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Use of GIS and RS in Shallow-Water shipwreck archaeology

Underwater archaeology, in comparison to terrestrial archaeology, is a young discipline, and one still developing norms and mores in both theory and fieldwork. In that, underwater archaeologists are eager to try new technologies and methodologies to assist in site identification and analysis. This summary addresses the contributions of GIS and Remote Sensing to one particular field of study within underwater archaeology: shallow water shipwrecks, defined here as wrecks that can be reached by divers. These wrecks are typically coastal and subject to a unique blend of natural and manmade post-depositional processes. Not only can these wrecks be disturbed by their environment, but can prove deadly to this same environment, particularly more recent wrecks carrying fuel and other potentially harmful cargoes. GIS and remote sensing are both excellent tools for use in all stages of shallow-water shipwreck investigation.

Remote sensing in underwater archaeology is used to identify and monitor sites. While remote sensing is often associated with deep-water survey, it is also a useful tool in shallow water environments. While expensive, remote sensing techniques such as side scan sonar are much faster and more systematic than visual survey. Sub-bottom profiling is essential in identifying buried sites that would be invisible or difficult to identify for a diver. Remote sensing can also be effective in areas where diving is not possible—Australian researchers recently used aerial magnetometry to identify the Correio da Azia, a Portuguese wreck off of Western Australia in an area difficult to access with divers that had been eluding researchers for five field seasons. Post-depositional damage to sites can also be monitored using remote sensing, as it will show anchor and trawling lines, the most common manmade problems, as well as site changes after storms or extreme weather.

There are issues with using remote sensing in an archaeological context, however. Remote sensors are prone to interference—proton magnetometers, which were first used in the 1960’s to identify wreck sites, are heavily impacted by “noise,” which makes distinguishing manmade anomalies difficult. Sub-bottom profilers are useless in areas with dense sea floor sediments or highly ferrous sediments. Data analysis can be difficult or impossible if too large of a resolution is used in data collection. Small cultural material that might mark a wrecking event or show post-depositional movement of artifacts, such as a cannon or munitions, will not show up in remote sensing surveys in any but the highest data resolutions. Underwater remote sensing is also time consuming, it is difficult to maintain position for systematic survey, and it can become very expensive.

One way to lower the expense of remote sensing is to have tight, specific search parameters. GIS is a way to achieve this. GIS has been embraced by underwater archaeologists from the landmark identification and excavation of the Mary Rose, off the south coast of England in the 1980’s. GIS is not only useful in creating site maps, but can be used in every step of the archaeological process. While using GIS in site prediction is difficult due to the number of factors that need to be considered, it has been successfully utilized. Because so many different
types of data can be synthesized in ArcMap, including historic maps, bathymetric data, and remote sensing returns, historic reports of shipwrecks and identified anomalies can be matched. In this vein, GIS can be used to predict shipwreck-environment interaction. This is useful in areas where shipwrecks pose a threat to the environment, such as World War II shipwrecks in the Pacific that are starting to leak oil into delicate ecosystems. A GIS program allows Pacific Island nations to identify the wrecks that are the largest threats, enabling to spend limited resources for oil removal prudently.

Beyond prediction, GIS can be used as a resource management tool. It can be used to create large databases of information that can be shared quickly and easily with different researchers. This stored information can also help archaeologists to conduct spatial analysis on the macro level. While most spatial analysis is conducted on individual shipwreck sites, GIS can be used to show shipwrecks within a larger maritime landscape, such as shipping lanes, known navigational hazards, and aids to navigation. Shipwrecks, while traditionally studied in isolation, did not sink in isolation. Other aspects of the maritime landscape should be taken into consideration in studying shipwrecks, and GIS can help establish the larger context of a particular wrecking event. Having a large and detailed GIS database also means more information can be shared with the general public. It is important to integrate the public into the archaeological process, to promote preservation funding and awareness of the human past. This manifests both in sharing over the internet and heritage tourism, which is on the rise.

For all of the benefits of GIS in underwater archaeology, there are some limitations. In building large datasets from multiple data sources, different projections and standards for data collection may make it difficult to actually use. Known shipwrecks may not all have the same historical information available, and actual locations may be contested. In Ireland, an established GIS database was compared to a new remote sensing survey, in which at least one shipwreck was found over a kilometer from its recorded location. GIS can also sometimes be a limiting factor; because it was traditionally used to make site maps, it is sometimes not used by archaeologists to its full potential.

In this paper, Barrett discusses shipwreck management from a natural resource conservation angle, rather than the traditional cultural resource conservation angle used by archaeologists. Over 4,000 American and Japanese wrecks from WWII pose a threat to marine biodiversity in the Pacific. Many of these ships sank with thousands of gallons of oil and gasoline on board, and are starting to release it into the water. As part of his study, Barrett designed an ArcMap program that allows researchers and affected island nations to identify those shipwrecks posing the largest risk to marine ecosystems, including such factors as proximity to shore, the type of ecosystem the wreck is in, and the type of ship and the amount of oil on board. This allows Pacific nations to prioritize particular wrecks that pose the most immediate threats, as removing oil, though highly effective, is also very expensive and dangerous. The removal of oil both protects the marine ecosystem and the cultural resource. I think this use of GIS programming represents an interesting intersection between underwater archaeology and ecosystem preservation, and certainly has applications outside of the Pacific in which shipwrecks are both threatened and threatening.

Green, J. 2014. “Notes: The Application of Aerial Magnetometers in Maritime Archaeology.”

The International Journal of Maritime Archaeology. 43.2: 436-442.

Proton magnetometry is a survey technique developed in the 1960’s and used in underwater archaeology. Proton magnetometers are extremely sensitive to background noise and have a long rate of return, making data collection times lengthy and data confidence somewhat low. In this article, Green discusses an experiment conducted in Western Australia using aerial magnetometry, traditionally used in terrestrial geological survey. Survey of known wrecks in both deepwater and shallow water environments showed that aerial magnetometry was capable of identifying shipwreck sites in both environments, and was able to relatively accurately predict size and tonnage. There are shortcomings, however, in that it is unclear whether the aerial magnetometer could show wooden shipwrecks in deepwater and if shipwrecks could be identified in areas with large amounts of natural ferrous materials. While expensive, Green concluded that aerial magnetometry is a legitimate alternative to surface survey in situations where a large area needs to be survey in a short time span. I found this study very exciting, as it expands the options for underwater archaeologists looking for survey methods for use in dangerous or hard-to-reach locations, even if its viability cannot be confirmed by one study.

In this paper, Kimura attempts to demonstrate the feasibility of using GIS to analyse shipwreck patterns on a macro level. Traditional spatial studies in maritime archaeology focus on intrasite analysis, but Kimura argues that GIS can help us place individual shipwrecks into a larger maritime landscape. Using historical maps, modern bathymetric data, shipping lane information and the placement of lightships and lighthouses over the course of the 19th century, he demonstrates that wrecking patterns can be identified and explained in a region-wide context. He also argues that this shows that predictive modeling using GIS is a feasible tool for archaeological researchers interested in macro-level spatial analysis, but the number of factors that need to be taken into consideration and the rampant inaccuracy in some data sources can be a hindrance to the usefulness of predictive modeling. Recognizing and interpreting “cultural landscapes” over focus on individual sites is a growing trend in terrestrial archaeology, but is difficult to do in a maritime situation. I think this article is a good representation of what can be achieved and learned from by studying shipwrecks within a larger landscape and the role GIS plays in doing this.

Oxley, I. 2001. “Towards the integrated management of Scotland’s cultural heritage: examining historic shipwrecks as marine environmental resources.” World Archaeology. 32.3:413-426.

In this article, Oxley outlines the approach taken by Scotland in the early 2000’s to preserve its known cultural resources and identify other sites within their jurisdiction. Oxley identifies GIS as an essential element to this process, for both storing and analysing shipwreck data and distribution. Importantly, GIS allows researchers to incorporate environmental factors in management and conservation plans. Oxley identifies physical and cyber-tourism as important contributions to the need to preserve submerged cultural resources. GIS allows shipwreck data to be shared via the internet and mapping and monitoring can help maintain the integrity of sites popular with sport divers. Improved mapping and surveying techniques can also increase the number of sites accessible to tourists, increasing tourist revenues in sometimes remote locations in Northern Scotland. While this article is somewhat old, the continuing and positive trend towards public inclusion in archaeology it demonstrates is important.


In this article, Papatheodorou et al, outline the importance of remote-sensing in identifying underwater cultural heritage in Greece through a case study of the Navarino Battle Site. The
battle took place in July 1827 between allied European and Turkish-Egyptian ships. 55 Turkish ships sank in Navarino Bay in a single day, making it a location of archaeological importance. Navarino Bay is also an active shipping stop, and the sea floor is scarred with anchor furrows, up to 4m deep. The remote sensing study at Navarino was meant to determine the overlap of the historical battle site and modern anchor furrows, and found that a significant portion of the remains have been damaged by dragging anchors. The sea floor, made of a soft muddy sediment, has facilitated both the preservation of ships from the battle, and made the dragging of anchors a more serious concern. Because it was clear from the remote sensing survey that the current use of Navarino in this way is damaging archaeological resources, the team recommended further survey to find an area not archaeologically significant and build docking stations for modern ships there instead. I think this is an interesting article because it includes not only how remote sensing is used to monitor known wrecks, but also the importance of maintaining those wrecks, and a practical solution to mitigating the damage the site is subject to.


This article by Plets et.al. reports the Phase 1 findings of a three Phase project aimed at identifying potential wreck sites off of the Irish coast using remote sensing. Tradition held that the Irish coast was too turbulent an environment for archaeological remains to be preserved, but recent work has shown that there are pockets of low-energy environments that may contain cultural material. The data was obtained through the Joint Irish Bathymetric survey, an interdisciplinary project meant to collect data for use in multiple fields. 389 anomalies were detected in the bathymetric data and ranked from 1 to 3 based on the likelihood it represented a shipwreck. Only 11 were identified as “probable”, but further analysis is needed to determine if more of the anomalies labeled “possible” are also wrecks. The researchers ran across several issues in this first phase: 1, it became clear that the recorded locations of wrecks were often inaccurate, sometimes by over a kilometer, and 2, the resolution of the data was too poor to clearly identify any shipwrecks over 100 years of age. This could be due to either these wrecks being broken up, buried, or too small to be identifiable using the resolution data available. This article is a summary of the first step in a three part research project, and I would like to read about the rest of the project, because this article did not get far in discussing the actual findings of the study and the sorts of unique post-depositional processes that impact the Northern Irish coast.