New Remote Technologies for SEA in Asia: Maritime Heritage and Beyond

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Introduction

International lenders identify offshore wind (OSW) energy as a key response to future energy needs of developing Asian countries that aligns with the Sustainable Development Goals[1] (SDGs). While OSW development is a critical step in addressing climate change, the construction and operation of OSW projects will result in environmental and social impacts that need to be addressed if these projects are to be developed in a sustainable way and with the support of local communities (World Bank 2021). This paper reports the efforts of a multi-disciplinary team developing a Strategic Environmental Assessment (SEA) methodology to address the challenge of scale specifically for maritime cultural heritage in alignment with relevant environmental and social safeguards.[2] The effort and the team has grown from a partnership between the US-based Cultural Heritage firm SEARCH and the UK-based robotics and marine survey company Ocean Infinity. In our paper, we apply this method to a hypothetical case study, showing how the approach could be applied in Vietnam, a country with substantial OSW resources.

Background: The Role of Policy SEA for OSW in Emerging Markets

SEA assesses the environmental and social impacts of a policy, program, or strategy that allows for environmental and social considerations to be integrated into the strategic decision-making process (World Bank Group [WBG] 2012). SEAs undertaken by national authorities or prospective financing entities address the potential impacts of the strategies, policies, and frameworks created to support the development of the OSW industry on environmental and social receptors, including cultural heritage. SEA at the policy development stage can be a powerful tool to assess the potential environmental and social impacts of OSW policy but should also be designed to collect sufficient information to inform framework development, including marine spatial planning (MSP) and to establish environmental and social impact review processes aligned international standards.

Marine CH Resources and SEA

Maritime CH resources consist of archaeological and historic resources including: 1) ancient and historic shipwrecks; 2) archaeological sites and historic landscapes hosted on now inundated paleo-landscapes; and 3) recent commercial and conflict related shipwrecks and aircraft which may contain human remains. OSW projects have the potential to cause direct physical impacts to these sensitive sites, through direct impacts of infrastructure construction and through the indirect impacts of visual effects project infrastructure on the viewsheds onshore historic sites and landscapes (TRC 2012; BOEM 2020; Wessex 2005).

Based on the large size of SEA study areas, covering thousands if not hundreds of thousands of square kilometers, the uneven distribution and location of marine CH resources, and the time and resource intensive nature of marine investigations, SEAs are typically forced to rely on marine CH desktop baseline studies to assess potential policy impacts. Such assessments use existing shipwreck databases, academic

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[1] United Nations Development Program (UNDP) SDG 7: Affordable and Clean Energy; and SDG 13: Climate Action.

[2] World Bank Environmental and Social Safeguard 8 (ESS8) for Cultural Heritage (2017).

studies, and development led/project specific investigations for other major capital projects to identify and characterize the types of marine CH that could be present and to assess potential impacts. While these sources provide useful data on the types of marine CH resources that may be present, they typically lack specific locations of resources and comprehensive geographic coverage. (Wessex 2005; TRC 2012; BOEM 2020). As a result, CH components of SEAs typically consist of generic regional maritime history summaries, estimated total numbers of wrecks or downed aircraft in study areas with limited locational accuracy, and generalized statements that submerged archaeological sites are "likely" present. This results in ***"SEAs with long descriptions of environmental conditions and <u>potential</u> risks that are of little use in decision making*** (World Bank 2012)."

Wide-scale geophysical reconnaissance needed to fill these gaps are costly and time consuming, especially using traditional technologies. A recent marine geophysical survey, for example, was conducted in New York State (NYSERDA 2021) The study included two OSW development areas in the New York Bight between Long Island and the coast of New Jersey (Figure 1). This survey exemplifies an effective and useful reconnaissance-level marine survey for OSW, covering nearly 3,000 square kilometers at survey intervals from 900 m to 1,800 m by 4,500 m. It also demonstrates the substantial time and effort needed to collect marine geophysical data, with 73 days needed to complete the survey (NYSERDA 2021). Autonomous marine survey vessels can provide a faster more efficient method for obtaining reliable and useful, reconnaissance survey data. This approach has the added benefit of requiring fewer person hours spent at sea and a much smaller carbon footprint.

<u>Automated Marine Survey Technology and SEA</u>

Remote sensing has already revolutionized terrestrial archaeological study. Robotic marine survey and supporting techniques for archaeological data collection, management, and analysis are poised to have a similar impact on marine investigations. Ocean Infinity, a leading marine robotics company is using this approach to develop an alternative to traditional marine survey operations. Ocean Infinity's robotic uncrewed ships and autonomous underwater vehicles can collect marine survey data faster, and the analysis of data in near-real time is made possible by advanced satellite communications and specialized data handling algorithms. Overall, the approach enables increased survey flexibility and effectiveness while dramatically reducing environmental impacts and health and safety risks. In the context SEA investigations, the advantages of this technology are significant:

- Reduced time necessary for standard geophysical surveys by 20-30%;
- Reduced exposure to human health and safety risk; and
- Reduced GHG emissions of up to 90% over similar work volume.
- Near real time data analysis and reporting, allows specialists to identify potentially significant receptors during a survey, so vehicles cab be re-tasked whilst still offshore to investigate receptors without follow-up mobilization.

<u>SEA Methodology of OSW</u>

Our proposed marine CH SEA methodology was developed to address the data gaps in previous CH components of policy level SEAs and the noted advantages of the automated marine survey technology. We build upon an existing OSW policy level SEA framework developed for the Irish Sea (Edwards and Holroyd 2010). While the approach retains the desktop study level analysis typically done for CH marine receptors, the desktop study is designed to provide context and goals for a CH marine baseline survey that is embedded in a larger multi-disciplinary survey (Table 1).

Table 1. Hypothetical Marine CH SEA for Offshore Wind Development

Part	Description
1.Generic Assessment	**Generic OSW components:** fixed foundation wind turbine generators (WTG); floating WTGs; offshore substation foundations; foundation scour protection; floating wind anchors; inter-array cables (buried and surface laid); export cables (buried and surface laid); construction and operation phase anchoring corridors around foundations and cables. **Generic marine CH receptors**: historic and ancient shipwrecks; wartime shipwrecks and downed aircraft; submerged paleolandscape features with archaeological potential.
2.Identify Assessment Areas	Identify OSW Assessment Areas: Use known variables such as wind resource assessments, proximity to areas of high electricity demand and onshore grid connections, proximity to ports, etc. and solicit industry input to identify areas favorable for or most likely to be developed. Size of Assessment Areas determined by the time and funds available for autonomous/remote marine baseline survey.
3.Marine CH Desktop Study	Identify Regionally Specific Types of CH receptors: Conduct desktop study to identify types of marine CH resources known to be present in the assessment areas. Desktop resources to be consulted include academic literature, shipwreck databases, and intergovernmental consultations to identify wartime wrecks and stakeholders.
4.Geophysical Reconnaissance Survey	Based on the results of the desktop review and intergovernmental consultations, incorporate marine CH identification needs into infield, reconnaissance level geophysical survey plans. Based on the types of resources likely to be present and their characteristics, refine types of geophysical survey equipment and methods to collect useful marine CH data as part of larger, environmental geophysical investigation protocol. CH baseline study goals would include collecting paleolandscape data to inform MSP and project-specific survey needs, ground truthing/identifying recorded shipwreck or downed aircraft locations and identifying previously unknown wrecks along survey transects.

Hypothetical Marine CH SEA Study: Vietnam

The following is a preliminary application of our methodology for collecting fit for purpose marine CH data as part of national level SEA for OSW development in Vietnam. The WBG recently published a document titled *Offshore Wind Roadmap for Vietnam* with the purpose of providing a strategic analysis of the OSW potential of Vietnam to provide the government with evidence to support the development of policy, regulations, processes, and infrastructure (World Bank 2021). The WBG analysis considers high and low growth scenarios for Vietnam's OSW industry both of which involve a mix of fixed foundation and floating offshore wind (Figure 2).

Using our method, the first step is to develop a generic assessment of the potential OSW project components, a list of maritime CH receptors, and potential interactions between OSW components and CH receptors. Based on the WBG report, a preliminary generic assessment for both scenarios would include both fixed bottom and floating OSW. For both scenarios, the indicative list of potential marine CH receptors includes submerged and buried paleolandforms with the potential to contain archaeological resources; ancient and historic wooden shipwrecks at or near the surface; 19th century to modern metal shipwrecks; and 20th century shipwrecks downed aircraft at or near the surface.

The generic assessment would include a comparison of the seafloor disturbance footprints of fixed foundation and floating wind technologies. Based on the generic assessment, we confirmed that fixed bottom OSWs result in greater seafloor impacts compared to floating wind and are more likely to interact with marine CH resources. These differences in project components need to be considered in strategy or policy level SEAs assessing a mix of both fixed and floating OSW as well as the development of MSP, ESIA, leasing, and permitting frameworks.

Our second step is to identify assessment areas. WBG study identifies two main areas that are most technically suited to OSW development, one in the northern waters in the Gulf of Tonkin and another in southern Vietnam. These two proposed development areas measure roughly 300 km east-west by 450 km north-south, both too large for infield assessment. Under the proposed approach, four smaller assessment areas would be established, two in each proposed development area. Using the NYSERDA 2020 reconnaissance studies as an example, this hypothetical case study assumes four assessment areas, with a 500 km^2 and a 2,5000 km^2 assessment area in the northern and southern development areas with the 500 km^2 survey areas in areas suitable for floating wind and the 2,500 km^2 survey area in fixed foundation development areas.

The third step in the proposed approach is to conduct a marine CH desktop study to inform the development of the geophysical survey of the identified assessment areas. This high level, preliminary desktop study resulted in the following key findings:

- Both development areas contain extensive areas of seafloor that were exposed from 21,000 B.P. to 6,000 B.P. Both having the potential to contain archaeological sites and resources (Figure 3; Vooris 2000);
- As of 2011, only five historic/ancient shipwrecks had been scientifically excavated in Vietnam's territorial waters. The wrecks are dated to the 15th through 18th centuries and consist of wooden vessel fragments, ceramic vessels, iron pans, and ceramic statuary (Figure 4; Flecker 2011).
- Review of The *Sunken Ships of the Second World War* project data identified over 200 shipwreck locations within the offshore areas suitable for OSW development by the WBG, including frigates, cargo ships, gunboats, tankers, and passenger liners from Japan, China, France, and the Netherlands (Figure 5; Heersink 2022);

The results of the preliminary desktop study suggest additional desktop investigations and consultations would be warranted, including consultations with the governments of Vietnam, United States of America, Japan, China, France, and the Netherlands related to the location, identification, and ultimate disposition of military wreck sites and the presence of war graves, which would necessitate consultations.

The fourth step would be to combine the generic assessments, assessment areas, and marine CH desktop study to develop a geophysical reconnaissance survey strategy that incorporates the collection of more detailed marine CH information. The proposed survey would not be limited to collecting marine CH data, but rather, would include the same broad multi-disciplinary objectives of the NYSERDA survey, creating the similar output for use in environmental, engineering, and CH assessments.

The proposed surveys would utilize two (2) robotic Armada ships to survey each assessment area. Each Armada vessel would be equipped with dual-head multi-beam echo sounder, towed side scan sonar, shallow sub-bottom profiler, and magnetic gradiometer All would be monitored by an ultra-short baseline (USBL) positioning system. The surveys would be conducted along a grid of survey/track line intervals of 900 m (north-south) x 4,500 m (east-west). All four assessment areas could be investigated in approximately 70 days, covering roughly twice the area covered by the NYSERDA survey example, in fewer days and, in the case of the 2,500 km^2, with closer interval survey lines. To take advantage of the increased speed and efficiency of the Armada survey vessels, the survey methodology would include provisions for additional, closer interval investigations of previously recorded shipwreck and downed aircraft locations identified during the desktop study and associated inter-governmental consultations. Thanks to near real-time data analysis, more detailed investigations can be conducted in the same vessel deployment without the need for remobilization, making the next stage of any campaign even more efficient.

The proposed survey would provide valuable CH data, addressing modern/large shipwrecks and debris fields and data to generate a reconnaissance geological model with sufficient paleolandscape information to identify areas of potential archaeological significance. To assess potential CH impacts of the proposed OSW policy, the results of the desktop study and marine survey would be combined with the generic floating and fixed OSW project descriptions to assess the potential impacts of each development scenario on marine CH and develop recommendations for framework development to address these impacts. At the project specific level, the results of the SEA could be used to develop OSW ESIA terms of reference could be developed that account for the varying marine CH sensitivity across wind development areas as well as the differences in the breadth and depth of seafloor disturbances associated with floating and fixed foundation OSW.

Conclusion

SEA for national, regional, and sector-specific development programing can be a powerful tool for addressing environmental and social impacts at scale. Properly applied, it can introduce impact considerations into the early decision-making processes where it offers maximum benefit, and in the manner that long-standing lender guidance suggests.[3] Hazy definition of potential impacts due to data collection challenges, however, remain a significant problem for impact assessment practitioners, with SEAs and follow-on project IAs potentially continuing the unhappy tradition of long descriptive documentation without the impacts-focus needed for truly useful decision making.

The approach outlined in this paper represents an institutionally and commercially viable methodology for assessing the OSW impacts to marine CH in emerging markets. Using these new techniques, initial generic assessment of OSW impacts is possible based on characterization of the type and location of local E&S receptors in the lesser-known settings of emerging market countries. These multi-disciplinary datasets would be used to assess impacts of OSW policies as well as to make informed decisions about the development of MSP, project specific ESIA requirements, and tailored permitting and leasing processes during framework development.

[3] World Bank Environmental and Social Safeguard 1 (ESS1), Paragraph 27, Assessment and Management of Environmental and Social Risks and Impacts (2017).

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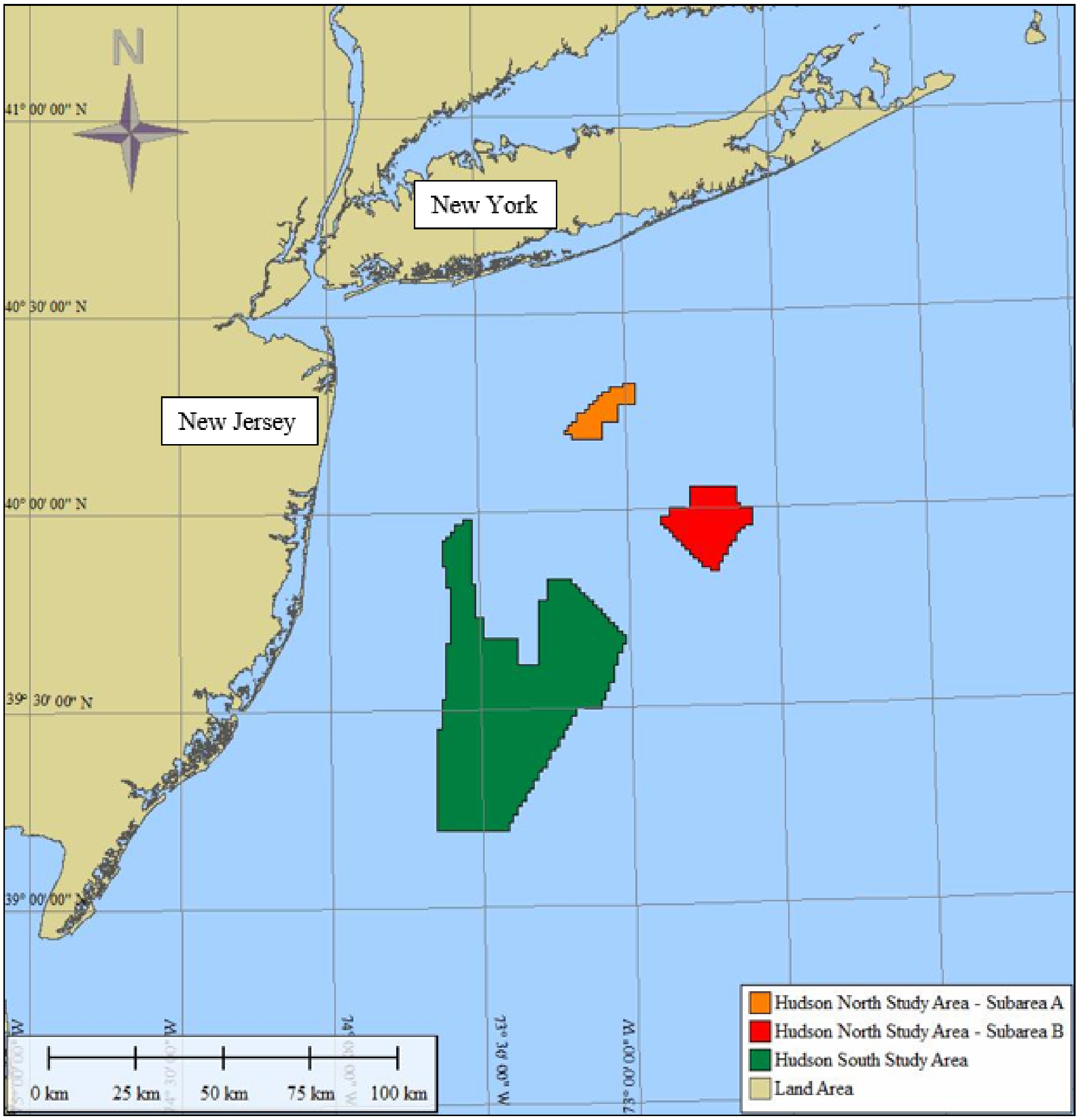

Figure 1: NYSERDA NY Bight Study Areas (NYSERDA 2021)

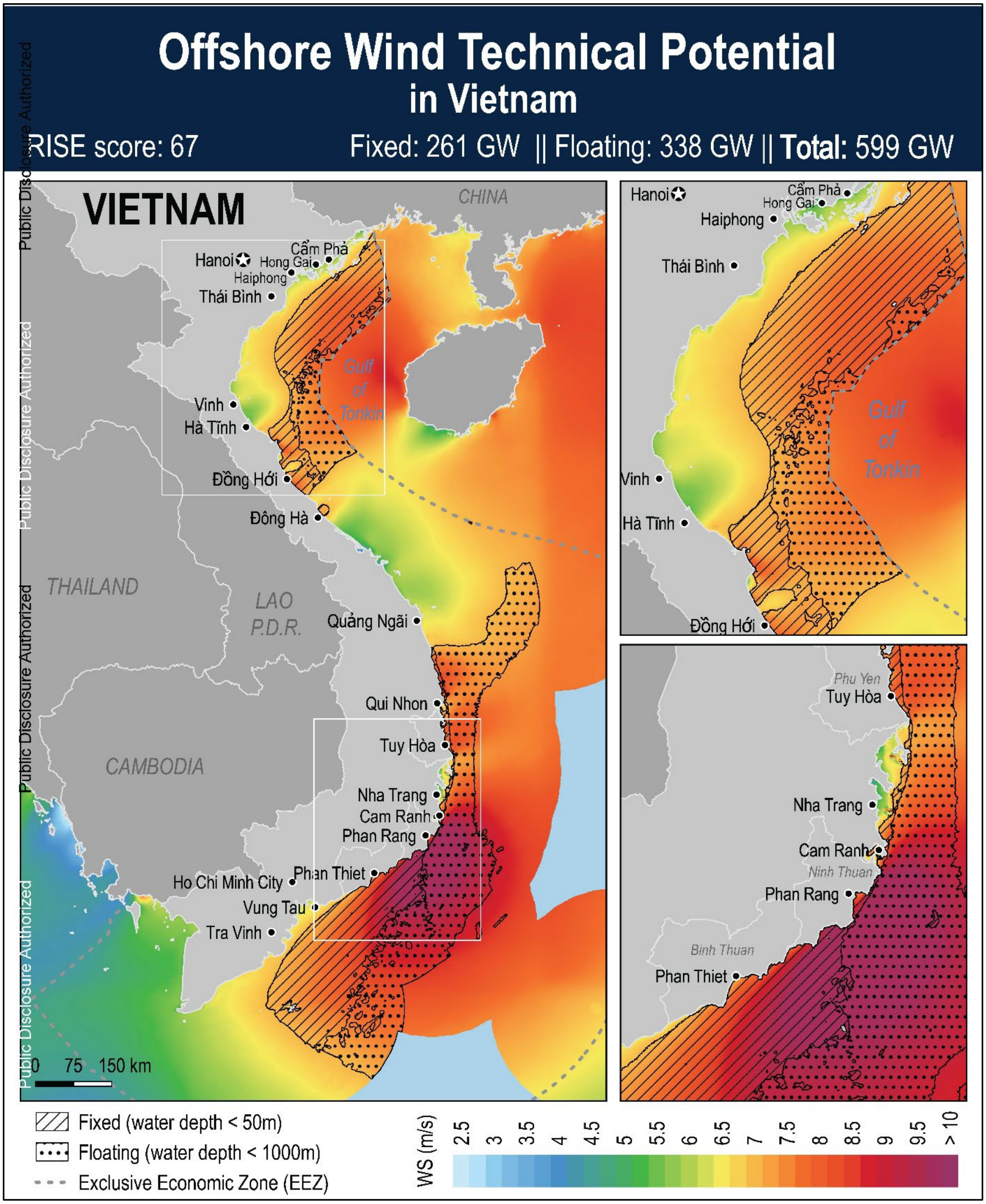

Figure 2: Offshore Wind Technical Potential in Vietnam (World Bank 2021)

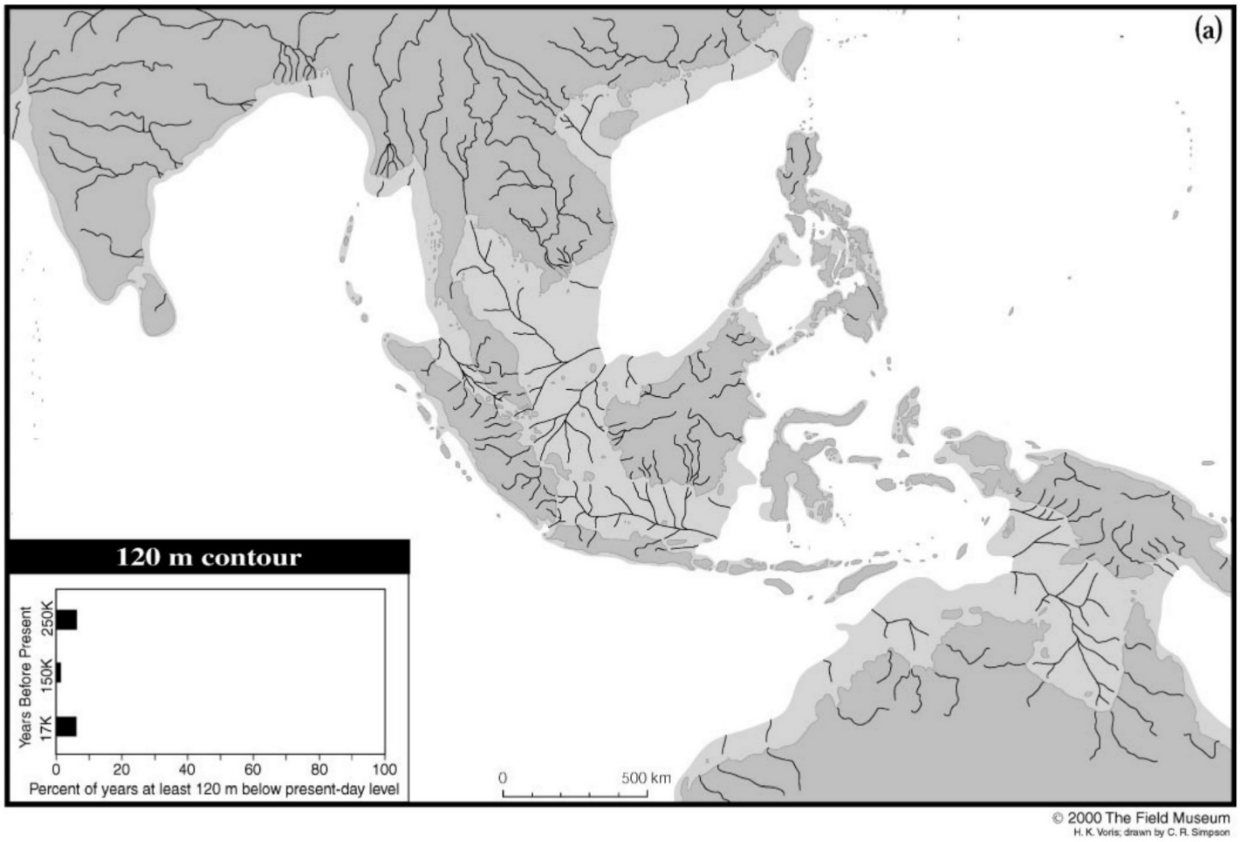

Figure 3: Exposed Sunda Shelf (Vooris 2000).

Figure 4: Map of historic shipwreck sites off the coast of Vietnam (left) and photographs of ceramic trade goods and wooden ship fragments recovered from the *Hoi An, Binh Thuan, and Vung Tao* shipwreck sites (Koh 2009; Daniel 2019).

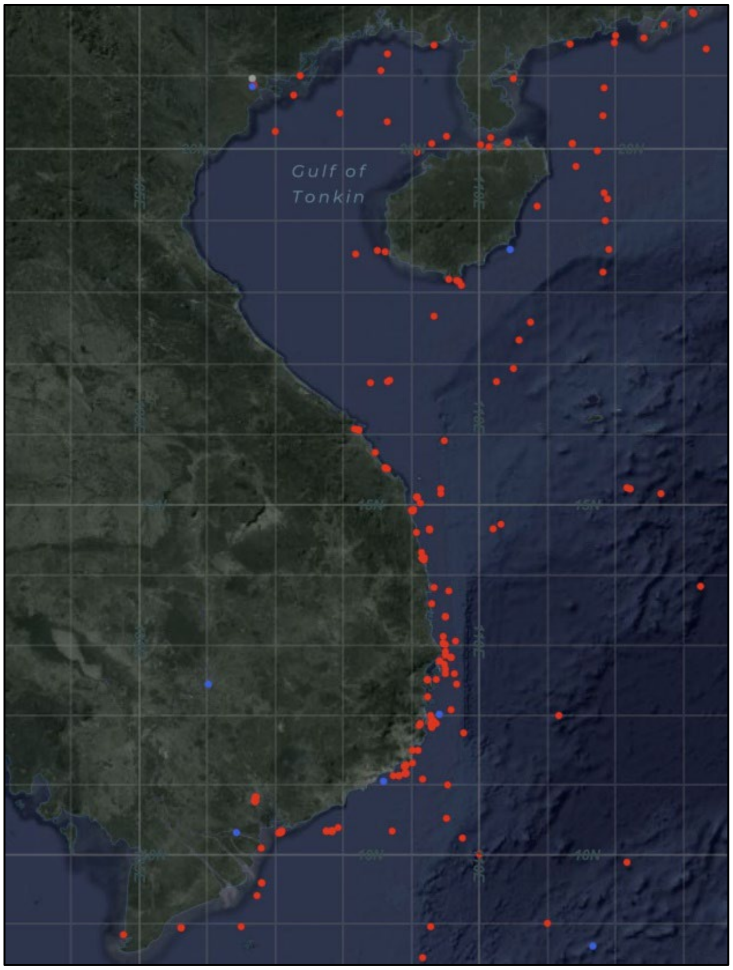

Figure 5: Second World War Shipwrecks off the coast of Vietnam (Heersink 2022)