



# **Marine Archaeology Goes Underwater with GIS**

*Journal of GIS in Archaeology, Volume I*

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<b>Contents</b>	<b>Page</b>
Introduction .....	25
Archaeological Evidence.....	27
Using a Marine GIS.....	28
References .....	32

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# Marine Archaeology Goes Underwater with GIS

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**Introduction** The topic of this study is Tel Shiqmona, a coastal site where human activity dated from the Late Bronze Age, c. 1500–1200 BCE, to the Arab period, c. 636–640 CE. The site is located 1.3 km southwest of the Carmel Cape at the southern tip of Haifa Bay, Israel. The view from Tel Shiqmona on a clear day extends from Atlit in the south to Akko in the north. The elevation and size of the mound, combined with its proximity to the coast, lend to its advantage as a nearshore observation point commanding an extended view in all directions to the sea. However, there are many unanswered questions regarding the reasons for the longevity of Tel Shiqmona as a coastal site of the eastern Mediterranean. Why would the site be located on this coastal perch isolated from the inland trade routes and exposed to the elements of wind and sea? To address this and other questions, this study focused specifically on the potential for maritime activity at Tel Shiqmona during the Persian Period (538 BCE–332 BCE). The goal of the research was twofold: (1) to establish the parameters of port capabilities or deficiencies at Tel Shiqmona by examining the coastal platform and shallow continental shelf using a GIS as the primary tool and (2) to examine the material ceramic culture of Tel Shiqmona as an indication of maritime trade with coastal sites of the eastern Mediterranean region during the Persian Period (see Figure 1).

**Figure 1**  
**A satellite image of the coast of Israel and the southern tip of Haifa Bay shows the research area of Tel Shiqmona on the Carmel Cape.**



To evaluate the potential for maritime trade at Tel Shiqmona during this period, the present study was divided into three sections: (1) the historical and geographical background of Tel Shiqmona and the Persian Period Levant, (2) the coastal parameters for maritime access to Tel Shiqmona, and (3) the archaeological and typological analysis of ceramic evidence of maritime trade at Tel Shiqmona. The development of a marine application of GIS was implemented to answer questions regarding the coastal parameters of the site.

Evaluating the coastal parameters for maritime access at Tel Shiqmona was based on the premise that a coastal site does not necessarily need harbor or port components to be accessed by sea. Geological and geomorphological data provided the basis for a thematic spatial representation of the coastal zone and bathymetric characteristics of the region. The stability of the coastal zone at Tel Shiqmona was established based on prior archaeological and geological studies that indicated that the sea level change in the past 2,500 years was minimal. This, combined with no evidence of recent tectonic activity at the site, enabled the comparison of modern coastal characteristics to those that may have existed during the Persian Period. The study of coastal characteristics included an examination of morphological features, tides, winds, currents, sediment transport, and sedimentation. The granulometric analysis of sediments at the site was made in comparison with sediments sampled north and south of the region. This study revealed

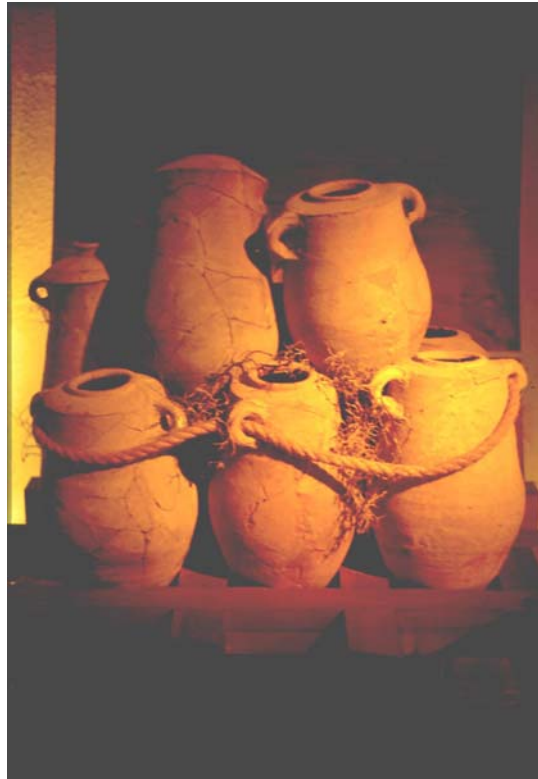
the longshore current present at the site and wave activity that must be considered as limiting factors to coastal access at Tel Shiqmona. As a result of the coastal and marine survey, additional coastal and bathymetric data was gathered regarding the bottom type, maximum depth, location of sediment, and the thickness of the sediment layer. The information was integrated into a marine GIS that was utilized for this research to enable an interactive graphic representation of the data collected; accurate contour lines were designed using ARC/INFO 7.2 Workstation, and maps were created using ArcView GIS 3.2 applications. As a result of the coastal and marine survey, two channels natural in their appearance were identified in the nearshore region to the west of the bay at Tel Shiqmona, and their characteristics were defined. The criterion for the required depth that facilitates the marine access to the site was established based on the information gathered from an excavated and reconstructed shipwreck of the period, the *Maagan Michael*.

It is important to note that wide development by the Haifa Marina Authority is proposed near this coastal archaeological site, and that this valuable cultural resource is at risk of becoming a part of the building zone for the Haifa Municipal Harbor. The conservation of this cultural resource is a goal shared by members of the Israel Antiquities Authority, the Haifa Municipality GIS Department, and the Israel Oceanographic and Limnological Research Ltd. Each of these organizations has contributed valuable data to this project. The GIS developed in this work used a coastal land/sea coverage as a basis. The data was collected from differential, echosound measurements, coastal survey, and marine surveys. From this data, layered coverages were produced that answer questions regarding depth, substrate type, and potential navigational routes.

### **Archaeological Evidence**

The archaeological and ceramic evidence for maritime trade at Tel Shiqmona was primarily based on the collection of storage jars found in the Persian Period strata at the site. The excavations at Tel Shiqmona, led by Joseph Elgavish during the 1963–1964 seasons, revealed a large collection of storage jars in the Persian Period strata. A study of the archaeological background of Tel Shiqmona, and nearby sites Tell Abu Hawam and Tel Megadim, indicated a similarity between these sites and other coastal sites of the region during this period. In addition, it was evident that the Persian Period storage jars were maritime in nature. The qualitative analysis of these storage jars included selected vessels from Tel Shiqmona and their maritime typology. This study included vessels that are widely referred to as storage jars and various ceramic assemblages on the coast of the Levant. Seal impressions and the significance of Phoenician inscriptions found on vessels of the period were also investigated. The typological study suggested that the vessels of the Persian Period strata at Tel Shiqmona were maritime in nature, and that olive oil and wine were most likely the primary goods transported by these vessels (see Figure 2)

**Figure 2**  
**An assemblage of Persian Period storage jars show the storage capacity and manner in which they were utilized in the holds of boats for the transport of oil and wine.**



### **Using a Marine GIS**

Organizations that collect and process data realize the value of their commodity. The Haifa Municipality GIS Department and the Israel Oceanographic and Limnological Ltd. were very generous in providing data that enabled the advancement of this research. One of the primary steps in the building of the basemap was the addition of GPS points. Differential GPS points were located on-site and ground-truthed in comparison to their location on the basemap. The GPS coordinates were then used as control points for the coastal and marine survey (see Figure 3).

**Figure 3**  
**Joe Breman gathers differential GPS points in the nearshore coastal zone of Cape Carmel on the abrasion platform west of Tel Shiqmona.**



The control points were used as a means of establishing the baseline. These baseline benchmarks were established using a "Total Station" providing the locational coordinates with a high level of accuracy. In utilizing the modern applications of computers and technology, it is important not to forget the surveying techniques involved and to confirm the accuracy of the data provided. An accuracy assessment and monitoring of the Total Station data was achieved using a spreadsheet designed to calculate the azimuth of the baseline. This accuracy test provided a resulting maximum error of 12 cm, enabling a layer of data to be used confidently in conjunction with other map layers.

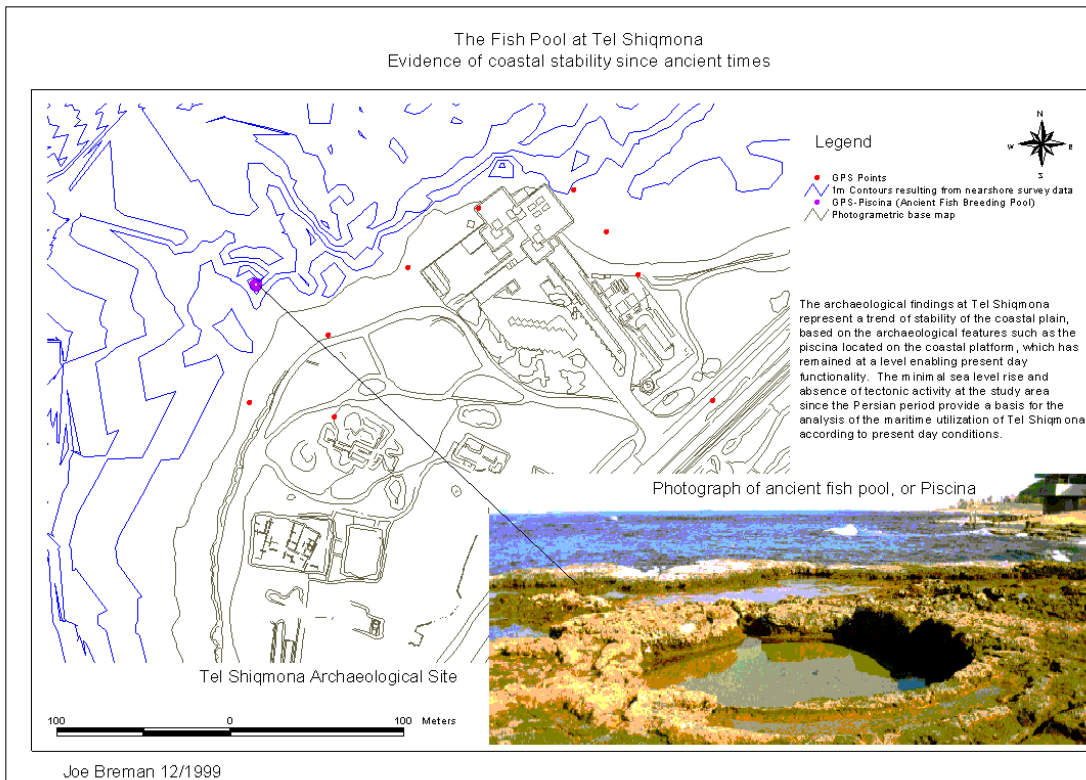
The Haifa Municipality GIS Department contributed the data for the basemap to this research. The basemap is a digitized rendering of a photogrammetric map from 1992, which was corrected in 1995. The map is used as the basemap for the coverages or layers of map information that are applied and referenced to it. One of these coverages is the maritime points echosounding layer.

The echosounding points were collected from the Israel Oceanographic and Limnological Research Ltd., which provided more than 6,000 points of data to be used for the bathymetric layer. Each of the points gives the exact location of the individual measurement in  $x$  and  $y$  coordinates, in addition to the  $z$ , which represents the depth of

each echosounding. The measurements were calculated with adjustments made according to tidal variance and wave height and have an accuracy of up to .01 percent of the depth recorded. With such confident measurements, very accurate contour lines could then be interpolated and, using GPS, archaeological benchmarks such as the *Piscina* Fish Pool of antiquity could be located accurately on a map for the first time (see Figure 4).

**Figure 4**

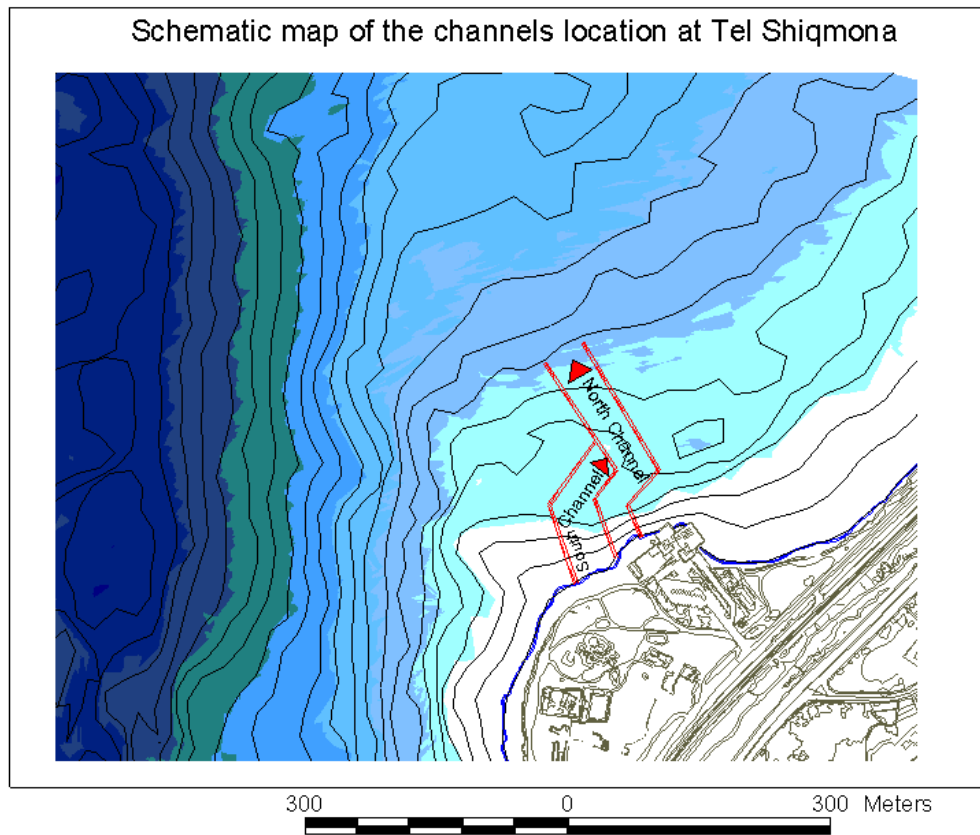
**The *Piscina* Fish Pool is an archaeological feature used as an indicator of coastal stability. The depth of the sediment layer in the pool was measured using a jet-probe device that pumps water at high speed out of a measured pipe. The depth of the pool was not more than two meters.**



These contour lines have a high accuracy and are easily manipulated. Queries can be made of them, and they will provide the answers. The analysis of the data reveals a nearshore area that was not included in the echosounding measurements. This belt of missing data is the primary reason for the coastal and nearshore survey (see Figure 5).














**Figure 5**  
 The survey results indicated that there are two channels existing in the nearshore zone through which small craft can launch and land. Not coincidentally, this area is designated and used for small boat traffic today.



Region accesible by small boat traffic



**Legend**

-  Splined 1 m contour lines
-  Coastline
-  Photogrametric Map
- Shaded sea floor elevation**
-  Shallow nearshore region
-  -4.2 m to -2.8m
-  -5.6m to -4.2m
-  -7m to -5.6m
-  -8.4m to -7m
-  -9.8 m to -8.4m
-  -11.2m to -9.8m
-  -12.6m to -11.2m



Aerial photograph illustrates the natural breakwater which enables marine access to the site even during high wave activity

The coastal and marine survey was executed in conjunction with the construction of the GIS. The target of the survey was to complete the area of missing information, while providing a ground truthing for the echosounding points. The depths and substrate type were recorded with the use of marine survey techniques and equipment including scuba, water-jet probe, and air probe. The resulting data layers provide a more complete and accurate contour map of the coastal and nearshore geomorphology and illustrate the regions most easily accessed by vessels of the Persian Period. In this way, a marine GIS was used to incorporate both coastal geomorphology and bathymetrical data. This, combined with archaeological findings, supports the maritime use of the archaeological site and may help to preserve this cultural resource from the impacts of development in the future.

This study, interdisciplinary in nature, takes into account the historical and geographical review, the survey and examination of coastal geomorphological parameters, and the typological analysis of ceramic evidence of maritime trade at Tel Shiqmona. It was concluded that local maritime trade was a likely practice at Tel Shiqmona during the Persian Period, and that marine access to the site was possible during calm sea conditions. The use of a marine GIS to evaluate coastal characteristics, and potential maritime trade at a site lacking a recognized harbor or port construction broadens the potential scope of maritime connections and opens new areas for future study.

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