Decolonising environmental risk assessments of Potentially Polluting Wrecks: A case study of the wreck of the USS Mississinewa in Ulithi Lagoon, Federated States of Micronesia

Polly Georgiana Hill (pollyghill@gmail.com)
Ministry of Defence

Sue Rodway-Dyer
University of Bristol

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Abstract

Millions of tonnes of oil lie entombed within wrecks from two world wars which, when released, can cause environmental devastation. Wrecks are predominantly risk assessed by the Global North Nations responsible, resulting in an epistemology that separates human from nature. This research aimed to decolonise risk assessments to capture the spatially heterogeneous nature of human vulnerability to oil pollution.

Triangulation analysis of interviews and official reports relating to the USS *Mississinewa* oil spill identified three Global South issues a Eurocentric risk assessment failed to capture: region-specific meteorological conditions causing the leak, remoteness making external resources slow to arrive, and the impact of the fishery closure on traditional subsistence lifestyles.

A vulnerability assessment is proposed to prioritise wrecks in susceptible locations. Recommendations are made for a collaborative approach to wreck management by including local voices, resisting the Global North assumption of generality, and recognising the priorities of those living with wrecks.

1 Introduction

In addition to the millions of military personnel and civilians killed, modern warfare has left a legacy of environmental hazards that insidiously continue the violence. Huge quantities of heavy metals (Pire and Budkovi, 1996), radioactive materials (Kudo et al., 1991) and oil (Literathy, 1993) remain where they were released, whereas surplus and captured munitions, bullets and chemical weapons were intentionally dumped in the sea from the end of the First World War (WWI) until the late twentieth century (Voie and Mariussen, 2017, Souchen, 2021). However, the greatest environmental concern with WWI and Second World War (WWII) wrecks is their fuels and cargoes (Bergstrøm, 2014). Hazardous cargoes include chemical warfare agents, conventional munitions, mercury and, mostly commonly, oil (Alexander, 2019, Bergstrøm, 2014, Forrest, 2015, Masetti and Calder, 2014, Monfils et al., 2006, NOAA, 2013, Roberts, 2017). There are an estimated 8,569 oil-containing wrecks globally, containing up to 20.4 million tonnes of oil, the majority of which are from WWI and WWII (Michel et al., 2005).

Steel wrecks, such as those sunk during WWI and WWII, are subject to corrosion, the rate of which varies depending on steel and build quality, ocean currents and dissolved oxygen concentration (Bergstrøm, 2014). As their steel hulls become increasingly corroded, they become more likely to release their contents. Wrecks are increasingly popular dive sites (Edney et al., 2021), so there is risk of interference by divers, some of whom take souvenirs, and whose bubbles can accelerate wreck corrosion (Edney, 2016). More concerning is the issue of illegal salvage as wrecks are targeted for their valuable ‘prenuclear’ steel (Manders, 2020). Illegal salvors typically use ‘smash and grab’ techniques with no regard for environmental protection, which can result in uncontrolled releases of oil and toxic chemicals (Browne, 2019). For recreational divers, wrecks can be wonderful sites of history and marine life (Edney et al.,

2021), but for those people living alongside potentially polluting wrecks, they are a threat to their food supply, income, and way of life.

Removing oil from a wreck costs millions of dollars (NAVSEA, 2004), making it impractical to empty them all, so they must be prioritised according to risk. Several wreck risk assessment methodologies have been devised to assess potentially polluting wrecks either globally (Michel et al., 2005; Goodsir et al., 2019) or regionally, in American (NOAA, 2013), Swedish (Landquist et al., 2016) and Greek (Ventikos et al., 2013) waters, and in the Pacific (Carter et al., 2021). All assessments use archival research to build up a picture of the wreck's condition and how much oil it is likely to contain, some use oil spill modelling to predict where spilled oil might end up, and most include an assessment of what ecological and socioeconomic resources could be impacted. The UK Ministry of Defence (MOD) prioritises its global inventory of ~ 5,700 wrecks for on-site investigation using a standardised Environmental Desk-Based Assessment (E-DBA) that assesses the likelihood of a wreck leaking oil and the ecological and socioeconomic impacts of that oil, to produce overall risk scores by which wrecks can be compared (Goodsir et al., 2019).

Although commendable that Global North nations have taken the lead on risk assessing WWI and WWII wrecks for which they are responsible, this has meant the use of the Global North epistemology that places emphasis on the monetary value humans derive from the environment rather than its intrinsic value and our dependence on it. Further, the Global North desire for standardised assessments may allow direct comparison for the prioritisation of wrecks, but Lövbrand et al. (2015) question the urge to standardise environmental assessments across a complex and heterogeneous world, as they fail to capture spatially variable human vulnerabilities.

By assessing wrecks using Eurocentric ontology that separates human from nature, we risk minimising or excluding what is important to those people living with potentially polluting wrecks, some of which lie in the Global South. Therefore, this study aimed to consider wrecks from the perspective of Indigenous people of the Global South so that we may begin to decolonise the risk assessment process to prioritise what is important to those people living with potentially polluting wrecks and capture the spatially heterogeneous nature of human vulnerability to oil pollution. This was done through a case study of the wreck of the USS *Mississinewa*, which lies in Ulithi Lagoon, Federated States of Micronesia (FSM; Fig. 1).

The USS *Mississinewa* was deployed to refuel ships and aircraft at the WWII Allied naval fleet anchorage in Ulithi Lagoon (Albertson, 2004). She was fully loaded with 19,000 m^3 of oil when she was struck by a Japanese suicide manned torpedo on 20th November 1944 (NAVSEA, 2004). The USS *Mississinewa* was first discovered by divers in early 2001, and just four months later a typhoon passed through the area causing the wreck to shift and release oil (Gilbert et al., 2003). This wreck was used as a research focus because it is the only military wreck in the Global South that is documented to have released oil, affecting local people, and subsequently had remaining oil removed.

This study aimed to reflect on the global applicability of existing risk assessments for prioritising wrecks for remedial work and to consider, using a case study, whether they fully captured the environmental risks

that materialised when the wreck of the USS *Mississinewa* leaked oil. A vulnerability assessment is proposed which captures Global South socio-economic differences, such as those of the Ulithian people.

2 Methods

This study, completed in 2021, used triangulation of an E-DBA for the USS *Mississinewa*, along with interviews and official documents relating to the USS *Mississinewa* oil spill to assess the suitability of the E-DBA method for risk assessing wrecks in the Global South.

Semi-structured interviews used non-leading questions to understand how the oil spill from the USS *Mississinewa* impacted the people of Ulithi. Ideally, Ulithians who were directly impacted by the USS *Mississinewa* would have been interviewed, but COVID-19 pandemic restrictions made travel to Ulithi impossible and Ulithians do not have broadband internet access, so people involved with the USS *Mississinewa* and other WWII wrecks in the Pacific were interviewed for their perspective. All interviews, lasting 20 to 60 minutes, were conducted remotely and recorded using Microsoft Teams. Transcripts were confirmed with the interviewees. Discourse analysis of interview transcripts was undertaken using NVivo v.12 with codes and sub-codes identifying key themes.

Official documents related to the USS *Mississinewa* oil spill and subsequent remedial work were reviewed alongside interviews for context and timeline. It was recognised that the events discussed occurred in 2001–2003 so interviewees' memories may be inaccurate, and the official documents may have failed to completely document the impacts on local people. This included the US Naval Sea Systems Command (NAVSEA) report on the USS *Mississinewa* oil removal operation and its appendices (NAVSEA, 2004) and the environmental impact survey report completed in September 2001 (Gilbert, 2001).

The E-DBA methodology produced for risk assessing MOD-owned wrecks (Goodsir et al., 2019) was used as an example to highlight how Global North environmental risk assessments might have overlooked the specific vulnerabilities that emerged from the interviews, to reflect on whether it would have highlighted the USS *Mississinewa* as a priority for further investigation, and to consider how environmental risk assessments could be decolonised to better capture place-specific vulnerabilities.

3 Results and Discussion

The analysis drew on interviews with six people (Table 1), four of whom were directly involved with the USS *Mississinewa* and two of whom have been involved with other polluting wrecks in the Pacific, including Chuuk Lagoon, FSM, since many of the issues are common across Pacific islands. Chuuk Lagoon was the site of a major conflict between Japan and the USA and is the resting place of over 50 WWII wrecks (Jeffery, 2012).

Two interviewees were involved in the various remedial operations on the wreck, which were contracted out by the Supervisor of Salvage and Diving (SUPSALV) who provide salvage and diving support to the US Navy, including remedial work on US legacy wrecks. Two interviewees were involved with the USS

Mississinewa when they worked for the Secretariat of the Pacific Regional Environment Programme (SPREP), and another interviewee joined SPREP subsequently but was familiar with the event and the issues relating to polluting wrecks across the Pacific. The SPREP is a United Nations (UN) organisation set up to provide environmental advice to the region; it is funded by Australia, New Zealand, USA, and France. The final interviewee was a maritime archaeologist who has spoken with people living alongside polluting wrecks in the Pacific.

Table 1
Code and affiliation of interviewees and whether they were directly involved with the USS *Mississinewa*.

ID Code	Affiliation	Involved with the USS *Mississinewa*?
SUPSALV-1	SUPSALV contractor	Yes
SUPSALV-2	SUPSALV contractor	Yes
SPREP-1	SPREP (during 2001–2003)	Yes
SPREP-2	SPREP (during 2001–2003)	Yes
SPREP-3	SPREP (currently)	No
Archaeologist	Maritime Archaeologist and Associate Professor, University of Guam.	No

3.1 Response to the USS *Mississinewa* Oil Leak

Figure 2 provides a timeline of events relating to the oil spill and remediation work done on the USS *Mississinewa*, based on official reports (Gilbert, 2001, NAVSEA, 2004) and interviews. It took around twenty months from the initial oil spill report to the final oil removal from the USS *Mississinewa* due to the various government processes and stages involved (NAVSEA, 2004), which is not unusual. It took two years from initial research to pumping oil off the wreck of the USS *Prinz Eugen* in the Republic of the Marshall Islands (NAVSEA, 2019) and five years to remove oil from the wreck of the RFA *Darkdale* in St Helena, a remote island in the South Atlantic (Saint Helena Government, 2015). Wreck research and surveys required for planning, together with government processes, are largely responsible for the long timescales, which are exacerbated by the logistical challenge of working in remote locations with little infrastructure and resources, as confirmed by the interviewees “this is a very remote part of FSM, it's about a two-hour flight from Yap [the nearest major island], [by] small plane” (SPREP-2).

Interviewees also raised the issue of lack of resources, which meant local islanders could not respond to an oil spill. No one knew of any oil clean-up efforts or post-spill monitoring following the USS *Mississinewa* oil spills. “There were impacts I could see on some of the seabirds, there were impacts on some of the turtles. But, of course, there was no wildlife capture or cleaning. There was no one out there assessing those damages.” (SPREP-1).

All resources for the oil removal operation had to be shipped to Ulithi. The main island, Falalop, has a short runway, a remnant of WWII, which only receives small planes, and there is not even a small boat pier within 120 miles (NAVSEA, 2004) so equipment and personnel could only get between Falalop and the operations vessels (8 miles) by small boat transfer. Planes and boats are infrequent, “there's usually only a ferry once every so often, sometimes only once a week or maybe once a fortnight” (SPREP-1). This was considered by the USA when they were weighing up options for dealing with the USS *Mississinewa*. “… when they looked at the logistics and the timing, they said it would take them a minimum of eleven days to mount a response and to get sufficient equipment ... out to Ulithi ... a lot of oil can leak out in that time, and a lot of damage can be done.” (SPREP-1)

Such factors leave people living in remote locations uniquely vulnerable to oil pollution, and this must be captured as part of wreck environmental risk assessments.

3.2 Critique of the Environmental Desk-Based Assessment (E-DBA)

The E-DBA used by the MOD consists of three individual assessments that are combined to generate overall risk scores for ecological and socioeconomic sensitivities (Goodsir et al., 2019; Fig. 3). The Likelihood of Release assessment uses archival information, local environmental data, and oil spill reports to determine how likely the wreck is to cause an oil spill. The Likelihood of Exposure assessment uses computational oil spill modelling to predict the spatial extent and environmental loading of oil pollution under different oil spill scenarios at different times of the year. Finally, the Ecological Impact and Socioeconomic Impact assessments combine the model outputs with sensitivity data for the region to predict the severity of impact for each scenario. This section explores whether the Ecological Impact and Socioeconomic Impact assessments E-DBA would have recognised the risk posed by the wreck of the USS *Mississinewa* to the people of Ulithi, based on the impacts identified in the interview analysis.

The Eurocentric Likelihood of Release Assessment (Table 2) does not consider local conditions, such as regular tropical storms or tectonic activity, or human activities that could increase the rate of wreck deterioration such as regular recreational diving or dynamite fishing. Ulithi Lagoon lies in the typhoon circulatory region and experiences typhoons all year round (Kuwahara, 2003), as do many of the tropical islands involved in WWII, and all interviewees noted their impact “every so often a major storm event like a typhoon will go through and ... the place would be decimated and then they rebuild and start again” (SPREP-1), and another typhoon caused a second leak shortly after the first leak had been stopped, “they fixed it, temporary fix, but then another hurricane came through so they had another leak” (SPREP-2). It was a tropical storm that caused the wreck of the RFA *Darkdale* in Saint Helena to leak in 2010 (SALMO, 2013) and likely Hurricane Arthur that caused the wreck of tanker *W.E. Hutton* off the North Carolina coast to leak in 2014 (Black, 2014). Tropical storms and cyclones, which are increasing in intensity with climate change (Tsuboki et al., 2015), can disturb wrecks causing them to leak, or increase the rate of deterioration (MacLeod et al., 2017). Storms can also increase the time it takes for external resources to get into the region to recover oil as well as hinder oil collection from the sea surface (Doerffer, 1992).

However, the frequency of such storms is not a feature of the E-DBA, despite it being considered in other wreck risk assessments (e.g. Landquist et al., 2016), nor are other natural hazards that can impact wrecks, such as tectonic activity (Dillenia et al., 2016).

Table 2
Criteria and sensitivities for the Likelihood of Release and Ecological Impact assessments, respectively (Goodsir et al., 2019).

Likelihood of Release	Ecological Impact
• Vessel depth	• Marine and coastal designated areas
• History of leaks	• Marine mammals
• Condition of wreck	• Marine reptiles
• Age of vessel at time of sinking	• Seabirds
• Length of time the wreck has been submerged	• Benthic features and species
• Method of oil storage	• Fish spawning and nursery areas
• Type of incident causing sinking	• Fish
• Seabed type	

Some islanders take munitions from wrecks to use in dynamite fishing (Jeffery, 2007), the shock of which can damage the wreck directly or dislodge the protective biological coverings that have grown on wrecks, leaving them exposed to corrosion (MacLeod et al., 2017). Sports diving on WWII wrecks in places like Ulithi and Chuuk Lagoon is increasingly popular (Edney and Spennemann, 2014, Jeffery and Nishikawa, 2021), which can increase the rate of deterioration (Edney, 2016). These wreck-specific details, which are not necessarily apparent using only online resources, must be considered when assessing the likelihood of a wreck to release oil. Although assessment could potentially be improved to better capture these additional factors, one could argue that predicting which wrecks will release oil first is a costly distraction, both financially and temporally, given the variables involved and the difficulty in quantifying their significance. It is perhaps more important to consider where a leaking wreck will have the biggest impact on local people and their environment. This is where the Socioeconomic Impact and Environmental Impact Assessments of the E-DBA come in, but they failed to capture the impact that even a small oil spill from the USS *Mississinewa* had on the people and wider ecosystem of Ulithi.

The Ecological Impact Assessment contains Global North worldview statements regarding what is important and worthy of protection. As is typical of colonial ecological assessments, it does not make space for place-specific worldviews (Trisos et al., 2021), and it is far from acknowledging the intrinsic value of the ocean that is required to fully embrace its protection (Bender et al., 2022). It also fails to capture some of the issues highlighted by the interviews, reflecting a lack of understanding of the Global South.

As seen in Table 2, the Ecological Impact Assessment prioritises designated marine areas, which Ulithi Lagoon was not when the USS *Mississinewa* started leaking oil in 2001, though some areas now are protected (Crane et al., 2017). The inclusion of marine and coastal designated areas, which are not inherently more sensitive to pollution than non-designated areas, disadvantages places that do not have official designation status, which can be detrimental to Indigenous peoples (Ban and Frid, 2018, Richmond and Kotowicz, 2015), and fails to consider the indigenous worldview which often embodies conservation of marine resources (Ban et al., 2020).

The Ecological Impact Assessment does consider fish nursery areas, but not mangroves specifically, despite their being particularly vulnerable to oil spills and slow to recover. The impacts of oil on mangroves, which provide fish nursery habitats, was highlighted within the interviews. Mangroves cannot be decontaminated "because this is persistent oil, and there's been lots of studies that have shown that … there is definitely long-term consequences to ... this pollution" (SPREP-3). The Swedish 'VRAKA' wreck risk assessment methodology offers an alternative by considering the specific vulnerability of shorelines that could become oiled, based on how easily pollution can be remediated on different shoreline types (Amir-Heidari et al., 2019, Landquist et al., 2016). This is an important aspect of shoreline pollution persistence which affects the people, plants and animals living with pollution, but it could go further to consider human vulnerabilities specifically.

The closure of fisheries in Ulithi Lagoon for a few months in response to the oil spill began to disrupt the local ecology, "[Ulithians] were decimating the [coconut crab] population, rather than just taking the large ones, they were also taking some of the smaller ones, so it cuts out the next generation of crabs ... They were decimating their crops; they were decimating the wildlife and they were potentially interrupting the ecology of the islands" (SPREP-1). A larger oil spill could have closed the fisheries for several months. The potential impact of the fisheries closure on the ecology of the islands as Ulithians sourced food from elsewhere would not have been captured by the Ecological Impact Assessment or by other wreck environmental risk assessments.

The socioeconomic impacts of an oil spill are likely to vary spatially and according to factors such as class and gender (Fadigas, 2017, de Oliveira Estevo et al., 2021). Oil pollution can have far reaching social consequences in some places; for example, frequent oil spills in the Niger Delta, Nigeria, led to a loss of fishing opportunities and therefore income, which meant parents could not afford to educate their children (Ipingbemi, 2009). The Socioeconomic Impact Assessment (Table 3) exudes a colonial worldview by viewing Nature as a resource from which humanity can extract resource and income (Fischer et al., 2022) and fails to capture all that is socially valuable, especially in the Global South. Socioeconomic impact is considered low (scored as 1) if there is less than 5% chance of oiling of infrastructure, shipping, or tourism areas; a medium impact (scored as 2) is 5–50% chance of oiling, and a high impact (scored as 3) is > 50% chance of oiling. Ulithi has none of the infrastructure specified in the assessment, there is no major shipping and there is very little tourism with there being just one small hotel on the island in 2001 (Rubinstein, 2003). Thus, the assessment assumes that Ulithians would be less impacted by an oil spill than people living in a place that does have those industries, despite the lack

of associated income and resources (including healthcare) leaving Ulithians more vulnerable. A focus on economic resources that are concentrated in densely populated areas deprioritises those in less populated areas and allows remote wrecks to remain out of sight and out of mind.

Table 3
Socioeconomic Impact assessment of a major oil spill from USS *Mississinewa* according to Goodsir et al. (2017).

	Socioeconomic Sensitivity	Low (1)	Medium (2)	High (3)	Oil Spill Score		
Current and planned infrastructure	Offshore wind farms	< 5% chance of oiling	5–50% chance of oiling	> 50% chance of oiling	1		
	Offshore oil and gas installations						
	Industrial water intakes						
	Aquaculture						
Shipping	Important shipping lanes	< 5% chance of oiling	5–50% chance of oiling	> 50% chance of oiling	1		
	Ports						
Tourism and leisure areas	Tourism (coastal towns, beach fronts and beach resorts)	5% chance of oiling	5–50% chance of oiling	> 50% chance of oiling	1		
	High use areas (monitored beaches, popular diving locations, tourist resorts, recreational marinas, and boating areas)						
Fishing grounds	Demersal	< 180 days of fishing lost	180–365 days of fishing lost	> 365 days of fishing lost	1	2	3
	Pelagic						
	Crustacean						
	Overall impact score (out of possible range 4–12)				4	5	6

Ulithians fish within the lagoon using hook and line, speargun and cast net (Crane et al., 2018), which could cover all types of fishing (pelagic, demersal, and crustacean fisheries) assessed in the Socioeconomic Impact Assessment, but it considers an oil spill that closes fisheries for up to one year as a low socioeconomic impact (Table 3). However, for the Ulithians and others who depend on fishing for most of their nutrition and income, this would have a huge impact without suitable alternative food sources being provided immediately. All interviewees raised the issue of subsistence fishing in the Pacific, “a lot of the locals there are basic subsistence living, if they don't fish, when their kids come out of school and come home there's nothing for them to eat for the night… they live from day to day off the natural world and if it's impacted, then, you know, how do they live?” (SPREP-1). Tribal lands are considered when assessing wrecks in American coastal waters, where subsistence fishing is recognised as distinct from

commercial fishing and therefore particularly important (NOAA, 2013), and this needs to be extended to the E-DBA for it to be applied globally.

The Socioeconomic Impact Assessment also excludes traditional Indigenous lifestyles more generally. The customs and traditions of Pacific Islanders are inextricably linked to their collective ownership of land, sea, and nature (McNamara, et al., 2021) and the importance of protecting traditional lifestyles must not be underestimated. The environmental impact of oil pollution, made worse by a lack of preparedness or proper clean-up, can lead to a loss of traditional livelihoods and a breakdown of the relationship between Indigenous people and their environment, which can be damaging to their spiritual and mental health (Gill and Picou, 2001, Pegg and Zabbey, 2013, Pellegrini et al., 2020). Disruption to Indigenous cultures can cause issues such as displacement, subsistence disruptions, depression, loss of autonomy, dependency, social conflict, and disease (Mansperger, 1995).

A disruption to food sources, as occurred in the USS *Mississinewa* case study, can cause displacement of Indigenous people, stripping them of their spatial and social identity (Pellegrini et al., 2020, Terminski, 2011). Furthermore, a change in diet to an imported western diet, together with a reduction in physical activity, can be damaging to physical health, as seen on Pacific Islands where people have shifted from a traditional subsistence lifestyle to a sedentary western lifestyle (Cassels, 2006). It was noted by some interviewees that alternative food must be supplied if fisheries are closed, “the island habitats just don't have the accessibility to supermarkets and shops as we would do in the cities, so they would be even more vulnerable” (SPREP-3). Food was eventually provided to the Ulithians following the fisheries closure, but evidently the Ulithians were not asked what food they eat and instead they were sent what was palatable to the Americans, so “nobody was really thrilled with the food. They looked at the pork chops and the pork chops were kind of grey, that's the one thing I remember was, ‘we're not going to eat grey pork chops’” (SUPSALV-2).Wreck owners have a moral obligation to proactively mitigate risks to traditional lifestyles and consider how the impacts can be minimised, based on the values in that specific social context (Barnett et al., 2016).

The Socioeconomic Impact Assessment does not consider the impact on human health despite the well-documented impacts of oil spills on mental and physical health (Laffon et al., 2016). This oversight is common to several wreck and oil spill environmental risk assessment methodologies (Amir-Heidari et al., 2019, Neves et al., 2015, NOAA, 2013), though health is occasionally considered (Webler and Lord, 2010). Even post-spill, as little as 1% of studies published 1968–2015 considered the impacts on human health (Murphy et al., 2016). The Global North tendency to separate human from nature (Trisos et al., 2021) means that humans are rarely considered in environmental risk assessments. The environmental assessment completed following the USS *Mississinewa* oil spill mentioned that the Ulithi Lagoon fisheries were closed to protect human health and recommended they be reopened immediately, but with long term oil contamination monitoring of certain species (Gilbert, 2001). However, no interviewee was aware of any seafood or human health monitoring done, “I've been sort of liaising backwards and forwards with SPREP over the last 20 years and I've never heard of any health assessments or surveys done” (SPREP-1). Similarly, in Chuuk Lagoon where “the oil has been leaking out of [WWII wrecks] ever

since they went down in 1944 ... I've never heard anything about healthcare issues to do with... polluted fish" (Archaeologist). Similarly, following a major oil spill off the coast of Brazil, artisanal fishers raised the issue of skin diseases (from direct contact with oil) and diarrhoea (from consuming contaminated fish) during a focus meeting, but, again, no human health monitoring was done (de Oliveira Estevo et al., 2021).

Some people chose to continue fishing despite the fisheries closure, and there were some local concerns about the oil, "heavy oil tends to irritate skin, you can get itchy, it's an allergic reaction to the oil. That was the main concern and [Falalop] is where the secondary school for that whole area is located, the boarding school, there was concern for the children" (SPREP-2). The Ulithians have limited access to healthcare due to financial and transport constraints (Hancock et al., 2007). The Yap State Health Department surveyed the health of the Ulithian community by interviews in July 2004, two years after the final USS *Mississinewa* oil removal operation. The survey was unrelated to the wreck but, although not asked about specifically, pollution of the ocean was self-identified as a problem by some of the community (Hancock et al., 2007).

Wreck managers have an obligation to protect the health of those living with potentially polluting wrecks, committing to seafood and/or health monitoring if necessary, and to ensure anyone who is impacted by pollution has access to adequate healthcare. Furthermore, in Chuuk Lagoon "the locals... can take off dynamite from the bombs and make dynamite bombs and throw it onto the wrecks ... and get a lot of money from catching fish like that" (Archaeologist). This is a dangerous activity and "most of the healthcare issues have been... people losing their limbs or dying because of recovering dynamite or cutting open bombs" (Archaeologist). This is a risk that needs to be better captured in wreck assessments, since there is a duty of care towards those living alongside wrecks.

The interviews gathered in the case study of the USS *Mississinewa* suggest that the assessment is currently missing some important considerations, which means that wrecks in vulnerable places like Ulithi could be wrongly deprioritised. It is proposed to introduce a further assessment of vulnerability to decolonise the E-DBA process, enabling it to highlight wrecks affecting subsistence living people in undeveloped places like Ulithi.

3.3 Proposed Vulnerability Assessment

Given the great uncertainty involved in assessing the environmental risks associated with wrecks, it might be more appropriate to reframe the question and ask instead: who is most vulnerable? The people who are most vulnerable are often the easiest to ignore (Davies, 2019) but it is the responsibility of wreck owners to identify those people and protect them. The term 'vulnerability', describing the harm that could be caused to people, was deliberately chosen over 'resilience', which describes people's ability to cope with and recover from a stressor (Webler and Lord, 2010). The people of Ulithi are resilient; they repeatedly rebuild after typhoons destroy their property. But to discuss resilience in the context of oil spills from wrecks implies that they (and others) should have to adapt and prepare for oil pollution that, rather than being a natural phenomenon, was inflicted on them by the conflict of others. It is unethical to expect

a community to be resilient at the expense of their wellbeing (Kaika, 2017), and more should be done to capture their unique vulnerabilities.

The impact of an oil spill depends on the ability of the local people to respond and recover (Chen et al., 2019). The recommended vulnerability assessment (Table 4) aims to address this, considering factors highlighted in the interviews that made the Ulithians particularly vulnerable to oil pollution: reliance on the marine environment for food and income, access to oil spill response resources and healthcare, and time to get required resources into a remote island location. As before, each vulnerability is scored one (low), two (medium) or three (high), with the total score divided by five (the number of criteria assessed) to give a vulnerability factor of between one and three with which to prioritise wrecks that could affect particularly vulnerable populations whether in the Global South or North. The USS *Mississinewa* would have the maximum vulnerability score of three, thereby highlighting the requirement for an on-site investigation to determine the quantities of oil remaining on the wreck, and an appropriate risk mitigation and management plan.

Control measures such as access to oil spill response resources are an important component of oil spill risk assessments but they are rarely included (Neves et al., 2015). Even in large, relatively developed countries a state-led oil spill response can be found lacking, leaving local communities vulnerable to oil pollution (de Oliveira Estevo et al., 2021, Fadigas, 2017). Pacific islands do not have sufficient oil spill response equipment or trained personnel for major oil spills. Each country has a metropolitan country (Australia, New Zealand, USA, or France) they can call upon through the Pacific Regional Marine Spill Contingency Plan (PACPLAN) if an oil spill exceeds their capability (SPREP, 2019), but the remoteness means it can still take days to get response equipment and personnel on site.

Table 4
Vulnerability scoring matrix for people living with polluting wrecks

Vulnerability	Low (1)	Medium (2)	High (3)
Reliance on marine environment for food	No reliance	Partial reliance, access to other food sources	Full reliance
Reliance on marine environment for income	No reliance	Partial reliance, access to other income sources	Full reliance
Access to oil spill response resources	Substantial stockpile of equipment and fully trained responders	Small stockpile of equipment and trained responders	No equipment or trained responders held locally
Time to get sufficient oil spill response resources to location	< 2 hours	< 24 hours	> 24 hours
Access to healthcare, either for monetary or geographical reasons	Full access	Access to limited services	No access locally

By considering vulnerability in wreck assessments, wreck managers can identify where and for whom an oil spill would be intolerable, thereby prioritising wrecks that might be dismissed as low risk using the existing assessment E-DBA method. The proposed vulnerability assessment goes some way to achieving this, but it does perpetuate the standardisation approach of Global North environmentalism and its colonial worldview (Trisos et al., 2021). Using just a few numbers to characterise the complex relationship between people and their environment is problematic in its reductionism since it tells us little of the lived experiences and vulnerabilities of local people (Hill et al., 2022; Lövbrand et al., 2015). Neves et al. (2015) recommend that coastal vulnerabilities be assessed according to variables (and weighting) decided upon by local stakeholders. It seems appropriate to extend this to human and non-human nature vulnerabilities since environmental risks and vulnerabilities are not evenly distributed across all scales of human society (Lövbrand et al., 2015), and what people value is not static over space and time (Barnett et al., 2016). Even within the Pacific Island nations perspectives on polluting WWII wrecks vary between communities and different stakeholders (Jeffery, 2012).

Rather than project our own concerns and understanding of risk onto others, wreck management should be a collaborative endeavour with the most vulnerable people, as demonstrated in the Pacific more recently (Carter et al., 2021). Similarly, any recovery from an oil spill affecting Indigenous people should include their perspective (Morgan and Fa'aui, 2018). By adopting co-design principles (IOC-UNESCO, 2021), wreck managers can work with people living alongside potentially polluting wrecks to co-produce knowledge of the wreck and its management plan, including possible solutions. In doing so, the local community at risk has some control over the mitigation measures put in place, so their specific vulnerabilities can be accounted for and protected as they see fit.

4 Conclusion

This study used triangulation of an E-DBA, official documents and discourse analysis of interviews related to the oil spill from the wreck of the USS *Mississinewa* to explore how people living in the Global South are uniquely vulnerable to polluting wrecks and consider whether the E-DBA used to prioritise MOD-owned wrecks is suitably designed to capture these vulnerabilities.

Wrecks in tropical regions may deteriorate quicker than in temperate regions due to tropical storms and local activities such as recreational diving and dynamite fishing. People with traditional lifestyles like the Ulithians are particularly vulnerable to polluting wrecks due to their reliance on the marine environment to feed their families, a lack of suitable resources to respond to oil pollution and a lack of health monitoring or comprehensive healthcare. Furthermore, their remoteness means there is always a delay in receiving external support. The E-DBA is written in a Global North ontology that excludes indigenous worldviews and knowledge. The issues identified through the interviews are not captured in the E-DBA, so wrecks in the Global South can be mistakenly overlooked as low priority. An additional stage in the E-DBA was proposed to assess local vulnerabilities and produce a vulnerability factor which will lower or raise the perceived risk, and therefore priority, accordingly.

Wreck research and government processes mean that it can take years to fully address a leaking wreck, and this is longer in remote regions due to logistical challenges. Therefore, remote wrecks that could impact vulnerable people should be prioritised for on-site assessment allowing for quicker oil removal if required. Wherever possible, local attitudes should be taken into consideration when assessing wrecks in collaboration with those people most at risk. This is just the first step in the decolonisation of the wreck risk assessment process, which is yet to include indigenous voices directly.

5 Limitations

We are acutely aware that, despite aiming to consider wrecks from the perspective of Indigenous people, we instead spoke predominantly to people from the Global North, and we were unable to speak with people directly impacted by the wreck of the USS *Mississinewa*. This was disappointing but an unavoidable consequence of the COVID-19 pandemic making travel impossible, and the lack of local internet infrastructure making online discussions with local people impossible. Consequently, we only had second hand accounts of events following the oil pollution from the USS *Mississinewa.* Just two of the interviewees were indigenous to the Pacific so there is undoubtedly Global North bias. It was disappointing not to give Ulithians the opportunity to express how they were impacted and, potentially, continue to be impacted by the wreck twenty years later. As a next stage in this work, we would like to invite the people of Ulithi to share their own personal experience of the pollution from the USS *Mississinewa* and ask how we can better protect people from potentially polluting wrecks.

Declarations

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Figures

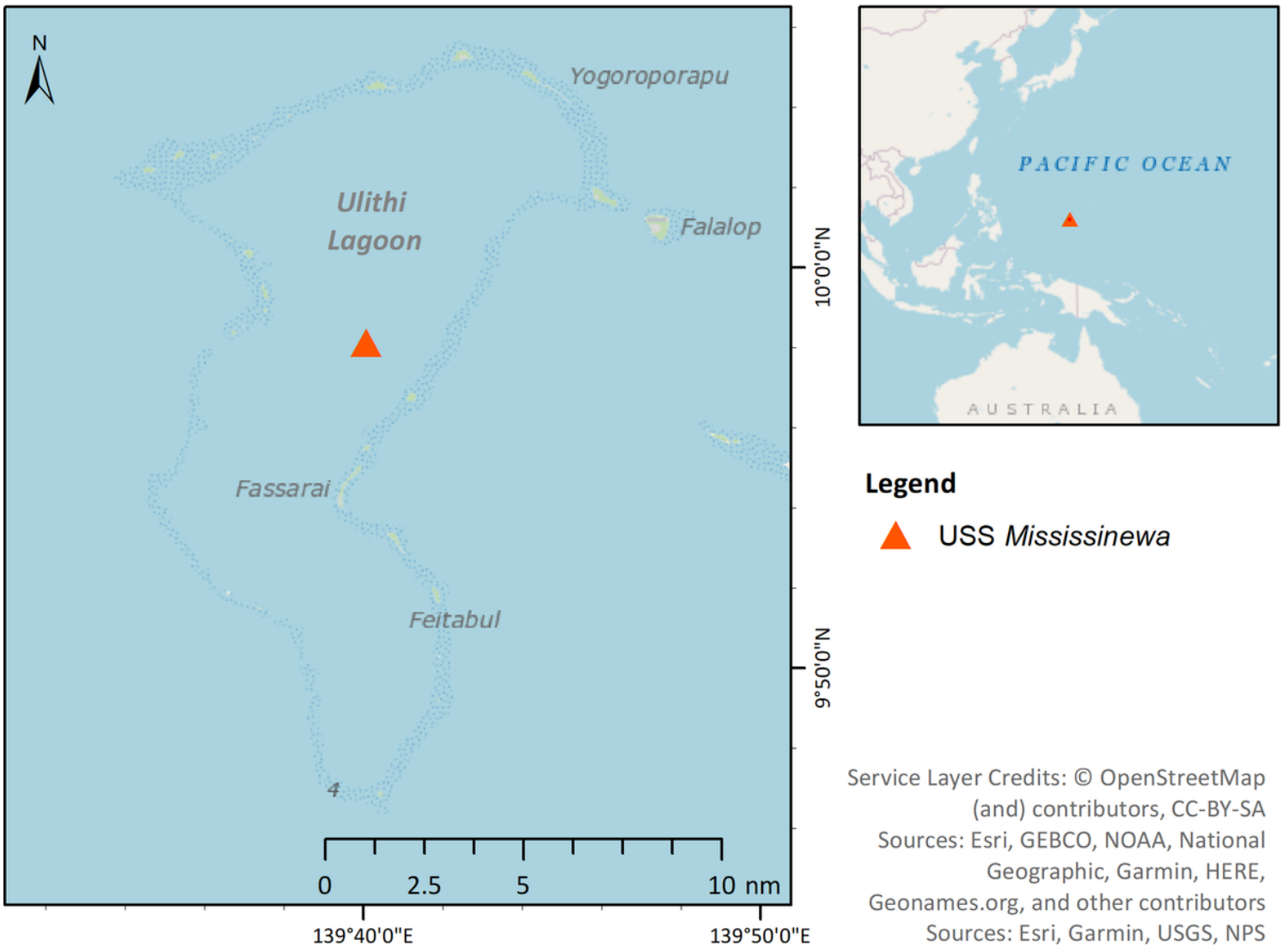

Figure 1

Location of the USS *Mississinewa* in Ulithi Lagoon, Federated States of Micronesia.

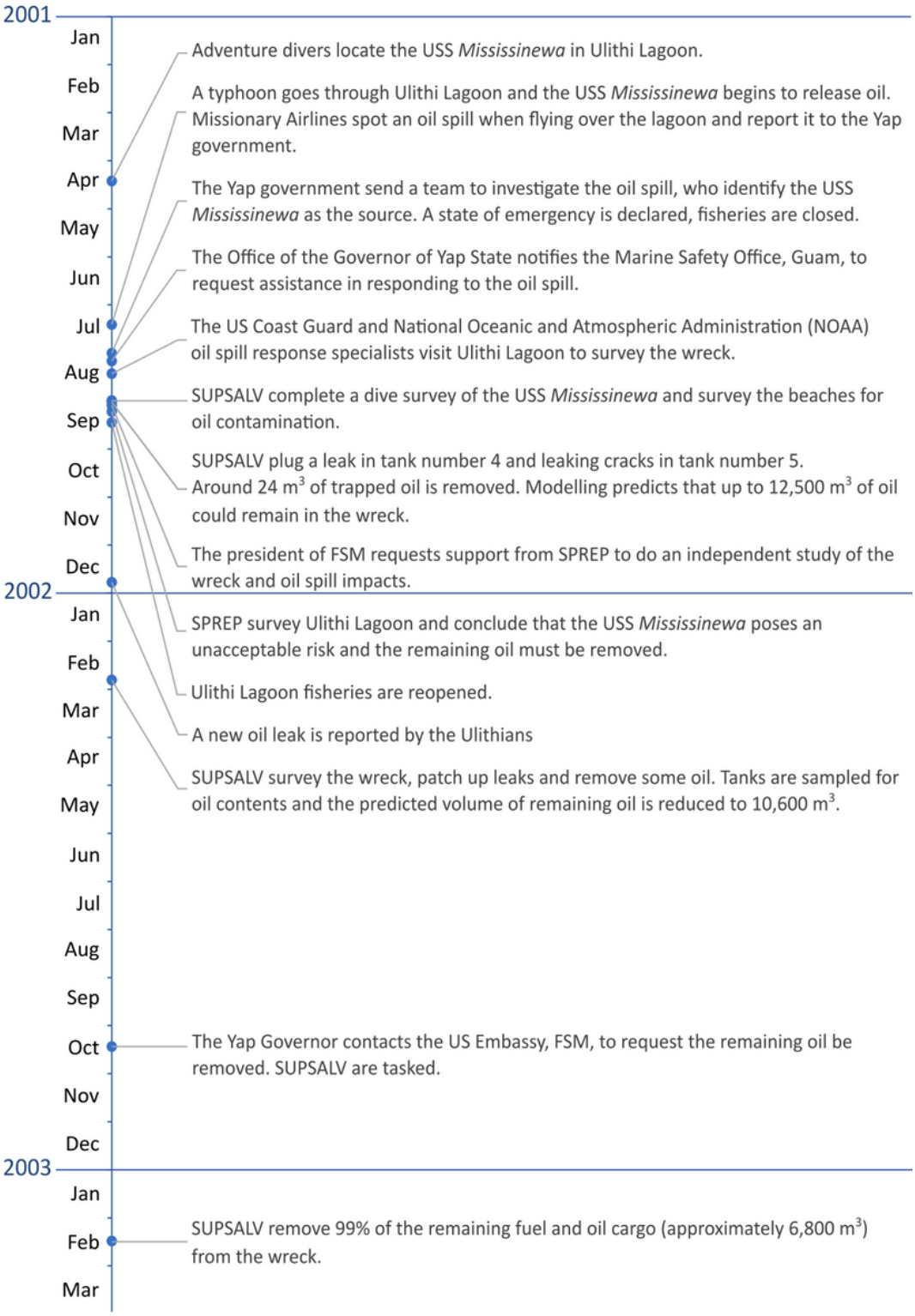

Figure 2

Timeline of events relating to the USS *Mississinewa* oil spill and removal.

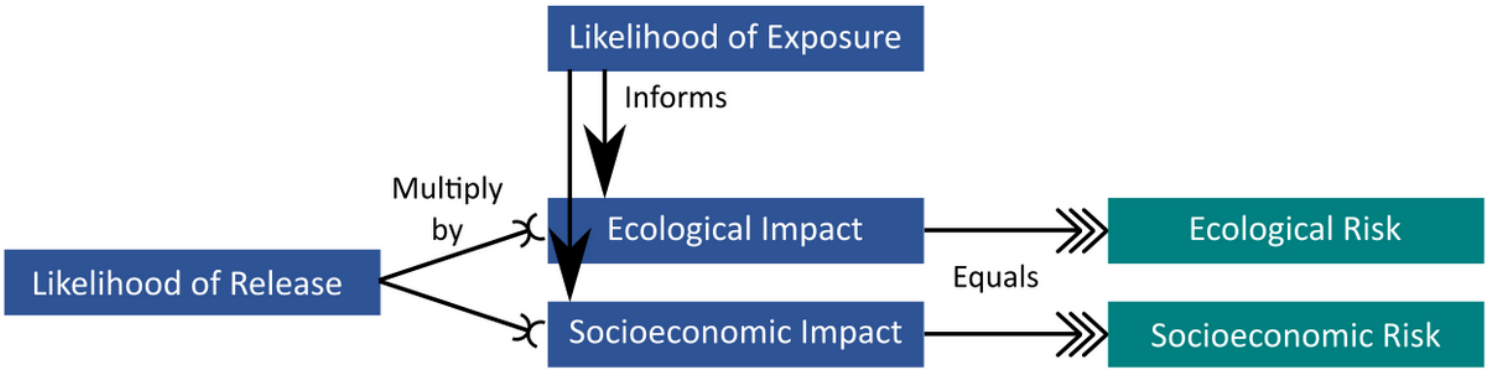

Figure 3

The assessments (blue) and outputs (green) of the E-DBA.