THE POTENTIAL IMPACTS OF CLIMATE CHANGE ON MARITIME BOUNDARIES AND EXCLUSIVE ECONOMIC ZONES

THREE GIS SCENARIOS FOR 20 JURISDICTIONS IN THE WESTERN AND CENTRAL PACIFIC REGION

LEVI WESTERVELD

DEPARTMENT OF GEOGRAPHY | UNIVERSITY OF BERGEN

2020

Abstract

Exclusive Economic Zones (EEZs) are maritime territories that extend 200 nautical miles from a country's coastline. They mandate sovereign rights over all the natural resources. For Pacific island states, these zones support large economic sectors such as fisheries and tourism. The United Nations' Convention for the Law of the Sea (UNCLOS) defines how EEZ territories are determined, but it is not explicit on whether changes to coastlines due to effects such as sea level rise could affect the delimitation of maritime boundaries and EEZs. The Pacific region is particularly vulnerable to climate change effects because of its many low-lying atolls. This study is the first which uses a scenario approach to quantitatively assesses the potential impacts of climate change on the shape, area, and connectivity of 20 jurisdictions' EEZs in the western and central Pacific region.

Due to competing legal arguments on whether and how climate change could affect the delimitation of EEZs, this study uses a scenario approach to capture the different legal interpretations of UNCLOS, and the potential development of international law. Based on a literature review and semi-structure interviews with legal scholars from the study region, three potential legal scenarios are developed. Scenario 1 assumes that EEZ boundaries are fixed regardless of changes in the coastline due to climate change effects unless they are provisional (i.e. disputed boundaries). Scenario 2 assumes that EEZ boundaries are also fixed unless *all* land in a jurisdiction is submerged due to sea level rise. Scenario 3 assumes that any EEZ boundaries change if their associated coastlines are submerged. Compelling arguments from the literature review and interviews provide credibility and legitimacy to each scenario in this study.

GIS methods are applied to calculate new EEZs, change in boundary connectivity, and change in the area and shape of the high seas for each scenario in the study region. The results show that the total decrease in EEZ area for the study region would be 0.94% in scenario 1, 11.45% in scenario 2, and 41.48% in scenario 3. In terms of connectivity, of the 91 adjacent EEZ boundaries, two would be lost in scenario 1, 21 in scenario 2, and 37 in scenario 3. Because the GIS results and maps for each scenario varies significantly, I argue that the conceptualization of EEZ territories could increasingly result in contested and fuzzy spaces, especially as the impacts of climate change such as sea level rise intensify, and the question of the effects on maritime boundaries remains unresolved.

Acknowledgements

Throughout this research, I have received significant support and assistance.

I would like to express my heartfelt gratitude to my two supervisors, Gidske L. Andersen (Geography) and Edvard Hviding (Social Anthropology) from the University of Bergen, for their guidance and continuous support during the research and writing process of this master thesis. I would also like to thank the Pacific Community (SPC), particularly the staff of the Geoscience, Energy and Maritime Division for inviting me as an observer to the 19th Maritime Boundaries Workshop, where important knowledge and data was acquired for this study. Furthermore, I would like to thank the informants of this study for their insight and precious time during the interviews conducted in Sydney in November and December of 2019.

Fieldwork conducted in Sydney for this study was supported financially by numerous institutions including the Mare Nullius project at the University of Bergen, GeoScience Australia, and the Association of American Geographers (AAG) Cartography specialty group. The Chr. Michelsen Institute in Bergen provided an office space and a stimulating research environment during the writing and analysis for this study.

Due to the very sensitive and contentious nature of the topic of this study, I want to stress that the results and findings of this research do not reflect the position or views of any person or organization from which I received financial support or otherwise. I would also add that this study is in no way intended to provide a basis for any legal considerations, deliberation, or resolutions.

Please reach out by email at levi.westerveld@gmail.com for any queries about this research. All GIS files of the data analysis are available upon request.

Table of Contents

List of Figures

List of Tables

Abbreviations

BBNJ	Biodiversity Beyond National Jurisdiction
DOALOS	Division for Ocean Affairs and the Law of the Sea
EEZ	Exclusive Economic Zone
FFA	Forum Fisheries Agency
FSM	Federated States of Micronesia
GDP	Gross Domestic Product
GEO	Global Environment Outlook
GIS	Geographic Information System
GIScience	Geographic Information Science
GSHHG	Global Self-consistent, Hierarchical, High-resolution Shorelines
ILA	International Law Association
ILC	International Law Commission
IPCC	Intergovernmental Panel on Climate Change
ISSF	International Seafood Sustainable Foundation
LAT	Lowest Astronomical Tide
NOAA	National Oceanic and Atmospheric Administration
PIF	Pacific Islands Forum
PMB	Pacific Maritime Boundaries project
PNA	Parties to the Nauru Agreement
PSIDS	Pacific Small Island Developing States
RCP	Representative Concentration Pathway
SPC	Pacific Community
SPREP	Pacific Regional Environment Programme
UN	United Nations
UNCLCS	United Nations Commission on the Limits of the Continental Shelf
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNGA	United Nations General Assembly
WCPFC	Western and Central Pacific Fisheries Commission

1. Introduction

In this introductory chapter, I discuss the importance of Exclusive Economic Zones (EEZs), especially for Pacific states and territories where this research is situated. The location and delimitation of EEZs are decided based on coastal geomorphologies, but it is the Convention on the Law of the Sea that governs how EEZs are measured and calculated. In a first section then, I review both the direct threat of sea level rise to low-lying islands in the Pacific, as well as the potential legal implications of coastal changes on maritime zones, including EEZs. In a second part, I present the specific knowledge gaps that this study seeks to address, and I outline the main and sub-research questions that frame this research. Third, I give a historical overview of the processes the led to the adoption of the concept of EEZs in the United Nations Convention for the Law of the Sea (UNCLOS), and present the technicalities of the convention that define how EEZs are calculated. This introductory chapter concludes in a fourth section with a description of the study region and a review of the latest legal status and location of EEZs boundaries in the study region.

1.1. The importance of EEZs and the threat of climate change

Briefly, Exclusive Economic Zones are maritime areas that extend 200 nautical miles from a country's coast. In its EEZ, a coastal state has sovereign rights over all the natural resources in the subsoil, seabed and superjacent water. The outer boundary of an EEZ can be adjacent to another's country EEZ, for example between two states such as Norway and Denmark. The outer boundary of an EEZ can also be adjacent to the high seas (i.e. international waters), which is the area that stretches beyond the 200 nautical miles limit of EEZs. Maritime boundaries can also have different legal statuses. They can be provisional if two adjacent jurisdictions that share a maritime boundary have not agreed on its location, or if it is disputed. Once settled, the boundary's location is then deposited with the United Nations' Division for Ocean Affairs and the Law of the Sea (DOALOS). EEZ boundaries to the high seas must also be unilaterally declared and deposited to DOALOS.

Because EEZs extend the sovereignty of coastal states, they provide a legal framework for the management and governance of marine resources. A unique feature of EEZs in the Pacific is their significant area compared to landmass. Tuvalu for example, has an EEZ area which covers approximately 750 000 km^2. It's land area consists of nine atolls with a total land area of 26 km^2 only (Sauni, 2000: 331), i.e. 0.0035% of its territory. It is no surprise then that significant parts of the economy of Pacific countries depend on these large ocean areas. Recent figures for Kiribati for example, show that an impressive 91% of its gross domestic product (GDP) comes from fishing license revenues (Webb, 2020). In fact, about 52% of the world's tuna fisheries is caught in the western and central Pacific Ocean, with an average yearly catch of 2.5 million tonnes between 2014 and 2018 (International Seafood Sustainable Foundation (ISSF), 2019: 35). EEZs also support maritime tourism in multiple ways. In Fiji for example, leisure fishing, snorkelling, and diving are some of the main activities offered to the yearly 750,000 international visitors (2015 figures) with a total gross value of 574 million US$ or approximately 11% of the country's GDP (2014 figure) (Gassner *et al.*, 2019: 48). Advancement in maritime technology are also exposing new resources such as seabed minerals found in deep ocean polymetallic nodules, which include cobalt, nickel, and copper, among others. The potentially large value of these deep-sea resources is such that it is fuelling disputes between adjacent jurisdictions in the Pacific. The Minerva reefs for example, which are claimed both by Fiji and Tonga (Song and Mosses, 2018), have attracted foreign investors that are seeking mining rights to mineral deposits in the seabed potentially worth "hundreds of millions" (Frankham, 2015). In recent news, the Cook Islands could be first nation in the world to host undersea mining, and it has just opened a tendering process for exploration licenses (Ewart, 2020).

Anthropogenic climate change means that the sea is not only a resource, but potentially also a threat to many inhabited islands in the Pacific. Because many islands have an average elevation of only a few meters, sea level rise poses a significant threat to the region. Studies that use historical data recorded from tidal gauges and satellite altimetry show that sea levels have risen much faster in the western tropical Pacific region than the global mean sea level rise (Becker *et al.*, 2012). Data for Funafuti atoll, the capital island of Tuvalu, recorded an increase three times faster than the global average between 1950 and 2009 (Becker *et al.*, 2012), approximately 2 ± 1mm yr^{-1} (Church, White and Hunter, 2006). Trends are not the same across the entire Pacific Ocean. From 1993 to 2001, whilst a positive trend was observed for the western Pacific, a pattern of negative sea level rise in the eastern Pacific was observed (Church, White and Hunter, 2006). Part of this variation is attributable to different changes in sea surface temperature. A greater increase in temperature results in ocean expansion, which drives regional differences in sea level rise.

Looking forward, a 2018 review of more than 70 global sea level rise projection studies found that future estimates for changes in sea level rise remain deeply uncertain (Garner *et al.*, 2018). With the most recent estimates for the 21st century ranging from 0.16 to 1.55 meters for lower projections, and 0.46 to 2.54 meters for upper ones (Garner *et al.*, 2018). Another recent study published in *Nature*, for which data was collected through interviews with 106 experts on the subject, found that under a 'business as usual scenario' for carbon emissions, global mean sea level could rise between 0.63 and 1.32 meters by the end of the century relative to 1986 -2005 levels, and between 1.67 and 5.61 meters by 2300 (Horton *et al.*, 2020). These values are global means estimates however, and do not consider regional variations described earlier.

Sea level rise is not the only climate change effect that could lead to the submergence of atolls in the Pacific. Indeed, atolls have shown to be somewhat resilient to sea level rise owing to the vertical growth of reefs (Webb and Kench, 2010). The 2010 study by Webb and Kench is an analysis of historical aerial photography and shows that over the past 20 to 60 years period, 43% of 23 atolls surveyed in the central Pacific Ocean had increased their land surface area by more than 3% (Webb and Kench, 2010). However, this historical analysis does not consider recent and more significant increases in sea level rise. Additionally, models from a 2015 research indicate that under increasing emissions of carbon dioxide in the 21st century, coral reefs' vertical growth are unlikely to keep up with sea level rise due to ocean acidification and sea surface temperature increase (van Woesik, Golbuu and Roff, 2015). Temperature increase and ocean acidification can lead to bleaching and dying of corals, which provide the sediments to build reefs. In turn, degraded reefs will also have a reduced wave protection effect, further exposing atolls to the impacts of waves, especially during storm surges. Severe bleaching events have been observed in recent years, most notably the 2016 record-breaking marine heat wave off the coast of Australia, which killed 30% of corals in the Great Barrier Reef (Hughes *et al.*, 2018).

Even if there is still uncertainty around when atolls will be submerged, the concern for inhabitants of these low-lying islands is much more pressing. The title of a 2018 study is telling: "Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding" (Storlazzi *et al.*, 2018). The authors argue that stronger and more frequent storms and flooding events would likely deplete most atolls from their potable groundwater by the middle of the 21st century. This would render human habitation difficult on these atolls beginning between 2030 and 2060 (Storlazzi *et al.*, 2018). An earlier study led by the same lead author suggests that increased wave activity will double the amount of land forecasted to be flooded due to sea level rise alone (Storlazzi, Elias and Berkowitz, 2015). As a result, many atolls may be uninhabitable within decades (Storlazzi, Elias and Berkowitz, 2015). During his visit to the Pacific in the spring of 2019, it was no exaggeration then for UN's Secretary-General António Guterres to say that climate change poses "an existential threat" to some Pacific Island countries (UN News, 2019).

Besides submerging islands, or making them inhospitable, sea level rise also has the potential to influence the shape and extent of maritime areas, including Exclusive Economic Zones. Indeed, international law is dependent on the overall stability of geographical conditions, but sea level rise has the potential to alter coastal geomorphology significantly. Several scholarly studies in international law argue that following the current UNCLOS text, maritime boundaries could change due to sea level rise effects (Symmons, 1998; Schofield, 2009; Powers, 2012; Trahanas, 2013; Vidas, 2014; Vidas, Freestone and McAdam, 2015). Vidas (2014: 73) explains for example that: "with rising sea levels, the baselines from which the breadth of the territorial sea is measured will move landward, affecting the outer limits of various maritime zones." On the impacts of sea level rise, Schofield (2009: 405) notes: "The loss of significant areas, or even all of the maritime jurisdictional zones claimed by coastal States would have profound economic consequences, as jurisdictional rights over the valuable resources within these maritime spaces would be lost."

Legal research on this topic frequently refers to the work of the Committee on Baselines that was formed in 2008 under the International Law Association (ILA) to specifically look at the implications of sea level rise on maritime boundaries (Vidas, Freestone and McAdam, 2015). The ILA is a non-profit organization with the objective to study, clarify, and develop international law (International Law Association, 2014: 1). One of the main points of discussion with regards to sea level rise and maritime boundaries is whether baselines are fixed or ambulatory. A baseline is the water line along a state's coast recorded at the lowest astronomical tide (LAT). It is used as a basis to figure out the location of other maritime boundaries, including EEZs. Fixed baselines – which do not change regardless of changes to the physical geography of a coastline – would not be affected by sea level rise. Ambulatory baselines that follow these physical changes would be affected. According to the interpretation of UNCLOS by the ILA Committee on Baselines, baselines are ambulatory

(International Law Association, 2012; Trahanas, 2013). In its 2012 final report, experts in the Committee concluded that:

> [a country's] baseline is ambulatory, moving seaward to reflect changes to the coast caused by accretion, land rise, and the construction of human-made structures associated with harbour systems, coastal protection and land reclamation projects, and also landward to reflect changes caused by erosion and sea level rise. Under extreme circumstances the latter category of change could result in total territorial loss and the consequent total loss of baselines and of the maritime zones measured from those baselines (International Law Association, 2012: 31).

When the third UNCLOS was negotiated, the amplitude of climate change and sea level rise effects were not foreseen and UNCLOS does not provide any mechanism to address this specific issue (Vidas, 2014; Schofield, 2009). Besides the ambulatory or fixed nature of baselines, sea level rise also has the potential to affect the status of land features, which in turn could affect whether these are capable or not to be used to generate an EEZ (Schofield, 2009: 409). According to Article 121 in the UNCLOS text, only elevated land features that *can sustain human habitation and economic life* can be described as islands and may generate an EEZ (1982: 66). Even if an island generating an EEZ may not be entirely submerged in the short term, sea level rise combined with stronger and more frequent storms may lead to land erosion and groundwater salinization, turning a habited island into an inhabitable one (Storlazzi *et al.*, 2018). Such change could result in a de-classification of a feature from 'an island' status to a mere 'rock' under the UNCLOS definition, and result in the cancelation of the EEZ area associated with the feature. Evidently, according to published interpretations of UNCLOS, the shape and extent of EEZs associated with low-lying atolls in the Pacific are potentially threatened by the effects of climate change, and sea level rise particularly.

To date, only one study has provided modelled estimates for changes in Exclusive Economic Zones in the tropical Pacific island region due to sea level rise. Based on sea level rise projections for 2200 under the business as usual scenario (RCP 8.5), the preliminary assessment by Webb (2016) identifies jurisdictions' atolls that are low-lying and at risk of sea level rise in the region. Using Geographic Information Science (GIS) software, the author calculates the potential changes in EEZ area for each jurisdiction. The sea level rise projections used in his analysis are from the 2014 Intergovernmental Panel on Climate

Change report (IPCC). Recent research shows that the IPCC's projections are overly conservative (Garner *et al.*, 2018). Newer studies estimate faster and higher rates of sea level rise increase in the 21st century (Horton *et al.*, 2020; Garner *et al.*, 2018). Still, the assessment finds that of the 24 jurisdictions analysed, 17 could have a reduced EEZ area due to sea level rise. The Marshall Islands, Tuvalu and Tokelau being most vulnerable as all their baseline features are low-lying and susceptible to climate change effects (Webb, 2016).

The study by Webb (2016) has four limitations and possibilities for improvement. The first concerns the scarce elevation data for the region, which limits the potential to classify islands' risk exposure to sea level rise quantitatively based on different emission projections. Second, the author only considers jurisdictions in a vacuum rather than taking a regional approach. This means that for each jurisdiction, the author only maps the potential move inwards of EEZ maritime boundaries. However, the potential effects on adjacent jurisdictions that share EEZ maritime boundaries is not determined or discussed. The third limitation concerns the legal aspect. The author does not distinguish nor assesses whether the impacts of climate change on maritime boundaries differ based on their status: deposited to DOALOS or provisional. Additionally, a distinction between equidistant EEZ maritime boundaries bound by treaties between two jurisdictions, and EEZ maritime boundaries that are unilaterally declared (between a jurisdiction and the high seas), is also not made. Last but not least, Webb (2016) assumes that baselines are ambulatory in his study but he warns the reader that the results of his research do not imply these changes will necessarily occur because the legal implications of climate change on UNCLOS remain unclear (Webb, 2016: 3). He does not however provide alternative scenarios that reflect this uncertainty in UNCLOS.

1.2. Research question and study scope

This study seeks to address the three last limitations noted from Webb's (2016) study, and to improve and advance knowledge and methods to determine the resilience of EEZs to the possible threat of climate change effects. Collecting new altimetry data for the region is beyond the scope of this study. Rather, this research seeks to develop more robust quantitative results that consider potential changes to EEZs considering their geography (adjacent to high seas or to another jurisdiction) as well as their status (deposited to DOALOS or provisional). Additionally, because this study considers the Pacific in its entirety rather than individual jurisdictions, changes to connectivity and to the shape and extent of the high seas area are also analysed. Finally, rather than assuming that baselines are necessarily ambulatory as some literature suggests, this study seeks to consider whether international law will change or clarify on this issue. Therefore, different scenarios are considered in the analysis to cover the plausible developments of international law on the issue of climate change and EEZs.

My main research question is: what are the possible impacts of climate change on Exclusive Economic Zones (EEZs) in the western and central Pacific region? Three sub research questions that structure my research follow:

1. As the United Nations Convention for the Law of the Sea (UNCLOS) does not explicitly addresses the effects of climate change, how do scholars and practitioners interpret UNCLOS to hypothesize on the resilience of EEZs to climate change in the future?
2. Based on possible developments of international law on the issue of climate change and EEZs, what are the impacts on the area and shape of individual EEZs in the study region?
3. From a regional perspective, what are the potential impacts of climate change on connectivity between EEZs, and on the shape and connectivity of high seas areas?

1.3. From a 'cannon shot rule' to UNCLOS

The history of maritime boundaries in Oceania goes back to the early concepts of *Mare Liberum*, *Mare Clausum* and the rivalries between European powers in the early 17th century to secure trade routes to the East Indies. At a time when the Dutch challenged the monopoly and political domination of the Spanish and Portuguese over the seas in South and South East Asia, Dutch jurist Hugo Grotius published *Mare Liberum* in 1609 in which he argued that the freedom of navigation and trade at sea is everyone's right (Brito Vieira, 2003). This idea was countered by other writers in what is commonly referred to as the 'Battle of the Books' (Papastavridis, 2011). Perhaps most notably is the 1636 work *Mare Clausum* by English jurist John Selden, who argued that the sea, just as land, can be conquered and appropriated (Papastavridis, 2011). Although the concepts of *Mare Liberum* and free navigation on an open ocean prevail today, *Mare Clausum* conceptualizations of maritime space management are increasingly part of contemporary maritime law (Papastavridis, 2011).

The first maritime boundaries have their origins in Northern and Western Europe. In the late 17th century, a fishing quarrel between the Dutch and Great Britain led to the establishment of the cannon-shot rule (Kent, 1954). Just as its name indicates, the cannon-shot rule sets forth that coastal countries are sovereign over the maritime area that is within the range of coastal artillery weapons from that time. This range was set up to be approximately 3 miles, which is equivalent to the distance that one can see from the coast to the horizon line. This rule was refined in the Northern Sea – now the Norwegian Sea – following another dispute, this time between the Kingdom of Denmark which claimed sovereignty over the waters between Norway and Iceland (both of which it owned) and Holland, England, France, and Russia who sought access for fishing and trade purposes (Kent, 1954). This conflict was resolved through the establishment of a territorial sea: a continuous 3 nautical miles wide belt (ca. 5.6 km, 1 nautical mile is equal to 1852 meters) along the coastline over which countries had sovereignty (Carleton, 2006).

The concept of extended maritime zones beyond a 3 miles belt is relatively modern. The Truman proclamation in 1945 was the first unilateral document in which a country claimed ownership over the continental shelf and the resources on and below the seabed in the area beyond its territorial sea. In this proclamation, the United States also claimed the right to manage fisheries in the seas adjacent to its territorial sea (Nandan, 1987). This strategic geo-political move was pursued by the United States just after the war to secure its access to more natural resources, particularly fisheries and oil in the Gulf of Mexico (Watt, 1979). Several other nations followed suit. Argentina first in 1946 with a claim over its own continental shelf. Then Chile and Peru in 1947 established maritime zones of 200 nautical miles from their coasts to protect their fisheries from offshore international fishing fleets (Division for Ocean Affairs and the Law of the Sea, 1998). In 1949, a number of Arab states declared sovereignty over their own continental shelves especially because of rich oil deposits (Nandan, 1987). By 1958, international negotiations at the United Nations in Geneva led to the adoption of the first United Nations Convention on the Law of the Sea. It encompassed four conventions that helped codify and crystalize customary law with regards to the continental shelf, sovereignty over the territorial sea, the rights in the high seas, and the management of the ocean's natural resources (Convention on the Continental Shelf, 1958; Ortolland and Pirat, 2010).

In the second half of the 20th century, access to ocean resources grew exponentially as technological innovations increased opportunities to exploit fish, oil, and valuable minerals at deeper and more remote places. By 1982, growing competition and rivalry at sea between nations with no clear plan on how administrate these resources led to the adoption of the third

United Nations Convention on the Law of the Sea (UNCLOS) in 1982. Whereas the second convention resulted in no new agreements, the third and most recent one is a detailed legal document which covers all aspects of ocean governance. It came into force in November 1994 and at the time of writing the text was ratified by 168 parties, including all Pacific countries. It is noteworthy that the United States has not ratified UNCLOS due to its inability to secure two-thirds' votes in the Senate, even if it has recognized the Convention as customary international law.

A crucial addition to the third UNCLOS is the concept of Exclusive Economic Zones (EEZs), which extends 200 nautical miles from a country's coast and provides sovereign rights over natural resources in it. Besides the EEZ, countries can claim an addition of four other maritime zones each of which comes with different rights and obligations (Fig. 1.1). The *Internal or Archipelagic Waters* include all waters landwards from a country's normal or territorial sea baseline. The *Territorial Sea* includes all waters up to 12 nautical miles measured from the baseline. In this zone, countries exercise sovereignty over the airspace, water, seabed, and subsoil. The *Contiguous Zone* extends 12 nautical miles from the territorial sea and coastal states exerts certain control over customs and immigration in this area. Finally, the *Continental Shelf* is the area that extends up to 150 nautical miles after the end of the EEZ providing certain geomorphological conditions are met. In this zone, countries exert the right to explore and exploit the seabed. All maritime space beyond the EEZ area is considered international waters and is also known as the high seas area.

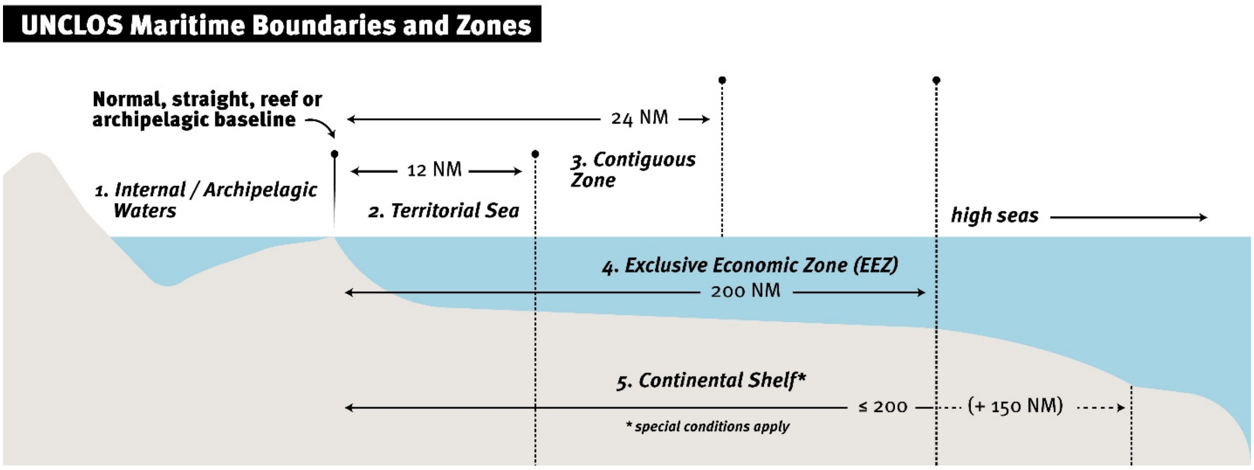


Figure 1.1 *Cross section diagram of the different UNCLOS maritime boundaries and zones.*

To determine the exact location of each of these maritime zones, countries must first establish a baseline, which in the simplest case is a country's coastline. Articles 5, 6 and 7 of

UNCLOS describe 3 different ways by which states may draw their baseline. The *normal baseline* simply follows the lowest astronomical tide (LAT) water line along a state's coast. The *straight baseline* connects islands with infrastructure such as lighthouses and that are in the vicinity of the coast to each other. Norway for example, uses the *straight baseline* approach to close all its fjords. As such, these are therefore part of Norway's internal waters. Finally, the *reef baseline* can be used by coastal states situated on atolls or which have fringing reefs. In case of a *reef baseline* the seaward low-water line of the reef can be used to draw a state's baseline. Article 14 of UNCLOS states that countries can use any combination of the three methods to draw their baselines. Article 47 makes an exception for archipelagic countries which can draw a unique *archipelagic baseline*. This special baseline joins the outermost islands or drying reefs of an archipelago, provided the length of the baseline does not exceed 100 nautical miles, and the land to water area ratio does not exceed nine to one. The Pacific includes a large number of archipelagic states and territories; so far only Tuvalu, Fiji, Vanuatu, Solomon Islands and Papua New Guinea have deposited archipelagic baselines to the UN's Division for Ocean Affairs and the Law of the Sea (DOALOS). Figure 1.2 below shows for example the archipelagic baseline of Tuvalu around 3 of its 9 islands.

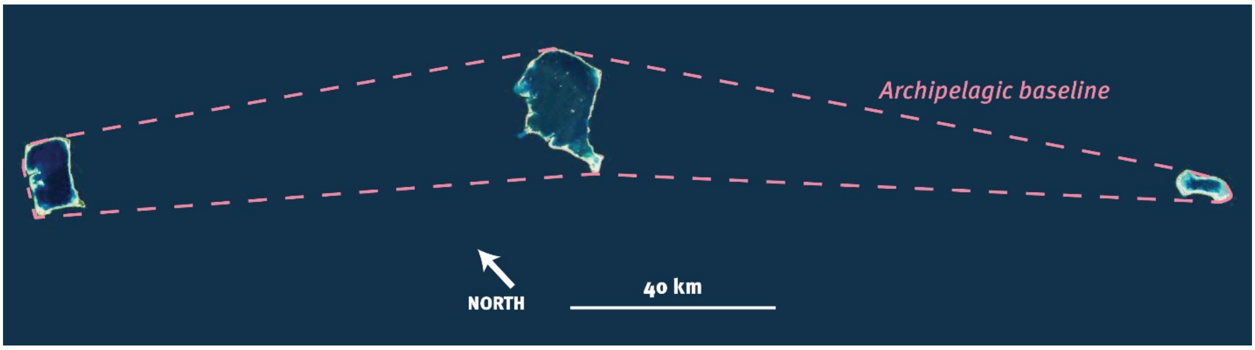


Figure 1.2 *Map of Tuvalu's archipelagic baseline around the Nukufetau, Funafuti, and Nukulaelae atolls (from left to right).*

Delimiting a country's maritime boundaries requires detailed legal and technical knowledge. States must follow several steps before their different maritime boundaries and any claims of the continental shelf are official recognized. The country's baselines must first be established, and they are subsequently used to calculate the different maritime boundaries according to set distances for each zone. Individual boundaries for each maritime zone are then deposited, reviewed, and gazetted by DOALOS. Due to the complex geomorphological requirements of claims to the continental shelf, these depositions are reviewed by an independent expert panel known as the United Nations Commission on the Limits of the Continental Shelf (UNCLCS) (Emily Artack and Kruger, 2015; Frost *et al.*, 2016).

1.4. Study region

In this research, I focus primarily on the islands states and territories of the western and central Pacific region. These include 12 independent countries: the Federated States of Micronesia (FSM), Fiji, Kiribati (which includes the Line Group, Phoenix Group and Gilbert Group), the Marshall Islands, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. It also includes two self-governing island countries in free associations with New Zealand: Niue and Cook Islands. Finally, there are also a number of overseas territories: American Samoa (US), French Polynesia (FR), New Caledonia (FR), Tokelau (NZ), and Wallis and Futuna (FR) (Fig. 1.3). Because this research considers maritime boundaries, an outer ring of adjacent jurisdictions to the study region are also considered when they share a maritime boundary with one of the main jurisdictions of this study. These are Australia, Guam (US), Howland and Baker Islands (US), Indonesia, Jarvis Island (US), Kingman Reefs and Palmyra Atoll (US), Norfolk Island (AU), the Philippines, Pitcairn Islands (GB), and Wake Island (US). Note that for the purpose of this study, the Matthew and Hunter Islands jurisdiction located south of Vanuatu – a disputed area claimed both by France (New Caledonia) and Vanuatu (Song and Mosses, 2018) – is considered as an independent zone.

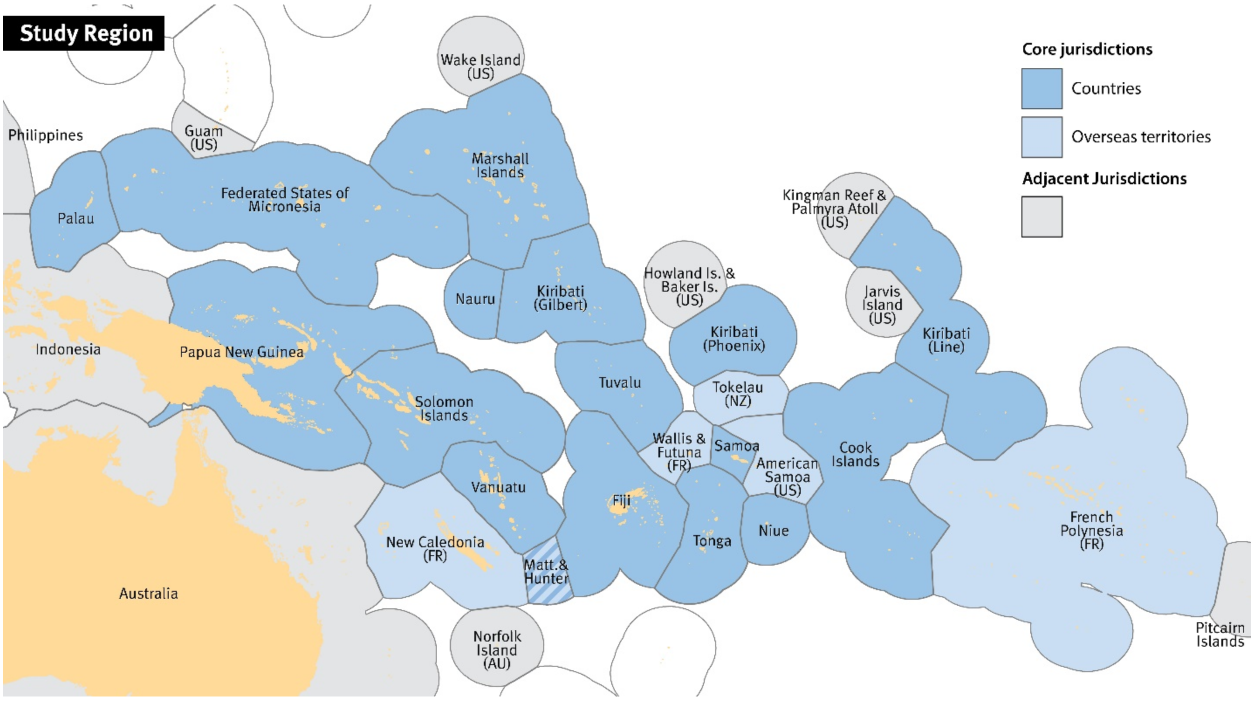


Figure 1.3 *Map of the EEZs in the core study region and the adjacent jurisdictions.Core jurisdictions countries and overseas territories are differentiated in the legend. Note the presence of five high seas pockets (i.e. white areas surrounded by EEZs) in the study region. The least visible one is the one located north of Palau.*

The earliest European empirical knowledge of Oceania dates to the end of November 1520 when Portuguese explorer Ferdinand Magellan and his fleet crossed the southern straits of South America – now known as the Strait of Magellan – and sailed from the Atlantic into the Pacific Ocean (Matsuda, 2012). Europeans were not the first to navigate the Pacific. They were predated by Austronesian and later Polynesian navigators whose open-ocean sailing talents led them to colonize most of the islands of Oceania approximately two millennia earlier (Matsuda, 2006; Horridge, 2006). Since Magellan first sailed the Pacific, European powers have exerted great influence over the fate of indigenous populations. Islands were colonized by the British, French, Spanish, Dutch, Germans, Americans, and Japanese. Even since the independence of the majority of island colonies at the end of the 20th century, Pacific states are generally portrayed as poor and dependent on international aid and support (Matsuda, 2006).

This dynamic of dependency was deconstructed in a thought provoking analysis by Tongan writer and scholar Epeli Hau’ofa (Hau'ofa, 1993). In an article titled “Our Sea of Islands”, Hau’ofa argues that Pacific island countries are conceived of as small, poor, isolated, and dependent not because of their remoteness or small land surface, but because European colonial history. He writes: “Nineteenth century imperialism erected boundaries that led to the contraction of Oceania, transforming a once boundless world into the Pacific Island states and territories that we know today.” (Hau'ofa, 1993: 155). Apart from the terrestrial border between Papua New Guinea and Indonesia on the island of New Guinea, all other boundaries between island states and territories in the study region are maritime. As Hau’ofa writes, the seemingly arbitrary imaginary lines that cut the Pacific in an intriguing puzzle play an incontestable role in shaping the lives of the people of Oceania. This is particularly true for the EEZ boundaries that dictate rights of access to natural resources. What Hau’ofa did not conceive however, is that the consequences of global warming such as sea level rise could submerge many islands in the Pacific, and as a by-effect could further contract Oceania, or EEZs more specifically, around the remaining elevated Pacific islands.

Geologically, Pacific islands are of volcanic nature and were created either as a result of colliding tectonic plates releasing magma that eventually formed an island, or through a process known as hotspots, by which hot magma breaks through a thin crust of the seabed and rises to create an island (Goldberg, 2018). Over time, the subsidence of the volcanic island on the one hand, and the vertical growth of coral reefs on the outer parts of the volcano on the other hand, led to the creation of fringing reefs islands, barrier reef islands, and atoll islands common to the Pacific today (Fig. 1.4) (Goldberg, 2018). All four types of volcanic islands described in figure 1.4 are present in the Pacific, but atolls – islands with the lowest elevation – are most common and most threatened by climate change effects. Tuvalu, for example, comprises of 9 atoll that have an average elevation of one meter, and a highest elevation point of only five meters (Powers, 2012). It is noteworthy that new islands are still occasionally ‘born’ in the Pacific, due to the active tectonic activity on the outer edge of the Pacific Ocean, also known as the ring of fire. In 2014, in Tonga for example, the unofficially named Hunga Tonga Hunga Ha'apai was born, covering a land area of 1.74 km^2 (Garvin *et al.*, 2018).

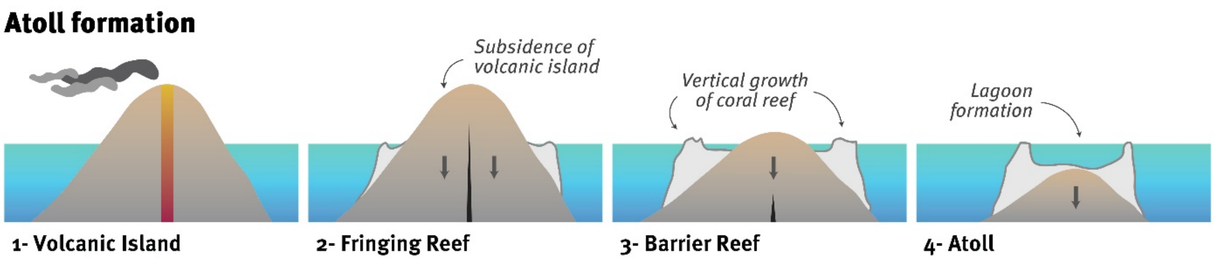


Figure 1.4 *Cross section diagram showing the temporal progression of an atoll island creation. A volcanic island first rises from tectonic activity or a hotspot (1). The volcanic island starts to sink whilst coral reef grows on the outer edge of the island (2) forming a fringing reef. The volcanic island continues to sink, and the coral reef grows outwards into a*

barrier reef creating a buffer of shallow sea between the outer edge of the reef area and the volcanic island (3). Finally, the volcanic island has sunken entirely under the surface water level creating a lagoon. The coral barrier reef stays and grows vertically to create an atoll (4).

The proximity of islands states and territories in the Pacific is such that EEZ areas from different jurisdictions tend to overlap. In such cases, states and territories with overlapping claims must negotiate a maritime border and come to an agreement either using an equidistant or median line approach, or another equitable solution (Schofield, 2010; Ortolland and Pirat, 2010). The delimitation of maritime boundaries in the Pacific region has been greatly eased by special initiatives such as the Australia-funded Pacific Maritime Boundaries (PMB) project of the SPC (Pacific Community). This initiative regularly brings together external experts and advisors with legal and technical teams from the different Pacific island countries to support countries finalizing and negotiating their maritime boundaries (Frost *et al.*, 2016). As of the end of 2019, of the 91 unique EEZ maritime boundaries in the study region, 55 have already been deposited to DOALOS. The remaining boundaries are either provisional or still need to be entered into force (Fig. 1.5).

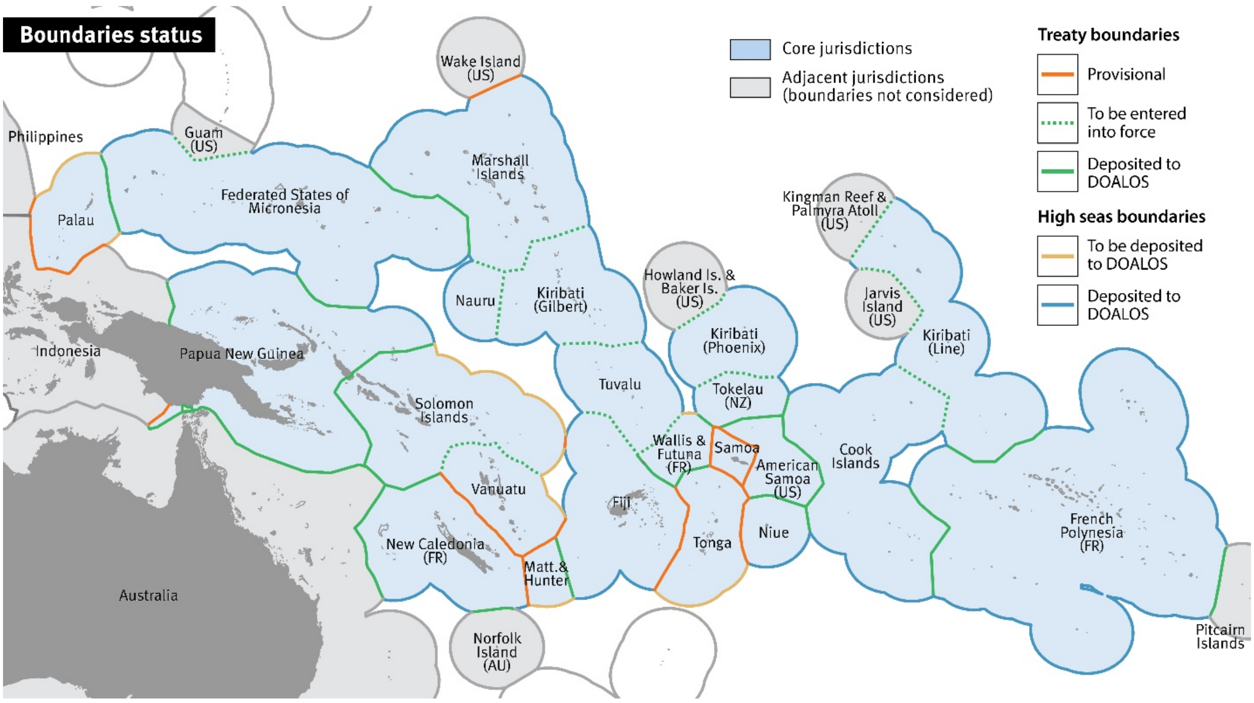


Figure 1.5 *Map of the legal status of maritime boundaries in the study region as of December 2019. Adapted from unpublished SPC map created at the Sydney 19th Maritime Boundaries Workshop.*

2. Theory

Although the delimitation of EEZ boundaries may appear like a simple geometrical issue, at a more theoretical level, this study grabbles with fundamental geographic concepts that concern the production of territory through an interplay of space and power. In this chapter, I first describe how post-modern geographers have conceptualized territory and argue that Exclusive Economic Zones (EEZs) are a manifestation thereof. In a second section, I draw on the work of Henri Lefebvre and David Harvey to consider the many ways by which EEZs can be apprehended as constructed spaces. I argue that tools such as Geographic Information Systems (GIS) and maps that are used to delimit EEZs play an important role in the production of these spaces. In fact, I argue that EEZs are constructed mostly through conceptualization: they exist in the forms of maps, as renderings of coordinate points in Euclidean space. The role of GIS in the production of these spaces is non-negligible. Therefore, in a last fourth section, I draw on work and theories from post-modern and feminist geographers Yapa and Kwan, as well as my own work, to take a critical and reflective approach on the use of GIS in this study. I explain how despite its connection with positivist scientific practices, a critical use of GIS in this research can be congenial to post-modern space, power and territory epistemologies and a suitable analytical tool for this research.

2.1. Territory

Territory – from the Latin *terra* or 'dry land' – is by definition a bounded space which assumes three geometrically distinct parts: an inside area, a border or edge, and an outside area (Delaney, 2009: 198). Using this definition centred on geometry, EEZs are also a form of territory even if they do not quite fit etymologically. They too consist of a main area, a border defined by geographic coordinates, and an outside area that consists of land on one side and of the high seas on the other. From a post-modernist perspective, territories are not static and fixed, quite the contrary, over time they are continually created, contested and discarded (Agnew *et al.*, 2015). Borders are not fixed but should instead be understood as "an evolving construction that has both merits and problems that must constantly be reweighted" (Agnew, 2008: 176). Rather than a fixed container, the production of territory, then, must be understood as a complex and ambiguous process (Delaney, 2009: 196). In the Pacific, several EEZ boundaries are yet to be determined, some are disputed, and as I analyse, some are potentially threatened by climate change. The territorialization of maritime space is not unique to the Pacific, in the Arctic for example, melting ice has set off a race to claim maritime space, and there too, territories are imagined, created and contested by adjacent nations (Elden, 2013). Elden argues that territory is both a historical, a geographical, and a political question (Elden, 2010). Indeed, territories are time and space bound objects, and have unique political implications with regards to strategy, law and economics (Elden, 2010). For EEZs, each of them has a history. Declared at a specific time, they are also geographically unique, but they all assume similar sovereign privileges over access to resources.

Human geographers have long argued that although territory is a concept commonly applied to describe the geography of countries and empires, territories are more pervasive and exist in multiple forms and scales (Delaney, 2009). Even mundane spaces such as a person's bedroom or someone's lawn are forms of territory. What makes a bedroom or a lawn a territory is not simply their geometric properties, but rather because just like EEZs these geographic units are the product of two complex social phenomena: space and power (Delaney, 2009: 203-204). The conceptualization and definitions of both these terms have shaped how human geographers approach territory. Because I research and model possible changes to EEZ territory, a theoretical understanding of space and power provides a framework to ground the methods employed in this research. In the next section, I draw on scholarly work from Lefebvre and Harvey to deconstruct both concepts in the context of Exclusive Economic Zones.

2.2. Space

Among the many works of French sociologist and philosopher Henri Lefebvre, his two books *The Survival of Capitalism: Reproduction of the Relations of Production* (1973, English translation in 1976) and *The Production of Space* (1974, English translation in 1991) are cornerstones for the development of a new understanding of space (Brenner and Elden, 2009; Merrifield, 1993). In the first paragraph of *The Production of Space,* Lefebvre explains that space has mostly been used to describe a simple empty area: "the general feeling was that the concept of space was ultimately a mathematical one" (1974: 1). And that, "To speak of 'social space'", therefore, would have sounded strange" (1974: 1). Lefebvre proposes a new theory on three ways by which space is produced: representational space, representations of space, and spatial practices (Merrifield, 1993; Santos Junior, 2014; Lefebvre, 1974). These can more simply be named *experienced space*, *conceptualized space*, and *lived space* respectively (Albright, Hartman and Widin, 2018). *Experienced space*, the first type, is the physical space we apprehend through our senses. It is qualitative, fluid, and dynamic. As Lefebvre puts it: experienced "space is alive: it speaks. It has an affective kernel or centre: Ego, bed, bedroom, dwelling, house; or: square, church, graveyard. It embraces the loci of passion, of action and of lived situations" (Lefebvre, 1974: 42). In the context of this study, as an experienced space, EEZs are the seawater, seabed, fish, fishers and their boats, the wind and all that can be ascertained empirically.

The second type in Lefebvre's definition, *conceptualized space*, is created either by technocrats including engineers, cartographers, or architects through the production of plans and maps for example (Merrifield, 1993; Brenner and Elden, 2009; Albright, Hartman and Widin, 2018). In the context of EEZs, these are conceptualized through the lines drawn on paper maps or the pixels on the screen of a GIS software that show the borders or areas of EEZs in a Euclidean space. One example of conceptualized form of EEZ space I came across frequently in this research are the declaration documents of EEZ boundaries (Fig. 2.1). These legal documents include text, maps, and most significantly, a unique set of coordinate points that jointly form the external boundary of an EEZ.

Finally, *lived space* is the third type; it is space as a social construct: spaces of oppression, of inequality, of fear. It is the space we imagine psychologically and emotionally to others and ourselves: for example, a sense of ownership over a space. (Santos Junior, 2014; Merrifield, 1993; Albright, Hartman and Widin, 2018). EEZs are also a form of lived spaces because they are produced through people's associative feelings and memories with these spaces. This can for example be a sense of identity and belonging, or a sense of ownership or resentment over a disputed reef, and even the fear of climate change and its implications on sovereignty over these areas.

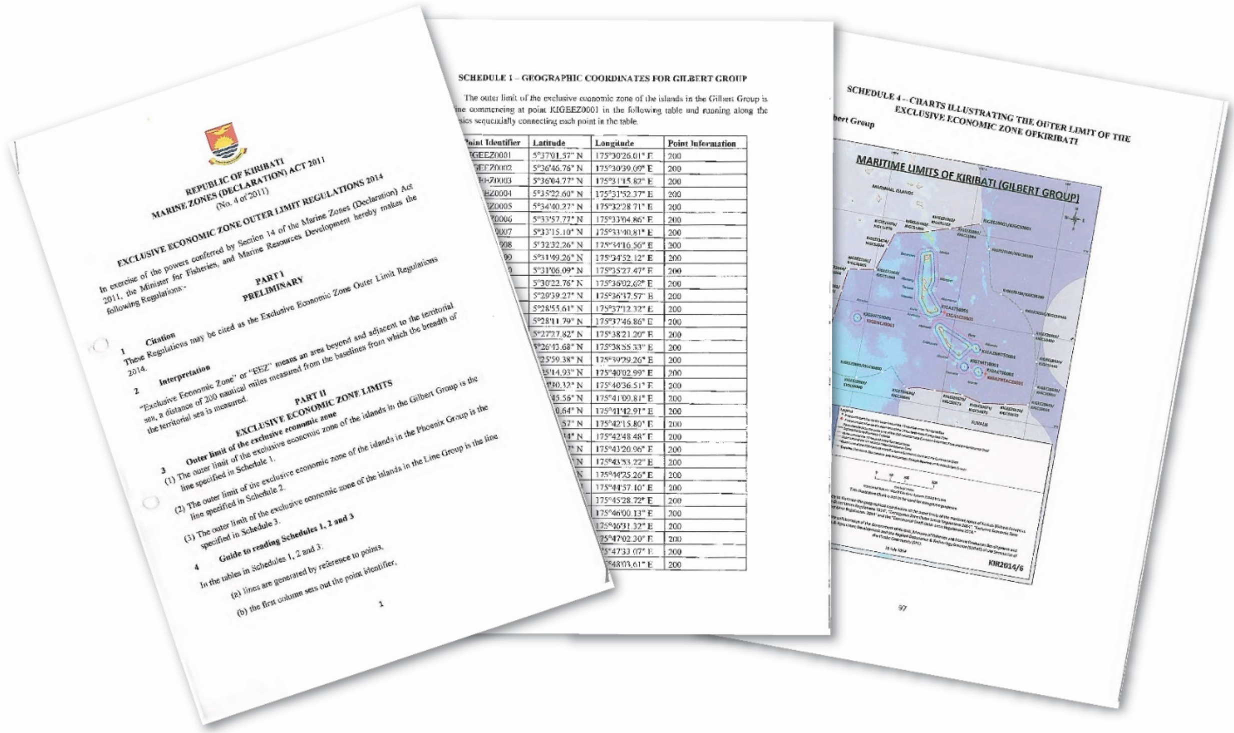


Figure 2.1 *Three pages extract from Kiribati's Maritime Zones declaration Act 2011 (No. 4 of 2011). The list of coordinates in the middle page, and map on the last page, suggest that EEZs can be apprehended as conceptualized spaces.*

For Lefebvre, these three types of productions of space are not exclusive but are held in dialectical tension (Harvey, 2006; Lefebvre, 1974). This means that one type of space affects the other, tug and pulls between spatial meaning and definitions of space: a flow of interconnectivity between productions of spaces. Taking the EEZ example further, the submergence of an island due to sea level rise is an empirical change in the experienced space. However, it could possibly imply changes to baselines and other maritime boundaries on maps and charts, and thus affect the conceptualized construction of an EEZ space. Consequently, changes to boundaries on maps would have new material impacts on the experienced space, by dictating for example where a fishing vessel may navigate to catch tuna. Both these inter-related changes to the experienced and conceptualized types of an EEZ space could change a person's feelings for that space, altering the third category of an EEZ as a lived and socially constructed space.

Around the same time as Lefebvre, contemporary geographer David Harvey also puts forth a tripartite theoretical conceptualization to answer the ontological question: what is space? Just as Lefebvre, Harvey's work is grounded in a critic of capitalist systems. In *Social Justice and the City* (2009), Harvey suggests that space can either be absolute, relative, or relational and that any spatial phenomenon can be described in all three ways (Albright, Hartman and Widin, 2018). Absolute space is in Harvey's own words: "the thing in itself", the structure where we can "pigeonhole of individuate phenomena" (Harvey, 2009: 13). Absolute space is then the space of "Newtonian physics, Cartesian philosophy and Euclidean geometry" (Harvey, 2006: 121), it is also the most common understanding of space as described by Lefebvre (1974: 1). In the EEZ example, absolute space is the grid system of latitude and longitudes used by GPS hardware and GIS software, to record and locate coordinate location.

A relative view of space is one where space exist "only because objects exists and relate to each other" (Harvey, 2009: 13). The relationships between objects creates relative space, and the definition of this relationship is relative to what units of analysis (e.g. distance as the crow flies versus walking) and frames of reference (e.g. an athlete versus an elderly person) are used. In the context of EEZs, the movement of tuna fish follows very different variable and parameters (food availability, temperature, etc.) than say fishers who may be restricted by other variables (fuel price, regulations, fishing quotas, etc.), and so the EEZ space exist differently in relative terms for the fish and the fisher, because of their different frames of reference. In this research, an important consideration for EEZ spaces is not only their location and area in the absolute Euclidean space, but also their relative and topological relationships or connectivity. I discuss later in this research the potential ramifications of changes to the connectivity and contiguity in-between EEZs, and between EEZ boundaries and high seas areas.

The relational theory of space builds on the relative one and is most easily defined as oppositional to the absolute or container view of space where space exists independently of objects. From a relational perspective, space *only* exists through the relationships between objects, where that relationship is itself contained by the object. Harvey writes that "an object can be said to exist only insofar as it contains and represents within itself relationships to other objects" (Harvey, 2009: 13). If space is created through the relationships that exist *between* objects in relative space, it is created through relationships that exist *in* objects in relational space (Harvey, 2009: 13). This distinction is difficult to grasp, but in the context of EEZs, they can be said to exist in a relational space through their relationship to UNCLOS; UNCLOS defines EEZ spaces, and EEZ spaces therefore inhibit this relationship with UNCLOS, which creates space in relational terms. In a same way, EEZ spaces have existential relationships, which they inhibit, with the legal and technical documents that authorities put together to produce them. They are relational, because each EEZ inhibits a unique political, historical, cultural, economic, etc. meaning.

Although Harvey's approach to space is different from Lefebvre's, he suggests that both conceptualizations can be combined in a three by three matrix, totalling nine different ways by which one can approach space (Harvey, 2006: 133). If both Harvey's and Lefebvre's take on space types and production are important, an elaboration of how EEZs can be described as nine unique spaces does not further the argument that space and the production thereof is a complex matter. Rather, I now turn to the issue of power. I argue that a heightened understanding of EEZ space can help depict the various scales at which power transpires in the production of EEZ territories. This critical approach will guide the research methods.

2.3. Power

Sack argues that territory and territorialization can be understood as a "geographic expression of social power" (Sack, 1986: 5). By power, I mean the ability or capacity to do and act in a specific and chosen way. Indeed, territories indicate a particular geographical organization of space that reflects ideologies held by those in power (Elden, 2010). Lefebvre and others have shown that state systems used to organize space at the global level today – reflected in contemporary country borders – suggests a western and historically European ideology and approach to political organization of space (Storey, 2015; Agnew, 2008; Brenner and Elden, 2009). Therefore, the *meaning* of a territory is the reflection of a particular ideology, and that different forms of *power* maintain and control meaning. This is eloquently described in *Territory and Territoriality* by Delaney (2009: 203) where he explains that territories are "'meaningful' spaces or spatial 'containers' of social meaning" and that the meaning of territories is maintained through different forms of power. On power, he writes: "one highly significant feature of power is the degree to which it is institutionalized" (Delaney, 2009: 200).

In the context of this research, the *meaning* of EEZs is primarily an economic one; they grant jurisdictions – states and their citizens – a specific access to maritime resources such as fish and minerals. The *power* in EEZs is institutionalized to the highest degree. Indeed, the United Nations Convention on the Law of the Sea (UNCLOS) is ratified by 168 parties; it is in effect a global and uncontested law that regulates the production and meaning of boundaries at sea. The legitimacy of the UN itself is grounded in the nation state concept, and so UNCLOS particularly is a self-perpetuating reinforcement of the Western nation state ideology (Aase, 1994). EEZ territories belong then to a hegemonic ideology that shadow a global statist division of our planet in nation states. The meaning and validity of EEZs as territories is maintained through the tight grip that statist ideology holds over the dominant conceptualization of EEZ space.

Reflecting on the tripartite production of space theory by Lefebvre then, the dominant means by which EEZ space is produced is through *conceptualization*. A simple google image search for the word 'EEZ' attests to this observation as it only returns images of maps and graphics outlining global or regional EEZ boundaries (Fig. 2.2). These territories exists then primarily because they are part of the "geographical imaginaries"; more so even than borders on land, as these can and are increasingly materialized through physical walls and fences (Delaney, 2009). Just as paper money only has value because of a globally recognized valuation system, EEZ borders only exists because they are globally recognized, even if they cannot be verified empirically. Therefore, those who control the means of production of EEZ territories hold significant power. Because I argued that EEZs are extensively a product of conceptualization of space through maps; lawyers together with the surveyors and GIS experts that collaborate to map and create these conceptual spaces on paper and screens, in the form of coordinate points and vector shapes, are fundamental producers of EEZ space. To a certain extent, they control the means of production of EEZ spaces, and perpetuate a hegemonic ideology through their practice.

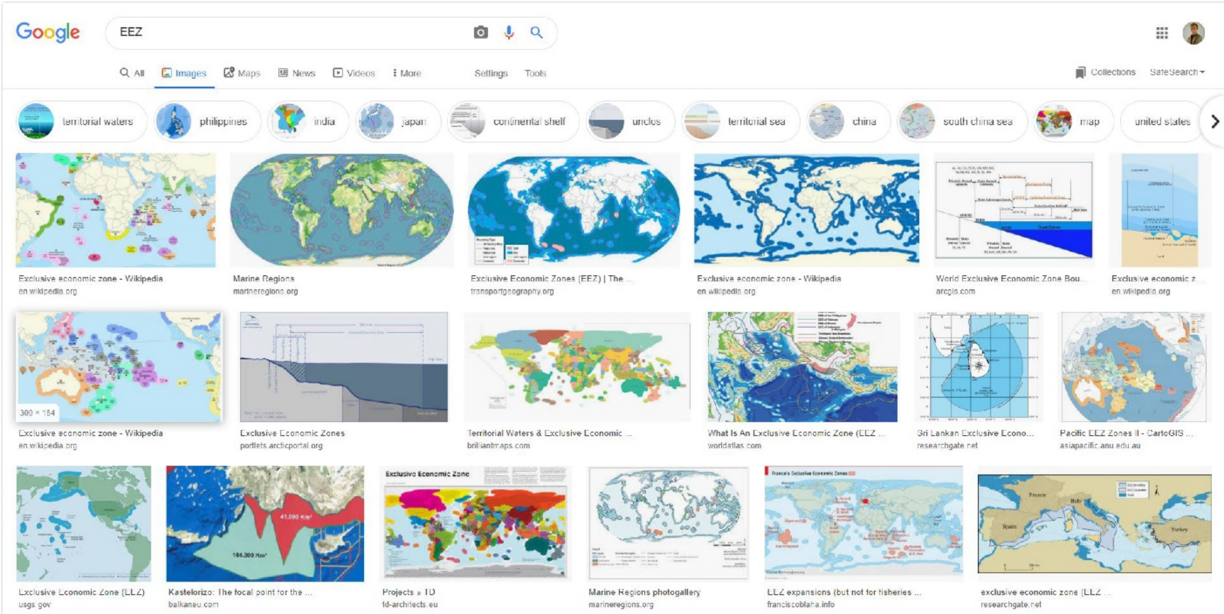


Figure 2.2 *Screen capture results from a google search for the word "EEZ". The results showing only images of maps and diagrams highlight the dominant discourse on the ontology of EEZ space. The emphasis on maps shows that it is predominantly a Lefebvrian 'conceptualized space'. Google search results from October 27th, 2019.*

2.4. GIS & Maps

Geographic Information Systems (GIS) can be broadly defined as the software and other technologies developed to collect, analyse and communicate spatial data (Thatcher *et al.*, 2016). The first GIS software was developed in the early 60s and a critic of this tool and its field of study (GIScience) emerged in 90s, mostly from within the field of geography (Leszczynski, 2009; Schuurman, 2000; O'sullivan, 2006; Kwan, 2002). The early development of a critical approach in GIS – known as 'critical GIS' for a critic of the tool, and 'critical GIScience' for the theory (Harvey, 2018) – was rooted in post-structuralist theory. It argued that the application of numerical and modelling analysis in GIS to social sciences research broadly "revealed the subscription of quantitative geography to a scientific ontology of empiricism most coincident with the philosophy of positivism" (Leszczynski, 2009: 354). Besides the critic of GIS for seeking to produce universally applicable truths and broad generalizations, GIS was also criticized for its 'masculinity' and its detached 'god eye view' gaze on the world which expresses "distancing, mastering, objectifying" and a form of control over the object of the study (Deutsche cited in Kwan, 2002: 138). Part of critical GIS calls out its imperialist nature, particularly because of its close ties with military-industrial complex that shaped its development and use (Thatcher *et al.*, 2016), but also more generally for the relationship between the production of maps and power: maps are a mechanism to control, depict and produce social relations (Schuurman, 2000) and control territory (Elden, 2010).

Drawing on Harvey's tripartite division of space, part of GIS criticism is in my perspective rooted in its structure that follows an absolute space type approach, over the relative and relational. Although it is easy to calculate a Euclidean distance, or area size in GIS, it is difficult to integrate qualitative, fuzzy or uncertain forms of spatial data, and even the dimension of time, which is often an important variable in relational and relative conceptualizations of space (e.g. travel distance by car versus by foot) (Albright, Hartman and Widin, 2018). There are examples of inventive applications of GIS around this problem, Kwan (2004) for example, developed time space cubes in GIS, using a third z-axis to depict change of position over time. Others have stepped entirely away from GIS, to develop their own visualization methods for spatial data to capture non-Euclidean spatial data and conceptualizations. Using networks to map degree of connectivity rather than distance between airports (Bergmann and Sullivan, 2018: 9), or a new 'place cookie setting' and 'spider models' to map spatial data in dreams (Iosifescu Enescu *et al.*, 2020). In my own work, I have developed a new cartographic perspective that challenges the standard 'god eyes view' in maps of refugee deaths in the Mediterranean Sea to better show the perspective of migrants (Westerveld, 2017). As well as new methods called 'inductive visualization' and 'topological mapping' to visualize the complex geographies of Holocaust survivors testimonies (Knowles, Westerveld and Strom, 2015; Westerveld and Knowles, 2018; Westerveld and Knowles, *forthcoming*).

In the context of this research however, the focus on understanding possible changes to shapes and areas of EEZ spaces in the western and central Pacific region requires to use GIS tools. A critical implementation of these tools is important, especially in the context of this study, where maps are vested with power. Fortunately, feminist geographers have shown that despite the positivist nature of GIS (Yapa, 1998) the tool can be employed critically. Kwan (2002) offers direction and suggests using *reflexivity* at three sites in a research process that involves GIS. First, at the site of production: why, how and to what ends does one use GIS? Second, at the site of the analysis and images self: what is shown and not shown? How is it shown? Third, at the site of communication: what are the real world ramifications of the maps produced, and how do these products relate to different perspectives, and existing social and power dynamics? (Kwan, 2002: 649). In this study, the sensitivity is particularly high because of the uncertainty that concerns UNCLOS and the extremely high political stakes, wherein the very sovereignty of states is involved. That is also why the technical assessment from Webb (2016: 3) cautions the reader that: “It is important to stress that the maps showing the relative influence of the vulnerable low water line features is not, in any way, implying such adjustments will occur in any jurisdictional zone.”

An important consideration at the site of analysis in this study is which views and perspectives the analytical methods and assumptions support. Webb (2016) approaches the question of changes to maritime boundaries from an ambulatory perspective of baselines only. In this study however – as I will describe in detail in the methods chapter – a scenario approach is used instead, where I consider the different perspectives on this issue, being particularly cautious of integrating the views expressed by stakeholders from the study region. At the site of production, this research is inspired by close communication and multiple meetings with maritime boundaries legal and GIS experts from the region during a two-weeks long workshop in Sydney. These connections helped ground this work with the latest knowledge from the region and increase its saliency for regional stakeholders. At the site of communication, if most maps will show potential changes to EEZ area in a standard Cartesian grid, I will also consider the region as network of jurisdictions connected through boundaries (Fig. 2.3). This approach can push the discussion in new directions, away from change to absolute space only, and including the notion of relative space and questions of connectivity, contiguity, and potential impacts of changes to those dimensions.

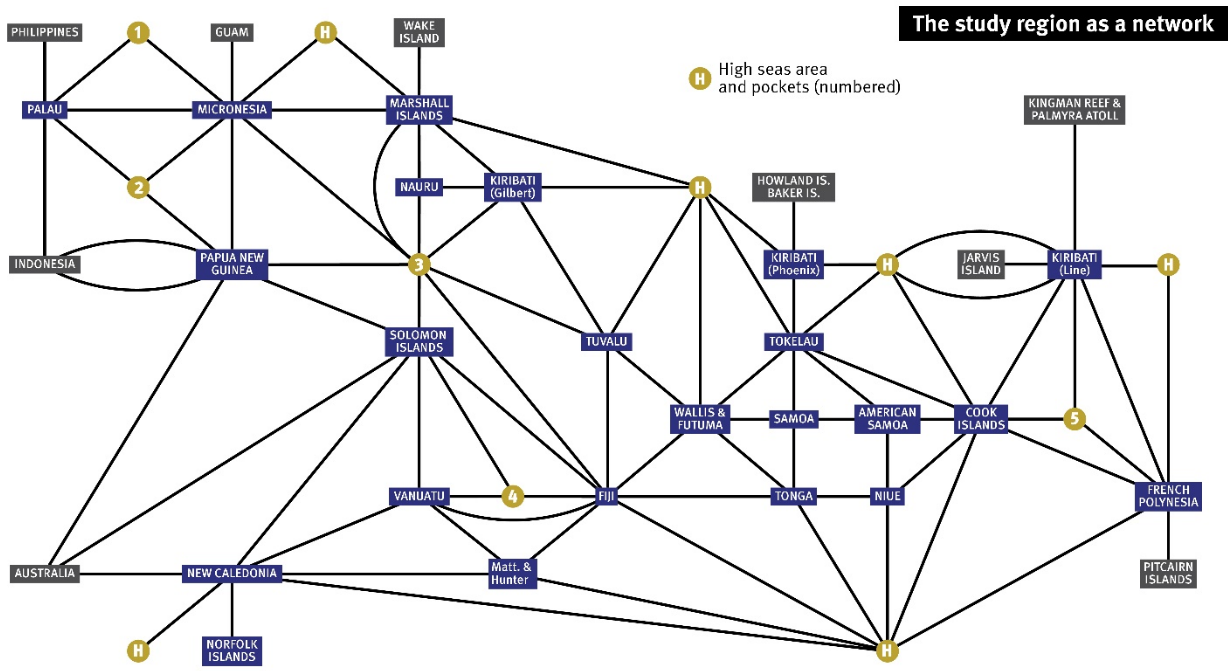


Figure 2.3 *Diagram visualizing the study region as a network of boundaries. Each line corresponds to an EEZ maritime boundary, either between jurisdictions, or between a jurisdiction and a high seas area (yellow circles). High seas areas that are surrounded by EEZ maritime boundaries (1, 2, 3, 4 and 5 on the map) are called high seas pockets.*

3. Methods

I have in the introductory chapter of this thesis outlined why it is important to study the potential impacts of climate change on maritime boundaries and Exclusive Economic Zones. In the theory chapter, I argued that EEZs are a form of territory and a type of space that is constructed mostly through institutionalized conceptualization. GIS and maps are important methods employed by governments to create and legitimize EEZs as a form of territory. Rather than employing GIS methods directly in this research, I employ reflexivity at the sites of production, analysis and communication of the methods (Kwan, 2002). GIS methods are not directly applied to spatial data in the study region, but instead an inductive approach is used to create scenarios that capture the potential developments to international law on the issue of climate change and maritime boundaries. Scenarios are based on findings from semi-structured interviews with government officials from the Pacific and legal experts from regional organizations. The purpose of these interviews is to gain insight on how these regional experts interpret UNCLOS, and perceive the issue at stake, namely the potential loss of EEZ territory because of sea level rise and the submergence of baselines. Based on these scenarios, spatial data were collected and analysed with GIS software. The resulting maps and quantitative results for each jurisdiction in each scenario form a basis to respond the research question: what are the potential impacts of climate change on EEZs in the western and central Pacific region?

The structure of the methods chapter is threefold, and it follows the same sequence than the research itself. A development method approach was applied with the results from one method informing the parameters of the following one (Fig. 3.1) (Gray, 2014). In this chapter, I first explain how semi-structured interviews with experts were conducted. Second, I outline how scenarios were produced through a process that emphasizes credibility, saliency, and legitimacy. Finally, I present the GIS data and processing steps used to derive quantitative results for each scenario in this study.

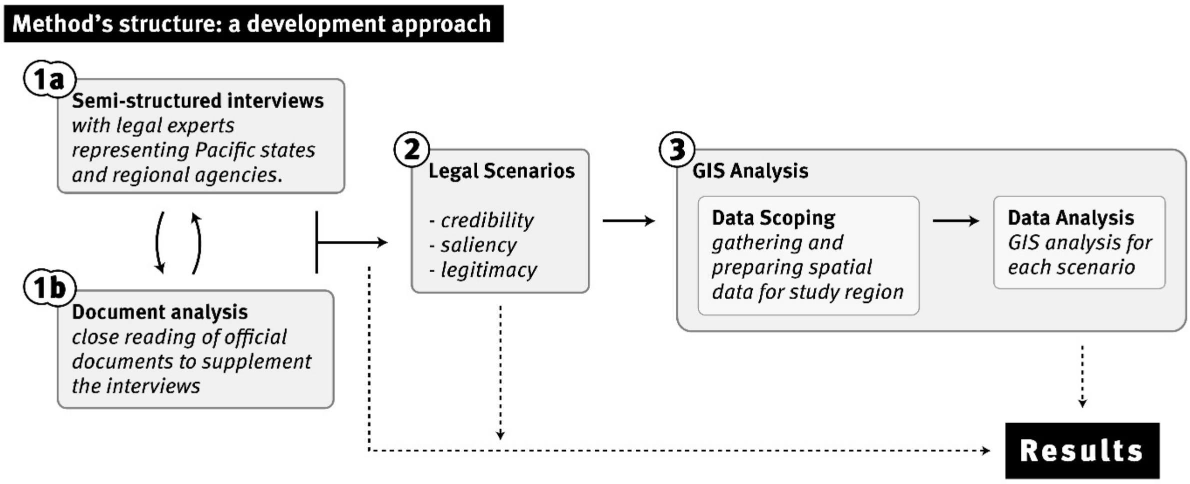


Figure 3.1 *Flow diagram of the 3-steps approach used in the methods of this research. Each step also informs the results of the analysis and their interpretation.*

3.1. Semi-structured interviews with experts

All informants were interviewed at the 19th Maritime Boundaries Workshop that took place in Sydney, Australia over two weeks in November 2019. This annual workshop is organized by the Pacific Community (SPC) with funding from the Australian government, its aim is to advice and support Pacific countries with legal and technical expertise to delimit and deposit their maritime zones under UNCLOS. The workshop also provides an avenue for countries with overlapping maritime zones to negotiate a common boundary and set a treaty in place to support it. Technical GIS experts as well as UNCLOS legal experts were present from Australia, Cook Islands, Fiji, Federated States of Micronesia, Kiribati, Marshall Islands, Niue, Nauru, Papua New Guinea, Palau, Samoa, Solomon Islands, Tonga, Vanuatu, Tuvalu and the United States of America. Representatives of the Pacific Community (SPC), GeoScience Australia, Pacific Islands Forum Secretariat, Office of the Pacific Ocean Commissioner, Pacific Islands Forum Fisheries Agency and GRID-Arendal/UN Environment were also in attendance. I was invited to attend the workshop as an observer but also to provide GIS training.

As presented in the introduction (cf. *1.1 The importance of EEZs and the threat of climate change*), scholarly research suggests that baselines are ambulatory under the current UNCLOS text, and that sea level rise could therefore results in a loss of territory (Symmons, 1998; Schofield, 2009; Powers, 2012; Trahanas, 2013; Vidas, 2014; Vidas, Freestone and McAdam, 2015). This scholarly and dominant interpretation of UNCLOS has not yet been vindicated in court as no tribunal has ruled a case that involves sea level rise and maritime boundaries. There is therefore still uncertainty around this issue, and stakeholders in the Pacific for whom the ramifications could potentially be very grave are actively engaged with this topic. Interviews conducted for this research provided a critical understanding of the arguments and different views put forth by legal experts from the study region.

These interviews were also crucial to provide timely insight on nascent legal processes taking place at the regional and international levels to shape the future of international law on this issue. During the Sydney workshop for example, country legal representatives were collecting and organizing national legislation relevant to the issue for a joint regional submission to the United Nations' International Law Commission (ILC). The ILC formed a study group in 2019 to study the impacts of sea level rise on international law at the request of Pacific island countries. This process could lead to the development of new international law or clarifications on the effects of climate change on maritime boundaries under the UNCLOS regime. The state-of-the-art nature of these legal processes could only be accessed through interviews as there is so far scarce literature on this topic. Additionally, the presence of GIS experts enabled me to gain much knowledge on the intricacies of calculating maritime boundaries as well as accessing the latest relevant spatial data.

Published work by Mullings (1999) on the challenges of navigating the 'insider/outsider' binary and the dynamism of positionality during fieldwork helped me reflect on the context in which my interviews were conducted. Despite the regional and broad geographic scope and scale of this research, the complex and possible grave implications of the topic of study required sensibility and the nurturing of trust by informants. In many ways I was an outsider to the informants I interviewed. Even if the interviewees came from different countries themselves, it was clear that there exist strong interpersonal connections, shared interests, goals, and values amongst them. I was concerned that my French identity may raise questions during the workshop because of France's colonial history in the Pacific. France also claims ownership over disputed territory in the study region, for example the Matthew and Hunter Islands located between the French overseas territory of New Caledonia and Vanuatu. This was not the case, however. Rather, my shared interests in GIS and my role as a technical instructor during the workshop allowed workshop participants to assign meaning to my presence (Carling, Erdal and Ezzati, 2013). At times, I even felt like an insider, who could for example fully grasp some of the technical difficulties workshop participants ran into when working with the spatial data of their country. As Mullings argues in her own research, the insider outsider binary is not clear cut, but rather a dynamic positionality reflective of the different roles and statuses ascribed to the researcher (Mullings, 1999).

In total, I conducted 8 semi-structured interviews with workshop participants closely familiar with the UNCLOS regime, either through their work as international lawyers working as legal officers and advisers for their countries, or as professionals working with UNCLOS in the Pacific under a different capacity. Interviews were conducted in English, which was the working language of the workshop. I contacted informants during breaks or over lunch, presented my research project to them, and asked whether I could interview them during the week at a suitable time. Interviews took place at the University of Sydney in a closed room in the same building where the Maritime Boundaries Workshop was happening. Informants were recorded using my phone and the interviews lasted 29 minutes on average, with the shortest interview lasting 22 minutes and the longest 38 minutes. There were 5 men and 3 women. One informant did not want the interview to be recorded. Detailed notes were taken instead. Because of the sensitivity around this topic, the names of informants, as well as their official titles, and countries of origin, are not provided to ensure anonymity.

The standard flow of the interviews followed a similar structure for each interview. Interviewees were first asked to describe the importance and role of EEZs and maritime boundaries in the Pacific and for their respective country. We discussed their perspective on whether and how UNCLOS addresses the climate change and sea level rise issue. I asked informants to describe the legal resiliency of different type of maritime boundaries, for example those that differ geographically (adjacent to another jurisdiction or to the high seas) or in terms of legal status (disputed, provisional or bound by a treaty). The interviews ended on a discussion about the steps and strategies Pacific countries are taking to secure their maritime boundaries amid climate change. A detailed list of the open-ended questions asked during the interviews is available in the appendix (cf. *8.1 Questionnaire*). During the interviews, several informants quoted or referred to a mix of official governmental published declarations, communiqués, as well as tribunal cases to support their claims. Mentioned documents were retrieved and integrated in the analysis process.

Despite the relatively low number of interviews conducted, saturation in the type of answers given was quickly reached. This could be attributed to informant's shared legal professional background and expertise, which suggests that they likely approached the questions and topics discussed from a similar angle. Additionally, despite the broad geographic span of the Pacific region, I noted several regional joint initiatives mentioned by informants suggesting a strong collaboration, including on international law. Such collaboration may contribute to the development of a common view on the issues discussed. This was most clearly voiced by the 6th informant, an attorney working for Fiji's government, who explained:

> For the region, if we speak individually, because we are so small our voice is drowned out by the crowd. Because we are very small Pacific island countries. Our economies are not as developed as other countries. We have very little sort of sway, if I can say politically on the international sphere, so for us it is good to speak as one voice, because when we speak as one voice we get more attention and we are able to get heard. And this is where messaging is important. Because it is a very critical issue [sea level rise] for us, and so, we have to talk in a way that is strategic and in a way that would benefit us as a region.

For the analysis, each interview was carefully transcribed. No codification software was needed as the amount of qualitative data resulting from this analysis was not large. Through close reading, themes and arguments described by informants were grouped in categories. Combined, these categories formed the basis to develop scenarios used in this research. These were further supported with the scholarly literature review on UNCLOS. Arguments supporting each scenario were synthesized from the different sources. In the following section, I describe in more detail why a scenario approach was used in this research, and the considerations that went into developing each scenario.

3.2. Scenario building exercise

In the literature on scenario methods, the work of Herman Khan is often cited as pioneering with the "future - now" theory, in which he argues that the best way to prevent nuclear war is to outlay its consequences in scenarios (Khan and Wiener, 1967; Chermack and Lynham, 2002; van Vuuren *et al.*, 2012). The Shell company's usage of scenario planning is also associated with the early development of a scenario method; their approach to scenario based strategic planning has since been adopted by many businesses and corporations (Chermack and Lynham, 2002; van Vuuren *et al.*, 2012). Nowadays, scenario methods are also employed in climate change research and assessments to explore the long-term environmental, social and economic consequences of human activities (van Vuuren and Carter, 2014). Perhaps most notable are Global Environmental Assessments such as the IPCC's Assessment Report or the UN Environment (UNEP) Global Environment Outlooks (GEO). In an examination of definitions for scenario planning, Chermack and Lynham (2002) traces the first definition to Porter (1985: 63): "An internally consistent view of what the future might turn out to be – not a forecast, but one possible future outcome". More recently, van Vuuren et al. (2012: 21) propose a relatively similar definition "a tool to explore different futures under clearly defined assumptions." In climate change science, the authors argue that the main rationale for using scenarios is because decisions taken today can have irreversible consequences in the future (van Vuuren *et al.*, 2012). In recent years, scenario planning and analysis have gained traction as useful methods because the world changes too fast for long term predictions to be accurate (Chermack and Lynham, 2002).

The distinction between predictions and scenarios is an important one. Whereas predictions focus on the most likely development, scenario analyses are rather "tools for exploring plausible future developments and examining associated uncertainties" (van Vuuren and Carter, 2014: 427). Predictions and scenarios approach uncertainty differently, where the first takes into account the question of uncertainty and probability, the latter focuses rather on *possible* developments conditional on fundamental assumptions (van Vuuren *et al.*, 2012). But how does one make good scenarios? According to Cash et al. (2003), the concepts of credibility, saliency and legitimacy can be used to assess the effectiveness and usefulness of scientific information for society. van Vuurden et al. (2012) argue that these same concepts can also be applied to assess how well a set of scenarios is structured and relevant to a designated context. I chose to use these guiding principles to develop the scenarios in the research. Below, I define credibility, saliency and legitimacy and discuss how they are achieved in the context of this study.

Credibility refers to the scientific adequacy of the technical evidence and arguments presented to support a particular scenario (Cash *et al.*, 2003). In this research, there was one main assumption that remained unchanged regardless of the scenarios: climate change will lead to the submergence of baseline features such as low-lying atolls in the future. This unchanging assumption was supported with academic literature from the natural sciences in the introductory chapter of this thesis (cf. *1.1 The importance of EEZs and the threat of climate change*). Each scenario has its own additional varying assumption concerning how international law could develop or how interpretations of UNCLOS could change and ultimately determine the impacts of climate change on EEZs. To support the credibility of these varying assumptions, arguments derived from interviews and official documents are presented for each scenario (cf. *4 Results*). Chermack (2005: 61) additionally explains that a well-crafted and credible scenario identifies "signposts or indicators that a given story is occurring". In the results, I therefore also mention indicators that suggested a given scenario is already taking place.

Saliency is the relevance and comprehensibility of the scenarios to the needs of its end-users (Cash *et al.*, 2003; van Vuuren *et al.*, 2012). The end users of this research are primarily the main stakeholders who are the inhabitants of the study region, particularly political decision-makers and lawyers directly working on the issue of climate change and maritime zones. Additionally, this research is also relevant to audiences engaged with this topic outside of the study region, particularly because EEZ maritime boundaries are part of a global regime and found in all oceans. It is then especially relevant to other places in the world where there are baselines threatened by the effects of climate change. To achieve comprehensibility and ensure that these scenarios are easy to communicate, I refer to van der Heijden (1997) and Chermack (2005) who suggest that each scenario must be communicable as a simple storyline that can be translated in a diagram. In the results chapter of this study then, each scenario is described in a short and simple language. Moreover, a simple diagram was designed to communicate conceptually the effects of climate change on EEZ boundaries for each scenario. These diagrams make it easier for readers to compare scenarios and understand their differences.

Additionally, these scenarios' results are relevant because of the extremely intricate island geography of the study region. This complexity means that it is difficult, or impossible, to imagine how EEZ maritime boundaries could change for different scenarios without a thorough GIS analysis. Therefore, the maps and results from the GIS analysis contribute to the geographic imaginary, providing insight into the effects of different international law scenarios on maritime boundaries in the study region. This new knowledge comes at a critical point as this issue is debated and discussed in and amongst governments (Pacific Islands Forum (PIF) Secretariat, 2018; 2019: 5). Comparing scenario results (cf. *5 Discussion*) helps explain how their implications differ. Much of existing literature emphasizes the potential loss of territory of Pacific jurisdictions, but does not explain how much may be lost, and where.

Legitimacy means that "the production of information has been respectful of stakeholders' divergent values and beliefs, unbiased in its conduct, and fair in its treatment of opposing views and interests" (Cash *et al.*, 2003: 8086). It would have been difficult to achieve legitimacy in this research without seeking the perspective and knowledge of stakeholders familiar with the issue from the study region directly. As said, through the semi-structured interviews, the knowledge from Pacific Islanders who are themselves internationally recognized experts on relevant issues in the region is collected and finds its way in the scenarios too, increasing their legitimacy.

3.3. GIS data scoping and analysis

In the last section of this methods chapter, I present the spatial data used for the GIS analysis and describe the analytical steps performed on this data. The ESRI ArcMap 10.5 software was used for the GIS analysis. It was chosen over other software such as MapInfo or the open source QGIS alternative because it provides an option to generate geodesic buffers instead of planar ones. Geodesic buffers are particularly important in this research because of the large size of buffers (200 nm) used to calculate EEZ areas. Planar or Euclidean buffers simply measure the buffering distance on a two-dimensional Cartesian plane, not considering the spherical shape of the earth. Moreover, the Geocap (version 7.2.4) Maritime Delimitation extension to calculate equidistant maritime boundaries between neighbouring jurisdictions exists in ArcGIS (Geocap, 2019). This tool was used extensively in some scenarios to calculate the location of new EEZ maritime boundaries between adjacent jurisdictions.

3.3.1. Data scoping

The unit of analysis of this research are the EEZ maritime boundaries of the Pacific Islands region. Within the study region, there are 91 unique EEZ maritime boundaries. These include 50 treaty boundaries between jurisdictions (including boundaries between core study region and adjacent jurisdictions) and 41 unique high seas boundaries. One jurisdiction can have multiple high seas EEZ boundaries if the boundary is not continuous but is separated by one or more treaty boundaries. Tuvalu's EEZ constitutes for example of three treaty boundaries: one in the north with Kiribati, one southwest with Fiji, and one southeast with Wallis and Futuna (Fig. 1.5). Between these treaty boundaries, Tuvalu has two high seas boundaries: one west between Kiribati and Fiji, and one east between Kiribati and Wallis and Futuna. It is worth noting that Kiribati – pronounced Kiribahss – is a unique jurisdiction that comprises of three unique EEZ areas separated by high seas: The Gilbert Group, the Phoenix Group, and the Line Group. Kiribati alone has 19 individual high seas boundaries.

For GIS data on maritime boundaries, the World EEZ Maritime Boundaries data package was downloaded from the Marineregions.org website. Marineregions.org is a project managed by the Flanders Marine Institute, funded by the European Union, and widely recognized as providing the most up-to-date global geographical data on maritime boundaries. This data package contains two shapefiles that are extensively used in this research (Table 3.1).

Table 3.1 *Metadata for two spatial data files used for the analysis in this research. * As explained in Marineregion.org's methodology (https://www.marineregions.org/faq.php), the resolution of the files varies between jurisdictions as the input data used by the authors is based on data submitted by countries to DOALOS at different resolutions.*

File name	eez_boundaries_v11_0_360.shp	eez_v11_0_360.shp
Description	This layer includes all the outer borders of EEZs in the forms of lines.	This layer includes the EEZ areas in the form of polygons. Where each polygon stands for a jurisdictions' EEZ area. The contour of each polygon is either the jurisdiction's outer maritime boundaries or their baselines when these are situated on the inside of the polygon (EEZ area).
Author / Institution	Flanders Marine Institute	Flanders Marine Institute
Publication date	2019-11-18	2019-11-18
Version	V11	V11
File type / format	Shapefile (.shp) polyline	Shapefile (.shp) polygon
Projection (GCS)	WGS 84 (0 to 360 degrees)	WGS 84 (0 to 360 degrees)
Resolution*	Varies across jurisdictions	Varies across jurisdictions

The first polyline shapefile called *eez_boundaries_v11_0_360* was used to create an up-to-date dataset of all boundaries and their legal status in the study region (Fig. 3.3). The original data was first cleaned to remove non-EEZ boundaries polylines from the layer, such as archipelagic baselines (step 1). Topological errors related to incorrect start and end points of each boundary in the polyline file were later fixed (step 2). Finally, the legal status of each boundary was added to the attribute table of the polyline based on the latest status for each that was communicated by SPC at the conclusion of 19th Maritime Boundaries Workshop in Sydney (step 3). Boundaries between jurisdictions can be categorized in one of three groups: provisional (or disputed), treaty in place but not entered into force, and treaty in place and entered into force. In the analysis of this research, the distinction between EEZ boundary treaties that have not yet been entered into force and those that have already entered into force was not made, as it is only a matter of administrative processes and a relatively short time before all signed treaties will be entered into force. Boundaries between EEZs and the high seas can be categorized in two groups: provisional, if they have not yet been deposited to DOALOS, or deposited if they have. A map of the final polyline shapefile output with the status of each boundary in the study region was shown above in the introduction (Fig. 1.5).

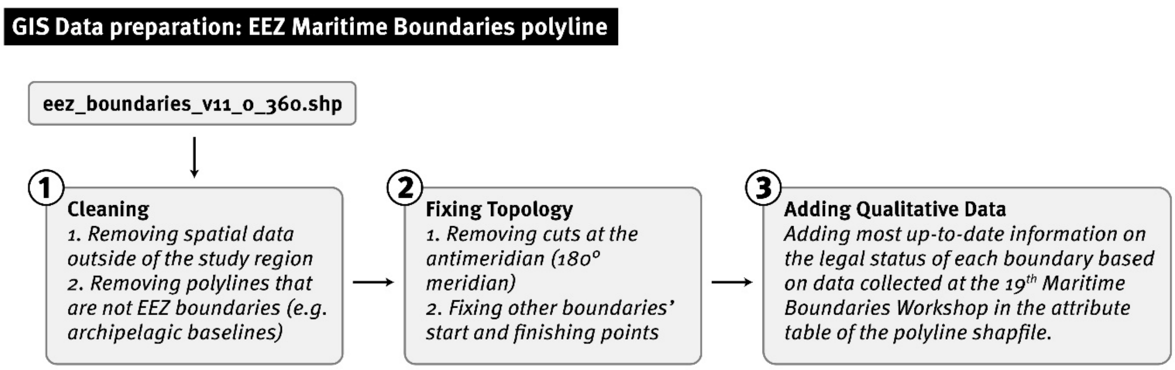


Figure 3.2 *Flow diagram showing the 3 GIS steps taken to prepare the EEZ boundaries file.*

The second polygon shapefile from the Flanders Marine Institute, namely *eez_v11_0_360*, was used to calculate the area in square kilometre of each EEZ. Areas for each jurisdiction were calculated in GIS for each original EEZ polygon using the ESRI World Cylindrical Equal Area projection as shown in step 1 in figure 3.4. Additionally, the baselines (inner boundaries of the EEZ polygon) were also extracted (step 2). One could have used a global coastline layer as a proxy for baselines such as the Global Self-consistent, Hierarchical, High-resolution Geography Database (GSHHG) of shorelines (Wessel and Smith, 1996) with the latest 2.3.7 version dating from June 15th, 2017 (NOAA, 2020). However, such dataset does not include straight baselines or archipelagic baselines, which several jurisdictions use in the Pacific. It was most handy to derive the baseline features layer from Marineregions.org's EEZ areas layer directly, as that dataset includes these.

To extract baselines, a simple rectangle polygon layer of the study region was generated and the EEZ polygons were erased from this rectangle. The output from this analysis was the negative space of the original polygon which represents all the high seas areas as well as the baselines, both of which are not covered by the EEZ polygon. The high seas features from the output were simply removed using the vector editing functionalities of GIS, and only baseline polygons for the entire study region were kept. Two missing baseline features from the analysis were found: the Australian Coral Sea as well as for the Indispensable Reefs in the southern part of the Solomon Islands. These features were important to add because both countries use them to extend their EEZ claims. Additional existing spatial data for Australia and digitized imagery for the Solomon Island (Table 3.2) were merged with the baseline polygon file to create a final baseline features layer for the study region (step 3).

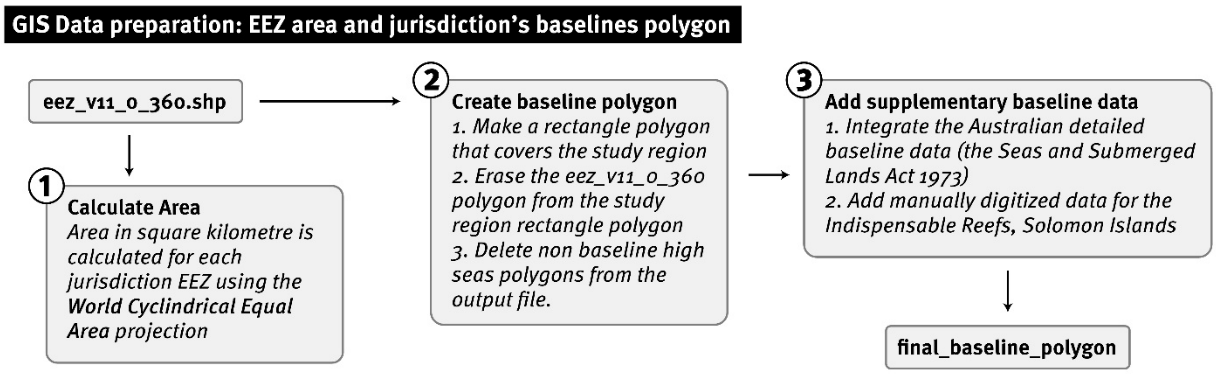


Figure 3.3 *Flow diagram showing the GIS steps taken to prepare the EEZ polygon file for the study region.*

Table 3.2 *Metadata for two additional baseline features polygon files for Solomon Islands and Australia. These were added to the file from the Flanders Marine Institute to create a final baseline shapefile. For the Solomon Islands, a manually digitized polygon of the Indispensable Reefs feature was created using the ESRI Imagery basemap in ArcMap at a resolution of 1:100000.*

File name	Seas and Submerged Lands Act 1973	Manually digitized Indispensable Reefs, Solomon Islands
Jurisdiction	Australia	Solomon Islands
Author / Institution	GeoScience Australia (Seas and Submerged Lands Act 1973 - Australian Maritime Boundaries 2014a - Geodatabase, 2017)	Levi Westerveld
Creation date	2017-06-24	2020-01-10
Version	V2.3.7	NA
File type / format	Shapefile (.shp) polyline	Shapefile (.shp) polygon
Projection (GCS)	GDA 1994	WGS 84
Resolution	Not specified	Digitized at 1:100 000

The final baseline features layers included over 30 000 individual features (small polygons). Many of these polygons belong to only one reef or atoll for example. Therefore, all these unique polygons were merged together in a multipart feature when these were part of the same atoll (e.g. Fig. 3.5).

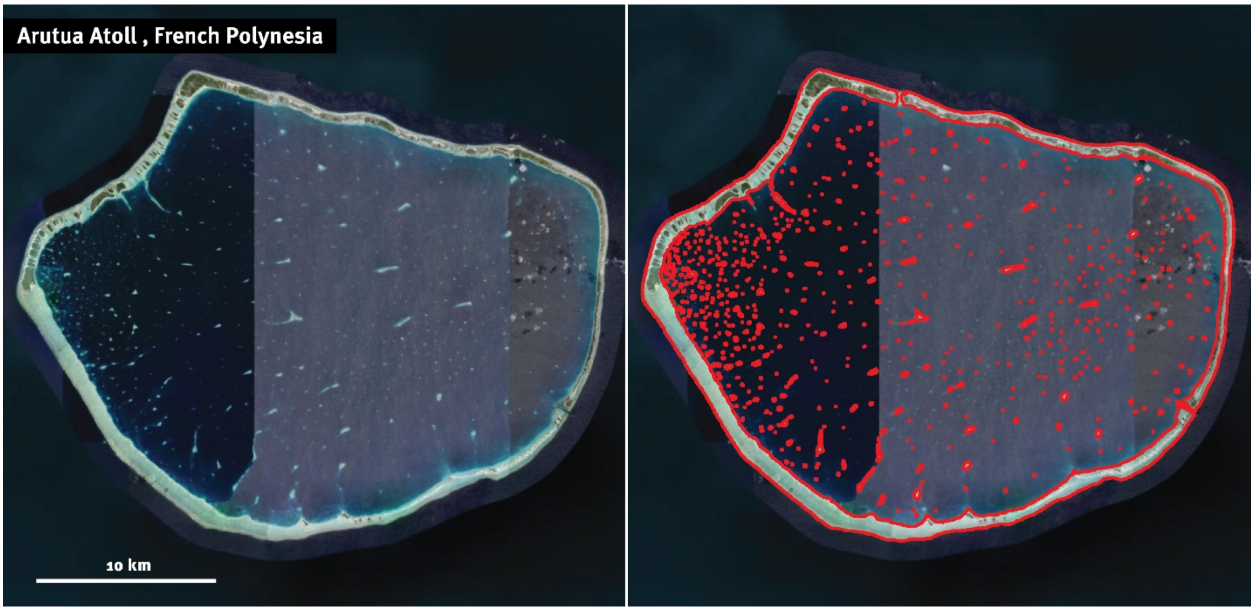


Figure 3.4 *Example map of the many baseline features polylines for the Arutua atoll. The atoll is in central French Polynesia and is composed of 577 unique land features polygons (red polygons on the right image). All these polygons were merged into one multipart feature.*

3.3.2. Data analysis

The analysis of the maritime boundaries and baseline features polygons followed five distinct steps that are visualized in figure 3.6 below. In the following section, I provide a detailed overview of each step of the analysis, with figures of outputs to illustrate the methods used.

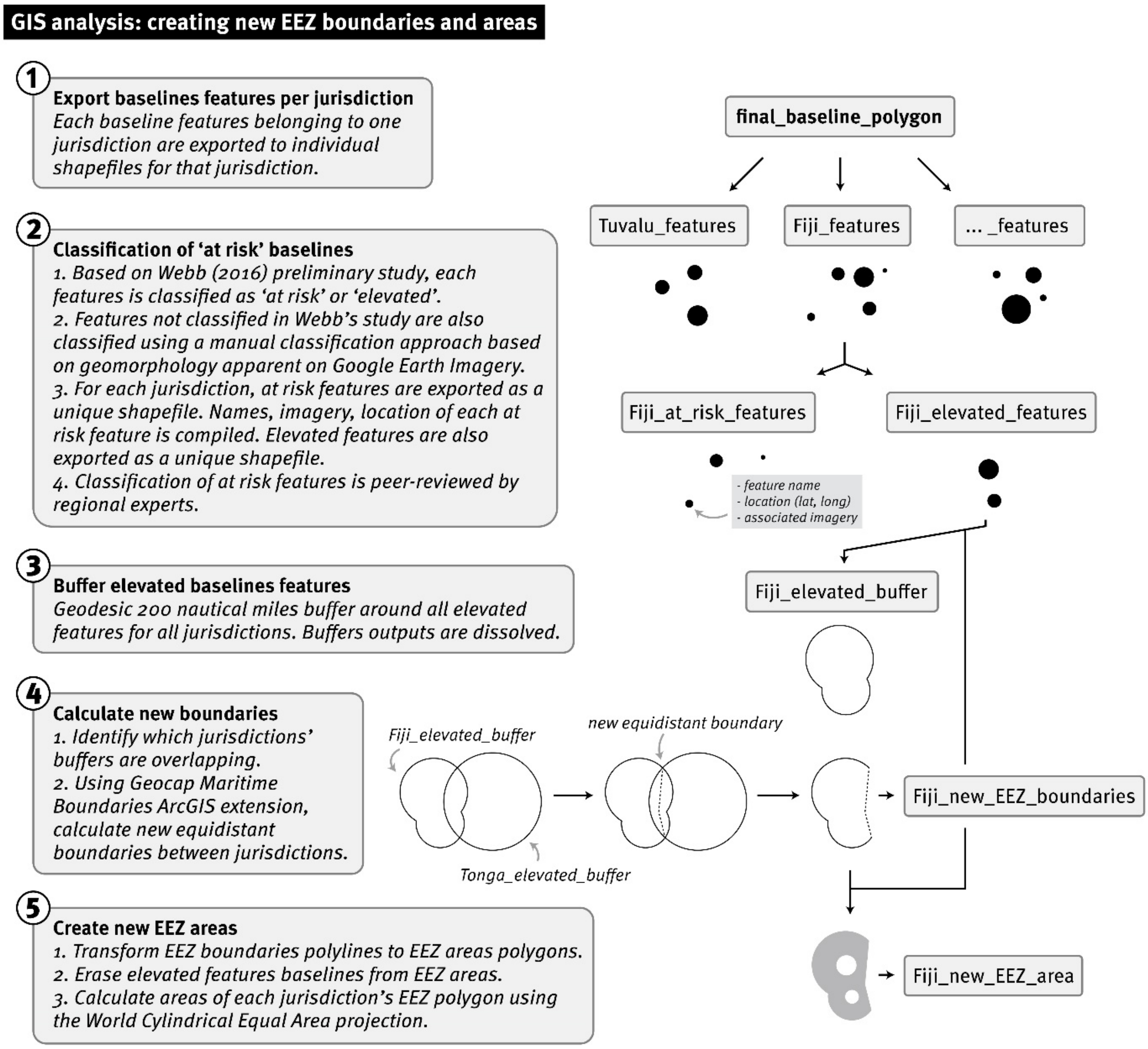


Figure 3.5 *Flow diagram showing the five GIS steps to calculate the new EEZ boundaries and areasfor all jurisdictions in the study region.*

Step 1: All baseline features were selected and exported to individual layers for each jurisdiction. In total, there were 20 separate files for all jurisdictions in the study region, and an additional 10 layers for the baselines of adjacent jurisdictions. Kiribati's three distinct EEZ areas (Phoenix Group, Gilbert Group, and Line Group) were joined in one layer and treated as one distinct jurisdiction.

Step 2: In a second step, all baselines features were classified as being either 'at-risk' or 'elevated' in the attribute table of each jurisdiction's layer. The classification of baselines features based on their likelihood of being submerged generated several problems. First, there exists only high-resolution elevation data for a small number of atolls in the study region. Collection of primary elevation data through on ground surveys or remote sensing technologies such as LiDAR data was beyond the scope of this study. Second, the rates of sea level rise vary within the study region and are dependent on several unknown variables such as future greenhouse gas emissions. Simultaneously, a number of natural processes such as reef building and geomorphic processes that result in the sinking or rising of features, including islands, further complicate the task of predicting when low-lying islands and baselines features will be submerged (cf. *1.1 The importance of EEZs and the threat of climate change*). However, this study follows the conclusion from several studies which predict that low-lying atolls in the Pacific will eventually be submerged in the near future (cf. 1.1). Variations in time were therefore not considered. Instead, I assumed a time when all low-lying baseline features are submerged.

In terms of classification of baseline features based on whether these were 'at-risk' or 'elevated', this study uses the same method and classification from Webb's (2016) preliminary assessment. Elevated features are those for which the baselines will remain elevated and unchanged under foreseeable sea level rise changes. I use the term 'at-risk' and 'low-lying' intermittently in this research to describe features for which the baselines will be submerged under foreseeable sea level rise changes. All features mentioned to be elevated for different jurisdictions in Webb's assessment were also classified as such in this one. All at-risk features are not always explicitly listed in Webb (2016), especially for jurisdictions which include many dozens such as French Polynesia. Therefore, I independently checked each baseline feature against available open source information and high-resolution satellite imagery through Google Earth Pro. From imagery, one can figure out whether a feature is an atoll. Because atolls are naturally built on coral reefs, these are always of very low elevation and at risk from sea level rise. A list of all at-risk features for each jurisdiction, their associated imagery, and coordinate location is made available in the appendices (cf. *8.2 List of 'at-risk' features in the study region*).

'At-risk' and 'elevated' baseline features spatial data were saved to two different spatial layer files for each jurisdiction in the study region. Most jurisdictions then included two data layers on baselines, one for at-risk features and another for elevated features. Some jurisdictions only had one of two layers if they are only constituted of 'at-risk' or elevated baselines features. The output data of the second step is shown in figure 3.7.

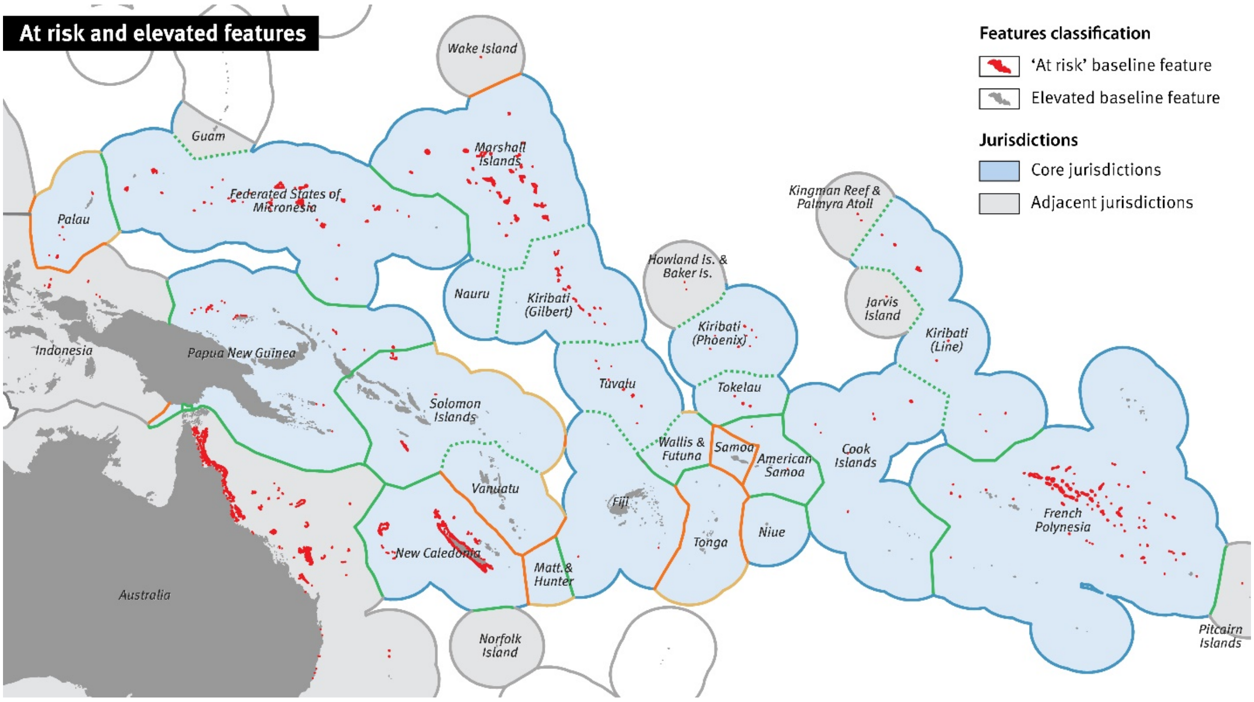


Figure 3.6 *Map of the at risk and elevated baseline features for all jurisdictions in the study region. The classification includes adjacent jurisdictions.*

Step 3: Using the buffer tool in ArcMap, 200 nautical miles geodesic buffers were created around elevated features for each jurisdiction. No buffer was generated for jurisdictions that only have at-risk features. Using the dissolve tool in ArcMap, buffers for features from the same jurisdiction were dissolved together. Figure 3.8 below shows the buffer analysis output from step 3 for the Pitcairn Islands jurisdiction, an adjacent EEZ area on the eastern most side of the study region.

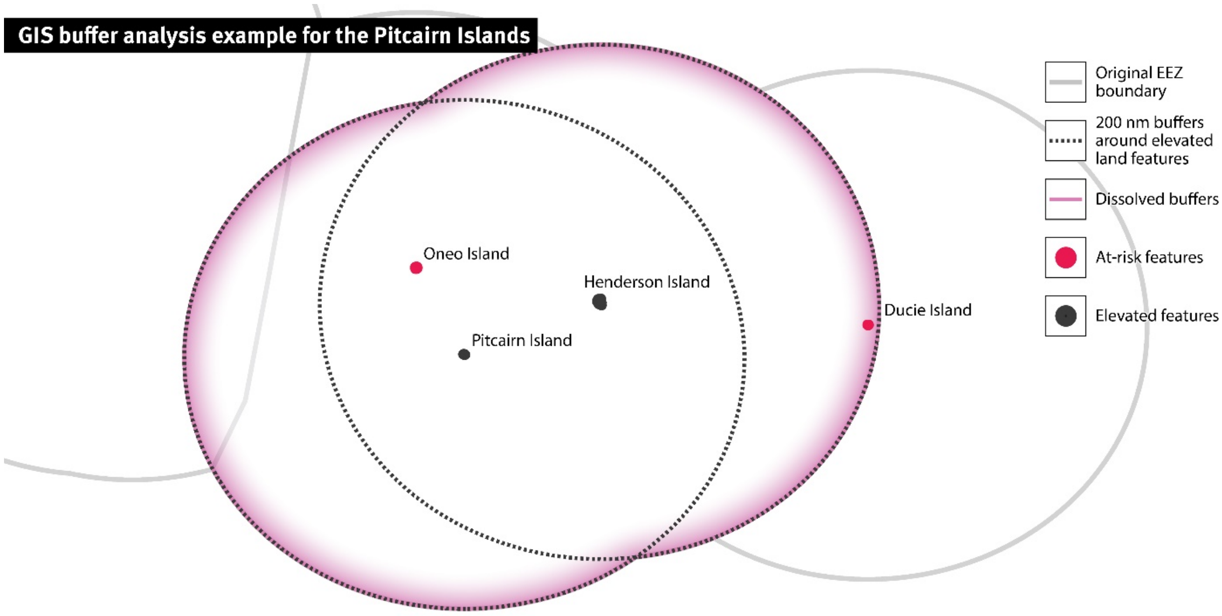


Figure 3.7 *GIS buffer analysis example for the Pitcairn Islands. The Pitcairn Islands jurisdiction is composed of 4 islands. Pitcairn Island and Henderson are elevated features, whilst Oneo Island and Ducie Island are at-risk features.*

Step 4: After the buffers were generated for elevated baselines in each jurisdiction, jurisdictions with overlapping buffers were found. In case of overlapping buffers, it meant that these jurisdictions' newly calculated EEZ claimed areas overlap, and a maritime boundary between the two jurisdictions that cuts through the overlapping area must be determined. This boundary, also known as the equidistant line, was calculated in GIS using the Geocap Maritime Boundaries extension for ArcGIS (Geocap, 2019). This analytical tool uses the baseline features data for both jurisdictions to determine the equidistant line between the two jurisdictions' baselines. A geographic extent must also be provided in the form of a polygon to Geocap for the tool to determine how far out the equidistant line should be generated. Figure 3.9 below shows as an example how midlines, midpoints and a new equidistant maritime boundary was generated between the overlapping EEZ area buffers of the Federated States of Micronesia and Guam. Midpoints are point locations that are equidistant from baseline features of adjacent jurisdictions for which a new equidistant boundary is calculated. For each midpoint there are two midlines of same distance that connect each baseline (basepoint) to the midpoint. The equidistant line is the line that connects these midpoints. Based on variations in the shape and location of baselines, the analytical tool automatically calculates how many midpoints and midlines must be generated and calculated.

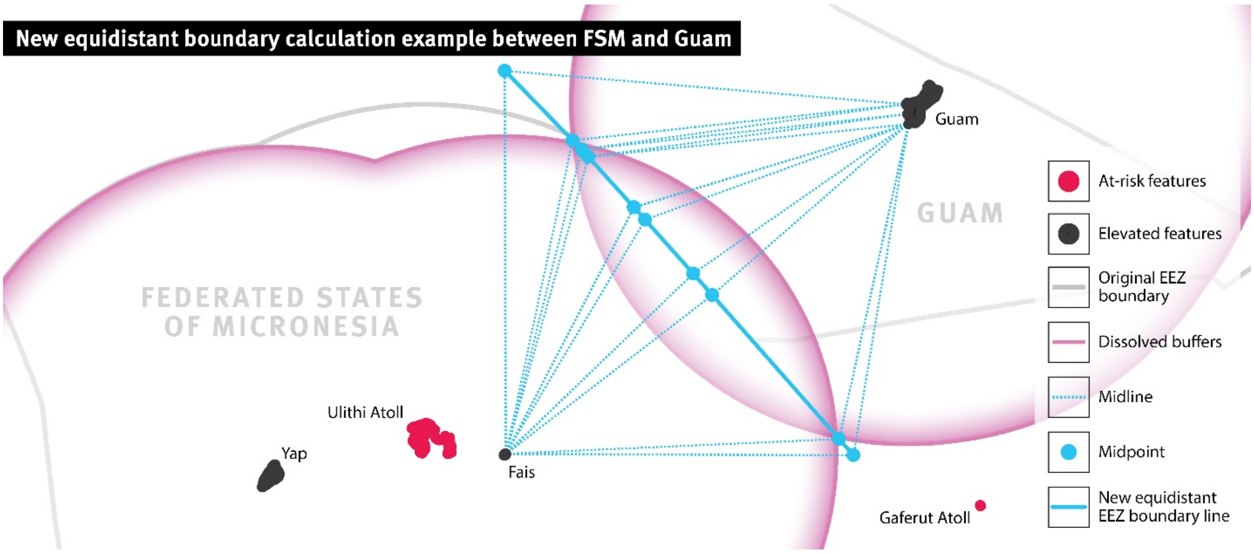


Figure 3.8 *GIS analysis example for calculating a new equidistant boundary.The map shows the new equidistant line generated between the Federated States of Micronesia (FSM) and Guam. The new boundary is based on the remaining elevated baseline features around Fais Island for FSM (south), and the elevated baseline features for Guam (north).*

Step 5: In a final step, the 200 nautical miles buffers output of each jurisdictions were combined with the relevant new equidistant treaty boundaries lines. For each jurisdiction, buffer lines and equidistant lines were combined to create the outer boundary of a jurisdiction's EEZ area. The line was transformed to a polygon in GIS, and the elevated baseline features (elevated land) was erased from each polygon for each jurisdiction. The final polygon represents the new EEZ for each jurisdiction. Using the World Cylindrical Equal Area projection, the area in square kilometres was calculated for each newly generated EEZ area.

4. Results

The results chapter is organized by scenarios. Based on the analysis of data from the interviews conducted in Sydney and the literature review, three scenarios were created. The first scenario assumes that boundaries that are already deposited to DOALOS are fixed and permanent and do not change because of the effects of climate change on baselines. The second scenario also assumes that boundaries that are already deposited are fixed, but jurisdictions were all features are classified as ‘at-risk’ lose their EEZ area, regardless of the status of the outer EEZ boundaries. The third scenario assumes that EEZ boundaries are ambulatory, and so these would be affected by climate change effects regardless of whether they have already been deposited to DOALOS. In each scenario section, I first provide a short description and a diagram to conceptually represent how the scenario functions given different combinations of at-risk and elevated features, high seas and adjacent boundaries, and deposited versus provisional boundaries. Then, the arguments derived from the semi-structured interviews and the literature are presented to support the credibility and legitimacy of each scenario. Finally, the GIS results of the scenario analysis are described in the form of tables, charts, and maps for the study region. This chapter concludes with a fourth section that focuses on the aggregated results of each scenario at the regional level. This last chapter also examines the effects of each scenario on the connectivity of EEZ boundaries in the study region, as well as the potential impacts on the area and shape of high seas areas.

4.1. Scenario 1: fixed and permanent boundaries

SCENARIO 1: fixed and permanent boundaries

Deposited EEZ maritime boundaries are fixed and permanent regardless of changes in the baselines due to climate change effects. Only provisional treaty or high seas boundaries may change when their baselines change due to the effects of climate change. Red arrows in the diagram of figure 4.1 depict the potential movement of provisional EEZ boundaries between a fictional jurisdiction A with an at-risk baseline feature (left), a jurisdiction B with an elevated baseline feature (right), and the high seas (bottom).

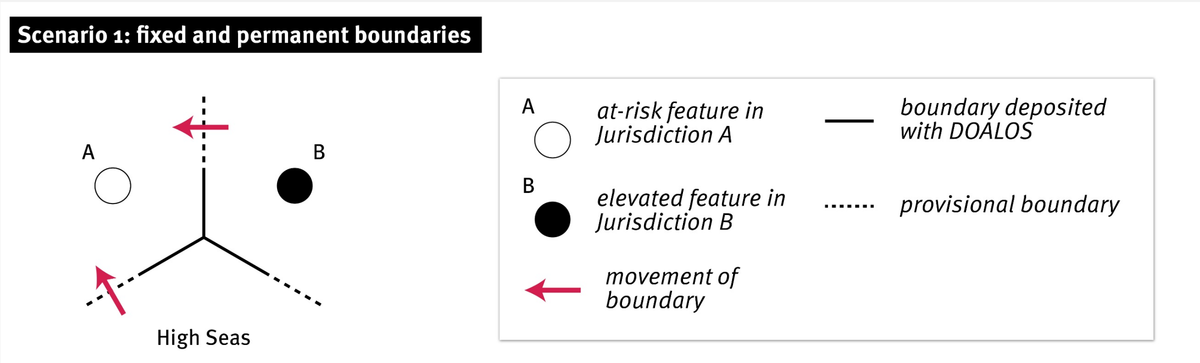


Figure 4.1 *Diagram showing climate change implications for EEZ boundaries in scenario 1.*

As shown in figure 4.1 above, only two types of EEZ maritime boundaries could be affected in scenario 1. The first type are *provisional treaty boundaries* between jurisdictions where one has an at-risk baseline feature (A in Fig. 4.1) and the adjacent jurisdiction has an elevated feature (B in Fig. 4.1). In this situation, a new boundary was calculated where the total EEZ area of A decreases, whilst it increases for B which extends its EEZ area into the previously territory held by A. The second type are *provisional high seas boundaries*. For those boundaries, if measured from an at-risk baseline feature, then the high seas boundary retracts towards the remaining elevated features of the jurisdiction.

4.1.1. Credibility and legitimacy of scenario 1

Scenario 1 is in line with the official view of jurisdictions and states from the study region on the issue. Their stance was most recently voiced during the 50th Pacific Island Forum meeting in Funafuti, Tuvalu in August 2019. The annual meeting gathered head of states from all Pacific countries, including Australia and New Zealand, and part of an official communiqué released after the meeting addressed the issue of climate change and boundaries directly. Article 26 of the communiqué reads that,

> Leaders committed to a collective effort, including to develop international law, with the aim of ensuring that once a Forum Member's maritime zones are delineated in accordance with the 1982 UN Convention on the Law of the Sea, that the Members maritime zones could not be challenged or reduced as a result of sea-level rise and climate change. (Pacific Islands Forum (PIF) Secretariat, 2019).

Semi-structured interviews conducted in Sydney provided me with more insight on the reasoning supporting this perspective that maritime zones, including EEZs, should not be reduced because of climate change.

Besides the obvious economic and political benefits of fixed maritime boundaries for jurisdictions in the study region, interviewees suggested four specific arguments to support the notion of fixed and permanent maritime boundaries. The main argument echoed across interviews is that because UNCLOS does not explicitly addresses climate change, the effects of climate change on maritime boundaries depends on the interpretation of UNCLOS. Additionally, interpretation is dependent on context, and in the context of the study region, fixed maritime boundaries are more suited than ambulatory ones. Second, it is an issue of stability and sustainability, from a legal but also a spatial planning perspective. It is not sustainable to change a maritime boundary each time a specific baseline feature is submerged due to climate change. Third, many boundaries in the study region are deposited as coordinates to DOALOS rather than as distances from baselines. This process disconnects EEZ boundaries from the baselines and increases their resilience to changes in baseline locations due to climate change effects. Fourth, informants also mentioned ongoing UN proceedings that may result in the development of international law that supports fixed and permanent maritime boundaries once deposited. Each of the arguments are outlined in greater detail below.

Argument 1: climate change is not addressed in UNCLOS; therefore, climate change effects on maritime boundaries is open for interpretation.

All interviewees shared the view that UNCLOS does not explicitly address climate change in its text. This view is shared amongst international lawyers outside of the region as well.

Climate change is not mentioned once in the UNCLOS document. The 4th informant said, "Well, I am not aware of any clause in UNCLOS that touches on this issue. So, it's a novel issue that has arisen in the light of developments after UNCLOS and it's a new challenge." His remarks were echoed by others. The 5th informant explained, "It [UNCLOS] doesn't really say. Because it was written so long ago that it [climate change] wasn't an issue that needed to be taken into consideration during the drafting of this Convention." Similarly, the 7th informant explained, "at the time when UNCLOS was negotiated, we did not predict or foresee that climate change or sea level rise would have such huge impact on our nations. So, if you go through UNCLOS article by article, I believe it is really hard to find a direct link between UNCLOS itself and climate change".

The gap left in UNCLOS on the climate change issue requires international lawyers to grapple with how to interpret UNCLOS and apply it to situations where climate change is affecting the shape and extent of baseline features used to determine maritime boundaries. For example, the 6th informant reasoned that: "nowhere in UNCLOS does it say that your baselines will, or your territory will recede because of sea level rise. And so, it is an open book, but we need some direction. So, for us in the region, we believe that our boundaries are permanent." In his interview, the 4th informant pointed to the importance of interpretation and context when assessing UNCLOS: "So, the thing about the law is, nothing is really black and white. Although things are stated in black and white, it just depends upon interpretation and interpretation depends upon context. You have to place legal clauses in the context in which they are meant." For the context of Pacific where many baselines features are vulnerable to climate change, three more arguments outlined below are proposes to support the view of fixed maritime boundaries.

Argument 2: stability and sustainability of maritime boundaries is important.

A recurring argument made by informants was that because the settling of boundaries requires significant diplomatic, legal and technical investment of time and resources, especially when these boundaries are adjacent and shared with another jurisdiction, it is unrealistic to go through that process each time a feature is submerged due to climate change. According to the 5th informant, "the idea of a fixed boundary makes sense for the Pacific. From our point, because, our boundaries would otherwise be constantly moving, and for a legal document that is just not sustainable." Besides the legal problem this entails, it was also noted to be an issue for marine spatial planning. The first informant captured this issue well in his interview. He explained: “If you go, readily changing the baseline and then changing your outer limits, it is counterproductive to development and utilization of natural resources of maritime space, because you won’t get the investment, […] you won’t get companies making a capital outlay if they get no certainty of tenure.” Therefore, without certainty of stability in maritime boundaries, companies that have to plan long-term investment in offshore marine infrastructure, such as deep sea mining for example, would be reluctant to do so without the certainty that maritime boundaries will not change in the future. This argument could be extendable to other long-term planning activities such as the management of fisheries or the establishment and management of marine protected areas.

Argument 3: maritime boundaries deposited as coordinates are dissociated from baselines.

Another argument made by informants was that maritime boundaries in the Pacific are increasingly filed with DOALOS as coordinates rather than distances from baselines, effectively dissociating them from the baselines and features from which they are drawn. As explained by the first informant, “if a country makes a proclamation, and put that in the public domain through the appropriate measures of lodging UNCLOS through DOALOS. And, giving due notice, marking it up on charts, publishing a list of coordinates, then, in effect, you are dissociating that outer limit with basepoints and you create a legal article of statement of limit that can stand for a long period of time.” A 2016 article by Frost et al. titled “Redrawing the map of the Pacific*”* also describes this argument. The authors write, “Declaration of the outer limits of maritime zones using geographic coordinates, rather than distance from the baseline has the potential to establish a body of regional state practice which may have a more wide-ranging impact on the law of the sea. This is because this practice ‘fixes’ the outer limits rather than leaving them as ‘ambulatory’” (Frost *et al.*, 2016: 306). More recently, at the 2019 high-level COP25 side event titled ‘The impact of climate change on maritime boundaries in the Pacific’ in Madrid, Dr. Suzanne Alika, a panellist at the event and legal adviser at the Australian Department of Foreign Affairs and Trade, made a similar argument. She said, “So, maritime boundaries are defined by coordinates, which of course provide more certainty in the face of climate change and sea level rise. Because in fact, you’re not looking at the features and where they are, but you are looking at the line which is being defined in a certain way in the text of the treaty.” (Pacific Community (SPC), 2019).

Argument 4: The Pacific region is shaping the future of international law on the climate change and maritime boundaries issue.

The last piece of knowledge that gave legitimacy and credibility to a scenario of fixed and permanent maritime boundaries is the ongoing lobbying effort by Pacific states to shape the development of international law. As noted by the 2nd informant, "I think that the maritime boundaries work is happening in the context of an emerging discussion about the Blue Pacific Continent and a deepening of regional solidarity generally. I think the threats posed by climate change, of sea level rise, is a further driver of that solidarity and a regional sort of collaboration around these issues." A manifestation of this solidarity and collaboration is the work done by the region to bring the issue of sea level rise and maritime boundaries on the agenda of international organizations. The 7th informant explained that in 2017, the Pacific Small Island Developing States (PSIDS) made a statement at the United Nations General Assembly (UNGA) calling for the United Nations International Law Commission (ILC) to study the issue of sea level rise and international law. The ILC itself was established by the United Nations General Assembly in 1947 to "initiate studies and make recommendations for the purpose of encouraging the progressive development of international law and its codification." (Office of Legal Affairs, 2020).

A year later, after the ILC added the issue to its long-term program of work, the Pacific Island Forum (PIF) asked at the United Nations that the ILC activates the topic from its long-term program of work, to its program of work. This activation took place in 2019 at the ILC's 71st session during which the Commission set up a study group to research this issue (Office of Legal Affairs, 2020). In 2019, The ILC also put out a call for countries to send in "examples from States of their practice that could be relevant (even if indirectly) to sea-level rise or other changes in circumstances of a similar nature." which will be used in their study of the topic (Office of Legal Affairs, 2020). During the 19th Maritime Boundaries Workshop in Sydney, some country legal representatives were preparing submissions of legal documents including relevant maritime legislations, declarations, and statements. I asked informants to give me more insight into this process. The 4th informant noted, "It is really the Pacific countries that have been asking the ILC to take this issue on board as a topic to study. […] So, we have to engage with them to bring across our position on this, and help them to decide on what, how international law should evolve in the future."

In January 2020, the ILC published the submissions it received on the issue. Besides the coordinated input from PIF to submit relevant information for all Pacific states, the ILC also received submissions from a handful of other states including the Maldives, the Netherlands, Romania and the United Kingdom. The opening statement of the PIF submission follows the arguments 1 and 2 described above (Pacific Island Forum (PIF), 2019). It is written that, “PIF Members consider that there are good grounds to work towards ensuring that, once maritime zones are delineated in accordance with UNCLOS, those maritime zones should not be challenged or reduced as a result of sea-level rise and climate change.” (Pacific Island Forum (PIF), 2019). It is unknown what final outcome will come from the ILC’s research and study on this issue, and what output will be supplied back to the UNGA. However, it illustrates the political will and practices by states in the Pacific region to shape international law. It also adds legitimacy and credibility to scenario 1 for a future where maritime boundaries are fixed and permanent regardless of the effects of climate change on baseline features.

A short note here, that at the time of concluding this research the ILC published its first report. Some of the most significant conclusions from the ILC is that the current UNCLOS text is clear that baselines and maritime zones such as the EEZ are ambulatory, and not permanent (International Law Commission, 2020: 27). However, it concludes that “bringing into question effected maritime delimitations would create legal uncertainty, insecurity, and would lead to disputes prompted by the frequent renegotiation of the maritime boundaries”; and, that “In order to preserve legal stability, security, certainty and predictability, it is necessary to preserve existing maritime delimitations” (International Law Commission, 2020: 54). This is important development which suggests that the ILC might recommend the UNGA to develop international law in line with fixed and permanent maritime boundaries. The ILC remarks that its study group has not yet considered the impacts of sea level rise on maritime boundaries that have not yet been deposited (International Law Commission, 2020: 54).

4.1.2. GIS analysis results for scenario 1

Scenario 1 assumes that at-risk baseline features only affect EEZ boundaries if these are provisional. At the time of writing, there were eight unique high seas boundaries, and 16 treaty boundaries, which were provisional and not yet deposited with DOALOS in the study region. The GIS analysis showed that in scenario 1, two of these high seas’ boundaries and seven of provisional treaty boundaries could potentially be affected by climate change effects. An exact list of each boundary affected is shown in Table 4.1. The location of these boundaries and the new EEZ areas calculated for these jurisdictions in scenario 1 is provided in the map on figure 4.2. Lastly, Table 4.2 shows the change in square kilometres for each of the affected jurisdictions in this scenario.

Table 4.1 *The 9 boundaries affected by climate change effects under scenario 1.*

Jurisdiction 1	***Jurisdiction 2 (or high seas)***	***map key (ref. Fig. 4.2)***
Palau	*High seas*	1
	Philippines	2
	Indonesia	3
Solomon Islands	*High seas*	4
New Caledonia	Vanuatu	5
Fiji	Vanuatu	6
	Tonga	7
Tokelau	Samoa	8
American Samoa	Samoa	9

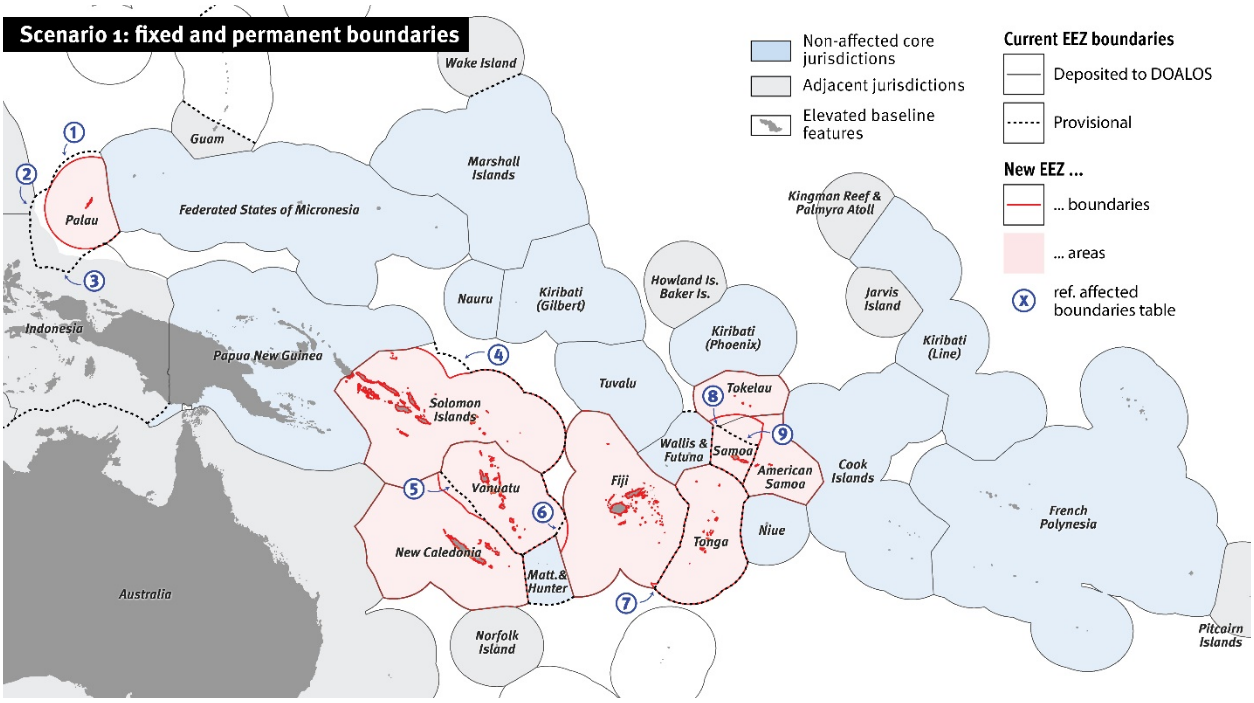


Figure 4.2 *Map showing the location of the 2 high seas EEZ boundaries (1 and 4) and the 7 EEZ treaty boundaries (2, 3, 5, 6, 7, 8 and 9) affected and changed under scenario 1. New EEZ areas and boundaries are shown in red. Red lines show both the outer EEZ boundary and the new inner EEZ boundary around the remaining elevated island features.*

Table 4.2 *Change in EEZ areas for jurisdictions whose provisional boundaries were affected under scenario 1. Jurisdictions are ordered based on latitude from west to east.*

Jurisdiction	***Current EEZ area (000 km²)***	***Sc. 1 new EEZ area (000 km²)***	***Change (000 km²)***	***Change from original area***

Palau	615	420	-195	-31.66%
Solomon Islands	1 605	1 555	-50	-3.12%
New Caledonia	1 176	1 142	-35	-2.96%
Vanuatu	623	679	+56	+8.95%
Fiji	1 289	1 264	-25	-1.94%
Tonga	666	667	+1	+0.16%
Tokelau	321	303	-18	-5.52%
Samoa	130	210	+79	+60.80%
American Samoa	406	344	-62	-15.19%
TOTAL	**26 251**	**26 004**	**-248**	**-0.94%**

Nine jurisdictions in the study region would see their EEZ areas affected in scenario 1. Six jurisdictions would have a decrease in EEZ area, these include Palau, Solomon Islands, New Caledonia, Fiji, Tokelau, and American Samoa. Three jurisdictions would increase their EEZ area, these include Vanuatu, Tonga and Samoa (Fig. 4.2 and Table 4.2). Palau had the largest decrease in EEZ area due to its provisional boundaries with Indonesia, the Philippines, and the high seas (north), all of which are dependent on at-risk baseline features. Samoa on the other hand, would extend its EEZ area into Tokelau and American Samoa and benefit from the provisional status of its boundaries with those jurisdictions. Whilst Samoa is only constituted of elevated baseline features, both Tokelau and American Samoa have at-risk baseline features on which their provisional boundary with Samoa depends. At the scale of the study region (core jurisdictions only), a decrease in EEZ area of 247 571 km^2 was observed in scenario 1. This represents a decrease of 0.94% from the original EEZ area calculated for the study region.

4.2. Scenario 2: ambulatory boundaries under some conditions

SCENARIO 2: ambulatory boundaries under some conditions

Deposited EEZ maritime boundaries are fixed and permanent regardless of changes in the baselines due to climate change effects unless *all* baseline features in a jurisdiction are at-risk. As for scenario 1, provisional treaty and high seas boundaries may change when these are associated with at-risk baseline features. Red and yellow arrows in the diagram of figure 4.3 depict the potential movement of provisional EEZ boundaries in scenario 2.

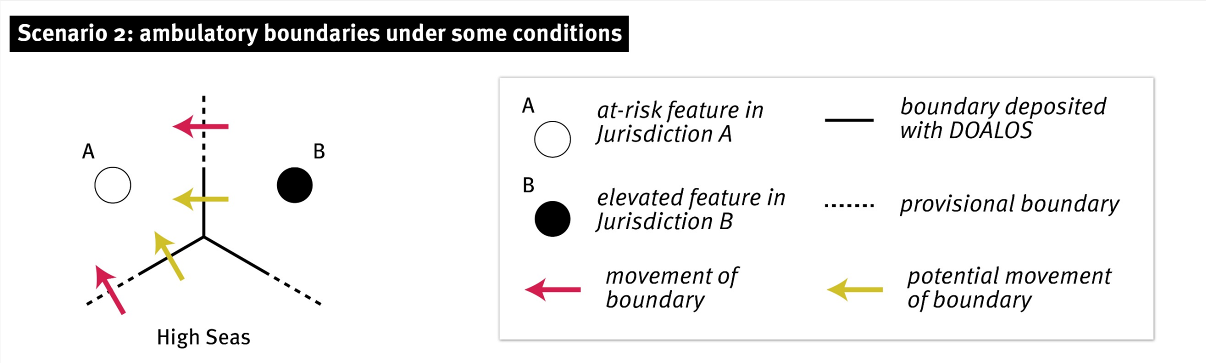


Figure 4.3 *Diagram showing climate change implications for EEZ boundaries in scenario 2.*

Scenario 2 includes all changes to EEZ boundaries and areas already observed in scenario 1. Additionally, however, jurisdictions that are only composed of at-risk baseline features would lose all their EEZ area in this scenario. The Marshall Islands, Tuvalu and Tokelau are the three jurisdictions of the study region that are solely composed of at-risk features. These would lose all their EEZ area in scenario 2. The territorial void left by these jurisdictions would be filled by high seas areas in some locations and the extension of adjacent jurisdictions' EEZ areas in others.

4.2.1. Credibility and legitimacy of scenario 2

Scenario 2 stems from the same arguments that were described under scenario 1. First, UNCLOS is not explicit about the effects of climate change on maritime boundaries. Second, it is not sustainable to revise continuously the location of maritime boundaries and their treaties. Third, maritime boundaries are deposited as coordinates and are effectively dissociated from baselines. And fourth, the Pacific is supporting the development of international law that supports a notion of fixed maritime boundaries. However, an important assumption that sets scenario 2 apart from scenario 1 is that jurisdictions that have lost all their baseline features, and have not any habitable land territory available to their population, could lose their statehood status and de facto forfeit all their claims to any maritime zones, including EEZs. In such circumstances, states with elevated features adjacent to a jurisdiction that has forfeited all its maritime zones can extend their own EEZ area provided it be within the 200 nautical miles limit. For example, Tuvalu is only made up of at-risk features that are severely threatened by the effects of climate change. If Tuvalu's baseline features are all submerged, it would under scenario 2 forfeits its statehood status and its maritime jurisdictions, and the adjacent states of Fiji and Wallis and Futuna could then extend their EEZ claims northwards into Tuvalu's previously held EEZ area.

The underlying argument for this scenario is that states must, to exist, have territory in the form of land area where its population can live. This legal argument was described to me during the interviews with informants. As the 6th informants puts it, "… and you look at the Montevideo Convention on the right of a state to exist it has to have landmass, so there are all these things that we are considering as Pacific island states, that we are looking into." The Montevideo Convention on the Rights and Duties of States was enacted in 1933 and sets forth in its first article that a state should possess the following qualifications: a permanent population, a defined territory, government, and the capacity to enter into relations with the other states. Although it does not specify the nature and form of territory, and whether it ought to be land, experts including the 6th informant suggest territory can be understood as landmass. Because of this notion, it can be argued that it is easier for states with some remaining elevated landmass to maintain their EEZ areas than states without any elevated land. This scenario then addresses this challenge and assumes that a state foregoes its entire EEZ area if all its baseline features are at risk.

4.2.2. GIS analysis results for scenario 2

Three jurisdictions in the study region are only composed of at-risk features that are highly vulnerable to climate change effects. These are Tuvalu, the Marshall Islands and Tokelau. Several jurisdictions adjacent to the study region are also at stake, these include Wake Island, Howland and Baker Islands, Kingman Reef and Palmyra Atoll, and Jarvis Island. Kiribati is a unique case as it is composed of three independent EEZ areas: Gilbert Islands group (east) Phoenix Islands group (centre) and the Line Islands group (west). The latter two are only constituted of at-risk baseline features that are highly vulnerable to climate change. However, Banaba Island in the Gilbert Islands group has a maximum elevation of 81 meters and is the only resilient land feature for Kiribati. In scenario 2, Kiribati then does not lose statehood status as it still has an elevated land feature resilient to climate change effects. Therefore, despite the dissociated nature of Kiribati's three EEZ areas, it kept all of them under this scenario. This issue underscores the complex interplay between law and geography in the study region. Indeed, the jurisdictions governed by the United States, such as Wake Island or Jarvis Island, also form unique EEZ areas where all maritime boundaries of those jurisdictions depend on at-risk baseline features. As for Kiribati, one may argue then that the EEZ areas of these jurisdictions are maintained in scenario 2, as they are governed by the United States whose statehood status is not threatened, because of its much larger landmass across the Pacific Ocean.

The GIS analysis shows that in addition to the nine boundaries affected under scenario 1, another 17 boundaries are affected under scenario 2 (Table 4.3). The map in figure 4.4 captures all changes in scenario 2. As expected, all new changes concentrate on boundaries that are adjacent to the Marshall Islands, Tuvalu or Tokelau. A number of boundaries, for example the boundary between the Marshall Islands and the Federated States of Micronesia (2 on Fig. 4.4) change from being a treaty boundary to becoming a new high seas boundary.

Table 4.3 *The 17 EEZ maritime boundaries affected by climate change under scenario 2. The number in parenthesis next to high seas boundaries indicate the number of unique high seas boundaries affected. Boundaries already changed in scenario 1 also take effect in scenario 2 but are not included in this table.*

Jurisdiction 1	***Jurisdiction 2 (or high seas)***	***map key (ref. Fig. 4.4)***
Marshall Islands	*High seas (3)*	1
	Federated States of Micronesia	2
	Nauru	3
	Kiribati (Gilbert)	4
	Wake Island	5
Nauru	Kiribati (Gilbert)	6
Tuvalu	*High seas (2)*	7
	Fiji	8
	Wallis and Futuna	9
Fiji	Wallis and Futuna	10

Tokelau	Wallis and Futuna	11
	High seas (2)	12
Wallis and Futuna	Samoa	13

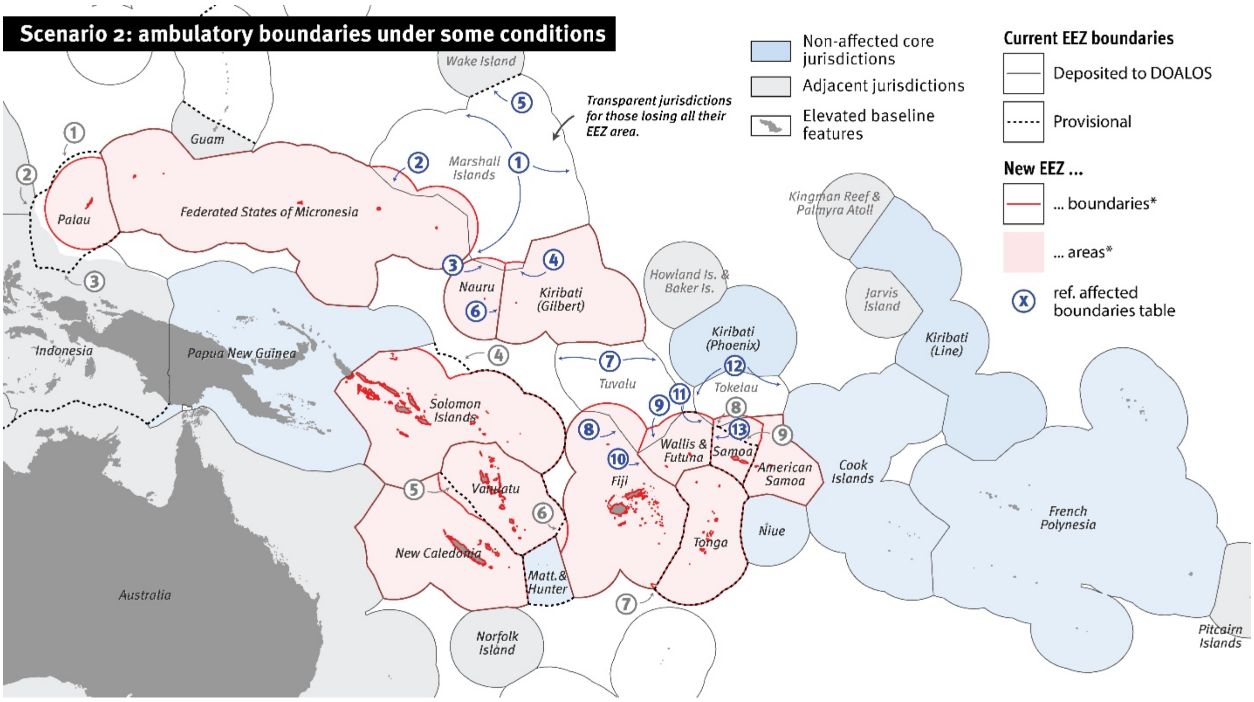


Figure 4.4 *Map showing the location of high seas EEZ boundaries (1, 7 and 12) and EEZ treaty boundaries (2, 3, 4, 5, 6, 8, 9, 10, 11 and 13) affected under scenario 2. Transparent jurisdictions of the study region are those that lose their entire EEZ area. These are the Marshall Islands, Tuvalu, and Tokelau. Grey numbers indicate boundaries that were already changed under scenario 1. New EEZ areas and boundaries are shown in red. Red lines show both the outer EEZ boundary and the new inner EEZ boundary around the remaining elevated island features.*

Table 4.4 *Change in EEZ areas for jurisdictions whose boundaries were affected under scenario 2. Changes for jurisdictions that were already recorded in scenario 1, and were not changed under scenario 2, are in grey. Jurisdictions are ordered by latitude, from west to east.*

Jurisdiction	***Current EEZ area (000 km²)***	***Sc. 2 new EEZ area (000 km²)***	***Change (000 km²)***	***Change from original area***
Palau	615	420	-195	-31.66%
Federated States of Micronesia	3 011	3 142	+132	+4.38%
Solomon Islands	1 605	1 555	-50	-3.12%
New Caledonia	1 176	1 141	-35	-2.96%

Marshall Islands	2 001	0	-2 001	-100%
Vanuatu	623	679	+56	+8.95%
Nauru	309	326	+16	+5.32%
Kiribati	3 441	3 452	+11	+0.33%
Tuvalu	753	0	-753	-100%
Fiji	1 289	1 359	+70	+5.43%
Wallis and Futuna	263	309	+46	+17.45%
Tonga	666	667	+1	+0.16%
Tokelau	321	0	-321	-100%
Samoa	130	209	78	+59.88%
American Samoa	406	344	-62	-15.19%
TOTAL (relative to all core jurisdictions of the study region)	**26 251**	**23 245**	**-3 006**	**-11.45%**

Under scenario 2, all new changes besides those already observed under scenario 1 were attributable to the Marshall Islands, Tuvalu, and Tokelau forgoing all their EEZ area. Adjacent jurisdictions including the Federated States of Micronesia, Nauru, Kiribati, Fiji, Wallis and Futuna, and Samoa all increased and extended their EEZ areas in the territorial void left by these three jurisdictions. However, the majority of the lost EEZ areas were not claimed by adjacent jurisdictions but rather turned into high seas area. Hence, a decrease in total EEZ area of more than 3 million km^2 occurred in the study region for scenario 2 (Table 4.4). This represents a decrease of 11.45% from the original area and is a significant increase from the 0.94% decrease observed in scenario 1.

4.3. Scenario 3: ambulatory boundaries

SCENARIO 3: ambulatory boundaries

Both fixed and provisional EEZ maritime boundaries change if their associated baselines are at-risk. The provisional or deposited status of maritime boundaries does not affect these changes. Red arrows in the diagram of figure 4.5 depict the potential movement of provisional and deposited EEZ boundaries in scenario 3.

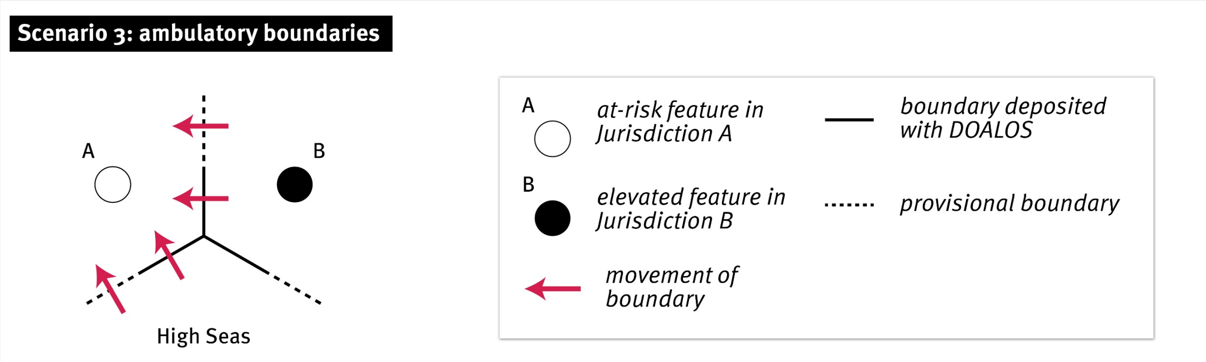


Figure 4.5 *Diagram showing climate change implications for EEZ boundaries in scenario 3.*

As figure 4.5 depicts, scenario 3 has the greatest implication for the study region in this analysis. All EEZ maritime boundaries, regardless of their status, change when a jurisdiction's baseline features are at-risk. Many jurisdictions whose boundaries were not affected under scenario 1 and 2 are affected under this scenario.

4.3.1. Credibility and legitimacy of scenario 3

Despite the large changes that occurred to maritime boundaries in the study region under this third scenario, there are also arguments that support the credibility and legitimacy of the assumptions of this scenario. There are two main arguments that support it. First, the status quo and dominant interpretation of UNCLOS in scholarly research is that changes in baselines automatically result in changes to their associated EEZ areas. The second argument is of geo-political nature. An increase in the high seas area in the Pacific would open resources, such as fisheries, to non-Pacific actors. This increase in access to resources may explain why other non-Pacific countries have not echoed or publicly supported their view that maritime boundaries should be fixed once deposited and that they should not be challenged by the effects of climate change. The benefits of an increased high seas area in the region could lead non-Pacific countries to support an ambulatory interpretation of UNCLOS. The two arguments are evaluated in detail below.

Argument 1: ambulatory boundaries as the status quo and dominant discourse

The initial desktop-based literature research on climate change and UNCLOS presented in the introductory chapter of this thesis showed that academic literature generally emphasizes the risk for Pacific island countries to loose part or all of their maritime zones due to sea level rise (Symmons, 1998; Schofield, 2009; Powers, 2012; Trahanas, 2013; Vidas, 2014; Vidas, Freestone and McAdam, 2015). The arguments presented in the literature follow the notion of ambulatory baselines, where a baseline must be representative of the current physical coastline of a country. Indeed, as noted in the ILA report: "[a] baseline is ambulatory, moving seaward to reflect changes to the coast caused by accretion […] and also landward to reflect changes caused by erosion and sea level rise." (International Law Association, 2012). This perspective could be described as the dominant view and it was also acknowledged as such by interviewees from the study region. As the 4th informant framed it: "The *default thinking*, if you will, is that when there is a change in baselines, when basepoints disappear, baseline change, then they should be changes as well. And so, that kind of argument is not consistent with the interest of Pacific Islands States. Yes, because they are likely to lose basepoints, baselines, or even disappear." (emphasis added). The first and recent ILC report on this issue also supports view, and remarks that "if, owing to the effects of sea-level rise on the baselines, a new baseline is drawn in a position more landward, the outer limits of the exclusive economic zone also move landward." (International Law Commission, 2020: 27)

During my interview with the third informant, she explained that although the United States has not yet taken an official position on the issue, its current practice is to update its baseline, charts and maritime zones, when and where those have changed following natural or human induced processes. As stated on the U.S. Maritime Boundaries & Limits government website, erosion or accretion of the low water line that results in changes to charts are investigated by the Baseline Committee which reviews and approves all changes these may have on the U.S. baselines or maritime limits (National Oceanic and Atmospheric Administration (NOAA), 2019). Therefore, the current default practice for the United States can be said to be in line with the ambulatory interpretation of UNCLOS: the location of maritime boundaries is reviewed to reflect changes to the coast and the baselines. This practice by the United States suggests that it is technically and legally possible to frequently change and update baselines and maritime boundaries. It adds credibility and legitimacy to scenario 3. Interestingly, the United States has several at-risk baseline features in the Pacific. It is unclear what its policy or view will be on the impacts on the location of its EEZ if these features will be submerged because of climate change in the future.

The notion of ambulatory baselines is also adopted by courts. A professor of international law who gave a presentation on UNCLOS and climate change at the Maritime Boundaries Workshop, explained that: “no international court or tribunal has expressively looked at the question of sea level rise and baselines. But, a number of cases have implicitly examined where baselines, or whether baselines might be affected by changing physical environment.” One such case according to him was the Guyana and Suriname maritime boundary conflict and legal case from 2007 (Permanent Court of Arbitration, 2007). An outcome highlighted in the award of the arbitration was that the tribunal used the actual physical low water mark to determine where the boundary should be, rather than what either parties had put in their charts (Permanent Court of Arbitration, 2007). In paragraph 373 of the award, the tribunal noted that “The geographical configuration of the maritime areas that the Court is called upon to delimit is a given. It is not an element open to modification by the Court but a fact on the basis of which the Court must effect the delimitation.” (Permanent Court of Arbitration, 2007). In addition, in the following paragraph it notes, “In short, international courts and tribunals dealing with maritime delimitation should be mindful of not remaking or wholly refashioning nature, but should in a sense respect nature.” (Permanent Court of Arbitration, 2007). This last paragraph emphasizes that law must reflect nature, which in other words is the current physical geography of a coastline. As the presenter explained: “it suggests that charts are evidence, certainly evidence as to where the baselines would be, but ultimately tribunals are going to look at where it actually, physically is. And that supports the view that article 5 is ambulatory.”

Argument 2: A geopolitical feud over ambulatory boundaries

One may think that fixed baselines and maritime zones is in everyone’s advantage because of the stability of territory it entails, but interviewees questioned at the 19th Maritime Boundaries Workshop explained that certain actors stand to gain from an increase in high seas areas following the shrinking of EEZ areas. According to the 5th informant, “I think the most beneficial would be to the private sector. So, they would be able to be outside the jurisdiction of any island nation in those little gaps and just wait for the fish, or whatever natural resources that they want to exploit." Indeed, fishing vessels inside Pacific EEZs are tightly monitored by the Pacific Islands Forum Fisheries Agency (FFA) and national governments. Each vessel must pay a daily fee to have the rights to fish inside the EEZ of a member state. The high seas are not regulated in the same way, and they face much more pressure from international fishing activity. Such activity is well documented by the Global Fishing Watch website (https://globalfishingwatch.org/, as shown in figure 4.6. On the map, bright areas depict important fishing activity in the high seas area between the Marshall Islands and Tuvalu on the west, and Howland and Baker Islands and Kiribati on the east. The fishing activity is much stronger in the high seas area than inside the 4 jurisdictions' EEZs. It suggests that distant-water fishing nations that are actively fishing in the Pacific could gain from an increased high seas area.

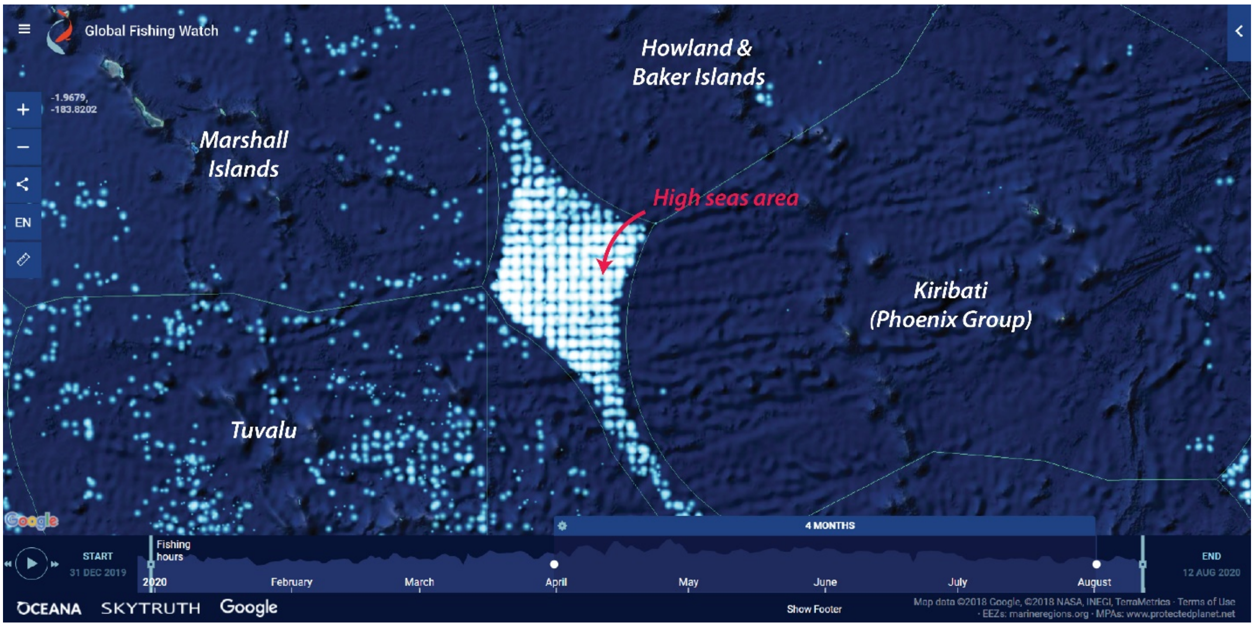


Figure 4.6 *Screen capture of the Global Fishing Watch showing fishing activity in the high seas area east of Tuvalu from April to August 2020. Brighter areas show more fishing activity based on automatic identification system (AIS) data monitoring. Webpage accessed on 08.16.2020 at https://globalfishingwatch.org/.*

Because foreign fishing fleets must pay to have the right to fish inside the EEZs of Pacific countries, the loss of EEZ territory in the Pacific would decrease the costs required for fishing in the region. The 2nd informant explained, "The obvious states with interest in the high seas in the Pacific Ocean are states with fishing vessels. The tuna industry would be the most obvious one, where the terms of access might be different between high seas and the Exclusive Economic Zones." This argument is also echoed in a recent book chapter by

Hviding, where the author concludes that EEZs in the Pacific have “such capacity to irritate distant-water capitalist fishing powers.” (Hviding, 2019).

The fisheries example is part of a broader discrepancy in the advantages that UNCLOS provides to coastal state versus landlocked countries, or countries with very small coastlines. Internationally, the UNCLOS regime has secured and recognized the rights of access to important marine resources for coastal states, especially island states, or states with long coastlines in the 200 nautical miles that extend from their baselines. However, this regime and approach to the management of ocean space does not provide any benefits to landlocked states, or countries with very small coastlines. On the contrary, it reduces the high seas area that they can access and explore for other resources. The 2nd informant explained that, “the obvious implication there is states like landlocked states or states with you know with very small Exclusive Economic Zones, which don’t benefit from other states having large Exclusive Economic Zones, there is obvious tension between the different interest there of coastal states and states which don’t have a coast.” During the drafting of the convention, several states objected to the concept of EEZ areas. It is possible that these same states would support an ambulatory notion of baselines, as it undermines and can result in the shrinking of EEZ areas globally. The 7th informant explained that a historical perspective could help predict which states may align themselves against the idea of permanent boundaries. He said, “The question is quite simple. So, we can just go back and see who supported 200 EEZ and who don’t support the 200 EEZ at the beginning of the UNCLOS negotiations. […] USA were against the EEZ […] Russia as well. That is the two biggest that were against the decisions.” The study region may therefore face challenges as it tries to clarify or modify international law to secure fixed and permanent maritime boundaries. The clear benefits of an increased high seas area put the interests of the Pacific states at odds with other international stakeholders. This tension is itself an argument that supports a third scenario where baselines are ambulatory, and maritime boundaries move as a response to the changes in location of baselines.

4.3.2. GIS analysis results for scenario 3

Scenario 3 had the largest impacts on the EEZ boundaries and areas in the study region. In addition to the changes observed under scenario 1 and 2, 49 new boundaries were affected under this scenario, which includes 20 unique high seas boundaries and 29 treaty boundaries. Table 4.5. below lists all the new EEZ boundaries that were affected under scenario 3. The location of these boundaries is shown on figure 4.7. This figure also depicts the newly calculated EEZ areas and boundaries in red for the affected jurisdictions. Finally, Table 4.6 captures the change in EEZ area for each affected jurisdictions under scenario 3. It includes new changes and the changes already recorded under scenario 1 and 2. It is noteworthy that under scenario 3, all jurisdictions in the study region had a change in their EEZ area. Of the 20 jurisdictions, 13 observed a decrease in EEZ area whilst seven had an increase in their total EEZ area.

Table 4.5 *The 14 EEZ maritime boundaries affected by climate change under scenario 3. Number in parenthesis indicate the number of unique high seas boundaries affected for that jurisdiction. To avoid redundancy, boundaries already changed in scenario 1 and 2 are not included in this table, even if they are also affected under scenario 3.*

Jurisdiction 1	***Jurisdiction 2 (or high seas)***	***map key (ref. Fig. 4.7)***
Federated States of Micronesia	*High seas (4)*	1
	Palau	2
	Guam	3
Papua New Guinea	*High seas (2)*	4
	Indonesia	5
	Federated States of Micronesia	6
	Australia	7
	Solomon Islands	8
Solomon Islands	Australia	9
	Vanuatu	10
New Caledonia	*High seas*	11
	Australia	12
	Solomon Islands	13
	Norfolk Island	14
Vanuatu	Matthew and Hunter Islands	15
Kiribati (Gilbert)	*High seas (2)*	16
	Tuvalu	17
Fiji	*High Seas*	18
	Matthew and Hunter Islands	19

Kiribati (Phoenix)	*High seas (2)*	20
	Howland Island and Baker Island	21
	Tokelau	22
American Samoa	Tokelau	23
	Niue	24
Cook Islands	*High seas (3)*	25
	Tokelau	26
	American Samoa	27
	Niue	28
	Kiribati (Line)	29
	French Polynesia	30
Kiribati (Line)	*High seas (3)*	31
	Kingman Reef and Palmyra Atoll	32
	Jarvis Island	33
	French Polynesia	34
French Polynesia	*High seas (4)*	35
	Pitcairn Islands	36

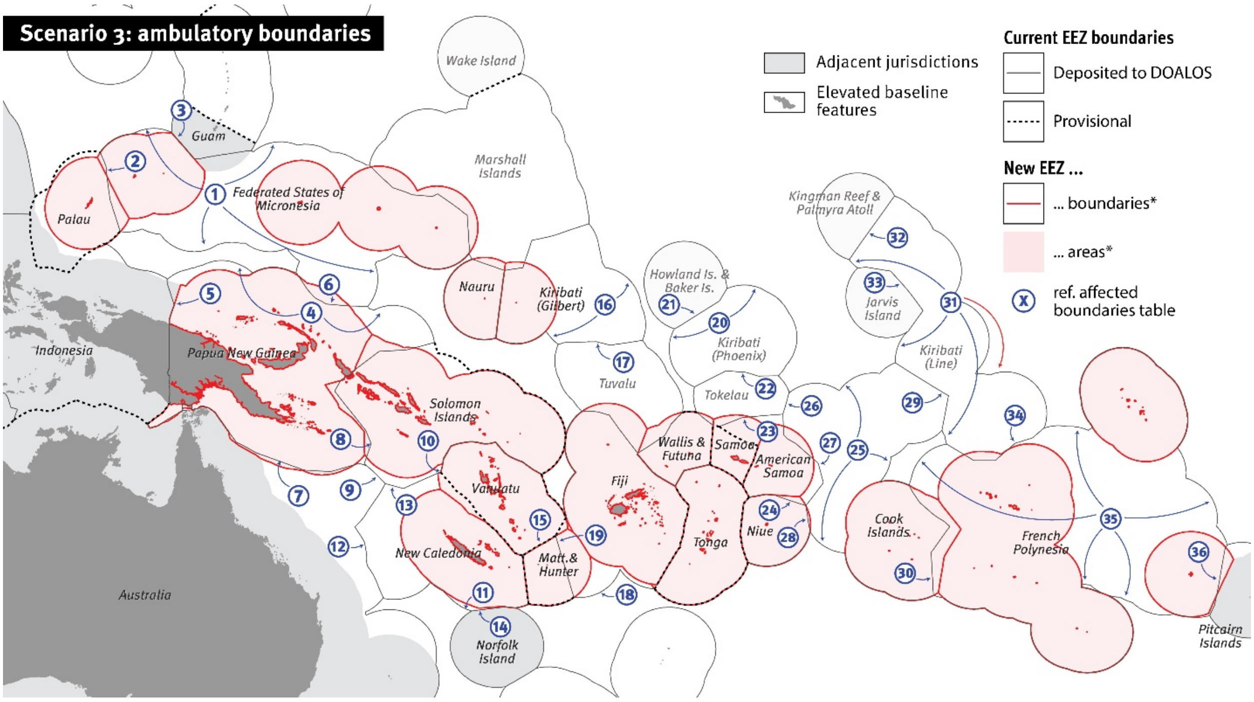


Figure 4.7 *Map showing the new location of high seas EEZ boundaries (1, 4, 11, 16, 20, 25, 31 and 35) and EEZ treaty boundaries (all others) affected under scenario 3. Changes to boundaries already affected under scenario 1 and 2 are included in the map, but not numbered. Lost EEZ areas in the study region are most transparent (e.g. Kiribati (Phoenix) and the northern part of Cook Islands). New EEZ areas and boundaries are shown in red. Red lines show both the outer EEZ boundary and the new inner EEZ boundary around the remaining elevated island features.*

Table 4.6 *Change in EEZ areas for jurisdictions whose boundaries were affected under scenario 3. Changes for jurisdictions that were already recorded in scenario 1 and 2, and have not changed under scenario 3, are in grey. Jurisdictions are ordered by latitude from west to east.*

Jurisdiction	***Current EEZ area (000 km²)***	***Sc. 3 new EEZ area (000 km²)***	***Change (000 km²)***	***Change from original area***
Palau	615	448	-166	-27.06%
Federated States of Micronesia	3 011	1 849	-1 162	-38.59%
Papua New Guinea	2 400	2 121	-279	-11.61%
Solomon Islands	1 605	1 584	-21	-1.30%
New Caledonia	1 176	732	-444	-37.75%
Marshall Islands	2 001	0	-2 001	-100%
Vanuatu	623	670	46	+7.44%

Nauru	309	326	16	+5.32%
Kiribati	3 441	322	-3 118	-90.63%
Matthew and Hunter Islands	188	295	107	+56.79%
Tuvalu	753	0	-753	-100%
Fiji	1 289	1 183	-106	-8.25%
Wallis and Futuna	263	309	46	+17.45%
Tonga	666	667	1	+0.16%
Tokelau	321	0	-321	-100%
Samoa	130	209	78	+59.95%
American Samoa	406	309	-97	-23.93%
Niue	318	331	13	+4.08%
Cook Islands	1 970	801	-1 168	-59.31%
French Polynesia	4 767	3 207	-1 560	-32.73%
TOTAL	**26 251**	**15 362**	**-10 889**	**-41.48%**

Of all scenarios in this study, the most significant changes were seen in scenario 3. Most notably is the loss of over 3 million km^2 of EEZ area for Kiribati alone, including the entire Line Group and Phoenix Group EEZ areas. The Cook Islands EEZ area was also reduced by more than half, from over 1.9 million km^2 to just over 0.8 million km^2. Both the Federated States of Micronesia and French Polynesia were strongly affected under scenario 3. Their remaining EEZ areas were split in smaller non-connected areas: two for Micronesia and three for French Polynesia. The disputed Matthew and Hunter Islands jurisdiction, which is claimed both by Vanuatu and France, increased its EEZ area significantly into Fiji's previously held territory. This is due to the unique at-risk Ceva-i-ra atoll that Fiji currently uses to determine its maritime boundary with the Matthew and Hunter Islands jurisdiction. Niue and Vanuatu also increased their EEZ areas by 4.08% and 7.44% respectively. Overall, the loss in EEZ area of the core study region in this scenario was significant as it shrinks from 26 million km^2 to 15 million km^2. This represents a decrease of 41.48% and it is a significant increase from the 0.94% and 11.45% potential loss observed under scenario 1 and 2, respectively.

4.4. Aggregated results, and impacts on connectivity and the high seas

At the scale of the study region, a broad division between jurisdictions with more northern latitudes versus the more southern ones was observed. In scenario 1, southern jurisdictions were most affected because of the comparably large number of provisional boundaries (Fig. 1.5). These are the Solomon Islands, Vanuatu, New Caledonia, Fiji, Tonga, Samoa, and American Samoa. Palau was the only northern jurisdictions affected in scenario 1, and it noted the greatest potential loss of -46% in the first scenario. All other EEZ boundaries for jurisdictions in the northern area of the study region are deposited to DOALOS, and where therefore not changed. The largest loss noted in the southern jurisdictions is 18% for American Samoa, followed by only 3% for the Solomon Islands and New Caledonia, respectively. In scenario 3 however, northern jurisdictions were more affected, as the status of boundaries was not considered, but only the location of at-risk baseline features. Northern jurisdictions such as the Federated States of Micronesia, Marshall Islands, and Kiribati are constituted of many more at-risk baseline features than southern jurisdictions such as Vanuatu, Fiji or Tonga, whose EEZ boundaries are mostly calculated from volcanic, elevated baseline features.

Regionally, a growing decrease in EEZ area was found as one moves from scenario 1, to 2, and 3. At the scale of each individual jurisdiction however, changes in EEZ area were not necessarily similar and depended on a combination of status of boundaries, and the overall location of at-risk and elevated baseline features in a jurisdiction and its immediate adjacent jurisdictions. In scenario 1 for example, Fiji would experience a loss in EEZ area of 1.94%. However, in scenario 2, it would experience an increase of 5.43%, and conversely in scenario 3, it would experience a loss again, of 8.25%. Other jurisdictions would only experience a net increase in EEZ area; these include Nauru, the disputed jurisdiction of Matthew and Hunter Islands, Wallis & Futuna, Tonga, Samoa, and Niue. An aggregated chart of the results of all scenarios for all jurisdictions in the study region is shown below (Fig. 4.8). An overview of the exact numerical values for each scenario and each jurisdiction are available in the appendices (cf. 8.3 Aggregated proportional change in EEZ area results).

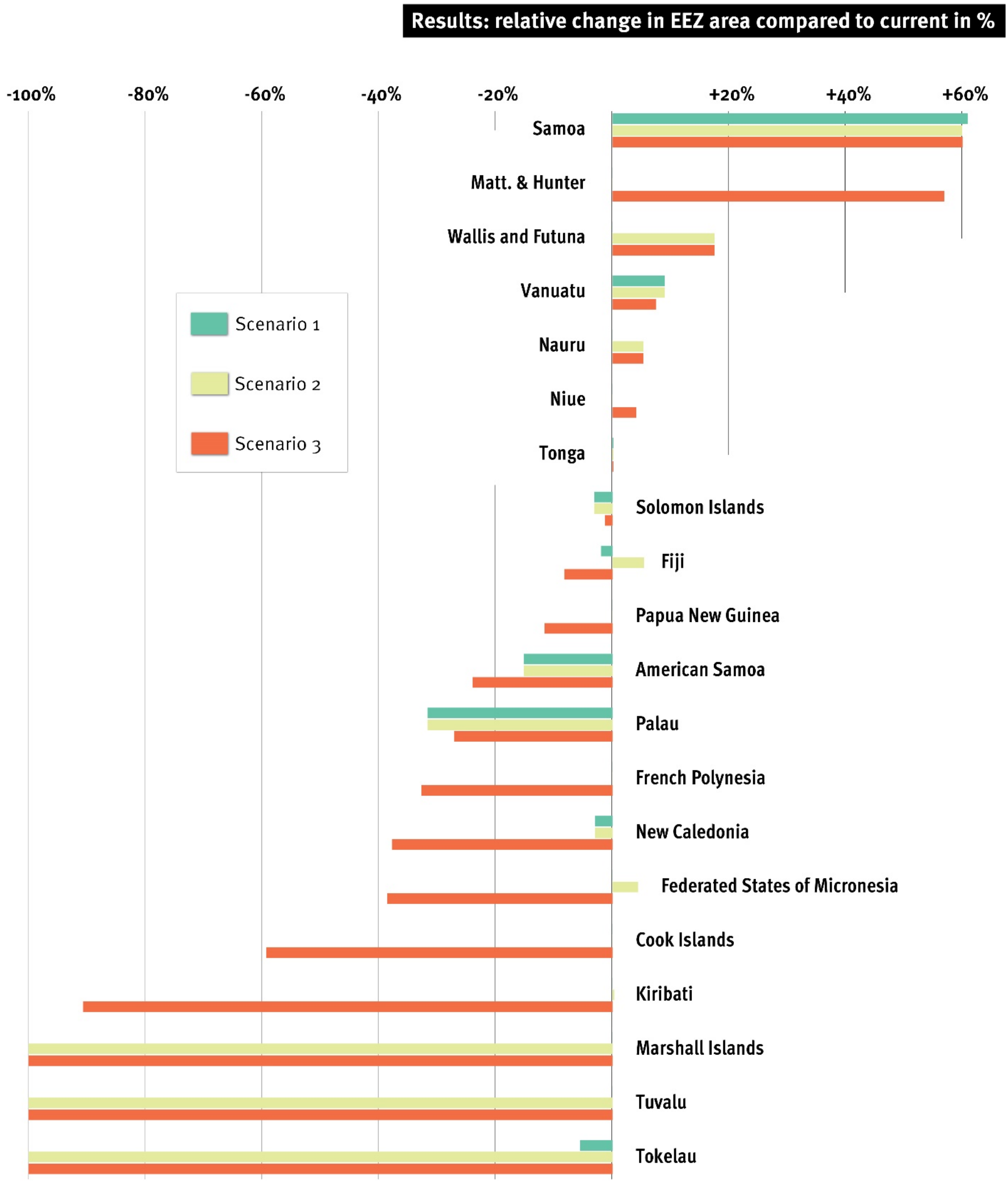


Figure 4.8 *Aggregated results in percentage change from original EEZ area for all scenarios in all 20 jurisdictions of the study region. Jurisdictions are ordered from largest proportional increase (top) to largest decrease (bottom) for scenario 3.*

Besides a decrease in EEZ area, a change in maritime boundaries connectivity between jurisdictions was also observed. As connectivity decreased in the study region, the connectivity of the high seas increased. Increase in high seas connectivity means that high seas pockets, which are high seas areas that are surrounded by maritime boundaries, were merged back with the larger global high seas area.

In scenario 1, of the 91 EEZ maritime boundaries in the study region, only 2 boundaries were revoked. These were the EEZ treaty boundary between Palau and the Philippines, and between Palau and Indonesia. This was due to the retraction of Palau's EEZ due to at-risk features. This retraction meant that Palau's EEZ was no longer bordering the EEZ area with the Philippines and Indonesia. This change resulted in an increase in high seas area around Palau. And the two maritime boundaries between Palau and the Philippines, and Palau and Indonesia, would be revoked in that scenario. To visualize changes in connectivity, it is useful to think of the study region as a network where nodes represents jurisdictions and edges represent the maritime boundaries between these jurisdictions. High seas pockets can also be described as nodes, with individual connections to jurisdictions with which they share a boundary visualized with their own edge. Figure 4.9 shows change in connectivity in the study region for scenario 1.

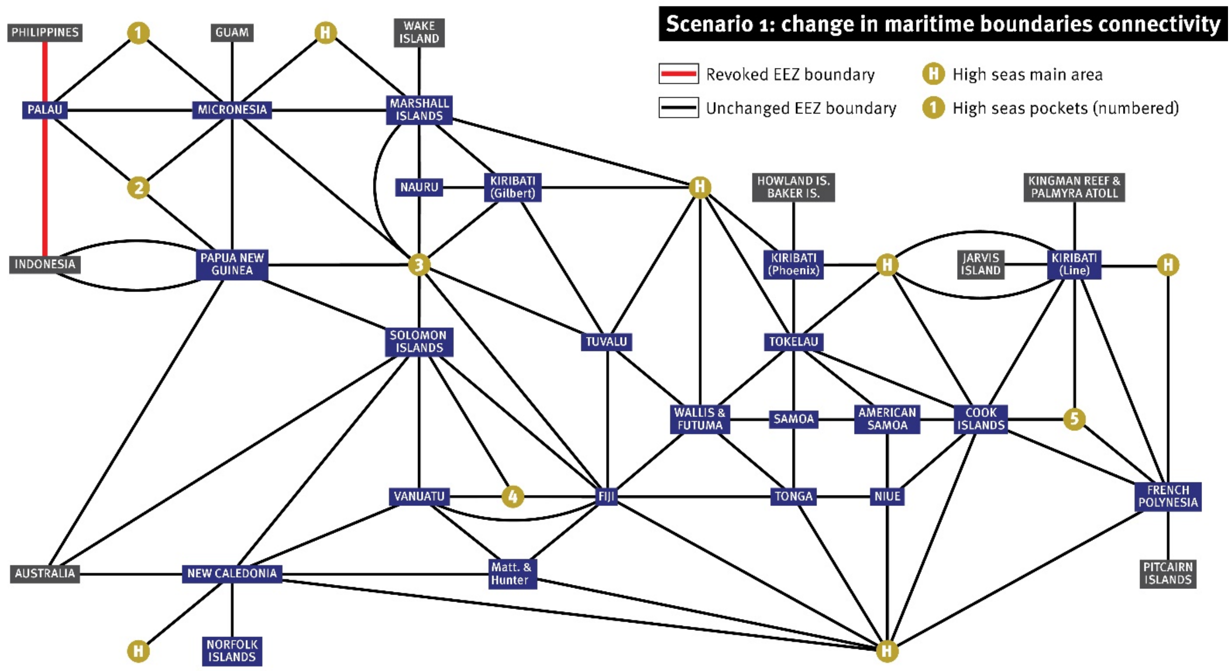


Figure 4.9 *Diagram showing the change in maritime boundaries connectivity for scenario 1.*

Figure 4.10 depicts changes in high seas area and shape for scenario 1. An increase on the western side of the study area around Palau, and in the centre, north of the Solomon Islands was observed. Combined, this change resulted in an 131,000 km^2 increase in high seas area in the study region.

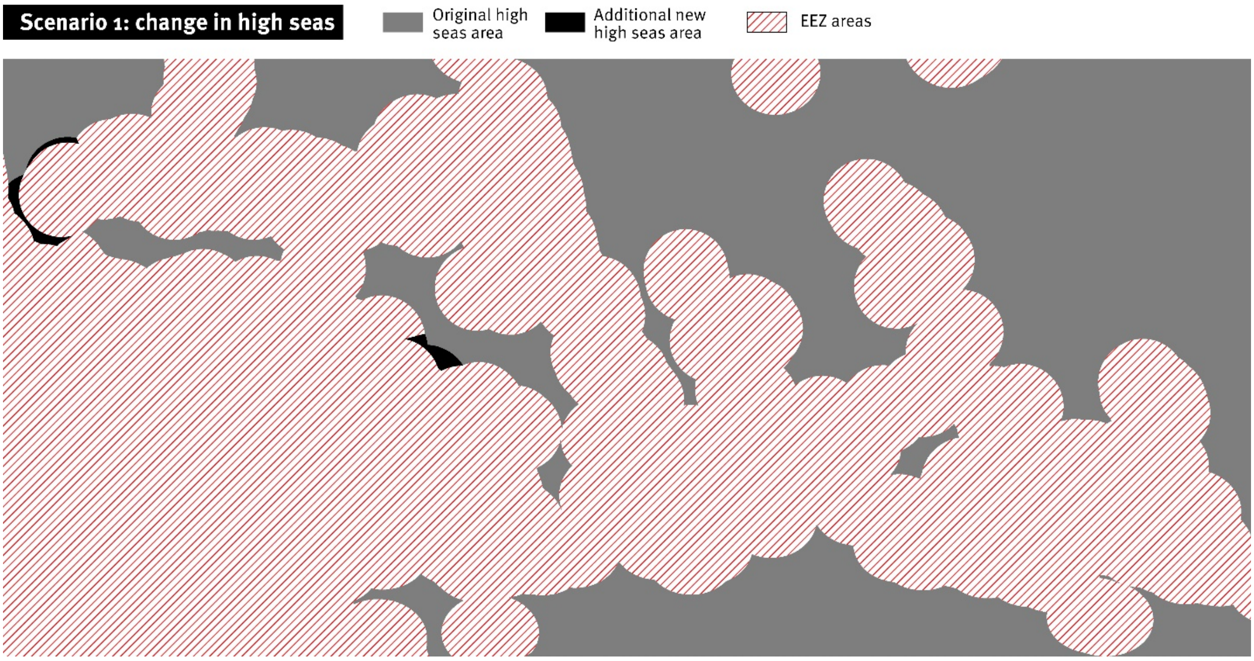


Figure 4.10 *Map showing the change in high seas area and shape for scenario 1.*

Changes in connectivity was much more significant in scenario 2, where an additional 19 EEZ boundaries for the Marshall Islands, Tuvalu, and Tokelau were revoked. With the two boundaries revoked around Palau, this resulted in a decrease of 21 EEZ boundaries from the original 91 maritime boundaries, or a decrease of 23.1% in connectivity (Fig. 4.11). Change in boundary connectivity resulted in an increase of high seas area of 2,894,000 km^2 in the study region. As expected and shown on figure 4.12, the increased high seas area mostly filled the void left by the Marshall Islands, Tuvalu and Tokelau. In turn, this resulted in the largest high seas pocket (3 on Fig. 4.11 and Fig. 4.12) to be dissolved back with the broader global high seas area. This means that whereas that high seas was previously a ‘pocket’ surrounded by EEZ maritime boundaries, the change in boundary connectivity meant that it was now connected with the main high seas which covers all of the planet’s oceans.

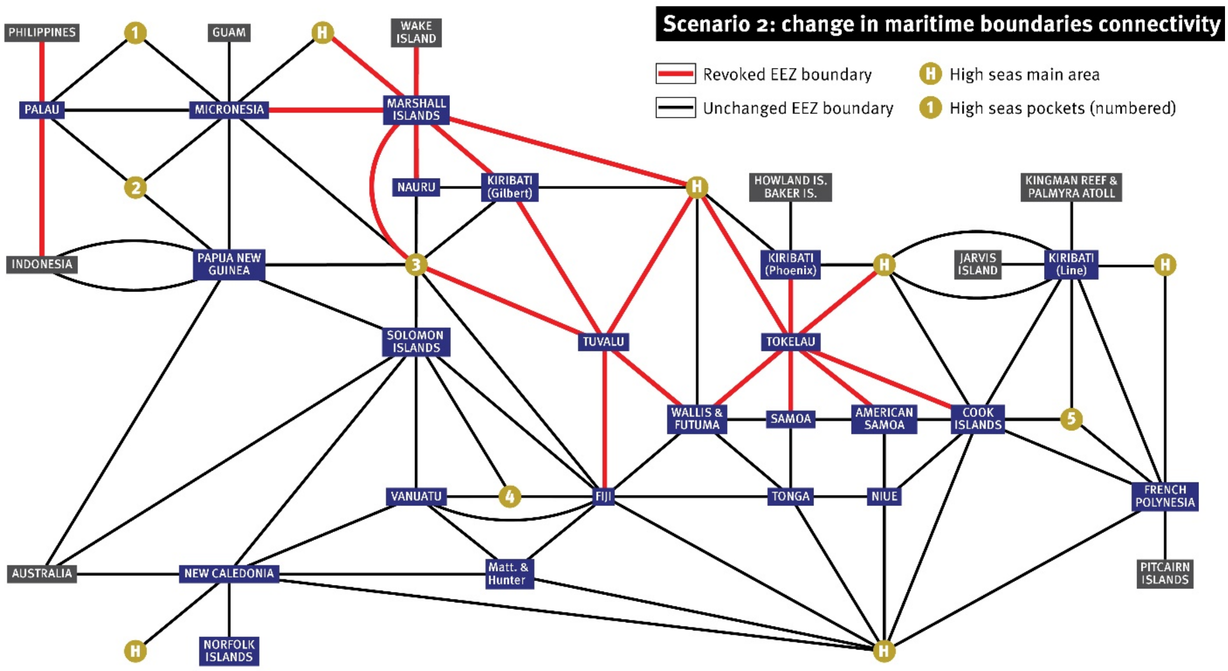


Figure 4.11 *Diagram showing the change in maritime boundaries connectivity for scenario 2.*

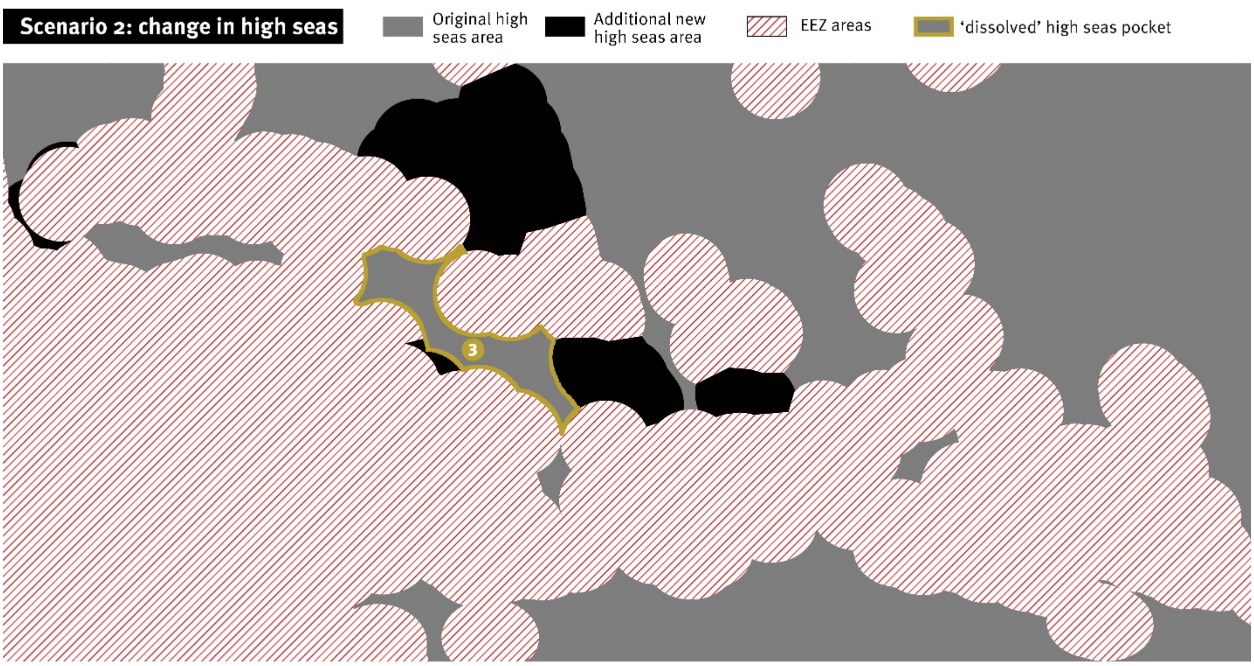


Figure 4.12 *Map showing the change in high seas area and shape for scenario 2. This results in a high seas pocket (3 on figure) to be dissolved back with the broader global high seas area.*

Scenario 3 had expectedly the most significant impacts on connectivity yet. Of the 91 maritime boundaries in the study region, 37 were revoked (Fig. 4.13). This represents a decrease of 40.7% in EEZ connectivity for the study region. The high seas area was also significantly increased by 10,758,000 km^2 (Fig. 4.14). More than three times the increase observed in scenario 2. This resulted in two additional high seas pockets to also be dissolved back with the broader global high seas area (Fig. 4.13 and Fig. 4.14). The increase in high seas area was mostly attributed to the loss of the Kiribati Line Group and Phoenix Group EEZ areas, but also the significant reduction in EEZ area for the Federated States of Micronesia and French Polynesia. The two latter ones saw their original EEZ areas split in multiple disconnected parts. Two in total for the Federated States of Micronesia, and three for French Polynesia (Fig. 4.7).

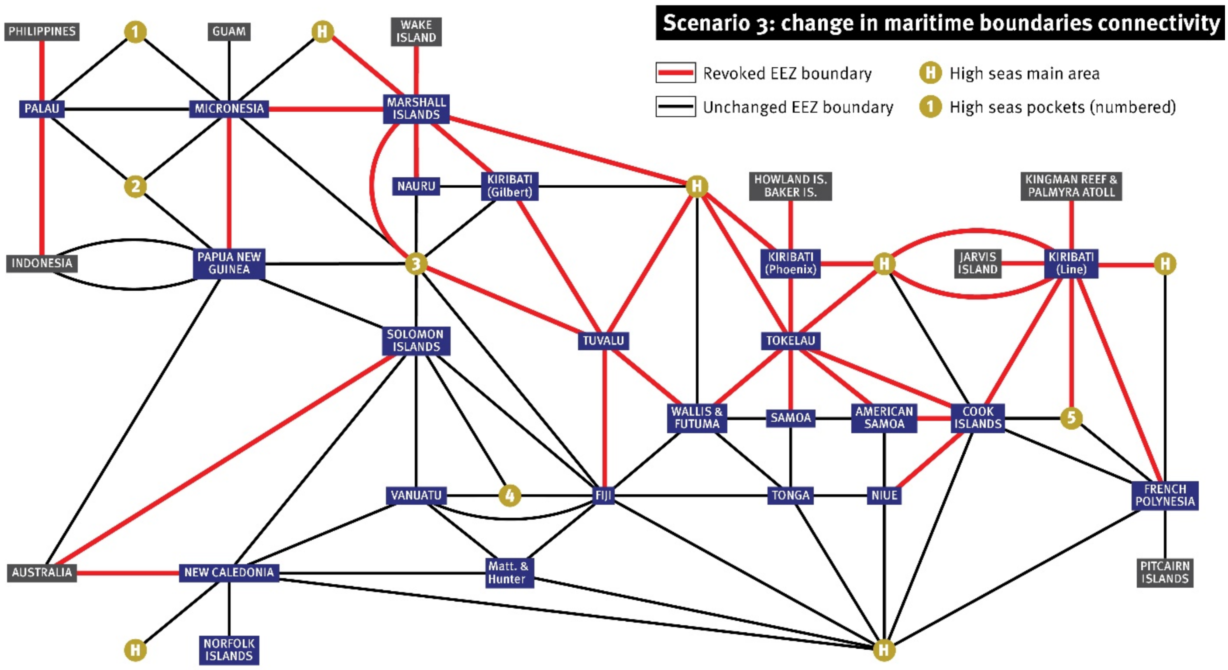


Figure 4.13 *Diagram showing the change in maritime boundaries connectivity for scenario 3.*

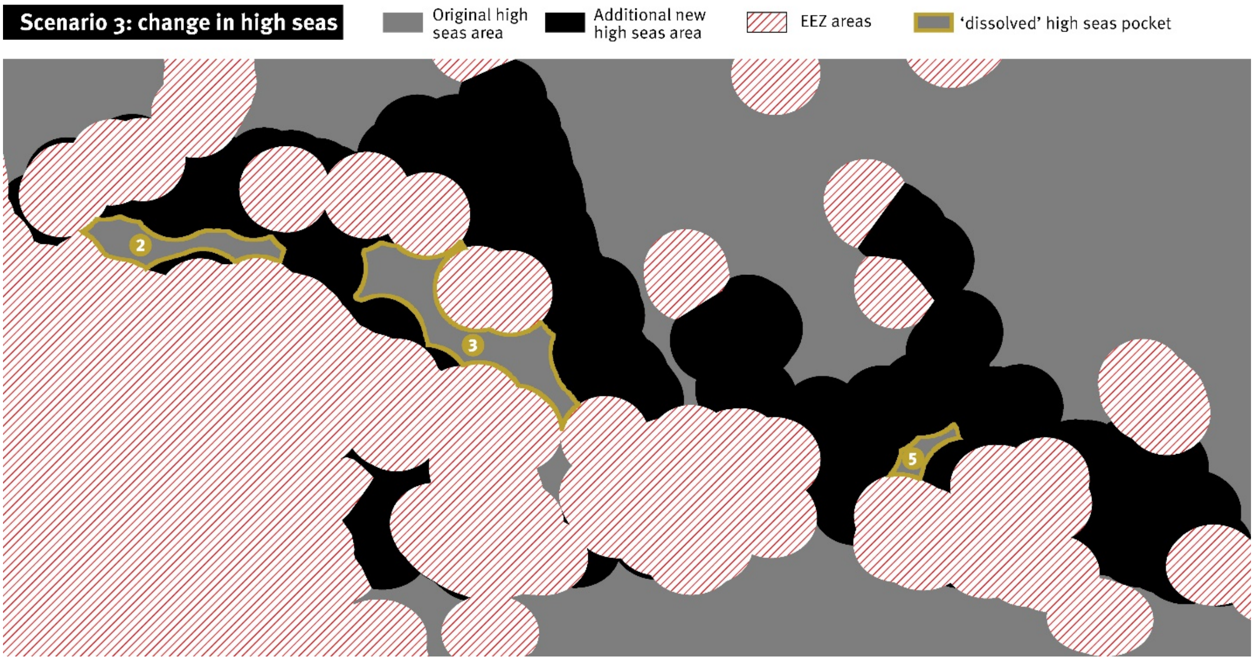


Figure 4.14 *Map showing the change in high seas area and shape for scenario 3. When compared to the original area, an increase of 10,758,000 km*^{2} *in high seas area took place in scenario 3. This resulted in high seas pockets 2, 3 and 5 on the map to be dissolved back with the greater global high seas area.*

5. Discussion

This discussion chapter starts with a reflection on the three sets of GIS results, comparing them with each other and with the preliminary assessment by Webb (2016). I describe some of the limitations of the results, particularly with regards to the question of time, an important variable in the context of sea level rise. In a second part, I discuss the results that concern connectivity and change in the high seas areas. The importance and meaning of these results are portrayed through a discussion of their possible implications on the management of fisheries in the study region. In a last section, I take a step back to reflect on the meaning of the results considering the initial theorization of EEZ spaces. I argue that because of climate change, EEZs are increasingly territorialized, with stakeholders competing with different arguments over the meaning and definition of these spaces. Particularly, can they, or can they not, remain unchanged if coastlines from which they are calculated disappear. I conclude that the competing discourses over this issue could result in altering the conceptualization of EEZ spaces. Whereas these spaces were previously institutionalized to the highest degree, bound by clear mathematical and GIS calculations, they risk becoming fuzzy spaces with contested borders, and potentially destabilizing the geographical structure of maritime space in the western and central Pacific region.

5.1. Contextualizing and reflecting on the three sets of GIS results

The results of the GIS analysis for each scenario provide insights into the impacts of climate change on the area and the shape of each jurisdictions' EEZ in the study region. Most notably, the changes observed in scenario 1 are least significant with a total decrease in EEZ area of 0.94%, compared to 11.45% and 41.48% for scenarios 2 and 3 respectively (Table 4.7). For scenario 1, these results show that the work jurisdictions in the study region have undertaken to deposit high seas boundaries to DOALOS as well as establish treaties between jurisdictions has greatly increased the resiliency of their maritime boundaries to climate change. Indeed, jurisdictions where at-risk baseline features concentrate, such as Kiribati, Tuvalu, Tokelau, the Marshall Islands, and the Federated States of Micronesia, have all deposited their EEZ maritime boundaries. In the study region, none of the three jurisdictions with most provisional boundaries (Vanuatu, Tonga, and Samoa) include at-risk baseline features. All three countries are only constituted of elevated volcanic islands.

Only one case study from Webb (2016) provides comparable quantitative results on changes in EEZ area due to climate change effects in the tropical Pacific island region. Of the three scenarios, only results for the third one can be compared to the study from Webb, as the assumptions used are the same. Indeed, both his assessment and the third scenario of this study considered that baselines are ambulatory, regardless of the status of outer EEZ boundaries. A comparison of the research shows that the results are only similar for 4 jurisdictions: Kiribati, the Marshall Islands, Tuvalu and Tokelau (Fig. 5.1). The results from both studies, show that Kiribati could lose approximately 91% of its EEZ area, whilst the three other jurisdictions lose their entire EEZ area. Because Webb does not calculate new treaty boundaries, but rather considers jurisdictions in a vacuum, results are different for the other jurisdictions. Most notably, this study shows that several jurisdictions could increase their EEZ area. Whereas Webb concludes that there would be no change in EEZ area for Samoa, Matthew and Hunter Islands, Wallis and Futuna, Vanuatu, Nauru, Niue, and Tonga, the results for scenario 3 of this study show that these jurisdiction could potentially increase their EEZ area. Most notably for Samoa, with a total increase of 60%.

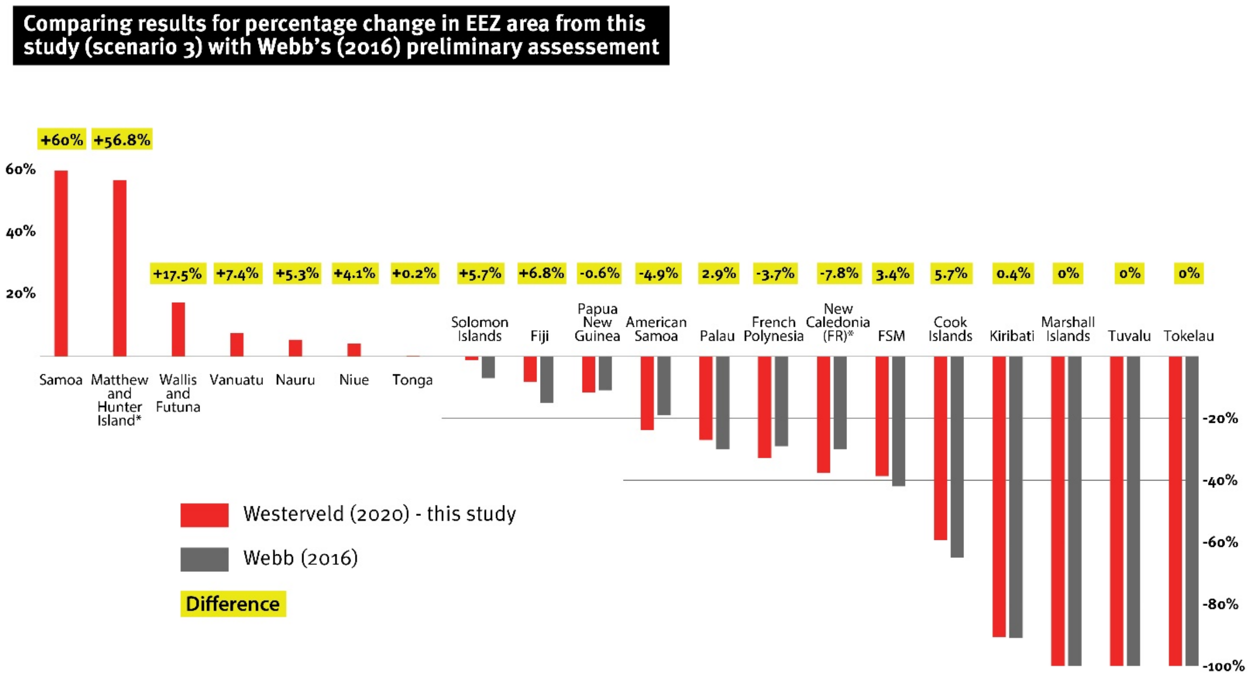


Figure 5.1 *Bar chart comparing the results of scenario 3 with Webb (2016). Relative change in percentage compared to the original EEZ area is shown on the y-axis. A few jurisdictions do not include a grey bar when the study from Webb did not note any change in EEZ area. *Note that Webb (2016) considers Matthew and Hunter Island as part of New Caledonia (France), while this study considers them as separate jurisdictions, as they are claimed both by France and Vanuatu.*

For the remaining jurisdictions where a decrease in EEZ area was observed, differences were also noted between the assessment from Webb and this study. In scenario 3, this investigation estimates that Fiji, the Solomon Islands, Palau, the Federated States of Micronesia, and the Cook Islands will have a total decrease in EEZ area that is smaller than the potential total decrease estimated by Webb (2016). Conversely, I estimated that for Papua New Guinea, American Samoa, French Polynesia, and New Caledonia the total decrease in EEZ area will be greater. These difference which range from -7.8% for New Caledonia to 6.8% for Fiji, are attributable to the new treaty boundaries which were calculated between jurisdictions in this study. Some more minor differences are also attributable to at-risk baseline features which were not included in Webb's study. For example, in Papua New Guinea, the Nukumanu and Nugugurigia atolls in the north are at-risk features that result in a new boundary between Papua New Guinea and the Solomon Islands in scenario 3.

An unexpected finding from the GIS analysis concerns the change in shape of maritime boundaries for scenario 1 where the status (provisional or deposited) is considered for the modelling. The main observation is that this scenario can result in conceptual conflicts when the increased area of one jurisdiction's EEZ overlaps with an existing deposited boundary. The example of Samoa is used below to clarify this issue (Fig. 5.2). All of Samoa's boundaries are provisional. Additionally, Tokelau and American Samoa are two jurisdictions adjacent to Samoa which include at-risk features. Therefore, Samoa increased its EEZ area into both these jurisdictions in scenario 1. However, Samoa's new potential EEZ area overlaps with a deposited treaty boundary between Tokelau and American Samoa. This gives rise to a conceptual conflict, where according to the premises of scenario 1, countries with deposited boundaries maintain those; yet this boundary ends up overlapping with Samoa's newly extended EEZ area. In this study, I chose to assume that Samoa's EEZ extension in scenario 1 is possible and unaffected by the deposited boundary between Tokelau and American Samoa. Nevertheless, this finding must be considered as international law concerning the effects of climate change on UNCLOS and maritime boundaries develops. If the notion of fixed and permanent boundaries once deposited is taken, it is crucial that there is clarity over whether this limits the potential changes to provisional boundaries as well.

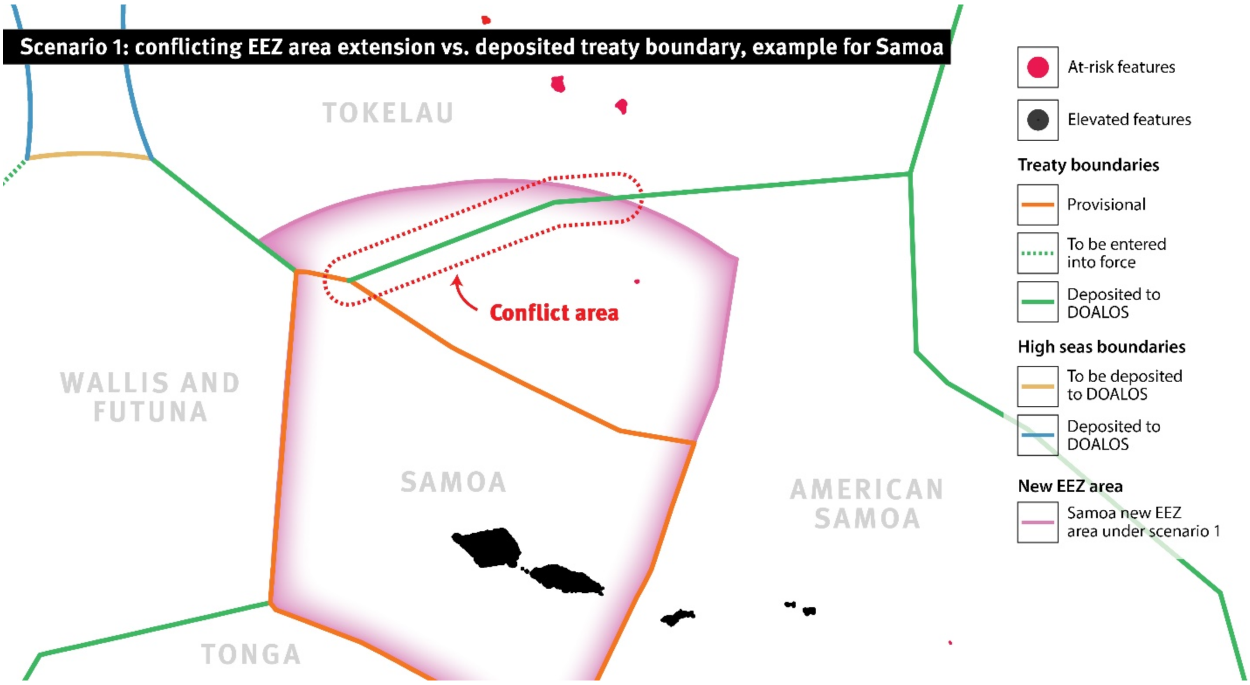


Figure 5.2 *Map showing the conflicting GIS results example for Samoa in scenario 1. Samoa's new extended EEZ area in scenario 1 overlaps with the deposited treaty boundary between Tokelau and American Samoa. The overlapping boundary is circled in red dots on the map.*

A dimension that this study has not considered is time. The elevation of at risk baseline features varies, as well as the regional differences in climate change effects, for example with different rates of sea level rise in the western Pacific compared to the eastern Pacific (*cf. 1.1 The importance of EEZs and the threat of climate change*). At-risk baseline features will not be submerged overnight, but rather at different rates, also pending on human interventions to protect these features. Time is also important because boundaries that are currently provisional could well be deposited by the time baseline features are submerged, which will have implications for the results in both scenario 1 and 2. Because of the uncertainty on the regional differences of climate change effects, as well as changes to status of maritime boundaries, time cannot be taken into account in this study. Besides uncertainty in UNCLOS on the impacts of climate change, the difficulty to integrate time also stems from the lack of precise sea level rise projections and high-resolution elevation data for the region. Overall, this suggests that in any legal scenario, changes would be gradual, and changes to multiple closely located baseline features could result in multiple small changes to a maritime boundary. For each scenario, one can imagine a dynamic image, showing the boundaries slightly moving based on gradual changes to baseline features for different scenarios over incremental time intervals. Such an illustration would strengthen the argument from a number of interviewees who explained that constantly changing a maritime boundary is not sustainable, as it is a complex legal procedure, and it would jeopardize the ability of jurisdictions to plan any long-term activities in EEZ areas that could potentially be lost.

The concept of moving borders however is not new. In the Alps for example, the border between Italy and Austria, and Italy and Switzerland is based on the location of a watershed that crosses glaciers (Ferrari, Pasqual and Bagnato, 2018). Climate change has resulted in the melting of glaciers and changes to the watershed, and led Italy and Austria and Italy and Switzerland to agree over a 'moving border' concept, which was entered into law in 2006 for Austria and 2009 for Switzerland (Italian Limes, 2016; Ferrari, Pasqual and Bagnato, 2018). Changes to the border are monitored and detected every two years and results in changes to official state maps (Italian Limes, 2016). This example suggests that there are legal precedents that support a moving border concept. However, the implications are very different between the Alps where shifts of a few hundred metres occur in high elevation mountain regions, as opposed to the Pacific where changes could potentially be much more significant in terms of area, and the associated impacts on the economy for example.

The question of time also calls for a discussion of Article 121 of UNCLOS that states, "Rocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf." (UNCLOS, 1982). Before at-risk atolls are entirely submerged, they will first become uninhabitable due to wave-driven floods impacts on freshwater availability and infrastructure (Storlazzi *et al.*, 2018). It is still unclear if and under what circumstances an island would be described as uninhabitable according to UNCLOS, and potentially lose its ability to have an EEZ. The 2016 South China Sea arbitration between the Philippines and China was the first time the Permanent Court of Arbitration and a judicial body considered what the references to 'human habitation' and 'economic life' means. The Court ruled against China and argued that its manmade islands are not naturally habitable and cannot be used by the country to generate an Exclusive Economic Zones. In legal research from Song and Mosses (2018), the authors argue that this ruling could already have implications in the Pacific region, where land features such as the disputed Matthew and Hunter Islands claimed by both Vanuatu and France (New Caledonia), cannot sustain human habitation or economic life, and could therefore not generate an EEZ. In the case of this research, climate change effects on islands may change their classification to mere rocks under UNCLOS before they are entirely submerged, simply because they can no longer sustain human habitation. This could mean that changes in EEZ maritime boundaries could occur much faster in the study region (i.e. before islands are submerged in their entirety).

5.2. Implications of changes to connectivity for EEZs and the high seas

With regards to connectivity, figure 4.8, figure 4.10, and figure 4.12 in the results chapter show that the network of 91 maritime boundaries in the study region is reduced significantly from scenario 1 (89 boundaries remaining), to scenario 2 (70 boundaries remaining), to scenario 3 (54 boundaries remaining). Decrease in connectivity from scenario 1 to 3 follows the same trend than the decrease in EEZ area from scenario 1 to 3. The implications of a change in connectivity are, however, different than a change in area. Whereas changes in geometrical area are a change in the Cartesian space of Euclidean geometry, which Lefebvre and Harvey describe in their tripartite definitions as conceptualized and absolute spaces respectively; changes in connectivity affects a different type of space which is more closely linked to Harvey's description of a relative space. Indeed, the change in connectivity in the study region affects relative space as it changes the spatial topology and contiguity of the regions' EEZ area. A decrease in connectivity means that there are fewer adjacent jurisdictions in the study region.

One way to interpret the significance of these results is to describe them in the context of the management of fisheries in the Pacific. The tuna industry in the study region is one of the most valuable fisheries in the world, providing some jurisdictions such as Kiribati and Tuvalu up to one third of their GDP (Havice, 2010). The regional management of tuna fisheries comprises a web of sophisticated treaties, conventions and institutional frameworks (Hanich, Teo and Tsamenyi, 2010; Miller, Bush and van Zwieten, 2014). Principally, it comprises of two sub-regional groups, the Parties of the Nauru Agreement (PNA) and the Pacific Islands Forum Fisheries Agency (FFA) that provide advice and regulatory functions as well as the regional SPC which provides scientific knowledge on stocks appraisal for example. In 2004, these institutions supported the establishment of a broader regional Western and Central Pacific Fisheries Commission (WCPFC) with the aims to support sustainable fisheries and conservation in the region (Miller, Bush and van Zwieten, 2014). The development of these institutions reflects the regionalism that takes place in the Pacific, where regional and sub-regional organizations are key players to strengthen the position internationally of jurisdictions whose individual capacity for research and monitoring is otherwise limited (Miller, Bush and van Zwieten, 2014; Yeeting *et al.*, 2017). The concept of regionalism is prominent in academia, diplomacy, and geopolitics, and a full discussion of the topic is beyond the scope of this argument, but the main point is that this process takes place amongst geographically contiguous areas (Artatrana, 2014). If there is not one definition of the term region, most agree that it implies "geographical proximity and contiguity" (Hurrell, 1995: 333). In the case of fisheries, the most notable geographical unit used to monitor, regulate and plan fisheries amongst the SPC, FFA, PNA and WCPFC are the EEZs where the tuna is fished. The implications then for a loss in connectivity or contiguousness of EEZs in the region is a possible weakening of the process of regionalism and the institutional power of regional and sub-regional organizations, such as the ones involved in tuna fisheries. For example, the Parties of Nauru Agreement, which comprise the Federated States of Micronesia, Kiribati, the Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands and Tuvalu form one contiguous group of EEZs that surrounds two high seas pockets (2 and 3 in Fig. 4.8). Together, these jurisdictions control the world largest tuna purse seine fishery. But, in scenario 3, the decrease in connectivity amongst the jurisdictions of the PNA results in not one but 4 non-contiguous EEZ areas (Fig. 4.7). Additionally, the two high seas pockets are dissolved with the broader high seas area (Fig. 4.13) further reducing the geographic cohesiveness of EEZs that are the part of the PNA.

The dissolution of high seas pockets, with a dissolution of high seas pocket number 3 (Fig. 4.11) in scenario 2, and high seas pockets number 2, 3 and 5 in scenario 3 (Fig. 4.13), could result in other implications for fisheries. Currently, the WCPFC regulates fishing activity in international waters enclosed by EEZs through agreements with distant water fishing nations and fleets. For example, a country may be granted fishing activity rights in an EEZ jurisdiction covered by the WCPFC providing their fleet does not engage in fishing activity in the high seas area (Miller, Bush and van Zwieten, 2014: 9). Such agreements are likely to be more difficult to set in place in case a high seas pocket is dissolved and no longer enclosed by EEZ areas. First, because of the challenge to define the boundaries of a high seas pocket that no longer exist. Second, the increased high seas area could decrease the incentive for fishing fleets to adhere to management practices in EEZs, and rather concentrate their fishing activities in the less regulated international waters. Indeed, UNCLOS imposes few restrictions on high seas area. Under article 136, mineral resources under the seabed are common heritage, but there are no restrictions over the exploitation of maritime resources in the water column. Conservation of the high seas is therefore of critical concern. Especially recently due to increased fishing activity, and new fishing techniques targeting deep-water areas for example, the use of marine resources for industrial purposes, and greater maritime traffic in general (Rochette and Billé, 2008). A potential increase in high seas areas, especially in scenario 2 and 3, would increase the vulnerability of marine spaces that are easier to conserve when they have an EEZ status.

5.3. Competing discourses and a rupture in the conceptualization of EEZ spaces

I argued in the theory chapter of this study that EEZs are a form of territory, not only because of their geometric features (an inside area, a boundary, and an outside area) but because they are the product of two complex social phenomena: space and power (Delaney, 2009). Power is reflected in the production of territory through the ways individuals or groups exert influence over how specific spaces are defined and how their meaning is controlled. In that light, I argued that EEZs are territories institutionalized to the highest degree because they are defined through UNCLOS, a convention ratified by almost all countries in the world. The literature review and interviews conducted in Sydney suggest however that UNCLOS is silent on the effects of climate change on maritime boundaries. This void left in the definition of EEZ spaces is taking on more importance as the effects of climate change intensify. Especially in the context of the Pacific, where many features are at risk of sea level rise. The interviews of this study exposed how this vacuum left in UNCLOS' definition of EEZ spaces is filled by competing arguments. These were highlighted through the three scenarios of this research. Taken together, the scenarios represent the rift that climate change has created, and how this issue is challenging a formerly cohesive definition and shared understanding of EEZs. The results exemplify particularly well how power in the context of EEZ as a form of territory, lies in the ability of stakeholders to define and attribute meaning to these spaces.

If the arguments presented in this research to support each scenario are mostly confined to the legal sphere, jurisdictions are not necessarily refraining themselves from taking other steps to secure their maritime sovereignty. Most recently for example, the Guardian newspaper reported that Kiribati would seek support from China to elevate its islands vulnerable to sea level rise through techniques such as dredging (Pala, 2020). This could possibly help Kiribati to secure its baselines. Similar trends are seen beyond the study region. In its submission to the ILC's study group on the effects of sea level rise on maritime boundaries, the Maldives noted that is has undertaken coastal fortification to try and protect islands which “displays Maldives’ commitment to preserving its land territory as well as its maritime entitlements” (International Law Commission, 2020: 31).

Besides securing baselines physically, the complex geo-political dynamics in the region are likely to also shape the development of this issue. For example, major powers in the region including France and the United States have not yet taken a public stance on this issue, but when they do, these will be important consideration for any assessment of the impacts of climate change in EEZ boundaries. Similarly, dynamics such as the one between Taiwan – which has sought diplomatic recognition from Pacific Islands in exchange of aid – and China that undermines it (Atkinson, 2010), could also further influence the development of this issue. If contestations over the effects of sea level rise intensify, it is no stretch to imagine that power over the control of these territories will not remain confined to the legal sphere, but transpire to the physical maritime space, possibly calling on country’s capacity to safeguard their territorial claims through military power.

The second argument that I made in the theory chapter was that EEZs are – in light of Lefebvre’s tripartite definition of the production of space (Albright, Hartman and Widin, 2018; Lefebvre, 1974) – mostly produced through conceptualization. Indeed, EEZs are the product of maps and coordinates that are calculated as distances from baselines; these cannot be verified empirically, but only exist because there is a globally shared agreement over the definition – or conceptualization – of these spaces. For example, the notion that EEZs extend exactly 200 nautical miles from a countries’ baseline. The implications of the competing discourses over the meaning of EEZ spaces in light of climate change are best visualized through the map results of each scenario for this research, particularly figure 4.2, figure 4.4, and figure 4.7. Beyond showing individual results for each scenario, these different maps reveal a potential rupture in the conceptualization of EEZ spaces. As stated earlier, a rupture in the conceptualization of EEZ spaces could jeopardize the clean cut and mathematical accuracy that EEZ spaces previously conveyed in maps. The combination of figure 4.2, figure 4.4, and figure 4.7 show instead that EEZ spaces have the potential of becoming fuzzy, contested, with unclear boundaries. Amid competing arguments and positions on this issue, and the likely broadening of stakeholders joining the debate in the legal sphere, these maps provide insight to understand the implications of different discourses.

Finally, a third important theoretical aspect of EEZ spaces discussed in the theory chapter of this study is how the power in the context of EEZ spaces lies in the GIS and maps used to calculate and communicate their existence and location. This awareness led me to use a scenario approach in this research to ensure that I did not contribute to perpetuating one interpretation of UNCLOS over another. However, it is possible that countries or other stakeholders may use maps in the future to advance one discourse or vision for the organization of EEZ space over another. In these circumstances, it is important that researchers stay aware of the technological and capacity gaps that exists between different stakeholders. In the context of the Pacific, many jurisdictions rely on financial and expert support from regional organizations such as the SPC to calculate their maritime boundaries and produce maps and charts to communicate them. Other countries with stakes in the region such as the United States or France, or distant water fishing nations from Asia, are likely to have more technological and mapping capacity specifically to advance their own discourses and views through these products. Therefore, it will remain crucial to be cautious and critical of GIS and mapping outputs that are created considering this issue.

6. Conclusion

This study assesses the possible impacts of anthropogenic climate change on Exclusive Economic Zones in the western and central Pacific region. Three sub research questions were used to provide a framework to the methods and analysis of this research. Each are briefly reviewed and answered here. First, because UNCLOS does not explicitly addresses the issue of climate change effects on maritime boundaries, I researched through a literature review and semi-structure interviews the arguments that support different interpretations of UNCLOS, and the potential development of international law on this issue. The results showed that there are three important legal opinions that seek to fill the gap left by UNCLOS on the question of climate change impacts on maritime boundaries. First, expressed actively by experts interviewed from the study region, the view that maritime boundaries are fixed once deposited, regardless of changes to the features used to determine their location in the future. Second, an intermediate view where only EEZ boundaries are affected if all land in a jurisdiction is submerged due to climate change effects. Third, the opinion that maritime boundaries are ambulatory and must coincide with the location of baselines: if those shift because of climate change effects, so should the maritime boundaries that are associated with those baselines.

Second, based on these three scenarios, I used GIS methods to research what the implications are on the shape and area of EEZs in the western and central Pacific region. The results showed that at the regional level in scenario 1 the decrease would be 0.94%. Palau was the jurisdiction most vulnerable in this scenario because all but one of its boundaries are deposited, and it includes multiple at-risk baseline features. The effects of scenario 2 were more pronounced, especially for the Marshall Islands, Tuvalu, and Tokelau that are only constituted of at-risk features. At a regional level, the decrease in total EEZ area was 11.45% for that scenario. Finally, scenario 3 was most impactful with 13 of the 20 jurisdictions in the study region potentially seeing a reduction in their EEZ area. The change in EEZ area at the regional level was a decrease of 41.48%. In this third scenario, jurisdictions in the northern and eastern areas of the study region were most vulnerable due to the concentration of at-risk atolls in those locations. In terms of changes to individual EEZs, the changes shown in maps for each scenario showed either a static, a contraction, or an expansion of EEZ areas. For the Federated States of Micronesia and French Polynesia in scenario 3, their EEZ area were split in 3 unique bounded EEZ spaces.

Third, this study assessed how each scenario would affect connectivity which means how the degree of EEZ adjacency in the study region could change due to climate change effects on baselines. Simultaneously, I also evaluated changes in area and contiguity of high seas areas. Of the 91 individual EEZ boundaries in the study region, the GIS analysis showed that in scenario 1 only the boundary between Palau and the Philippines, and Palau and Indonesia would be revoked due to the potential inward movement of Palau's EEZ area in that scenario. In scenario 2, 21 unique EEZ boundaries could be revoked, mainly around the Marshall Islands, Tuvalu, and Tokelau. Finally, in scenario 3, 37 unique EEZ boundaries could be revoked, significantly diminishing connectivity and contiguity in the study region. In terms of high seas area, it increased by 0.13 million km^2 in scenario 1, 2.89 million km^2 in scenario 2, and 10.76 million km^2 in scenario 3. In terms of high seas connectivity, high seas pocket number three located north of the Solomon Islands was dissolved with the largest and main high seas area in scenario 2. In scenario 3, in addition to high seas pocket number three, high seas pocket number two that is located north of Papua New Guinea and high seas pocket number five located east of the Cook Islands, were also dissolved with the main high seas area.

Although the uncertainty around UNCLOS was captured through the different scenarios used, differences in sea level rise projections and uncertainty around the exact extent of other climate change effects on coastlines – such as increase in sea surface temperature – are a limitation of this study. Additionally, more accurate altimetry data for the study region could allow for a more detailed classification of baseline features. This would enable to provide a temporal dimension to this research and show whether some EEZ boundaries are potential more at risk compared to others, based on whether the baselines on which they depend are relatively more vulnerable to climate change effects. Because this research does provides a first systematic GIS method to calculate potential changes to maritime boundaries due to climate change effects, more detailed input data on at-risk baseline features could always be used and processed using the methodology developed in this research in future work. Similarly, this method can be applied to other regions in the world with similar at-risk baseline features, such as the Indian Ocean that also includes many inhabited atolls. Ultimately, changes to EEZ boundaries will first and foremost depend on the interpretation and possible development of international law on this issue. Therefore, it is important for future GIS studies to consider whether the legitimacy and credibility of the different scenarios stands, or whether new developments in international law requires the GIS methods to be adjusted.

Overall, these results demonstrate that the implications of development of international law on the issue of climate change and maritime boundaries would either have relatively small or large and significant impacts on the delimitation of EEZs in the study region. The importance of EEZs to supporting key economic sectors such as fisheries and tourism in the region speaks to the relevance of these results. Maps and statistics for each scenario have the potential to serve multiple purposes. First, they can help inform and assess the implications of the development of international law on this issue. For example, the implications of the final recommendations expected from the International Law Commission to the UNGA may align more with one scenario than another. Second, the maps and quantitative figures can become important communication tools to highlight the importance of this issue to different stakeholders. Although the potential loss of EEZ territories due to climate change effects has been mentioned in numerous published studies, especially in law, these are the first regional maps that visually communicate the specific potential effects on shape and area of individual EEZs under different legal scenarios. The potential significance of these changes is better captured and communicated visually through the spatial data generated in this study, than in text. Third, these new spatial layers for each scenario could be integrated and used in further studies on this issue. Three specific examples of further studies come to mind and are outlined below.

One angle could be to research what these potential changes in EEZ area and shape mean for the economic sectors that these maritime areas support. For example, although I have noted the importance of fisheries, new research could quantify specifically which fisheries and to what extend these could be affected for different jurisdictions and scenarios. This could be done by overlaying spatial data on historical fisheries catch compared to the new EEZ areas for example. The same could be done looking at deep sea mining, and whether new EEZ areas could affect any planned activities in the region. Another angle that future research could take are the potential implications of changes in EEZ area and shape on conservation and marine spatial planning. Indeed, many conservation efforts, for example the delimitation of marine protected areas, take place within EEZs. Because the high seas are not governed by a single state, it is harder to put systems in place to advance and monitor conservation efforts. Potential changes in EEZ boundaries could affect such conservation efforts and strategies. As for fisheries, overlaying spatial data related to conservation and marine spatial planning with the results of this study in GIS could support the development of new knowledge. Finally, I have argued that the potential significant impact of climate change on maritime boundaries means that this issue may invoke the complex geo-political setting of the study region. Further research could look specifically into these geo-political dynamics and how different governments and other stakeholders are engaging politically in the region to secure and push for particular developments of international law with regards to the impacts of changing baselines on maritime boundaries. The results of this research provide a framework to contextualize that research and drive specific research questions. For example, is the political discourse of jurisdictions which could potential see a decrease in EEZ area different from the jurisdictions that could potential increase their EEZ area?

Theoretically, I have shown EEZs territories are complex spaces that can be apprehended in multiple ways. This research focused on EEZs in absolute terms, as spaces of coordinate points created through mapping techniques. But also, in relative terms, with a focus on contiguity and connectivity between EEZs. I argued that EEZs are constructed spaces which are dominated by a process of conceptualization. Indeed, the legitimacy of these spaces and the way they are communicated, is predominantly through maps or as list of coordinates. In that light, it is important for this research, and future research which could use the results of this study to remain self-critical and warry of the implications of creating maps which show potential changes to EEZ spaces. Cartography and map making has long be used as a tool to exert power and claim sovereignty over space. This highlights the importance to use reflexivity in GIS analysis, and to question whether the results are biased, and what the potential real-world ramifications the maps may have. Indeed, behind the coordinate numbers in GIS databases or the pixels on a screen, there are generations of people with a rich history and diverse culture living in the Pacific. As lived spaces, Pacific islanders have navigated EEZs and high seas in the study region long before they were 'discovered' and later colonized by Europeans. In 1994, Tongan writer Hau'ofa wrote that European 19^{th} century imperialism led to the contemporary boundaries and contraction of the region, "a once boundless world" (Hau'ofa, 1993). What this research has shown, is that pending on the development of international law, there is varying risk of further contraction of territories in the region.

7. References

Aase, T. H. (1994) Symbolic space: representations of space in geography and anthropology, *Geografiska Annaler. Series B, Human Geography*, 76(1), pp. 51-58. doi: 10.2307/490497.

Agnew, J. (2008) Borders on the mind: re-framing border thinking, *Ethics & Global Politics*, 1(4), pp. 175-191. doi: 10.3402/egp.v1i4.1892.

Agnew, J., Mamadouh, V., Secor, A. J. and Sharp, J. (2015) *The Wiley Blackwell companion to political geography*. Wiley Blackwell. doi: 10.1002/9781118725771.

Albright, J., Hartman, D. and Widin, J. (2018) *Bourdieu's field theory and the social sciences*. Palgrave Macmillan. doi: 10.1007/978-981-10-5385-6.

Artatrana, G. (2014) Regionalism and sub-regionalism: a theoretical framework with special reference to India, *African Journal of Political Science and International Relations*, 8(1), pp. 10-26. doi: 10.5897/AJPSIR2013.0611.

Atkinson, J. (2010) China - Taiwan diplomatic competition and the Pacific Islands, *The Pacific Review*, 23(4), pp. 407-427. doi: 10.1080/09512748.2010.495998.

Becker, M., Meyssignac, B., Letetrel, C., Llovel, W., Cazenave, A. and Delcroix, T. (2012) Sea level variations at tropical Pacific islands since 1950, *Global and Planetary Change*, 80-81, pp. 85-98. doi: 10.1016/j.gloplacha.2011.09.004.

Bergmann, L. and Sullivan, D. (2018) Reimagining GIScience for relational spaces, *The Canadian Geographer*, 62(1), pp. 7-14. doi: 10.1111/cag.12405.

Brenner, N. and Elden, S. (2009) Henri Lefebvre on state, space, territory *International Political Sociology*, 3(4), pp. 353-377. doi: 10.1111/j.1749-5687.2009.00081.x.

Brito Vieira, M. (2003) Mare liberum vs. mare clausum: Grotius, Freitas, and Selden's debate on dominion over the seas, *Journal of the History of Ideas*, 64(3), pp. 361-377. doi: 10.2307/3654231.

Carleton, C. (2006) Maritime delimitation in complex island situations: a case study on the caribbean sea, in *Maritime Delimitation.* Netherlands: Brill pp. 161-196.

Carling, J., Erdal, M. and Ezzati, R. (2013) Beyond the insider-outsider divide in migration research, *Migration Studies*, 2(1), pp. 36-54. doi: 10.1093/migration/mnt022.

Cash, D., W. , Clark, W., C. , Alcock, F., Dickson, N., M., Eckley, N., Guston, D., H. , Jäger, J. and Mitchell, R., B. (2003) Knowledge systems for sustainable development, *Proceedings of the National Academy of Sciences of the United States of America*, 100(14), pp. 8086. doi: 10.1073/pnas.1231332100.

Chermack, T. J. and Lynham, S. A. (2002) Definitions and outcome variables of scenario planning, *Human Resource Development Review*, 1(3), pp. 366-383. doi: 10.1177/1534484302013006.

Chermack, T. J. (2005) Studying scenario planning: theory, research suggestions, and hypotheses, *Technological Forecasting & Social Change*, 72(1), pp. 59-73. doi: 10.1016/j.techfore.2003.11.003.

Church, J. A., White, N. J. and Hunter, J. R. (2006) Sea-level rise at tropical Pacific and Indian Ocean islands, *Global and Planetary Change*, 53(3), pp. 155-168. doi: 10.1016/j.gloplacha.2006.04.001.

Convention on the Continental Shelf (1958) *United Nations Treaty Series*. Geneva. Available at: https://treaties.un.org/doc/Publication/UNTS/Volume%20499/v499.pdf.

Delaney, D. (2009) Territory and Territoriality, in *International Encyclopedia of Human Geography.* 1st edn. Elsevier, pp. 196-208.

Deutsche, R. (1991) Boys town, *Environment and Planning D: Society and Space*, 9(1), pp. 5-30. doi: 10.1068/d090005.

Division for Ocean Affairs and the Law of the Sea, U. N. (1998) *The United Nations Convention on the Law of the Sea (a historical perspective)*. Available at: https://www.un.org/Depts/los/convention_agreements/convention_historical_perspective.htm (Accessed: 01.11.2019).

Elden, S. (2010) Land, terrain, territory, *Progress in Human Geography*, 34(6), pp. 799-817. doi: 10.1177/0309132510362603.

Elden, S. (2013) How should we do the history of territory?, *Territory, Politics, Governance*, 1(1), pp. 5-20. doi: 10.1080/21622671.2012.733317.

Emily Artack and Kruger, J. (2015) *Status of maritime boundaries in Pacific Island countries*. Unpublished paper presented at 9th SPC Heads of Fisheries Meeting. Noumea, New Caledonia.

Ewart, R. (2020) *Tender process edges Cook Islands closer to becoming first nation in the world to give undersea mining the go ahead*. Available at: https://www.abc.net.au/radio-australia/programs/pacificbeat/cooks-seabed-mining/12825266 (Accessed: 14.11.2020).

Ferrari, M., Pasqual, E. and Bagnato, A. (2018) *A moving border: alpine cartographies of climate change*. Cambridge: Columbia Univeristy Press.

Frankham, J. (2015) *Empire of the Sea*. Available at: https://www.nzgeo.com/stories/empire-of-the-sea/ (Accessed: 30.08.2020).

Frost, R., Hibberd, P., Nidung, M., Artack, E. and Bourrel, M. (2016) Redrawing the map of the Pacific, *Marine Policy*, 95. doi: 10.1016/j.marpol.2016.06.003.

Garner, A. J., Weiss, J. L., Parris, A., Kopp, R. E., Horton, R. M., Overpeck, J. T. and Horton, B. P. (2018) Evolution of 21st Century Sea Level Rise Projections, *Earth's future*, 6(11), pp. 1603-1615. doi: 10.1029/2018ef000991.

Garvin, J. B., Slayback, D. A., Ferrini, V., Frawley, J., Giguere, C., Asrar, G. R. and Andersen, K. (2018) Monitoring and modeling the rapid evolution of earth's newest volcanic island: Hunga Tonga Hunga Ha'apai (Tonga) using high spatial resolution satellite observations, *Geophysical Research Letters*, 45(8), pp. 3445-3452. doi: 10.1002/2017GL076621.

Gassner, P., Yakub, N., Kaitu'u, J., Wendt, H., Westerveld, L., Macmillan-Lawler, M., Davey, K., Baker, E., Clark, M. and Fernandes, L. (2019) *Marine atlas, maximizing benefits for Fiji.* Suva, Fiji: MACBIO (GIS/IUCN/SPREP).

Geocap (2019) Geocap maritime limits and boundaries for ArcGIS (7.2.4 edn.). Oslo, Norway: Geocap. Available at: https://www.geocap.no/article/martime-limits-and-boundaries-for-arcgis.

Goldberg, W. M. (2018) *The geography, nature and history of the tropical pacific and its islands*. Cham: Springer International Publishing.

Gray, D. E. (2014) *Doing research in the real world*. 3rd edn. London: Sage.

Hanich, Q., Teo, F. and Tsamenyi, M. (2010) A collective approach to Pacific islands fisheries management: moving beyond regional agreements, *Marine Policy*, 34(1), pp. 85-91. doi: 10.1016/j.marpol.2009.04.018.

Harvey, D. (2006) *Spaces of global capitalism, a theory of uneven geographical development*. London: Verso.

Harvey, D. (2009) *Social justice and the city*. Athens: University of Georgia Press.

Harvey, F. (2018) Critical GIS: distinguishing critical theory from critical thinking, *The Canadian Geographer*, 62(1), pp. 35-39. doi: 10.1111/cag.12440.

Hau'ofa, E. (1993) Our sea of islands, in Waddell, E., Naidu, V. and Hau'ofa, E. (ed.) *A new oceania: rediscovering our sea of islands.* Suva: School of Social and Economic Development, The University of the South Pacific.

Havice, E. (2010) The structure of tuna access agreements in the western and central Pacific ocean: lessons for vessel day scheme planning, *Marine Policy*, 34(5), pp. 979-987. doi: 10.1016/j.marpol.2010.02.004.

Horridge, A. G. (2006) The Austronesian conquest of the sea - upwind, in *The Austronesians: historical and comparative perspectives.* Canberra: ANU Press, pp. 143-160.

Horton, B. P., Khan, N. S., Cahill, N., Lee, J. S. H., Shaw, T. A., Garner, A. J., Kemp, A. C., Engelhart, S. E. and Rahmstorf, S. (2020) Estimating global mean sea-level rise and its uncertainties by 2100 and 2300 from an expert survey, *NPJ climate and atmospheric science*, 3(1), pp. 1-8. doi: 10.1038/s41612-020-0121-5.

Hughes, T. P., Kerry, J. T., Baird, A. H., Connolly, S. R., Dietzel, A., Eakin, C. M., Heron, S. F., Hoey, A. S., Hoogenboom, M. O., Liu, G., McWilliam, M. J., Pears, R. J., Pratchett, M. S., Skirving, W. J., Stella, J. S. and Torda, G. (2018) Global warming transforms coral reef assemblages, *Nature*, 556(7702), pp. 492-496. doi: 10.1038/s41586-018-0041-2.

Hurrell, A. (1995) Explaining the resurgence of regionalism in world politics, *Review of International Studies*, 21(4), pp. 331-358. doi: 10.1017/S0260210500117954.

Hviding, E. (2019) Climate change, oceanic sovereignties and maritime economies in the Pacific, in *Climate, capitalism and communities: an anthropology of environmental overheating.* London: Pluto Press, pp. 171-187.

International Law Association (2012) *Baselines under the international law of the sea, Sofia report*. Available at: http://ilareporter.org.au/wp-content/uploads/2015/07/Source-1-Baselines-Final-Report-Sofia-2012.pdf.

International Law Association (ILA) (2014) *International law association, constitution of the association*. Available at: https://web.archive.org/web/20151013065635/http://www.ila-hq.org/download.cfm/docid/30692D54-747F-4D66-B9F8E5C08F69F3AF (Accessed: 22.10.2020).

International Law Commission (2020) *Sea-level rise in relation to international law: 1st issues paper / by Bogdan Aurescu and Nilüfer Oral, co-chairs of the study group on sea-level rise in relation to international law*. New York. Available at: https://digitallibrary.un.org/record/3865813/files/A_CN.4_740-EN.pdf.

International Seafood Sustainable Foundation (ISSF) (2019) *Status of the world fisheries for tuna: october 2019, ISSF technical report 2019-12*. International Seafood Sustainability Foundation (ISSF). Available at: https://www.issuelab.org/resources/35751/35751.pdf.

Iosifescu Enescu, C. M., Bär, H.-R., Beilstein, M. and Hurni, L. (2020) Place cookies and setting spiders in dream cartography, *Transactions in GIS*, 24(4), pp. 944-966. doi: 10.1111/tgis.12604.

Italian Limes (2016) Moving borders: a cartographic and political enquiry. Available at: http://www.italianlimes.net/project.html (Accessed: 05.09.2020).

Kent, H. S. K. (1954) The historical origins of the three-mile limit, *The American Journal of International Law*, 48(4), pp. 537-553. doi: 10.2307/2195021.

Khan, H. and Wiener, A. J. (1967) *The year 2000, a framework for speculations on the next thrity-three years.* New York: MacMillan.

Knowles, A. K., Westerveld, L. and Strom, L. (2015) Inductive visualization: a humanistic alternative to GIS, *GeoHumanities*, 1(2), pp. 233-265. doi: 10.1080/2373566X.2015.1108831.

Kwan, M.-P. (2002) Feminist visualization: re-envisioning GIS as a method in feminist geographic research, *Annals of the Association of American Geographers*, 92(4), pp. 645-661. doi: 10.1111/1467-8306.00309.

Lefebvre, H. (1974) *The Production of Space*. Translated by Nicholson-Smith, D. Oxford, UK: Basil Blackwell.

Leszczynski, A. (2009) Quantitative limits to qualitative engagements: GIS, its critics, and the philosophical divide, *The Professional Geographer*, 61(3), pp. 350-365. doi: 10.1080/00330120902932026.

Matsuda, M. K. (2006) The Pacific, *The American Historical Review*, 111(3), pp. 758-780. doi: 10.1086/ahr.111.3.758.

Matsuda, M. K. (2012) Navigators of Polynesia and paradise, in *Pacific worlds: a history of seas, peoples and cultures.* Cambridge: Cambridge University Press, pp. 127-143.

Merrifield, A. (1993) Place and space: a Lefebvrian reconciliation, *Transactions of the Institute of British Geographers*, 18(4), pp. 516-531. doi: 10.2307/622564.

Miller, A. M. M., Bush, S. R. and van Zwieten, P. A. M. (2014) Sub-regionalisation of fisheries governance: the case of the Western and Central Pacific Ocean tuna fisheries, *Maritime studies*, 13(1), pp. 1-20. doi: 10.1186/s40152-014-0017-2.

Mullings, B. (1999) Insider or outsider, both or neither: some dilemmas of interviewing in a cross-cultural setting, *Geoforum*, 30(4), pp. 337-350. doi: 10.1016/S0016-7185(99)00025-1.

Nandan, S. N. (1987) The exclusive economic zone: a historical perspective, in *Essays in memory of Jean Carroz: the law and the sea.* Rome: Food & Agriculture Organization of the UN (FAO).

National Oceanic and Atmospheric Administration (NOAA) (2019) *U.S. maritime limits and boundaries*. Available at: https://nauticalcharts.noaa.gov/data/us-maritime-limits-and-boundaries.html (Accessed: 20.01.2020).

O'sullivan, D. (2006) Geographical information science: critical GIS, *Progress in Human Geography*, 30(6), pp. 783-791. doi: 10.1177/0309132506071528.

Office of Legal Affairs, U. N. (2020) *International Law Commission*. Available at: https://legal.un.org/ilc/ (Accessed: 01.01.2020).

Ortolland, D. and Pirat, J. P. (2010) *Atlas géopolitique des espaces maritimes: frontières, énergie, pêche et environnement*. 2nd edn. Paris: Technip.

Pacific Community (SPC) (2019) *The impact of climate change on maritime boundaries in the Pacific (transcript)*. Unpublished paper presented at High level side event at COP25. Madrid.

Pacific Island Forum (PIF) (2019) *Submission of the members of the pacific islands forum to the International Law Comission on the topic of sea-level rise in relation to international law*. Available at: http://legal.un.org/docs/?path=../ilc/sessions/72/pdfs/english/slr_pif.pdf&lang=E (Accessed: 09.09.2020).

Pacific Islands Forum (PIF) Secretariat (2018) *Forty-ninth Pacific Islands Forum - Forum Communiqué*. Yaren, Nauru. Available at: https://www.un.org/humansecurity/wp-content/uploads/2018/09/49th-Pacific-Islands-Forum-Communiqu%C3%A9.pdf.

Pacific Islands Forum (PIF) Secretariat (2019) *Fiftieth Pacific Islands Forum - Forum Communiqué*. Funafuti, Tuvalu. Available at: https://www.forumsec.org/wp-content/uploads/2019/08/50th-Pacific-Islands-Forum-Communique.pdf.

Pala, C. (2020) Kiribati's president's plans to raise islands in fight against sea-level rise, *The Guardian*. Available at: https://www.theguardian.com/world/2020/aug/10/kiribatis-presidents-plans-to-raise-islands-in-fight-against-sea-level-rise (Accessed: 22.08.2020).

Papastavridis, E. (2011) The right of visit on the high seas in a theoretical perspective: mare liberum versus mare clausum revisited, *Leiden Journal of International Law*, 24(1), pp. 45-69. doi: 10.1017/S0922156510000580.

Permanent Court of Arbitration (2007) *Award in the arbitration regarding the delimitation of the maritime boundary between Guyana and Suriname. Award of 17 September 2007.* The Hague.

Porter, M. E. (1985) *Competitive advantage, creating and sustaining superior performance*. New York: Free Press.

Powers, A. (2012) Sea-level rise and its impact on vulnerable states: four examples., *Louisiana Law Review*, 73(1), pp. 151-173.

Rochette, J. and Billé, R. (2008) Governance of marine biodiversity beyond national jurisdictions: issues and perspectives, *Ocean and Coastal Management*, 51(12), pp. 779-781. doi: 10.1016/j.ocecoaman.2008.10.001.

Sack, R. D. (1986) *Human territoriality: its theory and history*. Cambridge: Cambridge University Press.

Santos Junior, O. A. D. (2014) Urban common space, heterotopia and the right to the city: reflections on the ideas of Henri Lefebvre and David Harvey, *Revista Brasileira de Gestão Urbana*, 6(2), pp. 146-157. doi: 10.7213/urbe.06.002.SE02.

Sauni, S. (2000) The status of the coral reefs of Tuvalu in *Coral reefs in the Pacific: status and monitoring, resources and management.* New Caledonia: Centre IRD de Nouméa.

Schofield, C. (2009) Shifting limits? Sea levels rise and options to secure maritime jurisdictional claims, *Carbon & Climate Law Review*, 3(4), pp. 405-416.

Schofield, C. H. (2010) *The delimitation of maritime boundaries of the Pacific island states*. Unpublished paper presented at International Seminar on Islands and Oceans. Akasaka, Tokyo.

Schuurman, N. (2000) Trouble in the heartland: GIS and its critics in the 1990s, *Progress in Human Geography*, 24(4), pp. 569-590. doi: 10.1191/030913200100189111.

Seas and Submerged Lands Act 1973 - Australian Maritime Boundaries 2014a - Geodatabase (2017). Australia: GeoScience Australia. Available at: https://data.gov.au/data/dataset/fc18ec3e-9d01-4cd4-8975-9f91bd879f47.

Song, L. and Mosses, M. (2018) Revisiting ocean boundary disputes in the South Pacific in light of the South China Sea arbitration: a legal perspective, *The International Journal of Marine and Coastal Law*, 33, pp. 768-798. doi: 10.1163/15718085-12333079.

Storey, D. (2015) Territoriality: geographical, in *International encyclopedia of social and behavioral sciences.* 2nd edn. Oxford: Elsevier, pp. 221-226.

Storlazzi, C. D., Elias, E. P. L. and Berkowitz, P. (2015) Many atolls may be uninhabitable within decades due to climate change, *Scientific Reports*, 5(14546). doi: 10.1038/srep14546.

Storlazzi, C. D., Gingerich, S. B., van Dongeren, A., Cheriton, O. M., Swarzenski, P. W., Quataert, E., Voss, C. I., Field, D. W., Annamalai, H., Piniak, G. A. and McCall, R. (2018) Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding, *Science Advances*, 4(4). doi: 10.1126/sciadv.aap9741.

Symmons, C. R. (1998) Ireland and the Rockall dispute: an analyis of recent developments, *Boundary & Security Bulletins* 6(1), pp. 78-93. Available at: http://www.andywightman.com/docs/symmons_rockall.pdf.

Thatcher, J., Bergmann, L., Ricker, B., Rose-Redwood, R., O'Sullivan, D., Barnes, T. J., Barnesmoore, L. R., Beltz Imaoka, L., Burns, R., Cinnamon, J., Dalton, C. M., Davis, C., Dunn, S., Harvey, F., Jung, J.-K., Kersten, E., Knigge, L., Lally, N., Lin, W., Mahmoudi, D., Martin, M., Payne, W., Sheikh, A., Shelton, T., Sheppard, E., Strother, C. W., Tarr, A., Wilson, M. W. and Young, J. C. (2016) Revisiting critical GIS, *Environment and Planning*, 48(5), pp. 815-824. doi: 10.1177/0308518X15622208.

Trahanas, C. (2013) Recent developments in the maritime boundaries and maritime zones of the Pacific, *Australian Yearbook of International Law*, 31, pp. 41-74.

UN News (2019) *UN chief outlines 'intertwined challenges' of climate change, ocean health facing Pacific nations on the 'frontline'*. Available at: https://news.un.org/en/story/2019/05/1038521 (Accessed: 01.01.2020).

United Nations Convention on the Law of the Sea (1982) *United Nations Treaty Series*. Available at: https://treaties.un.org/doc/Publication/UNTS/Volume%201833/v1833.pdf.

van der Heijden, K. (1997) *Scenarios: the art of strategic conversation*. 1 edn. New York: Wiley.

van Vuuren, D. P., Riahi, K., Moss, R., Edmonds, J., Thomson, A., Nakicenovic, N., Kram, T., Berkhout, F., Swart, R., Janetos, A., Rose, S. K. and Arnell, N. (2012) A proposal for a new scenario framework to support research and assessment in different climate research communities, *Global Environmental Change*, 22(1), pp. 21-35. doi: 10.1016/j.gloenvcha.2011.08.002.

van Vuuren, D. P. and Carter, T. R. (2014) Climate and socio-economic scenarios for climate change research and assessment: reconciling the new with the old, *Climatic Change*, 122(3), pp. 415-429. doi: 10.1007/s10584-013-0974-2.

van Woesik, R., Golbuu, Y. and Roff, G. (2015) Keep up or drown: adjustment of western Pacific coral reefs to sea-level rise in the 21st century, *Royal Society open science*, 2(7), pp. 1-8. doi: 10.1098/rsos.150181.

Vidas, D. (2014) Sea-level rise and international law: at the convergence of two epochs, *Climate Law*, 4(1-2), pp. 70-84. doi: 10.1163/18786561-00402006.

Vidas, D., Freestone, D. and McAdam, J. (2015) International law and sea level rise: the new ILA committee, *ILSA Journal of International & Comparative Law*, 21(2), pp. 397-408. Available at: https://nsuworks.nova.edu/ilsajournal/vol21/iss2/9.

Watt, D. C. (1979) First steps in the enclosure of the oceans: The origins of Truman's proclamation on the resources of the continental shelf, 28 September 1945, *Marine Policy*, 3(3), pp. 211-224. doi: 10.1016/0308-597X(79)90053-8.

Webb, A. (2016) A preliminary assessment of jurisdictional baseline feature vulnerability to climate change and sea level rise in the Tropical Pacific Island Region, *University of Wollongong*. doi: 10.13140/RG.2.2.11324.69767.

Webb, A. P. and Kench, P. S. (2010) The dynamic response of reef islands to sea-level rise: evidence from multi-decadal analysis of island change in the Central Pacific, *Global Planetary Change*, 72(3), pp. 234-246. doi: 10.1016/j.gloplacha.2010.05.003.

Webb, J. (2020) Kiribati economic survey: Oceans of opportunity, *Asia & the Pacific Policy Studies*, 7(1), pp. 5-26. doi: 10.1002/app5.297.

Westerveld, L. (2017) Those who did not cross. Norway: Vision Carto. Available at: https://visionscarto.net/those-who-did-not-cross (Accessed: 01.01.2020).

Westerveld, L. and Knowles, A. K. (2018) I was there. Norway: Vision Carto. Available at: https://visionscarto.net/i-was-there (Accessed: 01.01.2020).

Westerveld, L. and Knowles, A., K. (*forthcoming*) Loosening the grid: topology as the basis for a more inclusive GIS, *International Journal of Geographical Information Science*

Yapa, L. (1998) Why GIS needs postmodern social theory, and vice versa, in Taylor, F. (ed.) *Policy issues in modern cartography.* Academic Press, pp. 249-269. doi: 10.1016/S1363-0814(98)80015-4.

Yeeting, A. D., Weikard, H.-P., Bailey, M., Ram-Bidesi, V. and Bush, S. R. (2017) Stabilising cooperation through pragmatic tolerance: the case of the Parties to the Nauru Agreement (PNA) tuna fishery, *Regional environmental change*, 18(3), pp. 885-897. doi: 10.1007/s10113-017-1219-0.

8. Appendices

8.1. Questionnaire

Please note that the interview questions were only used as a guide. In general, each interview included some unique questions based for example on answers given to previous questions by the interviewee. Some questions were skipped if they were already covered previously, or if they did feel adequate or relevant for a specific interview. Several sub-questions often emerged based on answers given, and/or the particular affiliation and work area of an interviewee.

DATE:

INTRODUCTION (read):

Hello, my name is Levi Westerveld, and as you know I have been helping to run the GIS training during this maritime boundaries workshop. As I explained on the first day, I am also a master student at the University of Bergen (in Norway) conducting research on the effects of climate change on EEZ maritime boundaries in the Pacific region. Originally, I planned to assess the loss of EEZ area due to sea level rise projections for the region. However, I found out during the literature review for my research that there is disagreement amongst legal scholars on how maritime boundaries would react if baselines were submerged. Therefore, I decided to conduct interviews with you and other experts working in the Pacific and with knowledge of UNCLOS, to better understand that side of the question.

If you agree, I would like to record this interview with my phone so I can transcribe it later. The interview and the transcript will not be shared with anyone, but I will likely include quotes from this interview in my thesis. Please let me know if this ok with you. I will send you a copy of the master thesis once it is completed. If you prefer that I do not record this interview, I could also take notes instead.

Do not hesitate to let me know if there are questions that you prefer not to answer. Do you have questions before we start?

QUESTIONS:

- Can please state your name and title, and describe your work area and role, especially in the context of UNCLOS and this 11th Maritime Boundaries Workshop?

INTERVIEWEE NAME, TITLE & AFFILIATION:

- My first question concerns maritime boundaries in general: can you please describe what role they play in the Pacific and, if they are important, why?

- My second question regards UNCLOS specifically. From your perspective, can you please describe the relationship between UNCLOS and climate change? Does the Convention explicitly or implicitly address the issue of climate change?

- With regards to the 'legal strength' and resiliency of maritime boundaries, are boundaries deposited to DOALOS more resilient than provisional boundaries? How do these boundaries differ?

- With regards to the type of EEZ boundaries, they can either be high seas boundaries, or treaty boundaries (adjacent to another jurisdiction), do you think one or the other is more resilient from the a legal perspective? If so, why?

- With regards to article 121 of UNCLOS, which states that islands that cannot sustain human life cannot generate an EEZ area, do you think this will be an issue for EEZ areas in the Pacific if islands are submerged and inhabitants are forced to move?

- Recently, the Permanent Court of Arbitration ruled against China in the South China Sea Arbitration in case on whether built islands could generate EEZ areas. Are there any impacts of this arbitration on the Pacific?

- In a 2012, the International Law Association Committee on Baselines published a report which stated that based on its interpretation of UNCLOS, a baseline is ambulatory and may move landward in case of sea level rise, resulting in loss of maritime territory. What is your perspective on this argument? Has the law evolved on this issue? Are there any counter arguments to this claim?

- In the 2019, 50th Pacific Communique from Tuvalu, it was written that Leaders from the Pacific are committed to develop international law so that maritime zones (including EEZs) could not be challenged or reduced as a result of sea level rise and climate change. Are you aware of any steps taken to develop international law in this direction? What are possible outcomes? How could international law be developed?

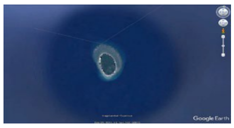
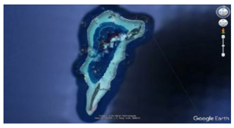
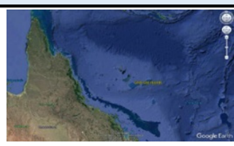
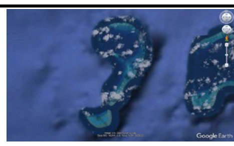
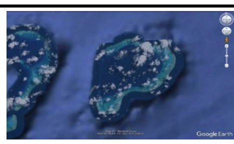
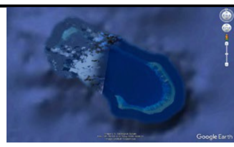
- With regards to the issue of climate change and maritime boundaries, how is the Pacific region engaging with this issue? Does your country/institution have a specific perspective on this issue?

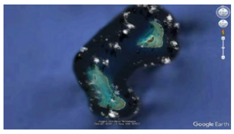
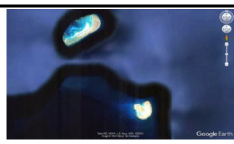
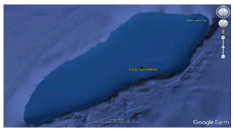
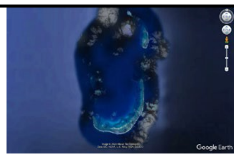
- If a baseline where submerged today, who could challenge the location of an EEZ boundary? How would this be done? Who would rule whether the EEZ boundary should move or not?

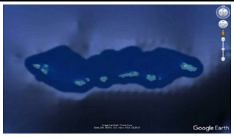
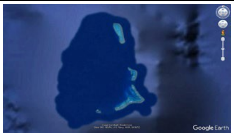
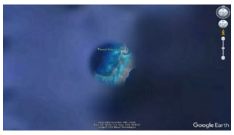
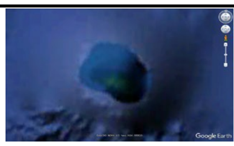
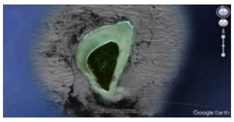
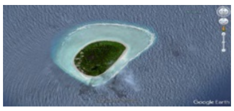
- Who would benefit from ambulatory baselines and the potential shrinking of EEZ areas in the Pacific due to sea level rise? Are they state actors or companies? Are there particular sectors (e.g. fisheries?)?

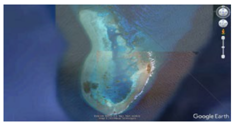
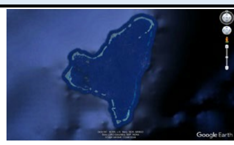
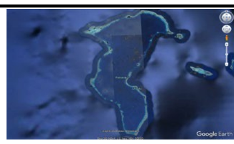
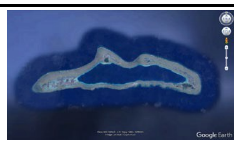
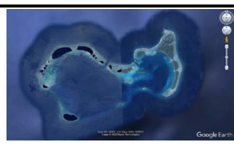
8.2. List of 'at-risk' features in the study region (cf. 3.3.2 Data Analysis)

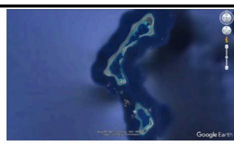
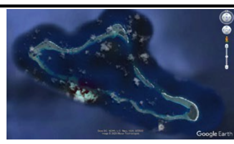
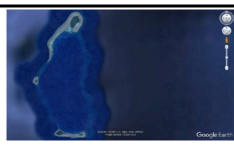
The table below includes a list of all at-risk features in the study region. At-risk features for adjacent jurisdictions are also included as these are used to determine potential changes to maritime boundaries and EEZ area and shape. This classification is based on Webb's (2016) preliminary assessment. For each feature, the corresponding jurisdiction name, the feature name, its position (latitude and longitude) and a screenshot image of the feature from Google Earth Pro is provided. Note that features are ordered by longitude. Features often have different names in different databases and are generally the result of a European approximation of a vernacular name, resulting in strange, possibly contested naming. Some feature names were updated based on feedback received during the review process.

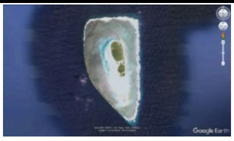
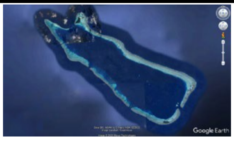
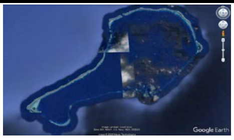
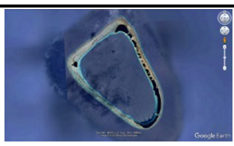
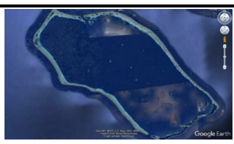
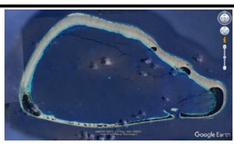
Jurisdiction	***Name***	***LAT***	***LONG***	***IMAGERY***
Indonesia	NA - west of Ayu Islands	0.530204	130.733239	
Indonesia	Ayu Islands	0.442491	131.087395	
Indonesia	Asia Islands (Pulau Miarin, Igi Island, Fani Island)	1.051105	131.255852	
Indonesia	Bras Island	0.873775	134.316651	
Indonesia	NA northwest of Pulau Bepondi	-0.208585	135.00992	
Indonesia	Pulau Bepondi	-0.40253	135.269637	
Australia	Great Barrier Reef	-16.7865	146.678428	
Australia	West Holmes Reef	-16.489751	147.851057	
Australia	East Holmes Reef	-16.4724	148.036039	
Australia	South Flinders Reef	-17.851141	148.492746	

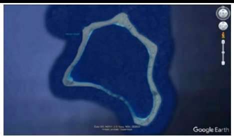
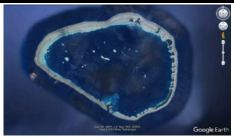
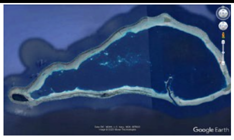
Australia	North Flinders Reef	-17.663175	148.5064	
Australia	Herald Cays and Herald's Surprise	-16.979644	149.164821	
Australia	Diane Bank	-15.724866	149.619758	
Australia	Chilcott and South West Islets	-16.942992	149.979354	
Australia	Willis Islets	-16.158258	150.001233	
Australia	Magdelaine Cays	-16.550684	150.301575	
Australia	Tregrosse Islets	-17.659701	150.829066	
Australia	Diamond Islets	-17.437177	151.014065	
Australia	Lihou Reef	-17.31298	151.841437	
Australia	Marion Reef	-19.1262	152.330519	
Australia	Saumarez Reef	-21.835291	153.680354	
Australia	Frederick Reefs	-20.997546	154.38288	

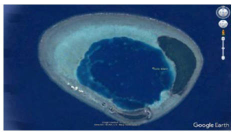
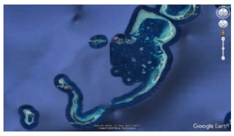
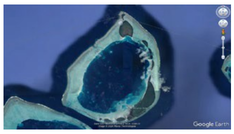
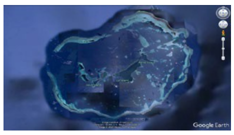
Australia	Wreck Reef	-22.191174	155.333246	
Australia	Cato Reef	-23.250889	155.548858	
Australia	Kenn Reef	-21.201351	155.761389	
Australia	Mellish Reef	-17.391788	155.861914	
Australia	Elizabeth Reef	-29.949489	159.071368	
Australia	Middleton Reef	-29.458488	159.10144	
Palau	Tobi Island	3.009446	131.12521	
Palau	Helen Reef	2.904896	131.788301	
Palau	Pulu Anna Island	4.656245	131.952109	
Palau	Sonsorol Island	5.327414	132.223691	
Palau	Fanna Island	5.355326	132.228044	

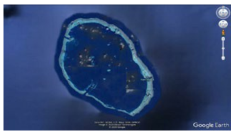
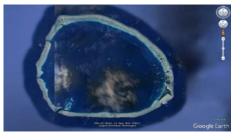
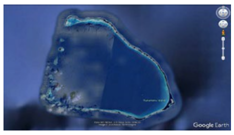
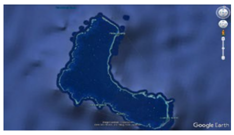
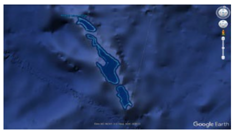
Palau	Merir Island	4.312522	132.311432	
Palau	Ngeruangel	8.173925	134.623101	
Palau	Kayangel Island	8.074448	134.71466	
Federated States of Micronesia	Ngulu Atoll	8.457635	137.476986	
Federated States of Micronesia	Ulithi Atoll	9.960729	139.662461	
Federated States of Micronesia	Falalop	10.018273	139.79452	
Federated States of Micronesia	Bulubul	9.922838	139.83309	
Federated States of Micronesia	Zohhoiiyoru Bank	9.86764	139.944099	
Federated States of Micronesia	Sorol Atoll	8.137444	140.379687	
Federated States of Micronesia	Eauripik Atoll	6.689793	143.04014	
Federated States of Micronesia	Woleai Atoll	7.353493	143.867017	

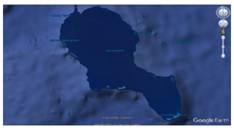
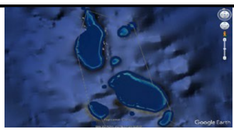
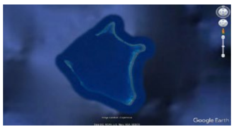
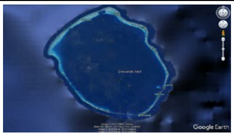
Federated States of Micronesia	Ifaluk Atoll	7.249564	144.449683	
Federated States of Micronesia	Faraulep Atoll	8.591927	144.512127	
Federated States of Micronesia	Garefut	9.228947	145.384452	
Federated States of Micronesia	Olimarao Atoll	7.691953	145.871129	
Federated States of Micronesia	Elato Atoll	7.468302	146.155886	
Federated States of Micronesia	Lamotrek Atoll	7.4887	146.327602	
Federated States of Micronesia	Piagailoe	8.077712	146.720738	
Federated States of Micronesia	Satawal	7.381512	147.033997	
Federated States of Micronesia	Pikelot	8.106734	147.652024	
Federated States of Micronesia	Pulusuk	6.805756	149.243595	
Federated States of Micronesia	Puluwat Atoll	7.311071	149.305641	
Federated States of Micronesia	Pulap Atoll	7.585724	149.421493	

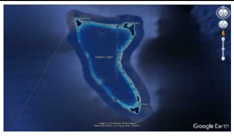
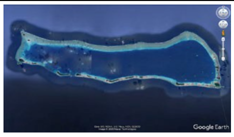
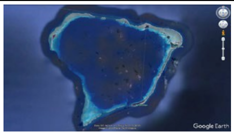
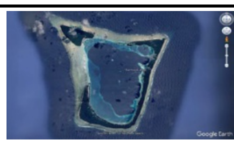
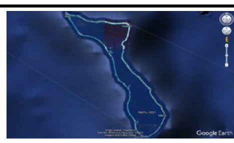
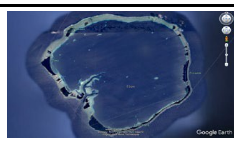
Federated States of Micronesia	Namonuito Atoll	8.697483	150.100098	
Federated States of Micronesia	Fayu	8.548712	151.339916	
Federated States of Micronesia	Nomwin Atoll	8.537562	151.788629	
Federated States of Micronesia	Fringing Reefs around Chuuk Lagoon	7.420537	151.797114	
Federated States of Micronesia	Neoch	7.055392	151.928784	
Federated States of Micronesia	Murilo Atoll	8.674826	152.197743	
Federated States of Micronesia	Nama	6.992528	152.576929	
Federated States of Micronesia	Losap Atoll	6.877838	152.700745	
Federated States of Micronesia	Namoluk Atoll	5.91488	153.137311	
Federated States of Micronesia	Etal Atoll	5.595475	153.564282	
Federated States of Micronesia	Satawan Atoll	5.408721	153.588768	
Federated States of Micronesia	Lukunor Atoll	5.526603	153.762687	

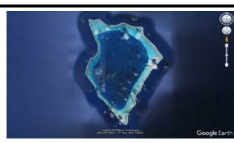
Federated States of Micronesia	Minto Reef	8.107122	154.283997	
Federated States of Micronesia	Kapingamarangi	1.075432	154.763848	
Federated States of Micronesia	Nukuoro Atoll	3.848567	154.943924	
Federated States of Micronesia	Oroluk Atoll	7.536502	155.297916	
Federated States of Micronesia	Ngatik	5.809965	157.2506	
Federated States of Micronesia	Pakin Atoll	7.060733	157.802918	
Federated States of Micronesia	Ant Atoll	6.783808	157.955789	
Federated States of Micronesia	Fringing reefs around Pohnpei	6.945948	158.21926	
Federated States of Micronesia	Mokil Atoll	6.682781	159.757548	
Federated States of Micronesia	Pingelap Atoll	6.217239	160.703469	
Papua New Guinea	Wuvulu Island	-1.737914	142.850503	

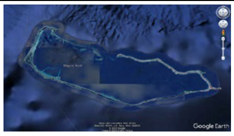
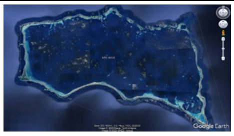
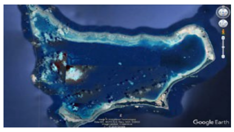
Papua New Guinea	Aua Island	-1.464641	143.060138	
Papua New Guinea	Manu Island	-1.310254	143.581174	
Papua New Guinea	Awin Island	-1.6499	144.026798	
Papua New Guinea	Sama Island	-1.394722	144.08352	
Papua New Guinea	Ninigo Group	-1.312764	144.242856	
Papua New Guinea	Pelleluhu Group	-1.129303	144.408651	
Papua New Guinea	Heina Group	-1.124811	144.512898	
Papua New Guinea	Liot Island	-1.407355	144.512898	
Papua New Guinea	Fringing Reefs around Luf et al.Islands	-1.543581	145.013694	
Papua New Guinea	Sae Island	-0.758155	145.305828	
Papua New Guinea	Suf Island	-0.884456	145.55489	
Papua New Guinea	Fringing Reefs around Manus Island	-2.001001	146.827277	

Papua New Guinea	Sumasuma Island	-1.471262	144.049937	
Papua New Guinea	Fringing Reef of Ressel Island	-11.448383	154.397282	
Papua New Guinea	Malum Atoll	-3.127427	154.464767	
Papua New Guinea	Nuguria Atoll	-3.377223	154.718046	
Papua New Guinea	Carteret Islands	-4.760117	155.430296	
Papua New Guinea	Nugugurigia Atoll	-4.761808	157.029803	
Papua New Guinea	Nukumanu Island	-4.559023	159.459069	
Solomon Islands	Ontong Java	-5.396103	159.516728	
Solomon Islands	Rennell Island Ridge	-12.617004	160.332553	
Solomon Islands	Sikaiana	-8.407037	162.926228	
New Caledonia	Avon Atoll and Reefs	-19.403352	158.584124	

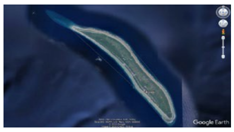
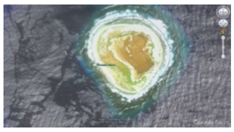
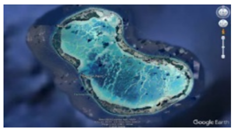
New Caledonia	Bellona Reefs	-21.442276	159.144487	
New Caledonia	Reefs north of Belep islands	-18.263125	163.051325	
New Caledonia	Unnamed north east reef	-18.547122	164.421478	
New Caledonia	New Caledonia's fringing reefs	-20.741705	164.815644	
New Caledonia	Astrolabe Reefs	-19.825301	165.637555	
New Caledonia	Ile Beautemps Beaupre	-20.345418	166.170566	
New Caledonia	Reefs only of Foyaoue	-20.528358	166.330381	
Marshall Islands	Ujelang Atoll	9.824112	160.893576	
Marshall Islands	Enewetak Atoll	11.530179	162.222539	
Marshall Islands	Bikini Atoll	11.613403	165.38886	
Marshall Islands	Ujae Atoll	9.073697	165.641261	

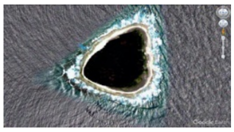
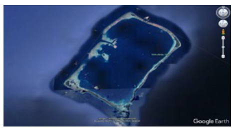
Marshall Islands	Wotho Atoll	10.112138	165.979123	
Marshall Islands	Lae Atoll	8.939023	166.241629	
Marshall Islands	Ailinginae Atoll	11.147517	166.417685	
Marshall Islands	Rongelap Atoll	11.375729	166.828907	
Marshall Islands	Rongerik Atoll	11.375729	166.828907	
Marshall Islands	Kwajalein Atoll	9.157222	167.374469	
Marshall Islands	Lib Island	8.313772	167.379665	
Marshall Islands	Namorik Atoll	5.618197	168.111026	
Marshall Islands	Namu Atoll	8.014574	168.153697	
Marshall Islands	Ebon Atoll	4.633138	168.70193	
Marshall Islands	Ailinglaplap Atoll	7.437317	168.766079	
Marshall Islands	Taongi Atoll	14.655398	168.964339	

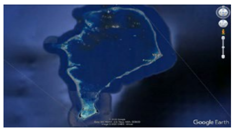
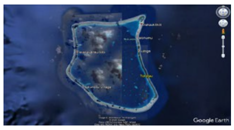
Marshall Islands	Jabat Island	7.752745	168.977231	
Marshall Islands	Kili Island	5.642968	169.119965	
Marshall Islands	Likiep Atoll	9.923914	169.148751	
Marshall Islands	Jaluit Atoll	6.067453	169.518347	
Marshall Islands	Jemo Island	10.079653	169.525239	
Marshall Islands	Taka Atoll	11.163938	169.62303	
Marshall Islands	Utrik Atoll	11.258834	169.791211	
Marshall Islands	Ailuk Atoll	10.343072	169.943565	
Marshall Islands	Erikub Atoll	9.138618	170.01773	
Marshall Islands	Wotje Atoll	9.469737	170.039682	
Marshall Islands	Bikar Atoll	12.245147	170.106681	
Marshall Islands	Mejit Island	10.28745	170.869937	

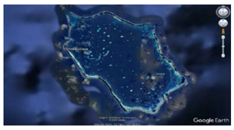
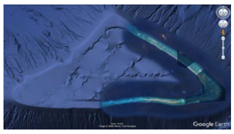
Marshall Islands	Maloelap Atoll	8.740825	171.055687	
Marshall Islands	Aur Atoll	8.250074	171.108491	
Marshall Islands	Majuro Atoll	7.132813	171.169294	
Marshall Islands	Arno Atoll	7.119502	171.696716	
Marshall Islands	Mili and Knox Atolls	6.098105	171.965942	
Wake Island	Wake Island	19.295134	166.6371	
Howland and Baker Islands	Howland Island	0.807415	183.382529	
Howland and Baker Islands	Baker Island	0.194811	183.52186	
Kiribati (Gilbert)	Makin Island	3.354496	172.988066	
Kiribati (Gilbert)	Butaritari Atoll	3.133151	172.82914	
Kiribati (Gilbert)	Abaiang Island	1.843523	172.940682	

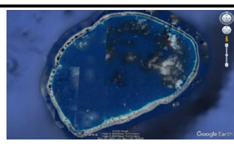
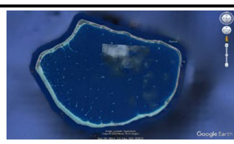
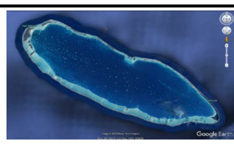
Kiribati (Gilbert)	Tarawa Atoll	1.465367	173.047704	
Kiribati (Gilbert)	Marakei Island	2.012004	173.27768	
Kiribati (Gilbert)	Maiana Atoll	0.934875	173.021911	
Kiribati (Gilbert)	Kuria Island	0.230649	173.416787	
Kiribati (Gilbert)	Aranuka Island	0.167188	173.596031	
Kiribati (Gilbert)	Abemama Island	0.403724	173.867461	
Kiribati (Gilbert)	Nonouti Island	-0.663273	174.372766	
Kiribati (Gilbert)	Tabiteuea Atoll	-1.307858	174.855992	
Kiribati (Gilbert)	Onotoa Atoll	-1.86751	175.569592	
Kiribati (Gilbert)	Beru Atoll	-1.324018	175.988586	
Kiribati (Gilbert)	Tamana Island	-2.499249	175.982423	
Kiribati (Gilbert)	Nikunau Island	-1.352357	176.448922	

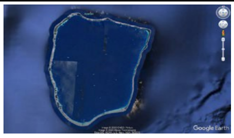
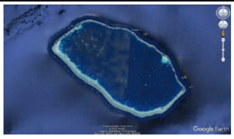
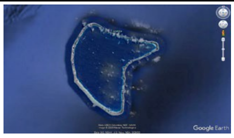
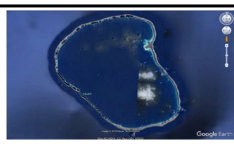
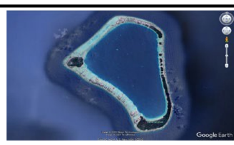
Kiribati (Gilbert)	Arorae Island	-2.64128	176.821634	
Kiribati (Phoenix)	Nikumaroro Island	-4.675118	-174.520014	
Kiribati (Phoenix)	Mackean Island	-3.595272	-174.122822	
Kiribati (Phoenix)	Hull Island	-4.514505	-172.181329	
Kiribati (Phoenix)	Kanton Island	-2.81467	-171.670578	
Kiribati (Phoenix)	Birnie Island	-3.584879	-171.517205	
Kiribati (Phoenix)	Manra Island	-4.454289	-171.244444	
Kiribati (Phoenix)	Enderbury Island	-3.126608	-171.084504	
Kiribati (Phoenix)	Rawaki Island	-3.721244	-170.711908	
Kiribati (Line)	Washington Island	4.683698	-160.37977	
Kiribati (Line)	Tabuaeran Atoll	3.86949	-159.31694	
Kiribati (Line)	Kiritimati Atoll	1.860746	-157.358258	

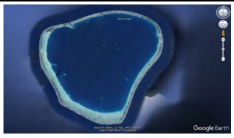
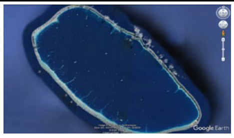
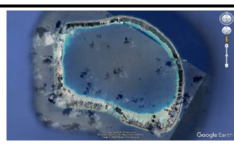
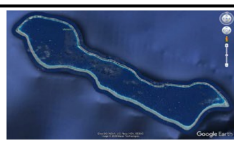
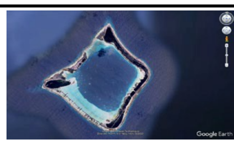
Kiribati (Line)	Starbuck Island	-5.640865	-155.883911	
Kiribati (Line)	Malden Island	-4.018207	-154.929942	
Kiribati (Line)	Flint Island	-11.429069	-151.819123	
Kiribati (Line)	Long Island	-9.956808	-150.213071	
Kiribati (Line)	Vostok Island	-10.062997	-152.311094	
Tuvalu	Nanumea Atoll	-5.669841	176.107347	
Tuvalu	Nanumanga	-6.288659	176.320769	
Tuvalu	Nui Atoll	-7.223643	177.155527	
Tuvalu	Niutao	-6.108786	177.342793	
Tuvalu	Nukufetau Atoll	-8.015914	178.378706	
Tuvalu	Vaitupu Island	-7.479731	178.680033	

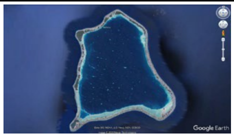
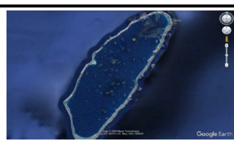
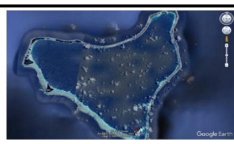
Tuvalu	Funafuti Atoll	-8.541426	179.143628	
Tuvalu	Niulakita Island	-10.789013	179.473099	
Tuvalu	Nukulaelae Atoll	-9.391121	179.843541	
Fiji	Ceva-i-ra Atoll	-21.73769	174.639745	
Fiji	Tuvana Atoll	-21.036973	-178.847147	
Fiji	East of Tuvana Atoll	-21.012316	-178.750179	
Tokelau	Atafu Atoll	-8.558104	187.50614	
Tokelau	Nukunonu Atoll	-9.168578	188.18228	
Tokelau	Fakaofo Atoll	-9.374885	188.780332	
American Samoa	Swains Atoll	-11.055918	188.92149	
American Samoa	Rose Atoll	-14.544645	191.853599	

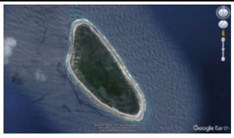
Cook Islands	Pukapuka Atoll	-10.883512	194.155193	
Cook Islands	Nassau Island	-11.560797	194.585399	
Cook Islands	Suwarrow Atoll	-13.2499	196.873181	
Cook Islands	Palmerston Atoll	-18.041945	196.842989	
Cook Islands	Rakahanga	-10.016936	198.907813	
Cook Islands	Manihiki Island	-10.41625	199.000557	
Cook Islands	Penrhyn Atoll	-8.987744	202.018971	
Kingman Reef and Palmyra Atoll	Kingman Reef	6.401021	197.637959	
Kingman Reef and Palmyra Atoll	Palmyra Atoll	5.881698	197.92617	
Jarvis Island	Jarvis Island	-0.373337	200.003412	

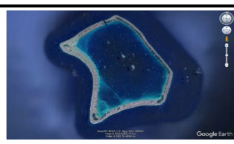
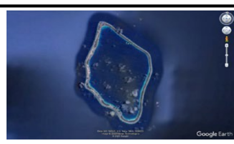
French Polynesia	Maria Island	-21.809536	205.294067	
French Polynesia	Scilly Atoll	-16.542274	205.317945	
French Polynesia	Motu One	-15.815492	205.474538	
French Polynesia	Maupiha'a	-16.816037	206.042683	
French Polynesia	Tupai	-16.262708	208.182222	
French Polynesia	Tetiaroa Atoll	-17.011347	210.438782	
French Polynesia	Mataiva Atoll	-14.883846	211.326917	
French Polynesia	Tikehau Atoll	-15.019247	211.826266	
French Polynesia	Rangiroa Atoll	-15.161679	212.404801	
French Polynesia	Arutua Atoll	-15.318039	213.235192	
French Polynesia	Kaukura Atoll	-15.752302	213.306838	
French Polynesia	Niau	-16.155654	213.645914	

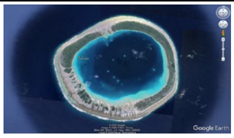
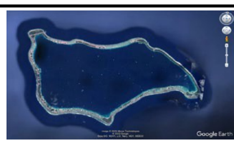
French Polynesia	Apataki Atoll	-15.45622	213.661302	
French Polynesia	Ahe Atoll	-14.493374	213.680549	
French Polynesia	Toau Atoll	-15.937667	213.952002	
French Polynesia	Manihi Atoll	-14.399804	214.045324	
French Polynesia	Fakarava Atoll	-16.326666	214.364839	
French Polynesia	Aratika Atoll	-15.541027	214.476185	
French Polynesia	Anaa Atoll	-17.410539	214.50057	
French Polynesia	Faaite Atoll	-16.758186	214.760202	
French Polynesia	Takapoto Atoll	-14.624267	214.797751	
French Polynesia	Kauehi Atoll	-15.871638	214.855994	
French Polynesia	Takaroa Atoll	-14.449199	215.033626	
French Polynesia	Hereheretue Atoll	-19.87088	215.038359	

French Polynesia	Raraka Atoll	-16.182518	215.101334	
French Polynesia	Tahanea Atoll	-16.900927	215.213287	
French Polynesia	Taiaro Atoll	-15.74319	215.36765	
French Polynesia	Tikei Island	-14.950295	215.452612	
French Polynesia	Motutunga Atoll	-17.105963	215.632967	
French Polynesia	Katiu Atoll	-16.432534	215.6381	
French Polynesia	Tepoto Atoll	-16.822099	215.718758	
French Polynesia	Tuanake Atoll	-16.657759	215.783445	
French Polynesia	Hiti Atoll	-16.729215	215.902501	
French Polynesia	Makemo Atoll	-16.609788	216.308617	
French Polynesia	Anuanuaro Atoll	-20.43667	216.462352	
French Polynesia	Haraiki Atoll	-17.465823	216.548589	

French Polynesia	Anuanuruga Atoll	-20.614961	216.713507	
French Polynesia	Marutea Nord Atoll	-17.035767	216.832829	
French Polynesia	Taenga Atoll	-16.356187	216.875379	
French Polynesia	Reitoru Atoll	-17.85835	216.924591	
French Polynesia	Nukutipipi Atoll	-20.700878	216.94646	
French Polynesia	Nihiru Atoll	-16.695842	217.165422	
French Polynesia	Hikueru Atoll	-17.589101	217.38545	
French Polynesia	Tekokota Atoll	-17.310387	217.423928	
French Polynesia	Raroia Atoll	-16.086997	217.582972	
French Polynesia	Marokau Atoll	-18.053905	217.722899	
French Polynesia	Takume Atoll	-15.802375	217.797027	
French Polynesia	Ravahere Atoll	-18.238436	217.842155	

French Polynesia	Tehuata Atoll	-16.835433	218.078058	
French Polynesia	Negonego Atoll	-18.758049	218.183697	
French Polynesia	Tauere Atoll	-17.379874	218.493167	
French Polynesia	Tepoto Nord Island	-14.101713	218.570966	
French Polynesia	Manuhangi Atoll	-19.201929	218.755373	
French Polynesia	Napuka Atoll	-14.173647	218.771526	
French Polynesia	Haorangi Atoll	-18.2631	219.121623	
French Polynesia	Fangatau Atoll	-15.823761	219.1365	
French Polynesia	Amanu Atoll	-17.810958	219.235206	
French Polynesia	Paraoa Atoll	-19.134191	219.309947	
French Polynesia	Tematagi Atoll	-21.680559	219.371815	
French Polynesia	Ahunui Atoll	-19.637151	219.59015	

French Polynesia	Fakahina Atoll	-15.985328	219.867176	
French Polynesia	Vairaatea Atoll	-19.34978	220.77623	
French Polynesia	Akiaki Atoll	-18.557666	220.787943	
French Polynesia	Vanavana Atoll	-20.781147	220.858663	
French Polynesia	Mururoa Atoll	-21.852472	221.090805	
French Polynesia	Vahitahi Atoll	-18.774576	221.177812	
French Polynesia	Pukapuka Atoll	-14.819497	221.182103	
French Polynesia	Nukutavake	-19.280462	221.215741	
French Polynesia	Fangataufa Atoll	-22.241995	221.252099	
French Polynesia	Pinaki	-19.395979	221.323868	
French Polynesia	Tureia Atoll	-20.828452	221.459897	
French Polynesia	Tatakoto Atoll	-17.342649	221.6054	

French Polynesia	Morane Atoll	-23.157553	222.867477	
French Polynesia	Pukaruha Atoll	-18.316561	222.982423	
French Polynesia	Tenararo Atoll	-21.305241	223.25387	
French Polynesia	Vahaga Atoll	-21.331805	223.348279	
French Polynesia	Tenaruga Atoll	-21.344366	223.457956	
French Polynesia	Maturei Vavao Atoll	-21.472524	223.605079	
French Polynesia	Reao Atoll	-18.523585	223.629989	
French Polynesia	Maria Atoll	-22.014874	223.809774	
French Polynesia	Marutea Atoll	-21.519008	224.439766	
French Polynesia	Temoe Atoll	-23.346031	225.520142	
Pitcairn Islands	Oneo Island	-23.927985	229.260288	

Pitcairn Islands	Ducie Island	-24.678012	235.21702	

8.3. Aggregated proportional results for change in EEZ area

Table showing the aggregated results in percentage change from original EEZ area for all scenarios in all 20 jurisdictions of the study region. For each scenario, the percentage change value for jurisdictions that experience a net gain in EEZ areas is shown in blue, whilst net decrease is shown in red. Jurisdictions are ordered by longitude (west to east).

Jurisdiction	***Current EEZ area (000 km²)***	***Scenario 1 change***	***Scenario 2 change***	***Scenario 3 change***
Palau	615	-31.66%	-31.66%	-27.06%
Federated States of Micronesia	3 011	0	+4.38%	-38.59%
Papua New Guinea	2 400	0	0	-11.61%
Solomon Islands	1 605	-3.12%	-3.12%	-1.30%
New Caledonia	1 176	-2.96%	-2.96%	-37.75%
Marshall Islands	2 001	0	**-100%**	**-100%**
Vanuatu	623	+8.95%	+8.95%	+7.44%
Nauru	309	0	+5.32%	+5.32%
Kiribati	3 441	0	+0.33%	-90.63%
Matthew and Hunter Islands	188	0	0	+56.79%
Tuvalu	753	0	**-100%**	**-100%**
Fiji	1 289	-1.94%	+5.43%	-8.25%
Wallis and Futuna	263	0	+17.45%	+17.45%
Tonga	666	+0.16%	+0.16%	+0.16%
Tokelau	321	-5.52%	**-100%**	**-100%**
Samoa	130	+60.80%	+59.88%	+59.95%
American Samoa	406	-15.19%	-15.19%	-23.93%

Niue	318	0	0	+4.08%
Cook Islands	1 970	0	0	-59.31%
French Polynesia	4 767	0	0	-32.73%
TOTAL	**26 251**	**-0.94%**	**-11.45%**	**-41.48%**