EEET ECOLOGICAL ENGINEERING & ENVIRONMENTAL TECHNOLOGY

Ecological Engineering & Environmental Technology 2022, 23(5), 218–223
https://doi.org/10.12912/27197050/152117
ISSN 2719-7050, License CC-BY 4.0

Received: 2022.06.30
Accepted: 2022.07.20
Published: 2022.08.01

Detection and Mapping of Shipwrecks in Al-Hoceima Coastal Using Remote Sensing

Morad Taher[1*], Taoufik Mourabit[2], Issam Etebaai[1], Abdelhak Bourjila[3], Ali Errahmouni[4], Mustapha Lamgharbaj[1]

[1] The Department of Earth and Environmental Sciences, The Faculty of Sciences and Technique of Al-Hoceima, The Abdelmalek Essaâdi University, Tétouan, Morocco

[2] The Department of Geology, The Faculty of Sciences and Techniques of Tanger, The Abdelmalek Essaadi University, Tétouan, Morocco

[3] Laboratory of Water and Environmental Engineering, Al Hoceima National School of Applied Sciences, The Abdelmalek Essaâdi University, Tétouan, Morocco

[4] The Department of Geology, The Faculty of Sciences of Tétouan, Abdelmalek Essaâdi University, Tétouan, Morocco

* Corresponding author's e-mail: geomorad@gmail.com

ABSTRACT

On the Mediterranean coast of Morocco, many military ships were sunk in the Al-Hoceima region during Rif war between Spanish army and the local Riffians. The aim of this study is to detect and to map shipwrecks embedded in sea-floor sediments in Al-Hoceima coastal. It has been carried out using free satellite radar image and the open-source software Sentinel Application Platform. The result of this study shows five possible locations of shipwrecks in the study area, two of them were confirmed by data shipwrecks of the Spanish hydrographic institute.

Keywords: Nekor, Rif war, sentinel, SNAP, underwater.

INTRODUCTION

Recently, several of advanced methodologies, and technological solutions have studied the underwater cultural heritage (Gkionis et al., 2021). One of these techniques is remote sensing, it can be suitably applied for detection in different landscapes and environmental contexts (Danese et al., 2022). Remote sensing is widely used (Table 1) in the archaeological field, for the identification of archaeological remains (Danese et al., 2022). The archaeological survey underwater maintains the same principal goal as that of field walking onshore, namely the locating, mapping and interpretation of sites and artifact distributions (Leidwanger & Howitt-marshall, 1978). In the last decade, the original efforts of remote sensing in marine archaeology largely focused on the location (Leidwanger & Howitt-marshall, 1978) and detection of shipwrecks (Geraga et al., 2020; Grøn et al., 2015). Furthermore, it is widely used for the reduction of risks and costs incurred for underwater investigations, beside the need for better data (Gkionis et al., 2021). Thus, the remote detection on a large scale of archaeological material underwater, amounting essentially to sensory imaging systems, offers key advantages in maximizing coverage, reducing time and danger, and improving chances of finding shallowly buried or low-profile sites (Leidwanger & Howitt-Marshall, 1978).

The total number of shipwrecks at the bottom of the Al-Hoceima Sea is currently unknown. Numerous detected wrecks remain unidentified except of the general Concha gunboat that was sunk by gunfire at the Bokoya coast on the 11th of June 1913, and the Juan De Juanes frigate that was sunk by gunfire at Al-Hoceima bay on the 18th Mars 1922. Therefore, the aim of this study is detecting, and mapping of all shipwrecks embedded in

Table 1. Examples of remote sensing used in the archeological survey underwater

Author	Title	Year	Country
Papatheodorou et al., 2001	Remote sensing in submarine archaeology and marine cultural resources management: An ancient shipwreck outside Zakynthos port, Greece	2001	Greece
Character et al., 2021	Archaeologic machine learning for shipwreck detection using lidar and sonar	2021	USA
Grządziel, 2020	Using remote sensing techniques to document and identify the largest underwater object of the Baltic Sea: Case study of the only German aircraft carrier, Graf Zeppelin Artur	2020	Poland
Ødegård et al., 2016	A multi-scalar approach to marine survey and underwater archaeological site prospection in Murujuga, Western Australia, Chelsea	2020	Australia
Grządziel, 2020	Using remote sensing data to identify large bottom objects: The case of World War II shipwreck of General von Steuben	2020	Poland
Zhang et al., 2020	LS-SSDD-v1.0: A deep learning dataset dedicated to small ship detection from large-scale sentinel-1 SAR images	2020	Japan
Danese et al., 2022	Pattern recognition approach and LiDAR for the analysis and mapping of archaeological looting: Application to an Etruscan site	2022	Italy

sea-floor sediments in Al-Hoceima coastal using remote sensing. Besides, the evaluation of the capability of sentinel-1 image for detecting shipwrecks. Table 1 shows examples of remote sensing used in the archeological survey underwater.

History of the General Concha and the Juan De Juanes

The General Concha

The General Concha (Fig. 1) was built in 1883 for gunboat purpose. It dimensions were 48.76 meters length, 7.8 meters width and 2.62 meters height. The name of the ship comes from the Spanish military José Gutiérrez de la Concha. Basic ship's technical data are shown in Table 2.

The Juan De Juanes frigate

The Juan de Juanes (Fig. 2) was built in 1891 and registered in Valencia in 1916, being included in the fleet of the nascent shipping company Trasmediterranea. It dimensions were 62 meters wide, 9.5 wide and 4.5 deep. The name of the ship comes

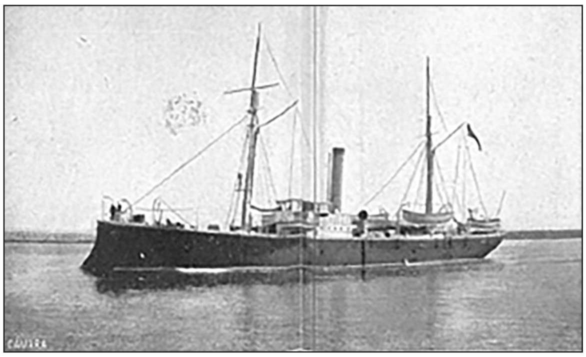

Figure 1. The general Concha gunboat before sinking, Mundo Grafico©

Figure 2. The Juan De Juanes frigate before sinking, Pier Vicente Sanahuja©

Table 2. Characteristics of General Concha gunboat

Parameter	Characteristics
Name	General Concha
Nationality	Spanish
Purpose	Gunboat
Date built	1883
Dimensions	48.76*7.8*2.62
About lost	Weather / Gunfire
Date lost	1913

Table 3. Characteristics of the Juan De Juanes frigate

Parameter	Characteristics
Name	Juan De Juanes
Nationality	Spanish
Purpose	Transport
Date built	1891
Dimensions	62.5*9.5*4.5
About lost	Gunfire
Date lost	18/03/1922

from the famous painter in Valencia Juan De Juanes. Basic ship's technical data are shown in Table 3. In March, the mail steamer Juan De Juanes was sunk by Riffian canon fire (José De Alvarez, 2001).

STUDY AREA

The study area is the Al Hoceima province coast on the Mediterranean seaboard of Morocco (Fig. 3a), between 35.1980 N and 35.1595 N latitude, -3.8230 W and -4.4290 W longitude. It has a coast length of approximately 60 kilometers. In the coastal plains in the Al-Hoceima region, agricultural activities were firstly developed, latterly followed by the emplacement of coastal towns and villages such as Bades in the West of the study area, and Ajdir in the East. Related to maritime transport for the importation/exportation of goods. This forced the construction of harbors in Bades and Ajdir (Mazama) as well as several defense structures to protect coastal towns. As a result, along with many coastal areas around the world, it is often possible to observe the presence of archaeological remains of different ages (Mattei et al., 2019). Furthermore, the Al-Hoceima coast has witnessed an important military activity during the colonial period, and many Spanish military landings during the Rif war (Fig. 3b and 3c); consequently, many military ships were sunk. As a result, the Al-Hoceima province coast has vast archeological sites and most of them have not yet been discovered.

MATERIALS AND METHOD

For its higher accuracy, faster speed, and less human intervention deep learning has almost dominated SAR ship detection community (Zhang et al., 2020). Recently, ship detection

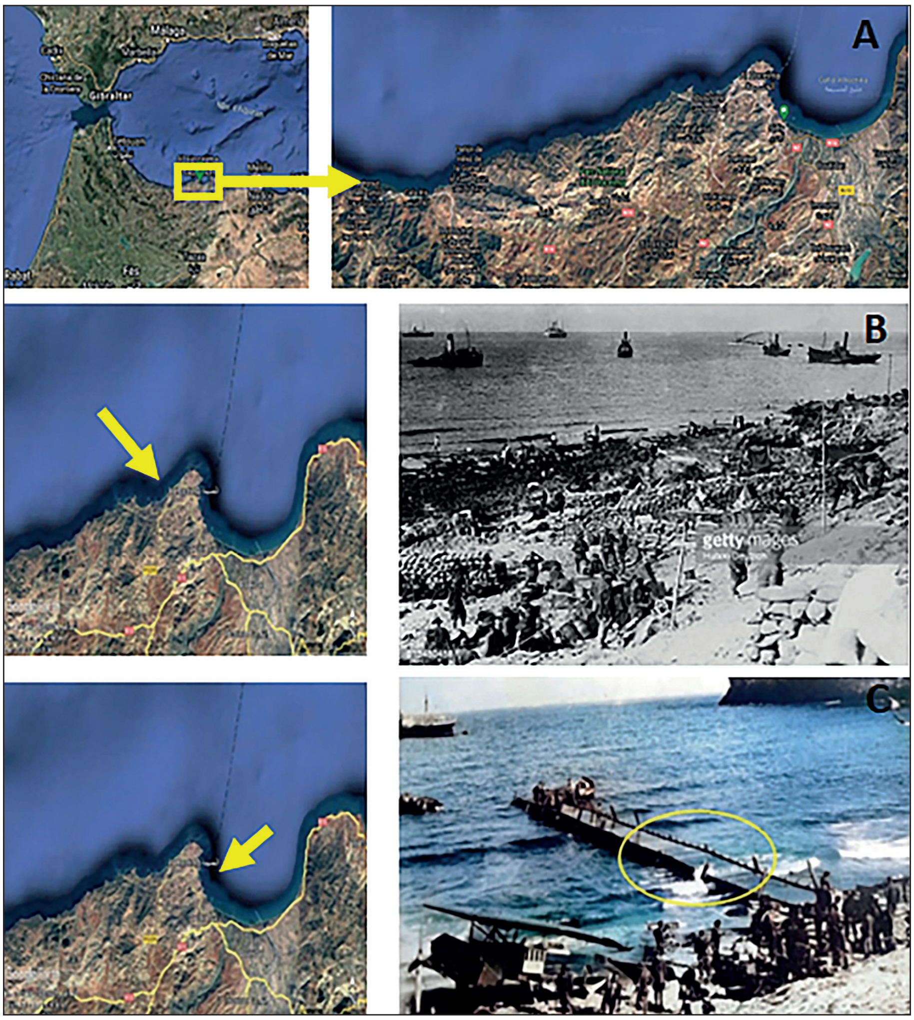

Figure 3. a) Location of study area (Google Earth images); b) Spanish forces landing in Sabadiya beach (West of study area), Hulton-Deutsch Collection/CORBIS/Corbis via Getty Images©; c) Spanish forces landing in Kimado beach (East of study area), el Museo de Ejército©

using a synthetic aperture radar (SAR) image is becoming a fundamental tool in remote sensing techniques. Therefore, the remote sensing technique has been applied to the free radar image captured by the sentinel-1 (Table 4) in SLC mode (Single Look Complex), which is provided by the scientific data Hub (https://scihub.copernicus.eu/). To do this, the open-source software (SNAP) provided by the European Space Agency (ESA) has been used in this study. The image is

Table 4. Sentinel-1 data information of image

ESA satellite	Mode	Product type	Dual polarization	Date and time of start acquisition	Date and time of end of acquisition	Orbit number	ID product
S1A	IW	SLC	DV	2016-01-21.18:17	2016-01-21.18:18	009596	E82F

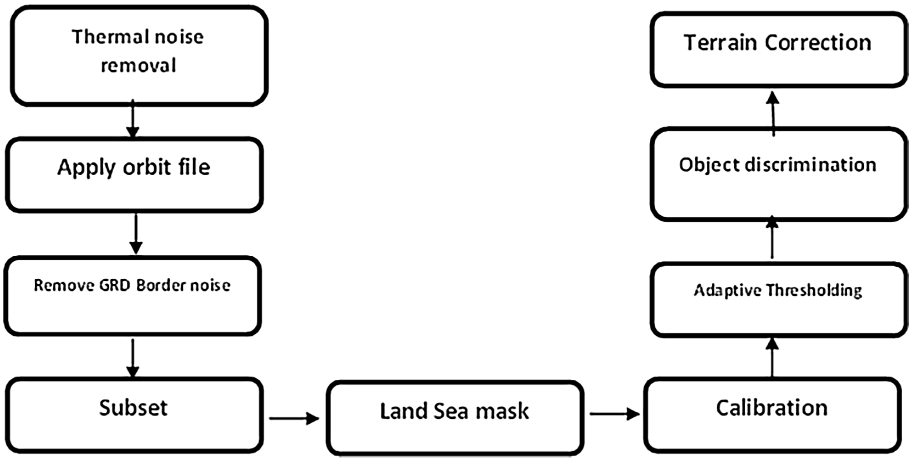

Figure 4. Chain processes of sentinel-1 image by using SNAP software

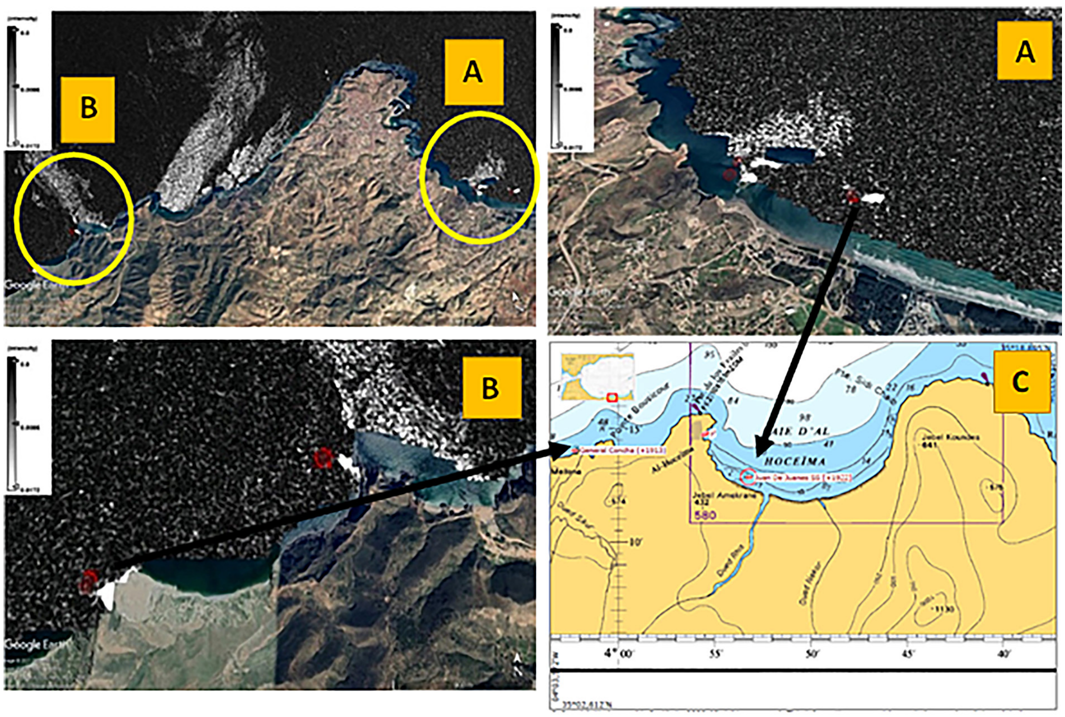

Figure 5. Possible location of shipwrecks in Al-Hoceima coastal; a) three (red points) possible locations of shipwrecks in the east of study area; b) two (red points) possible locations of shipwrecks in the west of study area; c) The Map of shipwrecks in Al-Hoceima coastal during the Rif war, Spanish hydrographic institute 2020©. The arrows indicate the similarity position between possible location of shipwrecks and the map of shipwrecks il Al-Hoceima coastal during the Rif war

atmospherically corrected. The processing chain in Figure 4 has been applied to the image mentioned above. We focused on the detecting and the mapping of shipwrecks because it has occupied a predominant role in the research undertaken in maritime archeology (Reggiannini & Salvetti, 2017; Secci et al., 2021).

RESULT AND DISCUSSION

The result of this study shows five possible locations of shipwrecks (Fig. 5) in the study area, three locations in Al-Hoceima (Fig. 5a) bay and two locations in Bokoya coastal (Fig. 5b). To confirm the result obtained, we used data shipwrecks of the Spanish hydrographic institute (Fig. 5c), which confirmed two of these locations. The first one is the location of the Juan De Juanes frigate, which is sinking in Al-Hoceima bay near the Nekor island (Fig. 6). The sinking of the Juan De Juanes frigate was mentioned by Ahmed Chochaib Khattabi Bourjila, he said "The Riffians gunfire sank the 'Juan de Juanes' ship near the Nekor island, its payload about 10 thousand tons, and it was carrying to the island 15 and a half large-caliber guns and other war munitions". The second location is for the General Concha gunboat, which is sinking in Bokoya coastal, it was mentioned by Muhammad Aras, nicknamed «Baku», he said "I was on the Nekor island for shopping, like other people from my village (Ajdir), while we were getting ready to leave the island, two Spanish ships arrived. The soldiers on these two ships said that the Concha ship had collided due to the thick fog. They tried to move the ship into the depths of the sea, but they couldn't..." (Abdelhamid Rais, 2016). Whereas the other detected wrecks remain still unidentified.

Figure 6. The sinking of The Juan De Juanes frigate, Juan Carlos Diaz Lorenzo©

The result obtained using the sentinel 1 image and the SNAP software is very important, but it must be noted that the shipwreck's locations are not very accurate. Indeed, Figure 6 shows where the Juan De Juanes exactly sunk to the right of the island, whereas Figure 5a shows the location on the left of the island, so there are dozens of meters of incertitude.

CONCLUSION

Using sentinel-1 image, and SNAP software can provide good quality detection of shipwrecks, especially at low depth. In addition, this technique costs nothing, but before diving for looking the shipwrecks, the results must be verified by other methods. The result obtained show that The Al-Hoceima coastal has a huge archaeological site, consisting of ancient shipwrecks, with broad potential for the development of the tourism sector.

REFERENCES

1. Character, L., Ortiz, A., Beach, T., Luzzadder-Beach, S. 2021. Archaeologic machine learning for shipwreck detection using lidar and sonar. Remote Sensing, 13(9), 1–15. https://doi.org/10.3390/rs13091759
2. Danese, M., Gioia, D., Vitale, V., Abate, N., Amodio, A.M., Lasaponara, R., Masini, N. 2022. Pattern Recognition Approach and LiDAR for the Analysis and Mapping of Archaeological Looting: Application to an Etruscan Site. Remote Sensing, 14(7), 1587. https://doi.org/10.3390/rs14071587
3. Geraga, M., Christodoulou, D., Eleftherakis, D., Papatheodorou, G., Fakiris, E., Dimas, X., Georgiou, N., Kordella, S., Prevenios, M., Iatrou, M., Zoura, D., Kekebanou, S., Sotiropoulos, M., Ferentinos, G. 2020. Atlas of Shipwrecks in Inner Ionian Sea (Greece): A Remote Sensing Approach. Heritage, 3(4), 1210–1236. https://doi.org/10.3390/heritage3040067
4. Gkionis, P., Papatheodorou, G., Geraga, M. 2021. The benefits of 3d and 4d synthesis of marine geophysical datasets for analysis and visualisation of shipwrecks, and for interpretation of physical processes over shipwreck sites: A case study off methoni, Greece. Journal of Marine Science and Engineering, 9(11). https://doi.org/10.3390/jmse9111255
5. Grøn, O., Boldreel, L.O., Cvikel, D., Kahanov, Y., Galili, E., Hermand, J.P., Nævestad, D., Reitan, M. 2015. Detection and mapping of shipwrecks embedded in sea-floor sediments. Journal of Archaeological

Science: Reports, 4(February 2018), 242–251. https://doi.org/10.1016/j.jasrep.2015.09.005

6. Grządziel, A. 2020. Using remote sensing techniques to document and identify the largest underwater object of the baltic sea: Case study of the only german aircraft carrier, graf zeppelin. Remote Sensing, 12(24), 1–23. https://doi.org/10.3390/rs12244076
7. Leidwanger, J., Howitt-marshall, D.S. 1978. Archaeological applications for remote sensing in the coastal waters of Cyprus : the experience of recent fieldwork and methodology for the future.
8. Ødegård, Ø., Sørensen, A.J., Hansen, R.E., Ludvigsen, M. 2016. A new method for underwater archaeological surveying using sensors and unmanned platforms. IFAC-PapersOnLine, 49(23), 486–493. https://doi.org/10.1016/j.ifacol.2016.10.453
9. Papatheodorou, G., Stefatos, A., Christodoulou, D., Ferentinos, G. 2001. Remote sensing in submarine archaeology and marine cultural resources management: An ancient shipwreck outside Zakynthos port, Greece. Proc. of 7th Internatioanl Conference on Environmental Science and Technology, C, Posters, 377–385.
10. Reggiannini, M., Salvetti, O. 2017. Seafloor analysis and understanding for underwater archeology. Journal of Cultural Heritage, 24, 147–156. https://doi.org/10.1016/j.culher.2016.10.012
11. Secci, M., Demesticha, S., Jimenez, C., Papadopoulou, C., Katsouri, I. 2021. A living shipwreck: An integrated three-dimensional analysis for the understanding of site formation processes in archaeological shipwreck sites. Journal of Archaeological Science: Reports, 35(June 2020), 1–11. https://doi.org/10.1016/j.jasrep.2020.102731
12. Zhang, T., Zhang, X., Ke, X., Zhan, X., Shi, J., Wei, S., Pan, D., Li, J., Su, H., Zhou, Y., Kumar, D. 2020. LS-SSDD-v1.0: A deep learning dataset dedicated to small ship detection from large-scale Sentinel-1 SAR images. Remote Sensing, 12(18), 1–37. https://doi.org/10.3390/RS12182997
13. Mundo Gráfico, número 85 de 11 de junio de 1913, página 18.
14. Bourjila, A.C. El. The captain and the wars of the Rif. Shop my books, 125.
15. De Alvarez, J. 2001. Contribution in comparative colonial studies, 40.
16. Rais, A. 2016. Testimonies about the resistance during the era of the leader Muhammad bin Abdel Karim Al-Khattabi. Tifraz publications.