplinary datasets.

Documentation Results

The geomorphological environment, in which the harbour of Arwad island was established, comprises a sheltered anchorage created by an offshore emerged reef. This practice is also attested at several harbour sites along the Eastern Mediterranean coastline such as Ras Ibn Hani, Tripoli, Sidon, Tyre, Jaffa, Tel Dor, as these reefs offer partial protection against prevailing wind[28]. The systematic archaeological documentation has covered most of the coastal archaeological remains located on the south and south-west coast of the island in addition to several preserved parts of the coastal fortification wall. Submerged remains in shallow water up to – 1 meter below present sea level were recorded as well during the topographical survey and the aerial photogrammetric mapping **[FIGURE 7]**. Moreover, a detailed analysis of Arwad harbour structures was performed and the results of this analysis will be published in the Mediterranean Harbour Cities I Conference Proceedings[29].

[FIGURE 7]: Arwad island. Overview map showing the results of the archaeological documentation, integrated with archaeological observations of Frost 1964-1966 © Done by the researcher

[28] POIDEBARD & CAYEUX 1939: 37.

[29] ANBAR forthcoming.

Construction Techniques of the Ancient Structures

The study of the construction techniques of the archaeological structures was one of the objectives of the study. Indeed, the construction patterns observed in the ancient structures on Arwad island exhibit distinctive characteristics:

A. The structures comprise walls constructed with sandstone ashlar blocks (cuboid).

B. The majority of walls follow a connected pattern at vertical angles, forming a crossed network. Exceptions are noted at the south-east and south-west corners of the island. The network is composed of long (east-west) lines parallel to the south coastal fortification wall and shorter (north-south) lines vertical to the coastal fortification wall. Some of the vertical walls are interconnected with the fortification wall.

C. The dimensions of the ashlar blocks are standardised, with lengths ranging between 100-120cm, widths between 40-60cm, and heights between 20-35cm.

D. All documented walls are observed at elevations ranging from -1m to +1m in relation to the present biological mean sea-level.

E. Typically, only one or two courses of ashlar blocks are visible in the structures, although in some instances, three courses were observed.

F. Given the location within the Low Elevation Coastal Zone (LECZ < 1m), the walls are subjected to substantial abrasion caused by coastal erosion.

Consequently, there is a lack of clear evidence of tool traces or binding material between the ashlar blocks, further emphasizing the impact of coastal erosion on the preservation of these structures. Two primary ashlar block positioning techniques were identified in the observed construction patterns:

- Walls Constructed with Single Row Alignment: These walls are built using either one row of headers (width: 100-120cm) or one row of stretchers (width: 40-60cm). Most of these walls are situated above the present biological mean sea-level.
- Walls Constructed with Headers Against Stretchers: In this technique, headers are positioned on one face of the wall, while stretchers are placed on the opposite face. Headers are commonly set on the outer side of the wall, and in some instances, headers alternate with a row of stretchers.

These distinct ashlar block positioning methods contribute to the overall diversity in construction styles observed in the ancient structures on Arwad island, reflecting variations in architectural practices and design **[FIGURE 8]**.

Finally, quarries positioned on the western side of the island, situated on the inner side of the double rock-cut fortification walls, are identified as potential sources of construction materials. These quarries are believed to have been the main source supply of the requisite materials for the construction of the ancient structures on Arwad island. This hypothesis is based on the matching measurements between non-extracted blocks still preserved at the quarries and those used in the construction of the ancient walls.

Construction Techniques of the Coastal Fortification

The fortification wall exhibits a diverse array of construction techniques across different sectors of the island. In the south and east, the wall is entirely composed of

constructed massive ashlar blocks[30], in both positioning headers and stretchers demonstrating a continuous construction technique **[FIGURE 9]**. Conversely, on the western side of the island, two fortification walls extend for over 400 meters and are intricately carved into the natural bedrock. Remarkably, the northern side combines both principles, featuring a fusion of the rock-cut wall serving as a foundation for the construction of the elevation of the fortification **[FIGURE 10]**.

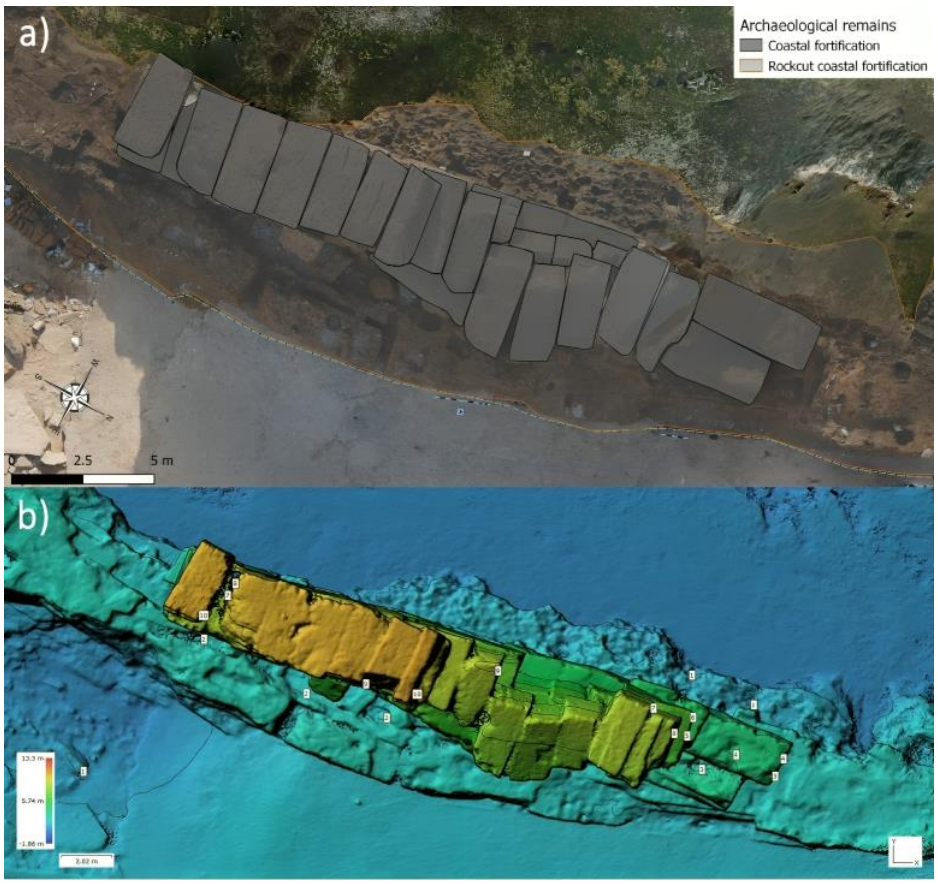
[FIGURE 8]: Aerial view of the southern side of Arwad island showing the submerged archaeological remains and the submerged coastal fortification wall © Taken by the researcher

Moreover, on the southern and eastern extremities of the island, the foundation of the fortification exhibits a construction technique characterized by the use of ashlar blocks. These blocks are arranged in a header positioning.[31]. Notably, on the eastern side of the island, topographical recording through the total station revealed the presence of three distinct courses of these headers. The lower part of the lowermost course is situated at an elevation of -1 meter below the present biological mean sea level. This multifaceted approach to fortification construction represents the strategic considerations and adaptive engineering solutions employed in response to the varied topographical conditions encountered on the island.

Finally, at the southeast corner of the island, a secondary fortification wall has been systematically documented, with a total length of 90 meters **[FIGURES 6 & 8]**. It is positioned approximately 14 meters to the south of the initial fortification wall. Remarkably, this secondary wall is submerged at an approximate depth of -4 to -5 meters below the present biological mean sea level. The construction of this submerged fortification wall entails the use of massive ashlar blocks, placed in a header positioning, comprising two discernible courses.

[30] Length: 2.5 to 5 m; Width: 1 to 2 m; Height: 1.5 to 2.5 m.

[31] Dimensions ranging from 2 to 2.6 meters in length; 0.4 to 0.6 meters in width; 0.25 to 0.35 in height.



[FIGURE 9]: A. 3D photogrammetric recording of a fortification wall on the northwest side of Arwad island. B. A digital elevation model of the same wall shows a total height of over 10 meters above the present biological mean sea level © Done by the researcher

IV. DISCUSSION

Construction Phases

Indeed, the eastern Mediterranean region, including archaeological sites along the Syrian coastline, bears witness to the widespread use of ashlar construction techniques. This construction method was prominent in the creation of durable architectural structures and showcased a high level of craftsmanship and engineering expertise. Notably, various sites dating to different periods have provided valuable insights into the application of these techniques. Some prominent examples include Ugarit (Ras Shamra) during the Late Bronze Age[32], Tabbat al-Hammam in the Early Iron Age[33], as well as Amrit[34], Tel Sukas[35], and Tel Kazel[36] in the latter half of the first millennium BC.

Arwad island has witnessed continuous occupation from at least the Late Bronze Age to the present day, necessitating the establishment of chronological sequences for its various construction phases. While the analysis of the documentation results is ongoing, preliminary observations regarding the layout of the archaeological remains indicate a coherence in construction timelines **[FIGURE 7]**. Initial assessments suggest that the majority of the structures on the island appear to belong to a singular

[32] BOUNNI 1979: 230.
[33] BRAIDWOOD 1940: 208.
[34] DUNAND et al. 1955: 193-196.
[35] RIIS 1970: PL.4.
[36] DUNAND et al. 1964: PL.4.

construction phase. The observed matching patterns in wall construction and connectivity across various structures strongly suggest the notion that these architectural elements share a common chronological origin. Acknowledging the complexity of Arwad island's history, it is important to note that the presence of restoration phases, particularly evident in the coastal fortifications, cannot be dismissed. Contrary to the prevailing patterns indicating a singular construction phase, the presence of structures featuring rubble walls suggests the existence of subsequent construction phases. On the other hand, the non-alignment of certain structures with the general site planning implies intentional deviations or adaptations, possibly reflecting shifts in architectural styles, functional changes, or cultural influences over time.

These observations highlight the importance of further underwater and coastal investigations through systematic archaeological excavations, to refine our understanding of the historical development and evolution of the architectural landscape of Arwad island.

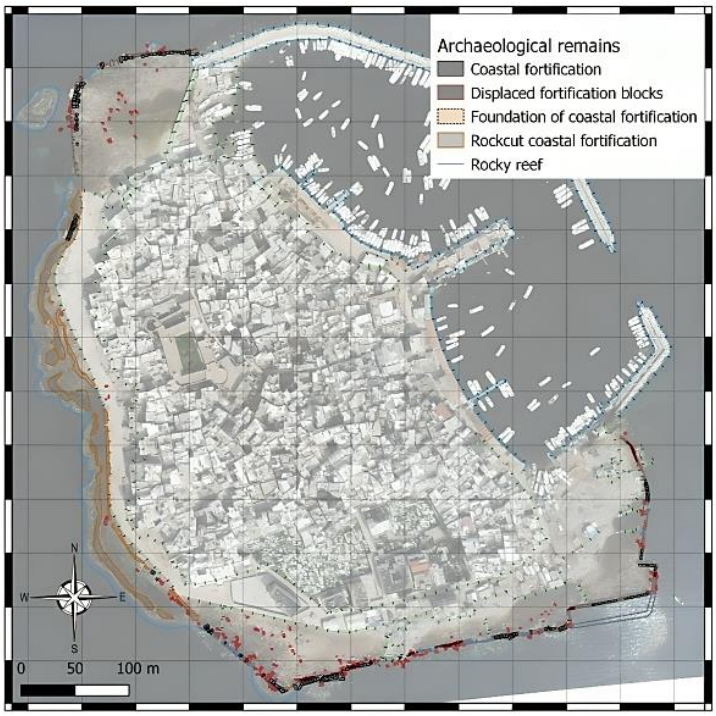
Relative Sea-Level Change

Incorporating the study of relative sea-level change into archaeological analysis enriches our comprehension of the complex interactions between human activities and the maritime environment. Arwad reef region has not yet received any analytical paleoenvironmental studies. Only two prograding shorelines with distinct characteristics were observed along the coast opposite the reef: a) beach rock shells at Tabbat al-Hammam and continental shells at Amrit (1st half of the second millennium BC), b) the second shoreline related to the al-Abrash River, dated between 165 AD and 186 AD[37]. The ongoing archaeological investigations on Arwad island have demonstrated the need for a comprehensive systematic study of relative sea-level change on the reef of Arwad.

Basically, submerged structures on the southern side of the island and the submerged foundation of the eastern fortification wall have been identified at a depth of approximately -1 meter below the present biological mean sea level **[FIGURE 8]**. Moreover, a fortification wall in the southeast corner of the island is situated at depths ranging from -4 to -5 meters **[FIGURE 6]**. These submerged ancient structures provide contradictory evidence for the establishment of relative sea-level changes, suggesting that the island has experienced a subsidence most likely caused by regional tectonic activities; this resulted in the southern landmass of the island sinking. Another factor to be considered is the sea level rise on the global level. Over the last 4,500 years, there has been a rise of 1.5 meters in sea levels[38]. This global trend may have contributed to the submergence of archaeological remains, especially since the island of Arwad is situated in a place where the elevation zone is particularly vulnerable to rising sea levels.

[37] DALONGEVILLE et al. 1993: 51-52

[38] STWEART & MORHANGE 2009: 389.



[FIGURE 10]: Overview map of Arwad island coastal fortification based on 2021 archaeological documentation © Done by the researcher

V. CONCLUSIONS

The development of the maritime façade of the Syrian coastline is quite remarkable, especially in the second half of the twentieth century. The establishment of coastal installations including industries, trade and tourism installations have contributed to the expansion and modernization of port facilities and waterfront areas, which have negative consequences on historical and cultural heritage sites, particularly ancient harbours and coastal areas. Several ancient harbours such as Arwad, Tartous, Jableh and Lattakia have lost all or some of their features due to the expansion of the modern ports. Certainly, the absence of underwater archaeological investigations along the Syrian coastline during this era of rapid development is a matter of notable concern. Addressing this gap becomes imperative to ensure the preservation and proper management of maritime cultural heritage resources, fostering a more extensive appreciation of the historical and archaeological richness that the Syrian coastline holds.

Nevertheless, the recent underwater archaeological research on the Syrian coastline marks an initial step toward establishing a systematic framework for future studies aimed at advancing maritime and underwater cultural heritage in Syria. Future endeavours should play an essential role in several key aspects, starting with setting up a cultural heritage management plan identifying archaeological sites with significant archaeological potential and cultural importance, or those facing preservation challenges. Moreover, sustained efforts for international collaborations will significantly encourage capacity building and the training of specialists in underwater archaeology, conservation, and related fields. Furthermore, interdisciplinary collaboration in applying near-shore and off-shore innovative technologies will be essential in advancing research on coastline evolution and relative sea-level change research.

Finally, concerning the international legal framework, the UN has recognised the importance and vulnerability of the coastal zones. To preserve and manage sustainably

the extended coastal and submerged cultural environment of Arwad, also taking into account the accelerating effects of climate change, several Sustainable Development Goals (SDGs) outlined by the United Nations[39] should be considered: SDG 14 (*Life Below Water*), focuses on the conservation and the sustainable use of marine resources, as well as the protection of coastal ecosystems including coastal and underwater cultural heritage sites for maintaining their resilience in the face of climate change induced threats. More specifically, addressing these issues SDG 13 (*Climate Action*) focuses on the need to take urgent action to combat climate change and its impacts, including sea-level rise, coastal erosion, and extreme weather events that particularly threaten the cultural heritage site of Arwad island. Moreover, like many ancient coastal cities, Arwad's archaeological remains are located in direct relationship with the urban area and, thus, are directly affected by urban development and associated infrastructure. Therefore, it is important to consider SDG 11 (*Sustainable Cities and Communities*), which emphasizes the importance of making cities and human settlements inclusive, safe, resilient, and sustainable through the preservation and promotion of cultural heritage in coastal regions and by raising awareness among the local population and stakeholders. Combined with SDG 15 (*Life on Land*), which addresses the importance of preserving cultural heritage, including terrestrial archaeological sites and landscapes that are often located in coastal areas, local communities can promote inclusive coastal management strategies. These can be inspired by international guidelines, such as the *Protocol on Integrated Coastal Zone Management in the Mediterranean (ICZM),* signed in 2008, which aims to protect coastal zones and help stakeholders deal with emerging coastal environmental challenges.

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[39] https://sdgs.un.org/goals. Accessed on (01/04/2023)

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